Maharashtra Genebank Programme

A multi-institutional project funded by

Rajiv Gandhi Science & Technology Commission, Govt. of Maharashtra

Project Progress Report 2014-2020

Volume - I

महाराष्ट्र जनुक कोश

IISER PUNE

Coordinated by
Indian Institute of Science Education and Research Pune

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Preface

It is my pleasure to present the consolidated report of the project Maharashtra Gene Bank Programme funded by Rajiv Gandhi Science and Technology Commission, Govt. of Maharashtra.

My association with the project started only from May 2019, after the erstwhile Project Coordinator, Prof. Milind Watve, decided to resign from IISER Pune and RGSTC requested IISER Pune to continue the project with an alternative arrangement to take the project to a logical conclusion. I am thankful to Director, IISER Pune and RGSTC for reposing confidence in me and assigning this responsibility. I am thankful to the Principle Investigators of the collaborating institutes / organisations for accepting this arrangement and cooperating with me. By this time, the first 5-year tenure of the project was completed and extension of one year was already sanctioned by RGSTC and was in progress. My job was made easier because the reporting formats were put in place by the previous coordinator and reports up to October 2018 were already available. Shri Girish Sohani and Smt. Rajashree Joshi from BAIF provided their wise counsel to me, and also agreed to anchor some of the activities during the extension period, to make me comfortable in handling this mega project.

The major thrust during 2019-20 was on building up a searchable database using the data generated during the previous five years by all the collaborating institutes. This involved several levels of consultation and discussion at multiple levels to generate formats for the data that are compatible for a database structure. Dr. Madhav Gadgil, Dr. Vijay Edlabadkar, along with Dr. Madhura Niphadkar, Dr. Prashant Hedao, Shri Ravikant Patil and Shri Yogesh Karyakarte (BAIF) ensured that the basic database is ready in a record time. More improvements in database are being made in the coming months.

It was envisaged that from April 2020 we will conduct a series of workshops at IISER Pune for finalizing the report. However, the unanticipated lockdown conditions due to the outbreak of COVID 19 pandemic, have thwarted all our efforts in that direction. Even after one year, the situation is no way near normal and physical meetings are not yet feasible. The report has been compiled with the limitation imposed through virtual meetings. I thank all the PIs for bearing with my frequent phone calls and video calls for clarifications regarding the contents of the report.

I would also like to place on record the valuable contribution of the coordination team and other project staff at IISER Pune, viz. Dr. Alok Bang, Dr. Ulfat Baig, Dr. Neelesh Dahanukar, Dr. Harshada Dube, Ms. Ojas S.V., and Ms. Anagha Pund for their help in compiling the reports. I would also like to thank the Grants office led by Dr. Vandana Gambhir, the finance team headed by CA Ms. Vasundhara Laad and Registrar, Col. G. Raja Sekhar (Retd.) for their cooperation in managing this project with diverse organisations. My particular thanks are due to Ms. Savita Mapari and Ms. Trupti Bhingarkar for their valuable administrative support during the entire project tenure.

The members of the Monitoring Committee and the Mid-term Review Committee had contributed immensely in shaping the progress of the project through their suggestions. I sincerely thank them. And fianlly, I would like to place on record the continuous advice and encouragement provided by Dr. Madhav Gadgil, Chairman EC, MGB project and Dr. Anil Kakodkar, Chairman RGSTC; Dr. A.B. Sapre and Shri A.S. Manekar, past and present Member Secretaries of RGSTC and other officials of RGSTC.

Vsprakasa Rao

(V.S. Rao)
MGB Coordinator

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Volume -I

SUMMARY REPORT

Maharashtra Gene Bank Project

A project financed by Rajiv Gandhi Science and Technology Commission, Govt. of Maharashtra

Key words: Biodiversity, genetic resources, agro biodiversity, marine biodiversity, freshwater biodiversity, grasslands biodiversity, livestock, forest biodiversity, bio- prospecting, informatics, Community led initiatives, *Ex- Situ* and *In -Situ* conservation pilots across Maharashtra

I. Premable

The Rajiv Gandhi Science and Technology Commission (RGSTC) of Maharashtra Government, had invited Dr. Madhav Gadgil to prepare a program on Gene Bank for Maharashtra in the year 2006.

Extensive consultations with the Government agencies like NBPGR, NBAGR, NBFGR, and Agricultural Universities etc. were held to crystallize the ideas and to avoid duplication of ongoing conservation efforts. It was decided that the Maharahstra Gene Bank Project would take a broader view and design a live gene bank with both in situ and ex situ components. This was followed by state-wide consultations with various stake holders to finalize the approach and themes.

The comprehensive, face to face consultations that have followed have taken the form of 122 events held in 24 districts and involving the representatives from all the 35 districts. Based on these above discussions and consultations Dr. Madhav Gadgil submitted to RGSTC a project proposal with 9 projects and 26 subprojects in 2009.

In 2011, Dr. Anil Kakodkar, Chairman of RGSTC, took active steps to roll out this project. It was decided that the project will be coordinated by IISER Pune. Since there has been a long gap after the submission of the project, the entire project was revised and resubmitted to RGSTC. RGSTC approved and sanctioned the project in January 2014.

MGB is a collaborative process of knowledge generation, documentation, validation and propagation of successful community-driven practices of conservation of biodiversity. The project is coordinated by IISER Pune, involving 3 national R & D institutes, 2 Academic Institutions and 15 dedicated NGOs, of which two are pan-India organisations, that help facilitating a reach-out to the people involved in conservation activities. The project was initially sanctioned for 5 years, i.e. up to March 2019. After a couple of extensions, during the Covid 19 pandemic, the project came to a conclusion on 31 December 2020. A consolidated report of each of the organisations is included in this compilation.

The program has identified the following seven major thematic areas:

1. Ex situ conservation of marine biodiversity
2. On farm conservation of crop genetic diversity
3. On farm conservation of livestock genetic diversity
4. Conservation and sustainable use of indigenous fish and shellfish diversity in selected water bodies
5. Conservation of grassland and savanna biodiversity
6. Eco restoration of community forest resource lands employing a diversity of life sustaining and economic plant species
7. Participatory management of relevant information

II. Objectives

1. Documentation of biodiversity, traditional wisdom, and conservation practices adopted by communities in different ecosystems and eco-zones in Maharashtra
2. Validation and upholding of successful conservation practices by observations, experimentations, data collection and analysis

3. Propagation of these successful practices by communication and intervention at the academic, policy and societal level, from the regional to the international scale.

4. To sustain our rich heritage of biodiversity resources on a long term basis to be able to address the issue of climate change related vulnerability and food and nutrition insecurity.

Except for 6 districts, viz. Buldana, Yavatmal, Wardha, Nagpur, Raigad and Thane, each of the districts of Maharashtra is covered by one or more of the thematic areas of the project.

III. Salient Features of the project

i. **Cross-institutional process:** The uniqueness of MGBP lies in the fact that it brought together several grass-root workers and social scientists, and marginalised communities together towards achieving a common goal of conservation of biodiversity.

ii. **Inter-disciplinary process:** Although the eight thematic areas are distinct from each other, the dialogue has resulted in beginning syntheses about broad questions and ideas cutting across themes.

iii. **Scientific validation:** Using the modern scientific methodology to separate the chaff from the grain from the massive pool of traditional Indian wisdom has been a significant achievement.

iv. **Documentation of local knowledge and biodiversity related wisdom of communities and preparation of Peoples Biodiversity Registers (PBR):** The project could help documenting vast traditional knowledge resource that local communities have on their surrounding biodiversity. In many villages, such knowledge could be compiled in the form of People's Biodiversity Registers.

v. **Scouting and introduction of crop cultivars and livestock breeds for better adaptation to climate change and variability:** Number of local crop types and local livestock breeds were seen performing better during climatic variability in many project clusters. These genotypes could be focussed and conserved in respective agro-climatic zones to help reduce vulnerability of farming communities. This is proving as an important strategy for building resilience of local tribal communities.

vi. **Demonstrating solutions to ensure food and nutritional security for marginalized communities**

The project has helped in documenting many local vegetables and crops which are on the verge of extinction and which once served as a rich resource for food security. Local crop and vegetable based traditional recipes and related knowledge has also been documented and being transferred to the next generation. The project could demonstrate how food and nutritional security can be achieved by introducing perennial and seasonal vegetable crops through kitchen gardens.

vii. **Creating a model of community-led conservation in India**

The project has helped strengthening many local level institutions in the form of Village Biodiversity Committee/Seed Savers groups, fishing communities, Breeders Association, Self Help Groups, Farmer's collectives, User Groups and Gram Sabhas. The project could demonstrate how community led actions for conservation and management of biodiversity is possible and effective. The project has helped creating a field evidence of model focusing on participatory and collaborative actions to facilitate long-term conservation of diverse, native bio-resources. The success of MGBP will serve as a model to be implemented in other states of India.

viii. **Contribution to and alignment with the State and National Level Policies and Programs:**

1. Dialogue could be established with Maharashtra State Biodiversity Board. The People's Biodiversity Registers could be prepared for nearly 25 Project villages. Partners could facilitate

village level meetings with the BMCs. A strategy note is also submitted to Maharashtra State Biodiversity Board (MSBB, Nagpur) on the theme of "Biodiversity Conservation Augmentation through Government/Non-government Projects and Programs with Special Emphasis on Cultivar Diversity Conservation " to mobilise funds through CSRs.

2. As a strategy, linkages have been established with Protection of Plant Variety & Farmers Rights Authority, New Delhi and 54 landraces have been registered under PPVFR Act, while 74 cultivars have been registered with NBPGR as IC numbers.

3. As a result of the work on Grassland diversity conservation, the Govt. of Maharashtra has constituted a joint Working group of Animal husbandry and Forestry Departments for giving recommendations for Grassland development. (जा.क्र. वैवि.अ. 6(20))/2084-85/ प. स. 14 दि. 22-10-2020.) which has One of the PIs of the Grassland diversity program, Shri Kaustubh Pandharipande as member. Shri Pandharipande has also been invited to submit a plan for a grassland development plan with community participation under CAMPA programme of Maharashtra Forest department (क्रमांक. कक्ष/कम्पा/प्र.क्रा. 47/2020-21/500 दि. 2-2-2021.

4. Work could be presented and shared on national and state level and to state Agriculture Universities, KVKs, Botany Department of Universities, Line Departments of government which could help getting better partnerships.

ix. Facilitated inputs from experts and collaborations with scientific & government Institutes

Project could benefit from the inputs from experts of various premier scientific and research organizations like, PPVFRA Authority, NBPGR, NBAGR, SAU of many states, KVKs etc. and peer reviewers.

IV. Thematic Highlights

1. Inventory and bio-prospecting of Marine Invertebrates of the Maharashtra Coast with special emphasis on Sponges and Associated Microorganisms

Participating Institutes: IISER Pune, CSIR-NIO, CoF, Ratnagiri, and NCCS Pune

Rationale for the study

Marine ecosystems are rich in floral and faunal diversity with exceptional bio-medical potential. India's on-going efforts to explore, document, conserve and utilize its natural wealth of biological resources; however, falls short of understanding true potential of marine capital. With the only exception of fish and other edible species, marine organisms, especially invertebrates, are relatively neglected. Marine invertebrates and associated microorganisms are known to produce a variety of novel secondary metabolites as defense mechanisms against predators and pathogens, which are hitherto not isolated from terrestrial ecosystems. Several of these metabolites are of pharmaceutical importance and need attention from pharma and biotech research and development sectors. The increasing realization of the importance of marine biodiversity in ecosystems functioning and sustaining livelihoods and the growing demands of the pharma and biotech research and development sectors for isolating novel compounds, there is a need for dedicated efforts to study, document and conserve marine invertebrates and their unexplored potential. This was the motivating thoughts behind the current project.

Special emphasis was placed on marine sponges as they have been shown to possess most potent and diverse bioactive molecules. Further, marine sponges are known to be associated with a wide diversity of microorganisms that are known to produce many bioactive compounds including polyethers, terpenoids, alkaloids, macrolides and polypeptides. Additionally, sponges play an important role in ecosystem functioning by cleaning and maintaining the healthy environment of a coral reef ecosystem as a result of removing pathogenic bacteria. As a result, studying sponges and their microbiota has a potential to understand the dynamics for the healthy working of marine ecosystems. Unfortunately, a comprehensive documentation of the number of diverse sponge species from the Maharashtra coast, associated organisms, their microbiota and bio-medical potential are not yet available. Therefore, the present study attempts to fill these knowledge and data gaps.

Objectives

(i) Creating an inventory of species of sponges in the intertidal zones and up to a depth of 20 meters in 4 selected locations along the Maharashtra coast line.

(ii) Classical as well as molecular taxonomy of sponges, tunicates and soft coral species along the Maharashtra coast.

(iii) Outlining strategies for in situ conservation of species.

(iv) Exploring means of ex situ conservation and gene bank through cryopreservation and any other appropriate strategy.

(v) Isolation and identification of microbial associates of sponges using cultural and molecular approaches.

(vi) Screening of sponges, tunicates, soft corals and other invertebrates and the associated microorganisms for bioactive compounds using a battery of assay systems.

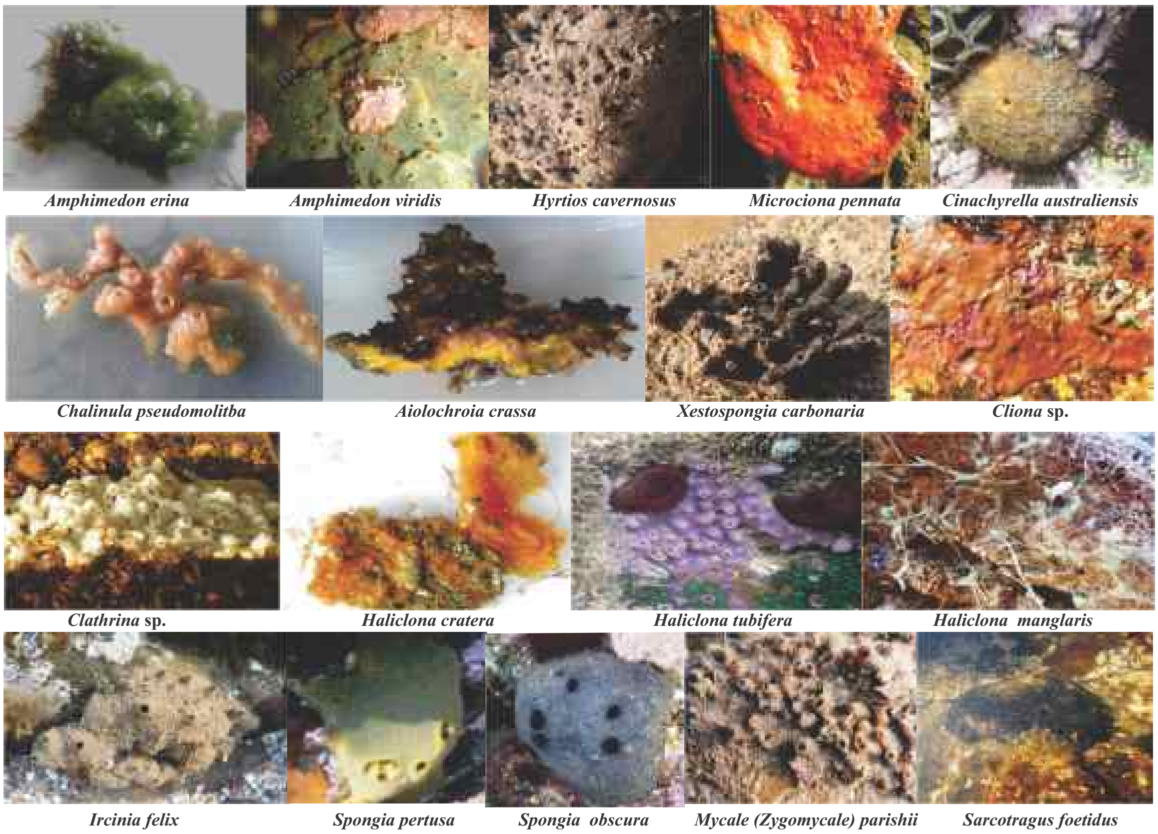
(vii) Isolation and characterization of active compounds.

(viii) Taking necessary steps towards commercialization of compounds of potential interest.

Key Achievements

Inventory of marine sponges and associated eukaryotic organisms

Extensive inventory of marine sponges and associated organisms was prepared. A total of 45 species of marine sponges were identified from the coast of Maharashtra and Goa. CoF documented 20 species of



18 Sponge species identified along the Ratnagiri coast

sponges under Class Demospongiae and Calcarea from 11 locations along the coast of Maharashtra, while CSIR-NIO documented 31 species from the coast of Maharashtra and Goa. Sponges were identified using traditional morphological taxonomy and molecular taxonomic methods using nuclear ITS1 and 28S rRNA markers and mitochondrial 16S rRNA and COI markers at CSIR-NIO and NCCS. CSIR-NIO generated genetic information for 22 specimens while NCCS generated genetic information for 31 specimens of marine sponges.

In addition to the sponges, sponge associated flora and fauna was documented by CoF, which included species of seaweeds, mollusks, Echinoderms, Nudibranchs, Corals, Phytoplankton and Zooplankton. A total of 25 species of hard corals, one Non-Scleractinian and four soft corals were identified by CSIR-NIO, where Porites was the most dominant genus. CSIR-NIO reported Foraminifera, Anthozoa, Turbellaria, Polychaeta, Crustacea, Bivalvia, Gastropoda, Ophiuroidea, Nematoda, and Sipuncula associated with the two most common sponge species *Cinachyra cavernosa* and *Ircinia fusca* of Maharashtra and Goa coast.

A new species of sponge from Maharashtra coast

Research team at CSIR-NIO described a new bioeroding sponge species, *Cliona thomasi*, from the central west coast of India. It belongs to the *Cliona viridis* species complex. The new species was described using traditional morpho-taxonomy and molecular data from nuclear ITS1 and 28S rRNA genetic markers. *Cliona thomasi*, is locally very abundant and a key bioeroder of corals. Discovery of *Cliona thoamasi* was recognized as among the "Ten remarkable new marine species from 2019" by LifeWatch, Belgium.

Inventory of prokaryotes isolated from sponges and associated environments

Both culture dependent and culture independent metagenomic approaches were used for understanding the prokaryotic diversity associated with sponges and their environment. Research team at IISER Pune isolated 2821 cultivable prokaryotes out of which 1961 were identified. The identified prokaryotes belonged to 111 genera. Out of the total 1961 identified bacteria and archaea, 386 were actinobacteria and there were seven archaea of the genera *Halobacterium* and *Methanococcus*. Actinobacteria from sponges and associated environments showed a rich phylogenetic diversity. The study provided first report of nine species, namely *Brachybacterium murisi*, *Jonesia denitrificans*, *Nocardiopsis salina*, *Pseudonocardia kongjuensis*, *Rhodococcus zopfii*, *Rothia terrae*, *Serinicoccus marinus*, *Streptomyces smyrnaeus* and *Streptomyces viridobrunneus*, from marine sponges. With the help of NCCS research team all the isolated prokaryotes isolated by IISER Pune are deposited in the Microbial Culture Collection (MCC) of NCMR, NCCS, Pune.

Culture independent metagenomics study to understand microbial diversity associated with the two phylogenetically distinct intertidal marine sponges, viz. *Callyspongia fallax* and *Amorphinopsis maculosa* was performed by NCCS. Sponge heterogeneity was found to drive the differences seen in bacterial community structure. The predominance of bacterial phylum Proteobacteria in this study was in coherence with the earlier reports published on sponge-microbial symbiosis across the world. NCCS also performed culture dependent prokaryotic diversity especially for halotolerant and halophilic organisms. Total 50 halotolerant bacteria and 13 haloarchael strains were isolated from 4 types of sponges collected from west coast of India.

Microbial community analysis of *Cliona thomasi* the newly described bioeroding sponge species was performed by CSIR-NIO. The 16SrRNA amplicon sequencing analysis performed on one specimen of

Cliona thomasi revealed that reads for bacterial prokaryotes dominated the overall community composition, followed by Archaea. Bacteria strongly prevailed in diversity and abundance over all other taxa we amplified, in the sponge tissue, as well as in the ambient sediment.

Ecological studies on sponges and associated organisms

Ecological studies on sponges and associated organisms are scarce in Indian context. Qualitative and quantitative studies were performed to understand abundance, biodiversity profile, seasonal variation, habitat preferences, and environmental variables associated with sponge diversity and distribution. Based on quantitative transect sampling, CoF researchers studied seasonal dynamics on diversity profile of sponges in four localities. The study revealed marked seasonal variation in the sponge diversity. They also studied the environmental physico-chemical determinants of sponge abundance and observed seasonal trends in environmental parameters and associated sponge diversity.

CSIR-NIO also performed quantitative survey of sponge associated organisms for two dominant sponges *Cinachyra cavernosa* and *Ircinia fusca*. Sponge associated fauna showed variation across sampling locations and strong seasonal variation. The fauna was also different for the two sponge species. Eight taxa were identified wherein Foraminifera, Polychaeta, Crustacea, Bivalvia, Ophiuroidea, Nematoda, Nemertea, and Sipuncula associated with *Cinachyra cavernosa* sponge. A total of 26 taxa were collected associated with the sponge *Ircinia fusca*. Ophiuroidea, was the most dominant group, present in all months, and the second abundant was the Polychaeta. Among Polychaeta, Family Syllidae was the most abundant family, followed by Eunicidae. Other taxa included Ophiuroidea, Polychaeta, Crustacea, Bivalvia, Sipuncula, Nematoda, Foraminifera and Gastropoda.

Documentation of threats to marine ecosystems

One major hindrance for designing and implementing conservation action for marine ecosystems is the lack of knowledge on the threats to the habitats and their biota. An attempt was made to understand the threats to the habitats and populations. A detailed study of reef biodiversity, the extent of the reef formation, the health status of reef-forming corals, and the impact of coastal pressure and changing climatic condition was planned and executed by CSIR-NIO. The study revealed recurrent coral bleaching events and subsequent coral mortality in the Malvan Marine Sanctuary (MMS) from October 2014 to April 2019. The coral disease prevalence was found to have amplified from the initial observations at all study sites during the monitoring period. Physical damage to corals due to fishing activities and recreational activities was also documented. In addition to this, sewage pollution was predicted based on fecal and sewage associated bacteria, *Aeromicrobium massiliense* and *Glutamicibacter mysorens*, isolated from sediments at Harne by IISER Pune.

Ex-situ conservation

An attempt was made to establish sponge culture under laboratory setup, which provided promising results. CoF was successful in culturing two sponge species *Clathria* (*Microciona*) *pennata* and *Haliclona* (*Reniera*) *manglaris* under laboratory conditions. Given the complex ecological niche of sponges and threats to their populations and habitats, such laboratory setups will not only provide valuable data on ecology of the species but can also serve as potential method for ex situ conservation.

New experimental setup for culture of sponges

Bioactive compounds from sponges and algae

Screening for active compounds from extracts of marine sponges and algae at IISER Pune yielded nine bioactive compounds with anti-bacterial, anti-fungal, anti-malarial, cytotoxic and anti-inflammatory activities. Sponge *Iricinia fusca* provided maximum number of novel secondary metabolites with broad spectrum antibacterial, antifungal and cytotoxic activities. Sponge *Mycale* (*Zygomycale*) *parishii* contributed two novel secondary metabolites both with antibacterial and anti-fungal activities. Sponge *Amphimedon viridis* provided one novel compound with cytotoxic and anti-inflammatory activity. While, red algae *Halymenia floresii* provided a novel secondary metabolite with anti-malarial activity.

Antibiosis, antibacterial activity and growth inhibition by bacterial isolates

Bacterial isolates from sponges and associated environments were used for screening for antibiosis, production of antibacterial compounds and growth inhibitors at IISER Pune. Of the 50 actinobacterial isolates screened for antibacterial activity, 25 showed antibiosis against at least one target organism. *Streptomyces*, *Nocardiopsis* and *Kytococcus* showed antibiosis against both Gram-negative and Gram-positive target species, while *Glutamicibacter* and *Rothia* showed antibiosis against Gram-positive organisms only. In addition, *Bacillus sonorensis* isolated from sponges showed antibiosis against Gram-positive target species, *Lysinimicrobium mangrove* and *Paracoccus haendensis* showed antibiosis against Gram-negative target species, while *Bacillus licheniformis* showed antibiosis against both Gram-positive and Gram-negative target species. Further isolation of active compound from *Nocardiopsis synnemataformans* revealed presence of bioactive compound Pentanyl-3 acetate.

Enzyme inhibitors

Actinobacterial isolates were screened for production of enzyme inhibitors at IISER Pune. Out of 50 actinobacterial isolates screened for inhibition of three proteoletic enzymes and angiotensin converting enzyme, 30 isolates inhibited at least one of the enzyme. The most prolific genera to produce enzyme inhibitors were *Streptomyces* and *Nocardiopsis*. Enzyme inhibitors have potential bio-medical applications. As a result, marine actinobacteria need special attention.

Anti-biofilm activity

Several actinobacterial isolates screened for anti-biofilm activity at IISER Pune showed good potential for biofilm inhibition. Actonobacteria of the genera *Nocardiopsis*, *Rhodococcus*, *Streptomyces*, *Kytoccous*, and *Cellulosimicrobium* isolated from marine sponges and associated habitats showed good anti-biofilm activity. Since, biofilms play a vital role in bacterial infectious diseases, exploring marine actinobacteria for active anti-biofilm compounds could lead to discovery of novel metabolites of therapeutic value.

Predatory actinomyces as potential for novel bioactive compounds

One of the major themes that was explored by IISER Pune research team was the non-obligate epibiotic predatory activity of actinobacteria and its potential for yielding novel bioactive compounds with pharmaceutical applications. Several important discoveries were made with respect to predatory actinobacteria, the ecology of predation and possible metabolites involved in predation. Out of the total 50 actinobacterial isolates screened for non-obligate epibiotic predatory activity, 26 isolates showed predation on at least one of the 14 target organisms. There was a significant association between the source of isolation (sponge or associated environment) and predatory behavior, where the isolates from sponge showed proportionately more predatory behavior. In the current study, for the first time, we show predatory behavior in six genera of actinobacteria, other than the known genera *Agromyces*, *Streptomyces* and *Streptoverticillium*, namely *Brevibacterium*, *Glutamicibacter*, *Micromonospora*, *Nocardiopsis*, *Rhodococcus* and *Rothia*. An interesting observation made when comparing the predation and antibiotic production by actinobacteria, was that, while predation was equally effective against Gram-positive as well as Gram-negative target species, antibiotic production was mainly effective against Gram-positive bacteria. It is therefore possible that studying the predatory behavior of actinobacteria and predation specific metabolites could lead to discovery of novel therapeutic agents that are more broad-spectrum. Initial attempts at isolating and characterizing predation specific compounds yielded small molecular metabolites that were expressed only in the presence of predation. Further studies on the compound is likely to yield new insights into the predation ecology and its bio-medical application.

Data for Relational Database Management System (RDBMS)

Data of marine prokaryotes and eukaryotes collected in the present study by all four partners were included in Relational Database Management System (RDBMS). There are 1900 data entries for prokaryotic database, which has 36 attributes (Table 1) and 520 data entries for eukaryotic diversity database, which has 34 attributes (Table 2).

Table 1 Attributes for data on marine prokaryotic diversity.

Attribute	Data type	Description
Domain	Character	Name of Domain
Phylum	Character	Name of Phylum
Class	Character	Name of Class
Order	Character	Name of Order
Family	Character	Name of Family
Genus	Character	Name of Genus
Species	Character	Name of Species
Data provider	Characters	Data providing institute
Culture repository number	Alphanumeric	Code used for data collection
Collection code	Alphanumeric	Code used for data collection
Location	Character	Name of locality
Latitude (°N)	Numeric	Decimal degrees
Longitude (°E)	Numeric	Decimal degrees
Isolation source	Character	Source of isolation
Habitat	Character	Type of habitat
Isolation medium	Character	Name of the medium
Habitat pH	Numeric	pH value
Habitat salinity (ppm)	Numeric	Salinity in ppm
Habitat TDS (ppm)	Numeric	Total dissolved solids in ppm

Attribute	Data type	Description
Habitat conductivity (microS)	Numeric	Conductivity in microS
Habitat Dissolved Oxygen (ppm)	Numeric	Dissolved oxygen in ppm
Habitat Temperature (°C)	Numeric	Temperature in degree Celsius
Genes sequenced	Characters	Present/absent (for what marker)
GenBank accession number	Alpha numeric	GenBank accession for sequences
Sequencing institute	Characters	Institute that performed molecular work
Colony size (mm)	Numeric	Diameter of the colony
Colony shape	Character	Shape of the colony
Colony margin	Character	Margin of the colony
Colony elevation	Character	Elevation of the colony
Colony color	Character	Color of the colony
Colony opacity	Character	Opacity of the colony
Colony consistency	Character	Consistency of the colony
Gram character	Character	Gram staining character of the colony
Publication status	Characters	Whether the observation is published
Reference	Characters	Reference for published observation
Remarks	Characters	Remarks, if any

Table 2 Attributes for data on marine eukaryotic diversity.

Attribute	Data type	Description
Phylum	Character	Name of phylum
Order	Character	Name of order
Family	Character	Name of family
Genus	Character	Name of genus
Species	Character	Name of species
Common name	Character	Common name in English
Location	Character	Name of locality
Latitude (N)	Numeric	Decimal degrees
Longitude (E)	Numeric	Decimal degrees
Collection code	Alphanumeric	Code used for data collection
Museum voucher number	Alphanumeric	Museum voucher of specimen
Location of voucher specimen	Character	Name of the museum
Method of sampling	Character	Method used for sampling
Frequency/Abundance	Numeric	Abundance of the organism
Association	Character	Co-occurring species
Habitat type	Character	Type of habitat
Habitat pH	Numeric	pH value
Habitat salinity (ppm)	Numeric	Salinity in ppm
Habitat TDS (ppm)	Numeric	Total dissolved solids in ppm
Habitat conductivity (microS)	Numeric	Conductivity in microS
Habitat Dissolved Oxygen (ppm)	Numeric	Dissolved oxygen in ppm

Attribute	Data type	Description
Habitat Biological Oxygen Demand (ppm)	Numeric	BOD in ppm
Threats to the habitat	Characters	Description of Threats to habitat
Photographs of Species	Alphanumeric	Code of photograph
Photograph of habitat	Alphanumeric	Code of photograph
Genes sequenced	Characters	Present/absent (for what marker)
GenBank accession numbers	Alphanumeric	GenBank accession for sequences
Molecular service provider	Characters	Institute that performed molecular work
Date of observation/collection	Alphanumeric	Date as dd-mmm-yyyy
Name of the observer/collector	Characters	Name of the observer
Institute	Characters	Data providing institute
Remarks	Characters	Remarks, if any
Published (yes/No)	Characters	Whether the observation is published
Reference	Characters	Reference for published observation

Outreach Activities

"Aquatic Ecosystems: Sustainability and Conservation", a national conference on aquatic conservation, was organized on 20th and 21st December 2019, which was hosted by Indian Institute of Science Education and Research, Pune (IISER-P). There were total 125 participants, 20 invited talks and 48 posters for the conference. The aim of this conference was to provide a common platform for researchers and young investigators in the field of aquatic diversity, ecology, conservation biology and socio-economics to share their experiences and knowledge for a collective effort towards building science based conservation policies and sustaining livelihoods of the future.

The 'First Porifera Identification Workshop in India' was organized by the CSIR- National Institute of Oceanography, Goa from 20th to 22nd November 2019. During this workshop, hands-on training was provided to identify sponges morphologically, carry out histology on certain orders of sponges, sectioning and extraction of spicule along with learning measurement, assign sponges to at least Order or Genus level and to overall enhance the taxonomic skills on sponge identification. International sponge expert Dr. J. Hooper (Queensland Museum, Australia), Dr. T. Samaai and Ms. Liesl Janson (Ministry of Environment, South Africa) were the key resource persons. The experts shared their knowledge with the participants. . A handbook of sponge identification guide entitled "Sponge taxonomy guidelines" was published during the events.

A number of outreach activities focusing on marine diversity and conservation were organized by CoF and include Biodiversity of Maharashtra exhibition; series of workshops on Mangrove culture and protection; workshop on Sponge identification techniques; seminar on Role of mangroves in our ecosystem; and a program on Biodiversity of the Rocky Shores for school students.

Publications and presentations

Scientific articles

Findings of the study are published in 22 peer reviewed research articles (10 from IISER Pune, 12 from CSIR-NIO and 1 from NCCS). In addition, 5 manuscripts are currently in preparation.

Conference presentations

Research conducted as a part of current study was presented in conferences (7 by IISER Pune, 11 by CSIR-NIO, 3 by CoF and 4 by NCCS).

Dr. Ulfat Baig from IISER Pune participated in the DST-AWSAR (Augmenting Writing Skills for Articulating Research) was selected as one of the top twenty articles in the post-doctoral fellow category for her article about her work on predatory bacteria that kill other bacteria and consume them for their own growth.

Popular articles

Four popular articles are published, online forum Gotul (IISER Pune) and Agrowan (CSIR-NIO, CoF Ratnagiri and IISER Pune).

Project material developed

Marathi leaflet "Kharfuti", giving the information of Mangroves and there uses, was developed by CoF.

2. Crop Genetic Diversity

Participating Institutes: Gramin Yuva Pragatik Mandal (GYPM, Bhandara); Institute of Integrated Rural Development (IIRD, Aurangabad); Sanskruti Samvardhan Mandal (SSM, Sagroli, Nanded); Sheti Pariwar Kalyan Sanstha (Atpadi); Lokpanchayat (Ahmednagar); BAIF, Pune

Background

Crop genetic diversity is the thematic group of organizations working closely with farmers' groups and farmers from remote parts of different agro-climatic regions of Maharashtra. Traditional farming practices take in account many indigenous, community conserved cropping patterns. Many of the crops are drought resistant and have greater significance in sustaining farmer's economy in changing climate. Some of the crops are specific to particular region and efforts are done to gain GI status to such crops. Many farmers are sustaining their own seeds and farmer's varieties, the efforts are being done to recognize those seeds as local landraces under PPVFR. Some organizations of this group also are linking farmer's special crops with market links, trying to provide niche market to the efforts of conservation. One of the important features of the traditional agricultural practices is 'local seed banks'. Major focus of this group is about identifying diversity in farmer's varieties of seeds; characterization of them scientifically, thereby connecting the local farmer's efforts to the wider scientific knowledge base.

Objectives

(i) To build up a systematic inventory of crop genetic resources of the state.

(ii) To identify one variety in each district covered for pilot scale efforts at on farm conservation, upgradation, value addition, marketing, and registration.

(iii) To establish district level seed banks focusing on traditional cultivars of superior quality

(iv) To engage educational institutions in study and promotion of crop genetic resources

(v) To plan and introduce activities for region wise in-situ and ex-situ conservation.

(vi) Germplasm collection, characterization, evaluation and participatory seed production

(vii) Building motivation of local communities to participate and manage the program

Organization wise Focus crops

Sr	Organization	Districts	Blocks	No of villages	Focus Crops
1	Gramin Yuva Pragtik Mangdal, Bhandara (GYPM)	Bhandara, Gondiya, Chandrapur	6	64	Rice, Linseed, Lathyrus

Sr	Organization	Districts	Blocks	No of villages	Focus Crops
2	Sanskriti Samvardhan Mandal, Sagroli, Nanded(SSM)	Nanded, Latur, Osmanabad	8	20	Chilli Safflower Sorghum
3	Lokpanchyat,Sangamner (LP)	Ahmednagar, Nashik, Pune	5	20	Rice, Pearl millet, Finger millet, Hycinth bean
4	Sheti Pariwar Kalyan Sanstha, Atpadi, Sangli	Pune, Solapur, Sangali, Kolhapur, Satar	5	15	Sorghum, Rice, Wheat
5	IIRD, Aurangabad	Aurangabad, Beed, Hingoli, Parbhani, Jalgaon, Jalna	6	69	Sorghum, Pigeon pea, Green gram, Safflower, Sesamum,Wheat
6	BAIF, Pune	Gadchiroli, Nandurbar, Ahmednagar, Pune, Palghar, Kudal	6	60	Rice, Millets, Maize, Sorghum, Hycinth bean, Cow pea, Local vegetables, Pulses
	06	**23**	**36**	**248**	**18**

Registration of Farmer varieties Under PPV & FR Act 2001

Sr	Partner	Name of group /Individual	District	Crop	No of varieties
1	BAIF	Seed Saver Farmers Group, (2014)	Palghar	Rice	29
2	BAIF	Mr. Sunil Kamadi(2014)	Palghar	Rice	1
3	BAIF	Mr.Mavanji Pawar(2014)	Palghar	Rice	3
4	BAIF	Kalsubai parisar Sthanik biyanee savardhan sanstha , Akole(2015)	Ahmednagar	Hycinth Bean	10
5	BAIF	Yaha mogi Biyanee savarthan samiti(2015)	Nandurbar	Maize	05
6	BAIF	Yaha mogi Biyanee savarthan samiti, (2015)	Nandurbar	sorghum	05
7	LP	Kalbhat utpadak sangh & Devthan bajri utpadka sangh (2016)	Ahmednagar	Pearl millet& Rice	02
8	GYPM	Chikli,Khapa(2015)	Bhandara	Rice	02
9	GYPM	Baudh Nagar(2015)	Gondiya	Rice	01
		Total			58

95 accessions of various crops submitted by BAIF to NBPGR have been registered with IC numbers. Five sorghum lines submitted by BAIF were registered with PPV & FRA.



Participatory seed selection in Little millet, Finger millet and Rice

Morphological Characterisation

Traditional seed storage systems

Seed bank at Jawhar

Output	Achievements
Bio-resource inventory preparation	Accession database (533 accessions), ITK (Traditional food recipes, traditional cultivation practices, cropping systems, seed storage methods, festivals, traditional seed selection methods), Wild edible plants database (304), Shifting cultivation in Akole
Scientific validation	Genotyping of rice and maize (167), Morphological characterization (271 crop cultivars of 18 crops), potential yield studies (25), nutritional studies (189 land races of 6 crops), crop economics (3)
Promotion of validated bio resources	Total no. of farmers (6956),Seed production (101 MT of 18 crops, Kitchen gardens (7200), Sale of produce (199 MT), Tubers (5 MT of 2 species), Area under cultivation (1602 ha)
Conservation and safeguarding of bio-resources	In-situ conservation (996 accessions), Seed banks (community-21, cluster level-7, ex-situ-1), Safeguarded germplasm-registration with NBPGR (74), PPV & FRA (54), ex-situ conservation at CRS (473), PBR prepared (6), BMCs formed (121)
Establishment of Seed saver groups/Po's	3 FPOs, 2 Cooperatives, 179 Seed Saver Groups
Publications (Research Papers, Articles, case studies)	13 (Morphological, nutritional characterization, traditional cultivation practices, Integrated Management of Dry Root Rot in chilli s,pickel standardization ,Wild edible plant diversity), Articles (38), Newspaper articles (20)
Other publications, IEC material	Landrace catalogue, Seed saver directory, Community seed bank working manual, Wild food recipe booklet, Community seed production guidelines, Organic crop production manual, brochures, Seed conservation booklet, Calendars, e-newsletters, posters
Value addition, Branding & Marketing	Kitchen garden kit sale (5000), Product developed (Mahua, Finger Millet,Herbal Coffee,Sorghum biscuits)
Recommended practices, protocols, methodology	Participatory seed production, improved cultivation practices of maize, rice, sorghum, millets, seed storage method.
Collaboration & Linkages	NBPGR, New Delhi, PPV & FRA, New Delhi, UAS Dharwad, National Agri Biotech Institute (NABI),Mohali, Dept of Agriculture (PKVY, ATMA, Maharashtra State Biodiversity Board (MSBB), Tribal Development department (TDD), Maharashtra State rural Livelihoods Mission (MSRLM), National Seed Sovereignty Alliance, SAUs, IIMR (Indian Institute of Millet Research), IIT Bombay, NGO's(15)

Recommendations

Related to Research

- In depth research is required for identifying specific traits like stress tolerance, nutritional status, medicinal properties, any other trait that communities find useful etc. for many crop landraces.
- Genetic diversity study using molecular markers needs to be undertaken to understand diversity among the landraces.
- The approach of participatory varietal selection involving local community may be adopted for identification and genetic improvement of locally suitable crop diversity.
- Mapping of crop diversity across diverse bio-geographic regions and collection of eroding germ plasm should be important research agenda.
- Need to expand the work of *in -situ* conservation of region's agro biodiversity and crop cultivars in different crop- wise native tracts in the state and in India as a whole.

- Need to have multi stakeholder, multi partner effort in future around indigenous crops by focusing on all aspects of food production from collection of germ plasm up to storage and innovative marketing.
- Need to study in depth the role of local crops and wild food resources in vital and essential part of human's food system.
- Mandate Programme on conservation of Regional crop diversity should be given to KVK's and agriculture seed farms which will be live gene centres and demonstration centres for community awareness

Related to Livelihood Security

- Community level seed production and seed banks concept may be adopted for seed sovereignty and to facilitate self-reliance in seeds which is the soul of farming.
- Community led enterprises for production and sale of kitchen garden seeds and grains produced has good livelihood potential and also ensure less dependence on outsider agencies for important seed supply.
- Promotion of selected landraces for cultivation among the farmers through various schemes implemented by state agriculture department needs to be considered, as this can lead to further multiplication of eroding base of worthy crop cultivars.
- Inclusion of local cultivars and landraces in seed production system and food system is pertinent.
- It is important to focus on registration of traditional varieties for its commercial use.
- Government should support promotion of indigenous crop cultivars under government programmes like Pulse development Programme, Indian Agriculture development Programme etc.
- Like the National Horticulture Development Programme, subsidy should be given for conservation and promotion of Millet crops
- Long term support to genome saviors needs to be given for conservation and maintenance of unique crop diversity
- Support for production and marketing of grains produced from unique crop cultivars

Related to Food and Nutrition Security

- A relook is necessary at region's agrobiodiversity and food resources which are potential sources of nutrition including micronutrients. Even key players in agriculture research, extension and crop promotion and varietal release need to focus on promotion of nutritionally rich crop varieties for nutritional security (Ex: ICAR institutes, KVK's, State Agricultural Departments, SAUs, Experts etc.)
- Food and nutritional security by introducing perennial and seasonal, diverse vegetable crops through kitchen garden is very good intervention to ensure household level food and nutrition security. There is need to upscale and replicate this intervention through ongoing and future government programs.
- Linking region's biodiversity with school mid-day meal and other government led nutrition efforts like PDS is important.

Related to Climate Change Resilience Building

- There is need to study various crops to understand their performance under biotic and abiotic stresses..
- There is need to promote climate resilient crops and landraces for sustainable crop production under adverse climatic situations and variabilities.

Gender Dimensions

- Women are traditionally custodian of local knowledge and wisdom associated with region's crop diversity and wild food resource. It is necessary to give recognition to rural farm women and ensure their centrality in any future program around agro biodiversity.

Benefit sharing

- There should be benefit sharing mechanism for indigenous crop cultivars used for breeding purpose by research institutes, SAU's and breeders to the seed saver of that crop cultivar.

Registration of Farmer varieties

- Needs to develop simplified process for registration of farmer varieties and Authority for recommendation of application should be given to BMC's.
- Registration of farmer varieties under PPV & FR Act 2001 needs to make simple and online so that possible for quick actions.

3. Livestock Diversity and Conservation

Participating Institutes: Lokpanchayat, Sangamner; BAIF

Lokpanchayat and BAIF are members of this thematic group. Lokpanchayat is involved in understanding and conservation of Dangi cattle system raised by tribal communities in Ahmednagar district of northern Maharashtra. BAIF's work is extended in Nanded, Parbhani, Nandurbar, Gadchiroli, Ahmednagar and Wardha working on various local breeds of cattle, goats and poultry.

Focused breeds

Local breeds of Cattle (Dangi, Lal kandhari and Gaolao), goats (Sangamneri and Berari) and Satpudi local poultry

Lokpanchayat

Objectives

a) Socio- economic and ecological research to understand community conservation system of Dangi cattle

- Participatory Rural Appraisal of the Dangi system
- Role of forests in Dangi conservation
- Documentation of practical ecological knowledge related to livestock management
- Cultural practices related to the cattle – feeding and nutrition of the cattle, use as a source of milk and as a source of motive power for agriculture

b) Capacity building of the tribal farmers in the context of maintaining good quality Dangi cattle.

- Awareness generation regarding simple low cost techniques that would help maintain good health of cattle
- Training programs based on local knowledge for veterinary health, fodder management,
- feed and nutrition management and importance of record keeping

c) Strengthen linkages for healthy Dangi animals

- Fodder management
- Cattle housing
- Veterinary first aid
- Government Animal Husbandry Department

d) Policy advocacy and information dissemination for the Dangi breed

- Popular articles in the local newspapers
- Coordinating a low cost monthly publication in Marathi language radio programmes

- Participating in the local programmes like weekly markets, annual fairs, exhibitions
- Participating in the state level, national and international seminar and workshops

Output of the project

a) Participatory research

- Facilitating participatory research process with selected 30 Dangi keeper families by organizing field demonstrations to diagnose cattle diseases and developing package of practices to control disease.
- Focussed on documentation of wild fodder continuously for two years. More than 200 fodder plants were documented and 53 grasses also identified.
- *Rakhanraan* (a small meadow of grassland) a unique community conserved area (CCA) for fodder newly identified in the north Western Ghats, documented for the first time.
- Comparative study of natural and artificial insemination initiated in working area.

b) Awareness and capacity building

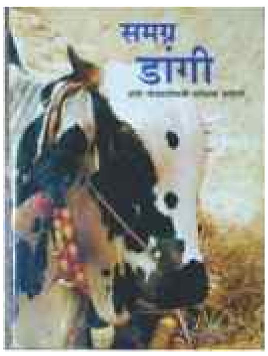
- Awareness related to seasonal vaccination among Dangi keeper community, challenging traditional keepers have some misunderstanding and superstitions about vaccination.
- Created concrete consciousness in the keepers by using *Kala-pathak,* regular meeting, workshops, formal conversation and organized vaccination drive with state veterinary department. Lokpanchayat reached up to minimum two thousand keepers through exhibition and *Kalapathak* program.
- Artificial Insemination Service (AIS) using semen tube of Dangi, which is made by BAIF Semen Bank in the project villages, where Dangi service bull is absent. Till today total 68 AI are done. 26 calves (15 female and 11 male) were born. Lokpanchayat reached up to 26 villages (15 project villages and 11 new villages.)
- Two training workshops were held for Dangi keepers and AHW every year
- A pilot program of Livestock Insurance started in two villages, keepers got compensation after death of cattle and goat.

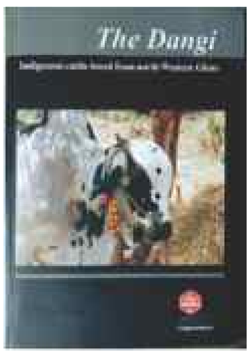
c) Networking

- Associated with BAIF, Dangi Research Station Igatpuri, MAFASU Nagpur, Veterinary colleges from Shiraval and Paral.
- Lokpanchayat has become a member of League for Pastoral People (LPP), an international network working for strengthening pastoral community
- At closing stage of project Dangi keepers have pro-actively decided to form Dangi Breeders Association (DBA). 11 member promoters body formed to develop governance system and associated legal compliances.

Documentation and publication

- Lokpanchayat has published a small book named '*Samgra Dangi'* given basic information about overall 'Dangi System' in English & Marathi language
- Detail report on Wild fodder study in 2016-17 with GIS mapping of selected grazing areas and separate survey report on *Rakhanraan.*'
- Published a paper on wild fodder and Rakhanraan. A small report on the carbon sequestration of the reservoir has been prepared.





BAIF

Approach

- Conservation of important indigenous livestock breeds by involving community
- Blending traditional and scientific knowledge in sustainable conservation program
- Scientific and technical assistance to the livestock breeders

Salient achievements

- Documented native livestock diversity and their management practices through socio-economic survey
- Under *in-situ* breed conservation program **8416** Artificial Inseminations performed through **12** cattle breeding centres and **2631** new calves born, **2340** goat breeding services through **23** elite bucks, **1680** kids born
- Elite bulls of Dangi, Lalkandhari and Gaolao procured from project areas and over 2.73 lakhs of semen doses produced for further breeding program and kept for *ex-situ* conservation.
- Milk yield potential studies undertaken by milk recording of 617 cows of focused 3 cattle breeds.
- Phenotypic characterization of 367 Dangi and Lalkandhari cattle, physical characterization of 5000 Satpudi poultry and growth measurements of 722 Sangamneri and Berari kids.
- Genotyped Dangi, Lalkandhari and Gaolao breeds using High-Density Illumina bead chip
- Community awareness through 786 events like health camp, calf rally, goat rally, deworming, vaccination, awareness meet, exhibition etc.
- Documented traditional forage resources and nutritional analysis of 107 samples completed.
- Documentation: 4 research papers, 13 articles/case studies, 4 best practices and 18 extension material.


Bahada


Shevara


Kala


Mahnera


Khaira


Para

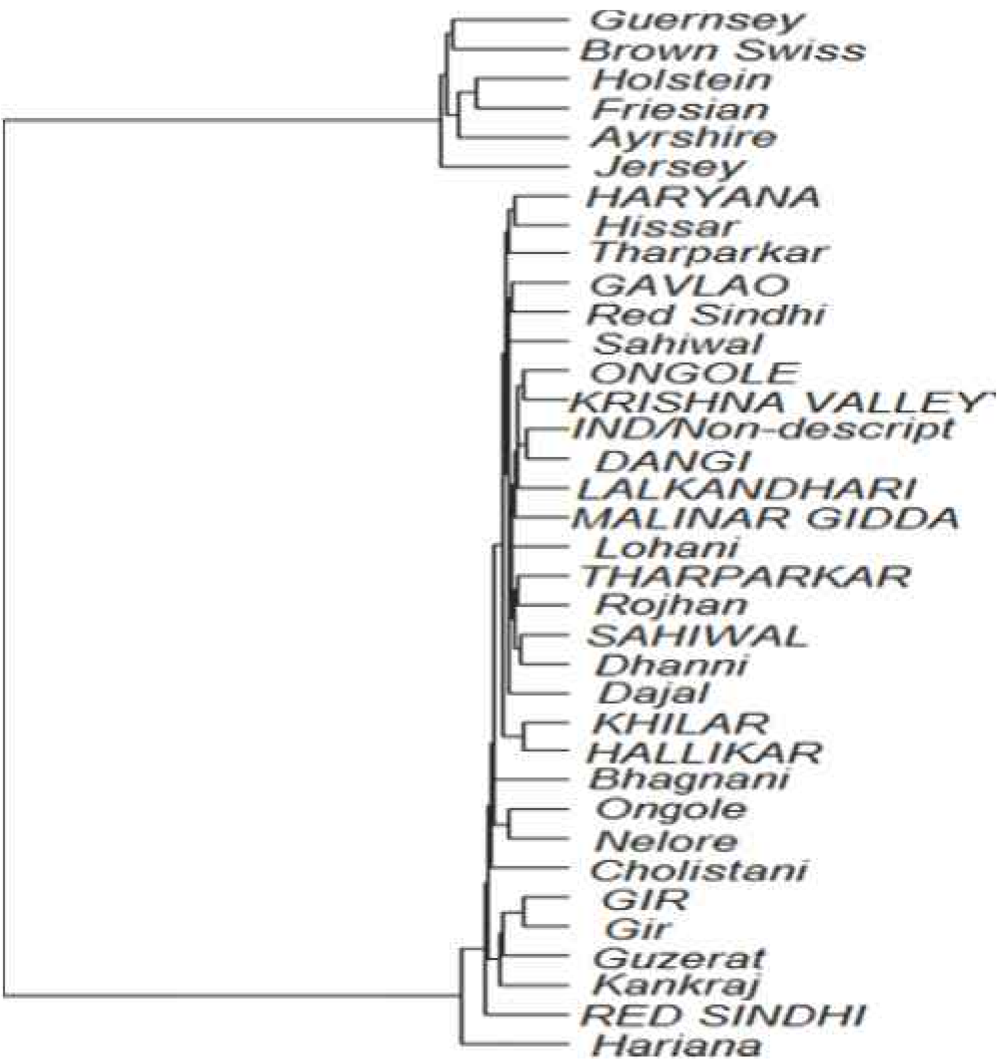

Hayali Kukadi


Talya Kukadi


Kalyo Kukadi


Gavathi Kukadi


Kabharyo Kukadi



Phylogenetic tree of Indian *Bos indicus* breeds

Policy Recommendations

1) The focused cattle, goat and poultry breeds under the project are well acclimatized to the native environment and each breed has its specific traits of performance under extreme agro-climatic conditions. The breed improvement and conservation measures undertaken during the project period has produced elite animals in the respective regions. The demonstrated participatory breed conservation program could be incorporated into state policies on conservation and genetic improvement of livestock resources.

2) The study on the genomic application in elucidating Indian cattle population structure indicated that genomic information especially the SNP (Single Nucleotide Polymorphism) marker information provides ample opportunity in understanding the genetic basis of the specific cattle population structure. Genomic tools could be used to determine effective population size that is indicative of the levels of population endangerment. Genomic tools could be useful in understanding within breed and between breed diversity levels in terms of allelic diversity, again a useful tool for designing the breeding program for a specific breed.

   a) It can elucidate certain levels of breed ancestry, useful to breed back the specific breeds which are in endangerment.

   b) It can provide information on the two most closely related breeds and populations, that will provide basis for breed conservation by designing specific mating program within or between breeds in a region simultaneously taking care of genetic diversity and genetic improvement.

   c) The genetic merit of individual animal within a population could be elucidated using genomic information, that will be highly useful in selection of high genetic merit breeding stock

3) Conservation and promotion of local fodder and grass species, preservation through silage, utilization of tree fodder and crop residues as well as introduction of improved fodder crops and varieties to enhance fodder availability in the areas.

4) Promotion and market linkage of milk and milk products, value added products from cow dung, urine needs to be undertaken to enhance the income which will support in motivating the farmer in conservation of animal genetic resources.

5) As these animal resources are being conserved at a very remote area, migrate during scarcity period and therefore necessary breeding and animal health services should be provided by govt. departments.

6) Convergence of state animal husbandry and forest department regarding making available the fodder resources from the forest areas will help farmers in reducing the expenses on feeding the animals.

7) Promotion of artificial insemination practices in goat for assurance of quality breeding and production of elite animals.

8) Traditional animal management system has developed over a period of time hence breed conservation and improvement measures will be helpful for livelihood of the community. The region specific micro policy may be arrived involving breeder's association, department of Animal Husbandry, Agriculture, MAFSU and NGO's like BAIF and Lokpanchayat. This will enable farmers in participating in various govt. schemes like *Rastriya Gokul Mission*. The concept of '*Pashu Mitra*' may be adopted at village level.

9) Capacity building and promotion of Ethno-veterinary practices among the farmers will be helpful for availability of cost effective and timely health services locally.

4. Fish and Shellfish Diversity in Freshwater Ecosystems

Participating Institution: Bhandara Nisarg va Sanskritik Abhyas Mandal, Bhandara

Background

Aquatic biodiversity is one of the most neglected areas, from conservation and research efforts as well as economic endeavours such as potential of fishing of indigenous fishes. Eastern Vidarbha, especially the districts of Bhandara and Gondia are well-known for the large number of tanks. Documentation, conservation, sustainable use, and management plans of these tanks are crucial for people who depend on them as well as aquatic biodiversity that inhabits these tanks.

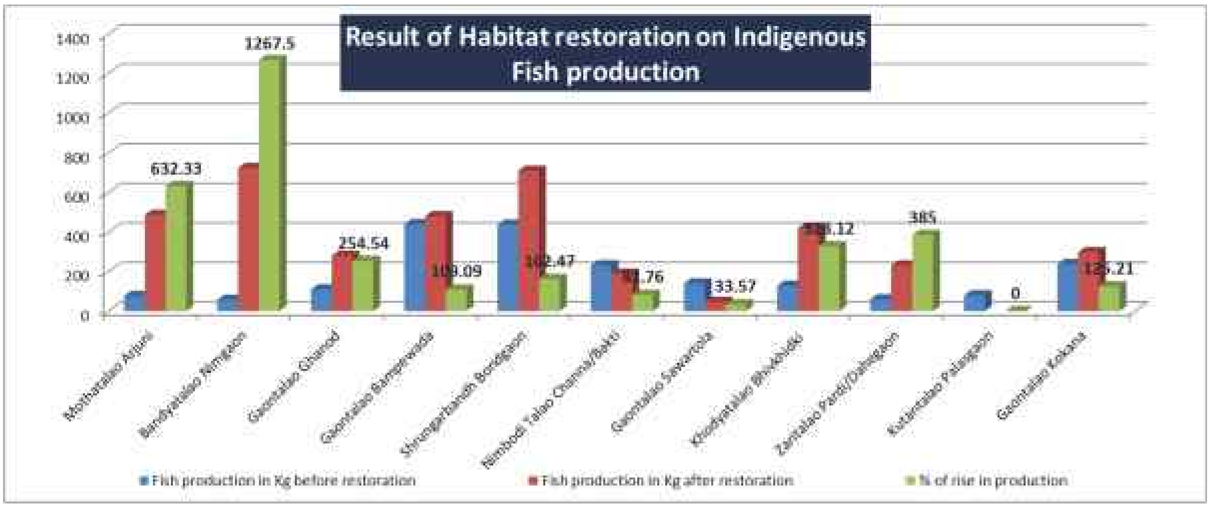
Objectives

1. Documentation of people's knowledge of freshwater biodiversity
2. Preparation and implementation of freshwater biodiversity management plans through fishing cooperative societies
3. Conservation and sustainable use of aquatic ecosystems and biodiversity
4. Advocacy for an inclusive biodiversity and fishery policy

Key Achievements

12 tanks with the water spread area of 208.94 ha. have been reserved by the Fishing cooperative societies for freshwater biodiversity conservation. Following activities have been carried out during the project duration in and around these 12 tanks:

1. Documentation of people's knowledge: Photo documentation of flora and fishes, preparation of formats for wetland related PBR and data collection in those formats, herbaria of aquatic flora of 12 freshwater ponds, involving 12 fishing societies.
2. Biodiversity management plans: Based on information of 12 freshwater tanks on catchment of tank, actual tank area, command area, land use pattern in catchment, forest and agro biodiversity in catchment and practices, livestock using the tank for water and grazing, fish diversity, bird diversity, and plant diversity, detailed management plans have been prepared for these 12 ponds. This process involved consultations and active involvement of Gram Panchayats, Biodiversity Management Committees, Fishing Cooperative Societies, the women SHGs and their Gram sangh.
3. Conservation and sustainable use of aquatic resources: Restoration works were carried out in 11 tanks (not only the reserved tanks, but other tanks were also included in this activity, falling under the jurisdiction of the partner fishing cooperative society), with area of 281.80 ha., which were degraded. This included *Ipomoea* extraction, planting those species which are preferred by fish and fauna. The process of conservation and sustainable use also involved regulations on fishing of local varieties.
4. A model of aquatic habitat restoration has been standardized, based on the work done. A step-by-step process is documented in Marathi and is available for dissemination to anybody who is interested in doing so.
5. Advocacy for an inclusive biodiversity and fishery policy: The major advocacy intervention includes the preparation of draft of freshwater fishery policy for the state of Maharashtra with inputs from the traditional fishing communities. The draft is prepared based on the experiences and work under MGBP and shared with the traditional fishing communities working in different regions of Maharashtra.
6. Developed the project ideas, based on freshwater biodiversity, with CEE, for school children. These have helped a lot to children to connect with their surrounding diversity and for teachers to interact with students and to improve on teaching methods, as per their own perception.



Recommendations

1. There is utmost need to differentiate between aqua culture and artisanal (traditional) fishery. Without doing this, fishery related policies, schemes and programs are being implemented by the State and Central Government departments. Without clear understanding of these two types of approaches, many voluntary organisations, CSRs and corporates are promoting aqua culture practices in the water bodies, which are part of the natural drainage system, resulting in short term gains and longterm aquatic biodiversity loss and then loss of fish production. A clear policy statement, law and programs are needed to control this situation and to conserve the freshwater biodiversity. A composite model of aqua culture and indigenous fish production needs to be evolved, based on the different agro climatic zones of Maharashtra.

2. The desiltation program of tanks needs to be rethinked, as currently the desiltation activity is taking place without the measurement of silt levels in selected water body. The program guidelines or the available funds decides on how much and how the silt is removed, and not the actual study of siltation. This silt needs to be managed as over siltation causes low water storage but desiltation by machines, destroys the aquatic biodiversity. This activity is very much attached with the political will also. Community level awareness is also required to stop the mechanized activities in tanks and freshwater flows.

3. The developed model of aquatic habitat restoration needs to be disseminated in the water bodies in Wainganga River basin. Also, this model needs to be tested in different agro climatic zones of Maharashtra for promoting sustainable fishery through biodiversity conservation.

4. River basin wise documentation of indigenous fish diversity, their habitat and people's knowledge, associated with it, needs to be documented. Biodiversity management committees can undertake

the work of People's Biodiversity Register (PBR) and the State Biodiversity Board should assist them in this work.

5. Public fund in freshwater biodiversity sector is exceptionally low, and no investment in production of Small Indigenous Freshwater Fish Species (SIFFS). Whereas minor carps contribute 75% to 95% of the total catch from freshwater. The study also shows that small reservoirs have the highest average yield (28.68 kg ha^{-1}), followed by the medium (14.44 kg ha^{-1}) and large (10.21 kg ha^{-1}). It is the worldwide fact that 90% workers, working in fishery sector are working in the small ponds and tanks, rivers, and streams. Therefore, fund allocation to this sector and that also for SIFFS production will make the livelihood sustainable and also contribute to conservation of freshwater biodiver

5. In-situ conservation of Grassland Biodiversity

Participating Institutions: Samvedana, Karanja Lad; Vasudha, Dhule, Ugam,Hingoli

Background

The state of Maharashtra harbours very extensive tracts of grassland, scrub, and tree savannas. They play a significant role in the economy. Ecologically, this is an important region as these grasslands are the place of origin of evolution of the legume genus *Alysicarpus* and support populations of blackbuck, chinkara, nilgai and birds like Lesser floricans and Great Indian bustards. The sustenance of communities such as Dhangars and Phasepardhis is dependent on these ecosystems. Unfortunately these ecosystems have undergone extensive degradation with the loss of productivity and replacement of palatable grasses like *Sehima* and *Diacanthium* by spiny, coarse ones like *Heteropogan*. In the last five years, the project focussed on conservation of localities that are earmarked as grasslands as well as the privately maintained grasslands.

Region like western Vidarbha has less known ecological history of grassland destruction during colonial era. Dr. Laxman Satya in his book 'Ecology Colonialism and Cattles: Central India in the Nineteenth Century elaborates the process of destruction. About 28 lakh hectors of land which was under grass cover in 17^{th} century got converted into cotton farms. This is just to support British cotton miles in Manchester.

Objectives

1. In situ conservation of grassland biodiversity with special focus on indigenous grass species
2. Livelihood strengthening and capacity building of communities dependent on grassland/scrubland areas through eco-restoration activities
3. Documentation of traditional knowledge through People's Biodiversity Registers
4. Advocacy efforts for creation of an inclusive grassland/scrubland policy

Key Achievements

1. Conservation: In-situ grassland conservation in about 2000 hectares across Maharashtra. This includes conservation of abiotic resources such as soil and water as a result of increased grass cover on the area.
2. This also included documentation and conservation of indigenous species of grasses, about 48 grass species found in the conservation sites.
3. Monitoring of sites of endangered Lesser florican and its territory mapping has been done. Our project area in Akola district is the only site in Maharashtra, where Florican is sighted and there are photographic records of its breeding. These records are published in BNHS journal Mistnet.

[1] Sugunan, V.V., Reservoir Fisheries of India. FAO Fisheries Technical Paper. No. 345. Rome, FAO. 1995. 423 p. Accessed online: http://www.fao.org/3/V5930E/V5930E00.htm#TOC

4. Community development: Livelihood strengthening efforts happened in the course of this project via activities related to fodder management. Around 2000 hectors of land is under grass species yielding about 4000 metric ton of palatable grass. This fodder availability is supporting about 3000 animal heads, which belongs to about 1000 livestock keeping families.
5. Capacity building workshops related to the Biodiversity Act, MREGS Act, Tribal Forest Rights Act with a specific focus on the sustainable use of grassland biodiversity and its conservation were carried out. Environment education was carried out in 30 schools in three districts.
6. In Laling 500 ha. and Lamkani - 500 ha. of area is protected successfully & good quality grassland conservation took place with predominance of *Sehim*a & *Crysopogon fulvus* in Lamkani while *Hydropogon, Apluda, Chloris* etc. in Laling.
7. PBR: PBR in 20 villages in three districts of Maharashtra, where grasslands are the dominant ecosystem, were prepared. The focus was on traditional knowledge related to grasslands and to prepare grassland/scrubland biodiversity management plans by providing a social, biological and legal backing to the efforts by the communities.
8. Grassland policy: A grassland/scrubland policy document was prepared in collaboration of Maharashtra Revitalizing Rain fed area Network. (MAHA RRAN)
9. Dr. Laxman Satyas book is translated into Marathi and published by Manovikas Prakashan Pune. This publication brings forward the less known ecological and agricultural history of the area. The book known as 'कापुसकोंड्याची गोष्ट' is widely appreciated.

Kayadu river grassland

Lesser Florican habitat

6. Forest Ecorestoration and management of Non-Timber Forest Produce (NTFP)

Participating Institutions: Lokparyay, Aurangabad; Khoj, Melghat; Janartha, Shahada; Shivaji University, Kolhapur; BAIF; and Gadchiroli

Background

The Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006, popularly known as FRA implemented from 1st January 2008, presents a significant opportunity and a great challenge, not only to conservation but sustainable use and regeneration of the state's forests, as well as the crop and livestock biodiversity. The Act recognizes the rights of The Scheduled Tribes and the forest-dwelling communities including the responsibilities and authority for sustainable use, conservation of biodiversity and maintenance of ecological balance and thereby strengthens the conservation regime of the forests while ensuring the livelihood and food security for all. While community rights over the forest are likely the ideal goal, the process has started in some regions of the state from individual rights over the forests and forest produce. This project monitored the implementation of community forest rights (CFR) and individual rights (IFR) and its effect on biodiversity conservation in 4 different eco-regions of Maharashtra, viz. north-west Maharashtra, Marathwada, Melghat and south-east Vidarbha. Another component of the project, located at the Shivaji University, Kolhapur has created an arboretum of rare, endangered and threatened (RET) species of the Western Ghats. It is crucial at this juncture to create models of how the Community Forest Resource lands can be managed to augment Maharashtra's forest biodiversity resources, while at the same time enhancing the quality of life in some of the most disadvantaged segments of the state's population.

Broad Objectives:

1. Biodiversity enhancement via eco-restoration activities in 4 districts of Maharashtra
2. Implementation with the help of Government watershed development, Afforestation and Rural Employment Guarantee Schemes (NREGA) and generation of employment for the disadvantaged communities
3. Documentation and validation of knowledge of ecology, propagation, utility and properties of the 150 plants and animal species selected by local communities
4. Policy and advocacy related interventions

Work Area and Focus

Organisation	Place of Work	Focus of Work
Janarth	District: Nandurbar Tahsils: 3 Villages: 4	• Forest conservation • Forest regeneration • Natural resource management • Biodiversity documentation • Community forest rights acquisition and management • People empowerment (focus on women) • Livelihood generation
Lokparyay	District: Aurangabad Tahsils: 2 Villages: 2 focal; 10 peripheral	• Forest conservation • Forest regeneration • Natural resource management • Biodiversity documentation • Individual forest rights (IFR) acquisition and management • People empowerment (focus on SC-ST-VJNT) • Livelihood generation
Khoj	District: Amaravati Tahsils: 2 Villages: 4	• Forest conservation • Forest regeneration • Herbal medicines • Natural resource management • Community forest rights acquisition and management • Sustainable and natural farming • Environmental education • People empowerment (focus on tribal communities) • Livelihood generation via convergence of programmes and schemes
Gadchiroli Project	District: Gadchiroli Tahsils: 3 Villages: 22	• Recording of “tapu” information and landscape elements

Organisation	Place of Work	Focus of Work
Shivaji University	Focal – Kolhapur Broader – The Western Ghats	• Germplasm collection and conservation of rare, endangered and threatened (RET) plant species • Research on survival, growth and propagation related research on these RET species • Introduction of RET species throughout Maharashtra and India

Salient achievements

1. Forest management and eco-restoration activities: Although the rights to the forest land were transferred by law, it took constant handholding and follow-up by the partner agencies for the actual transfer of the forest rights. Regeneration and forest eco-restoration of 2000 Ha of lost forest across four different eco-regions in Maharashtra was achieved. This effort involved conservation of soil, water and other natural resources for sustainable forest management and conservation, protecting the forest from grazing, tree-cutting, theft and illegal possession of the land, plantation of about 150 native and endemic species, eradication of exotic and invasive species such as *Lantana* and *Hyptis*, and germplasm collection and conservation of 90 RET and endemic species from Western Ghats.

2. Employment generation via forest eco-restoration: Activities such as tree plantation, minor and major construction activities aiding water and soil conservation, creation and maintenance of nurseries creating year-round employment for the communities were undertaken, including agricultural activities as one of the sources for livelihood.

3. Documentation of biodiversity: Documentation included PBR preparation, number and names of species preserved and regenerated, the special utility of plant parts, their storage and processing methods, duration of use, names and numbers of families using the said parts of the plants, and whether the material is sold in the market, was recorded.

4. In Gadchiroli project in the 22 project areas the following activities were done. a. Identified various land patches as are recognized by the local people called 'tapu' (ii) Identify land elements with different Landscape Types (LSEs) (iii) Collected data on species found in the area including their uses, qualitative abundance on each tapu for 5 Gramsabhas and for all 19 gramsabhas for landscape elements. (iv) Stock mapping using Point Centered Quarter Method for 5 gramsabhas for all tapus and for all 17 Gramsabhas for landscape elements. (vi) Data is collected on RET species from people as well as by a taxonomist10. Data was collected on efforts by the people to conserve the RETs.

5. In places where CFR have been provided to the Gramsabhas, the responsibility of preparing a working plan for management of CFR falls on the Gramsabhas. However, the gramsabhas do not have members capable of such technical work. To address this large scale issue, the Tribal Development Department decided to create a cadre of such workers from amongst the members of Gramsabhas. A diploma course was designed and conducted by Dept. of Economics and Public Policy, Mumbai University to create such cadre. Dr. Gadgil and Dr. Edlabadkar played a key role in this endeavor. The first batch of 27 diploma holders hailing from these Gramsabhas, who are now armed with technical knowledge and have a very strong feel of the ecosystem of this area, were utilized in the present eco-restoration project. We have taken full advantage of the rapidly advancing tools of ICT to organize a collaborative process of knowledge generation.The youth involved made use of smartphones which are generally GPS enabled. Following on-line and off-line tools were used in information gathering and collation: (i) Excel sheets (ii) GPS apps for boundary demarcation (iii) Google Earth (iv) On-line data capture using Epicollect5 modules. This will serve as a model for similar exercise in other forest communities.

7. Policy and advocacy interventions: The primary advocacy intervention includes the preparation of the draft of forest policy. This includes different models on forest management, including individual forest rights, for the state of Maharashtra, with inputs from the traditional forest-dwelling communities.

Recommendations:

1. The experiences on community forest management are best compare to lonely efforts of forest dept., One of the MGB project partners Lokparyay has developed "Community Biodiversity Park" on more than 1.2 ha. barren, soft rocky, dry land at village-Parala-Junone, Aurangabad district. It has planted, protected & conserved more than 28 species which was rare in drought prone Vaijapur taluka. It has encouraged Bhil-tribal community to protect different rare tree species on the farm bunds including adjacent forest department owned barren land. They are only taking grass out the land.

   In absence of CFR or with CFR the forest department along with Maharashtra State Biodiversity Board (MSBDB), community based organisations-NGOs and forest dweller community can develop "Natural Community Bio diversity Parks (NCBDP)" on hundreds of acres of barren forest land of drought prone area like Marathwada region. While developing NCBDPs, the involved community can take grass and develop their own dairy farm which will be one of assured income sources in draught prone area. It will reduce migration of tribal families as harvest area. Lokparyay study during MGB period, shows that by this way minimum 68% migration has been reduced.

   Therefore, it is strongly recommended that "Natural Community Biodiversity Parks" should be developed in every forest area of villages in Maharashtra.

2. The small scale NTFP units like natural colour from Palas flowers alongwith agro-based processing units in a cluster of villages can be established to generate assured employment for youths. It will increase assured income source to rural community and will reduce migration towards urban centres. Therefore, government should take special initiative and drive with special committed task force and community based organisations.

3. NTFPs are very important considering community's dependence on this resource for meeting various social- ecological, cultural and eco system service related needs. Hence even in forestry research, there is need to have special thrust on this along with timber species.

4. While selecting NTFP species for conservation and multiplication, equal weightage to be given to local people's preferences as, local communities value trees not only for economic purpose but also for ecological, social, cultural uses.

5. The project has evolved and introduced a methodology of identification of candidate plus tree which is an important and preliminary step in tree improvement programme of a particular species. Selection of NTFPs candidate trees should be based on locals needs, social, spiritual and economic importance for the local peoples of respective regions. This will augment the community to participate in large for conservation though sustainable harvesting and with its economic benefits at local level.

6. There is tremendous scope to mainstream efforts of community led forestry programs. For generations, communities have conserved trees and habitats in the name of God or as a part of community practice / tradition.

7. There is need to introduce science and technology tools for scientific harvesting of NTFP resource. This will help balancing economic well-being with eco system wellbeing.

8. Need of direct role play of local bodies in marketing system: The market of NTFP is extremely imperfect and unstructured. At present forest dwellers at project area collect NTFPs and sell it to local traders which in turn sell it to the urban center and finally reach to consumers. The distribution

channel from forest collector to urban wholesaler consists of 3-5 middlemen. It was nicked that, right from gathering the NTFPs from the forests to the first level of processing them at homes, the bulk of the work is done by women. Presently, they collect NTFPs (Gums, Mahua, Charuli, Herda, Behada etc.) for sale or barter simply because of lack of alternative employment opportunities. Hence, it is important to develop a strong value chain from collector to directly processor or end user to get direct large benefit through developing institutional level of support like Community based organizations / body of Gram Panchayat etc. The state and national policy should support such local bodies to play directly in marketing of NTFPs with due approval of Forest department.

9. NTFP nursery entrepreneurs: The good quality NTFP species seedlings and grafts were produced by local entrepreneurs after giving initial support and training. Such many entrepreneurs could be developed and strengthened with forest department support to cater the requirement of huge quantity of seedlings in plantation programs at village level.

10. Value addition in NTFP's: Local community has traditional knowledge in value addition of some of the NTFP's like Mahua flowers. Various products are being prepared and utilized for their own consumptions. However, there is tremendous scope to develop many such value added products for further market linkage and commercialization so that community could get attractive remuneration. This activity needs to be strengthen through linkage with various govt. schemes. Local self-help groups (SHG) may be encouraged for NTFP value added product entrepreneurship and incorporation of local value added NTFP products in school mid-day meal scheme.

11. Implementation of livelihood based forestry plantation on lands claimed under FRA /CFR land could help in sustainable use and conservation of forest resources. Convergence of govt. schemes like MGNREGA may be linked for eco-restoration of private and CFR land.

12. The forest rights act is a very pro-people and pro-nature act. The most significant provision of this act relates to community forest resource (CFR) rights. In Gadchiroli district of Maharashtra this provision has been adequately implemented and some 1100 Gram Sabhas have been granted CFR rights. One of the M. G. B. project has been active in this district and has put together considerable evidence that the implementation of CFR rights has led to the communities undertaking good management to ensure resource sustainability and to enhance protection to nature by sitting up new sacred groves. The youth in these villages are also acquiring skills such as Minor Forest Produce assessment, processing, value addition and marketing, along with keeping accounts and paying GST. Their enhanced incomes have also meant that the communities are now less and less dependent on earning a livelihood as migrant workers. It is therefore strongly recommended that the CFR rights provisions should be implemented in letter and in spirit in all the districts of Maharashtra with significant forest cover.

13. Conservation and development of arboretum RET and Endemic tree species Angiosperms of Western Ghats

    The Botanical Gardens are field gene banks from which germplasm of plants flow to various organizations . Considering the need of conservation the gene bank (arboretum) RET and Endemic tree species is established for generations to come (ex-situ conservation). Out of 102 targeted species of the project, 80 species are growing well in the Botanical garden (arboretum) with a 800 individuals. The saplings of 37 targeted species (5905 individuals) are distributed to various botanical, institutional, public and private gardens (857 beneficiaries). Nursery techniques of 20 RET and Endemic tree species are established.

    Dept.of Botany, Shivaji University, Kolhapur is ready to provide guidelines to undertake such programs for the conservation of RET and Endemic tree species in various parts of Maharashtra. The project has set a bench mark in Ex-situ conservation of Endemic tree species. It is a torchbearer for institutes who wish to carry on such projects on endemic tree conservation.

a) Targeting (identifying and listing) Rare, Endangered, Threatened (RET) Endemic tree species of Maharashtra is needed.

b) Forest department should undertake the programs on collection of seeds, their germination and sapling (nursery technique) of RET and Endemic tree species of Maharashtra and further their distribution to the people and plantation in natural habitats.

c) Local people should be trained for collection and direct sowing of seeds of RET and Endemic tree species in their natural habitats for which financial assistance and training be provided.

d) Maharashtra Government should undertake the programme to establish arboteria of native tree species in different parts of Maharashtra which in future will serve as germplasm bank of all tree species of Maharashtra.

8. Information, Education and Communication Management

Participating Institute: Centre for Environment Education, Pune

IEC for MGB component project has consciously chosen to work in partnerships with organizations implementing various thematic projects to strengthen organizational capacities in facilitating educational activities in their work areas.

The status of biodiversity education in the state when the MGB project was started was:

1. Lack of state wide bench marking in status vis-a-vis National Biodiversity Target 1
2. Low level of subject competencies among the teachers and students to build biodiversity learnings upon them
3. Lack of state contextualized pedagogical strategies and programs for biodiversity learning
4. Neglect and systemic destruction of linguistic diversity, which is rapidly contributing to the loss of Knowledge and Practices related to biodiversity
5. Lack of adequate financial resources for environmental education at large and biodiversity education in particular
6. Lack of adequate and effective consumer awareness on biodiversity, quality of life, food & nutrition etc.
8. Scheme like Environment Service Scheme (ESS), supported by Environment Department, Govt. Of Maharashtra are able to provide adequate and need based inputs but are currently restricted to small number of schools (50)

Salient Achievements

1. Project has developed a network of grassroots biodiversity educators associated with 15 partner organizations. These have been capacity built in areas of environmental education, biodiversity mapping and studies techniques, documentation and use of multimedia. Cluster level learning resources *'Pitaras'* have been created as a common resources with reference or field guides, binoculars, cameras, weighing machines, water and soil testing kits, magnifying glasses, seed collection boxes etc.

2. Gotul newsletter and web portal have been developed as tools for information exchange and networking. (www.gotul.org)

3. Project has been able to link school-based learnings to local environment and conservation initiatives by partner organizations and try test hands on activities towards strengthening constructivist approaches.

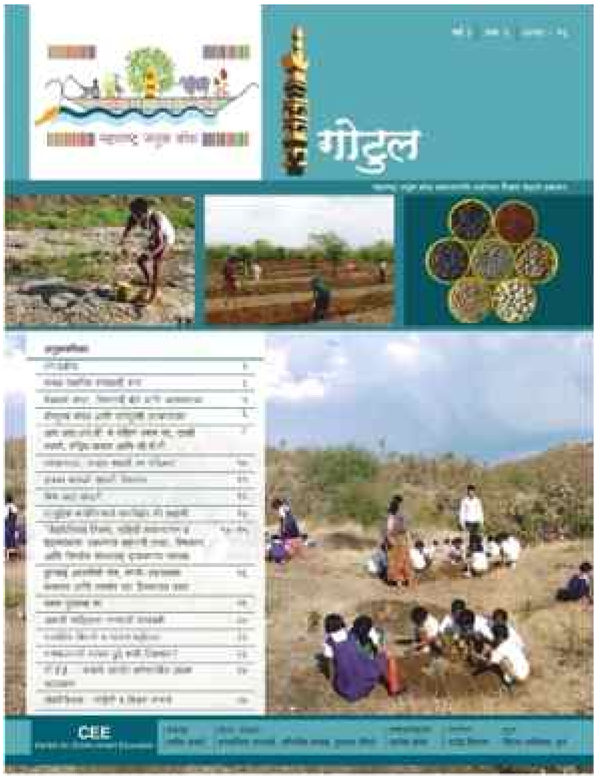
4. Designing and testing of *Shivar Feri* – school-based biodiversity registration ad studies handbook, and a resource kit for this process comprising 8 different resources

5. Secondary and higher secondary school level project ideas bank with 60 projects designed and tested in c. 150 schools. These project ideas are focused on themes of agro-biodiversity, forest, grassland and freshwater biodiversity, and also bringing cross cutting themes of gender, culture, economics and related policies as learning areas. Schools have submitted 73 school projects done by students back to CEE.

6. ***'Anandshala Shibirs'*** - workshop module for teachers and students- 3 days residential workshop modules were designed for teachers and students from participating schools.

7. In 2019-20 CEE conducted a study of food diversity among school students and across 3 generations. This study captures food diversity and intergenerational changes covering 39 different community groups with 152 families in total sample size.

8. As part of IEC for the MGB project, CEE Central organized 'A Very Curious Wedding: A photo-art Exhibition on Bio-cultural Diversity of Maharashtra' at IISER, Pune campus from 10-13 October 2019.



Database Development

A major exercise during 2019-20 and till the end of the project has been to collate and curate the data collected in MGB project during the entire period and modify into a searchable and usable data for further research and documentation.

Following steps were taken to build a Relational database using Postgresql server:

1. Interaction with all MGB theme partners to understand different types of data collected and formats/ sheets used by them for data collection.

2. Identifying metadata. Deciding on organization principles for the data.

3. Creating schema/s and tables using postgreSQL server. The tables were structured to satisfy 3Rd Normal form.

4. Collection of data from all the partners in Maharashtra Gene Bank Project (MGBP) partners.
5. Creating EXCEL sheets similar to the structures of the tables in the schema and populating these sheets using the data from various partners.
6. Validating data in the EXCEL sheets for attributes which are referred in more than one table and set relations using them viz. Species names, village codes, tapu names etc. Validation for those attributes which may take certain values only.
7. Data Migration : EXCEL sheets → csv files → Postgresql server
8. Spatial datasets were prepared for all the components of the MGB project
9. Geospatial data were created and posted on PostGIS and linked to PostgresSQL and Geoserver/Mapserver for a Webmap Portal.
10. A user interphase was prepared for accessing the data
11. Standard queries have been developed for drawing information from the database and additional queries can be generated as per the user/partners' requirement

Details of data included in the database	
1. Crop Diversity	
Village data	235
Seed bank data	34
Accessions	873
Crop data	649
Traditional knowledge and medicine	373
Traditional knowledge storage system	87
Traditional knowledge disease	89
Etymology	371
Festival biodiversity	108
TK-pest	122
TK-Reason for extinction	342
Traditional knowledge	
TK- Food recipe	461
TK-storage	174
Morphology	
paddy	165
linseed	2
hyacinth bean	33
Lakhori	2
Maize	19
pigeon pea	3
safflower	2
sorghum	32
pearl millet	1
Little millet	10
Finger millet	22

2. Forest Ecorestoration	
Village Plant Diversity	4633
Special utility	2514
Tapu Information	79
Tapu Plant abundance	3662
Tree measurement	2285
3. Grassland and Savanna Diversity	
Tapu	16
Diversity	45
Fodder product	290
Fodder consumption	296
Farmland	47
Livestock	441
Grazing	255
4. Habitat conservation	
Plant	1980
5. Livestock	
Animal utility	44
Breeder	87
Migration	104
Elite animal	77
Milk production	201
NTPF	
Utility	166
Survey	1470
Plant	1980
Marine Biodiversity	
Prokaryotes	1902
Eukaryotes	

The database is available at: http://mgb.iiserpune.ac.in

Other activities

1. The traditional knowledge and experience of the MGB partners while working with the community have been documented in a series of 50 articles published in "Agrowan" Marathi daily under the weekly column "Jagana Aani Jeevidha". These articles have been compiled into a book form for distribution to the partner organisations for wider dissemination
2. A series of video films (34 in number) on the activities of MGB partners were produced. These will be hosted on YouTube.

Possible Way Forward/Forward Directions

1. Strengthening the local institutions to ensure long term sustainability of the project activities beyond project tenure
2. Continued and expanded program of Community Led conservation in other biodiversity rich areas in the state of Maharashtra and in other states in NETWORK mode
3. Developing linkages and partnership with MSBB to explore post project continuation and support
4. Exploring Possibilities of mainstreaming biodiversity conservation related key pathways and best practices with the help of ongoing and future programs of state and central government (NREGA, POCRA , CFRA ,TSP, RKVY ,CAMPA etc) . NREGA Provisions could be used to support many innovative, locally useful works such as restoration of water bodies, regenerative plantation on CFRA lands and Grass land restoration
5. Exploring partnerships with agencies like, NABARD , TRIFED , Other Marketing institutions and MSRLM for Building Farmer Producer Organisations and to be able to develop a proper marketing system, brand for niche/broader markets and market linkages. There is scope to link the seed and grain producer farmers with government schemes like ATMA, Organic farming scheme, Tribal sub plans.
6. Advocacy for inclusive crop diversity and fishery policy, Conservation of grasslands, wetlands and forest resource is a necessity. This will facilitate wider dissemination of learnings and best practices at state and national level and for sharing with the policy makers so that appropriate biodiversity related programs could be framed and resource could be made available

Introduction

The Rajiv Gandhi Science and Technology Commission (RGSTC) of Government of Maharashtra requested Dr. Madhav Gadgil, in November 2006, at that time with Agharkar Research Institute, Pune to develop a concept note on the theme of Gene bank for the state. This note proposed a broad, inclusive approach involving both in situ and ex situ activities and drawing upon technical expertise as well as broad based participation of public. This concept paper was debated at a brainstorming session at ARI, Pune on June 9, 2007, with participation from the National Bureaus of Plant, Animal and Fish Genetic Resources, Agricultural Universities and a number of other experts.

At this meeting, it was noted that while "Gene Banks" do often denote means of preserving genetic material at low temperatures, the practices of safeguarding genetic resources are ancient and have taken varied forms such as protection of sacred groves and sacred ponds or pools in river courses. The group agreed that the Maharashtra Gene Bank (MGB) program too would take such broader view and design a live gene bank with both in situ and ex situ components.

It was further decided that MGB would be a collaborative effort building upon and complementing all the previous work at the national and state levels. It will network with a diversity of agencies in the country and within the state, making special efforts to reach out to the people at the grass-roots. The programme would not undertake to duplicate on-going national programs, such as the seed bank of National Bureau of Plant Genetic Resources or the Indian Biodiversity Information Network of the Department of Bio-technology. Instead, it will try to identify lacunae in the current efforts and attempt to complement them by filling such gaps. MGB would adopt a holistic systems view and design activities in an end-to-end fashion.

This was followed by discussion and planning session on October 23, 2007 with representatives of NGOs from all parts of Maharashtra. These exercises facilitated the identification of broad themes on which the Maharashtra gene Bank Program may focus and design a strategy of state wide consultations with a whole range of stakeholders. These state-wide consultations began on November 19, 2007.

The overall approach and the major themes identified were then shared with senior officials of various agencies of the Government of Maharashtra and the agricultural Universities at a meeting chaired by the Additional Chief Secretary at Mantralaya on December 6, 2007. Detailed discussions at this meeting helped in finalizing the approach and the themes. The additional Chief Secretary then wrote to the various government agencies concerned to help in the state-wide consultative process being undertaken. This process was planned in detail at a meeting of facilitators from many districts of Maharashtra on December 7, 2007. Following this discussion, a background paper on Maharashtra Gene Bank Program was prepared and widely circulated.

The comprehensive face-to-face consultations that have followed have taken the form of 112 events held in 24 districts, but with representatives from all 35 districts of the state. They have engaged a wide variety of institutions and individuals from all sectors of the society. The institutions represented included:

1. National Bureaus of Plant, Animal and Fish Genetic Resources
2. Central Government's Regional Centre for Organic Farming
3. Research institutes such as National Institute of Oceanography and National Centre for Cell Science
4. Botanical and Zoological Surveys of India
5. Agricultural Universities
6. Universities
7. Colleges
8. Maharashtra Livestock Development Board
9. Maharashtra Medicinal Plants Board
10. Elected Bodies like Panchayats
11. Self-help groups
12. Civil Society Organisations, and
13. Businesses

A total of 1464 individuals have participated in these consultations. They represent:

- Scientists: Agricultural scientists, plant breeders, veterinarians, forestry scientists, ecologists, food technologists, botanists, zoologists and oceanographers
- Teachers and students: school, college, university and agricultural universities
- Government officials, in particular representing agriculture, forest, fisheries, tribal welfare and education departments
- People's representatives, in particular, elected panchayat members, JFM committee members and SHG members
- Corporate sector scientists working on organic certification

- NGO workers from agencies working on issues of rural development, environment organic agriculture, education, health, animal health, Gorakshan and land rights
- Members of tribal communities including conventional farmers, organic farmers, horticulturists and medicinal plant cultivators
- Members of herder communities including buffalo herding pastorals, shepherds and livestcok breeders-conservers
- Members of fishing communities including freshwater, estuarine, and marine fisher folk
- Others including Vaidus (traditional healers), journalists, landscapers and traders

Apart from these extensive face-to-face consultations, many inputs have flown from use of a whole range of Marathi and English media including news items and articles in Marathi and English newspapers, a 30-minute interview on All India Radio and reporting on several TV channels. The process has also benefitted from an internet based discussion group and web postings.

Through this painstaking effort by Dr. Madhav Gadgil, a joint proposal comprising of 9 projects and 26 subprojects was submitted to the RGSTC on July 10, 2009.

Description of the problem

Gene banks denote means of preserving genetic material, be it plant or animal. In modern times, the focus has largely been on ex situ repositories. In plants, this could be freezing cuts, or the seeds themselves. In animals, this is the freezing of sperm and eggs in zoological freezers until further need. But the practice of guarding genetic resources is ancient and has taken forms such as protection of sacred groves and sacred ponds or pools in river courses. The Maharashtra Gene Bank (MGB) program, too, would take a broader view and design a live bank with both in situ and ex situ components. The in situ components should preferably be dispersed throughout the state so that the genetic resources will be accessible to people close to their own localities. This would keep open the possibilities that genetic resources continue to evolve through natural processes such as exposure to new pests and diseases. It will further ensure that farmers have ready access to superior traditional cultivars (in case they wish to adopt new strategies such as organic or natural farming), herders to locally adapted land races, fisherfolk to indigenous fish species, or forest dwellers to propagules of a variety of non-timber forest produce.

The ongoing ex situ conservation efforts in the country do not include any significant programs focusing on marine biodiversity, a major new frontier for bioprospecting. This is an important opportunity for Maharashtra to take a lead in the country. At the same time, there are well-designed efforts to conserve terrestrial plants, domesticated animals, endangered wild life species and freshwater fish genetic resources through ex situ programs. It is worthwhile complementing such efforts with in situ activities, so that the organisms continue to generate new genetic diversity.

The Protection of Plant Varieties and Farmers' Rights Act (PPVFR) does take this into consideration and provides for registration of traditional cultivars or farmers' varieties by both individual farmers and communities. It has led to the setting up of a National Gene Fund for benefit sharing to farmers and communities, and for capacity building of panchayats to organize on-farm conservation efforts. Special efforts would now need to be made to register the traditional cultivars and farmers' varieties in the state. It will not be practicable for MGB to try to promote in situ conservation of all existing cultivars and land races. Instead, MGB will concentrate on the most promising ones. Farmers will then be encouraged to cultivate the selected varieties in soil, rainfall and other conditions particularly conducive to them, and encouraged through organisation of special sales festivals. The efforts will be supported by scientific studies of the selected varieties regarding attributes such as nutritional quality and technical investigations on issues like processing and development of value added products. The growing interest in sustainable or organic farming amongst Maharashtra's farmers could be linked very effectively to on-farm conservation of traditional cultivars and farmers' varieties.

Many land races of domestic animals too possess attributes of value, and MGB will try to identify and maintain them. There exists today definite interest amongst the farmers/breeders in animals of certain breeds such as Dangi cattle of Sahyadris. There are still individuals committed to maintenance of such breeds. Such individuals need to be identified throughout the state and organised into Associations of Breeders of specific landrances. These Associations need to be supported technically and financially.

Maharashtra's fresh water biodiversity has suffered even more than terrestrial or marine biodiversity. The official programs too have tended to be focussed on propagation of a small number of species such as Rohu, Catla and Mrigal; neglecting practices like protection of sacred pools and ponds. Yet many local species are greatly valued and fetch a much greater price and very much deserve to be conserved. The existing Fishermen's Cooperatives, as well as the local Biodiversity Management Committees that will now be established under the Biological Diversity Act could play a positive role in good management of fresh water ecosystems as a whole, to considerable benefit of indigenous freshwater biodiversity.

Maharashtra's extensive tracts of grasslands scrub and tree savannas have supported sheep and cattle keeping, as well as wildlife like Back buck, Chinkara, Nilgai, Florican and Bustard. In this context, the MGB program may focus on (a) regeneration of palatable grass and legume species, and (b) protection of grassland/savanna wildlife. This may be most effectively accomplished with active involvement of herders and erstwhile hunters.

The recent Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act provides a major opportunity and a great challenge, not only for conservation, but sustainable use and regeneration of the state's forest, as well as crop and livestock biodiversity resources. The rights granted under the act include individual as well as community tenure. The latter comprise ownerships, access to collect, use or dispose of minor forest produce and the right to protect, regenerate or conserve or manage any community resource. The local community members have interest in the maintenance of a wide variety of species with a range of uses. For instance, the people's biodiversity Register of Chavani village in Raigad district records on-going local uses of 183 out of 240 locally known, naturally occurring species of flowering plants. When motivated and authorized to do so the local people will opt to encourage natural regeneration, or undertake replanting of a great diversity of plant species, thereby substantially enhancing the stock of the state's biodiversity. The MGB program will focus on our own indigenous biodiversity elements, and emphasize natural, supplemented by artificial regeneration. It will take advantage of EGS funds to support many of the component activities. Additionally, local communities may agree to extend full protection to about 10% of community forest resources on the traditional pattern of setting aside representative examples of all land and water ecosystems as sacred conservation sites.

Information management is an important component of the MGB project. The two outstanding challenges that it can address in this context are those of involving people, who are a great repository of detailed information on many facets of their local environment, and of reaching out to people in their own language, Marathi. Today, there are two important opportunities to involve people in their endeavour; namely, the introduction of environmental awareness courses at all stages of the educational process, and the Biological Diversity Act.

The MGB program will thus take a comprehensive view of biodiversity, covering the marine, freshwater and terrestrial realms, wild as well as domesticated species, and employing sophisticated technologies, while at the same time reaching out to people at the grass-roots. It will try to collaborate with and complement ongoing efforts. In so trying to complement the efforts, it will try to correct the glaring contradictions that have arisen. The existing programs of biodiversity conservation, focus on a few islands of plenty set in a milieu of environmental poverty. The more inclusive approach adopted by the MGB would render biodiversity resources much more broadly accessible and importantly contribute towards leaving options for self-reliant agriculture and animal husbandry open to people on a long term basis. It is only by thus making biodiversity everybody's business will we be able to tackle the most serious social challenge of growing rural unemployment and at the same time sustain our rich heritage of biodiversity resources on a long term basis.

The component projects of this proposal were reviewed, discussed and approved by a committee consisting of :

Dr. Manju Sharma, Former Secretary, Department of Biotechnology, Govt. of India

Dr. V. Arunachalam, Former Professor, IARI, New Delhi

Dr. S. Bala Ravi, Advisor, MS Swaminathan Foundation, Chennai

Dr. P.V. Dehadrai, Former ADG, ICAR, New Delhi

Dr. P.R. Dubhashi, IAS (Retd.) Former Secretary to Govt. of India, Cabinet secretariat and Vice Chancellor, Goa University

Dr. K.N. Ganeshaiah, Professor, Department of Genetics and Plant Breeding, University of Agricultural Sciences, GKVK, Bengaluru 560065

Dr. K.C. Malhotra, Former Professor, Indian Statistical Institute, ISI, 385, sector 29, Noida 201301

Dr. K. Venkataraman , Secretary, National Biodiversity Board, Chennai

Under the initiative of Dr. Anil Kakodkar, Chairman of RGSTC, a meeting was organized on 15th October 2011 wherein it was decided that the project will be coordinated from IISER Pune with Prof. Milind Watve as the coordinator. Because of the long intervening period from the proposal and final consideration, some modifications and revisions were necessitated and a revised project was submitted. An independent proposal submitted around the same time for funding by Shivaji University, Kolhapur on conservation of RET species was also included in the Maharashtra Gene Bank Project, since the objectives are found somewhat identical. The MGB project was approved for implementation from January 2014 vide letter No. RGSTC/File-2009/DPP-054/CR-28 dated 2nd January 2014 with an outlay of Rs. 33,15,30,000 for 5 years. An MoU was signed with each of the participating institutes before the actual fund transfer took place. Since this resulted in different start dates for each of the partners, it was decided that the project be deemed to have started on 1st April 2014.

The Project has the following seven major projects with a central coordination unit at IISER Pune.

S.No.	Component	Organisation	Principal Investigator
1	Inventory and Bioprospecting of marine invertebrates of the Maharashtra coast with special emphasis on sponges and associated microorganisms		
	1.1 & 1.2	IISER Pune	Dr. Milind Watve
	1.3	Institute of Science, Mumbai	Dr. Balasaheb Kulkarni
	1.4	College of Fisheries, Dr. BSKVV, Ratnagiri	Dr. Swapnaja Mohite
	1.5	CSIR-NIO, Goa	Dr. Baban Ingole
	1.6	NCCS, Pune	Dr. Yogesh Souche
2	Crop Diversity		
	2.1	Gramin Yuva Pragatic Mandal, Bhandara	Shri Avil Borkar
	2.2	Sanskriti Samvardhan Mandal, Sangroli, Nanded	Shri Pramod Deshmukh
	2.3	Institute of Integrated Rural Development (IIRD), Aurangabad	Shri Joy Daniel
	2.4	Sheti Pariwar Kalyan Sanstha, Atpadi, Sangli	Shri Prasad Deshpande
	2.5	Lokpanchayat, Sangamner, Ahmednagar	Shri Sarang Pande
3	Conservation of Dangi Cattle in Akole Block of Ahmednagar District		
	3.1	Lokpanchayat, Sangamner, Ahmednagar	Shri Sarang Pande
4	Conservation and sustainable use of freshwater biodiversity by involving fishing cooperative societies		
	4.1	Bhandara Nisarg va Sanskruti Abhyas Mandal, Bhandara	Shri Manish Rajankar
5	In-situ conservation of grassland biodiversity, with participation of local farming, pastoral and nomadic communities		
	5.1	Samvedana Samaj Vikas Sanstha, Karanja Lad, Washim	Shri Kaustubh Pandharipande
	5.2	Vanya Susthapana (Vasudha), Dhule	Dr. Dhananjay Newadkar
	5.3	Ugam Gramin Vikas Sanstha, Umra, Hingoli	Jayaji Paikrao
6	Ecorestoration of community forest resource lands employing a diversity of life sustaining and economic plant species		
	6.1	Janartha Adivasi Vikas Sanstha, Shahada	Vikram Kanhere
	6.2	Lokparyay, Aurangabad	Shri Shantaram Pandere
	6.3	KHOJ, Melghat	Smt. Purnima Upadhyay
	6.4	Vrikshamitra, Gadchiroli & Gadchiroli working group	Mohan Hirabai Hiralal (from 2019 Dr. Madhav Gadgil & Dr. Vijay Edlabadkar)
	6.5	Shivaji University, Kolhapur (Conservation and development of arboretum of rare, endangered, threatened (RET) and endemic tree species of angiosperms in Western Ghats)	Dr. S.R. Yadav/ Dr. Rajaram Gurav
7	Conservation, Management and revival of local resources		
	7.1	BAIF, Pune	Shri. G.G. Sohoni/ Smt. Rajashree Joshi/Dr. Vitthal Kauthale
8	Information management, education and communication for Maharashtra Gene Bank Project		
	8.1	Centre for Environment Education	Sanskruti Menon/ Satish Awate

After the first year of the project, the component 1.3 at Institute of Science, Mumbai had to be withdrawn because of the retirement of the PI and his inability to continue the project. This was subsequently integrated with IISER Pune component.

Project Implementation Mechanism

An Executive Committee chaired by Dr. Madhav Gadgil was set up to address the issues related to implementation of the project at the field level and to guide the coordination unit regarding allocation of funds and disbursement. The members were: Shantaram Pandere, Manish Rajankar, Dhananjay Newadkar, Girish Sohani/Rajashree Joshi.

The RGSTC constituted a Steering and Monitoring Committee to periodically assess the progress of the project and make suitable suggestions/ course corrections to meet the objectives of the project. The monitoring committee consisted of the following members:

1. Prof. Madhav Gadgil Chairman
2. Dr. K. Vijayraghavan, Secretary, DBT, GoI or his representative
3. Shri Pramod Kale, Member, RGSTC
4. Dr. R.G. Dani, Vice-Chancellor, Dr PDKV, Akola
5. Dr. Jay Samant, Retired Professor of Environmental Sciences, Shivaji University, Kolhapur
6. Dr. A.A. Nambi, Director, M.S. Swaminathan Research Foundation, Chennai
7. Dr. Anil Kumar, M.S. Swaminathan Research Foundation, Chennai
8. Prof. Pradeep Burma, University of Delhi, Delhi
9. Dr. S.R. Shetye, Vice-Chancellor, University of Goa, Goa
10. Dr. K.N. Ganeshaiah, University of Agricultural Sciences, Bengaluru
11. Dr. Chanda Nimbkar, Nimbkar Agricultural Research Institute, Phaltan, Maharashtra
12. Dr. A.K. Mishra, Vice-Chancellor, MAFSU, Nagpur
13. Dr. K.C. Bansal, Director, NBPGR , New Delhi (or his representative)
14. Dr. Arjava Sharma, Director, NBAGR, Karnal (or his representative)
15. Dr. B. Pisupati, Chairman, National Biodiversity Authority, Chennai (or his representative)
16. Dr. P.L. Gautam, Chairperson, PPV & FRA, Govt. of India, New Delhi (or his representative)
17. Shri Uday Avsak, Member Secretary, Maharashtra State Biodiversity Board, Nagpur
18. Commissioner of Agriculture, Govt. of Maharashtra, Pune
19. Dr. C.D. Mayee, Former Chairman, Agricultural Scientists Recruitment Board, New Delhi
20. Dr. V.V. Mahajani, Advisor, RGSTC, Mumbai
21. Dr. Milind Watve, IISER Pune,Member Secretary

The terms of reference of the committee were:

1. The committee would monitor progress of the project on a periodic basis. Record of discussions during the meeting and six monthly reports may be filed with the Commission
2. The Committee would guide/help the institution/PI in effective implementation of the project and achieve the intended objectives
3. The Committee would function for the entire duration of the project

During the tenure the project the MC met for 5 times along with invited experts of each theme. There was also a mid-term review of the project during 2018 wherein experts other than MC members also visited the project sites and submitted valuable suggestions.

Based on the recommendation of the Monitoring Committee held in October 2018 the project was given a no-cost extension of one year, i.e., up to 31-3-2020. During the meeting of Monitoring Committee held on 8th November 2019, Dr. Madhav Gadgil proposed constitution of a Working Group to examine and implement various activities to document the information and knowledge generated in the project through videos, brochures and Wiki media articles, in addition to the mandatory Project Completion Report for submission to RGSTC. The Working Group consisting of Shri Kaustubh Pandaripande, Shri Manish Rajankar, Shri Shantaram Pandere, Dr. Vijay Edlabadkar and Shri Satish Awate met several times and prepared a plan for developing various outputs. For carrying out these activities, EC recommended a further extension up to September 2020, which was approved by RGSTC. Because of the Covid 19 pandemic that gripped the country from March 2020 and lockdown enforcement for a major part of this period, it was not possible to carry out any of the proposed activities, and hence a further extension up to 31 December 2020 was requested, which was approved by RGSTC.

Organisational Information

About the partners of Maharashtra Gene Bank Program

Indian Institute of Science Education and Research Pune (IISER Pune)

IISER Pune is a premier institute dedicated to research and teaching in the basic sciences. It was established in 2006 by the Ministry of Human Resource Development, Govt. of India (now Ministry of Education). In 2012, it was declared as an Institute of National Importance by an Act of Parliament. As a unique initiative in science education in India, IISER Pune aims to be a Science University of the highest caliber devoted to both teaching and research in a totally integrated manner, with state-of-the-art research and high quality education, thus nurturing both curiosity and creativity. The institute offers 5 year BS MS, Integrated PhD and PhD program in biology, chemistry, earth and climate science, humanities and social science, mathematics, and physics. Research in Biology at IISER Pune currently encompasses both theoretical and experimental approaches to the broad areas of Systems Biology, Ecology and Population Dynamics, Evolutionary-Developmental Biology, Cancer Biology, Neurobiology, Epigenetics and Gene-Environment interactions.

IISER Pune has been ranked 25 in the National Institutional Ranking Framework (NIRF) 2020, an initiative of MHRD to rank national institutions based on parameters like teaching, learning and resources, research and professional practices, graduation outcomes, outreach and inclusivity and perception.

IISER Pune has been given the responsibility of coordinating the MGB project, which includes interaction with the partners for the technical program, arranging periodic review meetings, monitoring meetings, submission of consolidated annual report to RGSTC, receipt of grants from RGSTC and disbursal to the partners following the accounting standards of the institute.

College of Fisheries, Shirgaon, Ratnagiri, a constituent of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Considering the importance of fisheries in coastal rural economy and trained manpower for the growth of fisheries enterprise, the Government of Maharashtra established College of Fisheries under Dr. Balasahab Sawant Konkan Krishi Vidyapeeth, Dapoli in the year 1981. The college offers a four-year B.F.Sc. degree with the model syllabus of ICAR, and an intake of forty students. The college also had the privilege of receiving ICAR sponsored students for the undergraduate program since the year 1984 and for post-graduation in subsequent years. The college now has its own new campus at Shirgaon, at seven kilometer distance from Ratnagiri city. The well mandated departments of the college include the disciplines of Fisheries Biology, Aquaculture, Fisheries Processing Technology and Microbiology, Fisheries Hydrography, Fisheries Engineering and Fisheries Resources, Economics, Statistics & Extension Education.

The college also offers Masters degree in nine & Doctoral degree in six disciplines and equipped with excellent research facilities for students and faculty.

CSIR-National Institute of Oceanography

The National Institute of Oceanography (NIO) is a constituent of the Council of Scientific and Industrial Research (CSIR). It was established in 1966 and since then it has grown in to multidisciplinary oceanographic institute of international repute. CSIR-NIO has sufficient expertise and resources to undertake all type of marine survey, SCUBA diving, detailed biodiversity studies and primary extraction of compounds. The Biological Oceanography Division has all the required experience and expertise in marine biology whereas the chemical oceanography division of NIO has adequate expertise in natural product chemistry.

National Centre for Cell Science

The National Centre for Cell Science (NCCS), an autonomous organization aided by the Department of Biotechnology, Government of India, was established with a tripartite mandate of:

- Serving as a national repository of animal cell cultures
- Undertaking research in cell biology
- Human resource development

NCCS is located within campus of the S. P. Pune

University. Since inception, NCCS has been carrying out cutting-edge research in cell biology, has been providing valuable services as a national animal cell repository and has been supporting human resource development through various teaching and training programs. NCCS has been at the forefront of basic research in diverse fields of cell biology, especially those addressing paramount human health issues like cancer, metabolic and infectious diseases, and regenerative medicine. The research at NCCS is focused on answering challenging questions through approaches that integrate modern and conventional disciplines, including computational and structural biology, genomics and proteomics, stem cell biology, immunology and microbiology.

National Centre for Microbial Resource (NCMR) started as Microbial Culture Collection (MCC) in 2009 with a mandate to preserve and catalogue diversity of bacteria collected from different ecological niches from all over India and to make them available for biotechnological exploitation by researchers. With excellent infrastructure and expertise in microbial taxonomy and long term preservation, it started offering in 2013 various services involving microorganisms. In April 2017 MCC was transformed as a Centre of Excellence for National Centre for Microbial Resource (NCMR). It plays a crucial role as custodian of microbial diversity of India. With more than 1,80,000 microorganisms in its collection NCMR is the largest culture collection in the world and single-handedly lifted India to 3rd place among countries having collection of microorganisms. It was recognized in April 2009 as an International Depository Authority (IDA) for the deposit of microorganisms for the purposes of patent procedures under the Budapest Treaty by the World Intellectual Property Organization, Geneva. NCMR also got recognition as a Designated National Repository under the Biodiversity Act of 2002 from the Ministry of Environment, Forests and Climate Change, Government of India. It is an affiliate member of the World Federation for Culture Collections (WFCC) and registered with the World Data Centre for Microorganisms.

Gramin Yuva Pragatik Mandal (GYPM), Bhandara

Gramin Yuva Pragatik Mandal was conceived with the inspiration of revolutionary thought of Dr. B.R. Ambedkar about dignity and equality to all as human beings. It was started as a small group by youth who came together with the perspective that educated people should work for those struggling for their human rights, dignity and livelihood means. It emerged as an organization in Kondhi village situated in Bhandara district. It was registered as a Trust on 15 August 1987.

GYPM has addressed the following issues since its inception.

Issue	Programme	Activities	Beneficiaries
Women Empowerment	SwarnJayanti Gram SwarajYojna **(SGSY) Scheme**	· SHG Group formation · Capacity Building of SHG Women members for enhancement of livelihood skills	Women across castes and class; but special focus on women from marginalized sections.
Livelihood security	WADI project	Training farmers from Gond community, with small land holdings, to earn additional income through allied activities such as livestock keeping. 500 acres of land was brought under horticulture component includes plantation of mango, cashew and vegetables.	Project support and ensure livelihoods for 500 families in 10 villages in TumsarTaluka of Bhandara District. Project has major initiative to address soil and water conservation of 500 acres. Women's involvement was must for the project; their participation to ensure nutritional health to mitigate malnutrition in tribal community.
Natural resource management	**SRI Project** (System of Rice Intensification program) Support from SDTT Mumbai	Capacity building programme for farmers about techniques of growing paddy with less input for greater returns.	SRI technique for rice cultivation program was undertaken with **2356 farmers in 4000 acres in Bhandara district.**

Issue	Programme	Activities	Beneficiaries
Organic farming	**Organic Farming Project** Department of Agriculture (Government of Maharashtra)	· Organic farming Workshop · vermicompost · Training for Farmers (Farmers School) · Biodynamic compost · Study tour	Organic Farming Project was implemented in Bhandara and Chandrapur Districts. In all 259 farmers took initiative after getting training on organic farming and preparation of compost. In all, organic farming was taken up in 280 acres of land.
Education and Literacy	Learning and Migration Project (LAMP)	· Quality education programme, · RTE Campaign · School Management Committee orientation	Quality Education for school children (3 to 5 In Z.P school) from 10 villages - 650 students were benefitted. RTE Campaign was initiated in 60 villages; SMC orientation for Members; Computer Education; English speaking classes
Human rights and Social Justice	**Child Right Programme** MCCFZ Project Movement For Creation Of Child Labor Free Zone In Vidarbha Region	· Child Right awareness Program · Monitoring & Evaluation	Under this program 560 children were supported to continue their education from 60 villages in Bhandara district.
Water management	**Water Management & Right Program**	· To study role of water distribution committee · Capacity building for members · Advocacy & studies, Rain water harvesting,	Study was undertaken in 15 villages in Bhandara district on role of water distribution committee

Sanskrit Samvardhan Mandal (SSM)

SSM is a non-government organization active in integrated rural development since 1959. Started as Shivaji High school, SSM has now grown in to a 200 acres development hub. The focus of its activities has always been on the deprived rural communities especially women and girls. Key issues addressed by SSM are:

- Improvement in Rural Education through providing residential schools and high school.
- Skill development program for school dropouts and youth through "Utkarsh" –Vocational Training Centre.
- Motivating local students and young rural players to enhance their ability and providing better opportunities at different platforms through Sagroli Sunrise.
- KrishiVigyan Kendra (KVK) is a local level institution mostly focusing on development of agriculture and allied activities empowering local farmers in Nanded area through training, capacity building about new techniques and polices approved by Indian Government.
- Equine Welfare Program focusing on providing free health service to Donkey to sustain the livelihood of poor communities like Parit, Khumbar, etc.
- To mitigate the drought prone condition SSM implemented Watershed development program, Jansathi Duskal Niwaran Manch Network in Marathwada and Vidarbha.

Institute for Integrated Rural Development (IIRD)

IIRD was established in 1987 in Aurangabad, Maharashtra. The organization is committed to empowerment of the rural poor particularly in Marathwada region of Maharashtra.

IIRD and associated development volunteers at the village level believe that social justice and care of the environmental resources is intertwined. Over the past two decades, IIRD has established its presence in the Marathwada region in areas of non-formal education, vocational training, support of the aged, rural housing and sanitation, environmental awareness, biodiversity conservation, women's empowerment, micro-enterprise development, organic agriculture, and water conservation and management.

In the rural villages of Aurangabad district, the strategy adopted by IIRD is one of interactive and participative learning that is based on the PEACE philosophy – People Education and Action for Community Empowerment. This strategy involves facilitating collective learning and knowledge sharing among rural women to undertake ecological restoration, non-formal training, and other development interventions with the inclusion of the marginalized poor.

The organization has grown in its presence from the initial six villages to the current 210 villages in seven districts where there are direct beneficiaries who have benefitted from the various interventions – water conservation/ management, housing, sanitation, organic farming, biodiversity conservation, vocational training, health care, and micro-enterprise development. Moreover, the organization has influenced policies and strategies at national and international levels through its participation and lead in various networks. Besides the establishment of a national network of organic bazaars spread over 14 different towns and cities in different parts of India based on alternative guarantee systems for organic produce, IIRD is also a member of several national and international networks that include International Federation of Organic Agriculture Movements (IFOAM), Participatory Guarantee System (PGS) India Council, World Conservation Union (IUCN), and ASPBAE.

IIRD was awarded the Sustainable Agriculture and Rural Development (SARD) award for its contribution to sustainable agriculture and rural development presented under the International Federation of Organic Agriculture Movements (IFOAM). More recently, IIRD was also awarded the Krishi Bhushan award by the Government of Maharashtra for its commendable work in promotion of organic farming among small and marginal farmers.

Sheti Pariwar

Sheti Pariwar Kalyan Sanstha, Atpadi basically started with conservation of indigenous goat breed Osmanabadi since from 1985. Sheti Pariwar is proud to be the proponents of concept of stallfed goat rearing. Founder President of organization Shri Narayanrao Deshpande was awarded the title of ***Bakri Pandit*** by Central Institute of Research on Goat (CIRG) Farah, Mathura. Organization is located in drought prone area where scarcity of fodder is key problem. There is one jowar variety viz. Vandi in our area, which is popular for fodder but due to pre mature cutting of crop for fodder, there is no seed production and day by day area under cultivation of this variety also decreased. With the help of farmers, conservation of this particular variety was started in 2000. There is one more activity of our institute on agriculture accounting i.e., documentation of daily activities of farmer in his field. There are 2000 contact farmers in this programme and in the interaction with them information about traditional varieties of paddy, wheat, jowar crop has been collected by institute. Farmers are interested in traditional varieties but they do not have proper guidance of seed conservation, value addition and marketing.

LokPanchayat

LokPanchayat is a non-profit organization registered under the Societies Registration Act 1860 in 1993. It has been working with farmers since nearly last two decades at Sangamner and Akole blocks for conservation of indigenous and local crop varieties. Lokpanchayat has taken initiative for sustainable agricultural practices, bio-diversity conservation, women's empowerment, enterprise development and liberal school education in rural schools.

Lokpanchayat had organized awareness campaigns for the promotion of organic farming and conservation of agro biodiversity. It is working with farmers for the conservation of agro biodiversity and established sustainable livelihood in traditional agricultural practices such as Maliv and Irvad.('Maliv' and 'irvad' are traditional mixed cropping patterns totally dependent on rainfall.)

Lokpanchayat planned specific vision based working methods selecting the following areas of work: Watershed Development, Sustainable Agriculture, Women Empowerment: Micro Credit facilitation, livelihood activities, support and social processes for protection of women in domestic violence, NTFP based Livelihood Development activities for tribals assuring Forest Rights, Biodiversity conservation, Liberate School- self directed and experience based learning program.

Presently, Lokpanchayat is engaged in enhancing the development processes at the village level. Lok Panchayat reaches out to more than 100 villages of Sangamner, Akole & Ahmednagar blocks of Ahmednagar district through well- designed programs like Farmers' Forums, Women's SHGs, Vanpanchayats and Liberate Schools that focus on these thrust areas. It has established 355 women SHGs and 35 Farmer Clubs named 'Krishak Panchayat'. Till date, 2500 women SHG members have been facilitated to initiate & start their business and economic activities by the organization. The women SHGs established women cooperatives called *'Nirmiti Mahila Audhyogik Coop. Ltd.'*. 35 farmer clubs established a company named *'Baliraja Farmers Producer Company'*, of which turnover is reached to Rs. 30 lakhs/annum.

Besides, 326 single women who were facing the issue of domestic violence have been assisted for settlements, to get benefits of the govt. schemes & employment under BAHINA program. The organsation has 6 years of experience of working with the tribes of Western Ghat and organizing tribal communities for livelihood security and their rights. During the period, about 300 tribal farmers and 225 NTFP harvesters have benefitted from learning of Organic Farming techniques, sustainable NTFPs harvesting and processing, respectively. The organization has interlaced a good alliance and wider network with the tribal community in 30 villages nested in surrounding of *'Kalasubai-Harichandra wildlife sanctuary'*. Besides, the organization has a troupe of artists (चाळीसगाव डांगाणी कलापथक) which uses their musical & drama skills to perform skits and musicals in villages to spread awareness about social and environmental issues.

Lokparyay

Initially people's movement was started against atrocity on schedule caste, agriculture labor, minor girls under the banner Yuvak Kranti Dal (Yukrand), the youth organization of Loksamittee, a people's committee at Vaijapur taluka from Aurangabad district. Then Loksamittee concentrated on issue of "Dignity of women". Loksamittee is functioning since 1977. Bharatiya Lok va Paryavaran Vikas Sanstha (herein after referred as Lokparyay) was registered under Societies Registration Act in 2002. Lokparyay works in Aurangabad district in Marathwada region. The community profile of this area is Bhil, Thakar-Tribal, SC, Vimukta Jati-Nomadic Tribes (VJNT) Communities. Most of them are landless labor and marginal farmers. They have to migrate as harvest labor from October to May towards Western-Northern Maharashtra & Gujarat states for their livelihood.

Loksamittee addressed the key issues on various topics. Loksamiti mediated for implemented programmes like-

a) Agriculture: Implementation of Employment Guarantee Scheme-EGS to develop various water bodies like irrigation projects- percolation tanks, community wells, etc. The Project Officer of Integrated Tribal Development Project-ITDP Aurangabad and Block Development Officer sanctioned irrigation wells for tribal farmers. The schemes under Social Welfare Department for Scheduled Castes-SC community were implemented. Agriculture Officer of Agriculture Dept. allotted seeds - fertilizer bags, farm ponds to the SC-ST farmers from the villages-Parala-Wadi-S and their adjacent villages. Agriculture Equipment and traditional seeds Banks were established in the main villages.

Energy: The solar power unit was installed at Parala-Junone as an alternative source of energy.

Biodiverty: For those tribal farmers who succeeded to get forest land under FRA-2006, Lokparyay campaigned for plantation of various local species on their agriculture farm land.

Health: Health checking Programmes for Women-Children were organized with the help of Primary Health Centre-PHC. Marathi daily "Sakal" published special supplement on malnutrition in tribal women & children.

Social Reforms-women: Loksamittee fought against corruption in EGS & Revenue dept. Regular campaigns were organized on right to education for every child. Near about fifteen Mini Anganwadi including repairing of old Anganwadi were sanctioned at Parala and its adjacent area. Family Counseling Centers were established. Lokparyay along with women and tribal youths tried to organize campaigns against liquor. Lokparyay is running "Childhood Care and Development Care Centre (Bal Anand Jivan Shala)" for tribal children of migrant harvest labor and trying to convince both girls and their families to educate them up to twelfth standard.

SC-ST-VJNT communities and Land Right: Implementation of "The Scheduled Tribes and other forest dwelling community (Recognition of Forest Rights) Act-2006 and Rules-2008 (FRA)", the Programmes on distribution of Caste Certificates to Bhil, Thakar, Pardhi-Adivasi-ST communities were organized at Parala and Chimnapur.

Bhandara Nisarga Va Sanskruti Abhyas Mandal (BNVSAM)

The organization has informally started its work in 1988. At that time, it was popularly known as Bhandara Nature Club and has worked as an affiliated institution with WWF India. Environment and science popularization activities were undertaken in schools and colleges. In 1993, the organization was formally registered as Bhandara Nisarga Va Sanskruti Abhyas Mandal.

The work on traditional water management systems has been initiated in 1998. Initial work was focused on study and documentation. From 2007, the organization has started working in project mode and started working with water dependent communities, especially the fisher folks. Since then, on the basis of experiential knowledge of the community, the organization has developed method of aquatic habitat restoration for improving fish production. At the same time, community development issues were also addressed and efforts have been taken for developing women leadership in fishing community.

The area of work of the organization is mainly in the districts of Bhandara and Gondia, with headquarters at Arjuni Morgaon in Gondia District. Arjuni Morgaon block has the largest number of traditional tanks in both the districts. Therefore, tank dependent community also resides in large numbers in this area. We have selected this area for exploring the new approach and for initiating the change in the field of ex-malgujari tanks. This work was done in four villages in Arjuni Morgaon tehsil of Gondia district.

At the same time, the community leadership programme was also initiated in 10 villages of Arjuni Morgaon tehsil. Through this initiative, we have focused on developing leadership skills among the women of fisher folk community to address the natural resource governance related issues and for planning and execution of MREGS for the betterment of the community and the tanks. The population of Dhiwar, the traditional fishing community, is about 15% in the working area. They are the main focus group of the intervention of the organization.

Samvedana

Samvedana Samaj Vikas Sanstha is registered in 2001 under Societies Registration Act. Samvedana has aim to create a useful, decentralized and equitable governing system for the conservation of various ecosystems and dependent local communities. Initially, Samvedana started its work with rapport building and outreach activities with nomadic tribes in Akola and Washim districts of Vidarbha region of Maharashtra. Since there was less information about the nomadic communities and grasslands in this area, we undertook data collection, studies regarding the grassland ecosystem and communities.

Samvedana documented the ground situation of 12 different nomadic tribes and started work with them in 2005. After spending initial time in understanding the situation, we started our activities with community youths in selected villages and hamlets. Leadership development workshops, building and strengthening local youth groups, capacity building and livelihood development were some of the core activities with communities. Knowing our surrounding and strengthening our livelihood with the conservation of ecosystem are the activities took up in next phase. Nomadic tribes like Phasepardhi have very important traditional knowledge about grasslands so we started the documentation and use of this knowledge. Phasepardhi tribe used their knowledge for the conservation efforts of endangered lesser florican in 2007 when we sighted the live nest of florican. This sighting was very rare in Maharashtra and documented after many decades. Actual grassland conservation on surrounding forest land started in 2008 during the UNDP, MoEF funded project.

Samvedana is expanding its activities in different issues like conservation, youth empowerment, agrarian crisis, women issues and health. We are also expanding activities with different communities and areas. We are developing a grassland conservation program in six districts of Vidarbha. We are participating in different conservation and livelihood networks and initiatives.

Vany Susathapan Dhara , Dhule (Vasudha)

Vasudha is registered under Societies Registration Act in September 2000. It is actively doing community service in Dhule District, mainly in Lamkani, Laling, Arvi, Anakwadi, Sonewadi, Sadgoan, Morshewadi and Junner villages. The community profile of the villages is mainly Gavalis, Adivasi, Loni Patil, Hatkr Patil, and Dhangars. But other communities like Sutar, Lohar, Mali, Wani, Muslim, Bhoi, Koli, Mahar, Chambhar, Pardhi, etc. are also involved. Vasudha is involved in water and soil conservation works in ridge of village Lamkani watershed. CCT, loose boulder, earthen bunds etc. was done through shramdan, donations from individuals and through EGS of Maharashtra Government.

Restoration of forest land, which was degraded scrubland, through active people's participation and help of forest department was done by establishing Joint Forest Management committee in 2002. The main focus of this restoration process was on anti-grazing activity through active peoples participation.

UGAM

UGAM Gramin Vikas Sanstha, is a non-government organization based in Hingoli district of Marathwada region. It was started by Mr. Jayaji Paikrao, a post graduate in social work from Tata Institute of Social Sciences, Mumbai in the year 1981. UGAM is committed to promotion of environmental and agriculture sustainability through "Natural Resource Management" with intervention programs on watershed development, biodiversity conservation and sustainable agriculture. UGAM follows an "Integrated Rural Development" approach of working collaboratively with the communities in five blocks of Hingoli district. The organization acts as a facilitator to generate both farm based and non-farm based livelihoods especially empowering the rural women through Microfinance and encouraging them to be Entrepreneurs.

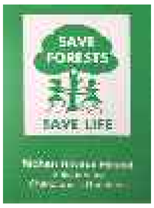
UGAM's working framework takes inspiration from the United Nation that defines Sustainable development as, "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." We are committed to the Earth Summit, Agenda 21 of United Nations Conference on Environment & Development that signifies Conservation and Management of Resources for Development.

Janarth, Adivasi Vikas Sanstha

Initially started as an outfit of Janarth Sanstha, Aurangabad, as Janarth Adivasi Vikas Prakalp" in 1996, it became an independent organization in 2003. Janarth is working on Health, education, nutrition, mental health, women empowerment and skill development of youth and women.

KHOJ

KHOJ has been working in Melghat region of Amravati district since 1996. The major focus of our work was to empower the communities to strengthen their collective governance in a manner that they are able to manage their resources sustainably. Our major area of intervention had been livelihoods, conservation, health and education. We are primarily a rights-based organization but also realized that if we are to make the best of the existing legal frameworks, we have to help communities with more legal and technical capacities to use their rights and convert them to resources.



Vrikshamitra

Vrikshamitra is registered under the Societies Registration Act in 1984 and has the objectives of working in the area of Environment, Forest and People. With financial aid from Central Government an Environmetal awareness movement was undertaken in 1986-87 in Dhanora and Kurkheda Talukas. In 1988-89, a participatory action research on "forest and people" was organised in villages of Dhanori tehsil of Gadchiroli District jointly with Mrs. Savita Tare, from Pune University. Similarly, a comprehensive study-cum-action research using participatory approach on culture and society of a predominantly Gond tribal village- Mendha(lekha) in Central India from anthro-ecological perspective was undertaken with Mrs. Tare during 1990-95. In 1989-90, a study was conducted for Centre for Science and Environment (CSE), New Delhi on E**mployment Guarantee Scheme of Maharashtra and Environment"** in three tehsils of Gadchiroli District of Maharashtra. During 2001-07, participatory study cum action research on "People's biodiversity register was undertaken with Dr. Madhav Gadgil. Participatory Action Research for the implementation of **" The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 and Rules 2008".** Two villages, **Mendha (Lekha)**, tal. Dhanora & **Marada**, tal. Gadchiroli claim their **Community Forest Rights**. Government declared recognition on 15th August 2009 and handover title at the hands of **Hon. Governor of Maharashtra** on 15th Dec. 2009 .

From 2010-14, Vrikshamitra is helping CFR recognized communities in Gadchiroli and Chandrapur district to implement ownership rights on Bamboo which is MFP as per FRA 2006. We supported Gramsabha Mendha(Lekha) in struggle for getting Transit Pass Book from Forest Department.

From 2014, A working group with a banner **'Center for Forest & Biodiversity Management Studies'** (CFBMS) was set up with Prof. Madhav Gadgil and Dr. Vijay Edlabadkar as core members under the aegis of 'Vrukshmitra'. This team has been working on developing code for Community Forest Conservation and Management plan for CFR areas. **Between** 2014-16, a sub-committee of ***Vidarbh Vaidhanik Vikas Mandal,*** Nagpur was formed for the preparation of Guidelines and Manual for Forest Working and Management plan of CFR areas of Gramsabha. Our CFBMC took active part in the work of this committee without any remuneration or honorarium.

Shivaji University

Shivaji University, established in 1962, is named after the Great Maratha warrior and founder of the Maratha empire, Chhatrapati Shivaji. One of the major objective behind foundation of this university was to cater the regional needs of south Maharashtra. The jurisdiction of the University is spread over three districts viz. Kolhapur, Sangli and Satara with strength of about 3,00,000 students studying in 283 affiliated colleges and recognized institutes. The region of Maharashtra boasts of rich and varied socio-cultural heritage. Under the innovative and society reformist leadership of Chhatrapati Shahu Maharaj, the princely ruler of Kolhapur, the city had become at the beginning of this century, a local point of educational opportunities for all classes and communities of south -western Maharashtra and northern parts of neighboring Karnataka. Shivaji University has a huge campus spread over about 850 acres situated on eastward hills of Western Ghats. The terrain consists of undulating hillocks providing varied microclimates for maintenance of plant diversity. The land mass has major features for introduction of RET species and their maintenance. In other words, it has great potential for conservation of plant diversity of Western Ghats.

Department of Botany is always taking initiatives in conservation of plant diversity of Western Ghats in Botanical Garden which is now declared as Lead Botanical Garden by Ministry of Environment, Forests and Climate Change (MoEF& CC), New Delhi. Several departmental programs are focused on conservation and bio-prospecting of plant diversity of Western Ghats. The required expertise and infrastructure to undertake massive program on bio-prospecting and conservation of plant resources of Western Ghats is greatly supported by MGBP.

BAIF

BAIF Development Research Foundation (formerly registered as the Bharatiya Agro Industries Foundation), is a reputed voluntary organisation established in 1967 by Dr. Manibhai Desai, a disciple of Mahatma Gandhi, at Urulikanchan, near Pune to promote sustainable livelihood in 160Rural India.

BAIF is committed to provide sustainable livelihood to the rural poor through climate-resilient agriculture, management of natural resources, livestock development, watershed development and agri-horti-forestry as major income generation activities. BAIF has evolved innovative models of micro-enterprises to ensure inclusive development through dairy husbandry, goat production, agri-horti-forestry and sustainable agricultural production for food security and poverty alleviation. Formation of Producers' Groups, Empowerment of women and environmental sustainability cut across all these programmes.

BAIF has developed the 'Village Cluster Development Approach' to reach the poorest of the poor. This facilitates identifying the problems and needs of poor families and introduction of appropriate technologies and services to solve them. To facilitate backward and forward development and to ensure sustainability, self-help groups of men and women of homogeneous socio-economic status are being promoted. These groups have identified various on-farm and non-farm income generation activities to boost their income further.

With a flexible and innovative approach to address needs of individual families, BAIF is now able to provide services to over 5.0 million small and marginal landless families spread over one lakh villages in backward regions of 16 states in the country.

BAIF's programme in Maharashtra is implemented by BAIF Institute for Sustainable Livelihood and Development (BISLD), an associate organization of BAIF. BISLD, Maharashtra is presently working in 31 districts, 188 talukas, 5612 villages and with nearly 2.8 lakh families.

CEE

Centre for Environment Education

Centre for Environment Education (CEE)

CEE was established in August 1984 as a Centre of Excellence supported by the Ministry of Environment and Forests, Government of India. CEE, a national institution with its headquarters in Ahmedabad, has a mandate to promote environmental awareness nationwide.

CEE is committed to ensuring that due recognition is given to the role of EE in the promotion of sustainable development. CEE develops innovative programmes and educational material, and builds capacity in the field of education and communication for sustainable development. It undertakes demonstration projects in education, communication and development that endorse attitudes, strategies and technologies that are environmentally sustainable.

To achieve the vision, CEE's mission is to enhance understanding of sustainable development in formal, non-formal and informal education through its work with schools, higher educational institutions, policy makers and reaching out to youth and the general community. It is to integrate education as a key driver for change in demonstrating and advancing sustainable practices in rural and urban communities, and in business and the public sector, and in meeting challenges of global issues such as climate change and biodiversity conservation. CEE also promotes individual and collective positive Handprint actions that are environmentally sound, economically viable and socially beneficial.

Inventory and Bioprospecting of Marine Invertebrates of the Maharashtra Coast with Special Emphasis on Sponges and Associated Microorganisms

Report 1.1

Microbial inventory, microbial ecology and bio-prospecting of aquatic living resources from Maharashtra Coast

Indian Institute of Science Education and Research, Pune

Background

The marine ecosystem is not only diverse with respect to microorganisms found in it but also the natural products being synthesized by those microorganisms (Ward & Bora 2006; Taylor et al. 2007; Lam 2006). As a result, exploring the wealth of biodiversity and screening for potential bio-active compounds has applications in both applied and basic sciences on ecology and evolutionary biology (Das et al. 2006; Salazar & Sunagawa 2017).

Culture-dependent and culture-independent methods have demonstrated that indigenous marine prokaryotes, particularly actinobacteria exist in the oceans and are widely distributed in different marine ecosystems (Lam 2006). There is tremendous diversity and novelty among the marine actinobacteria present in marine environments. Actinobacteria are ubiquitious in nature (Guimarães et al. 2020) and luxuriantly distributed in seas and oceans. They are one of the most important sources of pharmaceutically valuable and industrially relevant secondary metabolites (Wang et al. 2020).They are among the taxa richest in secondary metabolites and are widely distributed in soil (Ara et al. 2013; Chaudhary et al. 2014; Jose & Jebakumar 2014), fresh and sea water (Braesel et al. 2019; Sanghamitra et al. 2015) and sediments (Baskaran et al. 2011). They belong to the phylum Actinobacteria and represents largest phyla within the bacterial domain (Subramani & Sipkema 2019). They are aerobic, spore forming, Gram positive bacteria which often produce diffusible pigments. They occur as cocci or rods, branched filaments and aerial or substrate mycelium. The marine ecosystems have a wide range of unexplored diversity of actinobacteria and their metabolites with biological activities like anti-cancer, anti-inflammatory, antimicrobial and enzyme inhibitory (Manivasagan et al. 2014; Abdelfattah et al. 2016).

Watve et al. (2001) estimated that the genus *Streptomyces* alone is capable of producing up to 105 different metabolites majority of which remain unexplored. Of 23,000 medicinally important metabolites produced by marine microorganisms, 70% are contributed by actinobacteria (Mahapatra et al. 2019). Till date, 8 genera of actinomycetes have been reported to produce secondary metabolites and 267 products have been reported from 96 marine rare actinobacteria.

Ecologically it is difficult to understand the production of extracellular metabolites or enzymes by aquatic bacteria, since any molecule secreted outside the cell can be quickly washed off. Extracellular products could be useful to the producers only in viscous or partially enclosed environments. In the marine environment, sponges are likely to provide such an environment. Sponges are filter feeders and collect small nutrient particles including bacteria. This makes the environment locally nutrient rich in otherwise oligotrophic surroundings. Bacteria especially actinobacteria isolated from these sponges have been reported to produce antimicrobial compounds that play a role in defense against predators, stabilization of skeleton, translocation of metabolites and help in nutritional process (Lee et al. 2009). Also, since sponges are sessile and lack other anti-predator defenses, secondary metabolites of bacteria can provide them with chemical defense (Lee et al. 2001). Therefore, we expect more secondary metabolite activity associated with sponge.

Sponge associated actinobacteria are likely to have another ecological role. Actinobacteria, the genus *Streptomyces* in particular, is shown to be predators that kill and feed on other live bacterial cells (Kumbhar et al. 2014). Predatory actinomycetes have been reported from soil and other habitats (Zepht & Casida 1986). Kumbhar & Watve (2013) argued that antibiotic activity may have evolved primarily as a weapon in predation. However, the expression of secondary metabolites during predation may be independent of antibiotic expression in pure culture, the latter is likely to have evolved for mutualism with higher animal or plant hosts (Harir et al. 2018). For a niche of predation in association with sponge, the predatory species needs to protect itself from the digestive enzymes of the sponge as well as its own enzymes used for predation. Therefore, predatory actinobacteria are also expected to have efficient inhibitors of lytic enzymes (Pérez et al. 2015).

Omics approach points towards enormous diversity of bacteria which can make potential metabolites.

Majority of these chemicals have been identified from marine invertebrates of which sponges predominate. Sponge-associated bacteria has been a major focus in the search for novel marine natural products. Marine bacteria especially Actinomycetes produce silver nano particles (Ranjani et al. 2016) and bio surfactants (De Carvalho & Fernandes 2010). The marine ecosystems are believed to have a wide range of unexplored diversity of actinobacteria (Montalvo et al. 2005) and their metabolites (Taylor et al. 2007; Lam 2006; Manivasagan et al. 2005) with diverse biological activities like anticancer (Olano et al. 2009), anti-inflammatory (Trischman et al. 1994), antibiotic (Pimentel-Elardo et al. 2010; Cheng et al. 2015; Gandhimathi et al. 2008), cytotoxic (Abdelfattah et al. 2016) and enzyme inhibitory (Manivasagan et al. 2015; Imada 2005). Recent studies on halophilic and halotolerant actinomycetes from Goa, India for their anti-bacterial activity (Ballav et al. 2015) and similar study of antagonistic potential of actinomycetes from Tamil Nadu (Madheslu 2019) and bioactive secondary metabolites from actinomycetes of Indian Peninsula (Ravi & Kannabiran 2018) have provided new insights into actinobacterial bioactivites. Furthermore, for predation, antibiosis or extracellular degradation, mycelial morphology is specifically adapted. There seems a strong relationship between production of metabolites and mycelial forms of actinobacteria as well as fungi (Thomas et al. 2010). Mycelial forms as compared to cellular forms can afford to synthesize extracellular compounds without a problem of cheater mutants (Kumbhar & Watve, 2013). We expect this relationship to hold true in the sponge associated bacteria as well.

Despite the fact that the importance of marine invertebrate and associated microbial diversity has gained some importance in recent past from Indian perspective, the studies are limited in their scope, approach and coastal coverage in India. There are very few studies that explore these areas along the coast of Maharashtra and Goa. In this study, we made an inventory of bacteria from marine sponges of intertidal zones on the western coast of Maharashtra. We also, screened the isolated microorganisms, particularly actinobacteria for various activities including antibiosis, enzyme inhibition, anti-biofilm activity and predation. We isolated and characterized secondary metabolites from sponges, algae and bacteria for their potential in antibacterial, antifungal, anti-malarial, cytotoxic and anti-inflammatory action. We also studied the predatory actinobacteria in details so as to understand the ecology and evolution of predation and novel secondary metabolites that can have applied values.

Objectives

(i) Creating an inventory of cultivable bacteria from sponges in the intertidal zones and their associated habitats along the Maharashtra coast line and their molecular identification.

(ii) Comparing culture dependent and independent metagenomic approaches for understanding bacterial diversity.

(iii) Screening of sponges and algae and their associated microorganisms for bioactive compounds using a battery of assay systems.

(iv) Isolation and characterization of bio-active compounds.

(v) In depth studies on predatory actinobacteria for understanding their ecological role and potential to produce novel secondary metabolites that can have applied value.

Methodology

Survey

Konkan region of Maharashtra coast was surveyed for the presence or absence of sponges and associated flora and fauna. Based on the satellite images obtained from Google Earth, coastal areas having rocky patches were roughly identified. Various locations from Raigad and Ratnagiri districts were demarcated. Survey locations included Alibaug (18°38'53.4"N, 72°51'57.9"E), Korlai (18°31'14.7"N, 72°54'35.8"E), Murud (18°20'13.7"N, 72°56'58.6"E), Shekhadi (site 1: 18°06'30.7"N, 72°58'45.7"E; site 2: 18°06'07.8"N, 72°59'06.5"E), Harihareshwar (17°59'30.5"N, 73°01'07.5"E), Velas (17°57'12.5"N, 73°01'44.1"E), Kelshi (17°54'24.6"N, 73°03'01.5"E), Ade (17°52'19.4"N, 73°04'36.8"E), Harnai (17°48'29.6"N,

Figure 1 Survey locations.

73°05'47.1"E), Ladghar (17°43'49.2"N, 73°07'44.8"E), Burondi (17°42'24.1"N, 73°07'51.2"E), Aare Ware (17°04'48.3"N, 73°17'00.2"E), Konkaneshwar (15°46'47.1"N, 73°39'26.5"E) and Malvan (16°03'57.9"N, 73°27'46.9"E) from Maharashtra coast and Anjane (15°33'45.8"N, 73°42'37.0"E) from Goa (Figure 1).

A total of 14 surveys (Table 1) were conducted in pre-monsoon months (April-May) from the year 2014 to 2018 as sponges are known to have maximum abundance during these months. Sampling visits were planned around lowest low tide times in every month since it ensured maximum intertidal area exposed to air at the time of low tides. Surveys were made to screen for availability of sponges. Extensive surveys of the entire rock patches were carried out to assess invertebrate diversity on the ofersaid sites. Due to high abundance and easy accessibility, Ade and Harne sites were chosen for further sampling with few collections from Velas, Murud, Kelshi, Waingani and Kunkeshwar.

Table 1. Survey details for samples processed at IISER Pune

Date	Institute	Site	Purpose Of Sampling	Bacterial isolates
April 2014	IISER Pune; College of Fisheries, Ratnagiri	Are ware	Survey for sponge abundance	Only Survey, no collections
May 2014	IISER Pune; College of Fisheries, Ratnagiri	Waingani	Collection for microbial inventory	186
October 2014	IISER Pune; College of Fisheries, Ratnagiri; NCCS-MCC, Pune	Are ware	Collection for microbial inventory	117
January 2015	College of Ratnagiri	Are ware	Collection for microbial inventory	146
February 2015	IISER Pune	Ade, Murud	Collection for microbial inventory and secondary metabolite screening	207
April 2015	IISER Pune	Ade	Collection for microbial inventory	133
January 2016	IISER Pune	Ade, Harne	Collection for microbial inventory	150
February 2016	IISER Pune	Waingani, Murud	Secondary metabolite screening	-
March 2016	IISER Pune	Ade, Harne	Collection for microbial inventory	50
December 2016	IISER Pune	Ade, Harne	Collection for microbial inventory	752
January 2017	NIO, Goa	Kunkeshwar	Collection for microbial inventory	76
January 2017	IISER Pune	Ade, Harne	Collection for microbial inventory	397
February 2017	IISER Pune	Ade, Harne	Collection for microbial inventory	137
March/April 2017	IISER Pune	Ade, Harne	Collection for microbial inventory	321
October 2018	IISER Pune	Ade, Harne	Sampling for NGS	-

Sampling

From the shortlisted sites, sampling of sponge, sediment, sea water and air was carried out in all the seasons except monsoons. Small tissue samples (less than one gram) of marine sponges were collected at the time of low tide without damaging the sponge or its associated environment. Specimens were rinsed and flushed with sterile media (Kennedy 2009). Sponge samples for microbial inventory were collected in labeled polystyrene tubes containing sterile Poor Ravan Saline (Watve et al. 2000) and ZoBell Marine broth (ZoBell 1941). Sediment, water and air samples were collected from the same environment as that of the sponge and were collectively termed as environmental samples. The samples were brought to laboratory maintaining cold chain and were immediately processed for microbial culturing. Sponge and algae samples used for secondary metabolite screening were collected using sample grabbers, were placed in plastic bags and kept cool on the ice during transportation. Post collection processing of samples is outlined in Figure 2.

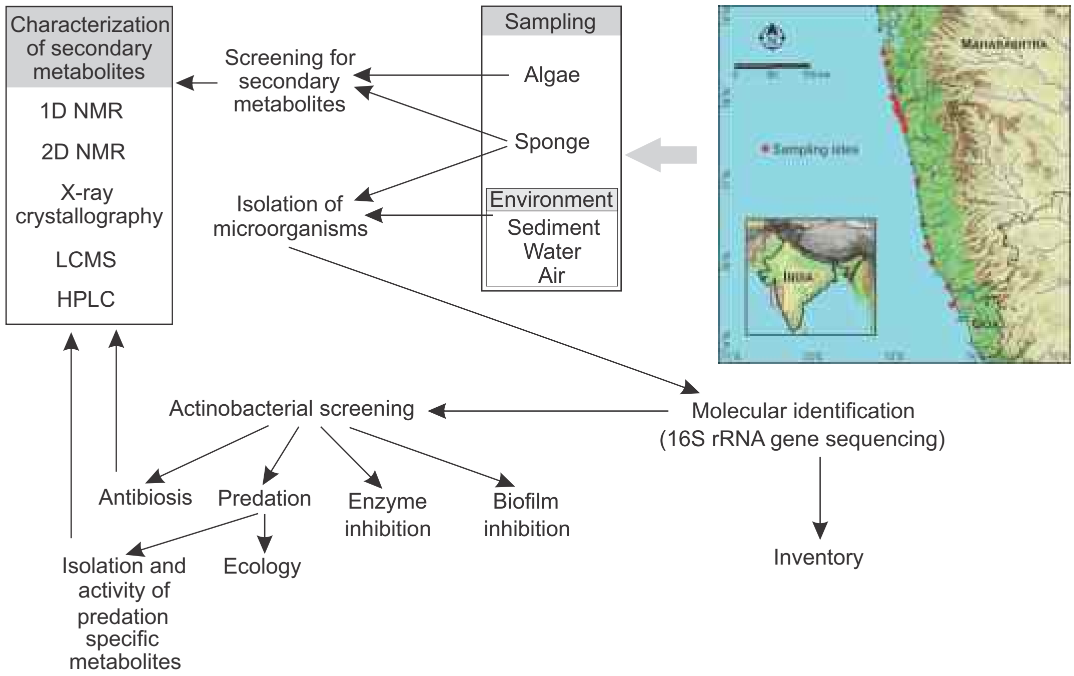


Figure 2 Post collection processing of samples.

Isolation of cultivable prokaryotes

Detailed protocols are provided in Baig et al. (2000). In brief, sponge tissue was homogenized 10^{-5} and was spread in triplicates on petri plates containing Zobell Marine Agar (ZMA) (ZoBell 1941) and Poor Ravan Saline Agar (PRSA) (Watve et al. 2000) with and without antibiotic chloramphenicol (25 µg/ml). Pure colonies were labeled as per Maharashtra Gene Bank (MGB) project code and preserved on ZMA slants at 4°C for further use. Similarly, glycerol (18%) stocks were prepared and maintained at -20°C for long term storage. Cultures obtained in the study are deposited in the Microbial Culture Collection (MCC) of National Centre for Microbial Resource, National Center for Cell Sciences, Pune, India.

Genetic identification and phylogeny

Bacterial identification was partially done by IISER Pune and partially by NCCS-NCMR using 16S rRNA gene sequencing. For samples processed in IISER Pune, near complete 16S rRNA gene of pure cultures of bacteria were sequenced. Gene sequences obtained in the study are deposited in the GenBank database under the accession numbers MN339687–MN339897, MT598037–MT598065. Sequences were checked in BLAST (Altschul et al. 1990) to find the closest sequences available in the GenBank database (http://www.ncbi.nlm.nih.gov).

Gene sequences were aligned using MUSCLE (Edgar et al. 2014) implemented in MEGA 7 (Kumar et al. 2016). Best nucleotide substitution model was determined using ModelFinder (Kalyaanamoorthy et al. 2017) based on Bayesian Information Criterion (Schwarz et al. 1978; Nei & Kumar 2000). Maximum likelihood analysis was performed in IQ-TREE (Nguyen et al. 2015) with ultrafast bootstrap support (Hoang et al. 2018) for 1000 iterations. Phylogenetic tree was edited in FigTree v1.4.2 (Rambaut et al 2009). To understand putative number of bacterial species we performed species delimitation based on Poisson Tree Processes (Zhang et al., 2013) with maximum likelihood partitioning (mPTP) and Bayesian partitioning (bPTP).

Culture independent metagenomics approach for bacterial diversity

To compare the seasonal variation in bacterial composition in sponges and to compare performance of different isolation media to understand diversity metagenomic approach using next generation sequencing (NGS) was used.

Seasonal variation in bacterial flora of sponges

Samples were collected pre-monsoon (May 2018) and post-monsoon (October 2018) from Ade and Harne. Sponges macerated in sterile distilled water, water samples collected from sites and supernatant of sediment samples subjected to heat treatment were submitted for NGS sequencing in duplicate.

Performance of different isolation media

To compare culturable and non-culturable bacterial diversity across different media, rich (100%) and oligotrophic (1%) forms of nutrient agar (NA) and rich (RR) and oligotrophic (PRS) forms of Ravan agar were selected. Water samples included two marine and two fresh water samples. Marine water samples were collected from Dona Paula, Goa and Morjim Goa in October 2019. Fresh water samples were collected from ARAI quarry, Pune and from stagnant water pool in IISER Pune campus in October 2019. To know what per cent of bacterial diversity can be cultured using different media, 1ml of each water sample was spread plated on all 4 media i.e, 100% NA, 1%NA, RR and PRS in triplicates. At 30ºC, rich medium plates were incubated for 7 days and oligotrophic medium plates were incubated for 21days. After incubation, plates were flooded with sterile distilled water and all the colonies were scraped off the plate and collected in centrifuge tubes. Bacterial growth from triplicate set of each sample was pooled together. DNA was isolated from the pellet using Qiagen DNeasy Blood and Tissue kit. Processed samples using above steps and 300ml water sample from each site were submitted for NGS.

Screening of actinobacteria for activities

Out of 237 actinobacterial isolates, 50 isolates were randomly selected for screening of three activities, namely predation, antibiotic production, production of enzyme inhibitors and anti-biofilm activity.

Target bacteria for predation and antibiotic screening

Test bacteria, used for checking actinobacterial predation and antibiotic production, were obtained from National Collection of Industrial Microorganisms (NCIM), National Chemistry Laboratory, Pune, India. Fourteen bacteria, namely *Acetobacter pasterianus* (NCIM 2317), *Alcaligenes fecalis* (NCIM 2262), *Bacillus subtilis* (NCIM 2063), *Enterobacter fecalis*, *Escherichia coli* (NCIM 2184), *Klebsiella pneumonae* (NCIM 2957), *Micrococcus luteus* (NCIM 2673), *Mycobacterium smegmatis* (NCIM 5138), *Proteus vulgaris* (NCIM 2172), *Pseudominas aeruginosa* (NCIM 5029), *Salinicoccus roseus* (MCC 7574), *Salmonella enterica* (NCIM 2501), *Serretia marcescens* (NCIM 2919) and *Staphylococcus aureus* (NCIM 2121), were used as target species for screening.

Screening for actinobacterial predatory growth

Growth of predator with the zone of clearance on prey cells was considered as predation as defined earlier (Kumbhar et al. 2014). The method for the preparation of prey cells was modified from Kumbhar et al. (2014). Detailed protocol is provided in Baig et al. (2020).

Screening for antibacterial activity

Selected actinobacterial cultures were screened for antibacterial activity by cross streak method (Velho-Pereira and Kamat, 2011; Valli et al., 2012) using ZMA medium. Detailed protocol is provided in Baig et al. (2020).

Screening for enzyme inhibitors

Actinobacterial cultures were screened for their ability to inhibit the activity of serine proteases and angiotensin converting enzyme (ACE). Three different serine proteases i.e., Subtilisin, Trypsin and α-Chymotrypsin were used for screening of inhibitory activity. Protease inhibitor activity was studied using unprocessed X-ray films and spot-test method (Cheung, 1991) with modifications (Tripathi et al. 2011). ACE inhibitors were screened following protocol suggested by Cushman & Cheung (1971) and Ng et al. (2008). Detailed protocols are provided in Baig et al. (2020).

Screening for anti-biofilm activity

Cell free supernatant of Actinobacteria cultured in ZMB was extracted with equal volume of ethyl acetate. Solvent extracts were evaporated to yield crude extracts and dissolved in 50% methanol. Biofilm producing laboratory strains used in study were *S. typhi*, *E.faecalis*, *P. aeruginosa* and *S. aureus*. Target bacterium was inoculated in nutrient broth and diluted culture was pipetted (100 µl) in 96 well microtiter plates. Autoclaved un-inoculated nutrient broth was used as medium control. Curcumin (1mg/ml) from *Curcuma longa* (Sigma) was used as positive control (inhibits biofilm). Wells with culture and without extract was used as negative control. Methanol (50%) was used as solvent control. Actinobacterial extracts were added (400 µg/ml) in broth containing the biofilm forming bacterial suspension. Plates were incubated for 48 hrs at 37ºC. In order to check if the extract inhibits the already formed biofilm, actinomycetes extracts at 400 µg/ml were added after the biofilm (48 hrs) was formed. All experiments were done in triplicates.

To check the biofilm inhibition/disruption, the wells were cleaned using water. Crystal Violet (0.1%) stain was added to each well and plate was kept at room temperature. Excessive stain solution was removed by rinsing with water. Plates were allowed to air dry. To solubilize the stain, absolute Ethanol was added in each well (Merritt et al, 2005). Anti-biofilm activity was determined by checking absorbance at 600 nm (A_{600}) in Kaleido 2.0, EnSightTM Multimode Plate Reader, PerkinElmer (Centre of Excellence, IISER Pune). The mean was used for determining the percentage inhibition/disruption of the biofilm (Costa et al. 2018).

$$\% \text{ Inhibition} = 100 - \left(\frac{A_{600} \text{ of experimental well}}{A_{600} \text{ of control well}} \times 100 \right)$$

Isolation and characterization of bio-active bacterial compounds

Bacterial isolates from the inventory were used for isolation and characterization of bio-active compounds.

Extraction of microbial compounds

Pure cultures were grown in ZM. After incubation, broth was centrifuged. Both supernatant (extracellular) and cells (intracellular) were processed for compound extraction using ethyl acetate and methanol. Concentrated fractions were screened for bioactivity.

Bioactivity of the crude extract

Antibacterial assay was performed using well diffusion method after dissolving the extract in DMSO (2.0-4.0 mg/ml). Plates were observed for zone of clearance after every 24 hours.

Chemical Characterization of the crude extract

Crude extracts showing antibacterial activity were further purified using reverse phase HPLC using water: methanol solvent system. Fractions from HPLC were lyophilised and again subjected to bioactivity to the fraction with activity. This fraction was then subjected to structure elucidation using NMR technique.

Extraction of bioactive compounds from marine sponges and algae

Marine sponges *Ircinia fusca*, *Mycale* (*Zygomycale*) *parishii* and *Amphimedon viridis* and the red alga *Halymenia floresii* were screened for bioactive compounds and the bio-active compounds were isolated and characterized.

Extraction of metabolites

Sponges and algae were dried using lyophilizer and extracted with methanol and desalted using acetone. Methanolic extracts were concentrated under vacuum followed by a partition with hexane, DCM, chloroform and ethyl acetate. All the partition layers were subjected to preliminary bioactivity studies.

Antimicrobial activity

The isolated compounds were tested against bacteria, *E. coli*, *S. typhimurium*, *B. subtilis*, *S. aureus*, *M. smegmatis*, and fungal strains *Aspergillus niger* (NCIM 1207), *Penicillium chrysogenum* (NCIM 1315), *Alternaria* sp. (NCIM 900), and *Fusarium* sp. (NCIM 1372). Methods for studying inhibitory potential follow Meesala et al. (2016, 2017a, 2017b, 2018) and Meesala & Watve (2017). Compound which showed ≥ 9 mm was selected for minimum inhibitory concentration (MIC) studies against various Gram-positive and Gram-negative bacteria test cultures (Andrews 2001).

Antimalarial activity

Plasmodium falciparum strain 3D7 was cultured as previously described (Radfar et al. 2009). The IC 50 was calculated from a plot of relative per cent parasitemia versus concentration of the compound as described earlier (Mishra et al. 2008). For further details see Meesala et al. (2018).

Cytotoxicity assay

Cytotoxicity was evaluated against breast cancer (MCF-7), human neuroblastoma (SHSY5Y), human non-small cell lung cancer (A549) and human liver cancer (HEPG2) cell lines using MTT test (Visconti et al., 1991). For details of cytotoxic activity see Meesala et al. (2016, 2017c, 2017b).

Anti-Inflammatory activity

In vitro anti-inflammatory effects were studied using macrophages like J774 cell lines. Nitric oxide (NO) produced was used following Giustarini et al. (2008). Detailed protocol is provided in Meesala et al. (2017c).

Structure elucidation of compounds

Optical rotations were determined on a Rudolph Research Analytical (AUTOPOL V) polarimeter. UV spectra were measured in UV-VIS spectrophotometer and Infrared spectra on Bruker ALPHA. Structures were determined using one or combination of following techniques: 1D and 2D NMR and MS data; ESI-MS-TOF; High-resolution electrospray ionization mass spectrometry (HRESIMS) and X-ray crystallography. Details of procedures are provided in Meesala et al. (2016, 2017a, 2017b, 2017c, 2018a, 2018b) and Meesala & Watve (2017).

Chemical characterization of compounds involved in predation

An attempt was made to isolate and characterize predation specific compounds.

Predation in liquid medium

For extraction of large quantity of predation specific compounds, predation experiments using liquid media were developed. Concentrated prey cells were inoculated in sterile distilled water and in sterile distilled water supplemented with mineral base (10% v/v). Predator (*Streptomyces* sp.) was inoculated in flask containing prey. Flasks containing experimental set up and controls (prey control, predator control and medium control) were incubated for 7-15 days. Growth of the predator and decline in prey was monitored by spread plate method. Media from each flask was then centrifuged and cell-free extract was mixed with equal amount 100% ethyl acetate (HPLC grade, Rankem). Ethyl acetate extract was concentrated using Rotary evaporator (Hei-VAP Core, Heidolph) and was resuspended in HPLC grade 100% Methanol.

Extraction of predation specific compounds

Samples were subjected to solvent extraction and aqueous extraction. In solvent extraction, zones of clearance found around *Streptomyces* colony spread on prey containing plate were cut out and were extracted sequentially in ethyl acetate and methanol along with controls (medium control, prey control, predator control). Extracts were concentrated with the help of rotary evaporator and finally dissolved in methanol. Concentrated crude extract was then subjected to reverse phase HPLC in water:methanol solvent system and only unique peaks (as compared to controls) were collected. This fraction was further lyophilized and submitted for chemical analysis (MALDI and NMR). For aqueous extraction, the cut out zones were subjected to intermittent cycles of freezing at -80°C and subsequent thawing at room temperature. This helped separation of aqueous part. This extract was then taken for purification by HPLC along with controls as mentioned above.

High-Performance Liquid Chromatography Analysis

The extracts were dissolved in 100% Methanol (HPLC grade, Sigma) and used for HPLC. Waters 600 pump and controller, C18 column (10x250mm) was used. The column was equilibrated using 100% Methanol. Extract (100µl) was injected into the column and flow rate was maintained at 0.5 ml/minutes and retention time of the compound was detected at 260 nm.

Ecology of actinobacterial predation

Target species *E. coli* (NCIM 2184), *S. aureus* (NCIM 2121) and *P. vulgaris* (NCIM 2172) were used for studying predation ecology in three species interactions. Detailed protocol for the study are provided in Pund et al. (2020).

Whole genome and transcriptome study of predatory bacteria

From Actinobacteria screened for predation against a battery of prey species, pure cultures of five predatory bacteria from different genera were submitted for whole genome and transcriptome sequencing.

Genome sequencing, assembly and annotation

Genomic DNA was extracted using Bacteria DNA Kit. The genomic DNA library was constructed using Library Prep Kit. The library was sequenced using an appropriate platform. Genome assembly of the pooled sequencing reads was performed. Functional categories were assigned by searching against the Kyoto Encyclopedia of Genes and Genomes (KEGG) database. The obtained cDNA libraries was multiplexed and sequenced as paired-end reads on a single lane on the sequencing machine. Sequencing was done using Illumina platform with 20 million reads and 500X coverage. Data was analysed using customised QIIME program.

RNA extraction, DNA library and transcriptomics

RNA was isolated and total RNA was quantified on Bioanalyzer. RNA samples quality and integrity was analyzed using 2100 BioAnalyzer. Only RNA samples with RIN > 7 were used for library construction and RT-qPCR assays. The resulting enriched mRNA was used for the preparation of cDNA libraries. Each sample was prepared as a replicate and sequenced using an Illumina platform to generate strand specific paired-end 100 bp reads. The NCBI non-redundant (nr), Swiss-Prot, Cluster of Orthologous Groups (COG), and Kyoto Encyclopedia of Genes and Genomes (KEGG) databases were used to annotate all the unigenes with local BLAST programs.

Survey Observations

From all the sites surveyed good invertebrate diversity was found on the coasts of Murud, Shekhadi, Kelshi, Ade, Harnai, and Ladghar. Rock encrustation because of barnacles was observed on all sites. Sponges were observed at Murud, Shekhadi, Ade, Harnai and Aare Ware (Fig. 3). However, density of sponge colonies in Murud was very less as compared to other four sites. Also, sponge colonies were observed only once and no sponge colonies were observed in Murud in the subsequent field visits. Hence, considering sponge abundance and diversity on the sites and proximity from the workplace, Ade and Harnai were shortlisted for further studies, although a few visits were made on other sites. Amongst shortlisted sites, Harnai had a high degree of anthropological disturbance followed by Shekhadi and these disturances include contamination through sewage, recreational and tourist activities, fishing activities and additionally Harnai also is an active port. Comparatively, only occasional fishing and clamp collection by local people were observed at Ade and Aare Ware.

Calcareous sponges (especially honey comb sponge) were spotted only in Aare Ware and Harnai. On rest of the sites, only silicaseous sponges were spotted. Sponges were identified based on the colour as orange sponge (Shekhadi, Ade, Harnai, Aare Ware), yellow sponge OTU1(Murud, Shekhadi, Ade, Harnai, Aare Ware), yellow sponge OTU2(Shekhadi, Ade, Harnai), blue sponge (Shekhadi), purple sponge (Shekhadi, Harnai), pink sponge (Ade, Harnai), black sponge (Murud, Ade) and white sponge (Ade). Most abundant distribution was of orange sponge followed by both type of yellow and purple sponges. All the remaining types were restricted to few colonies on particular sites. Although species identification is still underway, *Haliclona* spp. were the most common sponge in the study area.

Other organisms observed in the sponge associated habitats include variety of sea anemones, sea slug, sea snail, bivalves, lichens, sea cucumber, sea urchin, sea fans, blue buttons, starfish, Zoanthid (or colonial anemone) colonies, barnacles, limpets, variety of fishes found in the rock pools (like grouper and dart fish), variety of marine algae, variety of gastropods and bivalves, variety of crabs (like fiddler crab and hermit crab), sea snake (probably hook nosed) and sea weeds.

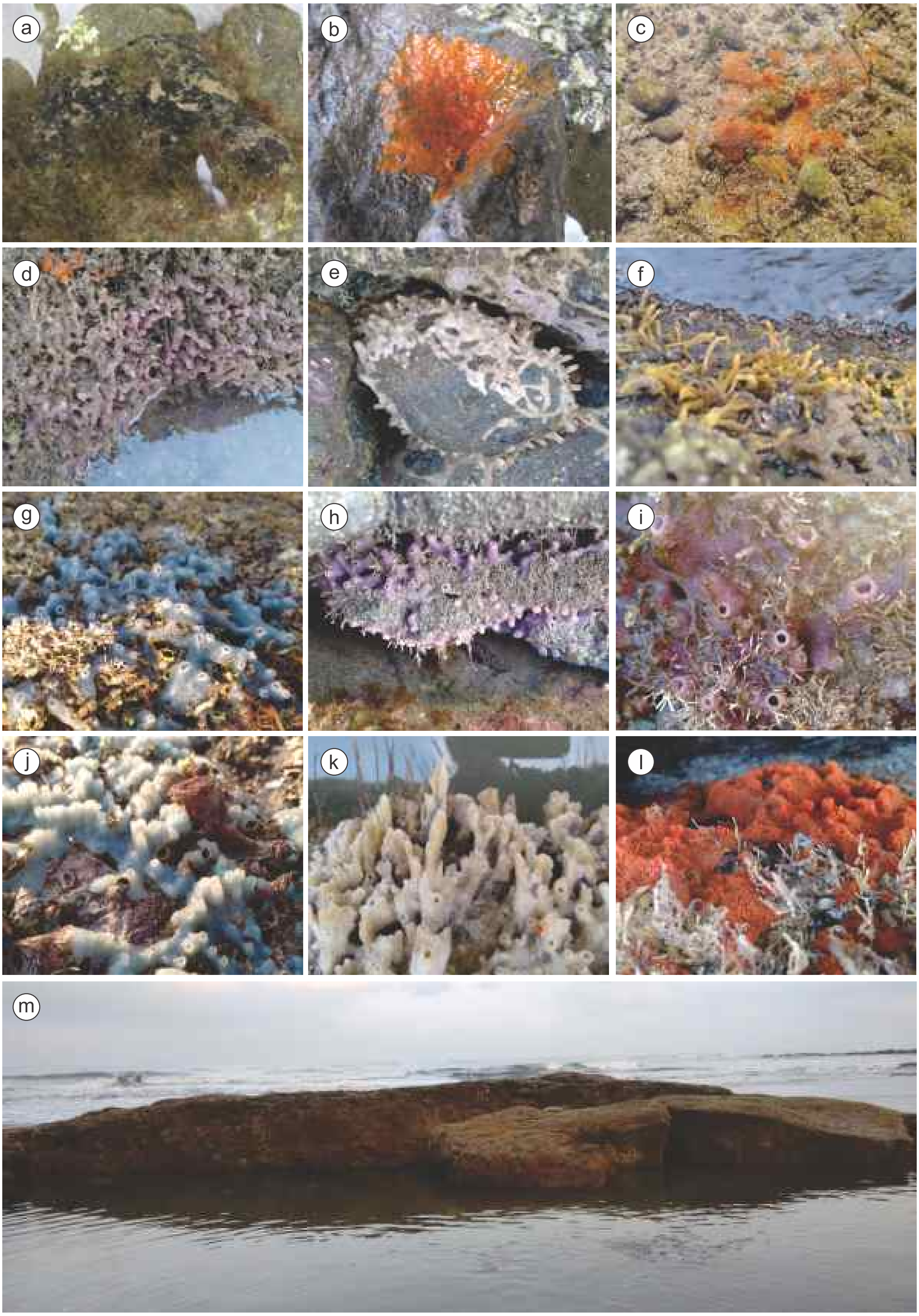


Figure 3 Sponge diversity at Maharashtra coast. (a, b) Are Ware, October 2014, (c) Harne, February 2015, (d) Harne, December 2015 (e) Shakadi, December 2015, (f) Harne, January 2016, (g, h, i) Shekhadi, January 2016, (j) Shekhadi, December 2015, (k, l) Ade, March 2016, (m) rock full of gregariously growing Orange sponge at Ade, March 2016.

Cultivable Prokaryotic Diversity

A total of 2821 bacteria were isolated from sponges and the associated environments. Out of these 2821 isolates, 1839 were from sponges.

Microbial inventory

Out of total 2821 isolates that were obtained, 1961 were identified, which belonged to 111 genera (Fig. 4a). Out of the total 1961 identified bacteria and archaea, 386 were actinobacteria and there were seven archaea of the genera *Halobacterium* and *Methanococcus*. Majority of the isolates were Bacilli followed by Gamma proteobacteria and Actibibacteria (Fig. 4b). Dominant genus was *Bacillus* followed by *Staphylococcus, Pseudomonas* and *Vibrio* (Fig. 4c). Phylogenetic diversity of bacteria is shown in Figure 5.

Higher number of isolates were obtained on ZM medium as compared to PRS (Fig. 4a); however, the bacteria diversity coverage by both ZM and PRS was comparable (Fig 6a). Nevertheless, both media represented different bacterial populations, which was evident from the fact that Jaccard similarity index (based on qualitative data) was 0.424 and Sørensen index (based on abundance) was 0.595. PRS had representation of 73 genera, while ZM had representation of 105 genera, of which 53 genera were shared by both. There were 20 unique genera in PRS and 52 unique genera in ZM. There was a strong positive correlation between total abundance of taxa and prevalence in different sites (Fig. 6b), indicating that most common species were also abundant.

Actinobacterial diversity

Actinobacteria from sponges and associated environments showed a rich phylogenetic diversity. Phylogenetic tree of 237 actinobacterial isolates, from sponge and associated environments, belonging to 19 families and 28 genera is shown in Fig. 7. Species delimitation based on mPTP suggested that these isolates belong to 95 putative species, while bPTP suggested 100 putative species. The two species delimitation methods, mPTP and bPTP, differed in the groups of species under genera *Micrococcus, Rhodococcus* and *Streptomyces*. Air was generally devoid of actinobacteria and we recovered only three isolates from air, belonging to genera *Brachybacterium, Brevibacterium* and *Rhodococcus,* as compared to 39 isolates from water, 105 isolates from sediment and 90 isolates from sponge.

From sponges, 56 putative species belonging to 18 genera and 14 families were isolated (Table 2). From the sponge-associated environment, 64 putative species as per mPTP and 65 putative species as per bPTP under 22 genera and 15 families were recorded (Table 2). A total of 12 genera under 9 families and 28 putative species based on mPTP and 25 putative species based on bPTP were common to both sponge and associated environment.

Six genera, namely *Gordonia, Jonesia, Mycolicibacterium, Pseudonocardia, Rothia* and *Serinicoccus* were isolated only from sponges (Table 2), which could be identified to species *Gordonia terrae* (MCC 6452), *Jonesia denitrificans* (MCC

a

Total isolates	2821
Total identified	1961
Number of different genera	111
Number of Actinobacteria	386
Isolates on ZM	1758
Isolates on PRS	1034
from other media	29
Isolates from Ade	1062
Isolates from Harne	1101
Isolates from Murud	63
Isolates from Are-Ware	187
Isolates from Ratnagiri	311
Isolates from Goa	90
From other sites	7
Isolates from sponges	1839
Isolates from water control	361
Isolates from sediment control	565
Isolates from air control	56

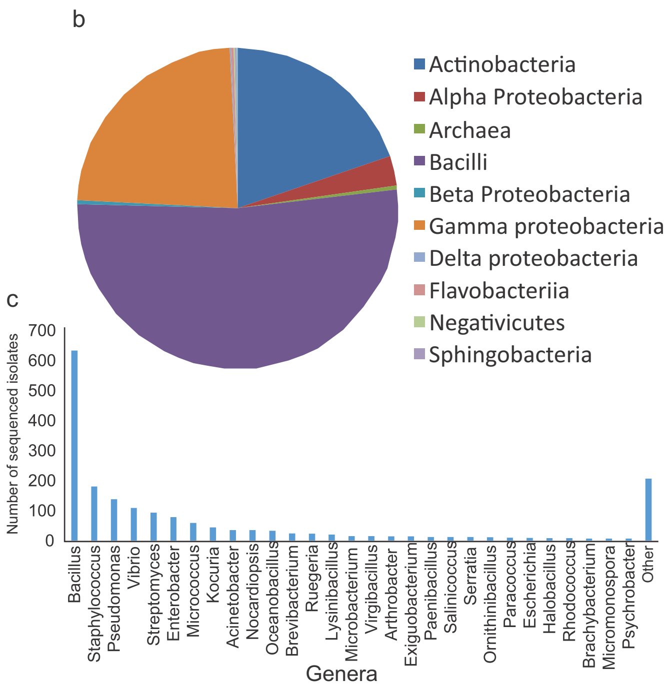


Figure 4. Summary of microbial inventory. (a) Basic statistics, (b) pie chart of different groups, (c) abundance of different genera.

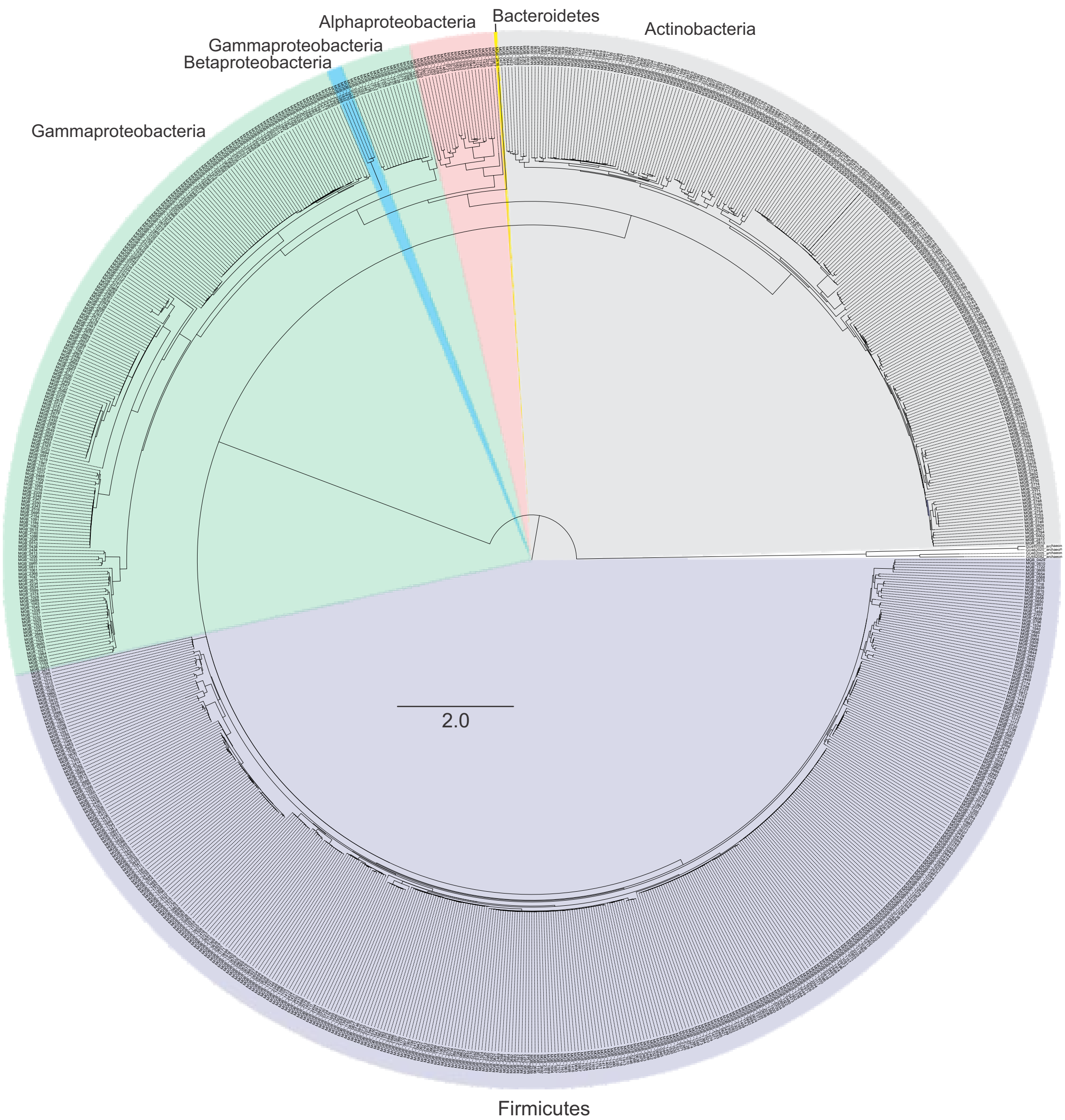


Figure 5. Phylogenetic diversity of cultivable bacteria isolated from sponge and associate habitats. Maximum likelihood tree is shown with Archaea used for rooting the tree.

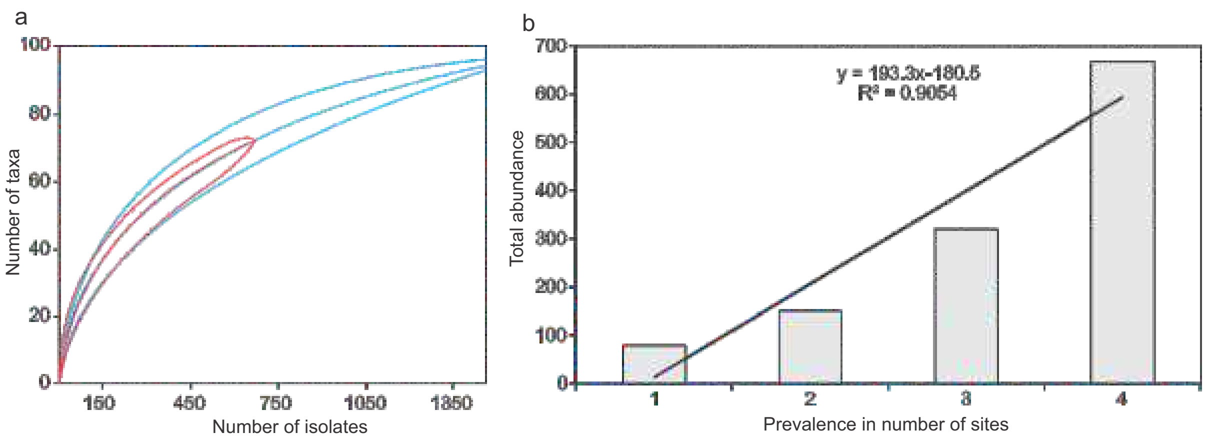


Figure 6. Diversity profile of cultivable bacteria. (a) Rarefaction curve for taxa diversity on ZM (blue) and PRS (red) media. (b) Prevalence versus abundance of bacterial taxa in different sites.

7852), *Mycolicibacterium poriferae* (MCC 6242), *Pseudonocardia kongjuensis* (MCC 7930) and *Rothia terrae* (MCC 7823), *Serinicoccus marinus* (MCC 7935) respectively. Although 12 genera, namely *Agrococcus, Arthrobacter, Brachybacterium, Brevibacterium, Klenkia, Kocuria, Microbacterium, Micrococcus, Micromonospora, Nocardiopsis, Rhodococcus* and *Streptomyces,* were isolated from both sponges and associated habitats, most of these genera had some putative species that were either exclusive to sponges or associated environments. In particular, 7 species, *Brachybacterium muris* (MCC 7614), *Brevibacterium casei* (MCC 6140, MCC 6152, MCC 6176), *Kocuria rhizophila* (MCC 8384), *Nocardiopsis salina* (MCC 7931), *Rhodococcus zopfii* (MCC 7934), *Streptomyces smyrnaeus* (MCC 7924) and *Streptomyces viridobrunneus* (MCC 7990), were recorded only from sponges.

With respect to both, the number of isolates and number of putative species, *Streptomyces* was the most dominant genus, which was found in both sponges and associated environments. *Nocardiopsis* was the second most common genus with two dominant species *Nocardiopsis alba* (MCC 8385) followed by *N. dassonvillei* (MCC 7845). Among the genera and species that were recorded only from the environment, we provide first record of species such as *Aeromicrobium massiliense* (MCC 6739) and *Glutamicibacter mysorens* (MCC 7825) from marine waters.

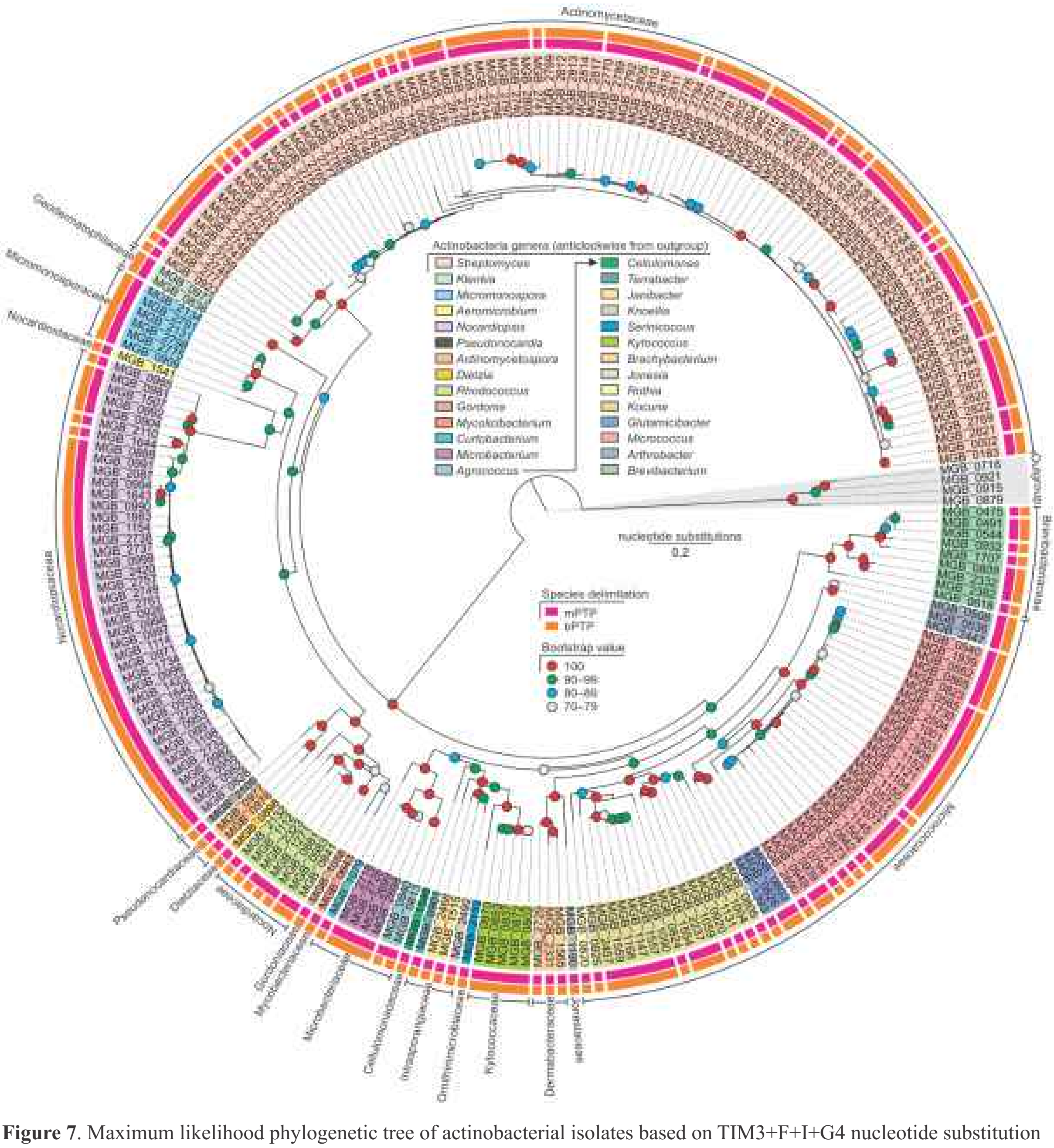


Figure 7. Maximum likelihood phylogenetic tree of actinobacterial isolates based on TIM3+F+I+G4 nucleotide substitution model (lnL of consensus tree: -18684.58). Firmicutes belonging to genus Bacillus were used as outgroups.

Sponges and associated environment in northern parts of western coast of India are rich in actinobacterial diversity with about 95 putative species under 19 families and 28 genera. We recorded 13 species of actinobacteria only from sponges. Out of these, *Mycobacterium poriferae* was originally described from marine sponge (Padgitt and Moshier, 1987), while three species, *Gordonia terrae* (Elfalah et al., 2013; Santos et al., 2019; Montalvo et al., 2005), *Brevibacterium casei* (Kiran et al., 2010) and *Kocuria rhizophila* (Palomo et al., 2013) have been previously reported from sponges. To our knowledge, we provide first report of nine species, namely *Brachybacterium murisi, Jonesia denitrificans, Nocardiopsis salina, Pseudonocardia kongjuensis, Rhodococcus zopfii, Rothia terrae, Serinicoccus marinus, Streptomyces smyrnaeus* and *Streptomyces viridobrunneus,* from marine sponges, although some of them are known from marine habitats (Stach et al., 2003; Satheeja and Jebakumar, 2011; Yi et al., 2004; Shinde et al., 2018).

Streptomyces was the most dominant genus among the isolates, which agrees with the findings of Zhang et al. (2008). Genus *Nocardiposis*, with its two species *N. alba* and *N. dassonvillei*, has been suggested (Bennur et al. 2015) as the second common genus after *Streptomyces* and that too agrees with our findings. Further, report of most genera, including *Agrococcus*,

Table 2. Putative number of species of actinobacterial genera based on PTP and bPTP methods isolated from sponge, associate environment and both sources.

Family	**Genus**	**Sponge**	**Environment**	**Both**			
		mPTP	**bPTP**	**mPTP**	**bPTP**	**mPTP**	**bPTP**
Actinomycetaceae	*Streptomyces*	23	23	24	25	12	11
Brevibacteriaceae	*Brevibacterium*	5	5	2	2	1	1
Cellulomonadaceae	*Cellulomonas*	0	0	1	1	0	0
Dermabacteraceae	*Brachybacterium*	1	1	2	2	0	0
Dietziaceae	*Dietzia*	0	0	1	1	0	0
Geodermatophilaceae	*Klenkia*	1	1	1	1	1	1
Gordoniaceae	*Gordonia*	1	1	0	0	0	0
Intrasporangiaceae	*Janibacter*	0	0	2	2	0	0
	Knoellia	0	0	1	1	0	0
	Terrabacter	0	0	1	1	0	0
Jonesiaceae	*Jonesia*	1	1	0	0	0	0
Kytococcaceae	*Kytococcus*	0	0	1	1	0	0
Microbacteriaceae	*Agrococcus*	1	1	1	1	1	0
	Curtobacterium	0	0	1	1	0	0
	Microbacterium	1	1	1	1	1	1
Micrococcaceae	*Arthrobacter*	1	1	1	1	1	1
	Glutamicibacter	0	0	2	2	0	0
	Kocuria	4	4	6	6	2	2
	Micrococcus	6	6	8	8	4	4
	Rothia	1	1	0	0	0	0
Micromonosporaceae	*Micromonospora*	1	1	1	1	1	1
Mycobacteriaceae	*Mycolicibacterium*	1	1	0	0	0	0
Nocardiaceae	*Rhodococcus*	2	2	2	2	2	1
Nocardioidaceae	*Aeromicrobium*	0	0	1	1	0	0
Nocardiopsaceae	*Nocardiopsis*	4	4	3	3	2	2
Ornithinimicrobiaceae	*Serinicoccus*	1	1	0	0	0	0
Pseudonocardiaceae	*Actinomycetospora*	0	0	1	1	0	0
	Pseudonocardia	1	1	0	0	0	0
	Total	56	56	64	65	28	25

Arthrobacter, *Brevibacteriu*, *Kocuria*, *Microbacterium* and *Micrococcus*, from sponges in our study are consistent with previous reports from other study areas including South China Sea (Li et al., 2015), Yellow Sea (Zhang et al., 2008), Mediterranean Sea (Cheng et al., 2015), coast of Florida in USA (Montalvo, 2005) and northern coast of Brazil (Menezes et al., 2010) indicating that there are common trends in the discovery of actinobacteria from sponges.

Among the first reports from marine environment from our study, *Aeromicrobium massiliense* and *Glutamicibacter mysorens* are known from human fecal microbiota (Ramasamy et al., 2012) and sewage (Nand and Rao, 1972) respectively. Presence of these two species in the sediments along the collection site Harne (17.81ºN, 73.09ºE) likely suggests fecal pollution in this area.

Culture Independent Bacterial Diversity

A comparison of bacterial diversity based on metagenomic approach on different rich and oligotrophic media suggested that the cultivable bacterial diversity was much different from the diversity estimates of culture independent approaches (Fig. 8). There was a significant association between bacterial diversity and different culture dependent and independent approaches ($\chi2 = 56141$, $P < 0.0001$). Canonical analysis of the data suggested that while PR, NA100 and NA1 represented similar diversity as that of RR1, all culture dependent methods had similar representation of bacterial diversity as compared to culture independent method (Fig. 8a), which was also evident in the hierarchal clustering based on Bray-Curtis similarity index (Fig. 8b).

Rarefaction curves (Fig. 8c) suggested that PR was the most efficient in resenting the diversity among the tested cultivable approaches, while RR was the least efficient. However, all cultivable approaches performed much poor as compared to the culture independent method. Same trend was observed in terms of Shannon diversity index (Fig. 8d). Thus, cultivable bacterial diversity only represent a fraction of culture independent methods, however, culture dependent methods are essential for screening for various bioactivities.

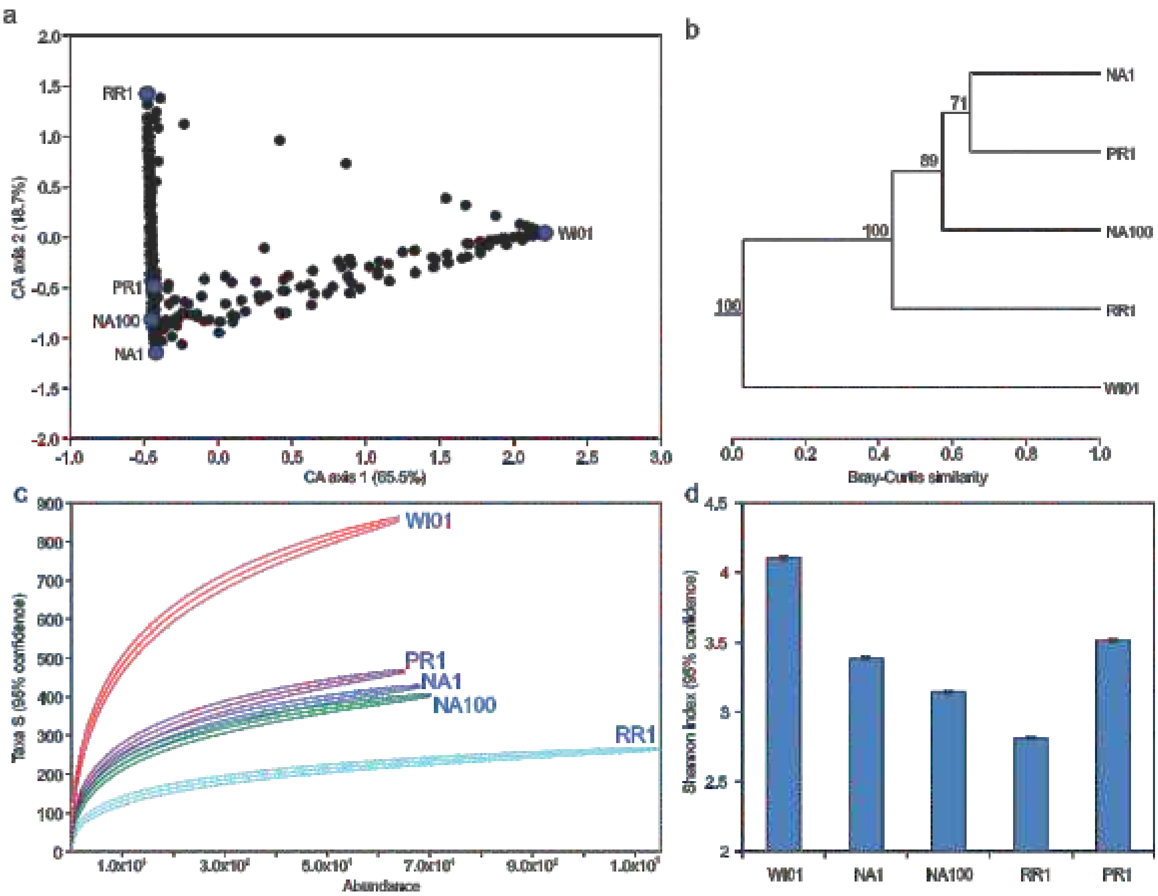


Figure 8. Comparison of bacterial diversity explained by culture dependent and independent metagenomic approaches. (a) Correspondence analysis, (b) hierarchal clustering based on Bray-Curtis similarity index and unweighted pair group method with arithmetic mean (UPGMA), (c) rarefaction curve and (d) Shannon diversity index.

Screening For Actinobacterial Activities

Out of 237 actinobacterial isolates, 50 isolates were randomly selected for screening of three activities, namely predation, antibiotic production and production of enzyme inhibition.

Non-obligate epibiotic predatory activity

Predatory activity of actinobacterial isolates was confirmed based on the zone of clearance (Fig. 9) and decrease in cell density with increasing predator density (Fig. 10).

Out of the total 50 actinobacterial isolates screened for non-obligate epibiotic predatory activity, 26 isolates showed predation on at least one of the 14 target organisms. Of the 26 isolates with predatory behavior, 17 preyed on Gram-negative prey, 21 preyed on Gram-positive prey, while 12 preyed on both Gram- negative and Gram-positive prey. There was no significant difference (Mann-Whitney U = 15, P = 0.2601) in the frequency of actinobacterial predators on Gram-negative and Gram-positive prey (Table 3). Most actinobacterial predators (n = 14) preyed on a single prey species while only a few predators preyed on multiple prey species. A single predator of the genus *Streptomyces* preyed on 8 prey species. There was a significant association between the source of isolation (sponge or associated environment) and predatory behavior (χ^2 = 5265, P = 0.0218), where the isolates from sponge showed proportionately more predatory behavior (Fig. 11).

All eight isolates of *Streptomyces* used for screening showed predatory behavior and preyed on both Gram-negative and Gram-positive prey. Out of 25 isolates of *Nocardiopsis*, 12 showed predatory behavior, out of which 5 preyed on Gram-negative bacteria while 11

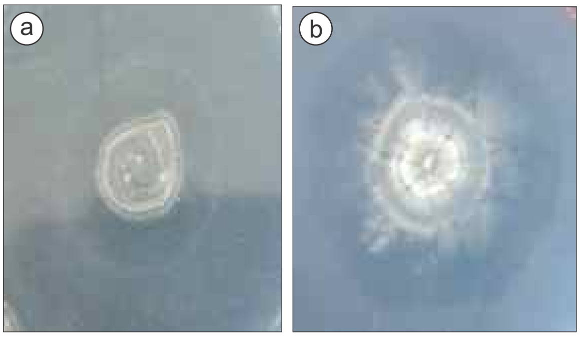


Figure 9. A zone of clearance for *Bacillus* (left) and *Staphylococcus* (right) and growth of *Streptomyces atrovirens* at the center.

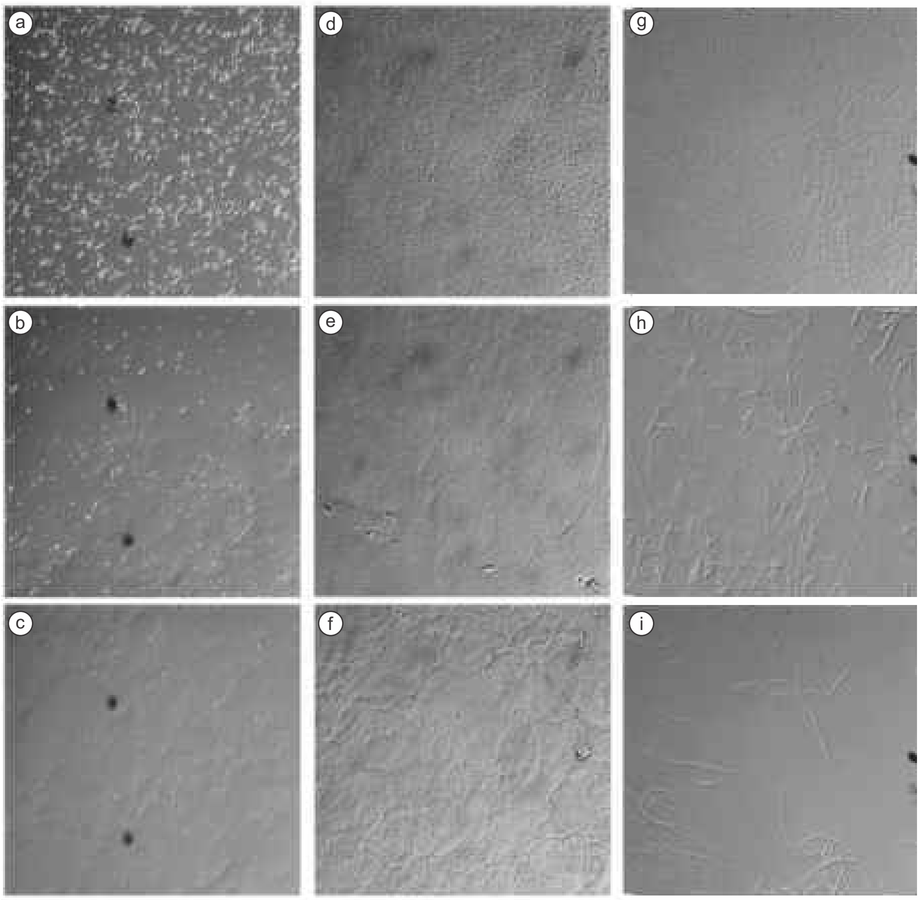


Figure 10. A pan across *Bacillus paralicheniformis* (a-c), *Staphylococcus aureus* (d-f) and *Protease vulgaris* (g-i) showing decrease in prey cell density as distance to the actinobacterial predator *S. atrovirens* decreases (100X oil immersion, Apotome Carl Zeiss)

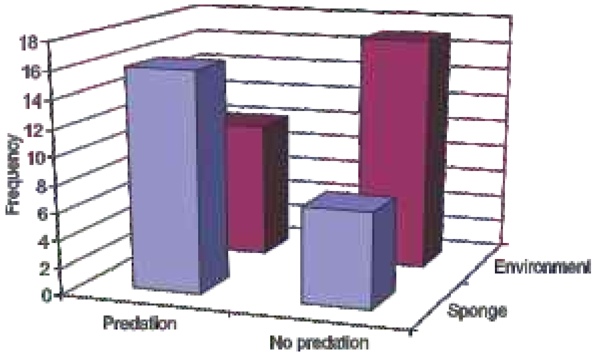


Figure 11. Association between source of actinobacterial isolation on their predatory behavior. There was a significant association between the source (sponge or associated environment) of actinobacterial isolation and predation ($\chi2$ = 5.265, P = 0.0218).

preyed on Gram-positive bacteria. Both the isolates of *Micromonospora* preyed on Gram-positive prey while only one preyed on Gram-negative prey. Isolates belonging to genera *Brevibacterium*, *Glutamicibacter* and *Rhodococcus* preyed only on Gram-negative prey while *Rothia* preyed only on Gram-positive prey.

Although predation is a widespread behavior in bacterial kingdom, proteobacteria of the orders Myxococcales and Bdellovibrionales have received more attention (Jurkevitch, 2007) as compared to other taxa, especially the Gram-positive bacteria such as actinobacteria. Among actinobacteria only three genera, namely *Agromyces, Streptomyces* and *Streptoverticillium,* are known to have predatory behavior against other bacterial species (Casida, 1980; 1983; 1988; Kumbhar et al., 2014; Zeph and Casida, 1986; Ibrahimi et al., 2020). In the current study, for the first time, we show predation in six other genera of actinobacteria, namely *Brevibacterium*, *Glutamicibacter, Micromonospora, Nocardiopsis, Rhodococcus* and *Rothia.* Kumbhar et al. (2014) argued that predatory behavior is widespread in genus *Streptomyces* and even in the current study we observed that all the isolates of *Streptomyces* used for screening showed predation on Gram-positive as well as Gram-negative prey.

Antibiosis, antibacterial activity and growth inhibition

Of the 50 actinobacterial isolates screened for antibacterial activity, 25 showed antibiosis against at least one target organism. Of these 25 isolates, all showed antibiosis against at least one of the Gram-positive target species, while only five showed antibiosis against at least one of the Gram-negative organisms. The frequency of antibacterial activity against Gram-positive organisms was significantly higher (Mann-Whitney U = 1.5, P = 0.003) than those against Gram-negative organisms (Table 3). Most antibacterial activities were broad spectrum with respect to the target organisms that they affected. There were 10 actinobacterial isolates that showed antibiosis against two target organisms, 6 isolates that affected 4 target species and 2 isolates that affected 6 target species. There was no association between antibacterial activity and the source (sponge or associated environment) of the isolation ($\chi2$ = 2.0129, P = 0.1560).

Table 3. Predation and antibiotic production by actinobacteria against the Gram positive and Gram negative target species.

Target species	Predation	Antibiotic	Predation and Antibiotic by same actinobacterial isolate
Gram positive			
Mycobacterium smegmatis	3	12	0
Micrococcus luteus	8	5	0
Bacillus subtilis	1	24	1
Staphylococcus aureus	17	9	4
Salinicoccus roseus	9	3	0
Enterococcus faecalis	3	20	1
Gram negative			
Acetobacter pasterianus	7	0	0
Alcaligenes faecalis	3	1	1
Escherichia coli	2	5	0
Klebsiella pneumoniae	3	0	0
Proteus vulgaris	8	0	0
Salmonella enterica	2	0	0
Serratia marcescens	3	0	0
Pseudomonas aeruginosa	1	0	0

Out of eight isolates of *Streptomyces* that were screened for antibacterial activity, five showed antibiosis, of which two showed antibiosis against Gram-negative target species, while all showed antibiosis against Gram-positive organisms. In the case of *Nocardiopsis*, of the 25 isolates used for screening 17 showed antibiosis, of which all affected growth of Gram-positive organisms, while only two affected growth of Gram-negative organisms. Genus *Kytococcus* showed antibiosis that affected both Gram-positive as well as Gram-negative organisms, while *Glutamicibacter* and *Rothia* showed antibiosis against Gram-positive organisms only.

Enzyme inhibition

Out of 50 actinobacterial isolates screened for inhibition of four enzymes, 30 isolates inhibited at least one of the enzyme of these 30 isolates, 28 inhibited trypsin, 24 inhibited chymotrypsin, three inhibited angiotensin converting enzyme (ACE) and only two inhibited subtilisin. Venn diagram of frequency of isolates inhibiting different enzymes (Figure 12) suggested that five isolates inhibited only trypsin and one isolate each inhibited chymotrypsin and ACE, while subtilisin inhibition was accompanied by inhibition of other enzymes. No isolate inhibited all four enzymes. Out of 30 actinobacteria that produced enzyme inhibitors, 19 produced two inhibitors, four produced three inhibitors while seven produced only one of the four inhibitors. There was no association between the enzyme inhibition and source of the actinobacterial isolate (χ^2=2.3386, P=0.1262).

Out of eight isolates of *Streptomyces* seven produced enzyme inhibitors against proteases, while 12 out of 25 isolates of *Nocardiopsis* produced enzyme inhibitors of which 11 produced against proteases and two produced against ACE (Table 4). One isolate of *Actinomycetospora* inhibited activity of ACE.

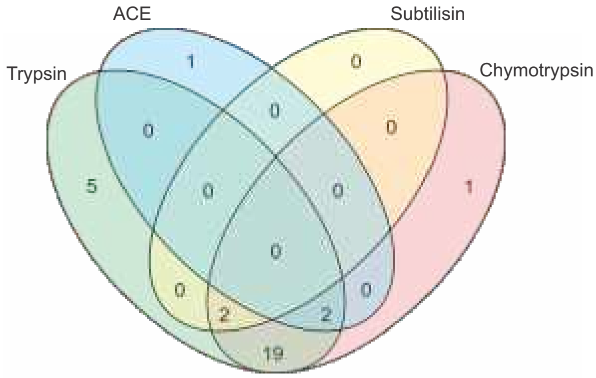


Figure 12. Venn diagrams combination of enzyme inhibitors produced by actinobacterial isolates. Venn diagrams are not to scale.

Associations between predation, antibiosis and enzyme inhibition

Out of 50 actinobacterial isolates that were screened for activities, 39 showed at least one of the three activities. Of these 39 isolates, 15 showed all three activities, while nine showed predation as well as enzyme inhibition (Figure 13). There were only seven isolates that showed predation and antibiotic production against the same target organism (Table 3) and all these isolates belonged to genera *Streptomyces* and *Nocardiopsis*.

Antibiotic production showed no significant association with predation (χ^2 = 2.8846, P = 0.0894) or

Table 4. Frequency of actinobacterial isolates producing four different enzyme inhibitors.

Genus	Number of isolates	Frequency of isolates inhibiting				Isolates with at least one inhibition activity
		Subtilisin	Trypsin	Chymotrypsin	ACE	
Actinomycetospora	2	0	1	0	1	2
Agrococcus	1	0	0	0	0	0
Brevibacterium	1	0	1	1	0	1
Glutamicibacter	1	0	1	1	0	1
Jonesia	1	0	0	0	0	0
Kocuria	1	0	0	0	0	0
Kytococcus	1	0	1	0	0	1
Micrococcus	1	0	1	0	0	1
Micromonospora	2	0	2	2	0	2
Nocardiopsis	25	0	11	11	2	12
Pseudonocardia	1	0	0	0	0	0
Rhodococcus	4	0	2	1	0	2
Rothia	1	0	1	1	0	1
Streptomyces	8	2	7	7	0	7

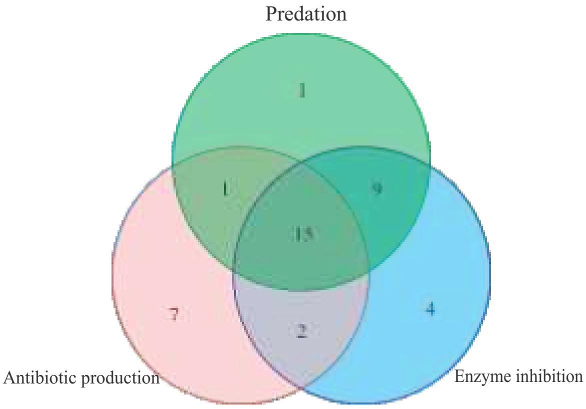


Figure 13. Venn diagrams of predation, antibiotic production and enzyme inhibition by actinobacterial isolates. Venn diagrams are not to scale.

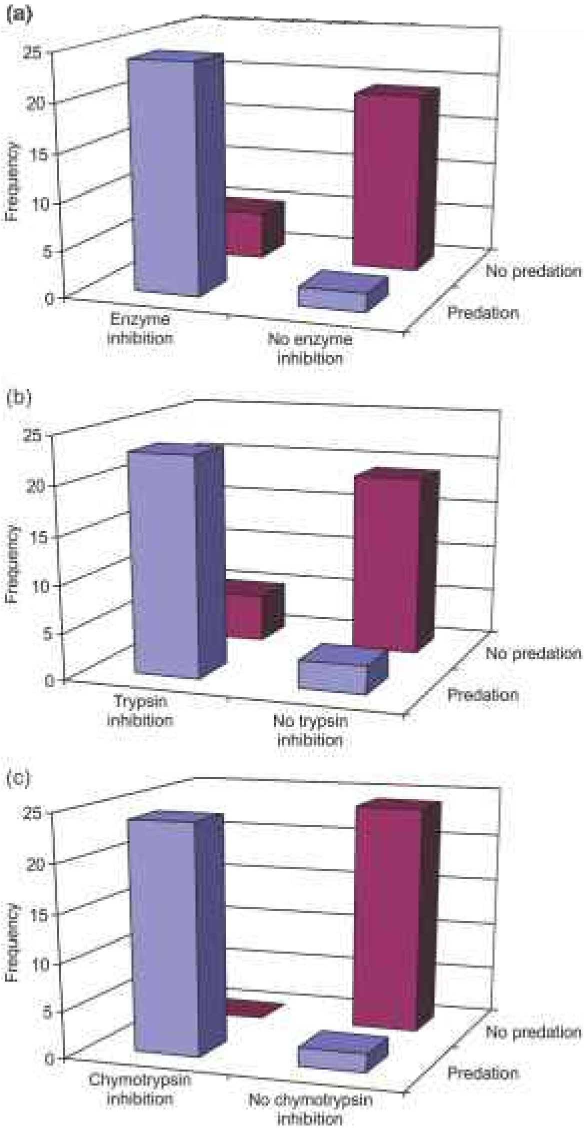


Figure 14. Association between enzyme inhibition and predation in actinobacterial isolates. Predation was significantly associated with (a) inhibition of any one of the four enzymes tested ($\chi 2 = 26.172$, $P < 0.0001$), (b) inhibition of trypsin ($\chi 2 = 23.165$, $P < 0.0001$) and (c) inhibition of chymotrypsin ($\chi 2 = 42.604$, $P < 0.0001$).

any of the four enzyme inhibition ($\chi^2 = 2.0525$, P = 0.1520). However, there were significant associations between predation and protease inhibitors (Figure 14). There were 24 isolates that showed both predation as well as inhibition of at least one enzyme and there was a significant association between the two activities ($\chi^2 = 26.172$, $P < 0.0001$), where predators proportionately produced more enzyme inhibitors than non-predators (Figure 14a). There were 23 actinobacterial isolates that showed predation as well as trypsin inhibition and there was a significant association between the two ($\chi^2 = 23.165$, $P < 0.0001$) with predators more likely to produce trypsin inhibitors than non-predators (Figure 14b). Similarly, 24 actinobacteria were predators as well as inhibited chymotrypsin activity and there was a significant association between the two ($\chi^2 = 42.604$, $P < 0.0001$) with predators more likely to produce chymotrypsin inhibitors than non-predators (Figure 14c).

Since sponges are sessile and lack other anti-predator defenses, it has been suggested that secondary metabolites of bacteria can provide sponges with chemical defense (Lee et al., 2001; Kumbhar and Watve, 2013). However, we did not observe any significant association between the source of actinobacterial isolation and antibiotic production, suggesting that isolates even from environment were equally likely to produce antimicrobials as that of the isolates recovered from sponges. However, there was a significant association between the source of isolation and predatory activity, with proportionately more predators among the isolates recovered from sponge. Ecologically this makes sense. As the sponges are filter feeders and have regular intake of environmental bacteria, sponge associated actinobacteria will have better predation opportunities. It is also possible that the predatory activity of sponge associated actinobacteria, could have evolved as a mutualistic activity as it can defend sponges from pathogenic bacterial invasions.

Actinobacteria are known to produce several enzyme inhibitors (Manivasagan et al., 2015; Imada, 2005). However, for the first time we show a strong association between predation and enzyme inhibition, specifically inhibition of trypsin and chymotrypsin, where predators produced proportionately more enzyme inhibitors as compared to non-predators. Predators themselves are known to produce a variety of hydrolytic enzymes for degrading the prey (Pérez et al., 2016). Therefore, it is possible that the production of enzyme inhibitors safeguards their own cells from being target of the enzyme. It is also possible that enzyme inhibitors also protect the actinobacteria from hydrolytic enzymes produced from the sponge host and other microbiota.

An interesting observation that we made, when comparing the predation and antibiotic production by actinobacteria, was that, while predation was equally effective against Gram-positive as well as Gram-negative target species, antibiotic production was mainly effective against Gram-positive bacteria. Recently, Ibrahimi et al. (2020) suggested that there are some bio-active secondary metabolites that co-cultured actinobacteria produce in the presence of prey cells. It is therefore possible that studying the predatory behavior of actinobacteria and predation specific metabolites could lead to discovery of novel therapeutic agents that are more broad-spectrum.

Anti-biofilm activity

Several actinobacterial isolates showed good potential for biofilm inhibition (Table 5). Maximum activity of biofilm inhibition was shown by *Nocardiopsis* against

Table 5. Summary of anti-biofilm activity expressed as percentage inhibition of actinobacterial isolates where the extract was added after and before biofilm formation. Inhibition more than 30% are shown in bold.

Isolate [MGB code]	Source	*S. typhi*		*E. faecalis*		*P. aeruginosa*		*S. aureus*	
		After	Before	After	Before	After	Before	After	Before
Streptomyces [0183]	Sponge	20.79	17.99	17.18	15.83	17.16	10.71	17.68	10.88
Brevibacterium [0809]	Sponge	6.32	16.66	11.91	2.70	8.07	9.80	17.64	15.25
Rothia [0820]	Sponge	9.04	4.04	22.25	4.36	4.19	6.38	20.03	17.50
Arthrobacter [0826]	sediment	6.47	6.65	13.28	2.32	7.79	1.73	17.77	15.38
Micrococcus [0833]	Sponge	7.18	5.10	11.17	3.65	2.65	6.34	18.39	15.96
Kytococcus [0853]	sediment	14.84	28.56	**41.58**	25.03	31.63	18.08	17.24	15.01
Nocardiopsis [0888]	sediment	7.31	2.68	12.23	2.97	7.63	3.92	18.51	16.07
Nocardiopsis [0891]	sediment	6.15	**46.91**	-12.75	**53.38**	4.70	-10.58	17.49	15.11
Nocardiopsis [0904]	Sponge	16.20	18.59	9.88	16.13	13.38	13.90	12.25	20.08
Kocuria rosea [0920]	water	6.43	3.89	21.69	3.72	13.81	5.51	17.73	15.34
Streptomyces [0924]	Sponge	7.01	9.32	25.36	**66.71**	-0.05	3.71	18.24	15.82
Nocardiopsis [0955]	sediment	6.79	3.82	16.10	6.34	6.82	1.91	18.05	15.64
Actinomycetospora [0976]	water	17.01	29.11	14.01	20.91	19.21	13.33	14.15	13.54
Actinomycetospora [0977]	water	6.48	5.45	5.93	5.82	14.88	6.48	17.78	15.38
Rhodococcus [0983]	water	5.69	**56.34**	24.74	**36.78**	3.51	6.91	17.09	14.73
Cellulosimicrobium [0984]	Sponge	5.32	4.63	**68.34**	4.21	-0.60	-3.76	16.76	14.42
Nocardiopsis [0985]	Sponge	11.72	29.36	25.92	25.89	**38.26**	25.37	12.10	**35.87**
Nocardiopsis [0991]	water	7.12	2.19	10.30	2.83	6.37	2.45	18.35	15.92
Nocardiopsis [0992]	Sponge	4.98	-3.65	-7.09	3.44	5.22	1.91	16.46	14.14
Nocardiopsis [0994]	Sponge	**51.13**	31.43	**41.05**	11.97	29.58	6.06	12.50	14.50
Streptomyces [0995]	sediment	11.27	12.03	25.97	21.29	**34.50**	11.94	17.65	30.07
Nocardiopsis [0996]	sediment	5.29	5.58	27.01	3.29	6.92	1.74	16.74	14.40
Nocardiopsis [0997]	sediment	5.39	**47.91**	26.02	1.58	1.66	1.10	16.82	14.48
Nocardiopsis [0998]	sediment	5.18	10.55	27.96	6.14	0.11	9.14	16.63	14.31
Nocardiopsis [1114]	sediment	15.82	20.77	6.06	24.86	20.57	10.79	12.81	12.91
Nocardiopsis [1198]	sediment	18.10	15.61	12.79	3.99	6.50	0.84	28.00	14.68
Nocardiopsis [1422]	Sponge	**57.53**	11.29	**46.11**	11.42	19.30	14.42	**53.15**	14.76
Nocardiopsis [1642]	Sponge	8.02	12.76	-14.31	2.76	-8.58	2.29	19.13	24.47
Nocardiopsis [1643]	Sponge	**76.21**	25.33	**38.22**	4.30	8.39	2.95	**63.55**	28.27
Streptomyces [1968]	Sponge	11.65	-0.24	-7.39	8.80	6.01	-0.77	22.33	19.66
Streptomyces [2018]	Sponge	17.48	**45.35**	11.51	3.39	7.10	1.60	27.45	24.99
Nocardiopsis [2087]	Sponge	8.26	9.63	-13.28	2.59	0.16	2.04	19.35	28.45
Pseudonocardia [2109]	water	8.42	9.00	17.03	5.48	-1.91	4.43	19.48	16.99
Streptomyces [2111]	Sponge	18.09	13.86	15.37	19.91	17.45	24.31	16.57	28.69

S. typhi. Different isolates had different anti-biofilm activity when added before or after biofilm formation. In the case of *S. typhi*, actonobacteria including *Nocardiopsis, Rhodococcus* and *Streptomyces* showed good anti-biofilm activity. For the target bacterium *E. faecalis*, actonobacteria including *Kytoccous, Nocardiopsis, Streptomyces, Rhodococcus* and *Cellulosimicrobium* showed good anti-biofilm activity. In the case of *P. aerogenosa*, actinobacterial isolates of the genera *Nocardiopsis* and *Streptomyces* showed good anti-biofilm activity. For *S. aureus*, only *Nocardiopsis* isolates showed anti-biofilm activity. In general, *Nocardiopsis* was the best candidate for studying anti-biofilm activity followed by *Streptomyces* and *Rhodococcus*. Since, biofilms play a vital role in bacterial infectious diseases, exploring marine actinobacteria for active anti-biofilm compounds could lead to discovery of novel metabolites of therapeutic value.

Bio-active Bacterial Compounds

After primary screening (by cross-streak method) shortlisted microorganisms were qualitatively explored for bioassay. *Bacillus sonorensis, Bacillus licheniformis, Lysinimicrobium mangrovi, Nocardiopsis alba, Streptomyces atrovirens, Rhodococcus* sp., *Kocuria rhizophila, Nocardiopsis synnemataformans, Staphylococcus warneri* and *Micrococcus aloeverae* exhibited antimicrobial activity against 14 laboratory strains of target bacteria (Table 6). Bioactivity of crude extract from *Bacillus sonorensis* against *Micrococcus luteus* and *Salinicoccus roseus* is shown in Fig. 15. Crude extracts from *Bacillus sonorensis* were purified using HPLC (Fig. 16) and the structure was determined using NMR (Fig. 17).

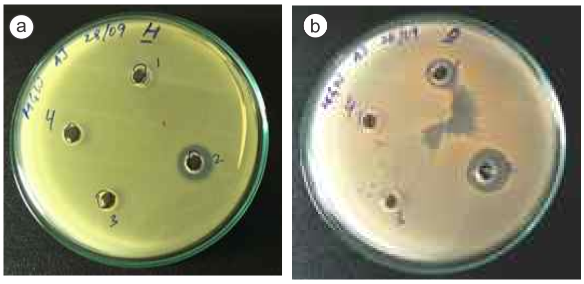


Figure 15. Bioactivity of crude extract from *Bacillus sonorensis* against *Micrococcus luteus* and *Salinicoccus roseus*.

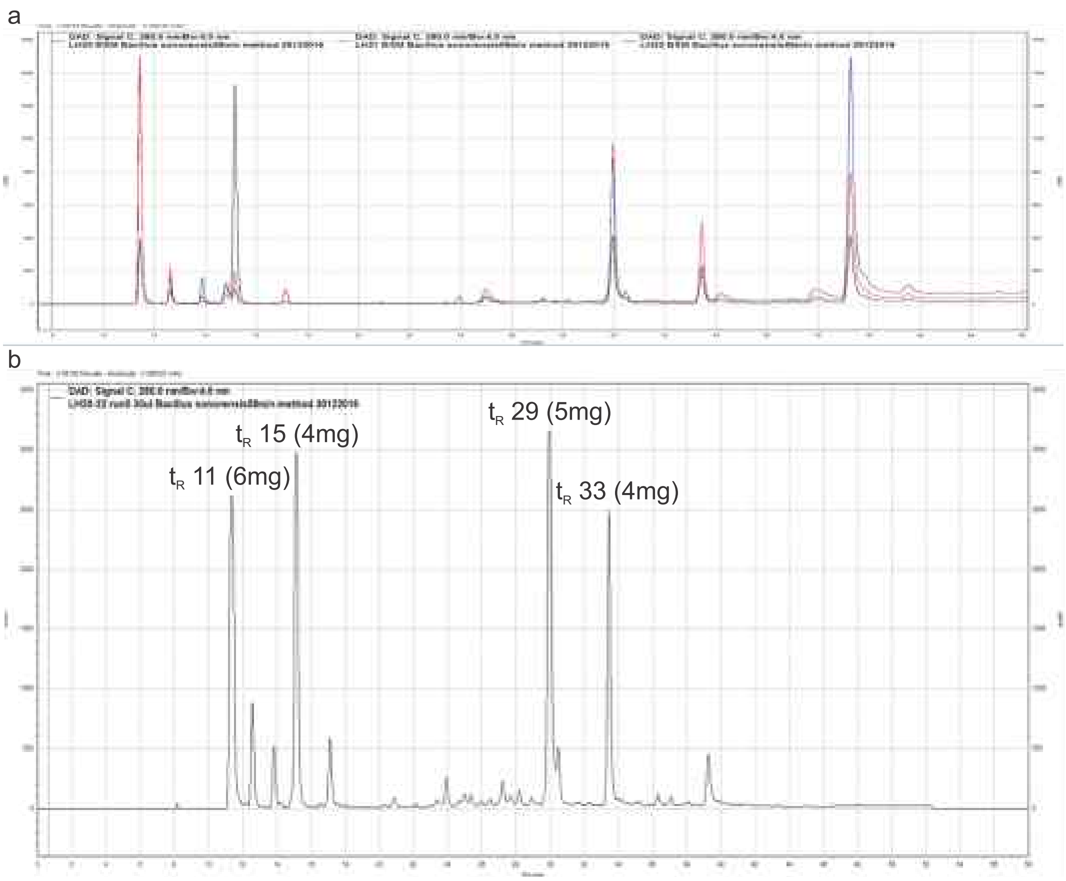


Figure 16. Reverse phase HPLC trace of Sephadex LH 20 fractions 20-22.

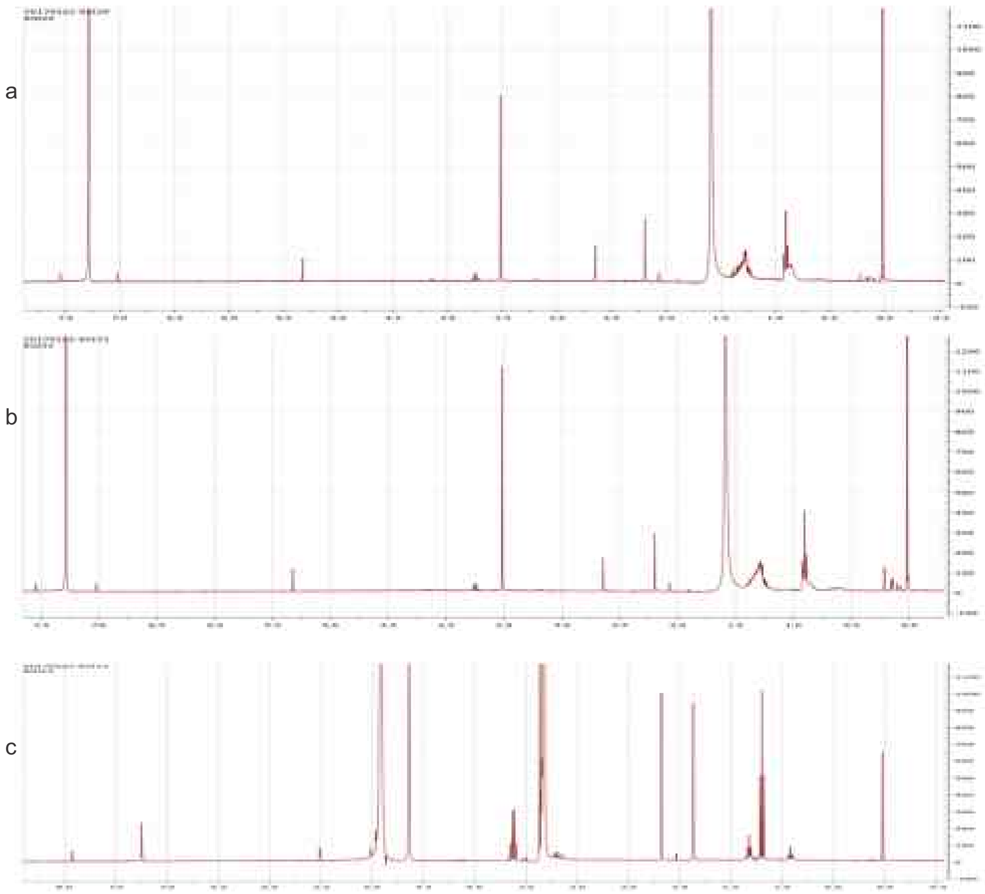


Figure 17. NMR data of purified peaks from HPLC for *Bacillus sonorensis* compound. NMR data for fractions, (a) tR 29 1H, (b) tR 33 1H and (c) tR 15 1H.

Table 6. List of bacteria showing bioactivity against at least one test organism.

Bacterium	Activity against target organism
Bacillus sonorensis	*Mycobacterium smegmatis, Salinicoccus roseus, Micrococcus luteus*
Bacillus licheniformis	*Escherichia coli, Staphylococcus aureus, Bacillus subtilis*, *Mycobacterium smegmatis, Salinicoccus roseus,*
Nocardiopsis alba	*Bacillus subtilis, Escherichia coli, Staphylococcus aureus, Mycobacterium smegmatis, Micrococcus luteus*
Nocardiopsis synnemataformans	*Bacillus subtilis, Acetobacter pasteurensis*
Streptomyces atrovirens	*Bacillus subtilis*
Nocardiopsis dassonvelli	*Bacillus subtilis*
Lysinimicrobium mangrovi	*Proteus vulgaris*
Paracoccus haendensis	*Proteus vulgaris*

After performing bioassay, it was found that *Nocardiopsis synnemataformans* crude extracts in 50% (Ethyl acetate: Hexane) as well as different fractions showed activity against *S. aureus.* Purified compound after NMR spectroscopy revealed presence of Pentanyl-3 acetate (Fig. 18). Similar derivatives are reported from marine sponges. This compound is not yet reported from bacteria associated with marine sponges.

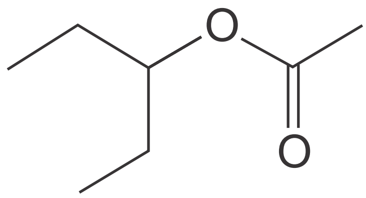


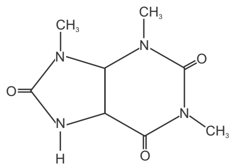
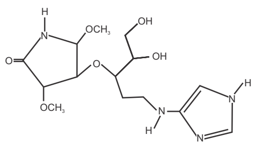
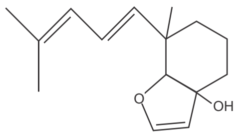
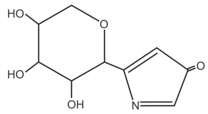
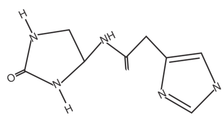
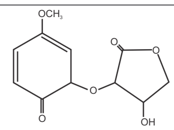
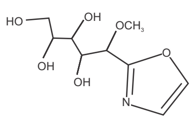
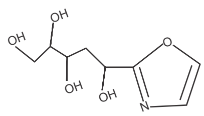
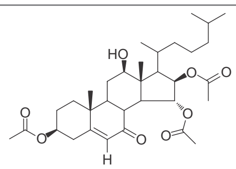
Figure 18. Pentanyl-3 acetate.

Bioactive Compounds from Marine Sponges and Algae

Screening for active compounds from extracts of marine sponges and algae yielded nine bioactive compounds with anti-bacterial, anti-fungal, anti-malarial, cytotoxic and anti-inflammatory compounds. Source of the compound, its chemical formula, chemical structure and activity are presented in Table 7.

Sponge *Iricinia fusca* provided maximum number of novel secondary metabolites with broad spectrum antibacterial, antifungal and cytotoxic activities. Sponge *Mycale* (*Zygomycale*) *parishii* contributed two novel secondary metabolites both with antibacterial and antifungal activities. While, sponge *Amphimedon viridis* provided one novel compound with cytotoxic and anti-inflammatory activity and red algae *Halymenia floresii* provided a novel secondary metabolite with anti-malarial activity.

Table 7. Bioactive compounds isolated from marine sponges and algae.

Source	Compound	Structure	Activity
Amphimedon viridis (sponge)	1,3,9 trimethyl purine derivative		1. Cytotoxic activity IC_{50} 1–3µM against breast cancer (MCF-7), human neuroblastoma (SHSY5Y), human non-small cell lung cancer (A549) and human liver cancer (HEPG2) cell lines. 2. Anti-inflammatory effects in LPS induced murine macrophage J774
Iricinia fusca (sponge)	1. 4-((1,2-dihydroxy-5-(methyl (1-methyl-1H-imidazol-4-yl) amino) pentan-3-yl)oxy)-3,5-dimethoxy-1-methylpyrrolidin-2-one		Antibacterial activity by inhibiting growth of *S. aureus* with MIC 280 µM.
	2. 7-methyl-7-((E)-4-methylpenta-1,3-dien-1-yl)-5,6,7,7a-tetrahydrobenzofuran-3a(4H)-ol		1. Broad-spectrum activity against bacteria and fungi at 2 µg/µL. 2. Cytotoxic activity against RAW264.7 cells (mouse monotype macrophage leukemia) and N2A cells (neuroblastoma) with IC_{50} values 55±4.21 µg/mL.
	3. 5-(3,4,5-trihydroxytetrahydro-2H-pyran-2-yl)-3H-pyrrol-3-one		Antibacterial activity against *Mycobacterium smegmatis* at MIC 116 µM
	4. N-(1,3-dimethyl-2-oxoimidazolidin-4-yl)-2-(1-methyl-1H-imidazol-4-yl) acetamide		Cytotoxic activity against HeLa, SiHa (cervical cancer cells), and MDA-MB-231(Breast cancer cell line) lines with IC_{50} values 200 µg/mL
	5. 4-hydroxy-3-((3-methoxy-6-oxocyclohexa-2,4-dien-1-yl)oxy) dihydrofuran-2(3H)-one		Cytotoxic activity against HeLa, SiHa (cervical cancer cells), and MDA-MB-231(Breast cancer cell line) lines with IC_{50} values 200 µg/mL
Mycale (*Zygomycale*) *parishii* (sponge)	1. 5-methoxy-5-(oxazol-2-yl)pentane-1,2,3,4-tetraol		Antibacterial and antifungal activity against *B. subtilis*, *E. coli*, *S. aureus*, *A. niger*, and *P. chrysogenum* at 100 µg/disk
	2. 5-oxazol-2-yl-pentane-1,2,3,5-tetraol		Antibacterial and antifungal activity against *B. subtilis*, *E. coli*, *S. aureus*, *A. niger*, and *P. chrysogenum* at 100 µg/disk
Halymenia floresii (red alga)	12β-hydroxy-3β,15α,16β-triacetoxy-cholest-5-en-7-one		Anti-malarial activity against chloroquine-resistant *Plasmodium falciparum* 3D7 strain with an IC_{50} of 3.0 µM

Characterization of Compounds Involved in Predation

HPLC analysis revealed a peak at RT 26.49, which was found to be unique in all the predation experiments (against *S. aureus, Proteus* and *Bacillus*) (Fig. 19, 20). This fraction was further lyophilized and submitted for chemical analysis (MALDI, NMR, etc.)

Amount of compound obtained after purification was very low. Zones extracted from 3000 plates yielded less than 1mg pure compound. Even after multiple such attempts, we could not obtain higher amount of the compound. Therefore, complete identification and characterization of the compound involved in predation was not achieved.

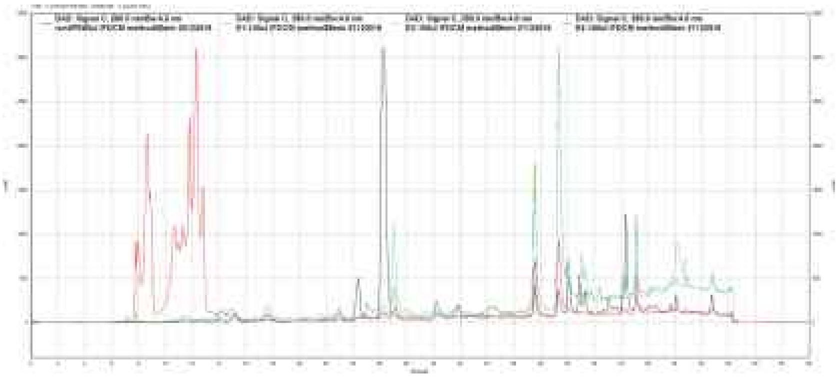


Figure 19. Overlay image for *S. aureus* predation HPLC peak profile along with controls (green, *S. aureus* control; blue, actinobacterial control; red, medium control; brown, experiment).

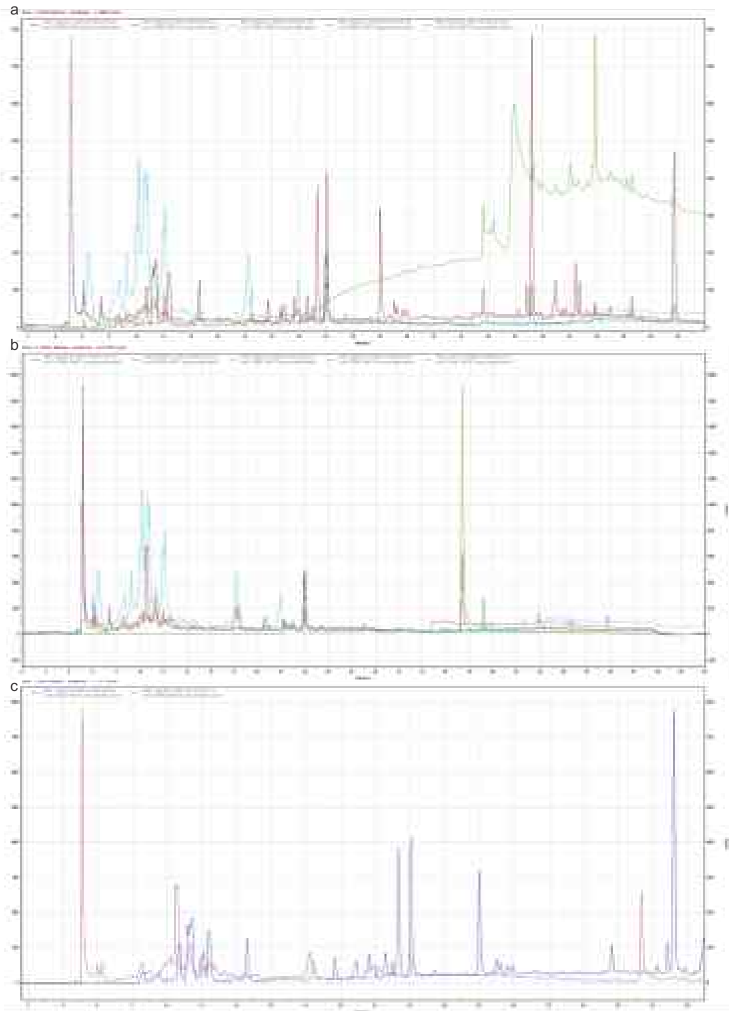


Figure 20. Overlay of peaks obtained during HPLC at 280nm from (a) ethyl acetate extract of compound obtained from zone of clearance in solid predation along with controls and blank and (b) methanol extract of compound obtained from zone of clearance in solid predation along with controls and blank. (c) Overlay of peaks obtained from ethyl acetate and methanol extracts in predation experiment.

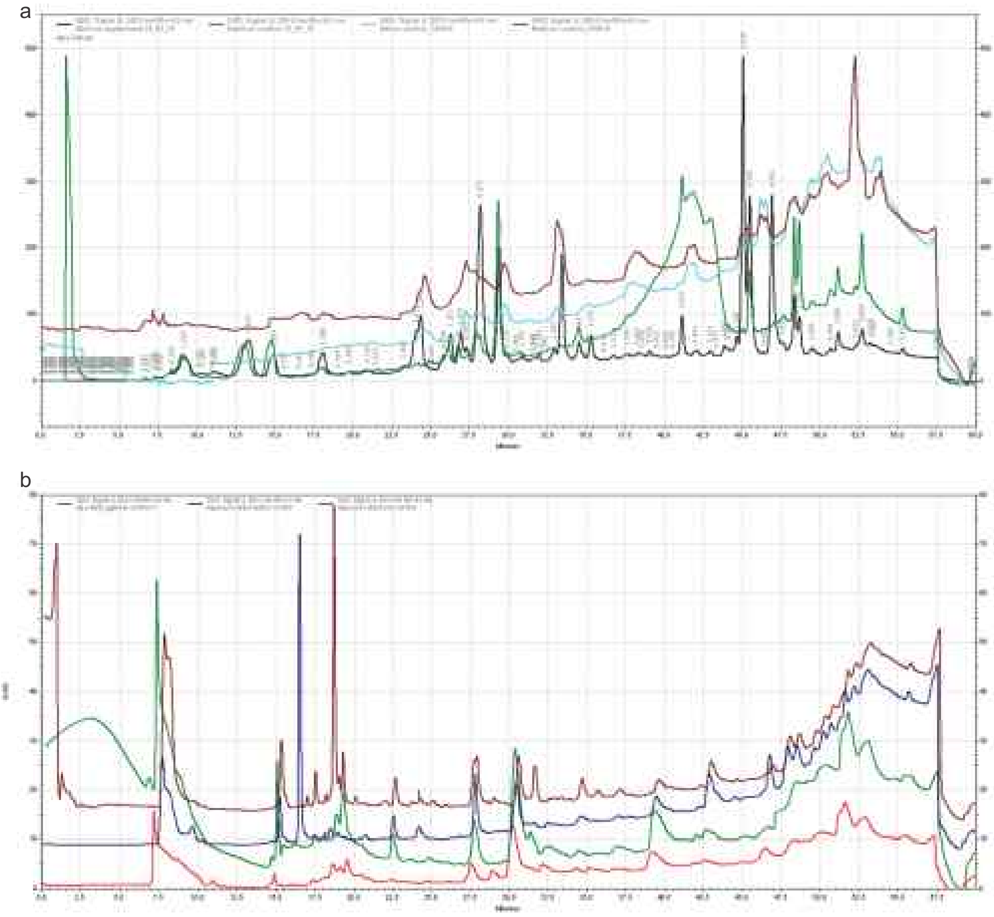


Figure 21. (a) Overlay image for *B. licheniformis* predation HPLC peak profile along with controls (green, *Bacillus* control; blue, actinobacteria control; brown, medium control; black, experiment). (b) Overlay image for *S. aureus* predation aqueous extract HPLC peak profile along with controls (green, agarose control; blue, actinobacterial control; brown, prey control; red, experiment).

HPLC profile based on aqueous extraction revealed no unique peaks when compared with controls (Fig. 20b). Therefore, this method was not continued further.

Ecology of Actinobacterial Predation

Since the medium contained no nutrients, in pure culture controls the prey cells did not show a significant trend in population during the incubation period. In prey co-culture there was no significant trend in the populations of *S. aureus* and *E. coli*; however, *S. aureus* and *P. vulgaris* populations showed a growing trend when co-culturing indicating some synergistic interaction. We did not investigate the nature of this interaction. In one to one predator-prey interactions, *S. aureus* and *P. vulgaris* populations showed a monotonic declining trend while the predator population increased. In the *E. coli* predator interaction, neither the population of the predator nor that of *E. coli* showed a time trend.

In the three species interaction experiment with *S. aureus* and *E. coli* along with the predator, the *S. aureus* population declined by 97% whereas the *E. coli* population increased by 60% (Fig. 22c). The predator population increased by 72% (Fig. 22d).

In the three species interaction experiment with *S. aureus* and *P. vulgaris* along with the predator by the second day, the *S. aureus* population declined by about 68% and remained low on the third day but *P. vulgaris* population did not show a significant change. However, during the last phase of growth the *P. vulgaris* population showed a decline by about 61% whereas *S. aureus* showed a small but significant increase (Fig. 22g). *Streptomyces atrovirens* population increased monotonically (Fig. 22h). This suggests that the predator might have selectively preferred *S. aureus* in the first phase and when its population declined below a threshold shifted to *P. vulgaris* allowing some comeback growth of *S. aureus*.

The results highlight the complexity of multi-species interactions in bacteria. Earlier studies have shown that in the absence of other soluble nutrients, some bacterial genera turn predatory and grow at the expense of surrounding cells. We show here that different bacteria show differential sensitivity to predation which is important in shaping the patterns of interaction. Since bacterial predation is an extracellular phenomenon, a resistant organism gets an added nutritional benefit when in the proximity of a predator and a susceptible organism. This was predicted earlier (Leisner et al. 2016) but our experiments have demonstrated this advantage of resistance empirically for the first time.

The mechanism of predation resistance is not yet known. Secondary metabolites of the predator are suspected to have a role in predation (Kumbhar et al. 2014), therefore it is likely that resistance to the secondary metabolites might be the primary mechanism of predation resistance. If this is true it gives an added dimension to the evolution of antibiotic resistance.

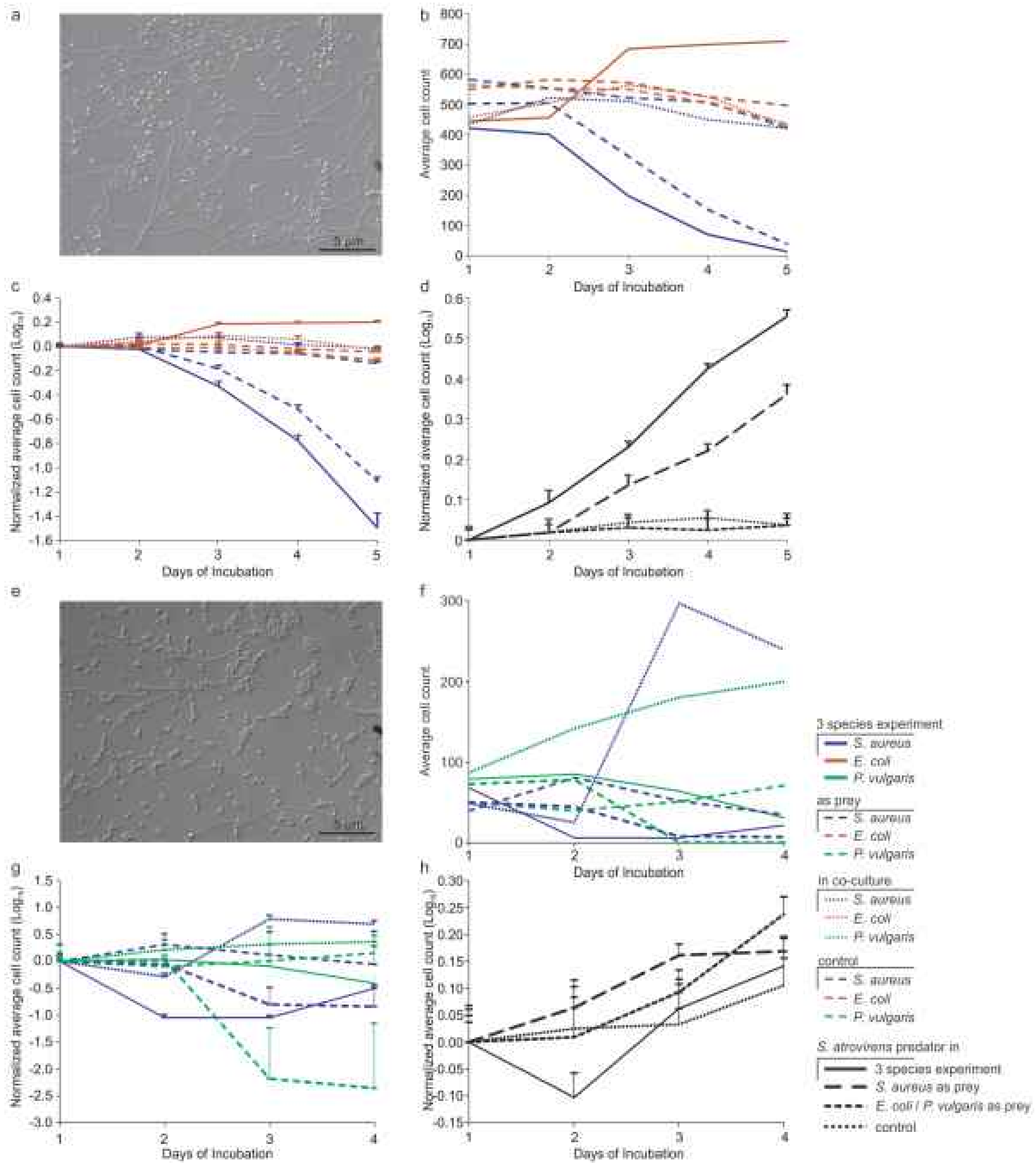


Figure 22. Change in cell density of prey cells and the predator. (a) Microscopic image of slide culture for three species experiment with prey and resistant cells. (b) Change in absolute average cell count of *S. aureus* and *E. coli* along with controls over the incubation period. (c) Change in cell count of *S. aureus* and *E. coli.* (d) Change in cell count of the predator, *S. atrovirens* along with controls. (e) Microscopic image of slide culture for three species experiment with two sensitive cells. (f) Change in absolute average cell count of *S. aureus* and *P. vulgaris* along with controls over the incubation period. (g) Change in cell count of *S. aureus* and *P. vulgaris*. (h) Change in cell count of the predator, *S. atrovirens* along with controls.

More complex and more interesting appear to be the interaction between two predation susceptible species. The predator that showed successful predation on both when tested separately appeared to exhibit preferential consumption of one species when challenged with both together. This appears to have spared the other species at least for some time. This demonstrates that even partial or relative resistance may give substantial selective advantages in natural multispecies settings.

Microbiology has largely progressed by pure culture studies. Natural ecosystems, on the other hand, have a variety of multispecies interactions about which our understanding is still quite primitive. The experiments suggest that studying multispecies interactions will reveal a variety of novel dimensions of bacterial life in nature.

Summary

Sponges and associated environments of intertidal zones, along the northern parts of west coast of India, are rich in microbial diversity, particularly Actinobacteria. The isolated bacteria from sponge and associated environments belonged to Preoteobacteria (Alpha, Beta and Gamma), Actinobacteria and Bacteroidetes.

We recorded Actinobacteria from 19 families and 28 genera, which could be attributed to 95 putative species using mPTP and 100 putative species based on bPTP methods. Although, at the genus level, the trends in the discovery of actinobacteria isolated from sponges was consistent with previous studies from different study areas, we provide first report of nine species, namely *Brachybacterium murisi*, *Jonesia denitrificans*, *Nocardiopsis salina*, *Pseudonocardia kongjuensis*, *Rhodococcus zopfii*, *Rothia terrae*, *Serinicoccus marinus*, *Streptomyces smyrnaeus* and *Streptomyces viridobrunneus*. Non-obligate epibiotic predatory behavior was widespread among actinobacterial genera and we provide first report of predatory activity in *Brevibacterium*, *Glutamicibacter*, *Micromonospora*, *Nocardiopsis*, *Rhodococcus* and *Rothia*. Sponges associated actinobacteria showed significantly more predatory behavior than environmental isolates, and we hypothesize that predatory actinobacteria might provide sponges with defense against pathogenic bacteria.

While antibiotic produced from actinobacterial isolates affected Gram-positive target bacteria with little to no effect on Gram-negative bacteria, predation targeted both Gram-positive and Gram-negative prey with equal propensity, suggesting that study of predation specific metabolites might provide novel therapeutic agents with broad-spectrum. Actinobacterial isolates from both sponge and associated environment produced inhibitors of serine proteases and angiotensin converting enzyme. Predatory behavior was strongly associated with inhibition of trypsin and chymotrypsin, which might be helpful for the actinobacteria for overcoming effects of proteolytic enzymes produced by sponge host and other microbiota. Understanding diversity and associations among various actinobacterial activities, with each other and the source of isolation, can provide new insights in marine microbial ecology and provide opportunities to isolate novel therapeutic agents.

Although actinobacteria are known to be rich in secondary metabolites, extracellular enzymes and enzyme inhibitors, the ecological role of these extracellular bioactive molecules is little known. We suggest that studying the ecological correlates of bioactivity and the inter-correlation patterns of different types of bioactivity can be a useful tool in understanding the ecological origins of bioactivity and testing alternative ecological hypotheses.

Antagonistic associations between microbial species have been viewed as two species interactions. The cost-benefits in multi-species interactions can be substantially different, understanding of which can be crucial in understanding evolution of phenomena such as antibiotic resistance or susceptibility. The ecological studies of pre-predator interactions that we performed, therefore has wide implications in both basic and applied biology.

Our preliminary analysis of metabolites specific to predation yielded presence of small molecules that were expressed only during prey-predator interactions. These secretary molecules need further studies to understand their chemical structures, bioactivity and ecological role. Although we studied the production of secondary metabolites only in *Streptomyces*, there is also a need to understand the molecules involved in predatory activity of other genera with predatory activity.

Screening for secondary metabolites in bacterial isolates, sponges and algae yielded 10 novel compounds with antibacterial, antifungal, antimalarial, anti-inflammatory and cytotoxic activities. We found the sponge species *Iricinia fusca*, to be most prolific in terms of secondary metabolites produced with diffrent bioactivities including broad spectrum antibacterial and antifungal activities, and cytotoxic activity that has implications in cancer therapeutics.

Implication and Recommendation

Current study has contributed towards three major outputs which have implications in both basic and applied sciences. Major implications of the study and recommendation for developing further investigations are provided below.

(1) Cultivable bacterial diversity and its bioactivity potential: We have cultured more than 2800 bacterial isolates from marine sponges and associated environments, all of which are in the national microbial repository held at Microbial Culture Collection,

National Center for Cell Sciences. A subset of 50 Actinobacterial isolates suggested that these organisms have a great potential for production of secondary metabolites and useful bioactivities, which can substantially contribute to basic sciences and have applied values. Further studies on the remaining isolates, therefore, are likely to yield more bacterial isolates with interesting secondary activities.

(2) Our study suggests that the predatory activity is widespread in actinobacteria and predation specific metabolites might provide novel therapeutic agents with broad-spectrum therapeutic activity. Although we establish that there are predation specific small molecules produced by bacteria, studies on isolation and characterization are essential. Further, genomics and transcriptomics approaches are likely to provide important insights on the predation activity and secondary metabolites involved.

(3) We isolated 10 novel compounds from marine bacteria, sponges and algae, which showed broad anti-bacterial, anti-fungal, anti-malarial, anti-inflamatory and cytotoxic activities. Further studies, however, are essential to understand the potential of these compounds for therapeutic purposes. Dedicated projects in biotechnology and chemical engineering can be developed to understand large scale production of the compounds and their applications in medicine.

Publications and Presentations

Published papers

- Pund A, Holkar K, Watve M, Baig UI (2020) Bacterial predator prey and the third beneficiary. Sci Matters 201911000003: 1-6.
- Shintre N, Baig U, Pund A, Patwardhan R, Tamhane V, Deshpande N (Accepted) Diversity of culturable actinobacteria producing protease inhibitors isolated from the intertidal zones of Maharashtra, India. *Current Microbiology*.
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Preprints and manuscripts

- Baig U, Dahanukar N, Shintre N, Holkar K, Pund A, Lele U, Gujarathi T, Patel K, Jakati A, Singh R, Vidwans H, Tamhane V, Deshpande N, Watve M (2020) Phylogenetic diversity and activity screening of cultivable actinobacteria isolated from marine sponges and associated environments from the western coast of India. bioRxiv. https://doi.org/10.1101/2020.01.09.901108
- Baig U, Pund A, Dahanukar N, Holkar K, Lele U, Gujarathi T, Patel K, Jakati A, Singh R, Vidwans H, Watve M (In manuscript) Phylogenetic diversity of cultivable bacteria isolated from marine sponges and associated environments from the western coast of India.

Conference presentations

- Dahanukar N (2019) Maharashtra Gene Bank Programme: model system for aquatic conservation in India. In Book of abstracts, Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation organized by Indian Institute of Science Education and Research, Pune, 20-21 December 2019. p. 35.
- Baig U (2019) Phylogenetic diversity, predatory behavior and activity screening of cultivable actinobacteria isolated from marine sponges and associated environments from the western coast of India. *ibid*. p. 38.
- Baig U, Pund A, Vidwans H, Dahanukar N, Watve M (2019) Inventory and bio-prospecting of marine sponges and associated microorganisms of the Maharashtra Coast. *ibid*. p. 92.
- Baig U, Dahanukar N, Shintre N, Holkar K, Pund A, Lele U, Gujarathi T, Patel K, Jakati A, Singh R, Vidwans H, Deshpande N, Watve M (2019) Phylogenetic diversity and activity screening of

cultivable actinobacteria isolated from marine sponges and associated environments from the western coast of India. *ibid.* p. 93.

- Pund A, Baig B, Dahanukar N, Watve M (2019) Predatory activity of Streptomyces atrovirens: Potential for discovering novel secondary metabolites and new ecological interactions. *ibid.* p. 94.
- Shaikh S, Shaikh U, Bhatia A, Vidwans H (2019) Anti-biofilm activity of actinobacteria isolated from marine sponges and associated habitats from west coast of Maharashtra. *ibid.* p. 95.
- Baig U, Pund A, Holkar K (2018) Predator, prey and the third beneficiary IISER-WIS conference on Chemical Biology, an international interdisciplinary conference to present cutting-edge advancements in chemical biology, 17-19 January 2018.

Outreach Activities

As a part of outreach activities, the findings of the current research was disseminated through a national conference organized by IISER Pune team and through popular articles.

National conference

Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation, was organized on 20th and 21st December 2019, which was hosted by Indian Institute of Science Education and Research, Pune. There were total 125 participants, 20 invited talks and 48 posters for the conference. The conference was organized with the following aim.

Aquatic habitats, both marine and freshwater, are a home to a vast diversity of life forms, provide valuable ecosystem services and are source of livelihood for millions of Indian households. Despite their pivotal role in our existence, Indian aquatic environments are under stress due to several anthropogenic activities that can lead to severe ecosystem collapse in the near future.

Sustainability and conservation of aquatic ecosystems, therefore is a major concern. A successful conservation management plan needs liaison between various stakeholders and a strong scientific support, which can help in decision-making and implementation of action plans. Although, several government and non-government organizations in India are actively working on the conservation of aquatic habitats and are producing excellent scientific literature, often the crosstalk to share knowledge and collaborate towards a common goal is lacking. The aim of this conference was to provide a common platform for researchers and young investigators in the field of aquatic diversity, ecology, conservation biology and socio-economics to share their experiences and knowledge for a collective effort towards building science based conservation policies and sustaining livelihoods of the future.

Four themes were covered in the conference namely, (1) Sustainability and conservation of aquatic living resources, (2) Diversity of aquatic organisms, (3) Aquatic ecology and functioning, and (4) Maharashtra Gene Bank Program: model system for aquatic conservation in India.

Popular articles

Following two popular articles are published as a part of the project work,

- Baig, U. (2018). Stalking Streptomyces on hunt. https://www.awsar-dst.in/assets/winner_article_2018/06_PDF1.pdf [Selected for Augmenting Writing Skills for Articulating Research (AWSAR) Award, 6th Rank in Post Doc category, sponsored by DST 2018].
- Baig, U., Holkar, K., Pund, A. and OJas, S.V. (2018) Samudratil Sukshmajiv (in Marathi). Available at <http://www.gotul.org.in/stories/>

Future Prospects

The baseline studies can be developed into projects in both basic and applied sciences. Following future directions have been set for further investigations based on current study.

(1) Genomics and transcriptomics of selected actinobacteria to understand the genetic basis of predatory behavior and the metabolites involved in predation activity.

(2) Isolation and characterization of predation specific metabolites and exploring their use in therapeutics.

(3) Further studies on the isolated 10 compounds from bacterial, sponge and algal source for their applicability in therapeutics.

S. No.	Name	Designation	Tenure
1.	Dr. Milind Watve	Principle Investigator	January 2014- March 2019
2.	Dr. Neelesh Dahanukar	Principle Investigator	May 2019- September 2020
3.	Dr. Ulfat Baig	Co-PI & Post-Doc	June 2014- September 2020
4.	Dr. Harshada Vidwans	Post-Doc	January 2017- March 2020
5.	Anagha Pund	Senior Research Fellow	September 2016- September 2020
		Junior Research Fellow	March 2014 –July 2015
6.	Ojas SV	Senior Research Fellow	September 2016- March 2020
7.	Ketki Holkar	Senior Research Fellow	May 2014- September 2017
8.	Tejal Gujarathi	Senior Research Fellow	May 2014- November 2018
9.	Dr.Ruby Singh	Post-Doc	January 2017- September 2018
10.	Dr. Sneha Asai	Post-Doc	October 2015- October 2016
11.	Dr. Uttara Lele	Post-Doc	April 2014- June 2016
12.	Neha Shintre	Junior Research Fellow	May 2014- May 2016
13.	Avantika Jakati	Junior Research Fellow	September 2016- June 2018
14.	Chinmay Kulkarni	Junior Research Fellow	September 2015- May 2016
15.	Poortata Lalwani	Junior Research Fellow	September 2015- May 2016

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Report 1.2

Diversity of marine invertebrate along the Maharashtra coast

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Background

Maharashtra State has a coastline of 720 km with 173 fish landing centers and the area suitable for marine fishing is 1.12 lakh sq km. The state consists of five coastal districts with 456 fishers' villages and 152 fish landing centers. Almost 3, 86,259 fishers living in these villages are involved in fisheries industry and 81,492 families are drawing their livelihood from this industry (Anon 2010). There are 15,716 marine fishing boats in operation, of which 13,002 are mechanized (Anon 2017).

The coastal region of the Maharashtra state has six districts viz. Thane, Greater Mumbai, Navi Mumbai, Raigad, Ratnagiri and Sindhdurg popularly known as Konkan region. The entire region is hilly, narrow, highly dissected with transverse ridges of the Sahyadri hill ranges (Western Ghats) on its east and at many places extending as promontories, notches, sea caves, embayment, submerged shoals and offshore islands. The coastline comprises of rocky, sandy and sometimes marshy beaches. The coastline also supports dense mangrove forests.

Rocky shores in Konkan are outcrops of foot hill of Sahyadri. These are formed in between sandy shores which have characteristic "c" shape forming bays. There are about 32 rocky shores along the costal Maharashtra (Gole 1997). Rocky shores are made up of eroded cliffs; wave cut platforms and vertical cliffs. The main feature of rocky shores of Ratnagiri is tidal pools. Coastal areas of Konkan especially Ratnagiri are known for the presence of patch reefs along the shoreline. Total 2-3 species of corals has been recorded from the area (Apteet. al. 2012), very few species are recorded from intertidal area. These coralline rocky habitats are usually shallow water zones which are highly diverse and are very productive. They serve as a substratum for sessile species such as sponges, corals, crinoids anemones and seaweeds. These areas also act as breeding grounds for fishes and are home for variety of invertebrates. The rock pools are breeding and feeding ground for many marine organisms. Ecological changes are clearly seen and easily quantified for intertidal habitat providing cheap sensitive indicators of environmental changes.

Sponges are a common, and in certain sites, dominant component of the sessile fauna and occasionally even a dominant component of the total fauna. There is no industrial pollution as there are no chemical or heavy metal industries at Ratnagiri. Fishing is the major activity along the smaller coastal villages like Bhatye, Karla, Juve, Purnagad, Sakhartar etc., with a major fishing harbor Mirkarwada where the trawlers, purse seiners and other smaller boats land their fish.

Marine invertebrates are known to produce a variety of secondary metabolites as defense mechanisms against predators and pathogens (Petersen et al. 2020), hitherto not isolated from terrestrial plants and animals; many of which are of pharmaceutical importance. Research has shown that sponges [Phylum Porifera] are those metazoans which do not have their own defense systems and hence harbor wide diversity of microorganisms. These microorganisms are rich sources for the isolation of biologically active and pharmacologically valuable compounds with a high potential to become effective drugs for therapeutic use. These are likely to produce many bioactive compounds including polyethers, terpenoids, alkaloids, macrolides and polypeptides. In the 1960s, along with taxonomic and descriptive studies, marine metabolites also started to be investigated. A range of bioactive metabolites have been found in about 11 sponge genera, three of which (*Haliclona*, *Petrosia* and *Discodermia*) produce powerful anti-cancer, anti-inflammatory agents (Perdicaris et al. 2013).

Many marine invertebrates, especially sponges are known to have several associated microorganisms (upto body weight of 40% in some cases), triggering a big debate as to the exact origin of the bioactive metabolites. Certain species of marine sponges in the order Dictyoceratida were found to harbour very large populations (30 to 50% of the tissue volume) of cyanobacterial symbiont, *Oscillatoria spongeliae* in their mesophyll. At present, microbial communities residing within the sponges and their genomes are poorly understood and a substantial unknown fraction exists within this microenvironment.

Current work focuses on the taxonomical identification of poorly studied and understood marine sponge species found along the Maharashtra coast. The abundance and diversity of sponges are of great concern as these sponges form the micro habitats for variety of microorganisms. So the work was undertaken to not only identify the sponges but also the flora and fauna with which these are associated and depend on.

Objectives

- Creating an inventory of species of sponge in the intertidal zones and up to a depth of 20 meters in 4 selected locations along the Maharashtra coastline.
- Classical as well as molecular taxonomy of sponges, tunicates and soft coral species along the Maharashtra coast.
- Outlining strategies for in situ conservation of species.
- Cultivating sponges in laboratory under controlled conditions.

Methodology

Study sites

During the study eleven stations were sampled (Table 1) and three sites viz. Alawa, Undi and Waigani among them were finalised for further sampling along the rocky shore of District Ratnagiri (Figure 1). Stations were finalized by considering abundance of sponges on rocky shore.

Intertidal collection of the sponges was done up to 0-5 m water depth, using minimum three transects of 20m gap or according to rock pools. Minimum possible sponge tissue samples were collected for identification of the sponges in laboratory. Sampling was done fortnightly at same tidal amplitude and depth range. To investigate sponge abundance, three transects on each tidal zone (High, Intermediate, and Low tide zone) were selected and 1.0 m×1.0 m (1.0 m^2) quadrant was used at each zone. Area of 3.0 m×3.0 m (9.0 m^2) was taken for sampling monthly from each sampling station as per Darumas et al. (2007). The number of sponge individuals per sampling station was used to estimate sponge abundance within each rock pool monthly.

Sponges were collected from selected site by using sterilized knife and scalpel in plastic bottles, under submerged conditions. Small pieces of sponge were hand cut from top and bottom of the colony. Care was taken not to contaminate the samples by touch. Collected samples were fixed in 80-90% ethanol and kept refrigerated.

Sampling design

Transect and quadrants were used to quantify the relative abundance of sponges. Total 3 transacts were fixed for each sampling station (Table 1, Figure 1 and 2). The sampled rock pools had an average depth of 3-5 metres. Each transact was marked permanently on sampling station by using natural landmark like big immovable rocks. For each transact 9 sub points were fixed in inter tidal zone. Expanse of each transact was from lowest low tide point to high tide point. On each sub point, quadrant of size 0.5 m x 0.5 m was placed. Sponges and other organisms inside the quadrant were

Table 1. Names and GPS co-ordinates of sponge sampling sites.

Name of site	GPS co-ordinates	Status
Undi	17º14'47"N 73º13'41"E	Selected for study due to sponge abundance
Varavwade	17º13'38"N 73º14'17"E	Rejected due to non availability of sponges
Bhandarpule	17º08'00"N 73º16'05"E	Rejected due to non availability of sponges
Aare ware	17º04'49"N 73º17'00"E	Selected for study due to sponge abundance
Mirya	17º02'20"N 73º16'20"E	Rejected due to oil contamination of the shore due to ship building yard
Alawa	17º01'20"N 73º16'19"E	Selected for study due to sponge abundance
Mandavi	16º59'15"N 73º17'03"E	Rejected due to the contamination of the site due to sewage from hotels and human settlements
Wayangani	16º55'40"N 73º16'56"E	Selected for study due to sponge abundance
Purnagad	16º47'37"N 73º18'58"E	Rejected due to heavy siltation of the creek
Kasheli	16º43'31"N 73º18'36"E	Rejected due to non accessibility of the site
Ambolgad	16º38'14"N 73º19'25"E	Rejected as the permission to sample the site was rejected by the local people

Figure 1 Sampling locations at (a) Alawa, (b) Undi, (c) Wayangani and (d) Aare ware.

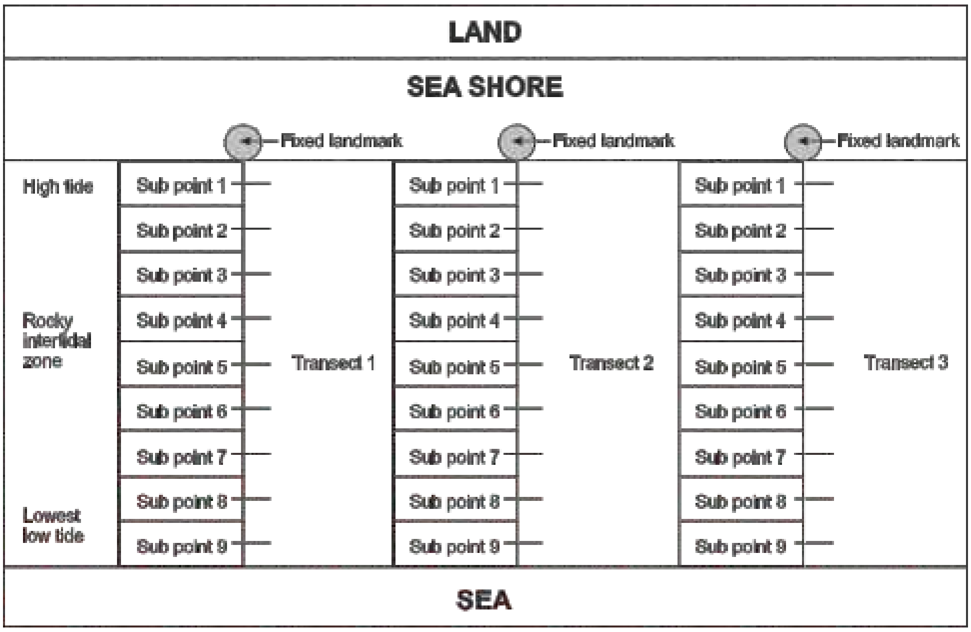

Figure 2 Sampling design, layout of transects.

recorded for further study. Sponge samples of approximately 50 to 200 gm were collected depending on the size of sponge colonies and kept in bottles containing ambient sea water and 75% ethanol. The total number of individual sponge patches was recorded in situ as per Powell et. al. (2010).

Water parameters like salinity, pH, temperature and DO were recorded by using 28-62 Erma Portable Handheld Refractometer and water testing kit by Transchem Agritech Limited, Vadodara (Accredited by UNESCO Microbial Resources Centre for Marine Biotechnology, Dept. of Fisheries Microbiology, College of Fisheries, Mangalore). These parameters were taken on the same tidal amplitude (Low tide range) and at the same sampling points. Samples handling and preservation were done in accordance with standard method prescribed by APHA (1998).

Sponge identification

Sponges collected from these sites were identified using classical taxonomy as per Ackers et. al. (2007). In addition, samples preserved in 75% ethanol and freeze dried as per Simister et. al. (2011) and Straube and Juen (2013) were submitted to NCCS, Pune for molecular taxonomy.

The sponges were studied using the classical taxonomy based on the morphological characters such as colour, slime, consistency, surface, ostia and osculum, skeletal structures such as spicules as per Ackers et al. (2007).

Spicule preparation

Longitudinal and transverse sections of the sponges were stained and studied under microscope for the primary and secondary skeletal structures. Spicule preparation methods follow Hooper and Soest (2002). Nitric acid and sodium hypochlorite were used for digetion of organic compounds leaving only mineral skeleton for seperating the spicules. Seperated spicules were pipetted out and placed on cover slide. Spicules were examined under Zeiss Primostar Microscope.

Bleach digestion technique was useful for rapid surveys of spicules within a sponge, although preparations were not as clean as those obtained through acid digestion process. Sponges with calcareous spicules were routinely prepared in this manner. Small fragments of 'tissue' including fragments from both the surface and deeper parts of the sponge were placed in small flasks or directly on microscope glass slides. A small quantity of active bleach (sodium hypochlorite) was added to the fragment, so as to get only the mineral skeleton. This method was found more suitable for Class Demospongiae.

Acid digestion technique provided cleaner, permanent preparations, but the process involved noxious chemicals. This process involved nitric acid instead of bleach. Fragments of sponge were placed either in flasks, or directly on glass slides. Several drops of acids were placed on the fragment, gently heated over a flame until bubbling, and repeated until all organic matter was digested (this was easily ascertained by eye). Siliceous spicules were bonded directly onto the substrate by this technique.

Statistical analysis

Quantitative data obtained using transect method was used to calculate alpha diversity indices. We calculated three diversity indices, namely Simpson's index, Shannon-Wiener index and Evenness index.

Simpson (1949) index

Simpson's index (D) is the probability that two randomly selected individuals belong to two different species/categories. The Simpson's diversity index (D) is calculated using the following equation:

$$\sum_{i=1}^{S} \frac{n_i(n_i-1)}{n(n-1)}$$

Where, 'n_i' is the frequency of the i^{th} taxon in the community. Simpson's index gives relatively little weight to rare species and more weight to the common species. It ranges in value from 0 (low diversity) to a maximum of (1-1/S), where, S is the number of taxa.

Simpson Diversity Index (D) calculates species diversity in a community in a different way. D considers both species richness and species evenness although it tends to favor species evenness. It "quantifies the probability that two individuals picked at random from the dataset do not represent the same species" (Tuomisto, 2010). Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species. For a given richness, D will increase as evenness increases and likewise, for a given evenness, D will increase as richness increases. It is always a value between 0 and 1 where 1 indicates a perfect evenness between species.

Shannon-Weaver index (1949)

Shannon-Wiener index (H) is measuring the order/disorder in a particular system. This order is characterized by the number of individuals found for each species/category in the sample. A high species diversity may indicate a healthy environment. This is widely used method of calculating biotic diversity in aquatic and terrestrial ecosystems and is expressed as:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Where, H = index of species diversity, S = number of species, pi = proportion of total sample belonging to the ith species. A large H value indicates greater diversity, as influenced by a greater number and/or a more equitable distribution of species.

The Shannon index measures the degree to which richness and evenness changes across sampling levels and is sensitive to rarer species (Veech et al. 2002). Shannon's Diversity Index (H) is the most common measure of species diversity in ecology. It "quantifies the uncertainty in the species identity of an individual that is picked at random" from a dataset (Tuomisto, 2010). A larger value represents greater species evenness while a lower value represents lower species evenness and/or fewer species. As it is not on a linear scale, a single Shannon value is quite meaningless unless compared to something else. Shannon's diversity index considers each species according to its frequency within the community.

Evenness (E)

Evenness (E) is a measure of how similar the abundances of different species/categories are in a community. Evenness ranges from zero to one. When evenness is close to zero, it indicates that most of the individuals belongs to one or a few species/categories. When the evenness is close to one, it indicates that each species/categories consists of the same number of individuals. This is relative distribution of individuals among taxonomic groups within a community and is expressed as:

$$E = \frac{H'}{\ln D}$$

Where, E= Taxon Evenness, D is the Taxon Dominance defined as total no. of distinct taxa in a population. Evenness is a measure of the relative abundance of the different species making up the richness of an area.

Species Richness (S)

Species richness (S) is the total number of species found in an environment/sample. Richness is a simple numerical count of the number of different types of organisms present. Species richness is a count of the number of species (named or otherwise) that are present. Taxonomic richness is a count of the number of different taxa present. One would presume that more species equals more diversity. However, comparing two areas of equal species richness may show that they are not equally diverse. Richness tends to increase over area. In other words, a larger area will harbor more different species, probably because of a larger variety of microhabitats and resources. Additionally, sampling over a larger area increases the chance of finding rare species.

Laboratory setup for live sponges

Attempts were also made to cultivate sponges under laboratory conditions to understand whether *in situ* conservation of sponges is possible. Sponges were collected from selected sites along with the attached substratum, taking care not to disturb the attachment. Collected sponges were transported to the laboratory by keeping them in same sea water. Special care was taken to avoid exposure of sponges to the air during collection and transportation. The glass aquarium tank (5 x 2.5 x 1.25 ft) with filtered sea water collected from the same shore was matured for 1 month with the seaweeds, fishes and other aquatic organisms collected for the same sites. The collected sponges with the substratum were introduced in this tanks after taking their initial measurements (initial length and breadth, height). The survival, growth and water parameters were recorded fortnightly.

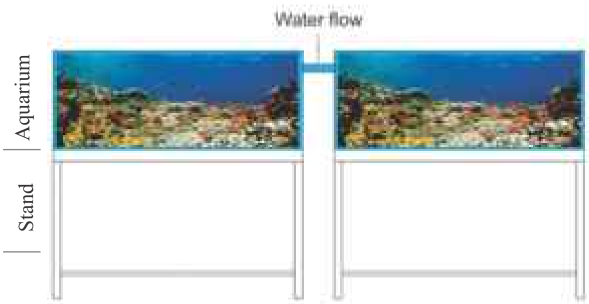

Figure 3. Design of display aquarium.

Sponge Diversity and Distribution

Total 20 species of sponges were collected (Table 2, Figure 4). Among the collected species 17 are identified and 3 are unidentified (Ackers et. al. 2007) using morphological characters and spicules (Figure 5-8, Table 3). Out of 17 identified sponge species 16 species of sponges belong to Class Demospongiae and 1 belonged to Class Calcarea.

During the current work, the morphological and anatomical characteristics of the collected sponges were analysed and the species were identified through microscopic and macroscopic comparative analyses (Ackers et al. 2007). The typical characteristics taken into account included color, size, shape and internal structure and then the sponges were compared with the existing photographs and data (Hooper et al., 2002). During the study, seven species belonging to Class Demospongiae were recorded from the selected stations. They were *Clathria (Microciona) pennata* (=*Ophlitospongia pennata*), *H. cavernosus*, *C. pseudomolitba*, *H. cratera*, *C. australiensis*, *X. carbonaria* and *H.* (*R.*) *manglaris*. The most predominant order associated with rocks in the pools was Order Haplosclerida. It was particularly represented by the family Chalinidae, and within that the genus *Haliclona*. *Xestospongia carbonaria* was the only sponge growing in the turbid water at Alawa where the percentage of TDS was high. This sponge showed dark purple to black colouration during submerged condition. Certain groups of sponges are characteristically brightly coloured (e.g. *Clathria*, *Chalinula* and *Haliclona*) whereas others are typically drab (e.g. *Hyrtios*, *Cinachyrella*). These characters are often useful for field identification, and therefore colour notes and/or colour photographs are now considered to be essential for accurate identification.

These sponges also showed variation in their skeletal framework. The sponge skeleton is one of the primary features used to identify sponges. Demospongiae skeletons are quite variable and may include only fibrillar collagen, spongin, or some combination of spongin and spicules. A specialized type of collagen, termed spongin, forms different types of skeletal structures within many of the Demospongiae; but it is absent in *Calcarea* and *Hexactinellida* (Bergquist, 1978). *Clathria* (*Microciona*) *pennata* showed confused type of skeleton with irregularly positioned megascleres. *Hyrtios cavernosus* showed cored spongin fibers that incorporated indigenous spicules and foreign material such as sediments. The coring was light and limited to a central axis or filled in the whole fibers. Unusual twisted fibers with spicules embedded in them were seen forming braids. *C. pseudomolitba* also showed confused skeleton with irregularly positioned megasclere. *H. cratera* had reticulate skeleton, which is the characteristic feature of Order Haplosclerida, with three-dimensional network of fibers, tracts, lines, or single spicules. *C. australiensis* had a much rigid consistency which could be attributed to irciniid filament containing long, slender (0.5-15 µm thick) spongin element, terminally knobbed; intertwined or free in the sponge body. *X. carbonaria* and *H.* (*R.*) *manglaris* both showed branching and rejoining reticulate network of spicules, but the oxea

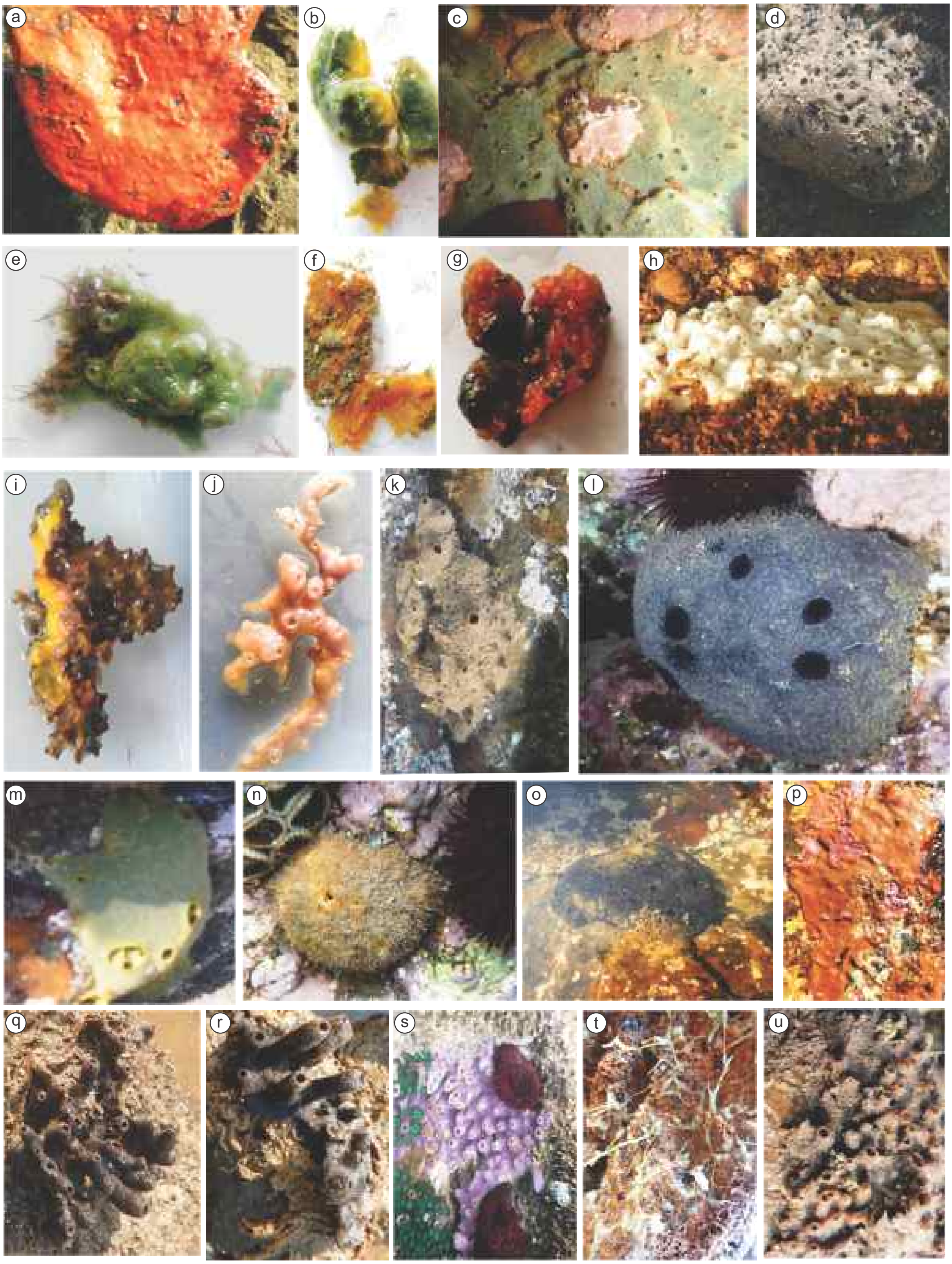

Figure 4 Sponges of Maharashtra coast. (a) *Clathria (Microciona) pennata*, (b, c) *Amphimedon viridis*, (d) *Hyrtios cavernosus*, (e) *Amphimedon erina*, (f, g) *Haliclona cratera*, (h) *Clathrina* sp. (i) *Aiolochroia crassa,* (j) *Chalinula pseudomolitba,* (k) *Ircinia felix,* (l) *Spongia (Spongia) obscura,* (m) *Spongia (Spongia) pertusa,* (n) *Cinachyrella australiensis,* (o) *Sarcotragus foetidus,* (p) *Cliona* sp., (q, r) *Xestospongia carbonaria,* (s) *Haliclona (Reniera) tubifera,* (t) *Haliclona (Reniera) manglaris,* and (u) *Mycale (Zygomycale) parishii*.

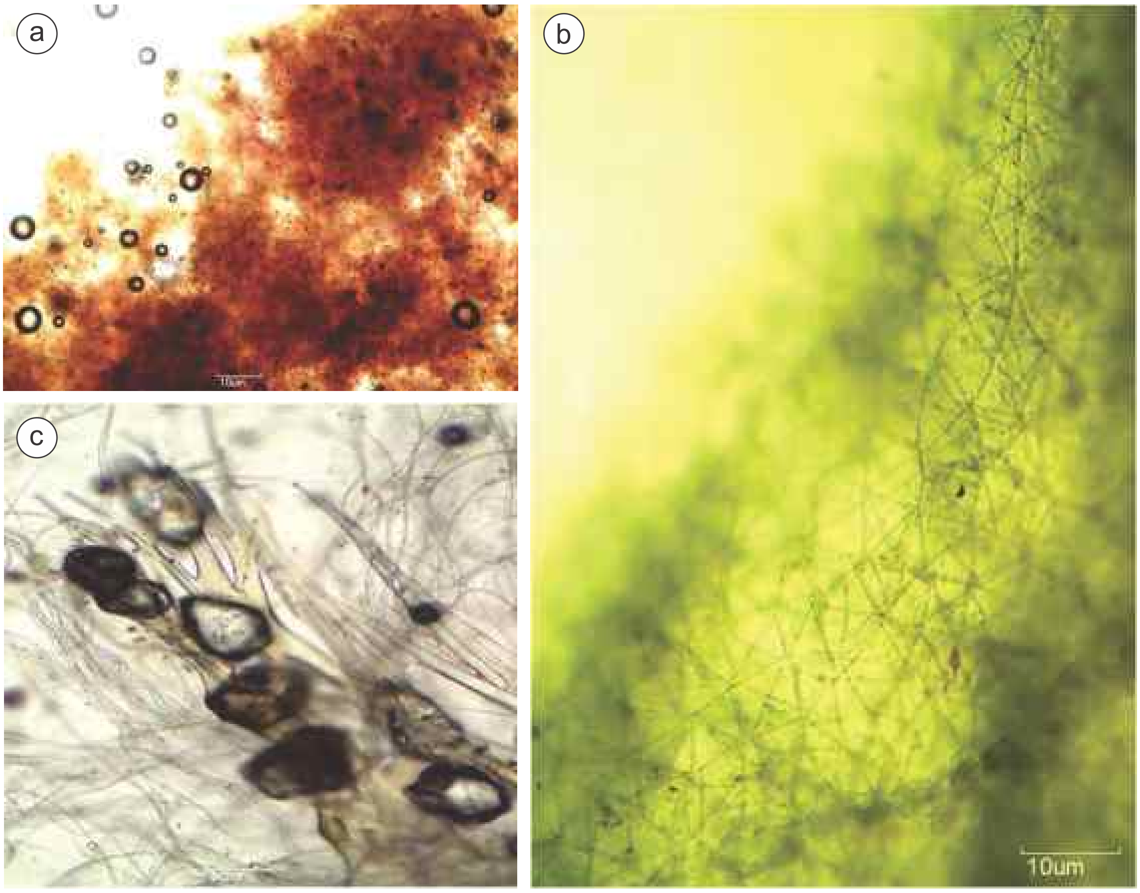

Figure 5 Skeletal structures of (a) *Haliclona cratera*, (b) *Heliclona manglaris* (Isodictyle reticulation) and (c) *Cinachyrella australiensis.*

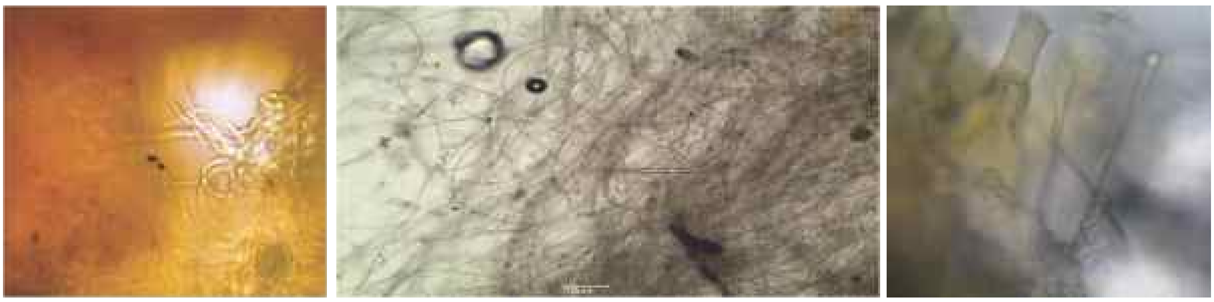

Figure 6 Skeletal structure consisting of secondary spongin fibers in *Hyrtios cavernosus.*

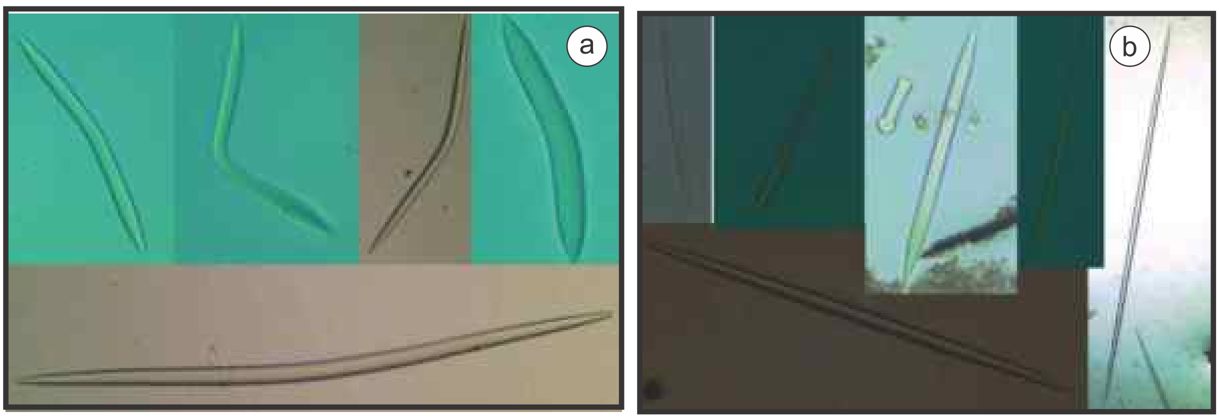

Figure 7 Sponge spicule structures. (a) Diact-Oxea and (b) Diact-Tomote.

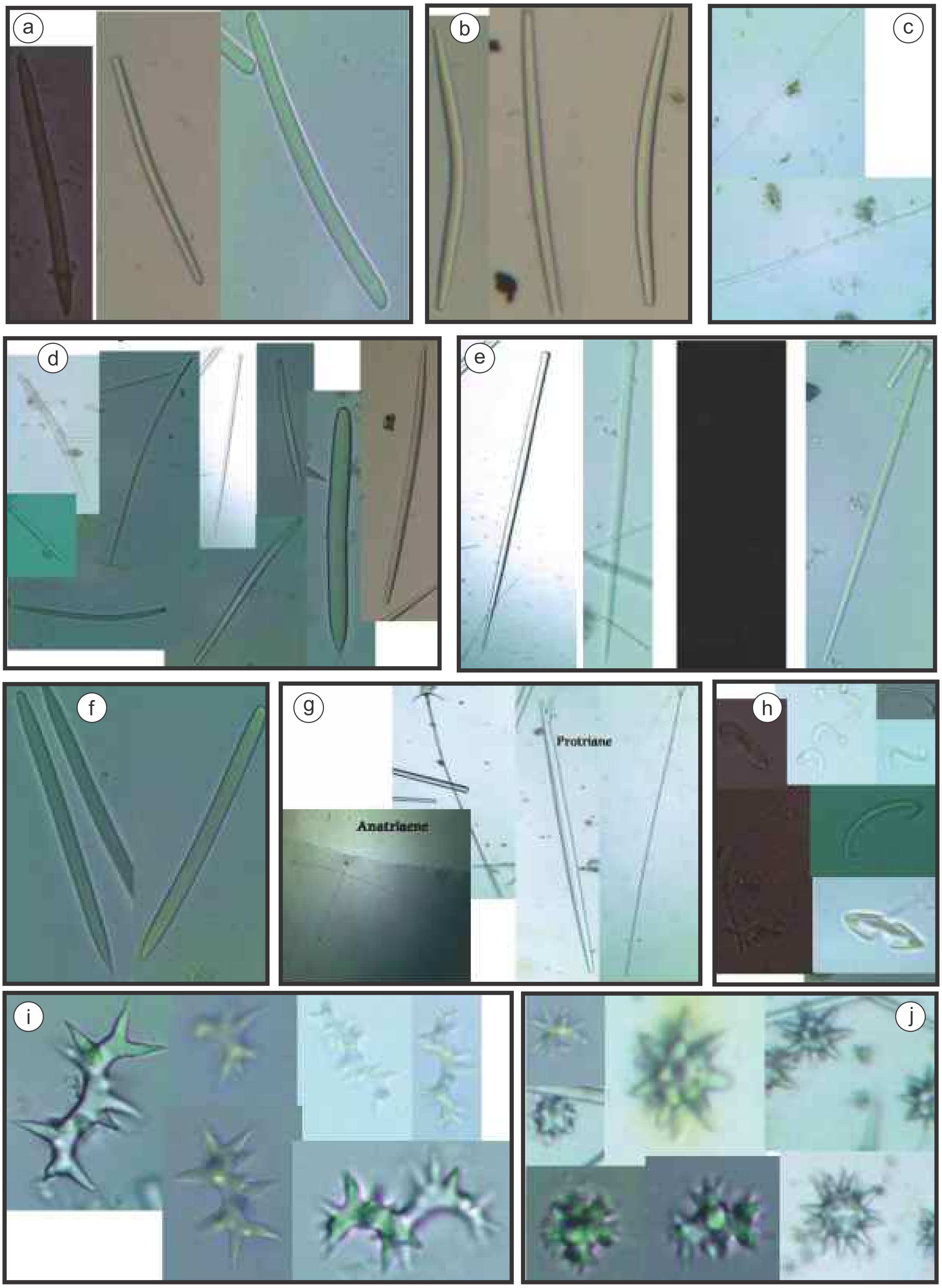

Figure 8 Sponge spicule structures. (a) Diact-Strogyloxea, (b) Diact - Strogyle, (c) Diact - Tylote, (d) Monact - Style, (e) Monact - Tylostyle, (f) Monact - Styloid, (g) Megascleres, (h) Chelae, (i) Amphiasters, and (j) Asters.

embedded in the spongin of the latter were much larger than that of the former. Hooper et al. (2002) opined that the firmness of the sponge body was provided by (1) collagen fibrils of the mesohyl, (2) spongin fibres, and (3) an inorganic skeleton consisting of various supporting mineral elements composed of either calcium carbonate ($CaCO_3$) or silica (SiO_2) material (including discrete spicules, articulated or fused spicules and/or hypercalcified mineralised basal skeleton). During the study, two basic types of sponges i.e. encrusting and free-standing, were observed at the selected sampling stations. Encrusting sponges are similar to moss because they tend to cover the surfaces of rocks. Free- standing sponges have lots of inner volume compared with their surface area (Hooper and van Soest 2002).

Table 2. List of the identified sponge through morphology (+ present) from the study area.

Sr.No.	Species	Undi	Var.	Aar.	Mir.	Ala.	Waig.	Ambol.	Gavk.	Purn.	Kash.	Bhag.
1	*Ophlitospongia pennata*	√	√	√	X	√	√	X	X	X	X	X
2	*Amphimedon viridis*	√	√	X	X	X	X	√	X	X	X	X
3	*Hyrtios cavernosus*	√	√	√	√	√	√	√	X	X	X	√
4	*Amphimedon erina*	X	X	X	X	X	X	X	X	X	X	X
5	*Haliclona cratera*	√	√	√	√	√	√	√	X	X	X	X
6	*Clathria sp.*	√	√	X	X	X	X	X	X	X	X	X
7	*Aiolochroia crassa*	X	X	X	X	X	√	X	X	X	X	X
8	*Chalinula pseudomolitba*	X	X	√	X	√	√	X	X	X	X	X
9	*Spongia pertusa*	√	√	X	X	X	X	X	X	X	X	X
10	*Cinachyrella australiensis*	X	X	X	X	X	√	X	X	X	X	X
11	*Sarcotragus foetidus*	X	√	√	X	X	X	X	X	X	X	X
12	*Xestospongia carbonaria*	X	X	X	X	√	X	X	X	X	X	X
13	*Cliona sp.*	√	X	X	X	√	X	X	X	X	√	X
14	*Haliclona (Reniera) tubifera*	√	X	√	X	X	√	X	X	X	X	X
15	*Haliclona (Reniera) manglaris*	√	√	√	√	√	√	√	X	X	X	X
16	*Ircinia felix*	X	X	X	X	X	√	√	X	X	X	X
17	*Spongia obscura*	√	X	X	X	X	X	√	X	X	X	X
18	*Mycale (Zygomycale) parishii*	√	X	X	X	X	√	√	X	X	X	X

Abundance of Sponges

Haliclona (*Reniera*) *manglaris* was most abundant on the sheltered rocky expanses in association with green algae and zooxanthellae species. Similarly, *H. catera* was the second most abundant species. (Table 4, Figure 9) and found with seaweeds and zooxanthellae species. *Aiolochroia crassa* was also found in rocky substrata exposed to heavy wave action.

There was a secondary gradient related to transects with higher coral cover versus transects with higher sand and rock cover. Species more strongly associated with corals included *Amphimedon erina*, *Sarcotragus foetidus*, *Ophlitospongia pennata* and *Clathria* sp. (Wulff 1997; Cruz-Barraza and Carballo 2008)

These sponges were also associated with brittlestar, *Ophionereis annulata*. *Cinachyrella australiensis* and *Hyrtios cavernosus* were abundant in most of the rock pools and even crevices at the depth of 0.5 m. These sponges were not found in areas exposed during low tide.

These rock pools are true sponge gardens containing distinct assemblages of sponge species. They displayed a markedly high abundance and cover of sponges compared with the other coastal areas with high wave action and expanse of exposed areas during low tide regimes.

Transects in the rock pools samples harbored great densities of sponges with over 50 - 60 individuals in an

Table 3. Types and average sizes (in µm) of spicules observed in the sponges

Spicule types	*C. (M.) pennata*	*C. pseudomolitba*	*C. australiensis*	*H. cavernosus*	*H. cratera*	*H. (R.) manglaris*	*X. carbonaria*
Straight oxea		525-763 x 5-7	220-260 x 10-15		250-300 x 10-12	220-230 x 5-7	265-280 x 5-7
Curved oxea			380-410 x 10-15	410-450 x 10-13	220-33 x 10-12	265-275 x 7-8	270-300 x 5-8
Slender oxea						275-290 x 5-7	
Micro oxea	60-71 x 3-5						
Long oxea					335-420 x 10-13		
Tylote			460-510 x 5-8	390-410 x 8-10			
Style	220-335 x 10-13	320-341 x 7-10	3500-4200 x 5-8				
Slender style	310-330 x 8-10						
Trachy style		320-410 x 6-8					
Strongyloxea			510-560 x 5-8				
Clad			2857 - 3100 x 10-15				
Tetract: Protriaene			4250-4400 x 3-5				
Anatriaene			5350-6100 x 3-5				
Sigma			48 -105				
Arcute chelae			15-20				
Trichodragmata		5-10 x 2-3					
Small isochela				20-31			
Large isochela				40-52			
Acathostyle	62-95 x 5-8 µm			100-110			
Large Sigma				48-62 x 5-7			
Strongyle	110-120 x 7-9 µm						
Subtylostyle (spiny heads)	270-320 x 10-13 µm						
Subtylostyle (smooth heads)	230-250 x 10-15 µm						
slender Subtylostyle							
Large toxa	69-150 x 2-4 µm						
Slender toxa	110-130 x 3-5 µm						
Polytylote	240-310 x 5-7 µm						

area of only 3 m^2, occupying at times up to 70% of available substrate. These habitats provide a continuously sheltered and submerged environment for large sponges like *H. cavernosus* and *Sarcotragus foetidus*, whereas sponges like *H. manglaris*, *H. crater*, *O. pennata*, *Xestospongia carbonaria* and *Chalinula pseudomolitba* are found in habitats, which are more exposed to air and sunlight at low tide.

Even though the rock pools were separated by 1 km, their other faunal assemblages were more or less similar to each other, but the sponge species showed a marked preference for the associated macro fauna. The marine lakes thus formed harbored only a subset of the adjacent sea fauna.

The difference in species composition between the rock pools can for a large part be attributed to both the nature of the barrier between the pools and sea as well as to various environmental characteristics within the pool systems. Depending on the degree of connection to the sea, the pools more or less resembled a coastal lagoon in geomorphology and species assemblage.

The sponges showed fluctuations in the distribution and availability depending on the seasonal conditions like salinity, temperature and wave action. The colonies of sponges are seen to be dislodged or washed off during rainy season and the re-establishment is seen from September onwards. The abundance and diversity reach the peak during pre-monsoon months.

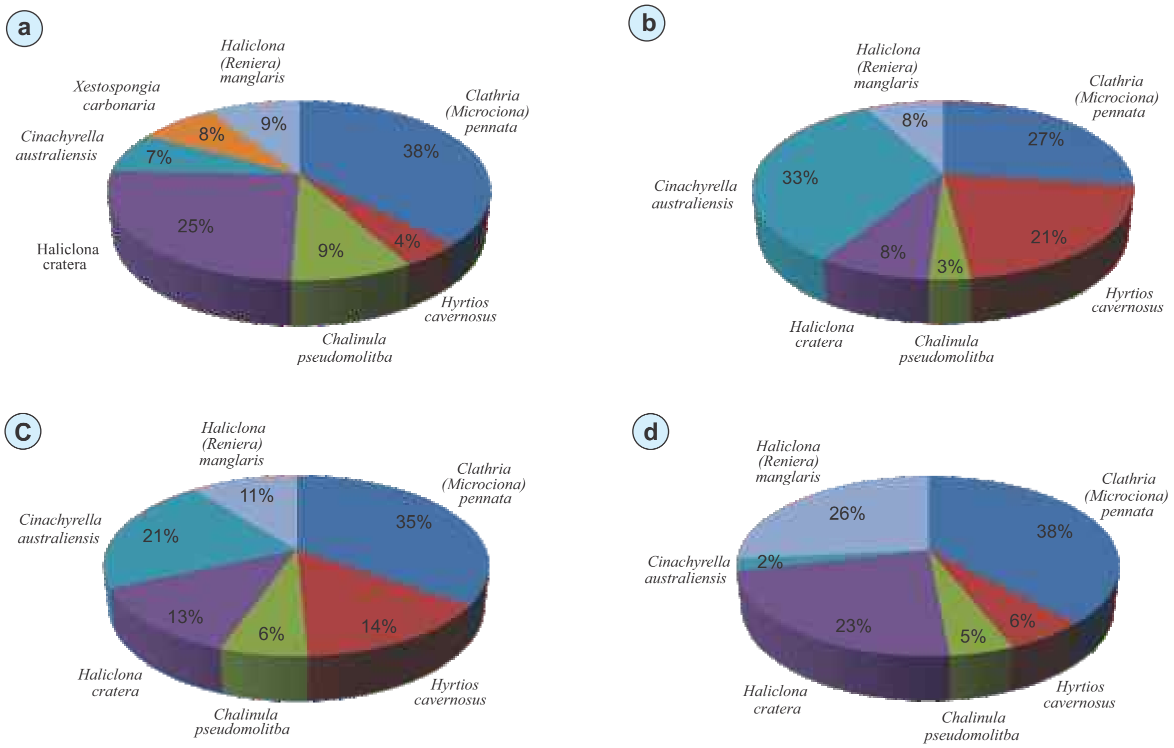

Figure 9 Annual percentage distribution of sponge species at (a) Alawa, (b) Undi, (c) Wayangani and (d) Aare ware.

Table 4 Pooled data for the sampling stations

Stations/ Species		*Clathria (Microciona) pennata*	*Hyrtios cavernosus*	*Chalinula pseudomolitba*	*Haliclona cratera*	*Cinachyrella australiensis*	*Xestospongia carbonaria*	*Haliclona (Reniera) manglaris*
Alawa	No.	203	24	47	136	40	42	50
	%	37.45	4.43	8.67	25.09	7.38	7.75	9.23
Undi	No.	172	131	19	51	208	0	50
	%	27.25	20.76	3.01	8.08	32.96	0	7.92
Wayangani	No.	209	87	37	77	127	0	64
	%	34.77	14.48	6.16	12.81	21.13	0	10.65
Aare ware	No.	208	32	25	124	12	0	145
	%	37.44	5.76	4.5	22.32	2.16	0	26.1

Biodiversity Analysis

The number of each species was counted in each fixed quadrant along the sampling stations throughout the year to calculate different diversity indices (i.e. Shannon-Wiener index, Simpson's diversity index, Shannon index, Evenness and Dominance) as per Simpson (1949) (Table 5, Figure 10).

Shannon - Weiner index (H')

The Shannon - Weiner index at Alawa during investigation ranged between (2.29 ± 0.14). The maximum H' value was recorded in the month of December (2.4328) and minimum H' value was recorded during month of January (2.1498). Seasonally, during the pre-monsoon period, H' value ranged between 2.18 and 2.3313 whereas in the monsoon period, it ranged between 2.2018 and 2.4047. In the post-monsoon period, it ranged between 2.1498 and 2.4328.

The Shannon index at Undi during investigation ranged between (2.16 ± 0.19). The maximum H' value was recorded in the month of June (2.3525) and minimum H' value was recorded during month of January (1.9655). Seasonally, during the pre-monsoon period, H' value ranged between 2.1024 and 2.3358 whereas in the monsoon period, it ranged between 2.1212 and 2.3525. In the post-monsoon period, it ranged between 1.9655 and 2.1572.

The Shannon - Weiner index at Wayangani during investigation ranged between (2.29 ± 0.165). The maximum H' value was recorded in the month of January (2.4459) and minimum H' value was recorded during month of July (2.1222). Seasonally, during the pre-monsoon period, H' value ranged between 2.2408 and 2.3463 whereas in the monsoon period, it ranged between 2.1222 and 2.3429. In the post-monsoon period, it ranged between 2.2916 and 2.4459.

Simpson's diversity index (D)

The Simpson index (D) at Alawa during investigation ranged between 0.75 ± 0.0541. The maximum D value was recorded in the month of December (0.8080) and minimum S value was recorded during month of July (0.7009). Seasonally, during the pre-monsoon period, D value ranged between 0.7353 and 0.7694 whereas in the monsoon period, it ranged between 0.7009 and 07851. In the post-monsoon period, it ranged between 0.7098 and 0.8080.

The Simpson index (D) at Undi during investigation ranged between 0.75 ± 0.05. The maximum D value was recorded in the month of June (0.7986) and minimum D value was recorded during month of January (0.7032). Seasonally, during the pre-monsoon period, D value ranged between 0.7298 and 0.7911 whereas in the monsoon period, it ranged between 0.7474 and 0.7986. In the post-monsoon period, it ranged between 0.7032 and 0.7628.

The Simpson index (D) at Wayangani during investigation ranged between 0.78 ± 0.04. The maximum S value was recorded in the month of January

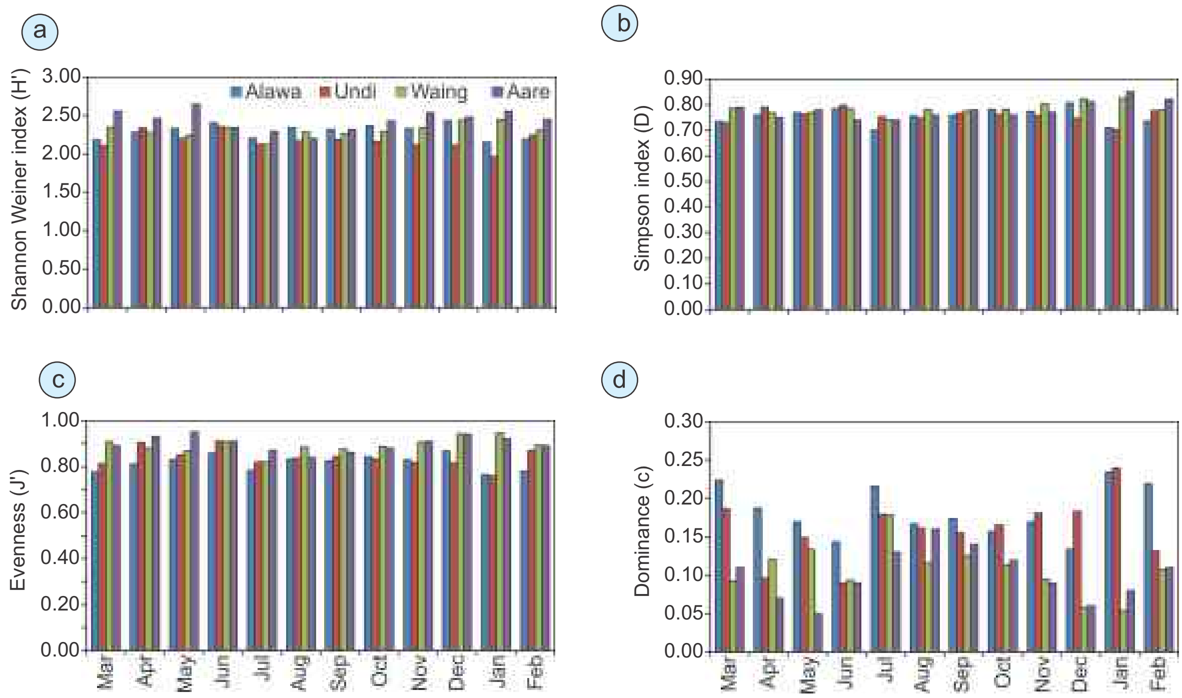

Figure 10 Month wise comparison of (a) Shannon Weiner index (H'), (b) Simpson index (D), (c) Evenness (J') and Dominance (c) of the four stations.

Table 5 Diversity indices calculated for four sampling stations viz. Alawa, Undi, Waingani and Aare ware

Month*	Shannon Weiner index (H') (log_2)				Simpson index (D) (log_2)				Evenness (J') (log_2)				Dominance (c) (log_2)			
	Alawa	Undi	Wayng.	Aare	Alawa	Undi	Wayng.	Aare	Alawa	Undi	Wayng.	Aare	Alawa	Undi	Wayng.	Aare
March	2.18	2.10	2.35	2.56	0.74	0.73	0.79	0.79	0.78	0.81	0.91	0.89	0.22	0.19	0.09	0.11
April	2.28	2.34	2.27	2.46	0.76	0.79	0.77	0.75	0.81	0.90	0.88	0.93	0.19	0.10	0.12	0.07
May	2.33	2.20	2.24	2.65	0.77	0.76	0.77	0.78	0.83	0.85	0.87	0.95	0.17	0.15	0.13	0.05
June	2.40	2.35	2.34	2.34	0.79	0.80	0.78	0.74	0.86	0.91	0.91	0.91	0.14	0.09	0.09	0.09
July	2.20	2.12	2.12	2.29	0.70	0.75	0.74	0.74	0.78	0.82	0.82	0.87	0.22	0.18	0.18	0.13
August	2.34	2.17	2.28	2.20	0.76	0.75	0.78	0.76	0.83	0.84	0.88	0.84	0.17	0.16	0.12	0.16
Sept.	2.32	2.18	2.26	2.32	0.76	0.77	0.78	0.78	0.83	0.84	0.88	0.86	0.17	0.16	0.12	0.14
Oct.	2.37	2.16	2.29	2.43	0.78	0.76	0.78	0.76	0.84	0.83	0.89	0.88	0.16	0.17	0.11	0.12
Nov.	2.33	2.12	2.34	2.54	0.77	0.76	0.80	0.77	0.83	0.82	0.90	0.91	0.17	0.18	0.10	0.09
Dec.	2.43	2.11	2.44	2.48	0.81	0.75	0.82	0.81	0.87	0.82	0.94	0.94	0.13	0.18	0.06	0.06
Jan.	2.15	1.97	2.45	2.56	0.71	0.70	0.82	0.85	0.77	0.76	0.95	0.92	0.23	0.24	0.05	0.08
Feb.	2.19	2.24	2.31	2.45	0.74	0.78	0.78	0.82	0.78	0.87	0.89	0.89	0.22	0.13	0.11	0.11

(0.8245) and minimum D value was recorded during month of July (0.7402). Seasonally, during the pre-monsoon period, S value ranged between 0.7689 and 0.7859 whereas in the monsoon period, it ranged between 0.7402 and 0.7845. In the post-monsoon period, it ranged between 0.7825 and 0.8245.

Species Evenness (J')

The Evenness (J') at Alawa during investigation ranged between 0.82 ± 0.05. The maximum J' value was recorded in the month of December (0.8666) and minimum J' value was recorded during month of January (0.7658). Seasonally, during the pre-monsoon period, J' value ranged between 0.7765 and 0.8304 whereas in the monsoon period, it ranged between 0.7843 and 0.8566. In the post-monsoon period, it ranged between 0.7658 and 0.8666.

The Evenness (J') at Undi during investigation ranged between 0.84 ± 0.075. The maximum J' value was recorded in the month of June (0.9101) and minimum J' value was recorded during month of January (0.7603). Seasonally, during the pre-monsoon period, J' value ranged between 0.8133 and 0.9036 whereas in the monsoon period, it ranged between 0.8206 and 0.9101. In the post-monsoon period, it ranged between 0.7603 and 0.8345.

The Evenness (J') at Wayangani during investigation ranged between 0.88 ± 0.06. The maximum J' value was recorded in the month of January (0.91462) and minimum J' value was recorded during month of July (0.8210). Seasonally, during the pre-monsoon period, J' value ranged between 0.8668 and 0.9077 whereas in the monsoon period, it ranged between 0.8210 and 0.9064. In the post-monsoon period, it ranged between 0.8865 and 0.9462.

Simpson's dominance index (c)

The Dominance (c) at Alawa during investigation ranged between 0.18 ± 0.05. The maximum dominance value was recorded in the month of January (0.2342) and minimum dominance value was recorded during month of December (0.1334). Seasonally, during the pre-monsoon period, dominance value ranged between 0.1696 and 0.2235 whereas in the monsoon period, it ranged between 0.1434 and 0.2157. In the post-monsoon period, it ranged between 0.1334 and 0.2342.

The Dominance (c) at Undi during investigation ranged between (0.17 ± 0.075). The maximum dominance value was recorded in the month of January (0.2397) and minimum dominance value was recorded during month of June (0.0899). Seasonally, during the pre-monsoon period, dominance value ranged between 0.0964 and 0.1867 whereas in the monsoon period, it ranged between 0.0899 and 0.1794. In the post-monsoon period, it ranged between 0.1655 and 0.2397.

The Dominance (c) at Wayangani during investigation ranged between 0.12 ± 0.065. The maximum dominance value was recorded in the month of July (0.1790) and minimum dominance value was recorded during month of January (0.0538). Seasonally, during the pre-monsoon period, dominance value ranged between 0.0923 and 0.1332 whereas in the monsoon period, it ranged between 0.0936 and 0.1790. In the post-monsoon period, it ranged between 0.0538 and 0.1135.

Species diversity is a combination of species richness and species evenness. The common measures are Shannon index, Simpson index, Evenness and Dominance. Species richness is simply a count of the number of species present in a given area. The diversity of species in a particular area depends not only on the number of species found, but also in their numbers. Ecologists call the number of species in an area its richness, and the relative abundance of species its evenness. Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species. For a given richness, D will increase as evenness increases and likewise, for a given evenness, D will increase as richness increases. It is always a value between 0 and 1 where 1 indicates a perfect evenness between species. Species with a low occurrence do not affect the Simpson value much; thus, it favors dominant species. Evenness is a measure of the relative abundance of the different species making up the richness of an area.

Physico-chemical Determinants of Sponge Abundance

Water parameters for the three locations are provided in Tables 6-8. Sponge assemblage and abundance differed significantly among substrate types in the rock pools sampled. Sponge abundance and cover was highest on rocky substrates, underneath the boulders and sheltered surfaces and was lowest on muddy substrate. Sponge species composition also differed significantly among locations, depending on the distance of the habitat from the sea. There was also no significant interaction between locations. Each location formed a distinct cluster. These rock pools were true sponge gardens containing distinct assemblages of sponge species. They displayed a markedly high abundance and cover of sponges compared with the other coastal areas with

Table 6 Physico-chemical parameter of sampling station 1 (Alawa)

Month	Air Temp.	Water Temp	pH	Salinity	DO	T.D.S.	Conductivity
	(°C)	(°C)		(ppt)	(mg/l)	(mg/l)	(S/m)
March	30	27	8.6	34	6.4	15.6	26.90
April	33.5	27	8.6	35	6.4	15.9	27.41
May	34	26.5	8.7	35	6.5	20.7	35.69
June	33	26	7.8	34	6.7	20.9	36.03
July	29	24.7	7.5	29	6.9	25.4	43.79
August	27.3	24.3	7.6	27	6.9	25.8	44.48
September	28.4	24.6	7.8	27	6.8	26.7	46.03
October	29.3	24.8	7.9	31	6.8	26.1	45.00
November	27.7	25.3	8	33	6.7	25.5	43.97
December	27.3	25.3	8.1	33	6.7	25	43.10
January	28	26	8.5	34	6.5	20.6	35.52
February	28.5	26.5	8.4	34	6.5	17.8	30.69
Mean	**29.67**	**25.67**	**8.13**	**32.17**	**6.65**	**22.17**	**38.22**
Max.	**34.00**	**27.00**	**8.70**	**35.00**	**6.90**	**26.70**	**46.03**
Min.	**27.30**	**24.30**	**7.50**	**27.00**	**6.40**	**15.60**	**26.90**
Range	**30.65±3.35**	**25.65±1.35**	**8.1±0.60**	**31±4**	**6.65±0.25**	**21.15±5.55**	**36.47±9.56**
n	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Standard deviation	**2.4511**	**0.9595**	**0.4202**	**2.9491**	**0.1834**	**4.1174**	**7.0990**
Standard error	**0.7076**	**0.2770**	**0.1213**	**0.8513**	**0.0529**	**1.1886**	**2.0493**

high wave action and expanse of exposed areas during low tide regimes. During the current study, at these three locations, the composition of the substrates showed slight variations as Alawa had rocky (basalt) substratum, Undi had coralline rocky depositions and Wayangani showed rocky areas with calcium deposits due to attached molluscan fauna and corals. The percentage of sponge species belonging to Order Haplosclerida was more at Alawa (57.14%) as compared to 42.85% each at Undi and Wayangani. Sponge species belonging to Orders Poecilosclerida, Dictyoceratida and Tetractinellida did not show much variation in composition at all the three stations.

Aggregation in sponges is often attributed to low turbulence at such locations which enables recruits to settle amongst conspecifics (Bell and Barnes 2000a). Beepat et al. (2013) reported that despite being an uncommon substratum for sponges, many *S. vagabunda* colonies were found attached to sand, an observation common to both assemblages. Abundance and size frequency patterns of sessile organisms such as sponges may vary among and within neighbouring islands and regions. Heterogeneity over both small and large spatial scales is the result of the interaction of physical, biological and stochastic factors influencing the distribution and abundance of individual species (Wilkinson and Cheshire 1989; Zea 2001).

There was significant interaction between the habitats and monthly water parameters. The sponges were mostly absent during the monsoon months when the salinity had decreased significantly. These fluctuations in the water parameters were seen to affect the abundance, cover and frequency of the sponges at these locations. The abundance and cover of sponges were high during the pre - monsoon period (March - May) and a decline was observed during the monsoon period as this coincided with the decrease in salinity, pH and temperature. The frequency of these sponge species were seen to be reduced considerably during monsoon (June - September), with an exception of *H. cavernosus*. The number and cover of these sponges started to increase after the monsoon. Changes in the distribution, composition and abundance patterns of sponges are likely to affect overall reef ecosystem functioning (e.g. nutrient recycling and spatial interactions). Phase shifts have been widely associated with declining reef quality and reduced herbivore abundance (Hughes et al. 2010) and most often reefs have changed from coral to algal-dominated states.

Table 7 Physico-chemical parameter of sampling station 2 (Undi)

Month	Air temp	Water Temp	pH	Salinity	DO	T.D.S.	Conductivity
	(°C)	(°C)		(ppt)	(mg/l)	(mg/l)	(S/m)
March	30	28.4	8.6	35	6	14.5	25.00
April	32	28	8.6	35	5.6	15	25.86
May	34	26.8	8.7	35	5.6	20.3	35.00
June	31	26	7.8	34	6.7	20.3	35.00
July	29	25.3	7.5	29	6.9	22.6	38.97
August	27	24	7.6	27	6.9	22.5	38.79
September	27.8	25	7.8	27	6.8	24.6	42.41
October	29.7	24.6	7.8	31	6.8	24.4	42.07
November	27.6	24.8	8	33	6.7	23.2	40.00
December	27.3	26.5	8.3	33	6.7	23	39.66
January	28	26	8.7	34	5.8	20.6	35.52
February	27.7	26.5	8.7	35	5.8	17.8	30.69
Mean	**29.26**	**25.99**	**8.18**	**32.33**	**6.36**	**20.73**	**35.75**
Max.	**34.00**	**28.40**	**8.70**	**35.00**	**6.90**	**24.60**	**42.41**
Min.	**27.00**	**24.00**	**7.50**	**27.00**	**5.60**	**14.50**	**25.00**
Range	**30.5±3.5**	**26.2±2.2**	**8.1±0.6**	**31±4**	**6.25±0.65**	**19.55±5.05**	**33.71±8.7**
n	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Standard deviation	**2.1673**	**1.3413**	**0.4712**	**3.0847**	**0.5418**	**3.3971**	**5.8571**
Standard error	**0.6256**	**0.3872**	**0.1360**	**0.8905**	**0.1564**	**0.9807**	**1.6908**

Table 8 Physico-chemical parameter of sampling station 3 (Wayangani)

Month	Air temp	Water Temp	pH	Salinity	DO	T.D.S.	Conductivity
	(°C)	(°C)		(ppt)	(mg/l)	(mg/l)	(S/m)
March	30.2	27.4	8.6	35	6.5	16.3	28.10
April	33.5	27.4	8.6	35	6.5	16.8	28.97
May	34.2	27.5	8.7	35	6.5	20.7	35.69
June	29.4	26.4	7.6	34	6.7	20.9	36.03
July	29	24.7	7.5	30	7.2	25.4	43.79
August	27.3	24.9	7.5	29	7.2	25.8	44.48
September	28.4	25	7.7	29	7	26.7	46.03
October	29.3	25.6	7.9	31	6.8	26.1	45.00
November	27.7	25.3	8	33	6.7	25.5	43.97
December	27.3	25.3	8.1	33	6.7	25	43.10
January	28	26	8.5	34	6.5	22.5	38.79
February	28.5	26.5	8.4	35	6.5	17.8	30.69
Mean	**29.40**	**26.00**	**8.09**	**32.75**	**6.73**	**22.46**	**38.72**
Max.	**34.20**	**27.50**	**8.70**	**35.00**	**7.20**	**26.70**	**46.03**
Min.	**27.30**	**24.70**	**7.50**	**29.00**	**6.50**	**16.30**	**28.10**
Range	**30.75±3.45**	**26.10±1.40**	**8.1±0.60**	**32±3**	**6.85±0.35**	**21.5±5.20**	**37.07±8.97**
n	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Standard deviation	**2.2591**	1.0278	**0.4562**	**2.3789**	**0.2674**	**3.8606**	**6.6563**
Standard error	**0.6522**	**0.2967**	**0.1317**	**0.6867**	**0.0772**	**1.1145**	**1.9215**

Flora and Fauna Associated with Sponges

Sponge associated fauna and flora is shown in Figure 11 and are listed below.

- Fifteen species of seaweeds: *Caulerpa microphysa*, *Caulerpa peltata*, *Caulerpa serrulata*, *Chaetomorpha antennina*, *Caulerpa sertularoides*, *Corallina berteroi*, *Dictyota bartayresiana*, *Dictyota dichotoma*, *Grascilaria foliifera*, *Hypnea musciformis*, *Hypnea valentiae*, *Padina boergesenii*, *Sarconema filiforme*, *Ulva fasciata*, *Ulva lactuca*.
- Twenty species of molluscs: *Donax scortum*, Babiloniaspirata, *Bursa spinosa*, *Cardita calyculata*, *Clypidina notate*, *Conusa madis*, *Conus dorotheae*, *Cypraea* (*Erosaria*) *lamarkii*, *Oliva todusina*, *Planax issulcatus*, *Paphia textile*, *Neverita didyma* (=*Polinices didyma*), *Turritella duplicate*, *Turritella terebra*, *Trochus radiates*, *Turbo bruneus*, *Garis tangeri*, *Lottia pelta*, *Vapricardium asiaticum*, *Vasticardium assimile*
- Brittle star : *Ophionereis annulata*
- Nudibranchs : *Elysia expansa*
- Corals: Soft corals (*Zoanthid* spp.), Hard corals (Family: Poritidae)
- Phytoplankton: *Coscinodiscus*, *Nitzschia sigma*, *Chaetoceros* spp., *Thallasionema nitzschoides*, *Asterionella* sp., *Ceratium* sp., *Dictiocha* sp., *Dinophysis* sp., *Miniduscus* sp., *Ornithoceros* sp., *Peridinium* sp., *Pleurosigma* sp., *Prorocentrum* sp., *Rhizosolenia* sp., *Thallasiothrix* sp.
- Zooplankton: *Calanopia* sp., *Calonopia elliptica*, *Centropages dorisispinatus*, *Cypris subglobosa* (Ostracod), *Eucalanus* sp., *Eucyclops* sp., *Favella brevis*, *Favella philipiensis*, Fish larvae, Copepod larvae, *Longipedia coronate*, *Longipedia webri*, *Mesocyclops* sp., Nauplius of balanus, *Oithona* sp., *Oncaea* sp., *Pontelllina* sp., Nauplius of Calanoida, *Phylodiaptomus blanci*, *Heliodiaptomus cinctus*.

Figure 11 Sponge associated fauna and flora.

sponge culture under laboratory conditions

Sponge culture under laboratory setup provided promising results. The setup used for sponge culturing is shown in Figure 12 and the details of the tanks are provided in Table 9. We were successful in culturing two sponge species *Clathria (Microciona) pennata* and *Haliclona (Reniera) manglaris* (Figure 13).

Table 9 Dimensions of the tank set up

Sr. No.	Particulars	Dimensions L x W x H (feet)
1	Glass Aquarium size	5' x 2.5' x 1.5'
2	Aquarium stand size	5' x 2.5' x 3'
3	FRP water sump size	8' x 4' x 2.5'

Recycled Seawater culture system for sponge culture

Mechanical Filter

Biological Filter

Protein Skimmer

Figure 12 Experimental setup of sponge culture.

Clathria (Microciona) pennata

Haliclona (Reniera) manglaris

Figure 13 Successful culture of two sponge species *Clathria (Microciona) pennata*, and *Haliclona* (*Reniera*) *manglaris*.

Summary of Project Findings

- Distribution wise, maximum number of species was encountered in low and intermediate tide zone as compared to high tide zone.
- *Haliclona* (*Reniera*) *manglaris* was most abundant on the sheltered rocky expanses followed by *C.* (*M.*) *pennata* which encrusted the rocks in exposed zones.
- Species more strongly associated with higher coral cover included *Amphimedon erina*, *Sarcotragus foetidus*, *Ophlitospongia pennata* and *Clathria* sp.
- *C.* (*Microciona*) *pennata* and *H. cratera* were dominant in the shallow water zone at a depth of 10 - 50 cm; while, *H. cavernosus* and *C. australiensis* were dominant at a depth up to 5 m.
- Out of the eighteen sponge species encountered during the study, *C.* (*M.*) *pennata*, *H. cavernosus*, *C. australiensis* and *X. carbonaria* showed significant difference with respect to location. However, only one species *C.* (*M.*) *pennata*, showed significant difference with respect to month. The remainder species showed no significant pattern with respect to location and month.
- Low or nil sponge abundance was recorded during monsoon when the pH, salinity and temperature decreased and the abundance was found to be increasing with an increase in these parameters.
- Sponge abundance differed significantly among substrate types in the rock pools sampled. Sponge cover also differed significantly among substrate types in these habitats. Sponge abundance and cover was highest on rocky substrates, underneath the boulders and sheltered surfaces and was lowest on mud substrate.
- There was significant interaction between the habitats and monthly water parameters.
- The most speciose order associated with rocks in the pools is composed of the Haplosclerida, particularly the family Chalinidae, and within that the genus *Haliclona*.
- Sponges like *Xetospongia carbonaria* grow even in muddy and turbid water
- Sponges like *Haliclona* (*Reniera*) *manglaris*, *H. cratera* grow at all the zones in the intertidal regions.
- *Aiolochroia crassa*, which changes its colour as soon as it is taken out of water (within 2-3 min.) from sulfur yellow to dark purple, was found at only one station, i.e. Waingani
- *Clathria* (*Microciona*) *pennata* and *Haliclona* (*Reniera*) *tubifera* could be cultivated under laboratory conditions. Currently, these two species are being cultured at the CoF laboratory since January 2018.
- Sponges require more time for acclimatization under laboratory conditions. Water parameters such as salinity, pH and temperature play a vital role in the acclimatization process (Rützler, 1995; Thomas, 1968) which have to be monitored on daily basis. Currently, the experiment is being done in one tank of 5ft x 2.5 ft x 1.5ft.
- All the sponges except *Hyrtios cavernosus* showed seasonal variations in the abundance and diversity, with zero availability during the monsoon months and the colonies were found to re-establishing during the post monsoon period.(Stations like Alawa, Are ware and Undi were visited even during the monsoon months, depending on tides and rains.)
- *Haliclona* sp. was observed to release the algal cells sheltered within their bodies, once they were removed from water.

Implications and Recommendations

Implications

- **Communities:** Conservation of coastal and mangrove ecosystems would benefit the coastal communities in augmenting their income through fishery and mangrove based products such as value added products from the by catch or low value fish/clams etc. Mangrove plants with medicinal values could become an income source through proper management of the mangroves.
- Managers or policy makers: Through interventions for small scale business such as micro financing, short or long term loans, subsidies for women entrepreneurs

Recommendations

- There is need to understand the co-relations and interactions between sponges and the environmental parameters. Hence a continuous monitoring of the sponge habitats is recommended.
- Being filter feeders, work needs to be done on the selective feeding habits of sponges, the food organisms and their culture for effective cultivation of sponges under laboratory conditions. College of Fisheries, Ratnagiri could undertake this work, if funding is made available.
- Research work on the bacterial assemblage within the wild sponges and cultivated sponges needs to be undertaken.
- It is recommended to provide further assistance to continue the culture and transplantation of *Clathria* (*Microciona*) *pennata* and *Haliclona* (*Reniera*) *tubifera*.

Publications and Presentations

Conference presentations

Presented at International conference on Ethical Prospects: Economy, Society and Environment organized by Ratnagiri Sub-Centre, University of Mumbai, Ratnagiri, 13 - 14th March 2015.

- Mohite SA, Salvi PV, Mahakal BV, Bhatkar HR, Shireeshkumar. Study of Marine sponges of South-West Maharashtra coast. pp. 209 - 214.
- Mohite SA, Salvi PV, Mahakal BV, Bhatkar HR. Novel Bacteria from the marine sponges of Maharashtra coast. pp. 251 - 255.

Presented at National conference on Mangroves of Konkan coast. R. P. Gogate College of Arts & Science, Ratnagiri. 2nd -3rd February 2015.

- Mohite SA, Salvi PV, Mahakal BV, Bhatkar HR Biodiversity Study of Kalbadevi mangroves along Shirgaon coast of Ratnagiri, Maharashtra, India.

Outreach Activities

Total 8 training programs (Figure 14) were conducted under five themes, in which 1905 participants from 18 schools and institutes participated.

Biodiversity of Maharashtra exhibition

Exhibition and talks were conducted from 1st October to 5th October 2016 at three venues, viz. Avishkar school (1st October), Swayamvar Mangal Karyalay (2nd October to 4th October) and Patwardhan High School (5th October). Talks were given by Mr. Sarang Oak and Mrs. Vaijayanti Thakur (Aseemit Foundation, Pune), Dr. S. A. Mohite (College of Fisheries, Ratnagiri), Mr. Sachin Sarolkar (Learning point, Ratnagiri) and Dr. Rahul Mungikar (Biodiversity board of Maharashtra). A total of 1500 students attended the program from 12 schools, including Phatak High School, Patwardhan High School, Shirke High School, GGPS High School, Convent High School, Desai High High School, Mestri High School, Mane international, Avishkar School, Vichapute English Medium, Khedashi High School and Navnirman High School. Posters were presented by 100 college students from College of Fisheries, Ratnagiri, University of Mumbai Sub-centre, Ratnagiri and Gogate College, Ratnagiri.

Mangrove culture and protection

These series of workshops was conducted four times. The first was conducted on 23rd October 2015 at Aagarnaral Fisheries Cooperative Society, which has 87 participants including 20 fishermen, 27 fisherwomen and 40 students and five speakers, Dr. S. A. Mohite, Dr. R. A. Pai, and Dr. V. R. Joshi (College of Fisheries, Ratnagiri), Mr. D. J. Jadhav (AFDO, State Fisheries Department) and Mr. Vitthala P. Mahakal (Gangaphal Macchimar Society, Aagarnaral). Second, third and

Figure 14 Outreach activities

fourth programs were conducted on 2^{nd} December 2015, 21^{st} April 2016 and 18^{th} May 2018 at College of Fisheries, Shirgaon, Ratnagiri, each of which was attended by 31 students.

Sponge identification techniques

This workshop was conducted on 16^{th} June 2018 at College of Fisheries, Shirgaon, Ratnagiri with Dr. S. A. Mohite as the speaker. Program was attended by 35 students and fisheries officers.

Role of mangroves in our ecosystem

This seminar was conducted on 15^{th} September 2018 at M.S. Naik High School, Ratnagiri. There were two speakers, Dr. S. A. Mohite (College of Fisheries, Ratnagiri) and Shri. Suyash Patil, Senior Research Fellow, Maharashtra Gene Bank Programme. Program was attended by 40 students.

Biodiversity of the rocky shores

This program was conducted on 19^{th} November 2018 at Shirke High School, Ratnagiri by three Senior Research Fellows of Maharashtra Gene Bank Programme, namely Bahar Mahakal, Suyash Patil, and Hrishikesh Bhatkar. The programme was attended by 50 students.

Project material developed

Marathi leaflets giving the information of Mangroves and there uses "Kharfuti”

Media coverage

The project work has been highlighted in media through activities and programme organized through the project. The news has been published in the known Daily Newspapers as the project coverage (Figure 15).

Figure 15 Media coverage.

Future Prospects

Currently, experiments are being conducted on the culture and transplantation of the sponge species. We would like to continue this work as there is a need to standardize the culture of food organisms of sponges for the cultivation of sponges under controlled conditions. Experiments on cultivation of edible seaweeds are also underway. Both these studies could be taken up simultaneously as sponges and seaweeds have a very close interrelationship.

The seawater and the sponges would be collected from the natural sources. The sponges would be quarantined initially for acclimatization. Then they would be transferred to the treated sweater tanks. The explants would be carefully monitored for survival and growth. After certain intervals the sponges would be harvested for extract preparation and microbiological studies. The prepared extracts would be stored for further analysis. Linkages with institutes like Indian Institute of Science Education and Research, Pune and National Center for Cell Science, Pune have been established. Molecular characterization of the extracts would be done with the help from these institutes. This would help in creating a database of the extracts for further use by creating linkages with pharmaceutical industries after patenting the processes and molecules.

Ex situ conservation of sponges: The work on ex situ conservation and laboratory culture of sponge species has given promising results. The sponges like *Haliclona (Reniera) tubifera, Ophlitaspongia pennata,Hyrtios cavernosus, Xestospongia carbonaria* and *Clathria (Microciona) pennata* are being cultured in the glass aquarium in the laboratory. This experiment will be further conducted for other sponge species under controlled conditions. Parameters like salinity, pH, DO, ammonia and temperature as well as light intensity and photo period required for each species need to be standardized. This would also provide insight about the sponge cultivation and transplantation of the cultivated sponges in the wild to improve the declining diversity of sponges.

Design for the proposed sponge culture laboratory is shown in Figure 16.

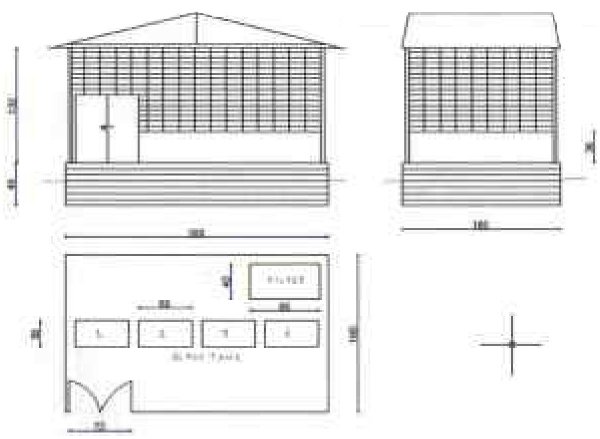

Figure 16 Proposed Sponge Culture Laboratory.

List of researchers and project staff

- Dr. Mrs. S. A. Mohite, P. I. and Professor (CAS), College of Fisheries, Shirgaon, Ratnagiri - Associated with this project since its inception
- Mr. Bahar V. Mahakal, S.R.F. (Joined on 12.6.2014 till 10.6.2020, on 11 monthly basis with 4 days break in between and reappointed by following Dr. BSKKV, Dapoli norms)
- Mr. Hrishikesh R. Bhatkar, S.R.F. (Joined on 12.6.2014 till 10.6.2020, on 11 monthly basis with 4 days break in between and reappointed by following Dr. BSKKV, Dapoli norms)
- Miss. Pooja V. Salvi, S.R.F. (Joined on 12.6.2014 till 16.9.2017 on 11 monthly basis with 4 days break in between and reappointed by following Dr. BSKKV, Dapoli norms)
- Mr. Suyash S. Patil, S.R.F. (Joined on 7.10.2017 till 10.6.2020, on 11 monthly basis with 4 days break in between and reappointed by following Dr. BSKKV, Dapoli norms)
- Mr. Kunal K. Bargode, Field worker (Joined on 12.6.2014 till 31.1.2019, on 11 monthly basis with 4 days break in between and reappointed by following Dr. BSKKV, Dapoli norms)

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Report 1.3

Marine invertebrate diversity and conservation along the coast of Maharashtra and Goa

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Background

Sponges are essential members of marine ecosystems. The field of taxonomy remains a prominent discipline of sponge research and is mostly based on morphological characteristics. However, sponge taxonomy is quite a tricky task, even for the expert because of their variability. In reef ecosystem sponges play a significant ecological role, forms a habitat for other organisms (Duffy 1992; Schönberg et al. 2016), helps in nutrient recycling and as food (de Goeij et al. 2013; Powell et al. 2015) and, in binding and strengthening coral reef framework (Wulff & Buss 1979). In recent publications sponges have been predicted to be more resilient to environmental change than corals, to replace coral reefs gradually and to form functional sponge habitats that may continue to provide vital ecosystem services where coral reefs disappear (Bell et al. 2013; Kelmo et al. 2013; McMurray et al. 2015). Relating to recent environmental changes bioeroding sponges may act as a more aggressive, where, their abundances increase, or their activities are amplified beyond normal levels, they can significantly unbalance local bioerosion rates and carbonate budgets (Rose and Risk 1985; Rützler 2002; Ward-Paige et al. 2005; Schönberg and Ortiz, 2009). Thus, it is crucial to investigate the occurrence of the bioeroding sponges and understand their biology and the ecological role and how they may change in presently changing environments (Schonberg 2016).

Several studies explored the potential factors which may influence the distribution and abundance of excavating sponges. These include ocean warming, coral mortality (Rützler, 2002; Schönberg & Ortiz 2009) and eutrophication (Holmes et al. 2000; Ward-Paige et al. 2005). Sponge bioerosion rates have been shown to rise with eutrophication and ocean acidification (Holmes et al. 2000; Wisshak et al. 2012; Enochs et al. 2015).

The Arabian Sea, cradling a diversity of marine habitats including coral reefs, is witnessing acidification of its surface waters, a consequence of excessive carbon dioxide in the atmosphere. Recent study revealed a rapidly decreasing presence of marine phytoplankton (an alarming decrease at the rate of 20 per cent over the last six decades) in the western Indian Ocean (Roxy et al. 2016). This report warns that the Indian Ocean may reduce to an ecological desert, given the level of ocean warming and acidification. Also, there are two coral reef patches known from the Central west coast of India named as Grande Island (Goa) and Malvan Marine Sanctuary (Maharashtra). The sites represent two nearshore coral reefs, located approx 54 nautical miles distance from each other. Earlier studies reported, 15 genera and eight genera from Grand Island (Manikandan et al. 2016). The sponge's diversity from the Central west coast of India is poorly studied, and most of the earlier reports represent different species. Here, in this project, we have taken the efforts to study diversity, distribution, and ecological importance of sponges in the Central West Coast of India. Our key objectives are described below.

Sponges (Phylum Porifera) are among the most abundant benthic animals colonizing consolidated substrates in tropical zones, coral reefs, rocky shores, and many artificial structures. They are widely distributed in marine systems and occur mainly in shallow waters of the continental shelf, but some species can be found up to 7000 m water depth. Abiotic factors are critical first-order filters dictating which sponge species can thrive at a particular site. Also, ecological interactions play essential roles in influencing the distribution and abundance of sponges. The prevailing global climate change negatively impacts most of the organisms but supports some of the sponge groups such as *Cliona* spp. (bioeroding sponges) in tropical ecosystems. This indicates the opportunistic behavior of *Cliona* spp. in rapidly changing environmental conditions, which may eventually affect the ecological interactions and disturb the marine ecosystem. Our study confirms the existence of sponges belonging to *Cliona viridis* complex and their accelerated infestation over corals in Maharashtra and Goa coast. These species are known for their high growth rate and aggressive encroachment over a coral worldwide. It is evident from various studies that globally increased temperature, acidification, as well as increased sedimentation and anthropogenic pollution, will alter the Clinoid sponges' growth and distribution. Therefore, assessing the distribution and recruitment of sponge under changing climatic conditions is very important in the temperate region also because some of the studies suggested that complex community of sponge- microbes in a mutually-beneficial relationship are at risk from higher sea surface temperatures because the symbiotic relationship between the sponge and its microbes breaks down. Bleaching is also a breakdown in the symbiotic relationship between the host and its microbes.

It is vital to investigate the impact of climate change over the sponge assemblage, including the symbiont and non-symbiont. Monitoring the impacts on the sponge assemblages will help to identify the effect on community restructuring. The increased dominance of *Cliona* spp. appeared to be an essential indicator of reduced coral reef health and was interpreted as a warning sign for coral reef deterioration along the West Coast of India. However, further analysis of the microbial community associated with a sponge will be required. In order to assess the sponge and microbial relationship, the next-generation sequencing approach is required. The functional role of the sponge microbial community will be assessed by meta-transcriptome analysis.

Objectives

- To make an inventory of Sponge and sponge-associated biological communities in the intertidal and subtidal zone in two (Kunkeshwar, Malvan) selected locations along the Maharashtra coast and two locations in Goa (Grande Island and Anjuna) during different seasons to study their spatial and temporal variation.
- To identify and classify sponges and sponge-associated biota using classical as well as molecular approaches
- Screening of sponge associated microorganisms for bioactive compounds using a battery of assay systems.

Methodology

Sponges sample collection

Sponge sample were collected from five main study sites from Central west coast of India (Fig. 1). These sites were divided in to the sub sampling sites based on rocky intertidal habitat and accessibility for sub tidal sampling. The sponge samples were collected during the low tide from intertidal regions. In subtidal regions of Grande Island and Malvan Marine Sanctuary sampling were performed by using SCUBA diving for the depth of 5-15m.

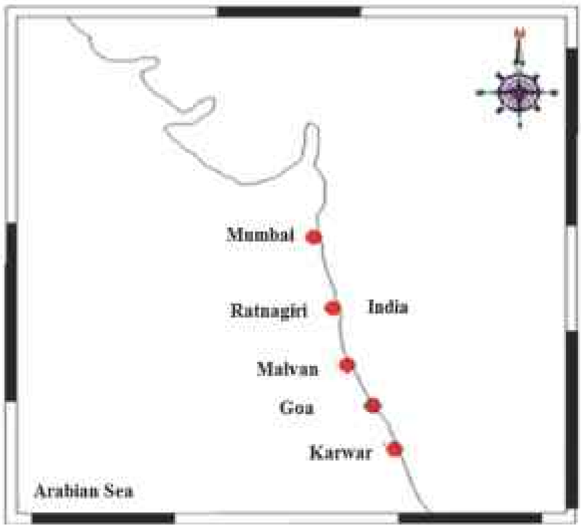


Figure 1 Map of studied locations for sponge sample collections.

Sponge morphological identification

The detailed morphological analyses inclusive of the skeleton arrangement, spicule types, and dimensions were made following Rützler (1974) and Schönberg (1999). Briefly, spicule preparations for both light and scanning electron microscopy (SEM) were obtained after 12 h digestion of sponge tissue with 70% nitric acid heated to 80^{o}C. Spicules were rinsed with distilled water and dehydrated in 96% ethanol, concentrating the spicules partly by sedimentation, partly by centrifugation, before carefully removing the supernatant. The final spicule-ethanol suspension was carefully mixed, spread, dried, and mounted on microscope slides. Spicules were similarly spread and dried on SEM stubs, but without adhesive, and gold-sputtered for 15–20 minutes in a compact vacuum coating system (12157EQ, SPI-Module Sputter Coater). Stubs were viewed with a JMS-5800LV scanning electron microscope. Viewing with light microscopy and micrometer eyepiece generated spicule dimension. For each specimen, 15-100 spicules were measured for biometric analyses. Depending on specimen and comparisons needed, dimensions for taxonomic comparisons were then obtained as spicules maximum length and shaft width, as well as tyle width and length, and spiraster total length, including spines, width without spines, and a count of bends.

Sponge identification using molecular markers

Molecular analysis: DNA was extracted from representative subsamples of the Indian sponge with a DNeasy kit according to the manufacturer's protocol (Qiagen, Hilden, Germany). DNA was amplified using the following primers: nrITS1 DNA (after Escobar et al. 2012), 28S rDNA (Barucca et al. 2007), and COI primers. The amplifications were carried out in a Mastercycler by following required conditions of each primer set. The amplified DNA was purified with a PCR Clean-Up Kit according to the manufacturer's protocol (Sigma Aldrich, Bangalore, India). The final DNA product was sequenced (ABI 3130xl sequencer, Applied Biosystems), and the obtained chromatogram was edited using the ABI sequence scanner software 1.0v. Few sequences were deposited in GenBank (NCBI; Benson et al. 2013) under the accession numbers MG367332-MG367341.

Microbial community associated with the sponge and its surrounding environment

Study sites and sample collection

This study was conducted in the Malvan Marine Sanctuary on the West Coast of India (15°58′N 73°30′E). Sponge tissue samples were collected from one specimen of the locally common *Cliona thomasi* Mote et al., 2018 in 8 m depth by SCUBA diving. Before sample collection, underwater photographs and measurements of the sponge and the neighboring coral *Turbinaria mesenterina* (de Lamarck, 1816) were obtained using a Nikon AW130 digital camera and a measuring tape, respectively. To spatially assess the sponge's microbial diversity, we collected sponge surface tissue from three different patches of which only one was adjacent to the invaded coral T. *mesenterina*. Accordingly, we distinguished sponge tissue from the coral-sponge interface region (CIM), mid-region of the sponge (CMM) and a peripheral region of the sponge neighbouring free water (CPM). Sponge tissue samples (measuring 1.5-2 cm in diameter and 0.2-0.5 cm in thickness) were collected from each region of the sponge by scraping material off with a pre-autoclaved fine chisel. Additionally, sediment was also collected at ~20 cm away from the respective sponge in a pre-autoclaved 20 mL vial in order to compare the sponge microbial community with the ambient communities.

After the dive, all samples were immediately fixed in liquid nitrogen on the boat and transferred to the laboratory. Samples were kept at -80 ˚C until further processed. The sponge species was identified by spicule morphology and molecular analysis (Mote et al., in press).

DNA extraction and library preparation

DNA was extracted from sponge tissue fragments with the aid of a tissue DNA extraction kit (Invitrogen, Mumbai, India) and adhering to the respective protocol. The sediment sample was processed using a Mo-Bio soil DNA extraction kit (New Delhi, India). The quantity and integrity of the resulting DNA was measured with an Agilent 2200 TapeStation system (California, United States). The primer pairs 341F and 518R of the V3 region, and 505F and 801R of the V4 region were employed to amplify 16S rRNA gene fragments (Muyzer et al. 1993; Li et al. 2009). Sequencing libraries of the V3–V4 region were prepared according to the Illumina MiSeq system instructions (Illumina Guide, 2013). Library preparation and subsequent paired-end V3-V4 region sequencing for 16S rRNA were performed by Scigenom Laboratories Pvt. Ltd., India.

Amplicon sequencing data analysis

Prior to the diversity analyses of the bacterial communities, the quality of the raw sequence files was evaluated by using FASTQC (Andrews 2010), including the assessment of base quality score distributions, average base content per read, GC distribution in the reads, as well as raw paired-end reads for all samples. To ensure our analysis, we followed two approaches in comparison; one was implemented by using a de novo assembly, and another without de novo assembly. For the de novo assembly we applied Velvet (Zerbino and Birney, 2008), among other programs, which relied on the de Bruijn graph algorithm for assembly of short reads (Zerbino and Birney 2008). Among different other parameters, assembly was validated by K-mer lengths (ranging from 19 to 31; Chikhi and Medvedev 2013). Above K-mer size 25 a given assembly was accepted as robust, and all our results produced here are for K-mer size of 31. We aligned these reads against the United States National Center for Biotechnology Information (NCBI) database of non-redundant protein sequences, using BLASTX D in DIAMOND with an E-value cutoff of 0.01 (Buchfink et al. 2014). DIAMOND produces .daa files, which were meganized by the program MEGAN 6.0 (Huson et al. 2016). In summary, in the first approach, files that were assembled de novo were meganized, and in the second approach raw sequence files were meganized. All the results included in the main text are from de novo assembled sequence files only. For better comparative analysis and conclusion, the results were merged in different combinations, followed by individual comparison.

Taxonomic assignment and functional annotation

Our analysis resulted in a total of 15,851,731 high-quality reads from the sponge and sediment samples. These reads were assigned to the taxonomic levels phylum, class, genus and species by alignment to known sequences in different databases (Cole et al. 2013; De Santis et al. 2006; NCBI Resource Coordinators, 2016; Quast et al. 2012). Final data analyses included a comparison between sponge and ambient bacterial diversities and their shared proportions (Venn diagram). Bacterial communities found in the different parts of the sponge and in the sediment were further compared statistically by using PRIMER 7 (Clarke and Gorley 2015). The datasets were analysed in a weighted UniFrac distance matrix (Lozupone et al. 2011) and clustered by non-metric multidimensional scaling (NMDS). We used MATLAB to interpret metagenomics data and plotted the figures for taxonomic data. For functional annotation our first approach is based on based Orthologous Groups (OGs) of proteins at different taxonomic levels, each with integrated and summarized functional annotations in eggNOG (Powell et al. 2012). In second approach provide an estimation of the microbial content based on the "Prokaryotic Attributes Table" of NCBI (Mitra and Huson 2011). These attributes describe the physiology and habitat types of the sample. Accession numbers of nucleotide sequences submitted to NCBI (reference) are Bio project ID-PRJNA436772.

Survey and identification of sponge- associated fauna

The sponge *Ircinia fusca* and *Cinachyra cavernosa* were collected from tide pools of Anjuna rocky shore, Goa, and Kunkeshwar rocky shore, Maharashtra. Five specimens of *Ircinia fusca* and *Cinachyra cavernosa* were collected on every sampling each month from September 2016 to 2018.

Sponges were removed from the rocks with a scalpel and quickly transferred to the sample jar to prevent the escape of fast-moving associated fauna. In the laboratory, the wet weight of the sponge was recorded. Then the sponge was macerated to remove all the macro fauna present in the pores. Sponge samples were washed in 0.3mm sieve. Fauna retained on the sieve were sorted and preserved in 5% neutralized Formalin. The fauna was identified to lowest possible taxa using literature.

Coral reef survey in Malvan Marine Sanctuary

The underwater survey was carried out using a fishing trawler from November 2014 to March 2015. Five sites were chosen in the reef along a distance gradient of 500m-1000m (Fig. 2 and Table 1). During each survey, 20m line transect (English et al., 1997), in triplicate, were placed randomly on each location of the sub-tidal reef flat by employing Self Contained Underwater Breathing Apparatus (SCUBA) diving to assess benthic community composition. Measurements of all coral colonies were done in-situ by measuring tape. All the coral colonies and the number of coral colonies invaded by boring sponge falling within 1m of each side of the transect tape (20x (1+1) m) were enumerated. The total numbers of unbleached, partially bleached, and fully bleached colonies were counted to estimate the bleaching prevalence.

Additionally, the areal cover of the dominant benthic component (live coral cover, macro-algae, and algal turf cover) within the belt transects were quantified by the line-intercept method (20m), following the central transect tape of the belt transects (English et al., 1997). All the coral colonies falling within the belt transect were identified up to the genus level, enumerated, and photographed using underwater Camera. During the survey, the position fixing was carried out by using a handheld GPS device.

Live corals were not collected for identification, because of corals are Schedule I protected species in India by Wildlife Protection Act, 1972. Hence, identification of the coral species up to lowest possible taxa was carried out based on morphological and macrostructural features by in situ observation and from high-resolution digital photographs (Veron 1986; 2000; Venkataraman et al., 2003, Mark, 2000, Woods, 1983, Wallace, 1999).

Coral diversity in Grande Island, Goa

Coral patches have been identified all around the Grande island archipelago (Fig. 3). Four locations, with good diversity and abundance of hard corals as well as reef fishes, were identified, at an average depth of around 5-9 m. The extent of the presence of corals has been recorded to an average of 200 m from the shore. Dominant corals include Porites spp. and Favites spp. in the lower depths (< 5m) and *Turbinaria mesenterina* at greater depths (>5m). Line intercept transects (LIT10m) were conducted in triplicate at each site, parallel to the shore at an interval of ~50 m from each

Table 1. Location and characteristics of underwater survey sites in the Malvan Marine Sanctuary.

Site	Category	Type of substratum	Geographical positions		Water Depths (m) at High tide	Specific Characteristic of the site
			Latitude (°N)	Longitude (°E)		
T1	Inshore	Rocky	16°02'22.8"N	73°27'41.9" E	3	Recreational diving site
T2	Inshore	Rocky	16°02'31.5" N	73°27'43.4" E	3	Recreational diving site
T3	Inshore	Rocky	16°03'786.4"N	73°27'725" E	5.6	Recreational diving site
T4	Inshore	Rocky and sandy	16°02'24.3"N	73°28'13.8" E	8	Fishing site
T5	Inshore	Rocky and sandy	16°03'84"N	73°27'43.3" E	5	Fishing site

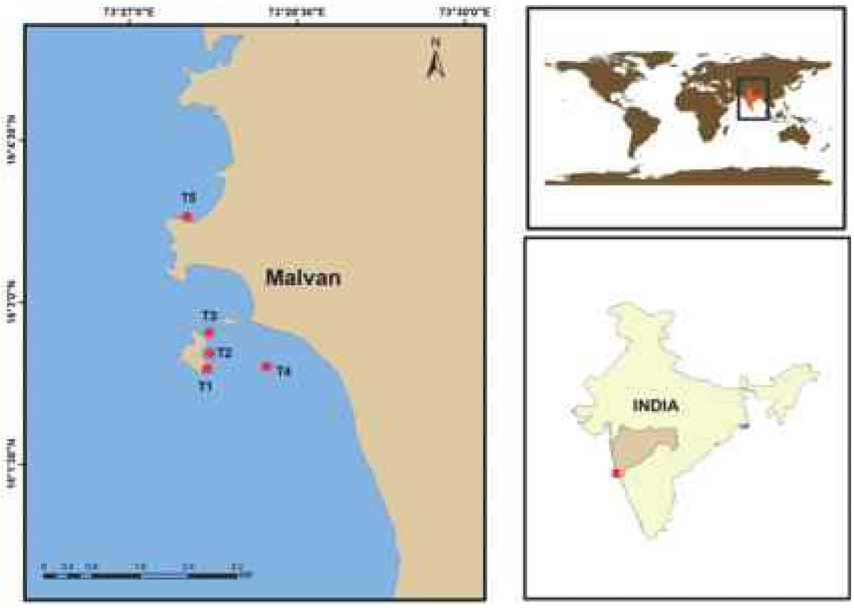


Figure 2 Map showing the location of Malvan Marine Sanctuary and study sites (T1-T5) in MMS.

other. All the coral colonies falling within the line transect were enumerated and digital photographs and videography were done using a Nikon AW130 (14 Mega Pixels) and a GoPro Hero4 (12 Mega Pixels) camera and were identified according to Veron (2000) and standardized using the World Register of Marine Species (WoRMS Editorial Board 2017).

Coral bleaching monitoring in Grande Island, Goa

As part of the on-going coral and associated biodiversity study of CSIR-National Institute of Oceanography, Goa, field surveys were conducted between October 2014 and April 2016 in Grande Island using SCUBA with belt transects (20 X 2 m, triplicate) to study the coral composition in the study area. Number of colonies bleached were also counted (Fig. 4). CRW NOAA issued bleaching threats and alerts on 2nd June 2015 for the period of Oct-Nov 2015. Therefore, an intensive field survey and examination was conducted in November 2015, to estimate the severity and extent of bleaching across different genera. Following the method of Hill and Wilkinson (2004), belt transects of 20 m X 2m were laid in triplicate at both the sites. The transects were laid parallel to the shore along the water depth contour of 2-4 m in site 1 and 4-8 m in site 2 at a distance of ~100 m from each other. All the coral colonies falling within the belt transect were enumerated, and digital photographs and videography were done using a Nikon AW130 (14 Mega Pixels) and a GoPro Hero4 (12 Mega Pixels) camera. Coral colonies were identified to genus level according to Veron (2000) and standardized using the World Register of Marine Species (WoRMS Editorial Board 2017). A qualitative assessment of “beaching severity” was done for each colony following an index developed by Hill and Wilkinson (2004). The following categories were used: (0) no bleaching evident; (1) partially bleached (surface/tips); or pale but not white; (2) white; (3) bleached and partially dead; (4) completely dead. Marshall and Baird (2000) characterized recently dead corals by an absence of living tissue and minimal algal overgrowth, and they considered these to be bleaching fatalities.

Sponge Diversity From Goa And Maharashtra And Coast

We have identified a total 31 sponge species throughout the central west coast of India (Table 2). There is no previous study exclusively on sponge diversity with detailed taxonomic description about sponges from studied sites of Central West Coast of India. The diversity and distribution of sponges opens the new opportunities for further study on ecological importance as well as chemical properties of these sponges. The general observation in the present study indicated that the Kunkeshwar harbored more diverse species than other studied sites. In the present study, we have reported variability in the *Cinachyrella* sp. from Vijaydurga, Kunkeshwar, Malvan, Reddy and Anjuna region. Our study distangle the morphological and molecular identity complex of these difficult *Cinachyrella* sp. from the Maharashtra and Goa coast.

During the project tenure, we had taken the effort for understanding the processes that have led to current levels of reef space occupation by bioeroding sponges in terms of density, cover and size, substratum availability, and the presence and abundance of live corals and other bottom components. The bioeroding sponge species *C. thomasi* was found to be dominant in Malvan Marine Sanctuary and overgrowing in faster rate over live corals. Here we represent dislodge of live coral colonies by heavily invaded boring sponges, 20% of the live colonies are lost of their original framework

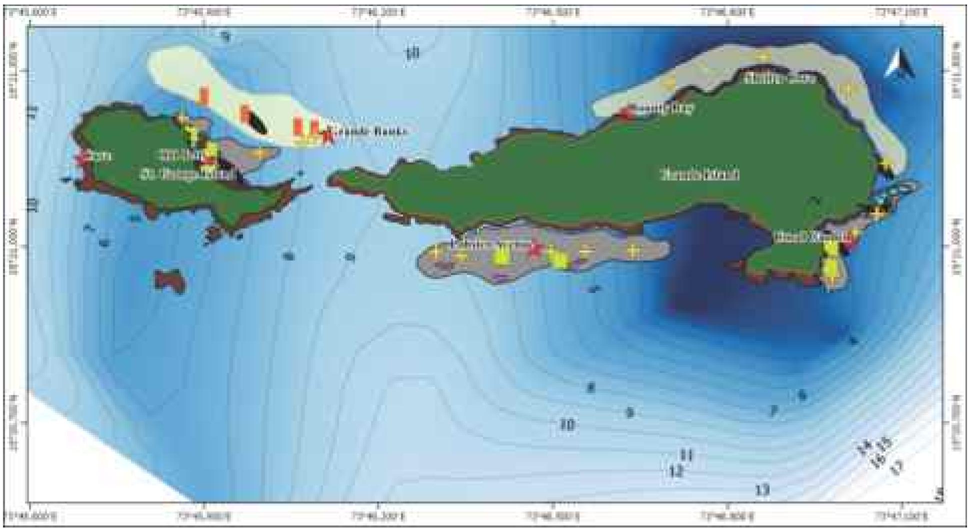


Figure 3 Study sites in Grande island archipelago.

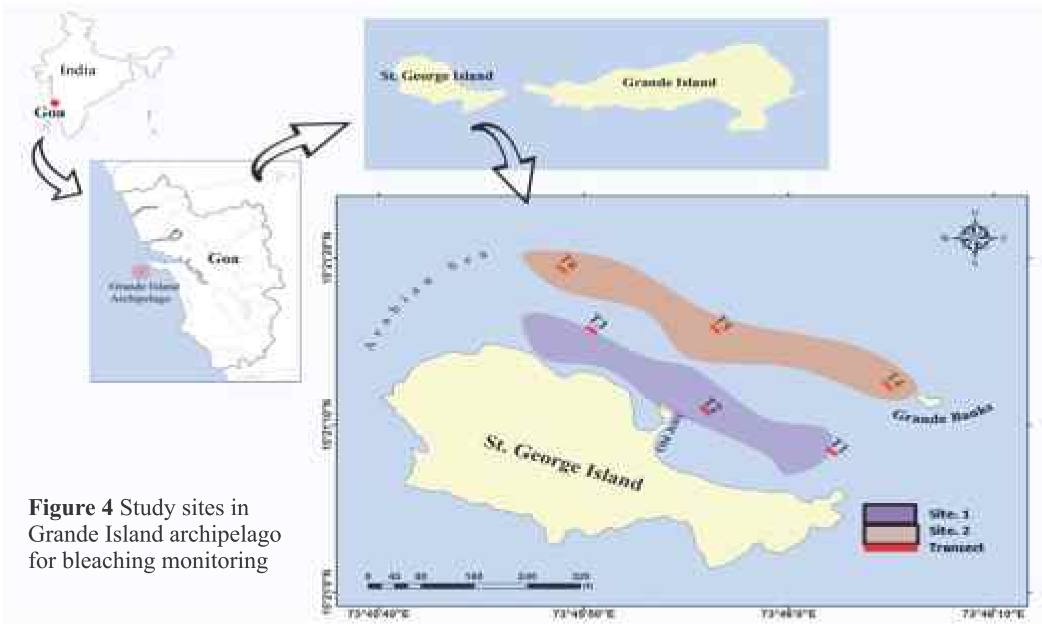


Figure 4 Study sites in Grande Island archipelago for bleaching monitoring

Table 2. List of the identified sponge through morphology (+ present) from the study area.

Sponge species	Karwar	Goa	Ratnagiri and Malvan	Mumbai
Cinachyra cavernosa	+	+	+	+
Amorphinopsis foetida		+		
Haliclona sp.		+		
Halichondria sp. 1	+	+	+	+
Chondrilla australiensis		+		
Ircenia fursca?	+	+	+	+
Spongia sp.		+		
Suberites cornosus		+		
Clathria sp.		+	+	
Cliona celata	+		+	

Sponge species	Karwar	Goa	Ratnagiri and Malvan	Mumbai
Pione sp.			+	
Cliona sp.		+	+	
Cliona thomasi sp. nov		+	+	
Halichondria sp. 2	+	+	+	+
Ophlitaspongia sp.		+	+	
Cliona Viridis			+	
Haliclona simulans			+	
Ircinia sp. 1		+	+	
Halichondria panacea	+			
Ophlitaspongia sp.	+	+		
Halichondria sp.3	+			
Halichondria sp.	+			
Halichondria bowerbanki	+	+	+	+
Hymeniacidon perlevis	+			
Haliclona cinerea	+			
Haliclona sp. 1	+			
Suberites sp.	+			
Paraleucilla sp.				+
Hallichondria panicea	+			+
Axinella dissimilis				+
Halichondria bowerbanki?	+	+		+

and affected survivability and high and higher abundance of sponges on dead corals or live corals were observed in station 4 and 5 compared station 2 and (see map, Figure 3).

Molecular Identification Of Sponge Samples

The extraction of DNA from sponge is always difficult due to the tissue complexity of sponges and chances of bacterial DNA contamination. Here, we have used the spin column method (protocol manufactured by Qiagen Blood and tissue DNA extraction kit). Depending upon the sponge tissue (hard tissue/soft tissue), we have optimized the tissue lysis step for sponge material to get better result of DNA, with all these changes we found that spin column method is to be the most feasible method for the extraction of genomic DNA from fresh as well as preserved sponge tissues. Fresh tissue of the sponge was taken within 24 hours so the cells were more active and live. It was relatively easy to homogenize such tissues. Preserved tissues showed cell morphology changes and DNA also get damaged according to the time and temperature of the storage. By using Spin column method, more intact bands for the fresh tissue of sponge samples were obtained. But for the preserved tissues light and very light bands were observed. The lambda DNA is used to check the size of DNA on an agarose gel and 10 µl of sponge DNA along with 2µl loading dye was used for the gel electrophoresis. Amplification of extracted sponge DNA has carried out with the genetic markers 28S rRNA and ITS region. Amplification is processed in the thermal cycle and annealing temperatures were standardized according to the melting temperature of the specific primers.

Molecular tools are clearly most suitable to assess phylogenetic relationships in character-poor taxa like sponge at different levels, ranging from species to phyla. A molecular species concept among demosponges is lacking because a distinct barcoding gap and a genetic distance threshold to clearly distinguish species has not been defined. The samples were been taken from different regions of west cost of India (Karwar, Kunkeshwar, Vijaydurg, Malvan, Goa). The PCR gene amplification of the samples was done using three primers namely 28S rRNA and ITS1 rRNA. We successfully extracted DNA from the specimens listed in Table 3. We have described the new sponge species from the west coast India which having more ecological value due its aggressive growing ability over corals.

Table 3 Molecular analysis conducted on the sponge species..

Species	**Field reference**	**Gene Bank reference**		
		nrITS1	**28SrRNA**	**COI**
Cliona thomasi sp. nov.	MGB 21	MG367337	MG367332	NA
Cliona thomasi sp. nov.	MGB 23	MG367338	MG367333	NA
Cliona thomasi sp. nov.	MGB 33	MG367340	MG367335	NA
Cliona thomasi sp. nov.	MGB 35	MG367341	MG367336	NA
Cliona orientalis	MGB1	NA	NA	KT861406
Cliona sp. 1, indet. aff. *Cliona viridis*	MGB 20	+	+	NA
Cliona sp. 2, indet. aff. *Cliona rhodensis*	MGB 12	+	+	NA
Porifera indet. (not a clionaid)	MGB 24	+	+	NA
Cliona thomasi sp. nov.	MGB 7	+	+	NA
Cliona sp.	MGB 28	+	+	NA
Cliona orientalis	MGB 2	NA	NA	+
Cliona orientalis	MGB 3	NA	NA	+
Cinechyrya sp.	MGB9	NA	NA	+
Cinechyrya sp.	MGB10	NA	+	+
Cinechyrya sp.	MGB11	NA	+	+
Axinella sp.	MGB6	NA	NA	+
Axinella sp.	MGB R7	NA	+	NA
Axinella sp.	M7	NA	+	NA
Halichondria sp.	MGB R2	NA	+	NA
Haliclona sp.	MGB 39	NA	+	NA
Terpios sp.	KK3	NA	+	NA
Amorphinopsis sp.	A31	NA	+	NA

New Clionaid Sponge Infests Live Corals

Coral reef ecosystems depend on the balanced interplay of constructive and destructive processes and are increasingly threatened by environmental change. In this context bioeroding sponges play a significant role in carbonate cycling and sediment production. They occasionally aggravate erosional processes on disturbed reefs. Like other coral ecosystems, Indian reefs have suffered from local and global effects. However, the systematic affiliation and diversity of many Indian bioeroding sponges and their infestation rates are largely confused or unknown. The present study describes a new bioeroding sponge species, *Cliona thomasi* sp. nov. from the central west coast of India. It belongs to the *Cliona viridis* species complex, displaying the key characters of tylostyles and spirasters, as well as photosymbiotic dinoflagellates. Specific morphological characteristics and molecular data from nrITS1 DNA and 28S rDNA distinguished *C. thomasi* sp. nov. from other known *C. viridis* complex and a number of Spheciospongia species. The historic sample of "*Suberites coronarius*" from Mergui Archipelago (sensu Carter, 1887), but not from the Caribbean (sensu Carter, 1882), is conspecific with *C. thomasi* sp. nov. *C. thomasi* sp. nov. is locally very abundant, appears to be a key bioeroder, and thus regular monitoring of its abundance, distribution and infestation patterns is recommended.

Taxonomic Description of *Cliona thomasi* sp. nov.

External morphology: Both, in α- and β-morphology in the field, with tendency to ɡ-morphology in thick specimens, but without fistular processes typical for specimens. Papillate α sponges in *Turbinaria* and *Favites* spp., individuals up to 20–40 cm in total diameter. Papillae circular or oval, very small, 0.3–0.8 mm in diameter. Encrusting to sponges forming patches of 60–100 cm in diameter, with epilithic tissue 0.5–3 cm thick (Figures 5a and 5b). Surface smooth. Texture hard and incompressible due to underlying coral skeleton. Live colour beige–brown to dark brown, in alcohol initially pale brown with green surface, later fading. Oscules in live sponges lighter in colour than

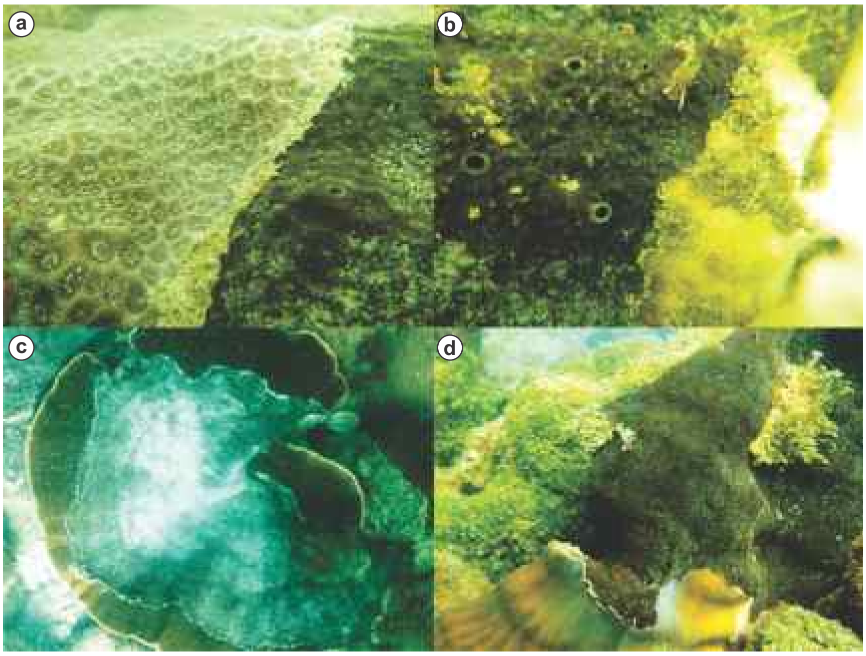


Figure 5 The encrusting-endolithic sponge *Cliona thomasi* sp. nov. in different coral substrates. (a) In live *Favites* sp. (b) In live, but partially bleached *Porites* sp. (c) In live *Turbinaria mesenterina*. (d) Spreading from dead substrate into live *T. mesenterina*.

remaining surface, being pale yellow. Choanosome pale yellow in all observed specimens.

Excavation pattern: Boring 2–3 cm into substrate, initially exploiting existing porosity of coral, but also forming small, rounded chambers pitted with erosion scars (Fig. 6a and 6b). Macroscopic appearance of bioerosion traces in specimens dense and eroded to similar porosity apart from marginal extensions. In specimens in more patchy distribution. Chambers of 1.0–1.5 mm in diameter, with minute connecting tubes.

Spicules: Megascleres robust tylostyles (mean length: width ratio 28.9), widest mid-shaft or slightly above. Comparatively straight, occasionally with very slight bend in upper 5th of shaft, with sharp points, last sixth of shaft near tip occasionally slightly angling away from main axis. Tyles round and well-formed, as a rule terminal, but occasionally second tylar ring at about 50 µm below main tylare. Tyles usually marginally shorter than wide, in fully formed tylostyles of similar width as shaft, with weakly to strongly pronounced neck crease, sometimes with single vesicle (Figure 7). Average tylostyle

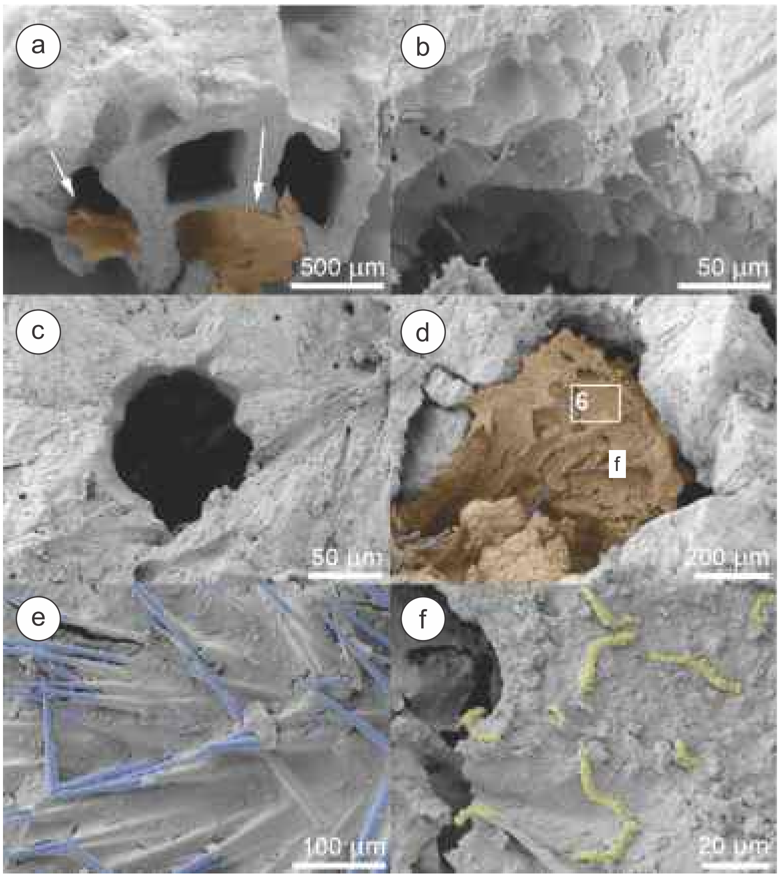


Figure 6 Morphological characters of *Cliona thomasi* sp. nov. viewed by scanning electron microscope. (Source : Mote et al. 2019)

dimensions as shaft length x shaft width x tyle width x tyle height: 330 x 12.1 x 13.6 x 13.9 µm. Microscleres rare spirasters, apparently restricted to choanosome, most frequently bow- or C-shaped, some S-shaped, very few short-helical or with straight shaft. Spines along convex side of shaft, as tiny bouquets on short stalks, distributed in very regular distance to each other. Spination terminally stronger and more pronounced, occasionally forming dense caps. Spirasters of comparatively uniform size, very slim and usually <1 µm wide, commonly 15-18 µm in total length.

Skeleton: Ectosomal skeleton tylostyles in palisade. Choanosomal skeleton consisting of ill-defined fibres of tylostyles within erosion chambers and in parallel with chamber walls. Choanosomal spirasters rare, with unconfirmed arrangement, but apparently associated with membranes.

Distribution: Eastern rims of the Northern Indian Ocean (Figure 8). Okha, Gulf of Katchchh, Northwest India (Dendy 1916; as *Cliona coronaria*), Malvan and Grande Island, central West India (our material), South India, Palk Straits (Thomas 1972, 1979; as Cliona orientalis; Devi et al. 2011; as *Cliona varians*), Mergui Archipelago, Myanmar (Carter 1887; as *Suberites coronarius*). Assumed also Andaman and Nicobar Islands (Raghunathan 2015a, 2015b; Kiruna-Sankar et al. 2016; as *Cliona varians*).

Ecology: The sponges were sampled from 4–10 m water depth. Distribution to deeper water was not confirmed or rejected, but we assume a prevalence in shallow waters due to the photosymbiosis with *Symbiodinium* sp. In the Malvan Marine Sanctuary *Cliona thomasi* sp. nov. occurs predominantly in live coral (*Turbinaria mesenterina* (de Lamarck 1816), *Porites compressa* (Dana 1846), *Favites melicerum* (Ehrenberg 1834), and *Pseudosiderastrea tayami* (Yabe and Sugiyama 1935); the latter two being more commonly infested), but also in dead coral, e.g. as rubble. Where in g-morphology, the sponges usually completely cover the surfaces of entire corals.

It is now widely accepted that the guild of bio-eroding sponges contains a number of insufficiently resolved species complexes with

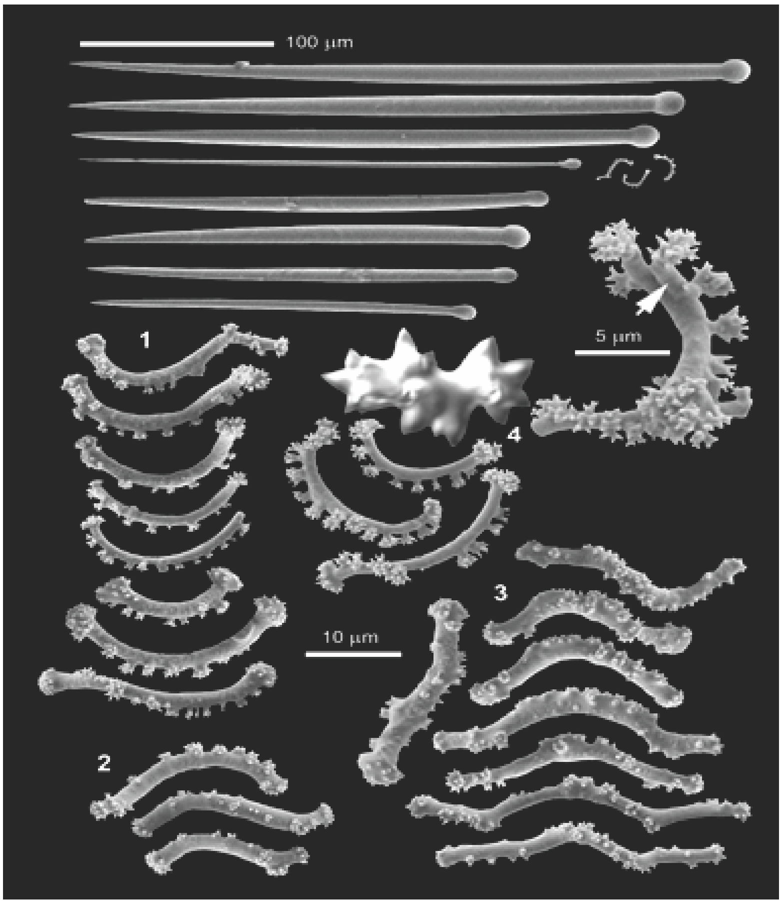


Figure 7 Scanning electron microscopy images of spicules of *Cliona thomasi* sp. nov.

Figure 8 Known and putative sample sites for *Cliona thomasi* sp. nov. along the western coast of India and Myanmar, as well as around the Andaman and Nicobar Islands.

similar morphological characters (Schönberg et al., 2017b). As a consequence, a number of species have traditionally, but erroneously been grouped under one name and were regarded as cosmopolitan or as having a wide distribution across different oceans (e.g. Xavier et al., 2010). With molecular taxonomy being increasingly used in addition to morphological studies, new species have been recognised and described, as well as morphological features identified that characterise and distinguish them within these difficult groups (e.g. Boury-Esnault et al. 1999).

The *Cliona viridis* species complex is one of the most difficult species complexes within the Clionaida, causing confusion through history as well as in recent studies. As has been done for other groups, brown endolithic sponges have commonly been lumped under the same name per bioregion, but this group is particularly speciose. The Caribbean/Floridian *C. caribbaea* and *C. varians* were eventually resolved into the partially sympatric *C. acephala*, *C. caribbaea*, *C. aprica*, *C. paucispina*, *C. tenuis*, *C. tumula* and *C. varians*; the Mediterranean *C. viridis/nigricans* were accepted as *C. labiata*, *C. viridis* and *C. parenzani,* but some workers still recognise older synonyms as possibly valid (Longo et al. 2017); and respective Indo-Pacific species are presently recognised as *C. albimarginata, C. caesia, C. minuscula, C. orientalis,* and likely *C. subulata* and *C. vallartense*. All these species harbour symbiotic dinoflagellates that are thought to provide essential nutrients to their hosts (Fang et al., 2014; Weisz et al. 2010). This may in part explain the diversity of this group, the large average specimen size and fast growth rates, their competitive strength and their success in general (Schönberg et al., 2017b). *C. viridis* complex species are as a rule among the most dominant and destructive macroborers on coral reefs (Schönberg, 2001; Schönberg et al., 2017b), and *C. thomasi* sp. nov. is abundant and aggressive as well.

We therefore think that like some other *C. viridis* complex species, *C. thomasi* sp. nov. can aggravate coral bioerosion where it is common. Should abundances of *C. thomasi* sp. nov. increase, this could cause a gradual phase shift from constructional to erosional conditions on local reefs. Increasing abundances of *C. viridis* species have repeatedly been linked to disturbance in reef environments (e.g. Rützler, 2002; Schönberg and Ortiz, 2009). Bioeroding sponges of the *C. viridis* complex are believed to be relatively tolerant to environmental deterioration and able to benefit from increased substrate availability after coral mortality (reviewed in Schönberg et al. 2017a, 2017b). At our West Indian sample sites reports on reduced reef health largely related to sedimentation (De et al. 2015, 2017; Hussain et al. 2016; Manikandan et al. 2016). At Carter's (1887) and Dendy's (1916) historical sample sites of *C. thomasi* sp. nov. pollution and thermal bleaching may be more relevant (De et al. 2017). Thomas' (1972, 1979, 1986) sample sites in Palk Strait have undergone degradation due to coral mining, pollution and bleaching events (Manikandan et al. 2014). The Andaman and Nicobar Islands have been regarded as comparatively unperturbed reef environments, but river sediment discharge into the Bay of Bengal, tsunami damage and global change have taken their toll (e.g. Brown 2007). We therefore think that monitoring the abundance, distribution and boerosion capacity of dominant *C. viridis* complex species such as *C. thomasi* sp. nov. is essential in order to recognise changes in the benthic community over time and to develop suitable strategies for protecting and managing the coral reef ecosystem in the region (Schönberg 2015).

Microbial community analysis of *Cliona thomasi*

The 16SrRNA amplicon sequencing analysis performed on one specimen of *Cliona thomasi* revealed that reads for eubacterial prokaryotes dominated the overall community composition (96.9%), followed by Archaea (0.2%). Bacteria strongly prevailed in diversity and abundance over all other taxa we amplified, in the sponge tissue, as well as in the ambient sediment. However, our study was not designed to resolve the eukaryotic community, and further investigations with 18SrRNA would be needed to cast light on this aspect. Likewise, our analyses do not allow a quantification of relative amounts of prokaryotes compared to eukaryotes.

Comparison of observed microbial communities at the phylum level

A total of 15 microbial phyla were associated with *C. thomasi*, while the sediment sample contained 31 phyla. Among those phyla, 16 were found only in the sediment, but all phyla retrieved from the sponge samples also occurred in the nearby sediment. Both the sediment and sponge samples were clearly dominated by Proteobacteria (sponge: 79.3%, sediment: 58.7% of the bacterial reads), followed by Firmicutes (sponge: 2.9%%, sediment: 4.0%), Actinobacteria (sponge 1.7%%, sediment: 3.2%), Cyanobacteria (sponge: 1.2%, sediment: <0.1%), Tenericutes (sponge 0.8%%, sediment: 0.4%), and Bacteroidetes (sponge: 0.2% sediment: 2.2%). In *C. thomasi* the Proteobacteria community was comprised of Betaproteobacteria (36.3%) and Gammaproteobacteria (30.1%), while Alphaproteobacteria (20.3%) were less predominant. However, in the sediment the Gammaproteobacteria (33.8%) dominated, followed by Alphaproteobacteria (16.3%) and Betaproteobacteria (15.4%).

Comparison of observed microbial communities at the genus level

Significant differences in genus level diversity of the bacteria were recorded between the sponge and sediment samples. The microbial community of the sediment sample was far more diverse than that of the sponge, with 194 genera assigned to the former and 120 genera to the latter. Communities found only in *C. thomasi* were largely represented by the genera *Aeromonas*, *Janthinobacterium, Chitinimonas, Pseudoxanthomonas, Fuerstia, Sphingobium, Acidovorax, Ferriphaselus, Xylella, Azonexus, Moraxella, Prevotella, Spirochaeta, Labilithrix, Calothrix, Chromobacterium, Faecalibacterium, Xanthomonas, Bifidobacterium, Bradyrhizobium, Roseomonas, Synechococcus,* and *Cupriavidus.* Dominant genera which were common in both sample sets were *Serratia* (sponge: 5.8%, sediment 3.3% of bacterial reads), *Pseudomonas* (sponge: 7.4%, sediment: 1.1%), *Vibrio* (sponge: 4.2%, sediment: 4.8%), *Delftia* (sponge: 1.6%, sediment: 1.4%), *Brucella* (sponge: 6.6%, sediment: 1.3%), *Vogesella* (sponge: 0.6%, sediment: 0.1%), *Pandoraea* (sponge: 0.6%, sediment: 0.1%) and *Brevundimonas* (sponge: 0.4%, sediment: 1.1%). The largest part of this dataset consisted of genera that remained unidentified (sponge: 68.7%, sediment: 54.1%).

Comparison of observed microbial communities at the species level

Species composition and abundances again differed between sediment and sponge tissue samples. The sediment sample contained 243 bacterial species, while only 169 bacterial species were associated with the sampled sponge tissue. A total of 97 bacterial species were found only in the sponge samples, 171 species only in the sediment, and 72 species were shared between both. The species only occurring in the sponge included *Rickettsia prowazekii, Taylorella asinigenitalis, Chitinimonas taiwanensis, Pseudogulbenkiania subflava, Synechococcus* sp. RS9916, and *Synechococcus* sp. WH 8109. Shared bacterial species with higher predominance in the sponge than in the sediment were *Vibrio parahaemolyticus* (sponge: 4.2%, sediment: 3.5% of bacterial reads), *Serratia liquefaciens* (sponge: 1.1%, sediment: 0.4%), *Brucella suis* (sponge: 1.2%, sediment: 0.4%), *Pandoraea sputorum* (sponge: 0.1%, sediment: <0.1%), *Aquitalea magnusonii* (sponge: <0.1%, sediment: <0.1%), *Entomoplasmatales bacterium* (sponge: 0.6%, sediment: 0.1%), *Chromobacterium haemolyticum* (sponge: <0.1%, sediment: <0.1%) and *Pararhodospirillum photometricum* (sponge: 1.4%, sediment: 0.6%). Bacteria species with higher predominance in the sediment than in the sponge were *Acetobacter pomorum* (sediment: 0.8%, sponge: 0.7%), *Treponema socranskii* (sediment: 0.4%, sponge 0.1%), *Streptococcus pneumoniae* (sediment: 0.3%, sponge: 0.2%), *Serratia marcescens* (sediment: 0.2%, sponge: 0.1%), *Escherichia coli* (sediment: 0.7%, sponge: 0.4%) *Magnetospirillum gryphiswaldense* (sediment: 0.4%, sponge: 0.3%).

Comparison of bacterial communities in different parts of the sponge

The bacterial community differed in different regions of *C. thomasi*. Phylum level diversity was similar and higher in the interfacial sponge edge competing with the coral and the free edge bordering water (CPM: 15, CIM: 14) than in the middle of the sponge (CMM: 8). Similar trends were also observed at the genus (CIM 86 > CPM 76 > CMM 56), and species levels (CIM 104 > CPM 92 > CMM 62). The phylum Proteobacteria dominated in all three regions. Yet at the class level variable dominance was observed, which mainly detected Gammaproteobacteria (33.2%) in CIM, Alphaproteobacteria (32.6%) in CPM, and a doubled predominance of Deltaproteobacteria (60.8%) in CMM, compared to the two values in CIM and CPM. The most dominant genera among all the three sponge sections studied included *Pseudomonas, Serratia, Brucella,* and *Vibrio.* Again, their abundances showed significant variation among the different parts of the sponge. In this context, the most common genera were *Pseudomonas* (CIM: 12.5%, CPM: 3.1%, CMM: 6.8% of bacterial reads), *Brucella* (CIM: 7.7%, CPM: 11.0%, CMM: 1.3%), and *Serratia* (CIM: 4.0%, CPM: 2.9%, CMM: 10.9%). Similarly, the abundances of species were also found to be highly variable among the three sponge tissue regions. For example, *Vibrio parahaemolyticus* was most common in CPM (CPM: 7.5%; CIM: 4.0%, CMM: 1.0%), followed by *Serratia liquefaciens* most prevalent in CMM (CMM: 1.8%, CIM: 0.9%, CPM: 0.4%), and *Pararhodospirillum photometricum* most prevalent in CIM (CIM: 1.6%, CPM: 2.1%, CMM: 0.3%). Certain bacterial species were only found in one of the three regions of the sponge, and the overall species diversity varied (CIM: 46, CPM: 33, CMM: 27). The overarching pattern was that a higher diversity of bacteria was observed at the margins of the sponge compared to its middle section. *Vibrio splendidus, Pseudomonas moraviensis, Pseudomonas putida, Aeromonas hydrophila, Fuerstia marisgermanicae, Sphingobium yanoikuyae, Acidovorax wautersii, Ferriphaselus amnicola, Mycobacterium abscessus, Salmonella enterica, Listeria monocytogenes, Xylella fastidiosa, Bordetella hinzii, Azonexus hydrophilus,* and *Prevotella copri* were only found in CIM. *Chitinimonas taiwanensis* and Aquitalea pelogenes were present in CMM, and *Janthinobacterium agaricidamnosum* and *Delftia acidovorans* occurred in CPM.

General observations on the bacterial communities and their distributions

Clear differences existed between the microbial diversities retrieved from the sponge compared to those from the sediment sample. Data from the three different sponge regions clustered together, while the sediment data formed an out-group. Among the sampled sponge regions the marginal parts CIM and CPM were more similar, and CMM separated out. A similar clustering pattern was also determined from weighted data.

Within the sponge samples, we found a remarkable diversity of what appeared to be opportunistic pathogens, some of which are known for biofilm production. This included genera that include partly very aggressive pathogens of terrestrial plants (e.g. *Pantoea, Xanthomonas*), domestic animals (e.g. *Brucella, Riemerella*) and humans (e.g. *Brucella, Chlamydia, Chromobacterium, Corynebacterium, Pandoraea, Rickettsia, Serratia, Staphylococcus*), as well as bacteria that have been recognised as responsible for coral diseases or occurring in stressed corals (e.g. *Azospirillum, Serratia, Vibrio*). In this group, known human pathogens appeared to be especially prevalent and diverse.

Functional annotation of the microbial community

In accordance to the taxon compositions, functional capabilities of the microbial communities showed pronounced differences between sponge and sediment samples (Table 4). In the sponge, the dominant bacterial functions related to energy metabolism and catabolism, as well as protein turnover, while bacterial functions in the sediment ranged over a wider spectrum, including functions associated with cell reproduction, growth and a variety of metabolic processes. The sponge-associated bacteria also exhibited marked functional capabilities with respect to chromatin structure and dynamics, translation and biogenesis, transcription, cell cycle control, cell wall biogenesis, signal transduction mechanisms, defense mechanisms, primary and secondary metabolites transport and metabolism. Further, these functional attributes were found to vary among the three sponge regions. Bacterial community presence in both of the marginal regions of the sponge facing coral and water (CIM and CPM) displayed stronger functional attributes for metabolism, energy production, genetic information and signaling, pathogenicity and diseases. In addition, dominant functions of the bacterial assemblages in these regions concerned metabolism under anaerobic, facultative aerobic and microaerophilic conditions. Within detected clusters of orthologous groups of the bacteria, chromatin structure and dynamics, signal transduction mechanism, and defence mechanisms were predominant functions in the central part of the sponge (CMM). Comparison to NCBI's prokaryotic attributes estimated microbial content which describes the physiology and habitat types of microorganism. Here, the majority of the bacterial species were gram-negative, aerobic, motile, pathogenic, and mesophilic. However, the bacterial community in the marginal region of the sponge (CIM and CPM) were rich in pathogenic bacteria, of which few were fully identified and known, and a large proportion remained unknown.

Discussion on bacterial community in Cliona thomasi

The brown, encrusting-endolithic sponge *Cliona thomasi* has recently been described as a coral excavating sponge that can outcompete and kill coral (Mote et al., in press). This species belongs to the *Cliona viridis* species complex, species of which are considered to be among the most dominant and destructive macroborers on coral reefs (Schönberg 2001; Schönberg et al. 2017b). Likewise, *C. thomasi* has been observed as a fast-growing, coral-infesting species with high ecological potential (Mote et al, 2019). It is thus important to know *C. thomasi* as a holobiont, to describe its microbial diversity, to understand the role of the associated microbes and whether these contribute to the sponge's success and competitive strength. This study is the first report characterizing the bacterial diversity associated *C. thomasi* using high throughput next-generation sequencing. As for other *C. viridis* complex species, *C. thomasi* was originally known for harbouring photosymbiotic dinoflagellates (Mote et al, 2019), however, to date no data are available on its prokaryotic communities and how these communities match those in other *Cliona* species. Hence, the present study examined the sponge holobiont system. Previously, knowledge on *C. viridis* complex prokaryotic microbial communities was largely limited to three sponge species: the Mediterranean *C. viridis* (Blanquer et al., 2013; Gloeckner et al., 2014; Garate et al., 2017), *Cliona varians* from the Florida Keys (Gloeckner et al., 2014; Poppell et al., 2014; Riesgo et al., 2014; Southwell et al., 2008), and *Cliona orientalis* from the Great Barrier Reef (Pineda et al., 2016, 2017a, 2017b). These investigations were conducted with regards to the role of such microbial communities in the sponge nutrition and changes in the microbial assemblages under different conditions of stress (Pineda et al., 2016; Ramsby et al., 2018). Some contributions on *Cliona*-microbe associations looked into host-microbe interactions, but again had a large focus on the Dinophyceae (e.g. Achlatis et al., 2018; Riesgo et al., 2014). Our study elucidated functional contributions of the prokaryotic microbial communities under investigation. Thereby, our findings relating to the bacteria in *C. thomasi* will further underpin our understanding of the sponge species complex and better explain its functional ecology as a holobiont that is presumably receiving significant support from its microbial community for nutrition, defense, immunity

Table 4 Bacterial diversity defined in sponge tissues and their putative ecophysiological role in coral reefs.

Species	CIM (%)	CMM (%)	CPM (%)	Known Characteristics of the organism	Putative functions and ecoplhysiological	References
Vibrio splendidus	0.06			Gram negative, short rods, motile, bioluminescent	Found in predicting community responses to disease studies in white plague syndrome, known for biofilm production activity	Portillo et al 2018, Roder et al 2014
Serratia plymuthica		0.15	0.11	Gram negative, short rods, capsulated, pigmented	Opportunistic pathogen for aquatic animals. Reported from coral mucus, known for AHL production	Nieto et al. 1990, Rodríguez et al 1990, Kalimutho, Ahmad and Kassim 2007, Houdt et al 2005
Pseudomonas fluorescens	0.17	0.07	0.11	Gram negative, rod shaped, motile	Genus is recognized to be associated with different coral species, *Pseudomonas fluorescens* is known for biofilm formation and reported as coral associate in white syndrome study.	Roder et al 2014, Kooperman et al 2007.
Pseudomonas syringae		0.15	0.11	Gram negative, rod shaped, motile	Pathogenicity to corals is unknown but reported as coral associate in white syndrome study, known for AHL production	Roder et al 2014
Pseudomonas moraviensis	0.06			Gram negative, rod shaped, motile	Pathogenecity to the coral are not known but reported as coral associate in white syndrome study, known for AHL production	
Pseudomonas putida	0.06			Gram negative, rod shaped, motile	Pathogenecity to the coral are not known but reported as coral associate in white plague disease study, known for AHL production	Cárdenas et al 2011
Aeromonas hydrophila	0.06			Gram negative, rod shaped, non- spore forming, motile	Causative agent for bleaching in *Turbeneria* sp. of corals also reported for Coral disease outbreak, white plague syndrome, known for AHL production	Hamid et al 2016, Bourne et al 2004
Rickettsia prowazekii	0.06		0.11	Gram negative, small, rod shaped, non- spore forming, non- motile	Reported as coral associate in few coral species and also in white band disease community in *Acrpoid* corals of Caribbean region.	Cases et al 2004, Roder et al 2014
Janthino bacterium agaricidamnosu m			0.11	Gram negative, rod shaped, motile	No known pathogenic impact, reported to possess a unique cell-cell signalling mechanism based on the synthesis of α-hydroxyketones (violicine), coral mucus associated bacteria *Fungia granulosa* from Red Sea.	Pantanella et al 2006; Kooperman et al 2007
Chitinimonas taiwanensis		0.09		Gram negative, curved rods, motile	Has chitinolytic capability, mostly known from freshwater environments, unknown ecological role on coral reefs, important nutrient recyclers in marine habitats	Li et al 2016
Pseudogulbenki ania subflava		0.15	0.11	Gram negative rods, motile	Capable of anaerobic, nitrate-dependent Fe (II) oxidation (NDFO) (important reaction for nitrogen and iron cycles), pathogenicity is unknown, reported from cold spring water	Ishii et al 2016
Delftia acidovorans			0.11	Gram negative, rod shaped, non- spore forming	Cause infections in humans, reported as coral associated bacteria.	Huseyin Bilgin et al 2015; Rohwer et al 2002

Species	CIM (%)	CMM (%)	CPM (%)	Known Characteristics of the organism	Putative functions and ecoplhysiological	References
Aquitalea pelogenes		0.15		Gram negative, short rods, non- spore forming, motile	Members of the genus *Aquitalea* represent common resident bacterial flora of frog skin, isolated from freshwater lake, sediments, activated sludge. Active cellulose degraders. Aquitalea pelogenes was first isolated from mineral peloid of Brazil	Roth et al 2013; Weber et al 2009; Adav et al 2010; Woo et al 2014; Sedlacek et al 2016
Arthrobacter woluwensis	0.06	0.27		*Gram positive, rods (exponential phase) and cocci (stationary phase)*	Common soil Actinobacteria, their marine counterparts appear to have antimicrobial in sponges and corals.	Mahmoud and Kalendar 2016
Fuerstia marisgermanicae	0.06			Gram variable, motile	Known to play key role in global carbon and nitrogen cycles, can attach to various surfaces in aquatic habitats, involved in biofilm formation	Fuerst and Sagulenko 2011; Kartal et al 2013
Sphingobium yanoikuyae	0.06			Gram negative, non-spore forming, non-motle	Disease causing pathogen in corals. Known to cause high rate of tissue damage (up to 2 cm per day) and the progression of the disease initiated from the base of the coral, found to be mucus-associated bacterial communities in bleached corals.	Cavicchioli et al 1999; Hadaidi et al 2017
Acidovorax wautersii	0.06			Gram negative rods, motile	Found as pathogen in hydra	
Ferriphaselus amnicola	0.06			Gram negative, neutrophilic, stalk-forming, iron-oxidizing, motile, bean shaped	Known to induce mineralization/ iron-oxidizing bacteria	Miot et al
Mycobacterium abscessus	0.12			Gram positive, acid-fast rods, non- motile	Human pathogen, known for antimycobacterial actvity from sponges	Izmi et al 2010
Salmonella enterica	0.06			Gram negative, rod shaped, motile	Human pathogen	
Listeria monocytogenes	0.06		0.11	Gram positive, rod shaped, non- spore forming, motile	intracellular pathogen of humans and animals,	
Xylella fastidiosa	0.06			Gram negative	Plant pathogen, known for biofilm production	Osiro et al 2004
Bordetella hinzii	0.06			Gram negative, short, rod shaped, motile	Mainly reported from human, domestic fowl and sea water, human pathogen	
Azonexus hydrophilus	0.06			Gram negative, rod shaped, motile	Role in nitrogen fixation	
Moraxella osloensis			0.11	Gram negative, coccobacilli, non-motile	Found in skin microbiota, biofilms of various pipe materials in drinking water distribution systems	Gao et al 2007; Zhu et al 2014
Prevotella copri	0.06			Gram negative, rod shaped, non- spore forming, non- motile	Human pathogen	
Spirochaeta odontotermitis			0.11	Gram negative, spiral shaped, motile, non-pathogenic		
Labilithrix luteola			0.11	Gram negative, rod shaped, motile	Known for synthesizing sterols.	

and development (Pita et al. 2018). Despite choosing a new approach, the microbes we determined in *C. thomasi* showed similar community patterns as obtained from 260 sponges analyzed under the global sponge microbiome project (Saurav et al. 2016; Thomas et al. 2016), as well as from other *Cliona* species (Alex and Antunes, 2015; Blanquer et al. 2013; Garate et al. 2017; Jeong et al. 2015; Pineda et al. 2016; Ramsby et al. 2018; Thomas et al. 2016). Sponge prokaryotic communities usually display a dominance of Proteobacteria, also with significant contributions by e.g. Actinobacteria and Cyanobacteria and frequent occurrence of e.g. Firmicutes, *Bacteroidetes* and *Chloroflexi.* At higher taxon level this matched our data very well. However, while most studies identified Alphaproteobacteria as clearly predominant in *Cliona* spp., especially in closely related species of the *Cliona viridis* complex (Blanquer et al. 2013; Pineda et al., 2016; Thomas et al. 2016; Garate et al. 2017; Ramsby et al. 2018), in *C. thomasi* Betaproteobacteria and Gammaproteobacteria were most common and shared similar proportions around 30% . While Proteobacteria include a number of known pathogens, the proportion of pathogenic bacteria in the present samples of *C. thomasi* appeared to be unusually high. This may be attributed to poor local water quality, to the sponge samples comprising a large proportion of surface tissue and the fact that some sponges very efficiently and selectively strip certain pathogenic bacteria from the water column and accumulate them above ambient conditions (Claus et al. 1967; van de Vyver et al. 1990; Fu et al. 2006; Stabili et al. 2008; Maldonado et al. 2010; Zhang et al. 2010). This may explain why many pathogens were present in the sponge samples, but not in the sediment, or not at the same levels. We cannot compare the microbial community of *C. thomasi* to that in the seawater, as our collected water sample did not provide a sufficient DNA concentration. However, if our interpretation of differences between microbes in the sponge tissue and the sediment is correct, then *C. thomasi* may have an excellent potential for water purification and bioremediation where it is locally abundant.

Given that the microbial community associated with *C. thomasi* was less complex than that in the ambient sediment, this finding may tentatively suggest it is a sponge with low microbial abundance (LMA), at least with respect to prokaryotes (see Gloeckner et al. 2014). While microbial communities in the sediment constitute different systems than in the free seawater, prokaryote communities in LMA sponges would be expected to resemble those of the ambient environment (Blanquer et al. 2013; Kamke et al. 2010; Weisz et al. 2008). Similar results of low microbial diversity were reported for closely related *Cliona* species, such as *C. orientalis, C. varians* and *C. viridis* (Alex and Antunes, 2015; Blanquer et al. 2013; Gloeckner et al. 2014; Mohan et al. 2016; Pineda et al. 2016; Poppell et al. 2014; Soares, 2015; Thomas et al. 2016). While the above studies did not assess the eukaryotic dinophycean symbionts, it is known that in *Cliona viridis* spp. Symbiodiniaceae reach densities in the sponges' surfaces that may be comparable with those of the diverse communities in sponges that were defined as having high microbial abundances (Fang et al. 2016; Riesgo et al. 2014; Schönberg and Suwa, 2007).

We noted a heterogeneous distribution of the bacteria associated with *C. thomasi*, with bacteria from marginal areas differing from those in the middle region of the sponge. Sponges can well recognise and distinguish between particles and various microbial cells they take up from the water column; they either expel them unchanged, digest them as food or retain them in their bodies for various purposes, which may result in an inhomogeneous distribution depending on the required use of the microbes (e.g. Wilkinson et al. 1984; Stabili et al. 2008; Maldonado et al. 2010; Hill and Hill, 2012). The bacterial community analysis further revealed presence of known pathogens and biofilm producing bacteria in higher concentrations and diversities at the sponge margins. Different scenarios seemed possible as explanation: (i) Pathogens spread out from the sponge: *C. thomasi* purposefully accumulates pathogens through filter feeding to defend its margins, or even to use allopathic/antibiotic effects of the pathogens against space competitors such as the neighbouring coral. We cannot presently confirm or reject this theory, because we have neither coral tissue nor water samples. (ii) Pathogens invade the sponge by colonizing its surface: Currents and closeness to the shore favour high turbidities, and particles commonly ge's defense at this unprotected edge. The central sponge surface, CMM, is here interpreted as the most typical, most sponge-relevant situation. Here, bacterial chromatin and signalling functions were comparatively active, implying central control originating from bacteria in this area. Counter intuitively, defense functions were also pronounced on the central sponge surface, which we are unable to explain, but defense was also comparatively well expressed near the neighboring coral, in the CIM region. CIM was most strongly characterized by microbial functions supporting carbohydrate and energy conversion, possibly suggesting that the space battle with the coral consumed much energy. Microbial distribution patterns may themselves explain the inhomogeneous distribution of these functions. Cyanobacteria had the highest abundance in the marginal regions (CIM and CPM) and likely fed energy into the higher metabolic activity at both these regions. The opposite patterns in prokaryotic functions in the sediment sample compared to the sponge further confirms the occurrence of meaningful interaction and exchange between the sponge and its associated bacteria, e.g. by favoring bacterial signal transduction in the sponge, not in the sediment.

While many questions remain unanswered (e.g. the reason for the heterogenic distribution of the bacteria and for the occurrence of the pathogens), the present study pioneers data on a little-known, but ecologically very important sponge-bacteria-holobiont. Apart from the diverse pathogen community, the mere diversity record of the bacterial associates did not generate immediately obvious differences in comparison to other studies on sponge-microbial relationships. However, through functional annotation we could show that at least some of the associated bacteria may significantly support the well-being or success of *C. thomasi*, possibly supplementing the contributions from the better-known Symbiodiniaceae. The diverse bacterial community and its varied functions further suggest a range of interactions that cannot yet be fully explained, but may imply mainly nutritional and defense-related contributions by the sponge-associated bacteria. Given the wide distribution of bioeroding sponges and their central role in coral reef health (Schönberg et al. 2017a, 2017b), we encourage the holobiont approach in further research.

Health Status of Coral Reefs in Malvan Marine Sanctuary

The Malvan Marine Sanctuary (MMS) is the only Marine Protected Area (MPA) in the Central West Coast of India with rich biodiversity with patch coral reefs. Despite the presence of coral reefs, very little is known so far about the coral reef ecology, health status, i.e., coral disease, bleaching, and influence of different environmental drivers on the reef ecosystem. Therefore, a detailed study of reef biodiversity, the extent of the reef formation, the health status of reef-forming corals, and the impact of coastal pressure and changing climatic condition was planned and executed. The present investigation, therefore, forms a comprehensive study on the biodiversity and ecology of scleractinian corals and associated biota in the MMS.

Eighteen species of reef-building scleractinian coral belonging to ten genera and six families, namely *Pseudosiderastrea tayami, Siderastrea savignyana, Coscinaraea monile, Favites melicerum, Favites halicora, Cyphastrea serailia, Plesiastrea versipora, Turbinaria mesenterina, Turbinaria frondens, Tubastraea coccinea, Porites lichen, Porites lutea, Porites compressa, Goniopora stokesi, Goniopora pedunculata, Bernardpora stutchburyi, Leptastrea* sp., and *Pavona* sp., were recorded during the present study. This number was significantly higher compared to the earlier report of only nine species.

Very limited knowledge is available on the occurrence and diversity of reef-associated fishes from the MMS. The present study reported, twenty-four species of reef fishes consisting of twenty-one genera belonging to sixteen families. Additionally, during the surveys, artisanal fishing activity was observed in the core coral reef area using gill net and cast net, which could lead to the declination of critical functional groups of reef species with cascading impacts on coral reef habitats and associated species in reef ecosystems health degradation.

The macroalgal community was comprised of 17 spp., dominated by *Sargassum* sp. Filamentous turf algae (*Dictyota* sp., *Calothrix* spp.) growth on coral species (*Porites* spp. and *Pseudosiderastrea* sp.) was also observed.

New settlements of juvenile *Porites* and *Turbinaria* colonies were found in a less disturbed area within the vicinity of coralline algae, which is a good indicator of resilience of the reef to the stress.

Recurrent coral bleaching events and subsequent coral mortality were recorded in the MMS from October 2014 to April 2019. During the coral bleaching survey in October 2014, the mean bleaching prevalence was estimated to be 14.58%±1.75SE. Underwater survey reveals partial and whole colony bleaching of *Porites lichen, Porites compressa, Favites melicerum, Turbinaria mesenterina, Pseudosiderastrea tayami, Cyphastrea serailia, Plesiastrea versipora, Goniopora* spp, *Siderastrea savignyana* (Fig.9). High coral bleaching also accounted in May 2015, which rose to 54.20%±2.58SE. Another survey in this region during December 2015 by Raj et al. (2018) recorded higher coral bleaching prevalence (70.93%). In May 2016, 46.76%±2.26SE bleaching was recorded, which declined in May 2017 and measured to be 20.22%±0.73SE. Relatively low bleaching observed in October 2018 to be 5.07%±0.61SE, and 8.37%±1.09SE in April 2019. Therefore, there is an urgent need for long-term monitoring (before-during-after bleaching) to understand the bleaching impacts of improved reef management practices. Thus, this study aimed to gain a synoptic view of the thermal-stress driven coral bleaching prevalence in the Malvan Marine Sanctuary (MMS) and provide insights on the impact of the bleaching events on the reef environment.

Coral disease prevalence was found to have amplified from the initial observations at all study sites during the monitoring period. A total of five types of coral diseases were found in all the study sites, viz. skeletal tissue anomaly (STA), the infestation of boring mollusk (VER), white syndrome (WS), tissue necrosis, or necrotic patches on colonies (TN), and trematodiasis or pink spot (TRM). Yearly disease prevalence recorded 16.13%, when the study was initiated in 2016, whereas in 2019, the prevalence reached to 29.39%. Physical damage to corals is well documented due to direct anchorage on corals, tourist standing, walking, holding the coral for support, fin movement, and jumping on shallow-water corals.

Figure 9 a. *Turbinaria mesenterina*; b. *Siderastrea savignyana*; c. *Favites melicerum*; d. *Cyphastrea serailia*; e. *Plesiastrea versipora*; f. *Turbinaria mesenterina* (photo credit Kalyan De).

The study has revealed that the abundance of live coral colonies declined dramatically in MMS after each bleaching event. Mean coral abundance drop from 2.54 individual colonies/m^2 in 2014 to 1.04 colonies/m^2 in 2019. Furthermore, live coral cover was declined from 45.09% in 2014 to 20.95% in 2019, which indicates dramatic coral loss due to the recurrent mass bleaching events, algal, and coral boring sponge competition with coral, and due to occurrence of different coral disease s. Extrapolation, based on the present cumulative coral damage trend, predicts the entire habitat to be altered and converted to a non-coral ecosystem within a decade if the current magnitude of stressors persists unabated.

Being a nearshore coral reef, the MMS is relatively more accessible for recreational activities than the other coral reefs of India. Hence tourism activity related to the beautiful coral reef is booming in MMS. Also, it appears that there is a significant urban development in progress to meet the increasing demand of booming tourism. Therefore, the presence of higher species diversity demands urgent ecological interventions and commencement of continual monitoring of the effects of local stressors on the reef community structure of the reefs and its health, which will aid in developing an action plan for proper conservation and sustainability of this fragile ecosystem.

The 2015-16 El Nino event spiked the temperature in this coastal water, negatively impacted the coral community from the MPA causing significant bleaching. In the Malvan Marine Sanctuary, the temperature anomaly that crossed the threshold of coral tolerance caused mean bleaching of 14.58% in 2014, followed by 54.20% in 2015, 46.76% in 2016, 20.22% in 2017, and 5.07% in 2018. This complete and partial beaching greatly impaired coral species in recovery while making them vulnerable to diseases being at their weakest (Brandt and McManus 2009; Miller and Richardson 2015; Brodnicke et al. 2019). Although coral communities at these locations are presumably hardy, bearing the adverse coastal settings, this study reports a series of undesirable impacts over the course of five years triggered by temperature anomaly due to El Nino effect in 2015-16. First disease survey of 2015 notes the dominance of molluscan infected coral colonies, presumably implying that infestation was an ongoing phenomenon and its onset is not the consequence of El Nino. As the MPA must be experiencing urban organic load and high turbidity due to localized hydrodynamic setting (De et al. 2015; Hussain et al. 2016; Raj et al. 2018), it provides an opportunistic environment favouring mollusc infestation (Shima et al. 2013, 2015).

The temperature anomaly caused bleaching in significant coral colonies (54.20% in 2015, 46.76% in 2016) while opening a niche for others to occupy. This was an opportunistic chance for seasonally proliferating macroalgae, as they find vacant non-allelopathic substratum to establish. Seasonal seaweed proliferation brought the second wave of deleterious effects in post-monsoon of 2015/16 which covered sizable area predominantly by *Caulerapa* sp., and *Sargassum* sp. Algal phase shifts are known to have significant negative impact on coral communities which includes dominance of macro-algae, and turf algae (Bruno et al. 2009; Fung et al. 2011; Wild et al. 2014). Seaweed proliferation triggered spread of pathogens that infected corals with potential pathogenic bacteria known to act as a causative agent of white syndrome and other coral diseases (Nugues et al. 2004; Sweet et al. 2013). Macroalgae or seaweeds also produce secondary metabolites those are allelopathic to corals and have potency to cause coral diseases (Rasher and Hay 2010a, b; Sweet et al. 2013; Longo and Hay 2017). The present study also shows that a total 16.55% of the colonies were infected during 2016 with multiple diseases, in the subsequent years, the average disease spread increased by 3.21% annually with increasing algal proliferation in the reef environment. Macroalgae requires nutrients which was delivered in the MPA by the constant organic drainage from landward urban increased usage. This drainage has remained steady (nutrient data did not show an increasing trend) over the years and could help the macroalgal bloom only due to unoccupied space created by bleaching event. In 2019 survey, most of the areas (52.77%) in the MPA were noted with algae having 6.14% rate of increase per year. Indirectly, El Nino mediated bleaching of corals helped the macroalgae to dominate.

Physical damage to corals is also well documented. As a result, estimation of carrying capacity for reef diving tourism is an important measure to evaluate how much diving pressure one reef can withstand without compromising reef health and species diversity over time; therefore, setting the diving limit is necessary for long-term sustenance of coral reef (Jameson et al., 1999; Wafar, 1997). Annual carrying capacity has been measured, and diving limits have been implemented in different reefs across the world. However, in none of the Indian reefs, estimates of diving carrying capacity have been determined so far and at the present MPA it exceeds many folds of the global average.

Coral Diversity in Grande Island, Goa

A total of 25 species of hard corals and four of soft corals and one Non-Scleractinian were identified (Table 5). *Porites* is the most dominated genera while there are no representatives from branching corals-Acroporidae family.

Bleaching monitoring revealed a deteriorating reef impacted with seasonal bleaching and other stressors. Coral bleaching differentially affects coral species (Marshall and Baird 2000), coral morphology (Loya et al. 2001) and colony size-frequency distributions by removing massive colonies. In this study, *Porites* was the severely affected which is also the most dominant genus in this turbid area. *Porites* is otherwise considered to be highly resistant species to bleaching (Guest et al. 2012). However Joshi et al. (2014) observed delayed recovery in *Porites* after the 2002 bleaching event in the Gulf of Kutch. It is possible that the corals had bleached during the heat stress of summer (May-June) of 2015 and were undergoing recovery but were hit by another round of bleaching episode in Oct-Nov 2015. As highlighted by Hughes et al. (2017), the critical point for coral reef recovery is the frequency of recurrent disturbances and the availability of sufficient time for the corals to recover and reassembly of adult corals. *Turbinaria mesenterina* colonies recorded here were least susceptible to bleaching and were in healthy state and corroborates with Marshall and Baird (2000) who stated that the genera *Turbinaria* are highly resistant to bleaching. Differential bleaching severity among coral taxa has ecological implications as it influences the potential of species to adapt to future thermal stress by natural selections (Baird and Maynard 2008). The recovery time of fast-growing corals and good colonizers like *Turbinaria* is usually 10-15 years (Connell et al. 1997, Kayanne et al. 2002, Gilmour et al. 2013), but the replacement of long-lived species like *Porites* may take decades. This progressively leads to phase shift in coral assemblage structure, as it has been observed in severely bleached reefs of Northern Great Barrier Reef (Hughes et al. 2017). Based on our result, the corals in the study may be on the phase shift to be dominated by highly resilient *Turbinaria* colonies replacing the sub-massive and encrusting colonies of *Porites*.

Table 5 Coral species from the grand island

Category	Genus/Species
Hard Corals	*Cyphastrea serailia*
	Favia abdita
	Favia lizardensis
	Favia mathai
	Favia veroni
	Favia complanata
	Favites flexuosa
	Favites halicora
	Favites veroni
	Goniastrea retiformis
	Goniopora columna
	Goniopora djiboutiensis
	Podabacea crustacean
	Porites spp.
	Goniopora spp.
	Psuedosiderastrea tayami
	Stylocoeniella guentheri
	Turbinaria mesenterina
	Acanthastrea sp.
	Coscinaria sp.
	Leptastrea sp.
	Plesiastrea sp.
	Pocillopora sp.
	Siderastrea sp.
	Montastrea annularis
Non-Scleractinian Soft corals	Dendrophyllidae
	Acanthogorgia ceylonsis
	Echinomuricea indomalaccensis
	Heterogorgia flabellum
	Junceela juncea

Monitoring Coral Bleaching at Grande Island, Goa

Surveys during the October 2014 revealed mild 5 % bleaching (n=8); 6.17% in April 2015 (n=10) which increased to 50.5% (n= 90) in November 2015. Surveys during April 2016 revealed growing colonies of *Porites* undergoing recovery with mean bleaching of 7.9 % (n=12) and an increase in the algae, macroalgal, and rubble composition from low 17.88 % in November 2015 to mean 35.83% in April 2016.

Porites were the most affected coral in site one and *Coscinaria* in site 2 (Fig 10). In site 1, around 25% of the *Porites* colonies were severely bleached (category 3), and ~30 % showed signs of mortality (category 4), whereas, in site two, around 58% of colonies were bleached and partly dead (category 3). In site 2, the *Coscinaria* genus was the worst affected, with ~55% colonies mildly bleached (category 1) and about 3 % incredibly bleached with signs of mortality (category 4). The few colonies of *Goniopora* spp. observed in site one were unbleached and healthy whereas, in site two around 7% of colonies were dead (category 4). *Turbinaria* spp. was the least affected coral in both the sites and was in a relatively healthy state (Hussain and Ingole 2020).

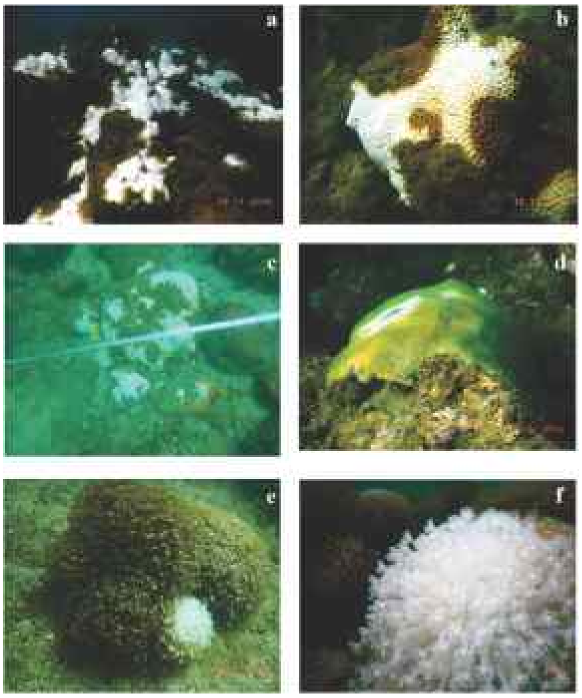


Figure 10. Bleached corals during 2015 bleaching event; a) *Porites* sp. b-c) *Favites* sp. d) *Plesiastrea* sp. e) *Goniopora* sp. f) *Goniopora* sp.

Sponge Associated Fauna

The sponge *Cinachyra cavernosa* was the most dominant sponge found in both the areas (Anjuna, Goa, and Kunkeshwar, Maharashtra), which we used to study the associated fauna. Sponges were collected from the rocky intertidal shore from September 2016 to August 2017. In total 10 taxa were identified. Foraminifera, Anthozoa, Turbellaria, Polychaeta, Crustacea, Bivalvia, Gastropoda, Ophiuroidea, Nematoda, and Sipuncula were found associated with Cinachyra cavernosa from Anjuna area. The high abundance of associated fauna from the Cinachyra cavernosa sponge from the Anjuna area was recorded in April 2017 with 765 ind/10g, and low abundance was recorded in December 2016 with 9 ind/10g (Table 6; Fig 11). Nematoda was the dominant group with 251 ind/10g and Harpacticoid copepod with 213 ind/10g, followed by Tanaidacea 170ind/10g (Figure 11a). Per cent composition showed 48% dominance by crustacean followed by 26% Polychaeta, 23% Nematoda and others 3% (Foraminifera (0.28%), Anthozoa (0.06%), Turbellaria (0.02%), Bivalvia (1%), Gastropoda (0.03%), Ophiuroidea (0.74%) and Sipuncula (0.89%) (Figure 12a). Crustacea was the most dominant fauna followed by Polychaeta found in all the months associated with the sponge (Figure 12a).

In total, eight taxa were identified wherein Foraminifera, Polychaeta, Crustacea, Bivalvia, Ophiuroidea, Nematoda, Nemertea, and Sipuncula were found associated with *Cinachyra cavernosa* sponge from Kunkeshwar area. High abundance was observed in January 2017 with 157ind/10g and low abundance in September 2016 with 14ind/10g (Table 7; Fig. 11b). Polychaetes were the most dominant taxa with 65 ind/10g, followed by Nematoda with 41 ind/10g. The per cent composition of macrofauna associated with the sponge showed Polychaeta (43.22%), Crustacea (27.05%), Nematoda (23.19%), Bivalvia (1.99%), Ophiuroidea (2.40%) and remaining 2% by others (Foraminifera (0.68%), Nemertea (0.16%) and Sipuncula (1.06%) (Fig. 12b). Among all the taxa, Polychaeta, Crustacea, and Nematoda were the most dominant group, which was found associated with the *Cinachyra cavernosa* from the Kunkeshwar area (Fig. 12b, 13, 14, 15).

The sponge *Ircinia fusca* was the dominant sponge that was collected from the rocky intertidal shore of the Kunkeshwar area, Maharashtra, to study the associated fauna of the sponge. A total of 26 taxa were collected in the *Ircinia fusca* during the study. The highest abundance of fauna was observed in December 2016 with 418 ind/100g and lowest in April 2017 with 58 ind/100g (Table 8; Fig. 11c). Among all the taxa, Ophiuroidea (mean average 130±120.74) was the most dominant group, which was present in all months, and the second abundant was the Polychaeta (mean average 43±31). The highest abundance of polychaetes was observed in May 2017and July 2017 and low in January 2017 (Fig. 11d). Among Polychaeta, Family Syllidae was the most abundant family (mean average 23.7±17.3), followed by Eunicidae (5.8 ±6.3). Ophiuroidea showed 67 % composition, Polychaeta 22%, Crustacea 6%, Bivalvia 1%, Sipuncula 2%, Nematoda 1% and others 1% (Foraminifera 0.08% and Gastropoda 0.70%) (Fig. 12c). From all the months, it is observed that Ophiuroidea was the most dominant and abundant fauna associated with *Ircinia fusca* followed by polychaetes and crustaceans (Fig. 12c, 16, 17).

Sponge associated fauna from two different sponges and commonly occurring polychaete species are shown in Figure 18 and 19 respectively. Feeding guilds of polychaetes within sponges define the nature of the relationship between the organisms. The polychaete species *Haplosyllis spongicola* takes refuge in species of sponge. The location and specific behaviour of this species suggest that the host sponge species probably provide shelter and enhance food sources. The position of filter feeders in the canals of the sponges close to the openings probably aid them in obtaining food from the water flow created by the Choanocytes in the sponge. Surface deposit-feeding polychaetes may obtain food from organic detritus accumulated in sponge canals. The microorganisms also live within the host sponge. The importance of sponge is that it enhances the food supply to the associated fauna and provides shelter and protection from predators.

Table 6 Monthly variation in macrofaunal abundance (ind/10g) associated with *Cinachyra cavernosa* from Anjuna rocky shore.

Taxa	Sep'16	Oct'16	Dec'16	Jan'17	Feb'17	Apr'17	Jul'17	Dec'17	Mean	SD
Foraminifera	0	0	0	1	2	0	0	0	0	1
Anthozoa	0	0	0	0	0	0	0	0	0	0
Turbellaria	0	0	0	0	0	0	0	0	0	0
Unknown polychaeta	0	0	0	11	19	0	95	58	23	35
Lysidice sp.	0	0	0	0	0	0	0	0	0	0
Marphysa sp.	0	0	0	0	0	0	0	0	0	0
Spiochaetopterus sp.	0	0	0	0	0	0	0	0	0	0
Chaetopterus sp.	1	0	0	0	0	0	0	0	0	0
Syllis sp.	0	3	0	7	1	77	3	0	11	27
Eunice sp.	0	0	0	0	0	9	0	0	1	3
Terebella sp.	0	1	0	1	0	7	0	0	1	2
Sabellaria sp.	0	0	0	0	0	5	0	0	1	2
Nereis sp.	0	0	1	0	0	5	0	0	1	2
Cirratulus sp.	1	0	0	3	0	14	0	0	2	5
Cirriformia sp.	0	0	0	0	0	0	0	0	0	0
Nephtys p.	0	1	0	0	0	0	0	0	0	1
Sternaspis sp.	0	0	0	0	0	0	0	0	0	0
Pectinaria sp.	0	0	0	0	0	0	0	0	0	0
Tanaidacea	0	0	1	0	0	170	95	9	34	64
Pycnogonida	0	0	0	0	0	0	0	0	0	0
Halacarida	0	0	0	0	0	2	0	0	0	1
Harpacticoid copepod	0	0	5	39	16	213	11	11	37	72
Isopoda	0	0	0	20	2	0	0	0	3	7
Amphipoda	1	1	0	8	3	0	0	0	2	3
Decapoda	0	0	0	0	0	5	0	0	1	2
Ostracoda	0	0	0	1	1	0	0	0	0	0
Bivalve	0	0	0	0	1	0	0	2	0	1
Chiton	0	0	0	0	0	0	0	0	0	0
Musculus sp.	9	0	0	1	0	0	0	0	1	3
Littorinidae sp.	0	0	0	0	0	0	0	0	0	0
Ophiuroidea	0	2	0	0	0	7	0	0	1	2
Sipuncula	1	4	1	0	1	2	1	1	1	1
Nematoda	0	0	0	7	9	251	7	12	36	87
Total	**15**	**12**	**9**	**100**	**56**	**765**	**213**	**94**	**158**	**254**

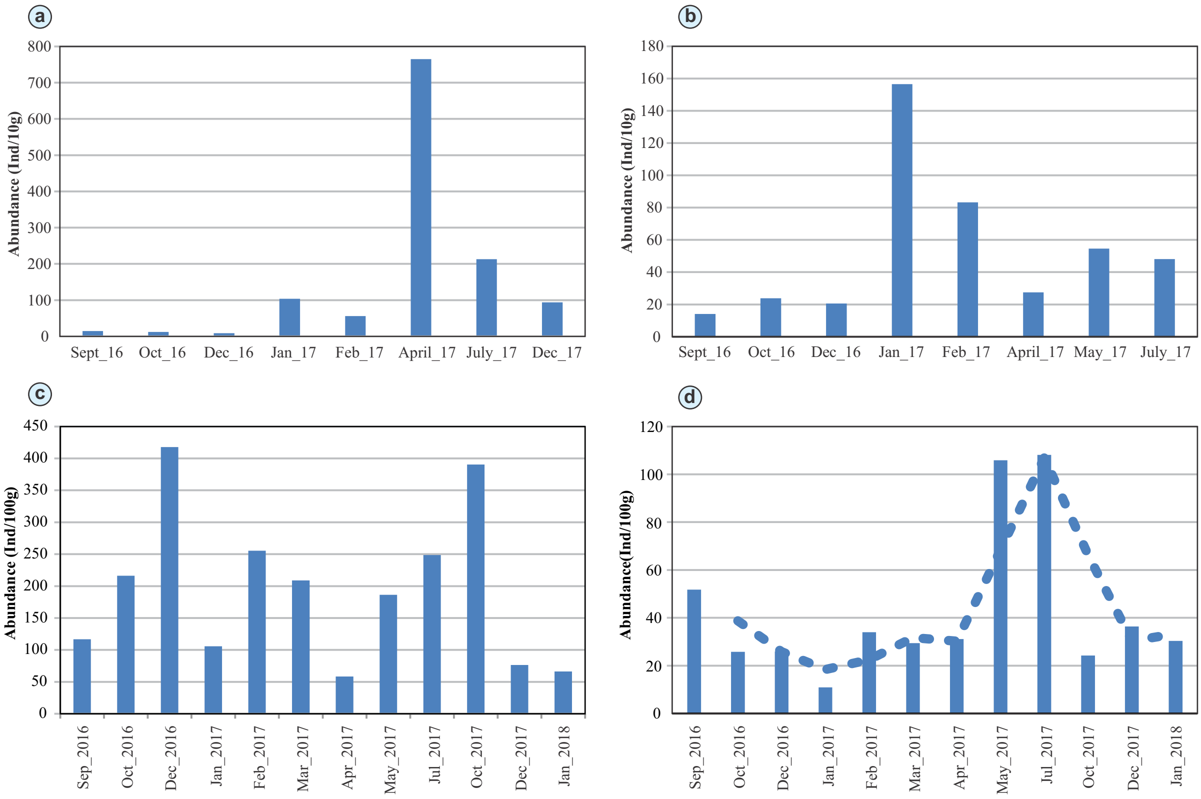
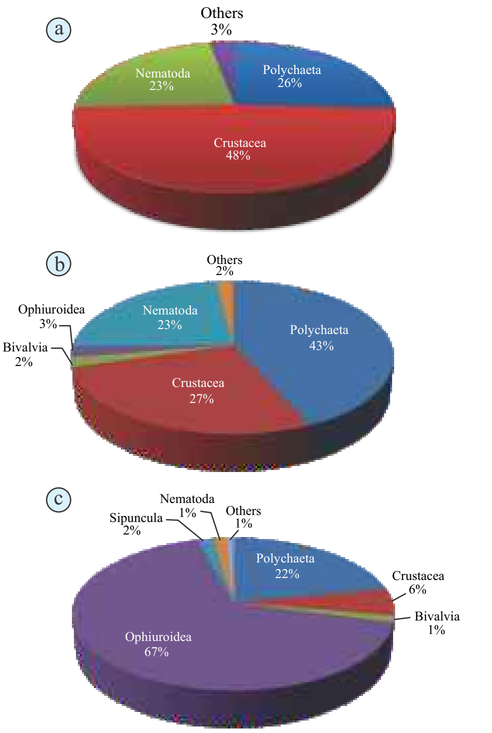


Figure 11 Macrofaunal abundance associated with (a) *Cinachyra cavernosa* from Anjuna Rocky shore, (b) *Cinachyra cavernosa* from Kunkeshwar rocky shore, (c) *Ircinia fusca* from Kunkeshwar rocky shore. (d) Abundance of Polychaetes associated with *Ircinia fusca* from Kunkeshwar.



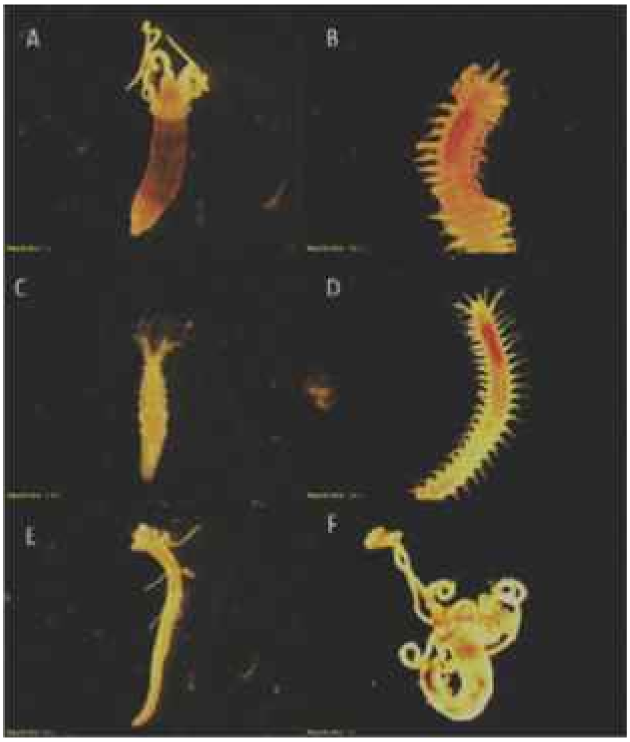


Figure 12 Percent composition (%) of fauna associated with (a) *Cinachyra cavernosa* from Anjuna Rocky shore, (b) *Cinachyra cavernosa* from Kunkeshwar and (c) *Ircinia fusca* from Kunkeshwar rocky shore.

Figure 13 Associated fauna of *Cinachyra cavernosa* A. *Cirriformia* sp.; B. Aphroditidae; C. *Amphiglena* sp.; D. *Syllis* sp.; E. *Cirratulus* sp.; F. *Terebella* sp. from the intertidal area.

Table 7. Monthly variation in macrofaunal abundance (ind/10g) associated with *Cinachyra cavernosa* from Kunkeshwar rocky shore.

Genus	Sep'16	Oct'16	Dec'16	Jan'17	Feb'17	Apr'17	May'17	Jul'17	Total	Mean	SD
Foraminifera	0	0	0	1	2	0	0	0	3	0	1
Polychaetes	0	0	0	40	33	0	0	0	73	9	17
Chaetopterus sp.	0	1	0	0	0	0	0	0	1	0	0
Platynereis sp.	0	0	0	0	0	0	0	1	1	0	0
Nereis sp.	0	0	0	0	0	0	0	0	1	0	0
Syllis sp.	3	7	4	23	10	8	17	10	83	10	7
Terebella sp.	0	0	1	0	0	0	0	0	2	0	1
Spiochaetopterus sp.	0	0	0	0	0	0	0	0	0	0	0
Spionidae	0	0	0	0	0	0	0	0	0	0	0
Nephtys sp.	0	1	0	0	0	0	0	0	1	0	0
Amphiglena sp.	0	0	0	1	2	0	0	0	3	0	1
Phyllodocidae	0	0	0	0	0	0	0	0	0	0	0
Aphroditidae	0	0	0	0	0	0	0	0	1	0	0
Cirratulus sp.	0	6	3	0	0	0	1	1	12	1	2
Cirriformia sp.	0	0	0	0	0	0	1	0	1	0	0
Eunice sp.	0	2	2	0	0	0	0	0	5	1	1
Marphysa sp.	0	0	0	0	0	0	0	0	0	0	0
Lysidice sp.	0	0	0	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	0	0	0
Amphipoda	1	1	1	2	1	0	0	0	6	1	1
Tanaidacea	0	0	1	3	1	2	10	0	17	2	3
Harpacticoid Copepoda	0	2	2	35	19	3	8	18	88	11	12
Ostracoda	0	0	0	3	0	0	0	0	3	0	1
Decapoda	0	0	0	0	0	0	0	0	0	0	0
Halacarida	0	0	0	0	0	0	0	0	0	0	0
Pycnogonida	0	0	0	0	1	0	0	0	1	0	0
Bivalvia	2	0	0	4	1	0	0	1	8	1	1
Musculus sp.	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0	0	0	1	0	0
Ophiuroidea	5	2	2	0	0	0	1	0	10	1	2
Nemertea larva	0	0	0	0	0	0	0	0	1	0	0
Nematoda	0	1	2	41	12	12	15	16	99	12	13
Sipuncula	0	1	2	1	0	0	0	0	5	1	1
Total	14	24	21	157	83	27	55	48	429	54	47

Table 8. Monthly variation in macrofaunal abundance (ind/100g) associated with Ircinia fusca from Kunkeshwar rocky shore.

Taxa	Sep'16	Oct'16	Dec'16	Jan'17	Feb'17	Mar'17	Apr'17	May'17	Jul'17	Oct'17	Dec'17	Jan'18	Mean	SD
Foraminifera	0	0	0	0	1	0	0	0	0	0	0	0	0.2	0.42
Polychaeta														
Terebellidae	8	1	0	0	4	0	0	1	0	0	3	2	1.7	2.44
Spionidae	0	1	0	0	4	2	0	37	14	0	0	3	5.1	10.65
Syllidae	12	8	21	8	20	26	20	43	70	19	22	16	23.7	17.25

Taxa	Sep'16	Oct'16	Dec'16	Jan'17	Feb'17	Mar'17	Apr'17	May'17	Jul'17	Oct'17	Dec'17	Jan'18	Mean	SD
Syllidae	12	8	21	8	20	26	20	43	70	19	22	16	23.7	17.25
Cirratulidae	5	10	1	2	1	0	0	7	7	1	1	5	3.6	3.31
Eunicidae	22	3	2	1	3	0	10	13	5	2	7	3	5.8	6.30
Nereidae	4	0	0	0	0	0	0	1	9	0	0	0	1.4	2.65
Amphinomidae	0	1	0	0	0	0	0	0	0	0	0	0	0.1	0.23
Aphroditidae	0	0	1	0	1	0	0	3	1	1	1	0	0.6	0.78
Phyllodocidae	0	0	0	0	0	0	0	1	1	0	0	0	0.1	0.27
Sabellidae	0	0	0	0	1	0	0	0	0	0	1	0	0.2	0.23
Hesionidae	0	0	0	0	0	0	0	0	0	0	1	0	0.1	0.27
Crustacea														
Isopoda	1	1	0	0	1	0	0	0	4	0	0	1	0.6	1.02
Amphipoda	22	0	5	0	2	0	1	1	11	5	1	0	3.9	6.49
Copepoda	0	0	0	6	0	0	0	1	0	0	0	0	0.6	1.71
Tanaidacea	0	2	7	0	3	4	1	3	1	6	2	0	2.4	2.28
Paguroidea	1	0	0	0	0	0	0	0	0	0	0	0	0.1	0.25
Decapoda larvae	3	0	0	0	0	0	0	0	0	0	0	0	0.2	0.81
Decapoda	6	1	1	0	0	0	2	0	5	1	1	0	1.5	1.94
Pycnogonida	0	0	0	0	26	0	0	0	0	0	0	0	2.2	7.49
Shrimp	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.12
Bivalve	1	1	1	0	4	0	5	1	7	1	11	1	2.7	3.32
Gastropoda	2	2	0	0	1	0	4	1	5	0	0	1	1.4	1.58
Ophiuroidea	23	181	364	80	175	169	11	65	106	341	19	31	130.4	120.74
Sipuncula	6	2	9	0	2	0	4	3	2	8	6	1	3.6	2.97
Nematoda	0	0	4	8	5	7	0	6	1	4	0	0	3.0	3.02
Total	116	215	418	105	255	209	58	186	248	390	76	66	195.2	120.08

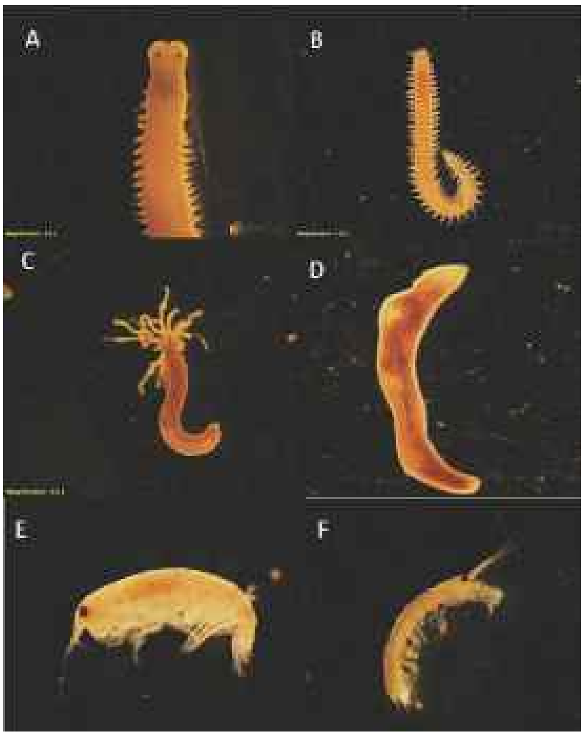


Figure 14 Associated fauna of *Cinachyra cavernosa* A. *Eunice* sp.; B. *Nereis* sp.; C. *Terebella* sp., D. *Sipuncula*; E. Amphipoda; F. Tanaidacea from intertidal area.

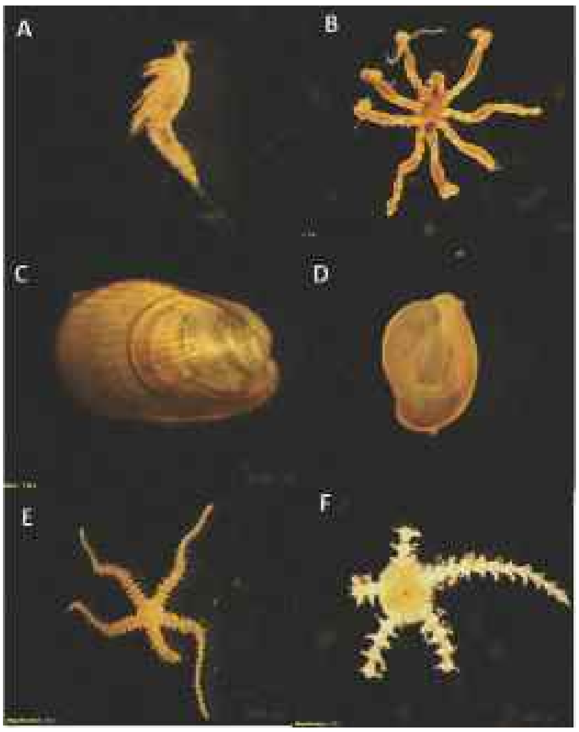


Figure 15 Associated fauna of *Cinachyra cavernosa* A. Harpacticoid copepoda; B. Pycnogonida; C. Bivalve; D. Foraminifera; E and F. Ophiuroidea from the intertidal area.

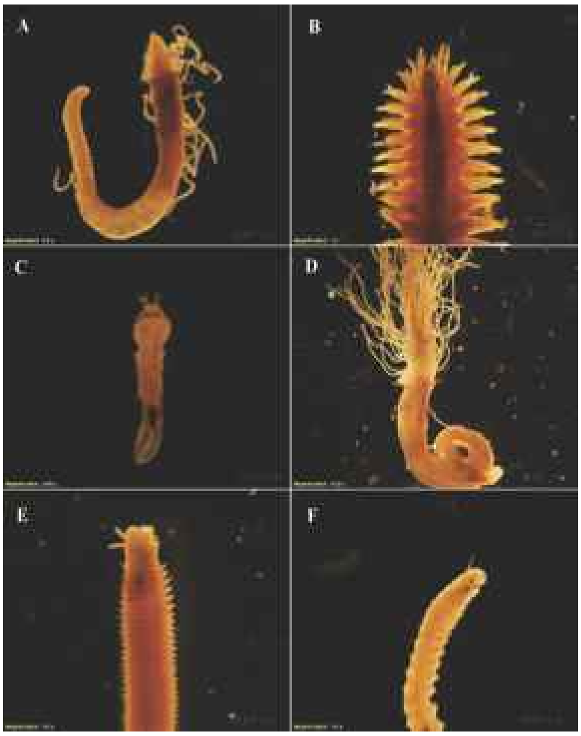


Figure 16 Associated fauna of *Ircinia fusca* .A. *Cirriformia* sp.; B. Aphroditidae; C. Sabellidae; D. *Terebella* sp.; E. *Eunice* sp.; F. *Lysidice* sp. from the intertidal area.

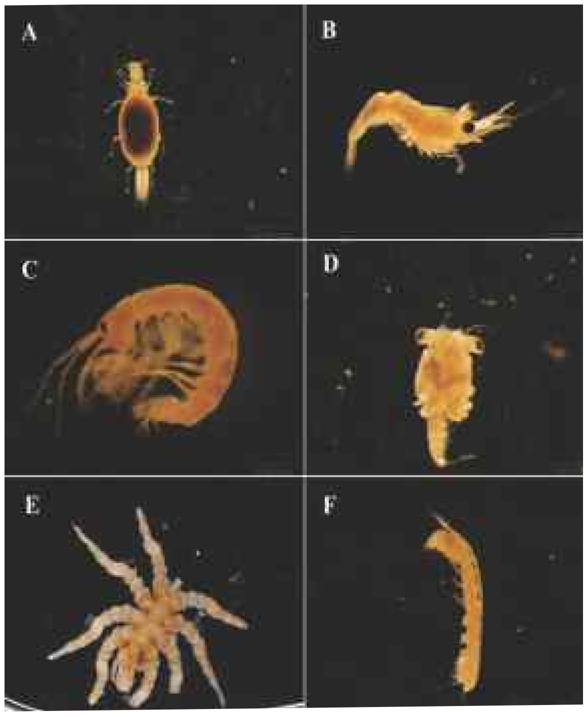


Figure 17 Associated fauna of *Ircinia fusca* .A. Isopoda; B. Shrimp; C. Amphipoda; D. Crustacea larva E. Pycnogonida; F. Tanaidacea from the intertidal area.

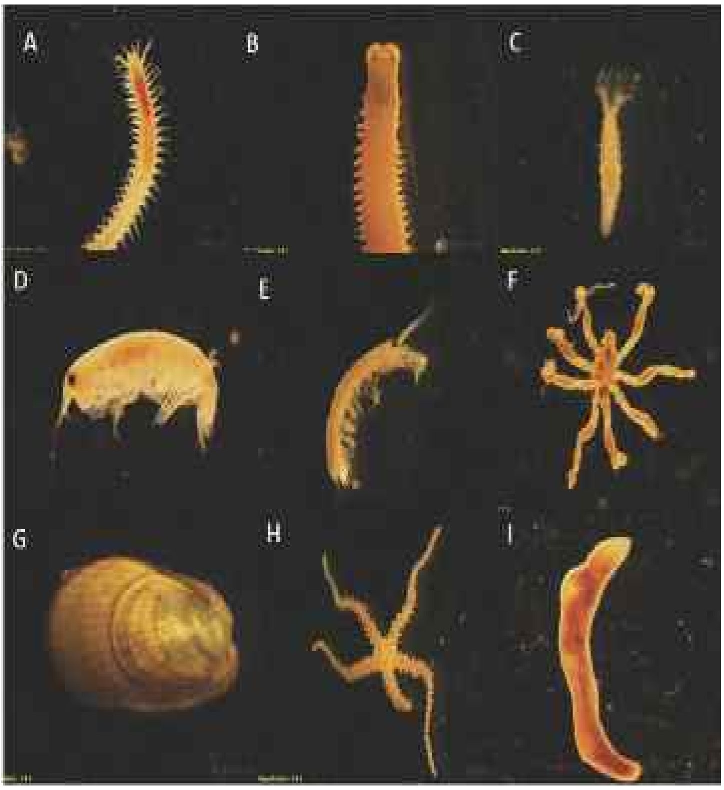


Figure 18 Sponge associated fauna from two different sponges. A. *Syllis* sp.; B. *Eunice* sp.; C. *Amphiglena* sp.; D. Amphipoda; E. Tanaidacea; F. Pycnogonida; G. Bivalvia; H. Ophiuroidea; I. Sipuncula from intertidal area.

The study of *Ircinia fusca* and *Cinachyra cavernosa* sponge associated fauna revealed that these two sponges are found common on the rocky shore along the west coast of India. In *Ircinia fusca* sponge, Brittle stars dominated the associated fauna followed by polychaetes. However, many studies have reported that Crustaceans as the single dominant taxa in most of the sponge species (Ribeiro et al .2003). Polychaetes were the next dominant taxa. Therefore, it can be assumed that most of the sponge species are dominated by single taxa, whereas in *Cinachyra cavernosa* sponge, the associated fauna were found to be less, mainly the Crustaceans. It may be because of the shape and size of the sponge.

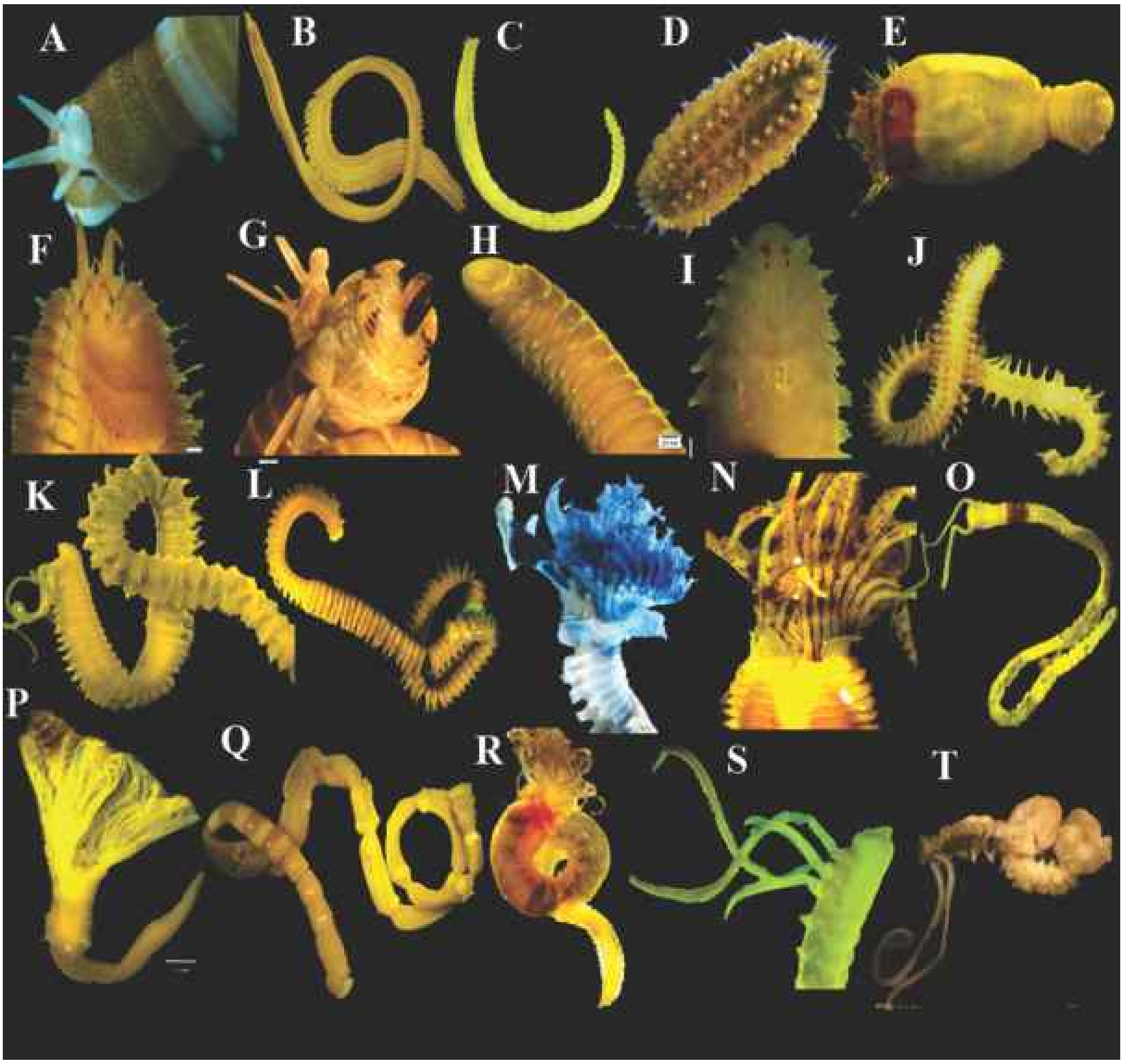


Figure 19 Commonly occurring polychaete species-A: *Lysidice* sp., B: *Eteone heteropoda*, C: *Haplosyllis* sp., D: *Thormora* sp., E: *Sternapsis suctata*, F: G: *Perinereis cultrifera*, H: *Lumbrineris funchalensis* I: *Pareurythoe borealis* J: *Ceratonereis japonica* K-L: *Scolelepis* sp., M: *Pomatoceros triqueter*, N: *Parasabellas axicola*, O: *Magelona cincta*, P: *Pomatostegus actinoceros* Q: *Euclymene* sp., R: *Terebella* sp., S: *Paraprionospio cordifolia*, T: *Spiochaetopterus* sp.

Summary of Project Findings

The *Cliona viridis* species complex is one of the most difficult species complexes within the Clionaida, causing confusion through history as well as in recent studies. As has been done for other groups, brown endolithic sponges have commonly been lumped under the same name per bioregion, but this group is particularly speciose. We described a new species from this complex as *C. thomasi*, whihc was recognized as among the "Ten remarkable new marine species from 2019" (Figure 20).

C. viridis complex species are as a rule among the most dominant and destructive macro-borers on coral reefs. Bioeroding sponges of the *C. viridis* complex are relatively tolerant to environmental deterioration and benefit from increased substrate availability after coral mortality.

The association of juveniles of *Ophiactis* sp. with *Ircinia fusca* indicates that the sponge is used as a breeding ground by the ophiuroid. Sponge provides abundant food through its internal current to the short –arm juveniles of the *Ophiactis* sp enhancing its survival. Therefore, sponges are important biogenic structures and it plays a vital role in maintaining the biodiversity of a region. Hence, it is concluded that most of the sponge species are dominated by a single taxa.

The study in Grande Island revealed a total of 25 species of hard corals and four species of soft corals were identified. *Porites* is the most dominating genera while there are no representatives from branching corals- Acroporidae family. Bleaching monitoring revealed a deteriorating reef impacted with seasonal bleaching and other stressors.

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Ten remarkable new marine species from 2019

Thomas' Coral-Eroding Sponge

[click on image for more information]

Contact:

- Christine Schönberg (christine.schonberg@uwa.edu.au), co-author of the new species

Image available at:

- https://www.marinespecies.org/aphia.php?p=image&tid=1324525&pic=141043

Cliona thomasi Mote, Schönberg, Samaai, Gupta & Ingole, 2019

https://www.marinespecies.org/aphia.php?p=taxdetails&id=1324525

This new species may at first appear to be simply a rather uninspiring brown sponge, but it has been selected as one of the top-ten new marine species of 2019 because it has an important story to tell; about taxonomy, about ecology, and about collaboration.

Sponges are often overlooked, and this one is prime example of this. The new species has been known for many years and is common and abundant in Indian Ocean coral reefs, but because the taxonomy of these sponges is complex and historically confused, it has remained unidentified or wrongly identified for a long time.

The new species is a bioeroding sponge and these fulfil many important functions in marine habitats. Apart from all the ecoservices any sponge provides, they rework calcareous hard substrate (such as corals), recycling materials and producing large amounts of fine sediments, while also creating small cavities that can be inhabited by other organisms. These bioeroding sponges invade and can kill live corals, and they therefore have an important ecological role on the local coral reefs. *Cliona thomasi* has an association with a dinoflagellate and this symbiosis plays a major role in the survival of the sponge as well as in its bioeroding capability.

It is thought that the species has significantly increased in abundance, a pattern that has been seen around the world. Experiments have shown that bioerosion rates will significantly rise in future, owing to environmental change, and should be closely monitored. New, quality descriptions for dominant bioeroders that provide quantitative data suitable for taxonomic comparison and that allow different stakeholders to recognise key characters are needed.

However, despite this species' ecological importance and the need for monitoring, surveyors were unable to identify it beyond 'morphotype'. Thanks to this comprehensive, collaborative, modern description, these problems are now solved; meaning monitoring and management agencies can now track trends relevant to the local habitat health, including trends in bioeroder ecology.

This new species description is also an excellent example of the importance of collaboration and training of new taxonomists. The paper was written jointly by sponge experts working closely with a PhD student, overcoming difficulties of access to samples and publication pressures.

Original source:

- Mote, S.; Schönberg, C.H.L.; Samaai, T.; Gupta, V.; Ingole, B. (2019). A new clionaid sponge infests live corals on the west coast of India (Porifera, Demospongiae, Clionaida). *Systematics and Biodiversity* 1-17. https://doi.org/10.1080/14772000.2018.1513430

Figure 20 New sponge species described in the study *Cliona thomasi* was selected among the "Ten remarkable new marine species from 2019".

With the rising temperatures and recurrent bleaching events, the corals are at an imminent threat of local extinction. Remote sensing-based technologies like the NOAA's Coral reef watch programme with predictive bleaching model provide us with tools to predict coral status well in advance. This provides a window period for reef managers and policy makers to plan for conservation and disaster management well in advance. With the rising temperatures, corals would bleach but the recovery depends on the environment provided post the thermal stress subsides. Therefore, it becomes highly eminent to provide the corals with the least anthropogenic disturbances during the recovery phase. This is where strict rules for reef tourism, fisheries and waste disposal around the reefs have to be implemented.

Despite being a hotspot of ecological and economic importance, scientific documentation of the coral reef biodiversity and mapping of the threats to marine life are yet to be complete in the MMS, which could assist for regulatory interventions from conservation point of view. Hence, habitat restoration and management practice should be focused to improve reef environment while limiting reef resource exploitation, which will help conserve the MMS area.

Implication and recommendation

In the year 2015 and 2016, we published two research papers based on our studies on the health of coral reefs in Malvan Marine Sanctuary. The data and information generated during the project assisted the policymakers and Maharashtra State Tourism Dept. to take initiatives and specific actions on the regularization of tourism and boat operations within the Malvan Marine Sanctuary. Therefore, regulations were formulated for controlling the anthropogenic stressors to conserve and protect the coral reef ecosystem in the coastal area.

Rising temperatures can lead to bleaching in corals; however, the recovery depends on the environment provided post the thermal stress subsides. Therefore, it becomes highly eminent to provide the corals with the least anthropogenic disturbances during the recovery phase. This is where strict rules for reef tourism, fisheries and waste disposal around the reefs have to be implemented.

We therefore provide following recommendations based on the findings of the current work.

- Present work suggests that there is imminent threat to the existence of fragile ecosystem at Malvan Marine Sanctuary and Grande Island, Goa due to various factors. More scientific studies and close monitoring is recommended for these habitats.
- Socio-environmental initiative should be of priority to save the coral habitat and inform the stakeholders about sustainable resource utility.
- Sponge encrusting corals is another threat looming over Indian coral reefs, its spread, causative factors and possible precursors should be identified by carrying out more extensive work on this subject.
- Strict rules for reef tourism, fisheries and waste disposal around the reefs have to be implemented.

Publications and presentations

Published papers

- Hussain A, Ingole B (2020) Massive coral bleaching in the patchy reef of Grande Island, along the eastern Arabian Sea during the 2015/16 global bleaching event. Reg Stud Marine Sci, 39: 101410.
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- De K, Venkataraman K, Ingole B (2019) The hard corals (Scleractinia) of India: a revised checklist. Indian J Geo-Marine Sci (accepted) (IF- 0.31).
- Nanajkar M, De M, Ingole B (2019) Coral reef restoration - A way forward to offset the coastal development impacts on Indian coral reefs. Marine Pollut Bull 149. https://doi.org/10.1016/j.marpolbul.2019.110504 IF: 4.049
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- De K, Venkataraman K, Ingole BS (2017) Current status and scope of coral reef research in India: A bioecological perspective. Indian J Geo-Marine Sci 46 04: 647-662. (IF- 0.316).
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- Hussain A, De K, Thomas L, Mote SG, Nagesh, R., & Ingole, B.S. (2016). Prevalence of skeletal tissue growth anomalies (STAs) in Scleractinian corals in Malvan Marine Sanctuary, Eastern Arabian Sea. Dis Aquat Organ 121: 79-83 (IF- 1.77)
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- Mote, S., Gupta, V., De, K., Damare, S., Nanajkar, M., Ingole, B. Prokaryotic diversity pattern associated with a newly defined coral-eroding sponge *Cliona thomasi*. Folia Microbiologica (in press). IF:1.73

Conference presentations

- Ingole, B. (2019) Diversity of sponge and associated biological communities around the Malvan Marine Sanctuary and Grande Island, Goa. In Book of abstracts, Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation organized by IISER, Pune, on 20th and 21st December 2019. p. 36.
- De, K., Mote, S., Nanajkar, M. & Ingole, B. (2019) Coral reef degradation in the Malvan Marine Sanctuary: Consequence of climate change and increasing human disturbances. In Book of abstracts, Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation organized by IISER, Pune, on 20th and 21st December 2019. p. 42.
- Mote, S., More, K., De, K., Nanajkar, M., Gupta, V. & Ingole, B. (2019) The holobioant approach to study sponge-coral interaction. In Book of abstracts, Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation organized by IISER, Pune, on 20th and 21st December 2019. p. 43.
- Pednekar, N., Tambre, G., Mote, S., Ingole, B. & Nanajkar, M. (2019) Marine sponge (Ircinia fusca) associated macrofauna from Kunkeshwar rocky shore, West Coast of India. In Book of abstracts, Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation organized by IISER, Pune, on 20th and 21st December 2019. p. 90.
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- Mote et al. 2016 "Ecological Effect of Multiple Stressors on Tropical Coral Reef" in 4th International Symposium on the Ocean in a High-CO2 World, 2016, Tasmania, Australia.
- Hussain et al. 2015, "Skeletal tissue anomalies (STAs) of Scleractinian corals: Consequence of increasing human disturbances?" IIOE organized by CSIR- NIO, Goa, India.
- Hussain et al. 2015 "Mass Bleaching of Porites in Grande Island, Eastern Arabian Sea- a consequence of Global Climate Change?" International Conference on Climate change & Sustainability, Mumbai, India.
- Mote et al. 2015, "Intrusion of coral encrusting sponge Cliona varians (Duchassaing & Michelotti, 1864) in Central west coast India" in International Conference on Climate Change & Sustainability, (IC3S), held at Thakur College Mumbai.India.
- Mote et al. 2015 Are boring sponges an increasing threat for coral growth in Malvan Marine Sanctuary? OSICON Organized by CSIR-National Institute of Oceanography, Goa, India

Outreach Activities

Workshop

The 'First Porifera Identification Workshop in India' was organized by the CSIR- National Institute of Oceanography (NIO) Dona Paula, Goa from 20th to 22nd November 2019. The main objectives of this workshop were to identify sponges morphologically, carry out histology on certain orders of sponges, sectioning and extraction of spicule along with learning measurement, assign sponges to at least Order or Genus level and to overall enhance the taxonomic skills on sponge identification. International sponge expert Dr. J. Hooper (Queensland Museum, Australia), Dr. T. Samaai and Ms Liesl Janson (Ministry of Environment, South Africa) were the key resource persons. The experts shared their knowledge with the participants that came from all around the country. A handbook of sponge identification guide entitled "Sponge taxonomy guidelines" has been published during the events.

Popular article

De, K., Mote, S. and Nanajkar, M. (2019) Malvanatil praval betanchi gatha ana vyatha (in Marathi). https://www.agrowon.com/agriculture-news-marathi-article-regarding-coral-conservation-21887

Kalyan De, Mote, S., Ingole.B, (2020). Multiple stressors impacting the corals on the Central West coast of India. Ocean Digest Quarterly Newsletter of the Ocean Society of India, 7 (2), 2-3.

Future Prospects

We want to continue the work on the ecological importance of sponges & Corals, to address the ecological questions, to understand their microbial associations and chemical properties. IISER Pune has all the expertise and facilities for microbial and chemical analysis. Thus, we would like to continue working with IISER to address the ecological questions. Collaborations with foreign scientists have resulted in confirming the identification of a new sponge and a polychaete species. Since there are many unidentified/undescribed species in our collection, we would like to continue with these collaborations. We would also like to continue monitoring of the coral reef health status at Malvan and Goa as well as update the inventory of biodiversity from these regions.

List of Researchers and Project Staff

- Dr Ingole B S (Rtd. Chief Scientist, CSIR-NIO)
- Dr. Mandar Nanajkar (Senior Scientist CSIR-NIO).
- Dr. Ravail Singh (Ex. scientist CSIR-NIO)
- Kalyan De (DST-INSPIRE fellow)
- Sambhaji Mote (CSIR-SRF)
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- Dr. Anita Mary George (DBT-RA)
- Neelam Pednekar (Project Assistant)
- Adreeja Chaterjee (Project Assistant)

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Report 1.4

Molecular systematics of sponges and associated microorganisms

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Background

Fossils indicate bacterial life existed in the oceans (3.7 billion years ago) long before than on land (3.1 billion years ago), but currently known marine species are only 16% of the named living species (Costello M et al 2017). Marine microorganisms are integral part of major biogeochemical cycles, fluxes and processes occurring in marine systems and are critically standing for the health of environment. The marine ecosystem is complex and has various organisms as niche which harbour these marine microbes, of which coral reefs harbor abundant microbial species, some by porifera, nematodes, and some arthropods. Sponges (Porifera) fossils record dating back to about 600 million years are found making it most ancient metazoan animal phylum. It includes 6000 taxonomically validated species, found preponderantly in deep sea, polar regions, tropical and subtropical oceans, and also in freshwater lakes and streams (Grozdanov et al. 2007). Sponges are constitutional part of major biogeochemical cycles, fluxes and processes occurring in coral reefs (Müller 2003; Webster and Thomas 2016). Sponges are considered important model systems for the study of high-diversity marine host–microorganism associations, and their evolution, as well as for enabling access to biotechnologically important symbiont-derived natural products (Hentschel et al 2012). Earlier only morphological characters were used to classify and distinguish different morphotypes of sponges, but recent development in DNA sequencing technologies have made it now possible to further distinguish this morphotypes to their species which are genetically different. DNA barcoding is a technique used to taxonomically identify the sponge species. DNA barcoding is shown to be very effective for molecular phylogenic studies, geographical distribution and conservation of marine biodiversity. Marine Barcode of Life (MarBOL), is an international campaign to barcode marine species. There are over 8500 sponge species in the World Porifera Database (Piel et al. 2004; Bucklin et al. 2011).

Sponges show high abundance of microorganisms which are known to be located mostly with the mesohyl matrix. Sponge microbial symbionts perform a wide range of functional roles, including vitamin synthesis, production of bioactive compounds and biochemical transformations of nutrients or waste products (Moitinho-Silva et al 2017). Sponges represent an evolutionarily divergent group of species with common physiological and ecological traits (Fan et al 2012). Generally sponge symbiont communities are highly specific to host species and are mostly consistent across time and space (Taylor et al 2007). Up to 60% of the tissue volume of certain sponge species consists of microbes with a density exceeding 109 microbial cells per ml of sponge tissue, orders of magnitude greater than that found in seawater or sediment. But only a small percentage 0.1-11% of the total bacterial community is culturable (Webster, 2001). Marine sponges are often found in symbiotic association with microorganisms, which can be very diverse and complex. Core sponge microbiomes are stable and characterized by generalist symbionts exhibiting amensal and/or commensal interactions (Thomas et al 2016). An unprecedented amount of information on the structural and functional diversity of microbial communities has been generated by high-throughput sequencing methods in recent years (Cleary et al 2019). Marine sponge associated prokaryotic communities have been reported to be diverse (Thomas et al 2016) and such sponges are able to sustain dense and diverse symbiotic communities comprising up to 35% of sponge biomass (Hentschel et al. 2012; Cleary et al 2019). Sponge-associated microbial communities based on 16S rRNA gene sequences can be used to address overarching hypotheses regarding host specificity, convergent evolution, environmental drivers of microbiome structure, and the sponge-associated rare biosphere (Hentschel et al. 2006; Naim et al. 2014). Bacterial association with the sponges have been studied with cultivatable and non-cultivable studies. But there are fewer studies regarding the association of archaea. Studies on sponge-archaeal association show communities with higher diversity of Crenarchaeota, which have been identified associated with pollution-tolerant sponge. These sponges show presence of archaeal amoA gene involved in nitrogen cycle within the sponge holobiont suggesting archaea are possibly involved in resistance to anthropogenic impacts (Karpushova et al 2005). Marine microorgansisms adapt themselves to the high concentration of NaCl and thus are mostly halotolerant or halophilic in nature. Halophilies are salt loving microorganisms inhabiting saline environments like sea water sponges, marshy environments, mangrove sediments, etc. The aerobic halophilic archaea of the order Halobacteriales, family Halobacteriaceae, are the halophiles par excellence. Novel characteristics of halophilic archaea and bacteria make them potential candidates for production of novel products like exopolysaccharides, carotenoids, poly-h-hydroxy-alkalonates etc. (Mata et al 2008). Amjres et al (2015) reported exopolysaccharide production by halophilic microorganisms isolated from saline environment.

Halophiles are the main component of the microbial biomass of environments such as the Dead Sea, hypersaline soda lakes and saltern crystallizer ponds (Rodriguez-Valera 1986). Several studies have examined the diversity of sponge-associated microbial communities by using cultivation-based approaches and 16S ribosomal DNA (rDNA) library. Haloarchaea have not yet been explored for their association with sponges (Amann et al. 1995).

In continuation of the different studies carried out across the globe, projects like Sponge Microbiome Project and the Earth Microbiome Project where a total of 3569 sponge specimens were collected for metagenomic study to deduce the sponge microbiome association around the globe, made a supreme effort to explicate the geographical as well as host phylogeny implications on the microbiome composition of sponges (Moitinho-Silva et al 2017). But unfortunately India was not part of Sponge microbiome project. There is only a single report from India (southeast coast) which explored the uncultured bacterial diversity using 16S rRNA amplicon sequencing of two cohabiting sponges, viz. *Cinachyra cavernosa* and *Haliclona pigmentifera*, of which the phylogenetic analysis shows the core bacteria has close affinity to other sponge-associated bacteria from different geographical locations (Jasmin, et al. 2015). Microbial composition of Indian intertidal sponges is yet to be explored and it can give a significant insight into geographically driven sponge microbe association. West coast runs along the Western Ghats which is significant reservoir of biodiversity. This may have some important meaningful ecological impacts on the residing life forms and hence if we study the microbial composition of marine sponges it can give a better picture of environment and ecosystem driven microbial composition and their potential role in sponge ecology. Isolated and identified bacterial cultures can help us in knowing the cultureable diversity of the samples, while barcoding will help in knowing the sponges present across the cost of Maharashtra. Host-associated microbial diversity study is performed to decipher their community compositions and justify their ecological role in terms of their function and their interactions with other living entity in the host ecosystem. Sponges, despite their simplicity, offer us to examine its enormous symbiotic complexity. There are numerous studies already performed to illustrate the microbial association with these simple living forms. The present study is the first attempt to characterize the microbial diversity associated with the Intertidal Marine sponges of the west coast of India.

Objectives

- An inventory of species of sponges in the intertidal zones and up to a depth of 20 meters in 4 selected locations along the Maharashtra coast line
- Classical as well as molecular taxonomy of sponges, tunicates and soft coral species along the Maharashtra coast
- Outlining strategies for in situ conservation of species
- Exploring means of ex situ conservation and gene bank through cryopreservation and any other appropriate strategy
- Isolation and identification of microbial associates of sponges using cultural and molecular approaches
- Screening of sponges, tunicates, soft corals and other invertebrates and the associated micro-organisms for bioactive compounds using a battery of assay systems
- Isolation and characterization of active compounds
- Taking necessary steps towards commercialization of compounds of potential interest.
- Discerning the implications of geography and phylogeny on sponge-associated microbes; and, it has also surfaced few notable significant observations exclusively associated with the sponges found in west coast of India

Methodology

Survey

In the first year (2014) survey was done along the west coast of Maharashtra (Konkan region) for selection of sponge habitat sites along with other institutes (CoF Ratnagiri, IISER Pune and NIO Goa) for the presence or absence of sponges and associated flora and fauna. Based on the satellite images obtained from Goggle earth, coastal areas having rocky patches were short-listed, as the major focus of the study was on intertidal sponges. Thirty sites across the western coast of Maharashtra and Goa were surveyed revealing the bare rock as the most common substrate for sponges in small pools. In the initial years (2015-2017) we were associated with other institutes for the sponge samples. In the fourth (2018) and fifth (2019) year we did our own sampling. After the survey based on factors such as sponge availability and accessibility, three sites were selected for this study, viz. Shekhadi [N18° 6' 56.93", E72° 58' 37.75"], Anjarle [N17° 51' 37.397", E73° 4' 52.215"], Harnai [N17° 48' 29.092", E73° 6' 10.388"] and Kunkeshwar[N16° 20' 01", E73° 23' 26"] forming a

Figure 1 Sampling locations

part of the Konkan coast (coast of submergence). Sampling was done during Pre monsoon (May) and Post monsoon (January) as the sponge availability during these seasons was high. Sampling was done during low tide generally upto 0.5 meter as intertidal zone was accessible at this period and sponge sampling would be possible.

Sampling of Sponges

A total (2014-2019) of 78 samples were collected (Sponge, n=26; water, n=26 and sediment, n=26). In the year 2018 sampling was done in the month of January and 15 samples were collected: Sponge n=5(1-Kunkeshwar, 2-Harnai, 2-Anjarle); similarly 5 water and 5 sediment samples were collected. Similar method was used to collect 15 samples in the month of May 2018 as well. We further collected similar samples in the year 2019, February and May. The purpose of collecting samples in January, February and May was to study the seasonal variation in microbial association with Sponges. The water samples were collected in sterile (gamma-irradiated) containers and transported to the laboratory at 4 ºC. Further, the collected water samples were filtered through 0.22µ filters (Merck Millipore, USA) and stored at -80° C for further analysis. Physicochemical parameters (Table 1) such as pH, temperature, dissolved oxygen (DO), and salinity was measured at the time of sampling. Sponge specimens were collected from the pools on the rocky beaches during the low tide levels (Tide levels: Anjarle- 0.25m, Harnai- 0.3m, Shekhadi- 0.28m, Kunkeshwar- 0.26m). Two sponge specimens and subsequently the surrounding sea-water and sediment samples were collected from different pools of each location. Further, sponge tissues were stored in absolute alcohol; transported immediately in dry Ice. Further storage was done at -80 ºC.

Sample processing and DNA extraction

The sponge specimens were gently rinsed thrice with sterile distilled water to wash out the loosely attached sediments and other particles. Each sponge was then sectioned into three tissue pieces (150mg to 200mg) using a sterile scalpel to maximize the throughput of DNA from individual sponges. The community DNA was extracted from each water, sediment, and sponge sample using DNeasy Blood & Tissue Kit or QIAmp DNA Stool Mini kit (Qiagen, Madison USA) as per the manufacturer's protocol with some variation. Sponge sections were cut into small piece and placed in a 1.5 ml microcentrifuge tube and 200 µl Buffer ATL was added along with glass beads to macerate the tissue and vortexing in between for one hour. The supernatant was transferred to another 1.5 ml microcentrifuge tube and 20 µl proteinase K was added. It was mixed thoroughly by vortexing, and incubated at 56°C until the tissue is

Table 1 Physicochemical parameters of water samples

Parameters	Harnai	Anjarle	Shekhadi
Dissolved Oxygen (DO)	6.4mg/L	4.8mg/L	6.0mg/L
pH	8.5	8.5	8.0
Salinity	35.1	35.2	35.0
Temperature	26	27	28

completely lysed. After lysis vortex for 15 s, add 200 µl Buffer AL to the sample, and mix thoroughly by vortexing. Then add 200 µl ethanol (96–100%), and mix again thoroughly by vortexing. Pipet this mixture from step into the DNeasy Mini spin column placed in a 2 ml collection tube. Centrifuge at ≥6000 x g (8000 rpm) for 2 min. Discard flow-through and collection tube. Place the DNeasy Mini spin column in a new 2 ml collection tube (provided), add 500 µl Buffer AW1, and centrifuge for 3 min at ≥6000 x g (8000 rpm). Place the DNeasy Mini spin column in a new 2 ml collection tube, add 500 µl Buffer AW2, and centrifuge for 5 min at 20,000 x g (14,000 rpm) to dry the DNeasy membrane. Discard flow-through and collection tube and give another empty spin, centrifugation for 1 min at 20,000 x g (14,000rpm). Air dry the column overnight. Then place the DNeasy Mini spin column in a clean 1.5 ml or 2 ml microcentrifuge tube, and pipet 50 µl Buffer AE directly onto the DNeasy membrane. Incubate at room temperature for 15 min, and then centrifuge for 2 min at ≥ 6000 x g (8000 rpm) to elute the DNA. The extracted DNA samples were quantified using NanoDrop spectrophotometer ND1000 (Thermo Scientific, USA). The extracted DNA was stored at -20ºC until further processing. For DNA extraction from sediment and water samples same protocol was used. For the extraction of DNA from sediments, the sample was weighed and used, but for the water samples that were filtered using 0.22µ filters these filters were used as starting material to extract the DNA.

Sponge Identification

A total of 78 samples were collected (Sponge, n=26; water, n=26 and sediment, n=26). The sponge specimens were gently rinsed thrice with sterile distilled water to wash out the loosely attached sediments and other particles. To identify the sponges we used a integrative method which uses traditional taxonomy methods along with molecular barcoding.

Spicule identification

Spicules are majorly involved in maintaining skeletal framework within the sponge. They can be silicate or calcitic, indicating division between the classes Demospongiae and Calcarea. Spicule sizes are essential criteria in defining species, in some cases providing the only easy clues to distinguishing related species. We further used spicule extraction for identification of sponge using the following protocol. Take a thinly cut section of each sponge (including both ectosome and choanosomal regions) and place in a durham tube (micro-test tube). Using a clothes peg or similar device to hold the tube add a drop of concentrated nitric acid to the tube. Wait for the vigorous reaction to finish and add another drop of acid. Repeat this step several more times, using drop-by-drop addition so as to control the reaction and production of oxide byproducts. After the acid digestion process appears to be complete, add enough nitric acid to nearly fill the tube. Directing the tube away from the face gently heat it over low heat (e.g. an alcohol flame), ensuring that only small bubbles form but not boiling rapidly. Maintain low boiling for 1-2 minutes and let stand until cool. Centrifuge (4000 rpm for 30 seconds is adequate) and pipette off nitric acid leaving the spicule mass at the bottom of the tube undisturbed. Refill the tube with fresh nitric acid and resuspend the spicules using clean, fine, glass rod. Repeat these steps. Then fill the tube with firstly demineralised water, 70% ethanol, then two series of 100% ethanol solutions, resuspending spicules, centrifuging and decanting the supernatant between each change of solution, finally ending with suspended spicules in a solution of absolute ethanol. Adhere a micro-cover glass onto an SEM stub using double-sided tape or copper dag; place stub in stub holder. Pipette a couple of drops of spicule solution onto the cover glass, ignite and spread out spicule solution with a glass rod or forceps until all ethanol is vaporized. Monitor the distribution of spicules on the cover glass under compound or dissecting microscope (magnification depending on spicule size). If the number of spicules is enough visualize on SEM, sputter coat stub, and view at 25kV, minimum working distance and smallest apperture for best resolution (Hooper et al. 2004).

Molecular barcoding

Each sponge was sectioned into three tissue pieces (150mg to 200mg) using a sterile scalpel to maximize the throughput of DNA from individual sponges. The sponge identification was performed by amplification of ~640bp long standard barcoding fragment located at the 5'site of mitochondrial cytochrome oxidase subunit-1(CO1) a universal marker for species identification in animals. COI gene is used in DNA barcoding due to its pattern of variation at DNA level which shows higher enough mutation rate to distinguish closely related species where as its sequence is conserved between conspecifics. The amplified product were purifed using PEG-NaCl. The sequencing of the amplified COI gene was done using Sanger Sequencer, further the obtained sequence was trimmed and corrected using ChromasPro and SeqScanner software. Following the Sanger sequencing, the query sequences were referred to BOLD Database for their identification. Further, phylogenetic analysis was carried out to examine the evolutionary relatedness. Phylogenetic analyses were done using the software package MEGA 7.0.26. Alignments of the sequences were carried out using ClustalW. The models with the lowest BIC scores (Bayesian Information Criterion) was considered and the tree was constructed by employing Tamura 3-parameter (T92+G). For better tree topology, clustering was performed using two different methods: neighbour-joining (NJ), maximum-likelihood (ML) with 1000 replications of Bootstrap value.

Table 2 Primers used for sponge barcoding

Sr. No.	Primer set	Primer Sequence
1	dgLCO	5'-GGTCAACAAATCATAAAGAYATYGG-3'
	dgHCO	5'-TAAACTTCAGGGTGACCAAAR AAYCA-3'
2	CO1porR1	5'-AANTGNTGNGGRAARAANG-3'
	CO1porF1	5'-CCNCANTTNKCNGMNAAAAAACA-3'
3	C1Npor	5'-TCTAGGTAATCCAGCTAAACC-3'
	C1J	5'-GAAGTTTATATTTTAATTTTACCNGG-3'
4	COX1-D2	5'-TGTTGRGGGAAAAARGTTAAATT-3'
	COX1-R1	5'-AATACTGCTTTTTTTGATCCTGCCGG-3'
5	LCO	5'-GGTCAACAAATCATAAAGATATTGG-3'
		5'-TAAACTTCAGGGTGACCAAAAAATCA-3'
6	HCO219	5'-GGTACWGCAATWATCATNGTWGC-3'
	COX1F2	5'-GGTACSGCAATSATCATNGTSGC-3'
7	16SH	5'-CCGGTCTGAACTCAGATCATGT-3'
	16SL	5'-CGCCTGTTTATCAAAAACAT-3'
8	M13FLCO	5'-GTAAAACGACGGCCAG-3'
	M13FHCO	5'-CAGGAAACAGCTATGAC-3'

Amplicon Sequencing of Bacterial 16S rRNA Gene

DNA extracted from all the samples was subjected to the amplification of V4 region of DNA to determine the bacterial community structure using primers 515F and 806R. The amplified products were further used for library preparation and sequencing on the Illumina MISeq.2000 platform as per the manufacturer's instructions (Illumina technologies, USA). Sequencing was performed using V4 paired-end sequencing (2 × 250 bp) chemistry. The paired-end reads obtained were assembled using FLASH assembler tool (Magoč and Salzberg 2011).

Community structure analysis and statistics

The assembled reads were used for community structure analysis using QIIME pipeline (Caporaso et al. 2010; Caporaso et al. 2012). The raw sequencing data plus metadata describing the samples are combined to de-multiplex the barcoded reads from the various samples, and to perform quality filtering. The sequences are grouped onto OTUs (Operational Taxonomic Units) at a user-defined level of sequence similarity (e.g. 97% to approximate species-level phylotypes). This step can be performed either using a reference database of OTU representatives (e.g. with BLAST), or purely based on sequence similarity (e.g. using uclust, cdhit, or MOTHUR). Once the OTUs are picked and the representative sequences chosen, taxonomy is assigned, the sequences are aligned, and phylogenetic trees are built. At this stage, a table showing the counts of each OTU in each sample is also produced. The OTU tables are used to perform alpha and beta diversity calculations (alpha diversity refers to the diversity within each sample, and beta diversity refers to patterns of similarity and difference among samples). Finally, the alpha and beta diversity measurements are combined with metadata about each sample to produce visualizations to be interpreted. The OTU picking was carried out using UCLUST closed reference method (Edgar 2010) with 97% similarity threshold, and the representative OTUs were assigned taxonomy using RDP classifier method (Wang et al. 2007) with SILVA database (Quast et al. 2012). Alpha diversity estimation such as OTU richness, Shannon, and Chao1 was calculated using QIIME V1.8. The beta diversity analysis was performed using Bray-Curtis distance matrices. Further, STAMP (Parks et al. 2014) was used to carry out statistical analysis of taxonomic profiles and GraphPad Prism was used for analysing and plotting graphs. A rarefaction step in QIIME was carried out to normalize data. Bar graph analysis was carried out using the non-parametric Mann-Whitney test and Krushkal Wallis test in GraphPad prism for evaluating significant differences in abundances of specific genera between two groups and more than two groups respectively. The Venn diagram was plotted using venny (Oliveros 2007).

Haloarchael diversity associated with sponges

Fresh sponge samples were collected in 50 ml falcon tubes containing sterile Sehgal and Gibbons medium (SG) having 20% NaCl concentration. All the samples were stored at 4°C until further processing. For the isolation of halophilic/halotolerant bacterial and archaeal community associated with the sponges, a direct inoculation method was used. In brief, the individual sponge samples were washed three times with double distilled water to remove un-associated microbial flora from the sponge body. Further, these samples were directly inoculated on SG medium plates containing 20% of NaCl concentration. The plates were incubated for one week at 37˚C, and the microbial growth surrounding the sponge was noted. The representative of each colony morphotype was streaked by sterile toothpick on SG medium with 20% NaCl agar plates until pure cultures were obtained. In order to study the salt tolerant properties of isolated cultures; the specific growth for each strain was observed on SG medium having different concentrations of NaCl. For this, the isolates were streaked onto the SG medium with a different concentration range of NaCl (0-32%); and were incubated at 37˚C at 24-48 hours. The growth was observed on the streaked plates and results were noted down for each isolate in terms of presence and absence of growth for each concentration of NaCl. The identification of isolates was done using MALDI and 16S rRNA gene sequencing, for which we have used the combination of four universal 16S rRNA gene PCR primers(8F, 27F: Bacterial, 21F: archaeal, 1492R: bacterial/archaeal) for getting positive amplification of bacterial and archaeal 16S rRNA gene. The gene was amplified using PCR and the futher the amplified product was sequenced using Sanger sequencing. To study the phylogenetic relationship between the isolated cultures, we have constructed the phylogenetic tree using MEGA version 7.0.26 (Kumar et al. 2008) at the bootstrap value 1000. In brief, first, the multiple sequence alignment was done by CLUSTAL W programme. The best nucleotide substitution model was optimized, and based on this Tamura-Nei G+ model was used for calculating evolutionary distances. The final tree was constructed by Neighbor-Joining method and further analysed in MEGA version 7.0.26.

Microbial identification and preservation

NCMR-NCCS has also contributed in identification of the bacteria isolated from sponges by IISER Pune and further accessioning and depositing the culture in general microbial depository at NCMR-NCCS Pune. The samples received from IISER Pune were subjected to identification by MALDI or 16S rRNA gene sequencing. For MALDI, formic acid extraction method was used for protein extraction. Bacterial cells are suspended in 300 µl distilled water and mixed thoroughly by vortexing to form a homogenized mixture. 900 µl ethanol is added to this mixture and centrifuged at 10000rpm for 2 min. Decant the supernatant and centrifuge then remove all the ethanol and let the pellet air dry for 10 min. Add 70% formic acid 80 µl to pellet and mix thoroughly. Add pure acetonitrile 80 µl and mix and then centrifuge at 10000rmp for 2min. Pipette 1µl of this supernatant on the MALDI target plate allow it to dry and then add 1µl α-Cyano-4-hydroxycinnamic acid (matrix) and allow it to dry before sujecting the plate to MALDI.

For identification using 16S rRNA gene the bacterial samples were first subjected to DNA extraction. 200 µl lysis buffer was added to cell mass and vortexed to homogenize the mixture, further incubate it at 70°C for 30min. Add 600 µl absolute ethanol and vortex , centrifuge for 6 min at 10,000rpm . repeat the ethanol washing step 3 times. Discard the supenatant and dry the pellet overnight. Elute the DNA in elution buffer 50 µl incubate for 15min and then centrifuge at 10,000rpm for 3 min. Use the supernatant for PCR amplification of the 16S rRNA gene and then the amplified product was subjected to purification by Polyethelyeneglycol- NaCl and then to Sanger sequencing using 518R, 946F, 704F and 1028R primers. The classical chain-termination method requires a single-stranded DNA template, a DNA primer, DNA polymerase, radioactively or fluorescently labeled nucleotides and modified nucleotides that terminate DNA strand elongation. The DNA sample was divided into four separate sequencing reactions, containing all four of the stranded deoxynucleotides (dATP, dTTP, dGTP, dCTP) and the DNA polymerase. To each reaction only one of the four dideoxynucleotides (ddATP, ddTTP, ddGTP, ddCTP) were added, which are chain terminating nucleotides lacking a 3' hydroxy group required for formation of the phosphodiester bond between two nucleotides, thus terminating DNA strand extension and resulting in various DNA fragments of varying length (Davis et al.2009). Purified ~1.5 kb products were directly sequenced using 518R and 907 R primers by ABI PRISM Big Dye Terminator v3.1 Cycle Sequencing kit on a 3730xl Genetic Analyzer (Applied BioSystems). Further the obtained sequence was trimmed and corrected using ChromasPro and SeqScanner software. Following the Sanger sequencing, the query sequences were referred to 16S rRNA gene databases (NCBI and Eztaxon) by BLASTn. Results in terms of Query sequence length, closest hit and similarity(%) was recorded.for their identification. Further, phylogenetic analysis was carried out to examine the evolutionary relatedness.

Phylogenetic analyses were done using the software package MEGA 7.0.26. Alignments of the sequences were carried out using ClustalW. The models with the lowest BIC scores (Bayesian Information Criterion) was considered and the tree was constructed by employing Tamura 3-parameter (T92+G). For better tree topology, clustering was performed using two different methods: neighbour-joining (NJ), maximum-likelihood (ML) with 1000 replications of Bootstrap value.

Survey Observation

The site surveyed along the western coast of Maharashtra showed notable diversity of invertebrates. Diversity of sponges along the western coast is poorly studied though it is abundant. Each group choose different sites in order to cover as many sites as possible. Sponges were observed at Shekhadi, Anjarle, Harnai and Kunkeshwar (Fig. 2). The diversity in sponges along with size and abundance was subjected to seasonal variation. In Pre- monsoon season (May) we could observe highly abundant sponge colonies, we could see entire rocky pool covered in sponge colonies. But during this season the other diversity such as sea weed, urchins, sea cucumber were comparatively low. During the Post monsoon season (January) the sponge abundance was comparatively low, which can be due to loss of sponges during the monsoon season and also the new sponge colonies have started to grow in winters and till the summer season the colonies are fully grown and dominating the habitat. Also during the post monsoon season we would see the diversity associated with sponges and nearby surrounding was quite diverse including barnacles, limpets, marine algae, fishes in rocky pool, crabs, nematodes and gastropods, bivalves, sea cucumber, and sea anemone. We could hardly find sponge colonies during the post monsoon season. The diversity was higher at Kunkeshwar as compared to Harnai and Anjarle. Kunkeshwar had higher degree of anthrapogenic activity near the sampling site due the presence of Temple on the beach. Harnai also had anthropological disturbance followed by Shekhadi contamination through tourist and fishing activities, Harnai also is an active port for fishing. Anjarle is famous for its turtle festival so the beach is also conserved by the locals but there some tourist activities and also locals can be seen near the sampling site for harvesting barnacles.

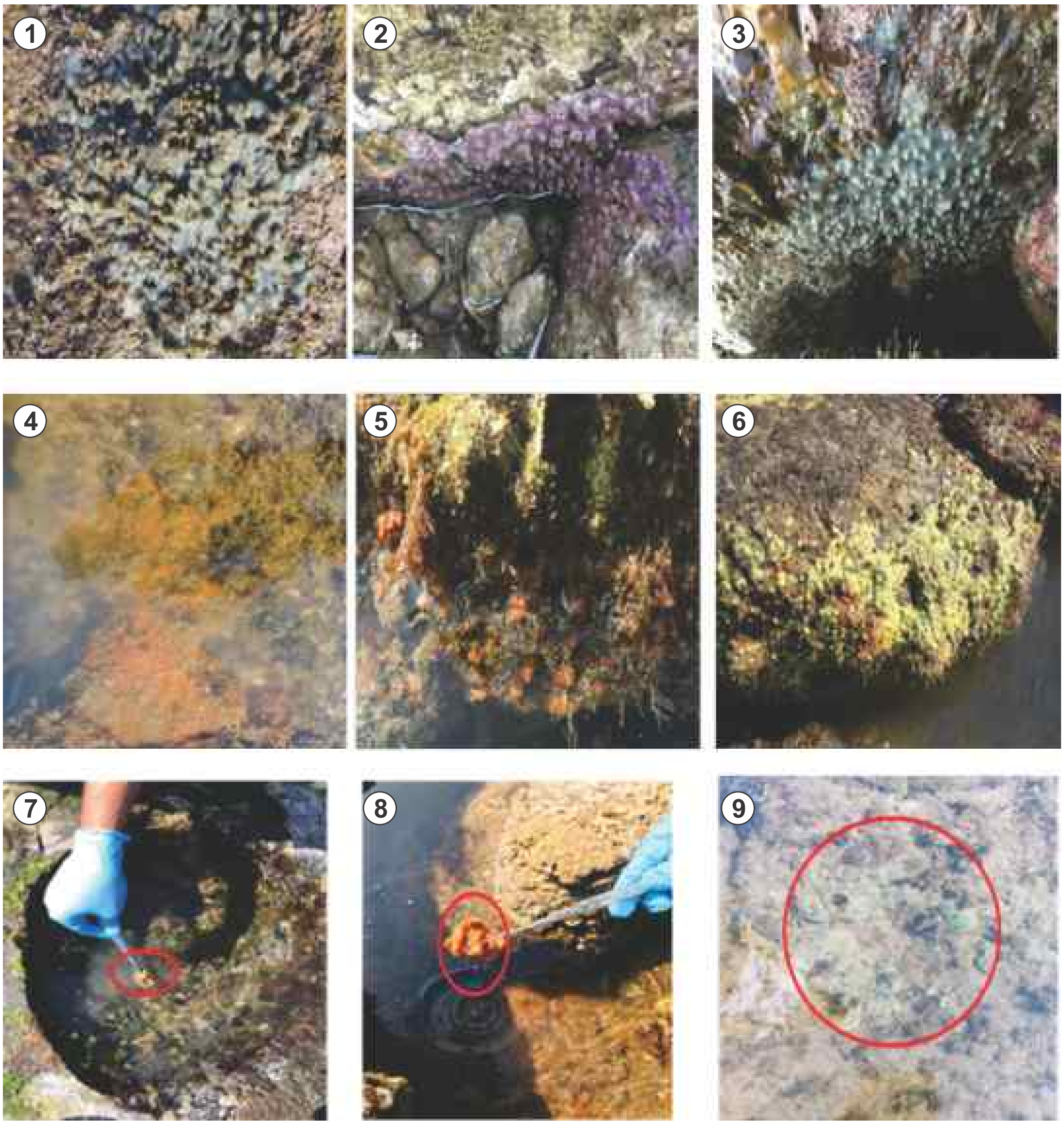

Figure 2 Sponge diversity at western coast of Maharashtra (1-3) Shekhadi, (4) Anjarle (5,6) Harnai, (7) Kunkeshwar, (8)Sample taken at Anjarle, (9) green sponge at Harnai and Anjarle.

Sponge Identification

As the Western coast of Maharashtra is poorly explored for its sponge identification, we took this as a challenge to identify the sponges using integrative method which uses traditional taxonomy methods along with molecular barcoding. A total of 31 sponge samples have been molecularly identified which belong to 11 different genera using molecular barcoding. We also helped COF ratnagiri with sponge molecular identification.

Spicule Extraction

Spicule is mainly composed of concentric layers of hydrated amorphous silicon dioxide. Diverse forms of spicules are important evidence of sponge taxonomic identification. There are different kinds of spicules all of which have particular constant diameter, and large number of components. Larger spicules, called megascleres, contribute to the skeletal framework within the sponge which range in size from 60-2000µm whereas smaller ones, microscleres, are packed between tracts of megascleres, scattered throughtout the tissue supporting the soft parts, the size rangeing from 10-60µm. As molecular identification of sponges is hard and gives only 20-30% positive results, spicule extraction is easy and can be essential criteria in defining species, in some examples providing the only easy clues to distinguishing related species, whereas absolute spicule dimensions are less important at higher taxonomic levels. We were able to extract only megascleres from sponges of two family Tedaniidae and Suberitidae. Family Tedaniidae showed presence of acantostyles with spined head as seen in Figure 3b

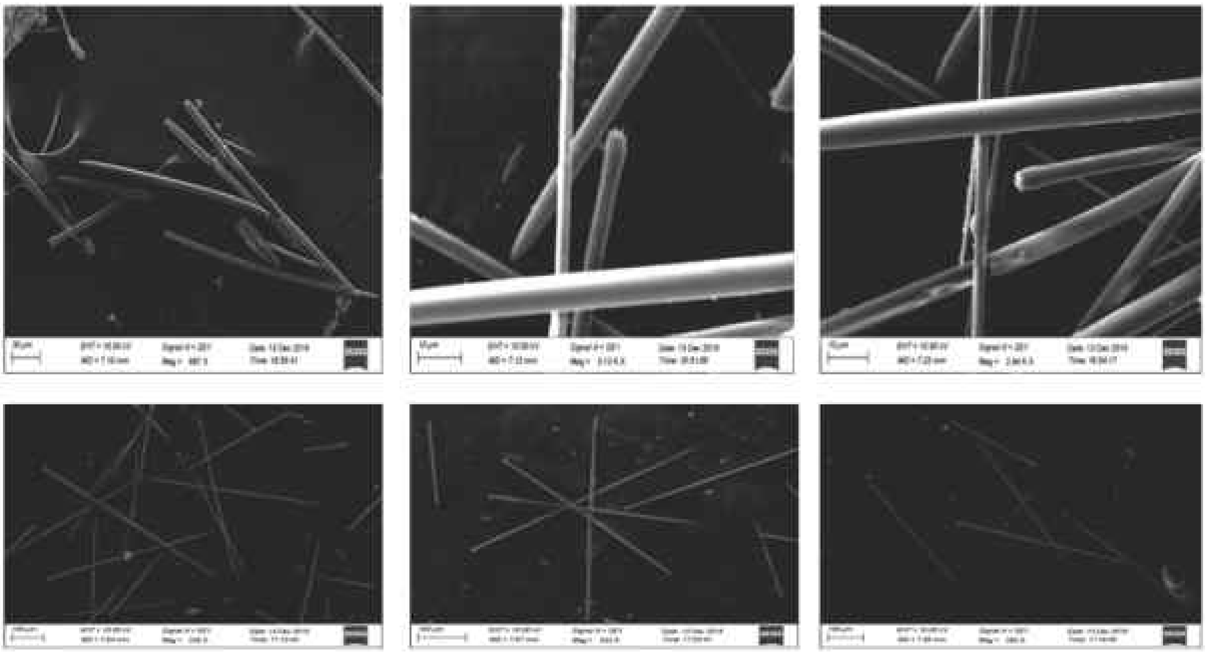

Figure 3 a-c megascleres of family Tedannidae, d-f megascleres of family Subertidae.

and c and also slight tyloste. Whereas spicules from family Suberitidae showed megascleres of type tylostyle, with tapering shaft and spheroid basal swelling as seen in Figure 3 d-f.

Molecular barcoding

Western coast of Maharashtra has ample amount of sponge diversity but there are few efforts taken to identify these sponges. We were able to identify 31 sponges using different primers variation of COI primers. Other sponges could not be identified as in some sponges extracting the DNA from tissue is tedious where as in some case since the databases are poor due to lack of data in the database it is difficult to identify the sponges even after the sequences are generated. Though we could sequence many of the sponges, barcoding for most of the samples did not work out due to limitations in lack of work done in the field in India.

The sponges AO1A and HO1A were found to be identical with *Tedania klausi* with the bootstrap value of 95 with zero nucleotide polymorphism. No branch length was observed for SO12A, SO1A, AO12A and HO12A, suggesting that all the 4 sponges are identical and can be considered as a single OTU (OTU 1 in Fig 4). This OTU was closely related to *Callyspongia fallax* at a good bootstrap support of 98. However, the branch length difference, as well as significant nucleotide diversity of 0.00577 was observed between *Callyspongia fallax* and the OTU 1, strongly suggested that the identified sponges could probably form a new novel taxon. Furthermore, G12A was closely related to *Cliona viridis* at a maximum bootstrap value; however, they were not identical as they had different branch length and showed significant nucleotide diversity of

Table 3 List of genetically identified Sponges.

Code	Closest Phylogenetic Neighbor	Base Pair	% Similarity
	Standard COI fragment		
A01A	*Tedania klausi*	610	100
A02A	*Amorphinopsis maculosa*	600	97.42
A012A	*Callyspongia fallax*	615	98.72
H01A	*Tedania klausi*	610	100
H02A	*Amorphinopsis maculosa*	600	97.23
H012A	*Callyspongia fallax*	612	98.72
S01A	*Callyspongia fallax*	605	98.72
S012A	*Callyspongia fallax*	605	98.72
P2A	*Amorphinopsis maculosa*	610	99.83
P5A	*Amorphinopsis maculosa*	610	99.83
G6A	*Phakellia carduus*	600	98.63
G12A	*Cliona viridis*	611	97.52
7A	*Haliclona sp.*	609	92.15
BA	*Haliclona sp.*	610	92.15
Ratnagiri	*Callyspongia fallax*	600	98.2
A1J18	*Haliclona toxia*	620	95.35
A2J18	*Suberites diversicolor*	646	99.81
A1M18	*Tedania klausi*	619	100
H2M18	*Tethya aurantium*	622	99.35
A2J19	*Suberites diversicolor*	656	99.81
H2J19	*Suberites diversicolor*	663	99.81
A1M19	*Tedania klausi*	671	99.69
A2M19	*Haliclona fascigera*	634	99.81
H1M19	*Suberites diversicolor*	652	99.83
H2M19	*Suberites diversicolor*	664	100

Code	Closest Phylogenetic Neighbor	Base Pair	% Similarity
	Extended COI fragment		
BGa	*Biemna fistulosa*	600	100
BCa	*Callyspongia plicifera*	600	91.41
Baa	*Xestospongia testudinaria*	600	88
	16S rRNA		
4a	*Cinachyrella kuekenthali*	610	97
G10a	*Cinachyrella kuekenthali*	610	97
Sp a	*Tedania ignis*	609	94

0.02474, thus suggesting its novelty and could represent a novel sponge taxon. Similarly, G6A was placed near to *Phakellia cardus* but showed significant polymorphism. Also among AO2A, P2A, HO2A, and P5A no branch length was observed, indicating, that all belong to a single OTU (OTU 2 in Fig 4) and were closely related to *Amorphinopsis maculosa.* However, a difference in branch length and nucleotide diversity of 0.00082 was recorded between OTU and *Amorphinopsis maculosa* thereby stating its novelty. Likewise 7C and BA were closely related to *Haliclona* and dissimilarity from branch length suggested their

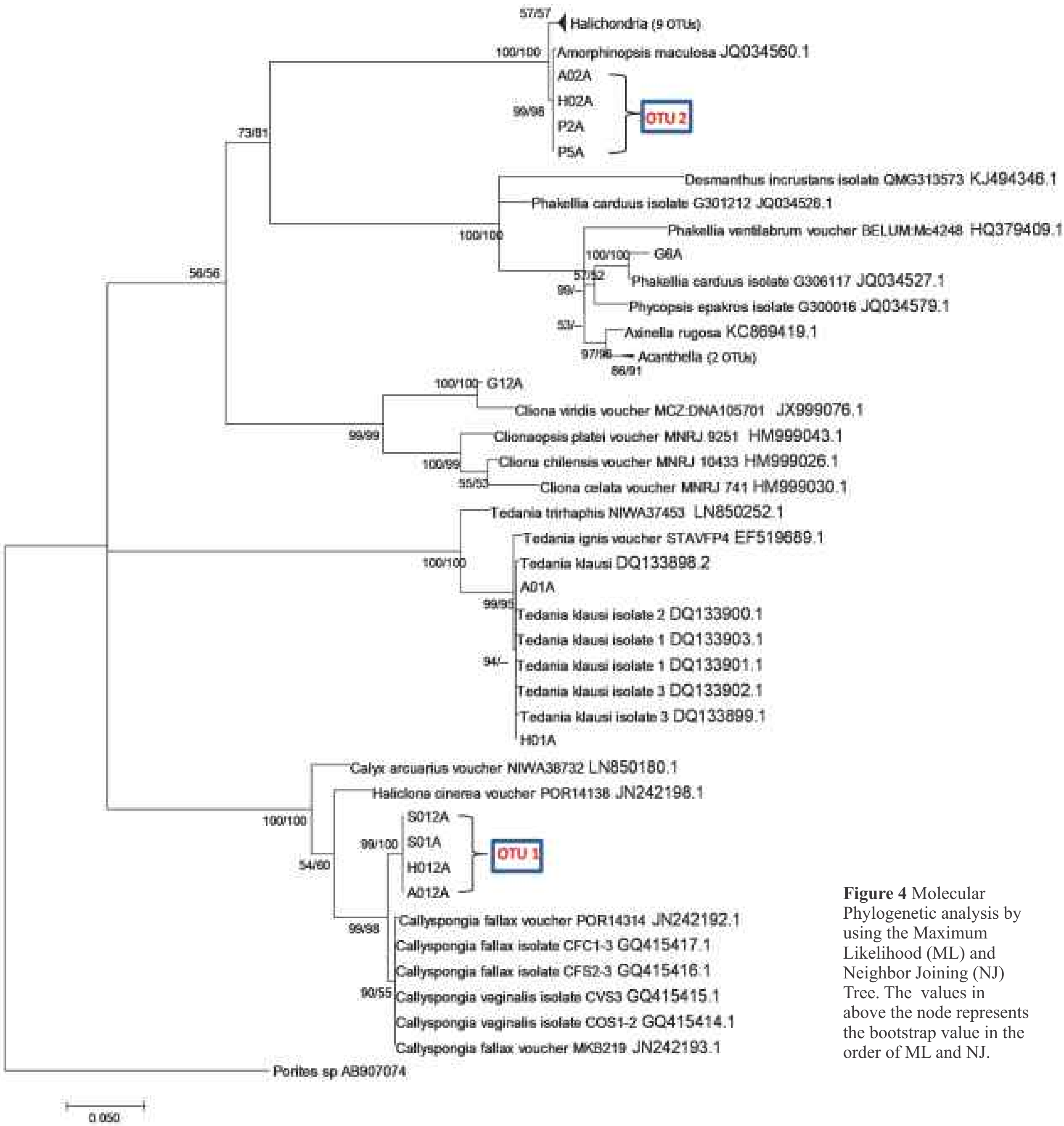

Figure 4 Molecular Phylogenetic analysis by using the Maximum Likelihood (ML) and Neighbor Joining (NJ) Tree. The values in above the node represents the bootstrap value in the order of ML and NJ.

probable novelty too. Two of the species namely *Tedania klausi* and *Amorphinopsis* sp. were found to be common at Anjarle and Harne stations. *Callyspongia* sp. was found at all the three stations (Anjarle, Harne, and Shekadi). Only fourteen samples could be identified on the basis of standard barcoding COI fragment gene and this could probably be due to the reasons stated herein (Vargas et al. 2012).

Therefore, a less success ratio (29%) of PCR reaction for COI gene amplification was observed. The total number of sponge species recorded during the present study expedition is far quite less when it is compared to that of the sponge's distribution in different parts of the country as shown in earlier studies (Vinod et al. 2014).This could be attributed to the rocky pools being patchy in this region and thus the further intensive studies at different depths may help to complement identification of more species to the present list. Moreover, from our study, approximately 83% of sponges showed a promise of forming a novel taxon. Thus, it substantiates that western coast can serve as the potential site for the novel sponges. As the marine sponges are of immense ecological significance, exploration of these invertebrates can surely be of extreme importance.

Molecular Taxonomy and Diversity of Sponge Associated Bacteria

The average combined reads obtained on the overlapping of paired-end reads using FLASH were 6,73,620 that accounted for 81% of mean combined reads. The OTU picking using close reference method to SILVA database, with 97 % similarity threshold, clustered the sequences in to collectively 5,666 mean OTUs. Subsequently, the richness of bacterial communities was estimated by the Chao 1 richness estimator and their diversity was determined by Shannon diversity index. The application of Kruskal-Wallis test ($\alpha = 0.05$) on these indices showed that the alpha diversity was not significant (p-value>0.05) (Fig. 5) between sponge, water and sediment samples across each of the three locations. Moreover, statistical comparison using Mann-Whitney algorithm ($p = < 0.05$) also showed insignificant alpha diversity among the sponges of the same location.

The COI sequencing confirmed the identity of all the sponges included in this study. The sponges identified belonged to two species; *Callyspongia fallax* (Sample ID: A012, H012, S01, S012) and *Amorphinopsis*

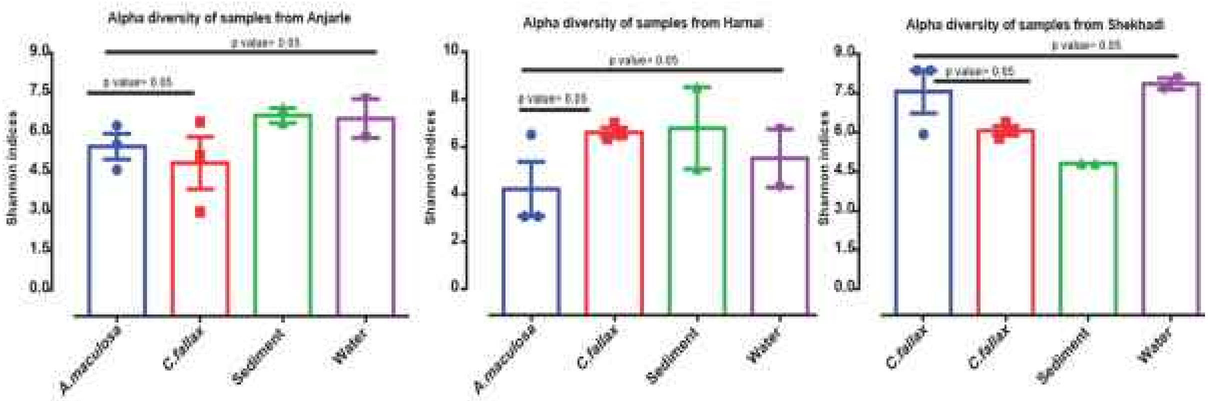

Figure 5 Frequency distribution plots illustrating the alpha diversity between all the samples (Sponge, Water, and Sediments) across all the locations (Harnai, Anjarle, and Shekhadi).

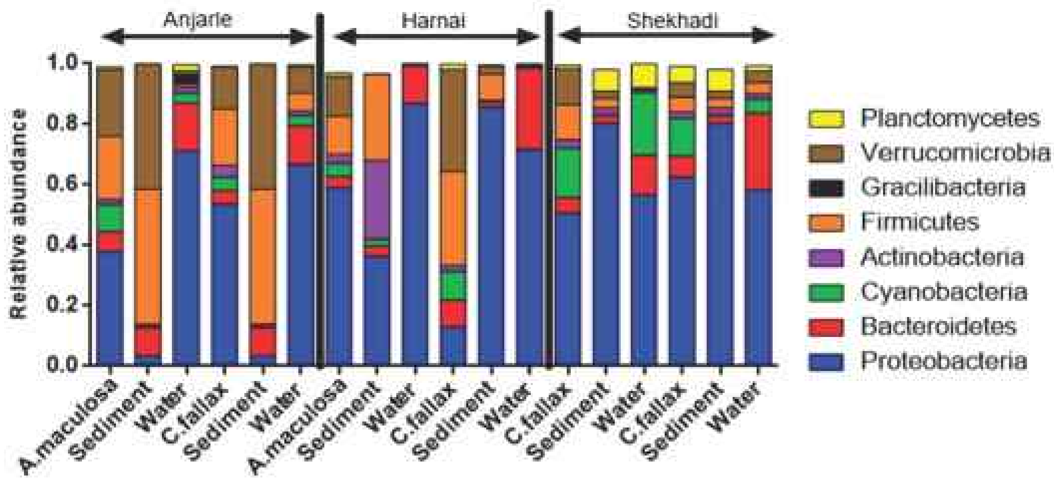

Figure 6 Phylum level (abundance $\geq 2\%$) distribution of bacterial communities in all the samples across all the locations.

maculosa (Sample ID: A02, H02). Collectively, more than 30 different phyla showed their inhabitancy in sponge. The analysis of microbial community structure (Fig 6) at the phylum (abundance $\geq$ 2%) level of classification suggested the predominance of Proteobacteria (13% to 62%) in both the sponges. The Firmicutes ranging from 4% to 30% and Verrucomicrobia ranging from 4% to 33% were also seen to be enriched in sponges. However, it was observed that both the *C.fallax* identified from Shekhadi site showed only marginal presence of these two bacterial groups relative to the other sponges. Similar low prevalence of these groups was also evident even in the surrounding water and sediments of Shekhadi, suggesting the significance of habitat's influence on the host microbial composition. Furthermore, the Cyanobacteria (4% to 16%) also formed a considerable portion of the microbial community in the sponges. The other phyla contributing majorly to the microbiome of sponge were of Actinobacteria and Bacteroidetes. A notable observation came from both the *C.fallax* of Shekhadi. The *C.fallax,* at this site showed enrichment of annamox group Planctomycetes while the sponge of other locations showed negligible presence of this group. This bacterial group is important for the sponges, as they are well documented in various nutrients cycling.

The surrounding water and sediment samples also accounted for a similar pattern of microbial community diversity at phyla level; however, the microbial composition showed disparity in their relative abundance. The cyanobacterial group was relatively very low in the sediments as compared to water and sponge samples. Bacterioidetes group were relatively more prevalent in all the water samples. Moreover, it was observed that bacterial population from Verrumicrobia group were highly enriched in all the sponge and also showed its considerable presence in the surrounding sediments, however, less abundant in sediments of Shekhadi. Collectively, at the higher level of classification i.e. at phylum level, these results suggested the presence of similar diversity with detectable variations in their relative abundance.

The predominance of bacterial phylum Proteobacteria in this study was in coherence with the earlier reports published on sponge-microbial symbiosis across the world. The functional role of Proteobacteria in the sponge is well documented for nitrogen fixation and production of bioactive metabolites for defense. Firmicutes formed the second most abundant group in *C.fallax* and *A.maculosa* across all the locations. Blautia formed the major OTU, representing both the sponges from the phylum Firmicutes. To the best of our knowledge, *Blautia* is not yet reported as a major group of Firmicutes in the sponge. Cyanobacteria also formed a considerable portion of the microbial community in both the sponges. The presence of Cyanobacteria is no surprise as Hentschel et al in 2006 have elaborated its irreplaceable role in sponges. In the previous studies, the Verrucomicrobia group displayed a small proportion of the microbial community while here, we observed the higher abundance of 11 to 33 %, which attributed to its presence in surrounding sediment and thus indicating their horizontal transmission. The Verrucomicrobial group preferred sponge as their more suitable niche as their hits were prevalent in all the sponges but were not seen uniformly in most of the water and sediments of the study. The Akkermansia formed the dominant genera from Verrucomicrobial group. The diversity indices showed that there were insignificant differences when it comes to comparison of sponges with its sediment and water habitat's microbial diversity. This leads to the interpretation that the sponge, though small and simple living entity, harbours a comparable diversity to its surrounding water and sediment, thus setting itself as an ideal example for symbiotic studies.

Significantly enriched groups were observed in the sponges belonging to the same taxa from different locations. The phyla Synergistetes, PAUC34f, and Fusobacteria were differentially abundant (p-value of 0.034, 0.033, 0.036 respectively) in Amorphinopsis maculosa of Harnai and Anjarle. Most of the Fusobacterium species are implicated in several animal diseases (Allaker 2012). Similarly, in Callyspongia fallax from different locations, nine differentially significant abundant groups (p-value<0.05) namely Chlamydiae, Chlorobi, Hydrogenedentes, Lentisphaerae, Planctomycetes, Synergistetes, Tenericutes, TM6, SHA 109 were observed. Planctomycetes are known to carry out anaerobic ammonium oxidation, forming a distinct phylum and possess unusual features such as intracellular compartmentalization and a lack of peptidoglycan in their cell walls (Fuerst and Sagulenko 2011). The Annamox reaction is a huge benefit for marine sponges in terms of nutrient acquisition. Furthermore, upon comparison of sponge with sediments and water, we did not come across any significantly enriched phyla.

Planctomycetes are reported to form a considerable portion of marine sponge and are a source of bioactive molecules. In our study, we observed a low abundance of Planctomycetes in most of the cases; however, it was significantly enriched in *C.fallax* found in Shekhadi. The horizontal transmission was quite evident in this case, as the surrounding water and sediment displayed the presence of this group in relatively more abundance as compared to the other locations. This indicates the role of environment in the shaping of these microbial communities in a sponge and also supports diversity differences due to allopatric occurrences. Delineation of diversity at the genus level was quite evident for these two spatially close and phylogenetically identical sponges. A marine symbiont Endozoicomonas, a Gama-Proteobacterium important in many environmental cycles, was enriched highly in one of the *C. fallax* (So1) of Shekhadi while Akkermansia displayed its enrichment in the other *C.fallax* (So12). Additionally, the differential prevalence of other groups such as Tenacibaculum, Nitrosococcus and few others indicate the dissimilarity maintained even at the individual level in the sponge. Endozoicomonas was also found to be exclusively associated with the *C.fallax* while absent in the surrounding water and sediments that further supports its functional vitality for the sponges.

The comparison of genera hierarchy further displayed the additional exclusive differences. In case of *C.fallax* (Fig. 7), at Shekhadi location, dissimilarity in phylogenetically identical and spatially proximal sponge was clearly evident. Endozoicomonas were dominant in So1, while the So12 showed the dominance of Akkermansia. Further differences included the higher prevalence of Tenacibaculum, Nitrosococcus, Planctomycetes, Blastopirellula in top eight abundant ($\geq$ 2%) genus of So12 sponge. These observations indicate the specificity maintained by sponge at an individual level. Sponge forms an ecosystem and displays an accessible opportunity to study its essence. The term 'generalist' was defined by Taylor et al. (in 2004) as the bacteria present in multiple hosts and its environmental surroundings. In our study, we made a very significant observation in the same line of thought. We observed that the seven bacterial genera (Fig 8) viz. *Akkermansia*, *Bacteroides*, *Synechococcus*, *Blautia*, *Prochlorococcus*, *Lachnoclostrdium*, and *Subdoligranulum* hits were present in all the sponge subjects with the abundance of more than 5 %, irrespective of the sponge's phylogeny and geographical location. Moreover, it was also observed that many of these genera were either present at a very low abundance or absent in the surrounding water and sediment sample. Also, these genera typically resembled mammalian gut composites. This suggests the vertical microbial transmission in sponges as well the portrayal of the sponge as an ecosystem that probably might serve as a functional entity for these groups of bacteria.

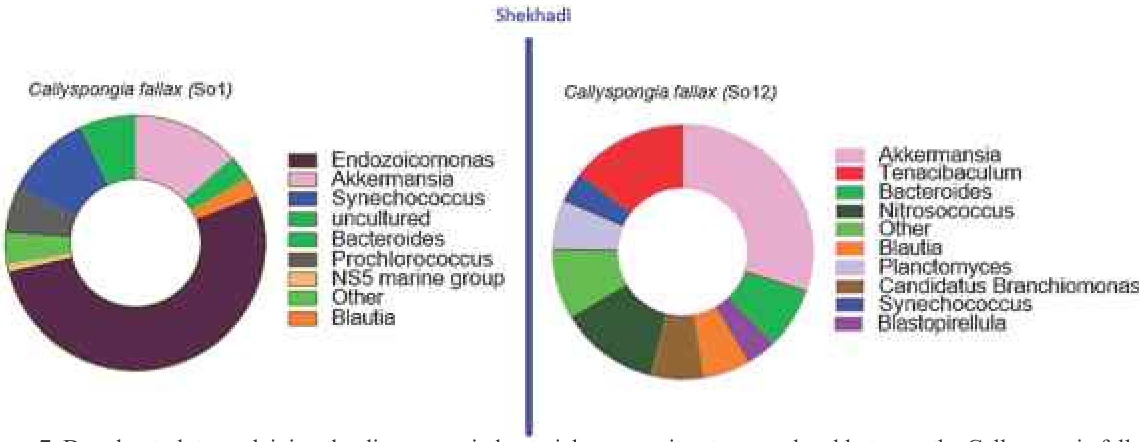

Figure 7 Doughnut plots explaining the divergence in bacterial community at genera level between the Callyspongia fallax of Shekhadi.

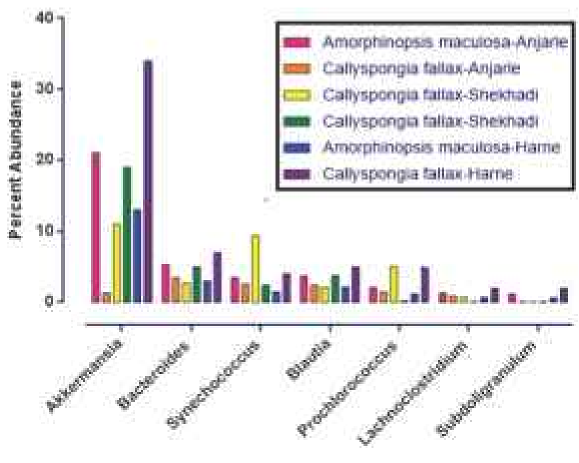

Figure 8 Common genera (abundance $\geq$ 5%) associated with the sponge individual under this study.

Beta diversity was analysed in order to compare the overall diversity of microbiome between phylogenetically distinct *A.maculosa* and *C.fallax* used in this study. NMDS (Non-metric multidimensional scaling) plots based on Bray-Curtis dissimilarity metrics showed the different clustering patterns in the two sponges (Fig. 9a) indicating the presence of dissimilar diversity. The Principle co-ordinates analysis plot (PCoA) using unifrac distance metric demonstrated (Fig. 9b) variations in the community structure of water, sediments, and sponge. The sediment community displayed overlapping similarity with the sponge microbial community. This could be due to the fact that these were intertidal sponges and may have frequent interference with the sediments and transient exposure to water only during high tide

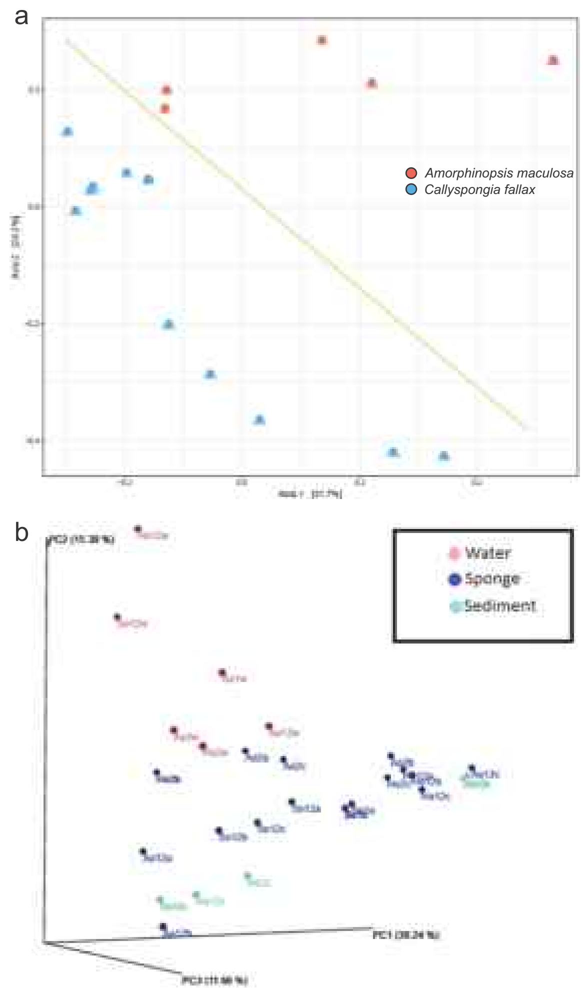

Figure 9 Beta diversity analysis using NMDS (Fig. 9a) plot explains the phylogenetic implications on the microbial diversity of the two sponges. PCoA plot (Fig. 9b) using unifrac distance metric representing the differences in the microbial diversity between sponge, water, and sediment samples. Note: a, b, and c are the sections (e.g. A02a, A02b, A02c) of the sponge.

period. The overall results suggested the specificity employed by these intertidal sponges in maintaining its microbial community.

Core microbiome was computed in order to unravel the shared and unique genera associated with these sponges. We observed that six genera (Fig. 10) were unique to sponge population viz. *Eubacterium hallii* group, *Eubacterium coprostanoligenes* group, *Serratia*, *Endozoicomonas, Candidatus Branchiomonas, Ruminiclostridium*. However, large numbers of OTUs remained exclusive to water (72%) and sediment (43%) and very few were shared (12%) with the sponges, thus providing evidence for the selectivity of sponges in maintaining its own microbiome.

The above findings indicated that most of the microbial source for these sponges would be other than the surrounding sediments and water. In order to test this

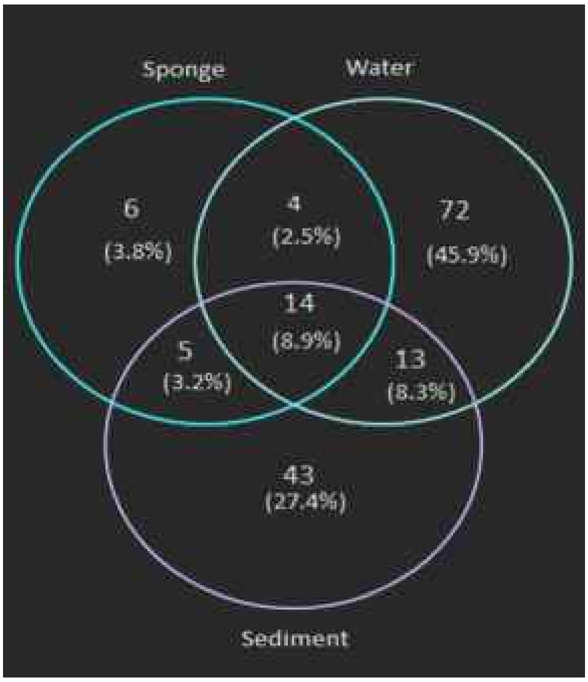

Figure 10 Venn diagram representing the shared and unique bacterial genera between sponge, water and sediment.

hypothesis, we applied Bayesian mixing model (Source tracker) (Fig. 11), to predict the source of microbial transmission in these intertidal sponges. In most of the cases, the predicted source was either the sediments or the source remained unknown.

These are intertidal sponges that are regularly exposed to interference by the social animals and also have lesser water retention time, their probable considerable microbial source could be the sediments, vertical transmission, and other environmental influences. Taylor et al. in 2004 explained the concept of 'specialists' that was present on only one host species, 'sponge associates' present on multiple hosts but not in seawater, and 'generalists' enriched in multiple hosts and seawater. We made a very intricate observation in the same context for the sponges used in our study. We showed that the 7 genera namely *Akkermansia, Bacteroides, Synechococcus, Blautia, Prochlorococcus, Lachnoclostridium*, and Subdoligranulum at 97 % similarity threshold level showed their abundant prevalence in all the sponges studied, irrespective of their low or high abundance in surrounding water and sediments. The cyanobacterial groups *Synechococcus* and *Prochlorococcus* are important to sponge as they provide organic carbon source. Similar to observation for Blautia, the presence of mucin degrading *Akkermansia* in such a high abundance was surprising as there are no such previous reports as per our knowledge. *Akkermansia* is known for its anti-inflammatory effect (Schneeberger et al. 2015) and is associated with the studies of obesity and diabetes. Out of these seven genera, four genera are known to be

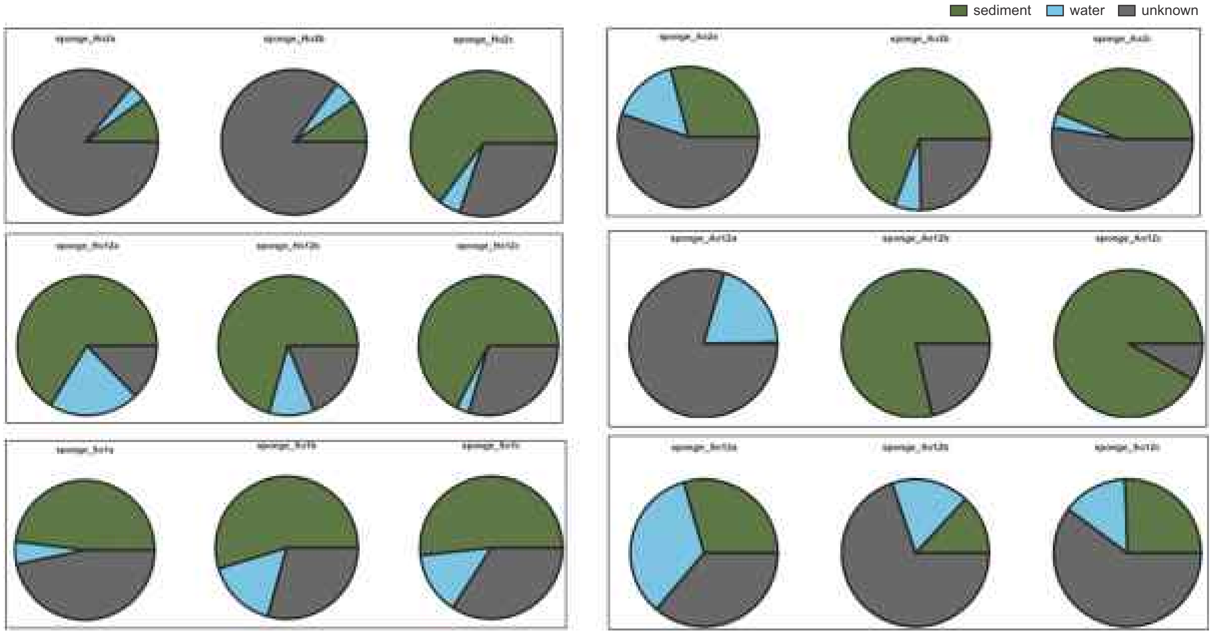

Figure 11 Tracking of Microbial source.

commonly associated with gut flora. These are intertidal sponges and are exposed to constant human influences so we suggest that this might be the reason for the above observations. This prediction was also supported by source tracking that in addition to the unknown sources, the intertidal sponge microbial composition was majorly driven by the sediments rather than water. Nevertheless, the presence of these genera at higher abundance in all the sponges across all the locations indicates that sponge is an ecosystem and provides a potential niche for them.

We also sampled sponge *Tedania klausi* from two locations, Anjare and Harnai to observe the associated bacterial diversity with respect to its location. We could observe the deferential bacterial diversity associated with sponges from that of water even though sponges being filter feeders, but was comparable to that of sediment samples. This can be due the close contact of inter-tidal sponges to the substratum. Proteobacteria, Cyanobacteria, Firmicutes, Actinobacteria, Bacteriodetes, Planctomycetes, Verrucomicrobia formed the core group in the sponges of this study (Fig 12). Similar to the previous studies across the globe, upon core computation of microbes, it was observed that sponge maintains its selectivity in terms of gaining microbial load from the surrounding water and sediment as it was clearly evident from higher percentage of exclusive genera in water (72%) and sediment samples (43%) and less sharing (14%). This shows the potential role played by the host in selection and abundance of particular taxa as compared to the surrounding microbial diversity. In coherence to our previous studies we also observed higher abundance of genera *Akkermensia* and *Blautia* associated with sponge *Tedania klausi* and the sediment samples (Fig 13). The Principle co-ordinate analysis plot (PCoA)

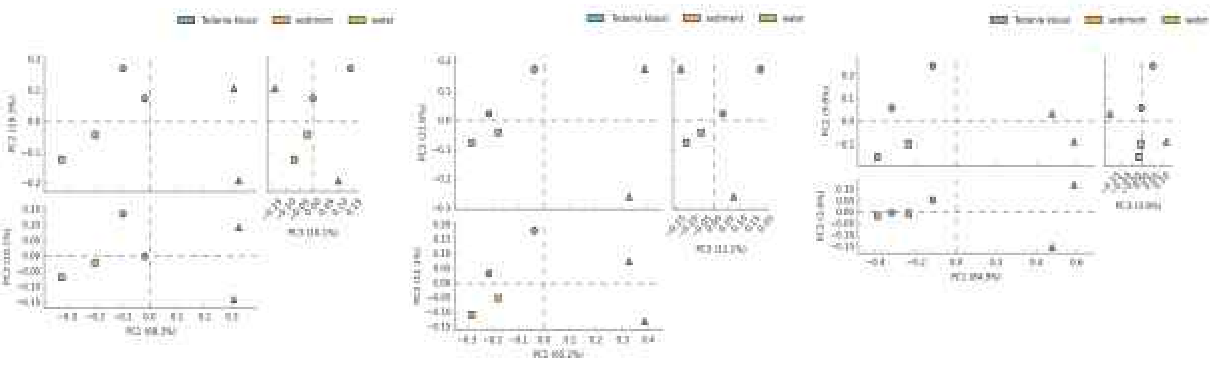

Figure 12 PCA plot representing the differences in the microbial diversity between sponge, water, and sediment samples. A.Phylum level diversity B. genus level diversity C. family level diversity.

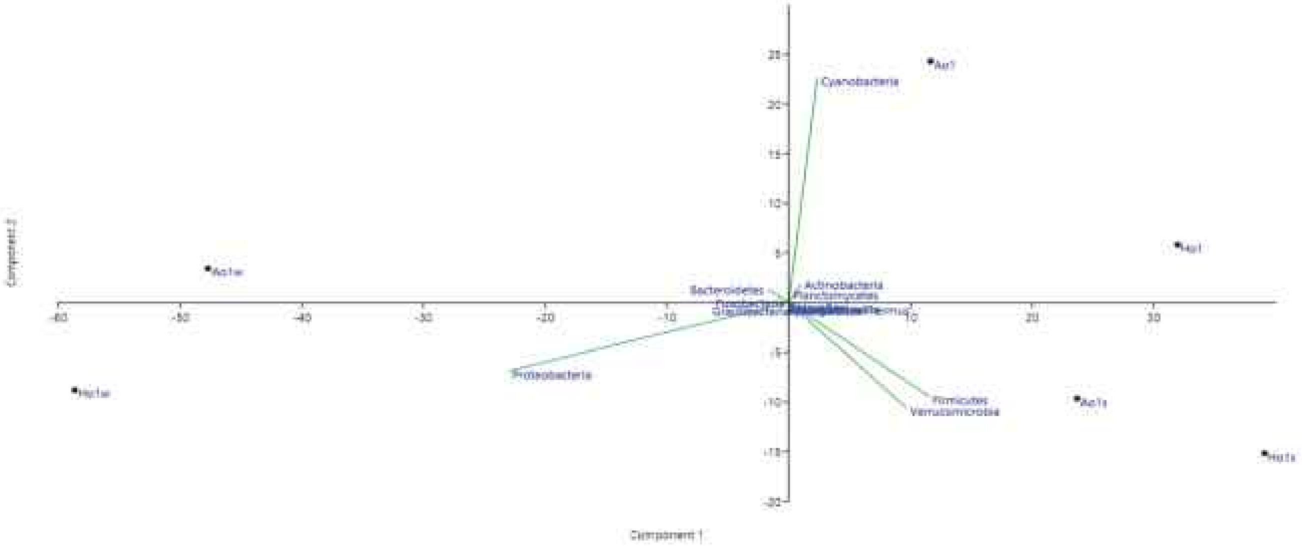

Figure 13 PCoA plot representing the differences in the microbial diversity between sponge, water, and sediment samples. Note: Ao1w and Ho1W are water samples from Anjarle and Harnai respectively, Ho1s and Ao1s are sediment samples, Ao1 and Ho1 are sponge samples from Anjarle and Harnai respectively.

also displayed the dissimilarity (at 39%) in microbiome composition of sponges and its habitat with marginal overlapping of sediment samples with the sponges. This overlapping could be attributed to the fact that these were intertidal sponges from the rocky shores and are mostly exposed to sediments.

This study, as per our knowledge, gives the first insight into the bacterial diversity associated with the intertidal sponges across the West coast of India. It also restates the selectivity of the sponges in maintaining microbial composition patterns and the impact of phylogeny in these associations. Few of the observations related to the presence of the few genera that are not reported elsewhere may represent the unique microbial diversity of Indian coast. Future research may be focussed on defining these genera as archetypal symbionts and studying their evolutionary convergence.

Haloarchael Diversity Associated With Sponges

Sponge associated bacteria are widely explored but relatively few studies have dealt with haloarchaeal communities associated with sponges and halo tolerance of the bacterial community associated with the marine sponges. Total 50 halotolerant bacteria and 13 haloarchael strains were isolated from 4 types of Sponges collected from west coast of India by using direct inoculation technique (table 4). After the incubation of one week at 37˚C, the microbial growth started to appear on SG medium (20% NaCl). Total of 63 colony morphotypes were recovered and further picked for obtaining pure cultures. Out of 63 colonies, 13 appeared to be forming pink pigmentation, indicating their haloarchaeal identity. While other colonies (50) are white, glistening and mucoid in nature and appeared to be bacterial isolates (Fig 14).

The results for the growth of cultures at different NaCl concentrations (0-32%) for archaea and bacteria are summarized as follows: out of 45 bacterial cultures studied, 18 cultures were showing the growth from 0-32% NaCl concentration and thus found to be halotolerant in nature. Further, we have also noted that optimum growth for nearly all bacterial cultures was ranged from 4-16% NaCl concentration; indicating moderate halophilic nature of these isolates. (Fig.15). Furthermore, we have done salt tolerance study for 13 archaeal cultures isolated from the sponge. As per the distinctive characteristic of haloarchaea, we have found that 10 out of 13 culture were growing only on 8-32% NaCl (no growth on 0-4%) concentration. This observation confirms the haloarchaea nature of these 10 cultures. The optimum growth for archaeal cultures was found to be in the range of 12-20% NaCl.

The total protein was extracted from all 63 bacterial isolates for MALDI based identification. However, due to the limitation of unavailability of halophilic/halotolerant bacterial protein mass spectra in Bruker, database large numbers of our isolates remained

Table 4 Number of bacteria and archaea isolated from sponges.

Sr. No.	Sponge sample	Bacterial isolates	Archaeal isolates
1	*Cinachyrella australiensis*	4	-
2	*Callyspongia fallax*	17	6
3	*Callyspongia fallax*	27	7
4	*Amorphinopsis maculosa*	2	-

Figure 14 Haloarchaea and halobacteria isolated from sponges.

unidentified in the results. Only five bacterial isolates were identified as tabled follow. In this, *Halomonas elongata* and *Chromohalobacter salexigens* are the most frequent bacterial isolates identified in MALDI-TOF MS (Table 5). None of the haloarchaeal isolates were identified by MALDI-TOF MS due to the unexpanded archaeal protein mass spectra in Bruker database.

Sequencing of 16S rRNA gene resultued in total 56 good quality 16S rRNA gene sequences which were used in NCBI-BLAST n/EzTaxon for getting a closest phylogenetic neighbor. These results show that halobacterial is the most abundant (77%) halotolerant community associated with *Callyspongia fallax;* as compared to haloarchaea (23%). Species-level identification of 45 bacterial isolates revealed that sponge *Callyspongia fallax* harbours/associated with seven different bacterial species; belonged from 7 genera. Further we have found that *Halomonas elongata* (47.7%) is the most abundant bacterial species associated with the sponge Callyspongia fallax, followed by *Chromohalobacter israelensis* (11.4%) and Salibacterium halochares. (11.4%) Total of 13 haloarchaeal cultures were isolated from sponge *Callyspongia fallax*. When identified at species level these isolates were found to be distributed in three different haloarchaeal species (*Haloferax alexandrines*, *Haloferax lucetence*, and *Haloferax volcani*) from genus *Haloferax* (Fig16). Furthermore, we found that *Haloferax alexandrius* (61%) is the most abundant haloarchaeal species associated/harboured by sponge *Callyspongia fallax*.

Table 5 MALDI-TOF-MS based identification of isolates

Culture ID	MALDI-Score	Identified microorganism
SP2-2	1.733	*Chromohalobacter salexigens*
SP2-8	2.113	*Chromohalobacter salexigens*
SP2-9	2.029	*Chromohalobacter salexigens*
SP3-15	1.892	*Halomonas elongata*
SP3-16	1.725	*Halomonas elongata*

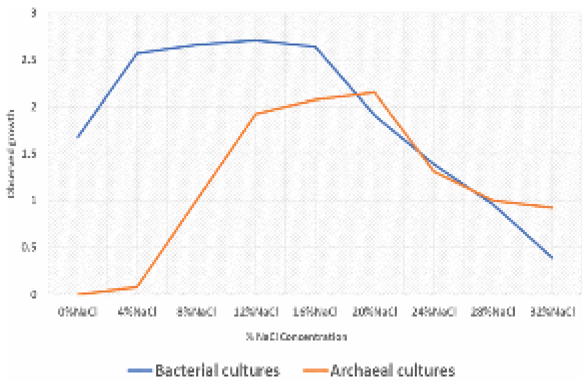

Figure 15 Salt tolerance of archaeal and bacterial cultures across different NaCl concentrations.

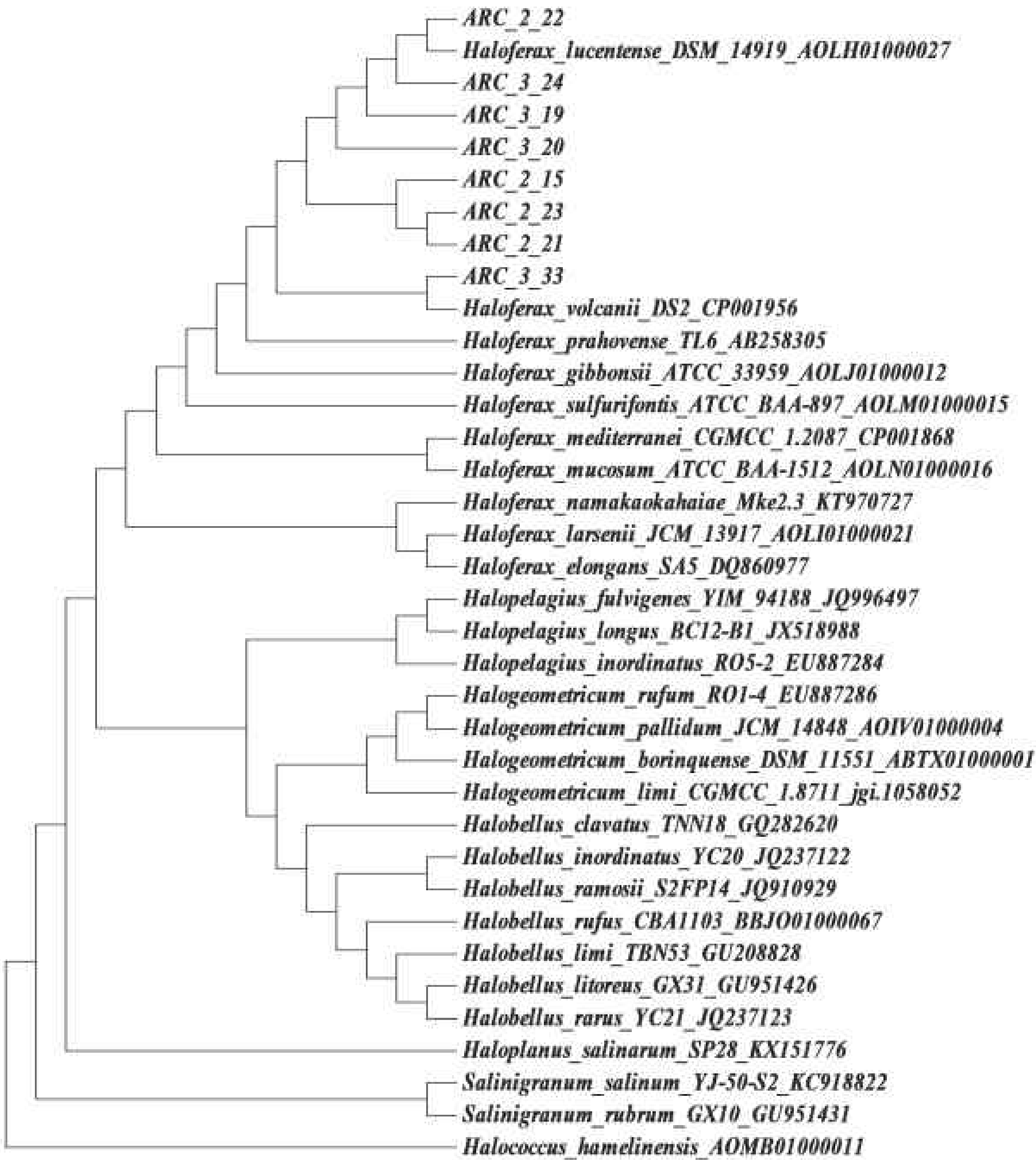

Figure 16 rRNA based phylogeny between isolated taxa.

Microbial Identification and Preservation

Till date we have sequences of more than 1800 bacterial isolates for IISER Pune, of which most cultures were identified using 16S rRNA gene sequencing (Fig. 17), while 46 cultures were identified with MALDI (Fig 18).

Majority of cultures belong to clade Bacillus and Staphylococcus followed by Vibrio and Lysinibacillus (Fig 18). Among the identified bacteria we could also deduce the probable functions this bacteria are known for (table 6). We have accessioned a total of 2743 cultures and deposited at NCMR-NCCS under general depository category.

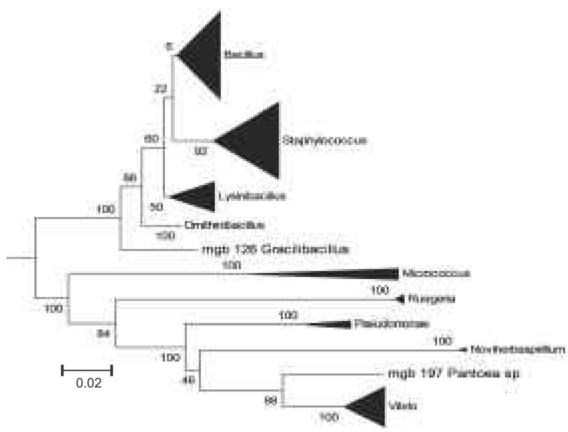

Figure 17 rRNA based phylogeny between identified isolates.

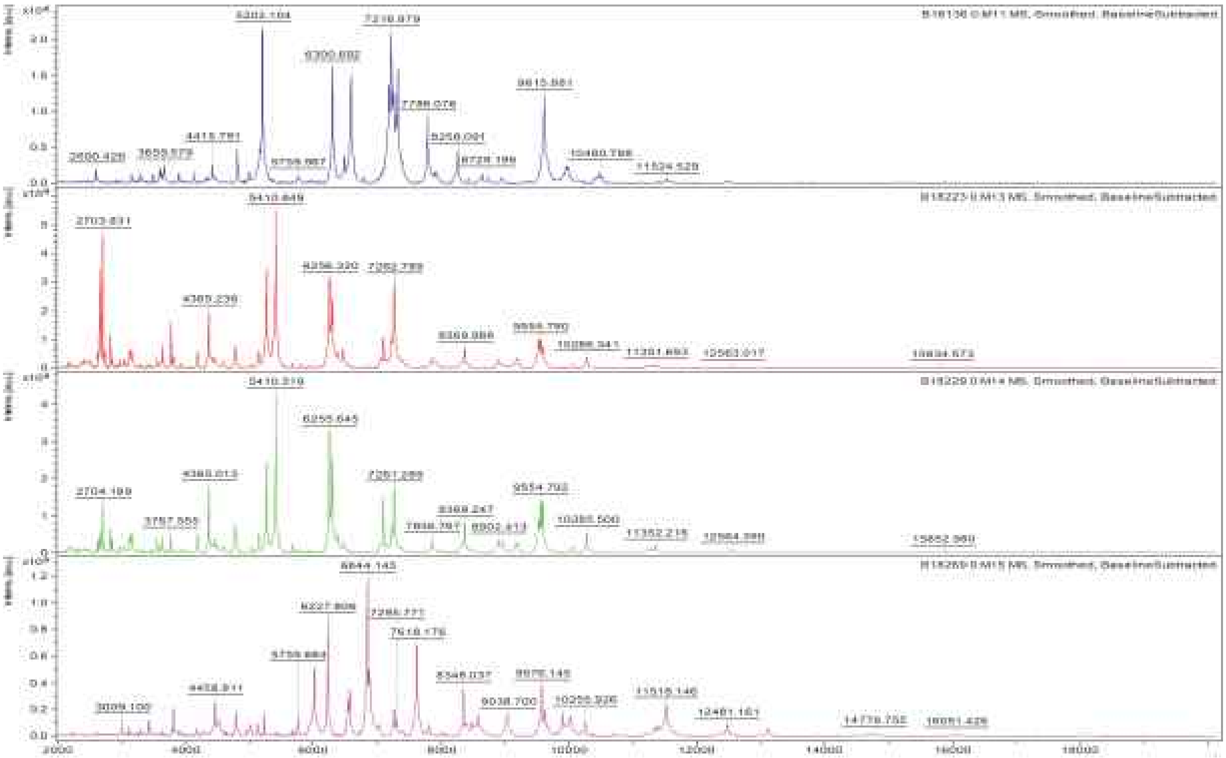

Figure 18 MALDI spectra for isolates.

Table 6 Properties of identified isolates.

Barcode	Identified As	PRODUCT
MGB00002	*Bacillus niacini*	6-hydroxynicotinate dehydrogenase/ Nicotinate dehydrogenase
MGB00003	*Vibrio fortis*	Extracellular polymeric substances - arabinose, galactose and mannose
MGB00004	*Vibrio brasiliensis*	Biofilm formation
MGB00005	*Vibrio nigripulchritudo*	Nigribactin, a Novel Siderophore
MGB00006	*Staphylococcus hominis subsp. novobiosepticus*	Novobiocin resistance,
MGB00008	*Bacillus licheniformis*	protease for use in biological laundry detergent
MGB00018	*Bacillus badius*	Novel enzymes, including a restriction enzyme and penicillin G acylase
MGB00027	*Staphylococcus arlettae*	able to degrade azo dyes.
MGB00035	*Spongiispira norvegica*	Enzyme esterase lipase C8, lipase C14
MGB00043	*Bacillus nealsonii*	γ-radiation resistant.
MGB00053	*Pseudomonas stutzeri*	a denitrifying bacterium
MGB00054	*Bacillus cereus*	probiotic feed additive to reduce Salmonella in the intestines and cecum.
MGB00055	*Ornithinibacillus californiensis*	Enzymatic manganese(II) oxidation
MGB00056	*Bacillus niabensis*	benzyldimethyl hexadecylammonium chloride
MGB00058	*Bacillus thioparans*	Bacillus thioparans
MGB00059	*Exiguobacterium himgiriensis*	lactic acid-producing bacterium
MGB00063	*Bacillus licheniformis*	protease has a pH optimum of between 9 and 10
MGB00066	*Micrococcus flavus*	Production of lipase
MGB00126	*Gracilibacillus dipsosauri*	Halotolerance
MGB00128	*Vibrio sagamiensis*	luminous marine bacteria
MGB00130	*Vibrio hangzhouensis*	Urydilate kinase
MGB00131	*Vibrio variabilis*	Anti bacterial
MGB00133	*Vibrio alginolyticus*	production of the potent neurotoxin, tetrodotoxin.
MGB00138	*Vibrio campbellii*	emerging aquaculture pathogen.
MGB00139	*Vibrio harveyi*	bioluminescent,
MGB00153	*Solibacillus silvestris*	thermostable glycoprotein bioemulsifier

Summary of Project Findings

The three sites selected for this study viz. Shekhadi [N18° 6' 56.93", E72° 58' 37.75"], Anjarle [N17° 51' 37.397", E73° 4' 52.215"], Harnai [N17° 48' 29.092", E73° 6' 10.388"] and Kunkeshwar [N16° 20' 01", E73° 23' 26"] form a part of the Konkan coast (Coast of submergence). A total of 78 samples were collected (Sponge, n=26; water, n=26 and sediment, n=26) in this study.

DNA extraction from sponge samples were done for sponge molecular barcoding and metagenomics. Molecular barcoding was performed by amplification of ~640bp long standard barcoding fragment located at the 5'site of mitochondrial cytochrome oxidase subunit-1(CO1) primer HCO and LCO, dgHCO-dgLCO and also ITS2. Results were obtained from HCO-LCO primers resulting in identification of 31 sponge samples, following the Sanger sequencing. The query sequences were referred to BOLD Database (Barcode of Life Data System) for their identification. Further, phylogenetic analysis was carried out to examine the evolutionary relatedness. Phylogenetic analyses were done using the software package MEGA 7.0.26.

Host-associated microbial diversity study is performed to decipher their community compositions and justify their ecological role in terms of their function and their interactions with other living entity in the host ecosystem. Sponges, despite their simplicity, offer us to examine its enormous symbiotic complexity. DNA extracted from the samples was subjected to the amplification of V4 region of DNA to determine the bacterial community structure. The amplified products were further used for library preparation and sequencing on the Illumina MISeq.2000 platform (Illumina technologies, USA). Sequencing was performed using V4 paired-end sequencing (2 × 250 bp) chemistry.

The metagenomics study describes the microbial diversity associated with the two phylogenetically distinct intertidal marine sponges, *viz. Callyspongia fallax* and *Amorphinopsis maculosa* procured from three spatially distinct locations across the west coast of India. Sponge heterogeneity was found to drive the differences seen in bacterial community structure. The predominance of bacterial phylum Proteobacteria in this study was in coherence with the earlier reports published on sponge-microbial symbiosis across the world.

The functional role of Proteobacteria in the sponge is well documented for nitrogen fixation and production of bioactive metabolites for defense. Firmicutes formed the second most abundant group in *C.fallax* and *A. maculosa* across all the locations. Planctomycetes are reported to form a considerable portion of marine sponge and are a source of bioactive molecules. In our study, we observed a low abundance of Planctomycetes in most of the cases; however, it was significantly enriched in *C.fallax* found in Shekhadi. The horizontal transmission was quite evident in this case, as the surrounding water and sediment displayed the presence of this group in relatively more abundance as compared to the other locations. This indicates the role of environment in the shaping of these microbial communities in a sponge and also supports diversity differences due to allopatric occurrences.

The microbial dissimilarity was delineated at the genus level for phylogenetically identical sponges inhabiting the same geographical niche. Moreover, the higher prevalence of the bacterial hits namely *Akkermansia, Bacteroides*, and *Blautia* suggested the inclined nature of the intertidal sponge microbiome towards the mammalian gut microbial composition, suggesting human influences on these rocky shores. Essentially, all the sponge species displayed a sharing of seven bacterial genera, infusing a thought that they might have effective functional roles in these intertidal sponges that probably act as an effective niche for them.

The tracking for microbial source predicted sediment as a considerable source of the microbial load; however, the major source remained unknown. Overall, these results suggested that the microbiomes of these intertidal marine sponges of Indian coast are driven by host identity, habitat, and other environmental influences. This is the first study to assess the microbial composition of the intertidal marine sponge across the west coast of India using amplicon sequencing of the 16S rRNA gene.

We also sampled sponge *Tedania klausi* from two locations, Anjare and Harnai to observe the associated bacterial diversity with respect to its location. We could observe the deferential bacterial diversity associated with sponges from that of water, even though sponges being filter feeders, but was comparable to that of sediment samples. This can be due the close contact of inter-tidal sponges to the substratum.

Sponge associated bacteria are widely explored but relatively few studies have dealt with haloarchaeal communities associated with sponges and halo tolerance of the bacterial community associated with the marine sponges. Total 50 halotolerant bacteria and 13 haloarchael strains were isolated from 4 types of sponges collected from west coast of India by using direct inoculation technique.

Salt tolerance study of 63 isolates revealed that 50 bacterial cultures showed growth from 0 to 28% (w/v) NaCl showing typical halotolerant behaviour, 13 haloarchael strains grew optimally from 8 to 32% (w/v) NaCl which is typical characteristic of haloarchaea. Molecular identification of 32 isolates by 16s rRNA showed 99 to 100 % similarity to closest phylogenetic neighbour *Halomonas elongata, Chromohalobacter salexigens, Kushneria sinocarnis, Salimicrobium salexigens, Pseudomonas hibiscicola, Haloferax lucentense* and *Haloferax volcanii*. To the best of our knowledge, this is the first report of isolation of haloarchaea for marine sponges *Callyspongia fallax.* Till date we have sequences of more than 1800 bacterial isolates. And accessioned approximately 2743 isolates and deposited in general depository category.

Studying sponge microbe interaction over the years has helped us to know succession of microbes over a period of time which will aid to know the core microbiome of sponge and also changes in microbiome due to environmental changes and effects on sponge metabolome and thus effecting the environment nearby.

Implications and Recommendations

- This study, as per our knowledge, gives the first insight into the bacterial diversity associated with the intertidal sponges across the West coast of India. It also restates the selectivity of the sponges in maintaining microbial composition patterns and the impact of phylogeny in these associations. Few of the observations related to the presence of the few genera that are not reported elsewhere may represent the unique microbial diversity of Indian coast. Also this is the first report of isolation of haloarchaea for marine sponges *Callyspongia fallax.*
- Studying sponge microbe interaction over the years has helped us to know succession of microbes over a period of time which will aid to know the core microbiome of sponge and also changes in microbiome due to environmental changes and effects on sponge metabolome and thus effecting the environment nearby.

Publications and Presentations

Published papers

- Lele-Rahalkar U & Pawar S (2017) Marine Sponge-Associated Microbiome: Reservoir of Novel Bioactive Compounds. In: Mining of Microbial Wealth and MetaGenomics (pp. 183-199). Springer, Singapore.

Preprints and manuscripts

- Yadav R, Ghattargi VC, Lele U, Shintre N, Watve M, Shouche YS, Pawar SP (manuscript submitted) Unfolding the essential microbial heterogeneity associated with the intertidal marine sponges across the west coast of India.
- Ghattargi VC, Yadav R, Shouche YS, Pawar SP (manuscript) Unpresented diversity of sponges across the west coast of Maharashtra.

Conference presentations

- Gaikwad, M., Gujare, M., Ghattargi, V., Yadav, R., Potnis, H., Kulkarni, S., Pawar, S. & Yogesh, S. (2019) Assessment of microbial diversity associated with Sponges from western coast of Maharashtra. In Book of abstracts, Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation organized by Indian Institute of Science Education and Research, Pune, on 20th and 21st December 2019. p. 37.
- Yadav, R., Ghattargi, V. C., Gaikwad, M., Gujare, M., Shouche, Y. S. & Pawar, S. P. (2019) Microbial diversity assessment of Sponges across the Western coast. In Book of abstracts, Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation organized by Indian Institute of Science Education and Research, Pune, on 20th and 21st December 2019. p. 89.
- Potnis, H. S., Gaikwad, M. A., Sawantdesai, S. P., Kulkarni, S. O., Khairnar, D. V., Ghattargi, V. C., Berde, C. V., Pawar, S. & Shouche, Y. S. (2019) Study of halotolerant bacterial and haloarchaeal community isolated from marine sponges collected from West Coast of India. In Book of abstracts, Aquatic Ecosystems: Sustainability and Conservation, a national conference on aquatic conservation organized by Indian Institute of Science Education and Research, Pune, on 20th and 21st December 2019. p. 88.
- Potnis HS, Pawar S, Shouche YS et al. (2018) Study of halotolerant bacterial and haloarchaeal community is marine sponges collected from West Coast of India. Poster presentation at International Conference on Microbiome Research (ICMR), Pune, India.

Outreach Activities

We could take few school students of std 8th and 9th and showcase to them the diversity of the western rocky beaches.We also have established collaborations with scientist from Wageningen University namely Dr. Detmer Sipkema. Within this collaboration we have initiated work to compare the microbial diversity of select sponges across the different continents of the world.

Future Prospects

To design project from metagenomics and genome sequence of the important sponges. Comparative study to asses seasonal variation in sponge microbiome. CARD-FISH experiment to localize Akkermansia and Haloarchea in sponge tissue with specific DNA probes.

List of Researchers And Project Staff

- Dr. Yogesh S Shouche: Scientist G, Project Investigator
- Dr. Shrikant P. Pawar: Scientist C, Project co-Investigator
- Miss. Meghna A Gaikwad: Project assistant
- Miss. Mitali Inamdar: Project assistant
- Mr. Mohak P Gujare: Project assistant

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Crop Genetic Diversity

Report

2.1

Crop Genetic Diversity

Gramin Yuva Pragatik Mandal (GYPM), Bhandara

Background

Agriculture is the main occupation and means of livelihood of the people in Bhandara district. It is the most important means of production as it not only supplies the basic necessities of life like food, but also the raw materials to feed the industries in the district. The population of Bhandara district is predominantly agricultural and agriculture labour community.

The main significant feature of the climate from the point of view of agriculture in the district is the monsoon. It has far reaching economic consequences. The south-west monsoon from June to October is the most important as it brings heavy rains in the district. The intensity of rainfall is the greatest in the months of August and September. The north-east monsoon breaks out in November and continues up to the end of December, providing rainfall for winter crops in the district. The rainfall in the months of November and December is very scanty.

The significance of the monsoon lies in the fact that it significantly affects the economy of the district. For predominantly agricultural district a like Bhandara and Gondia with 80 per cent of the population depending on land, rainfall is vitally important. The agricultural operations depend upon the timely arrival of monsoon and its quantity and distribution in the district. Gosikhurd and Bawanthadi projects are the main irrigation schemes in the district. Majority of agriculture land area is rainfed. But tanks, canals and wells are important sources of irrigation. The rainfall, therefore, determines the pattern of crops, and their rotation and the productivity of land in the district.

Bhandara District comes in Agro Ecological Sub Region (as per Indian Council of Agriculture Research) Satpura range and Wainganga Valley, hot moist subhumid ESR with shallow to deep loamy to clayey mixed Red and Black soils, low to medium AWC and LGP 180-210 days (10.4) ; Agro-Climatic Zone (as per Planning Commission) Eastern plateau and hills region (VII); Agro Climatic Zone (NARP) Eastern Vidarbha Zone (High rainfall zone) Other working area districts or part thereof falling under the NARP Zone Chandrapur, Bhandara, Gondia and Gadchiroli.

Kharif and rabi are the main agricultural seasons in Bhandara district. However, the district on an average has more area under kharif than under rabi crops. Only Bhandara tahsil is an exception where rabi crops predominate. The kharif season commences from June, i.e., from the Mrug Nakshatra and continues up to the end of November. Only in case of paddy the kharif season starts from May-June and continues up to November-December. The south-west monsoon which starts from June is mainly useful for pre-sowing preparatory tillage of the soil. The regular south-west rains set in by the fourth week of June. The sowing operations start with these rains and last for over 10 days. Rice, which is grown throughout the district, is drilled in the fields by the end of June. Rice and tur are the main crops grown in kharif season in the district.

The rabi season commences from the middle of October. The major rabi crops in the district are wheat, jowar, gram, lakhori and linseed. Sowing of wheat and gram begins from the second or third week of October while that of rabi jowar from the third week of September to second week of October. They are sown in non-irrigated fields. The crops in irrigated fields could be sown later. Wheat and gram are ready for harvesting in March. Rabi jowar and linseed are harvested in February.

GYPM initated Crop Diversity survey from 1998 to 2002 for Agriculture Diversity Research Award Program for South Asia Network on Food Ecology and Culture (SANFEC) in collaboration with International Development Research Center, Canada (IDRC). Based on our research study and survey we mapped geographical region, types of agroseasons, crop diversity and process of cultivation. We also observed majority of crop diversity is on the verge of extinction. We found 108 paddy varieties, minor millets, major millets, black linseed and white flax seed. We observed 10 scented varieties of paddy and 66 wild edible vegetables. We were able to meet farmers who had this last resort of seeds. We had discussion with farmers and initiated to save valuable, ecological and sustainable form of agriculture practices, their culture and festivals related to crop diversity. Ara of operation of the Organisation:

Journey with MGBP

Key issues

- Identification of traditional crop varieties and conserving their seeds
- Conducting capacity building workshops to sensitize farmers about need and importance of creating people's biodiversity registers
- Creating seed banks for easy distribution

- Training farmers to get better yields with less inputs
- In situ conservation of crop varieties
- Formation of Centralized Community seed bank in Bhandara
- Data generation on 19 varieties of traditional crops that were grown in the region before monoculture set in as impact of green revolution.
- Value addition to agricultural produce (Rice) to make it market ready.
- Motivating farmers to cultivate crop landraces by informing them about the SRI method for better rice yield. This helped in warding off the prejudice that indigenous varieties cannot give good yield.

Objectives

- To build up a systematic inventory of crop genetic resources of the Bhandara, Gondia and Chandrapur Districts of the Maharashtra State
- To identify one variety in each district for in situ demonstration at *on farm* conservation, upgradation, value addition, marketing, and registration
- To establish district level seed banks focusing on traditional cultivars of superior quality
- To engage educational institutions in study and promotion of crop genetic resources

Sampling methods

As mentioned earlier GYPM had done survey during 1998 to 2002 in this area. Based on our meetings with local farmers (Seed Conservators), we first documented availability of seed with our farmers. Seed testing and purification process were documented, and package of practice was developed.

After the baseline survey in three districts we formed seed savers group in each village. Before that we ensured farmers and their family's participation in our trainings. Rigorous trainings were organised at village level. After training for seed selection, testing and purification, we introduced them with package of practices of seed nursery. Later we continued monitoring of plantation, types of plantation and harvesting package. We developed pest and other growth monitoring sheets. We also trained about DUS guidelines of monitoring process for farmers.

After selection of farmers, we developed demonstration plots on their farm after proper training and monitoring at local level. Detailed observation parameters were set up with our field mobilisers and data was collected at regular intervals.

In the last 5 years of MGB project, we have worked with 1075 farmers. We have also experimented on two plots given by Agriculture Department of Maharashtra for demonstration of paddy varieties. Details data is given in Annexure 1.

Sr. No.	District	Cluster/Block	No. of Villages	Focussed Crop
1	Bhandara	Sakoli	12	Rice (Hiranakki, Luchai, Kalikammo), Lakhori (pulse) and Jawas (White)
2	Bhandara	Bhandara	8	Rice, (Hiranakki, Kalikammo, Dhubhraj & Luchai) Lakhori (pulse), Jawas (brown)
3	Gondia	Sadak Arjuni	12	Rice (Hiranakki, Kalikammo, Dhubhraj &Luchai), Lakhori (pulse), Jawas (brown) and Ranbhaji in village and adjacent forest areas
4	Gondia	Arjuni Morgaon	9	Rice (Hiranakki, Kalikammo, Dhubhraj & Luchai), and wild vegetables (32 varieties) in village and adjacent forest areas
5	Chandrapur	Bramhapuri	16	Rice (Hiranakki, Kalikammo, Dhubhraj & Luchai), Lakhori (pulse), Jawas (brown)
6	Chandrapur	Nagbhid	8	Rice (Hiranakki, Kalikammo, Dhubhraj & Luchai), Lakhori (pulse), Jawas (brown)

Sr. No.	District	Taluka	Villages	Totla Farmers	Kharif	Rabi
1	Bhandara	Bhandara	8	129	64	65
		Sakoli	12	210	96	114
2	Gondia	Moregaon Arjuni	9	202	116	86
		Sadak Arjuni	12	194	74	120
3	Chandrapur	Bramhapuri	16	235	128	107
		Nagbhid	8	105	61	44
		Total	65	1075	539	536

Major work done under MGBP

Objectives

As mentioned earlier, project was to build up systematic inventory of crop genetic resources of the Bhandara, Gondia and Chandrapur district of the Maharashtra State and also to identify one variety in each district for cultivation on experimental basis in in-situ conditions. The aim of the project was conservation, upgradation, value addition to the farm produce, marketing the finished product and registration.

Other major objective was to develop traditional seed variety focussing on traditional cultivars of superior quality.

Work done

1. A variety each from indigenous crops was identified for each of the districts for cultivation on pilot basis.

2. After selection of varieties, seed banks were created, both at Block level and central level

3. We have documented morphological data of varieties of paddy, linseed and Lathyrus (Indian Pea) pulse variety. Data has been submitted for database development.

4. Production of value-added products for better marketing of crop varieties.

5. Creating awareness about the importance of People's Biodiversity Register - we have formed 36 Biodiversity Management Committees and documented 6 People's Biodiversity Registers

6. Sensitizing school students about the importance of crop diversity. We have worked with 13 schools, and 787 students carried out different activities like awareness of biodiversity registers, varieties of plants, preparing natural resources map, herbarium, food diversity and traditional recipes.

Experience with Gene Bank Project

Associating with Gene Bank Project helped GYPM to learn the process of seed conservation in a scientific manner. Through the project we learnt the importance of cultivating varieties using DUS guidelines and then further characterize these varieties (to identify distinct traits). Prior to this collaboration, the seed conservation programme was based on general awareness, without sound understanding of scientific processes (DUS guidelines) involved. Using the knowledge imparted through gene bank project, GYPM could identify truly distinct varieties of crops being cultivated in the area of work.

Owing to monetary and logistical help that MGB has provided, the outreach of the project could be scaled up, thus involving more farmers from the region.

Achievements:

1.At present 1075 farmers are cultivating 3 paddy, 2 lakhori and 2 varieties of flax seeds (oilseed). We had developed package of practices for seed collection, testing, purification and also developed DUS guidelines for farmers to monitor their crops and harvest. We observed that there are no diseases and pests in the demonstration plots. We have seen there is 5% of increase in production, which encouraged more farmers to take production of traditional varieties of crops. We have done process of documentation under DUS guidelines and value addition of product. Hiranaki variety has aroma and is good for recipes like kheer.

2. We have filed application for two paddy seed varieties- Hiranaki and Piwli Luchai for Registration under PPVFRA.

3. We are promoting cultivation of Ranbhaji (forest vegetables) in kitchen gardens of 400 families currently. The number is increasing every year, since we are getting good response from the communities.

4. Under CEE program we had conducted Biodiversity programs in 14 schools, 14 teachers trained in three districts; and more than 332 students were made aware about local biodiversity, food security, nutrition security, kitchen garden and water conservation and also health awareness.

5. Increase of yield in Pivli Luchai variety: Before beginning of the project (in 2014) it was 800kg /acre, at present, it has reached to around 1500 kg/acre. Yield of another variety Hirranaki grew from 800kg/acre before 2014 to 1600 kg/acre at present.

By making farmers use these varieties, we could convince them of its potential marketability. Eventually our farmers benefitted, as some succeeded in selling their produce for a price as high as Rs. 80 per kg. The project was initiated with the understanding that Luchai is a popular rice variety among people. But during the marketing process, we learnt that due to availability of thinner varieties, people are refusing to accept thicker varieties like Luchai. Many buyers even returned the stock they bought in the local markets of Bhandara.

Qualitative impact of the work

Prior to engagement with this project, farmers from the area of our work were unaware about the process of seed cultivation and certification. Engagement with the MGBP has helped in percolation of this knowledge among farmers.

See Annexure 2

We are able to monitor our demo plots under given indicators and DUS guidelines. Tremendous development in paddy was seen in three indicator levels like cropping pattern, seed production and varieties.

Community participation in MGBP process

GYPM has always been working with farmers in different areas on themes like livelihood enhancement, women empowerment, watershed management etc. During meetings, Avil Borkar learnt that some farmers are keen on reviving the varieties that got lost due to various reasons, unfavourable market being one of them. This gave him the idea to initiate a project which would revive these landraces and thus gauge if they are more beneficial than the varieties existing in today's market. A baseline survey was thus planned in 2014, through which GYPM collected seeds that farmers had preserved for long. For example, a tribal farmer Wadve from Tumsar taluka had been growing Hiranakki variety solely for his own consumption. While working with farmers, we learnt that plastic bags work better than bags made of bamboo fibre, for storing seeds. We were able to collect data m 35 varieties of traditional cultivation (including paddy, pulses, oilseeds, wild edible vegetables), medicinal use, 39 existing and varieties, 35 pest data, 25 disease data, 10 various grain and seed storage data and 16 crops storage data.

Beneficiaries

The project did not focus on any particular community. However, through the programme it was realized that women play important role in in-situ conservation. Owing to the traditional knowledge that has been passed down by women over generations, they are equipped with the techniques of cleaning, storing and selecting good seeds, largely based on the physical characteristics.

It was never our focus to engage with just one particular community. From our interactions though, we noticed that farmers with small and medium land holdings (6 acres and below) are more keen to experiment with crop varieties that we identified. Our focus was *on farm* conservation, up gradation, value addition, marketing, registration of varieties and to establish district level seed banks focusing on traditional cultivars of superior quality.

1075 farmers who cultivated these identified varieties are direct beneficiaries of the project. On the matter of documenting People's Biodiversity registers we are working with about 5000 people. This group also include students, whom we are trying to sensitize about the importance of crop diversity and how it can be promoted through the medium of technical education.

- Community has benefitted in short term

1. Process of conserving tradition seeds techniques are low cost. According to our calculations, an average of Rs. 18,000 per acre is spent in high yield variety (chemical based) farming. Computing the money invested by 540 farmers associated with the project, we found that average spending comes down to as low as Rs. 10,000 per acre with this technique. (Annexure 2)

2. Process of community seed banks has given good exposure to conserve their seeds.

3. Initially, just 81 farmers were associated with our project. In four years, 489 farmers volunteered to work with us. Women from these 260 families are responsible for cleaning, storing and selecting good seeds. Men on the other hand look after sowing and protecting crops in field.

- Community benefitted in long term

1.Conservation of local crop landraces.

2.Awareness about preserving and promoting diversity in crop varieties.

3. Regular supply of climate resilient seeds at village level (3 paddy varieties)

- Monetary Benefits

1. Fetching good price for rice as it has good quality of rice and aroma.

2. Fetching good price for seeds at local market.

3. Develop seed bank for regular availability seeds at low price and exchange of seeds.

- Rights based benefits

1. We were able to understand importance of Registration of seeds under PPVFRA Act 2001 and Seed Act 2001.

2. We have formed 36 Biodiveristy Management committees and 6 village Biodiversity Registers under Access to benefits and sharing as per Biodiversity Act 2002 (Annexure 3)

Relationship with PPVFRA, BMC and NBGPR;

New varieties reported and registered, Raanbhajya and other non-commercial food.

- We are presently documenting two varieties as per DUS testing guidelines. We are in process registering of two varieties of paddy, one is Hiranaki and PiwliLuchai with PPVFRA on behalf of Local Seed Conservators.
- We are in discussion with Maharashtra State Biodiversity Board to access sharing resources of crop diversity (Seeds can be shared at local level)

Economics of seed banks, economics of traditional varieties

Seed Banks of traditional varieties is based on seed collection, testing and purification. Mostly it is possible at cluster level and seed savers interest. Most of the seed savers are not aware of its specification and characterisations. Majority of farmers are not aware of production and yield of traditional varieties. But after long term engagement farmers rely on traditional varieties but subject to implemental of proper package of practices. Seed bank should be supported at policy level and public investment is much needed at local level. Farmers can easily treat selling seed as small entrepreneurship in cluster level. We have 3 cluster level seeds exchange centre and one central level Seed Bank in Bhandara.

Collection of data

Data collected during the MGB project has been submitted to the database development as per the common approved formats. Details are given below: sample data is given in Annexure 4. Full data available at http://mgb.iiserpune.ac.in

Sr. No.	Table	No. of Records	Total No. of Records
1	1) Area Biodiversity		129
	Grain	21	
	Pulses	24	
	Oil Seed	9	
	Spices	10	
	Millets	4	
	Vegetable	30	
	Wild Vegetable	31	
2	2) Morphological Data		184
	Paddy	110	
	Flaxseed	39	
	Indian Pea	35	
3	3) BMC	36	36
4	4) PBR	6	6
	Total	**355**	**355**

Education related activities

In collaboration with CEE, Pune outreach activities were conducted as below:

Environment education program was implemented in 13 schools in Bhandara Taluka. Environmental education in schools is often neglected due to prioritizing examination centred learning. The projects were also being done by students mostly with readymade material. GYPM, with the help of CEE and permission of school management, created awareness among school teachers on the importance and method of teaching environment education. Students were given awareness about biodiversity and its conservation using the following topics:

- Study of traditional varieties
- Shivar Pheri for farm information
- Awareness about Biodiversity Committee
- Observation and recording of agricultural activities
- Student groups were formed for collection of seed of local varieties
- Information was collected on wild edible vegetables
- Flower bouquet preparation and collecting information on various flowers
- Tree plantation
- Cleanliness of village
- Preparation of village resource map
- Establishment of biodiversity committees in villages
- Drawing pictures of agriculture related aspects

List of participating schools is given below. Activities conducted with these schools is summarized in Annexure 5.

Sr No	Name of School	Village	Post	Teacher	Distance From Bhandara to Village (Km)	Logic behind their selection
1	Tirupati Vidyalaya, Madgi, Tal+District - Bhandara	Madgi	Kesalwada	G. M. Shende	29.9	जंगल व्याप्त गाव व शाळा
2	Sushil Adivasi Ashram Vidyalaya, Madgi, Tal+District - Bhandara	Madgi (Tekepar)	Kesalwada Vaghaye	P. S. Shahare	13.5	जंगल व्याप्त गाव व शाळा
3	Vittal Prasad Dube Vidyalaya, Gunthara, Tal+District - Bhandara	Gunthara	Gunthara	D. R. Uikey	17.9	कृषि जैवविविधते असलेले गाव व शाळा
4	Gandhi Vidyalaya, Pahela, Tal+District - Bhandara	Pahela	Pahela	Shamarao There	19.7	ग्रामीण परिसरातील सर्वोत्तम शाळा व शिक्षकाची मागणी
5	Adharsh Vidyalaya, Davadipar, Tal+District - Bhandara	Davdipar	Davdipar	Maroti Lanjewar	11.3	शिक्षकाची मागणी व कृषि जैवविविधता
6	Chaitanya Vidyalaya, Manegaon, Tal+District - Bhandara	Manegoan (Ba)	Manegoan	N. P. Khobragade	14.6	जल व कृषि जैवविविधता असलेले गाव
7	Vanvaibhav Adivasi Ashram Vidyalaya, Koka, Tal+District - Bhandara	Koka	Koka	Gita Tidke	27.2	आदिवासी बहुल गाव, आदिवासी विद्यार्थ्यांची शाळा व नैसर्गिक समृद्धी असलेले गाव
8	Vinod Vidyalaya, Tekepar, Tal+District - Bhandara	Tekepar (Dodmazari)	Amgoan Dhigori	D. N. Mhaske	13.6	जंगल व्याप्त गाव व शाळा
9	J. J. Highschool, Bhilewada, Tal+District - Bhandara	Bhilewada	Kardha	Ajay Walde	6.3	निवड झालेल्या क्लस्टर मध्ये येत असल्यामुळे
10	Jilha Parishad Highschool, Dhargaon, Tal+District - Bhandara	Dhargoan	Dhrgoan	S. B. Khurchani	15.7	जल व कृषि जैवविविधता असलेले गाव
11	Prakash Highschool, Kardha, Tal+District - Bhandara	Kardha	Kardha	Bharti Telmasare	5.9	वैनगंगेच्या काठावर असलेले गाव
12	Devi Sarsawati Vidyalaya, Shingori, Tal+District - Bhandara	Singori	Amgoan Digori	Viaks Wanjari	13.1	कृषि जैवविविधते असलेले गाव व शाळा
13	Navprabhat Vidyalaya, Amgaon, Tal+District - Bhandara	Amgoan Digori	Amgoan Digori	S. D. Bhoyar	12	कृषि जैवविविधते असलेले गाव व शाळा

List of publications

Presentations at conferences

- In 2018 and 2019 we participated in District Agri Expo in Bhandara District and Beejotsav in Nagpur, and presented about Crop Diversity and its importance of Vidarbha Region
- Participated in National level Seed Policy in Hyderabad organised by WASSAN, RRAN, and Agriculture Department of Government of India, Andhra Pradesh and Telangana on March 8-9, 2018.
- We participated in 1st International Agrobiodiversity Congress in Delhi in 2016. Our Poster was selected for the Congress on Community managed traditional seed.

News report

- Links to press coverage:

- https://timesofindia.indiatimes.com/city/nagpur/19-varieties-of-rice-in-10-acres-ngo-shows-the-way/articleshow/63775275.cms.
- https://timesofindia.indiatimes.com/city/nagpur/green-revolution-has-left-us-with-water-scarcity-and-land-infertility/articleshow/63954260.cms. Avil Borkar interview with TOI.

Networking with other MGBP groups

We are associated with ASHA network Alliance for Sustainable and Holistic Agriculture or ASHA-Kisan Swaraj network is a volunteer-driven large informal network of organisations and individuals that initially came together in 2010.

The network consists of farmers' organisations, consumer groups, women's organisations, environmental organisations, individual citizens and experts who are committed to the cause of sustainable and viable farm livelihoods in rural India by ensuring that productive resources are in the control of farming communities and thereby, safe, nutritious, diverse and adequate food is available for all Indians.

ASHA works with a mission to strengthen sustainable agricultural livelihoods and food diversity/safety/ nutrition by re-orienting policies, practices and public consciousness, towards a holistic vision of social, environmental and economic justice as described in the Kisan Swaraj Neeti. It is a network that enables, and draws upon synergies of collective wisdom and action, based on mutual trust and respect.

The four pillars of Kisan Swaraj Neeti are (1) income security for farm households; (2) ecological sustainability of agriculture; (3) people's control over agricultural resources like land, water and seed; and (4) access to safe, healthy, nutritious and sufficient food for all. We learned exchange skill share and knowledge.

We are part of NITI Ayog on Bharat Krishi project to understand traditional agriculture practices and public investment policies.

Connection with people beyond beneficiaries

- Journalists who are actively involved in studying agriculture related issues have taken a note of our projects. Times of India, for example, has interviewed our founder, Mr. Borkar about the models he is trying to promote in Vidarbha's agriculture scenario. Rural journalist Jaideep Hardikar too wrote about GYPM's model for revival of traditional, climate resilient crops.
- (Refer: https://www.in.undp.org/content/india/en/home/ climate-and-disaster-reslience/successstories/pari-undp-series/belated-rains-bhandara.html)
- We had association with Tata Institute of Social Sciences (TISS), Tuljapur Campus, engaged with students and researchers who were interested in studying about seed systems, conservation of crop diversity and agronomic techniques like SRI, etc. About 14 students from TISS have visited our work areas to learn about the projects. As part of the program students have documented crop diversity in two villages.
- Mr. D.K. Sadana, Ex Director of National Bureau of Animal Genetic resources, expert in preservation and promotion of native livestock breed, enlightened us about the need of preserving the unidentified varieties. He also stressed on importance of crop diversity in that area.
- Dr. Tarak Kate Agro Ecologist visited our field area and suggested us to study multi crops cultivation in our area.

Knowledge Outcomes

- As per our data we came to know and understand that communities knew these all process, but the production and yield was important for them.
- Communities are more aware of wild vegetables, seasonal calendar, local beans, grass and other varieties consume in area.

Observation about ecology – regeneration/ depletion/ conservation: Using organic farming techniques helped in reviving the population of Earthworms in the soil. Those in turn helped in loosening of the soil, leading to increased percolation of rain water and thereby increasing the capacity of the soil to retain moisture. This also promotes growth of other organisms which aid in essential activities like Nitrogen fixation.

New realizations emerged

It is important that institutions equip farmers about ways in which they can identify distinct varieties and ways to preserve them.

Marketability is an important factor (maybe the most important one) that farmers look at while sowing a particular crop. The concept of growing seeds is never the focus of a farmer. Earnings from selling crops is the only focus. This is why about 60 per cent of the farmers left the project after one year. This is a persisting trend since the initiation of the project. Bottomline is, unless farmers see seed as a commodity, they are not going to stick with the project. And for documenting various factors, that can only be observed in long term, continuous engagement of the farmers is necessary (at least for more than 2 years). So that ecological impact, etc. can be studies properly.

Failure stories

Seed Bank- Maintenance of seed bank was at first initiated at taluka level. It was noticed however, that the maintenance by individual farmers on local level has many challenges, such as lack of awareness among farmers to maintain seeds. Some contamination was noticed in the seed banks maintained by the farmer. This leads to compromise with seed quality. Thus, we decided to develop a centralized seed bank.

Way Forward

- This project is important as this will demonstrate the importance of registration under PPVFRA and will also impart knowledge on the process. The future activities should include further knowledge sharing and promotion of this concept for biodiversity conservation. Efforts are also to be undertaken to promote the consumption of produce from local crop varieties. Further, it will also be necessary to lobby with the government and other agencies to bring about an encouraging environment for the propagation of local crop varieties.
- We would like to hold regular meeting with farmers, government officials and experts to share our views and get their feedback on our work regularly.

List of staff involved in the project

Sr No	Name	Date of Joining	Date of Relieving	Qualifi-cation	Designation
1	Avil Borkar	01/04/2014	31/03/2020	B.A.	Principal Investigator
2.	Sudhir M. Dhakate	01/04/2014	31/03/2018	M. Sc. Ag.	Project Coordinator
3	Datta K. K. Chaterjee	01/04/2018	31/03/2019	M. Sc. (Botany)	Project Coordinator
4.	Kamlesh Turkar	01/04/2014	30/09/2014	B.Sc. Ag.	Project Assistant
5.	Deovilas Bhogare	01/10/2014	31/03/2016	B.Sc. Ag.	Project Assistant
6.	Rajshri Kamble	01/04/2016	31/03/2017	B.Sc. Ag.	Project Assistant
7.	Arvind Dhargave	01/04/2017	31/03/2018	B.Sc. Ag.	Project Assistant
8	Sachin Bondare	01/04/2018	31/03/2019	B.Sc. Ag.	Project Assistant
9.	Mrunali Khobragade	01/04/2014	31/03/2017	B.A.D. Ed	Environment Teacher
10.	Jageshwar Pal	01/04/2017	31/03/2019	M.A.D. Ed	Environment Teacher
11.	Jitendra Khobragade	01/04/2014	31/03/2016	Agri. Diploma	Farmer Motivator Tah -Bhandara
12.	JitendraWanjari	01/04/2016	31/03/2019	M.A. Soc.	Farmer Motivator Tah -Bhandara
13.	Dnyaneshwar Bankar	01/04/2014	31/03/2018	M..Sc. Botany	Farmer Motivator Sakoli, DistBhandara
14.	KishorMeshram	01/04/2018	31/03/2019	12th	Farmer Motivator Sakoli, DistBhandara
15.	Rumesh Shahare	01/04/2014	30/08/2014	B.Sc.	Farmer Motivator Morgaon Arjuni, District Gondia
16.	Devendra Raut	01/09/2014	31/03/2019	B.A.	Farmer Motivator Morgaon Arjuni, District Gondia
17.	Omprakash Funde	01/04/2014	30/06/2016	B.Sc.	Farmer Motivator SadakArjuni, District Gondia
18.	Prabhu Bagde	01/08/2016	31/03/2017	12th	Farmer Motivator SadakArjuni, District Gondia
19.	Giridhari Bansod	01/04/2017	31/03/2019	M.A.	Farmer Motivator SadakArjuni, District Gondia
20.	Asmita Dhondge	01/04/2014	31/03/2015	B.A.	Farmer Motivator Bramhapuri District Chandrapur
21.	Chatrapati Baghmare	01/04/2015	31/03/2018	M.A.	Farmer Motivator Bramhapuri District Chandrapur
22.	Vinod Gomaji Wasnik	01/04/2018	31/03/2019	M.A.	Farmer Motivator Bramhapuri District Chandrapur
23.	Mahadeo Kore	01/04/2014	31/03/2018	10th	Farmer Motivator Nagbhid, District Chandrapur
24.	Eknath Gajbhiye	01/04/2018	31/03/2019	M.A.	Farmer Motivator Nagbhid, District Chandrapur

Dhubhraj

Collection area : Bhandara & Sakoli blocks (Bhandara District)

Season of cultivation: *Kharif*

Days to maturity: 124-128

Plant height (cm): 130-134

Panicle characters: Semi straight, Erect to semi-erect attitude of branching, Panicle Awns Present, Exertion Mostly Exerted, Panicle length - Very Long, Panicle awns color - Yellowish white.

Grain characters: Grain is medium, slender and scented. White Rice

Average yield (q/ha): Rain fed – 30 and Irrigated - 34

Special features: Awns present hence less attack of wild animals, it has been used for Khir preparation and for Special dishes during Diwali, Pola & Sankaranti.

Hiranakki

Collection area: Bhandara, Sakoli, Moregaon arjuni block, Bhandara & gondia district

Season of cultivation: *Kharif*

Days to maturity: 118-124

Plant height (cm): 138- 142

Panicle characters: Deflexed, erect to semi-erect attitude of branching, panicle exertion – well exerted, Panicle length – Medium

Grain characters: Short bold, Scented, White Rice

Average yield (q/ha): Rainfed – 35 and Irrigated - 38

Special features: Used for religious and cultural purposes & specially preparing for kheer. Apex colour is of black colored hence it is Denominated as Hiranakki.

Pandhara Javas (Flax seed)

Collection area: Sakoli Block (Bhandara District)

Sowing season: *Rabbi*

Flower Shape: Star

Flower Color: Violet

Growth habit: Erect

Days of maturity: 93-105

Plant height (cm): 51-73

Pod characters: Capsule Size – average 7.8mm, Capsule - Indehiscent

Seed characters: Seed size is medium (4.7-5 mm) & Seed Colour is Whitish yellow

Special features: Plant Growth habit is erect (Top Branching) & sometimes semi-erect (Lateral branching) as well as Bushy (Bushy Branching), Oil Used for cooking & as a medicine. Color of seed is White. Hence, It is known as Pandhara Jawas.

CASE STUDY - 2

Seed Saver Non-profit Helps Tinkering Farmers in Bhandara

BHANDARA DISTRICT

Maruti Maske, a middle-aged farmer from Vakeshwar village of Bhandara district turned to growing Dubraj; a traditional paddy variety in 2018, having learnt that its scent and thin grain is preferred by local buyers. But the seeds were hard to find. Maske turned to Gramin Yuva Pragatik Mandal (GYPM) for help and borrowed seeds for 2 acres of land.

Vina Amrut Kumbhre is a 34-year-old widowed tribal farmer, trying to sustain by growing vegetables in her backyard; 2 acre of forest land claimed under Forest Rights Act. In her backyard, Vina grows rare-to-find gourds and beans. Her love for rare vegetables like different kinds of okra brought her in contact with GYPM, a Bhandara-based non-profit.

Radhelal Wadve is a farmer from the Gond tribe. The septuagenar tan farmer was the only one in the block to have preserved seeds of Hiranakki; a traditional paddy variety characterized by a black dot on its tip. He continues to grow the crop for his household consumption. In 2014, he contributed his seeds to the seed bank being created by GYPM for promotion of traditional land races among farmers.

Avil Borkar, a veteran agriculturist and activist founded Gramin Yuva Pragatik Mandal, a Bhandara based non-profit in 1987. Since the inception the organization has worked towards improving livelihoods of farmers, especially tribals living in Gondia, Bhandara and Chandrapur districts of Maharashtra, through projects like Wadi.

Starting 2014, GYPM initiated a program me to revive traditional land races in Bhandara, Gondia and Chandrapur districts. The organization also received help from Maharashtra Gene Bank Project; a State Government biodiversity.

During the initial phases of the programme, GYPM collected seeds of 40 distinct land races from farmers. Of these, two paddy varieties, one pulse variety and two oilseeds varieties were selected for promotion, looking at the demand in the market. Over the four year of GYPM's engagement, about 100 farmers experimented with growing seeds and thus learnt intricacies of seeds production; including DUS tests-the standard procedure of seed certification prescribed under PPVFR Act.

By 2018, it was noticed that some farmers, obtained higher yields in their Hiranakki farms. The yield went up from 800 kilograms per acre to about 1300 per acre.

(This case study is sourced from Gramin Yuva Pragatik Mandal, a Bhandara based non-profit).

2

महाराष्ट्र टाइम्स नागपूर । मंगळवार, ३ सप्टेंबर २०१९

धानसंवर्धन काळाची गरज

सर्ग-निसर्ग

प्रतिक्रियेसाठी mtnagpletters@gmail.com

लेखक पर्यावरण व सामाजिक धोरणाचे अभ्यासक आहेत.

Training

Production

Seed Bank

Double blind Testing

Program

Melawa

CEE Program

Biodiversity

Lakhori

Javas




Annexure 1

Details of the villages covered in MGB project

Sr. No.	Village Name	Taluka	District	Total No of farmers selected	Season (Kharif)	Season (Rabi)	Crop Name(Kharif/Rabi)
1	Sukali	Sakoli	Bhandara	32	13	19	Paddy/Flaxseed-Indian pea
2	Wadad	Sakoli	Bhandara	49	21	28	Paddy/Flaxseed-Indian pea
3	Papda	Sakoli	Bhandara	29	18	11	Paddy/Flaxseed-Indian pea
4	Mahalgaon	Sakoli	Bhandara	30	12	18	Paddy/Flaxseed-Indian pea
5	Sonaka	Sakoli	Bhandara	6	2	4	Paddy/Flaxseed-Indian pea
6	Palasgaon	Sakoli	Bhandara	21	10	11	Paddy/Flaxseed-Indian pea
7	Sonpuri	Sakoli	Bhandara	8	8	0	Paddy
8	Amgaon	Sakoli	Bhandara	8	8	0	Paddy
9	Umari	Sakoli	Bhandara	4	4	0	Paddy
10	Sakhara	Sakoli	Bhandara	9	0	9	Flaxseed-Indian pea
11	Jhadgaon	Sakoli	Bhandara	10	0	10	Flaxseed-Indian pea
12	Shivaniband	Sakoli	Bhandara	4	0	4	Flaxseed-Indian pea
	Total			**210**	**96**	**114**	
1	Golewadi	Bhandara	Bhandara	20	9	11	Paddy/Flaxseed-Indian pea
2	Pahela	Bhandara	Bhandara	28	11	17	Paddy/Flaxseed-Indian pea
3	Nimgaon	Bhandara	Bhandara	18	9	9	Paddy/Flaxseed-Indian pea
4	Wakeshwar	Bhandara	Bhandara	12	6	6	Paddy/Flaxseed-Indian pea
5	Chikalpahela	Bhandara	Bhandara	12	6	6	Paddy/Flaxseed-Indian pea
6	Chowa	Bhandara	Bhandara	12	8	4	Paddy/Flaxseed-Indian pea
7	Pagora	Bhandara	Bhandara	8	4	4	Paddy/Flaxseed-Indian pea
8	Rawanvadi	Bhandara	Bhandara	19	11	8	Paddy/Flaxseed-Indian pea
	Total			**129**	**64**	**65**	
1	Rampuri	Brahmapuri	Chandrapur	10	10	0	Paddy
2	Rampur	Brahmapuri	Chandrapur	13	7	6	Paddy/Flaxseed-Indian pea
3	Parsodi	Brahmapuri	Chandrapur	17	17	0	Flaxseed-Indian pea
4	Navegaon	Brahmapuri	Chandrapur	28	8	20	Paddy/Flaxseed-Indian pea
5	Tukum	Brahmapuri	Chandrapur	15	15	0	Paddy
6	Chak Bothli	Brahmapuri	Chandrapur	40	12	28	Paddy/Flaxseed-Indian pea
7	Tulaan	Brahmapuri	Chandrapur	7	4	3	Paddy/Flaxseed-Indian pea
8	Tulhan Menda	Brahmapuri	Chandrapur	11	8	3	Paddy/Flaxseed-Indian pea
9	Dharamgoan	Brahmapuri	Chandrapur	4	4	0	Paddy
10	Ranbothali	Brahmapuri	Chandrapur	16	2	14	Paddy/Flaxseed-Indian pea
11	Adyal	Brahmapuri	Chandrapur	7	7	0	Paddy
12	Bhagvanpur	Brahmapuri	Chandrapur	9	9	0	Paddy
13	Chorti	Brahmapuri	Chandrapur	16	6	10	Paddy/Flaxseed-Indian pea

Sr. No.	Village Name	Taluka	District	Total No of farmers selected	Season (Kharif)	Season (Rabi)	Crop Name(Kharif/Rabi)
14	Vaigaon	Brahmapuri	Chandrapur	11	5	6	Paddy/Flaxseed-Indian pea
15	Dhudhwahi	Brahmapuri	Chandrapur	16	8	8	Paddy/Flaxseed-Indian pea
16	Chandgaon	Brahmapuri	Chandrapur	15	6	9	Paddy/Flaxseed-Indian pea
	Total			**235**	**128**	**107**	
1	Mohadi	Nagbhid	Chandrapur	13	8	5	Paddy/Flaxseed-Indian pea
2	Banwahi	Nagbhid	Chandrapur	16	8	8	Paddy/Flaxseed-Indian pea
3	Mangali	Nagbhid	Chandrapur	11	6	5	Paddy/Flaxseed-Indian pea
4	Kotgaon	Nagbhid	Chandrapur	13	8	5	Paddy/Flaxseed-Indian pea
5	Vilamb	Nagbhid	Chandrapur	14	8	6	Paddy/Flaxseed-Indian pea
6	Kothurna	Nagbhid	Chandrapur	15	9	6	Paddy/Flaxseed-Indian pea
7	Bikali	Nagbhid	Chandrapur	12	7	5	Paddy/Flaxseed-Indian pea
8	Bamhani	Nagbhid	Chandrapur	11	7	4	Paddy/Flaxseed-Indian pea
	Total			**105**	**61**	**44**	
1	Khairi	Arjuni/Morgaon	Gondia	34	16	18	Paddy/Flaxseed-Indian pea
2	Kumbhitola	Arjuni/Morgaon	Gondia	43	26	17	Paddy/Flaxseed-Indian pea
3	Sukli	Arjuni/Morgaon	Gondia	25	13	12	Paddy/Flaxseed-Indian pea
4	Barabhati	Arjuni/Morgaon	Gondia	33	18	15	Paddy/Flaxseed-Indian pea
5	Bolde	Arjuni/Morgaon	Gondia	35	14	21	Paddy/Flaxseed-Indian pea
6	Baradhali	Arjuni/Morgaon	Gondia	3	0	3	Flaxseed-Indian pea
7	Pratabhgad	Arjuni/Morgaon	Gondia	10	10	0	Paddy
8	Dabhna	Arjuni/Morgaon	Gondia	6	6	0	Paddy
9	Tidka	Arjuni/Morgaon	Gondia	13	13	0	Paddy
	Total			**202**	**116**	**86**	
1	Kesalwada	Sadak Arjuni	Gondia	50	14	36	Paddy/Flaxseed-Indian pea
2	Parsodi	Sadak Arjuni	Gondia	1	1	0	Paddy
3	Raka	Sadak Arjuni	Gondia	9	9	0	Paddy
4	Mhaswani	Sadak Arjuni	Gondia	25	1	24	Paddy/Flaxseed-Indian pea
5	Maneri	Sadak Arjuni	Gondia	34	1	33	Paddy/Flaxseed-Indian pea
6	Ushikheda	Sadak Arjuni	Gondia	1	1	0	Paddy
7	Kodamedhi	Sadak Arjuni	Gondia	34	7	27	Paddy/Flaxseed-Indian pea
8	Kokna	Sadak Arjuni	Gondia	7	7	0	Paddy
9	Bothali	Sadak Arjuni	Gondia	8	8	0	Paddy
10	Shenda	Sadak Arjuni	Gondia	9	9	0	Paddy
11	Telighat bori	Sadak Arjuni	Gondia	8	8	0	Paddy
12	Chikhali	Sadak Arjuni	Gondia	8	8	0	Paddy
	Total			**194**	**74**	**120**	
	Total	**65**		**1075**	**539**	**536**	

Sr. No	District	Taluka	Villages	Totla Farmers	Kharif	Rabi	Kharif Total Area (Are)	Rabi Total Area
1	Bhandara	Bhandara	8	129	64	65	95.62	165.24
		Sakoli	12	210	96	114		
2	Gondia	Moregaon Arjuni	9	202	116	86		
		Sadak Arjuni	12	194	74	120		
3	Chandrapur	Bramhapuri	16	235	128	107		
		Nagbhid	8	105	61	44		
	Total		**65**	**1075**	**539**	**536**	**95.62**	**165.24**

Government Collabration Program - Agriculture Department

Sr. No.	District	Block	Year	Institute Name	Village Name	Variety No.	Area
1	Bhandara	Bhandara	2017-2018	Agriculture Demonstration Center Pahela	Pahela	Paddy -19	4 Acre
2	Bhandara	Pauni	2018-2019	Agriculture Demonstration Center Palora	Palora	Paddy - 4	4 Acre
	Total					**23**	**8 Acre**

Annexure 2

Farmers' data cultivated on traditional paddy seeds

District	Block	Total		Paddy Seed							
				Hiranakki		Dubraj		Luchai		Kalikamo	
		Village	Farmers	Farmer	Cultivated area	Farmer	Cultivated area	Farmer	Cultivated area	Farmer	Cultivated area
Bhandara	Bhandara	7	13	13	2.95	7	3	4	0.8	6	1.075
Bhandara	Mohadi	3	3	3	4	0	0	0	0	0	0
Bhandara	Tumsar	1	1	1	1	0	0	0	0	0	0
Bhandara	Sakoli	4	10	9	2.75	8	2.2	0	0	5	0.95
Bhandara	Lakhandur	1	1	1	1	0	0	0	0	0	0
Bhandara	Pavni	1	1	1	1	0	0	0	0	0	0
Gondia	Sadak/Arjuni	3	4	3	2	1	1	0	0	0	0
Gondia	Mor/Arjuni	2	4	2	0.75	2	0.5	2	0.75	3	1.25
Chandrapur	Bramhapuri	1	7	6	1.375	6	1.375	0	0	5	0.875
Chandrapur	Nagbhid	1	2	0	0	0	0	2	1	0	0
Total	10	24	46	39	15.825	24	9.15	6	2.5	21	4.15

Notes:

- 6 community meetings were organised as follow up on traditional seed processing and cultivation in villages
- Best Practices material in Brochure form for farmers was developed
- Data collection and observation of morphological data, biodiversity data , crop indicators of food and medicines related data is collected
- Achievement: Department of Agriculture has promoted Local traditional seed varieties in Chandrapur, Bhandara and Gondia District. Government has sought our help in procuring local seed , this year government has organised 20 farmers to take local seed cultivation of paddy seeds.
- We had organised 2 day seed workshop 26 and 27th July 2019 in Nagpur in collaboration with Vidarbha Development Board. Prominent scientists Dr B Venkateshwaralu EX VC of Parbhani Agriculture University, Dr Ravi Wanjari Soil Scientist ICAR, Dr C D Mayee (Ex Chairman Agriculture Scientists Board Delhi shared their valuable thoughts with 40 farmers. GYPM published detail stories of 10 Farmers booklet on this occasion.
- Participated in National Seed Policy in Surat Gujarat 31 August to 1 September 2019
- Revitalising Network of India organised National Seed Policy review meeting on 10th September 2019 in Nagpur

Annexure 3

BMC Village List

Sr. No.	Village Name	Taluka	District	Village Biodiversity Committiee (BMC) Established	Biodiversity Register (PBR)
1	Sukali	Sakoli	Bhandara	Sukali	-
2	Wadad	Sakoli	Bhandara	Wadad	-
3	Papda	Sakoli	Bhandara	Papda	Papada
4	Mahalgaon	Sakoli	Bhandara	Mahalgaon	-
5	Palasgaon	Sakoli	Bhandara	Palasgaon	-
6	Jhadgaon	Sakoli	Bhandara	Jhadgaon	Jadgaon
1	Golewadi	Bhandara	Bhandara	Golewadi	-
2	Pahela	Bhandara	Bhandara	Pahela	-
3	Thana	Bhandara	Bhandara	Thana	Thana
4	Madgi	Bhandara	Bhandara	Madgi	Madgi
5	Gunthara	Bhandara	Bhandara	Gunthara	Gunthara
6	Khurshipar	Bhandara	Bhandara	Khurshipar	Khurshipar
1	Rampuri	Brahmapuri	Chandrapur	Rampuri	-
2	Parsodi	Brahmapuri	Chandrapur	Parsodi	-
3	Tukum	Brahmapuri	Chandrapur	Tukum	-
4	Chak Bothli	Brahmapuri	Chandrapur	Chak Bothli	-
5	Tulhan Menda	Brahmapuri	Chandrapur	Tulhan Menda	-
6	Adyal	Brahmapuri	Chandrapur	Adyal	-
1	Mohadi	Nagbhid	Chandrapur	Mohadi	-
2	Banwahi	Nagbhid	Chandrapur	Banwahi	-
3	Mangali	Nagbhid	Chandrapur	Mangali	-
4	Kotgaon	Nagbhid	Chandrapur	Kotgaon	-
5	Vilamb	Nagbhid	Chandrapur	Vilamb	-
6	Bamhani	Nagbhid	Chandrapur	Bamhani	-
1	Khairi	Arjuni/Morgaon	Gondia	Khairi	-
2	Kumbhitola	Arjuni/Morgaon	Gondia	Kumbhitola	-
3	Sukli	Arjuni/Morgaon	Gondia	Sukli	-
4	Barabhati	Arjuni/Morgaon	Gondia	Barabhati	-
5	Dabhna	Arjuni/Morgaon	Gondia	Dabhna	-
6	Tidka	Arjuni/Morgaon	Gondia	Tidka	-

Sr. No.	Village Name	Taluka	District	Village Biodiversity Committiee (BMC) Established	Biodiversity Register (PBR)
1	Kesalwada	Sadak Arjuni	Gondia	Kesalwada	-
2	Parsodi	Sadak Arjuni	Gondia	Parsodi	-
3	Mhaswani	Sadak Arjuni	Gondia	Mhaswani	-
4	Kodamedhi	Sadak Arjuni	Gondia	Kodamedhi	-
5	Telighat bori	Sadak Arjuni	Gondia	Telighat bori	-
6	Chikhali	Sadak Arjuni	Gondia	Chikhali	-

Total District	3
Total Block	6
Total Village	36
Total BMC	36
Total PBR Register	6

Annexure 4

Gramin Yuva Pragatik Mandal

Dated 11/01/2020 **Accession Data**

Sr No	Partner ID	Accession No (Organization name/Taluka/Crop name/Accession no)	Year of Collection	Crop name English	Crop name Scientific	Biological status (Landrace/Farmers variety/Selection)	Name of accession ( )	Name of seed conservator	Village	Taluka	Village code	Pada/ Wadi/ Tola	District	Base line Information
1	**GYPM**	**Gypm/Tu/Rice/01**	2000	Rice	Oryza sativa	Landrace	Pivli Luchai	Hariram Kundlik Deshmukh	Chikhali	Tumsar	536649		Bhandara	Variety is pest resilient, soft and tasty rice, crop guarantee in any soil and popular variety of East Vidarbha
2	**GYPM**	**Gypm/Go/Rice/02**	2000	Rice	Oryza sativa	Landrace	Pandhari Luchai	Tilakchand Nanu Tembhare	Rapewada	Gondia	537844		Gondia	Variety is pest resilient, soft and tasty Rice, crop guarantee in any soil and short duration rice
3	**GYPM**	**Gypm/MA/Rice/03**	2000	Rice	Oryza sativa	Landrace	Lal Luchai	Narayan Sadashiv Kapgate	Pandharwani	Morgaon Arjuni	538061		Gondia	Soft and tasty rice, crop guarantee in any soil and long duration paddy
4	**GYPM**	**Gypm/Mo/Rice/04**	2000	Rice	Oryza sativa	Landrace	Bhedari Luchai	Vasudev Ghabhane	Kushari	Mohadi	536836		Bhandara	Soft and tasty rice, crop guarantee in any soil, grain size is short and short paddy duration
5	**GYPM**	**Gypm/MA/Rice/05**	2000	Rice	Oryza sativa	Landrace	Halki Luchai	Puna Lingu Madavi	Gothangaon	Morgaon Arjuni	538228		Gondia	Variety is pest resilient, soft and tasty rice, crop guarantee in any soil, grain size is long and short duration paddy
6	**GYPM**	**Gypm/Go/Rice/06**	2000	Rice	Oryza sativa	Landrace	Bhari Dubraj	Ramkrushna Khotele	Khambi	Gondia	538275		Gondia	High yielding, medium slender, white kernel, scented and tasty rice, long duration paddy.
7	**GYPM**	**Gypm/Go/Rice/07**	2001	Rice	Oryza sativa	Landrace	Halka Dubraj	Sampat Bahekar	Tedhava	Gondia	537757		Gondia	scented and tasty rice, short duration paddy
8	**GYPM**	**Gypm/Tu/Rice/08**	2009	Rice	Oryza sativa	Landrace	Hiranakki	Radhelal Wadhive	Pavnar Khari	Tumsar	536667	Ganeshpur	Bhandara	Smallest grain among all accessions, white, scented kernel, highly scented and short size rice & used only for making Khir

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9	**GYPM**	**Gypm/SA/Rice/09**	2000	Rice	Oryza sativa	Landrace	Eklombi	Bodku Dayaram Parteki	Sindipar	Sadak Arjuni	538090		Gondia	rainfed paddy variety with less water requirement, short duration paddy
10	**GYPM**	**Gypm/Gor/Rice/10**	2002	Rice	Oryza sativa	Landrace	Tulshi Manjula	Kuvarlal Bhanu Katre	Ghoti	Goregaon	537568		Gondia	Scented and tasty rice, long duration paddy
11	**GYPM**	**Gypm/Tu/Rice/11**	2012	Rice	Oryza sativa	Landrace	Basbhira	Gangadas Khandate	Susurdoh	Tumsar	536646		Bhandara	rainfed paddy variety with less water requirement & long grain
12	**GYPM**	**Gypm/SA/Rice/12**	2014	Rice	Oryza sativa	Landrace	Kakadsar	Devchand Khotele	Kesalwada	Sadak Arjuni	537594		Gondia	tall paddy and thick grain.
13	**GYPM**	**Gypm/Tu/Rice/13**	2012	Rice	Oryza sativa	Landrace	Damrul	Zalakram Salam	Vitpur	Tumsar	536674		Bhandara	Tall paddy, thick grain & Long Duration Paddy.
14	**GYPM**	**Gypm/Sal/Rice/14**	2012	Rice	Oryza sativa	Landrace	Angakor	Boholebaba	Sakharitola	Salekasa	537974		Gondia	tall paddy, tasty rice, thick rice & long duration paddy
15	**GYPM**	**Gypm/MA/Rice/15**	2010	Rice	Oryza sativa	Landrace	Koknehi	Deva Bhudhaji Rane	Gothangaon	Morgaon Arjuni	538228		Gondia	tall & long grain & long duration paddy
16	**GYPM**	**Gypm/Am/Rice/16**	2008	Rice	Oryza sativa	Landrace	Havda Churmure	Shicharan Durugkar	Buraditola	Aamgaon	537891		Gondia	The tribals use murra of this variety, mixed with the bark of phanas plant, to cure prolonged cough.
17	**GYPM**	**Gypm/De/Rice/17**	2009	Rice	Oryza sativa	Landrace	Vishnu bhoj	Rupchand Sontakke	Borgaon	Deori	537628		Gondia	murra & lahya of this variety, mixed with the bark of phanas plan is used to cure prolonged cough
18	**GYPM**	**Gypm/La/Rice/18**	2015	Rice	Oryza sativa	Landrace	Kalikammo	Vinod Masulkar	Mangli	Lakhani	537355		Bhandara	Hull is black in colour without awn, scented lahya for use, Making the Kane use of straw of this paddy
19	**GYPM**	**Gypm/Lk/Rice/19**	2015	Rice	Oryza sativa	Landrace	Pitris	Kundlik Buradkar	Donad	Lakhandur	537463		Bhandara	Popular non scented variety, Leaf sheath having anthocyanine pigmentation
20	**GYPM**	**Gypm/Go/Rice/20**	2013	Rice	Oryza sativa	Landrace	Dhaniya	Harichandra Isru Mankar	Kamtha	Gondia	537828		Gondia	Coleoptyle, basal leaf sheath, ligule and stigma have purple colour.

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21	**GYPM**	**Gypm/Tu/Rice/21**	2015	Rice	Oryza sativa	Landrace	Gurumukhiya	Sukhdeo Masram	Vitpur	Tumsar	536674		Bhandara	Leaf blade have purple margins, high water use in this paddy, soft & tasty rice.
22	**GYPM**	**Gypm/Mo/Rice/22**	2016	Rice	Oryza sativa	Landrace	Kalabhat	Prabhudas Uikey	Salai Khurd	Mohadi	536803		Bhandara	Fully awend with dark balck colour and glutinous kernel & grain size is short
23	**GYPM**	**Gypm/Mo/Rice/23**	2015	Rice	Oryza sativa	Landrace	Tulsi Rahul	Parasram Lilhare	Salai Khurd	Mohadi	536803		Bhandara	Scented rice, variety short slender & used for making khir.
24	**GYPM**	**Gypm/Gor/Rice/24**	2017	Rice	Oryza sativa	Landrace	Kamini	Dr. T. B. Lilhare	Ghoti	Goregan	537568		Gondia	Scented rice variety, short duration variety, grain size is Bold
25	**GYPM**	**Gypm/MA/Rice/25**	2015	Rice	Oryza sativa	Farmers	Khushi	Manda Gavadkar	Khairi	Morgaon Arjuni	537601		Gondia	Small short slender & scented rice
26	**GYPM**	**Gypm/Pa/Sorghum /01**	2001	Sorghum	Sorghum bicolor	Landrace	Motitura	Ramesh Marbate	Gardapar	Pauni	537387		Bhandara	Grain colour is white & famous for Lahya
27	**GYPM**	**Gypm/Pa/Sorghum /02**	2001	Sorghum	Sorghum bicolor	Landrace	Pandhari Jwari	Lilabai Harichandra Meshram	Gardapar	Pauni	537387		Bhandara	Making soft bread & Animal fodder
28	**GYPM**	**Gypm/Pa/Wheat/01**	2000	wheat	Triticum turgidum	Landrace	Jondhrya	Ram Hari Shende	Mendha	Pauni	537294		Bhandara	Grain size is slender, Production is high & plant size is short
29	**GYPM**	**Gypm/Tu/Wheat/02**	2002	wheat	Triticum turgidum	Landrace	Hawra	Vijay Patle	Sonegaon	Tumsar	536718		Bhandara	For making soft white Bread & Noodles
30	**GYPM**	**Gypm/Tu/Maize/01**	2004	Maize	Zea mays	Landrace	Pandhari Makai	Nirmala Chandan Shende	Yerli	Tumsar	536761		Bhandara	Grain colour is white & shaped rounded
31	**GYPM**	**Gypm/Tu/Maize/02**	2003	Maize	Zea mays	Landrace	Makai	Prabha Urkud Bisne	Yerli	Tumsar	536761		Bhandara	Grain size is small & rounded, colour is golden.
32	**GYPM**	**Gypm/Tu/Pigeon Pea/01**	2005	pigeon pea	Cajanus cajan	Landrace	Lal Tur	Kamal Bakaram Bankar	Dongarla	Tumsar	536774		Bhandara	Pest resilient variety:, Grain colour is red.
33	**GYPM**	**Gypm/Tu/Pigeon Pea/02**	2006	pigeon pea	Cajanus cajan	Landrace	PandhariTur	Shalu Bharat Raut	Dongarla	Tumsar	536774		Bhandara	Grain colour is white & xize is bold.
34	**GYPM**	**Gypm/Tu/Pigeon Pea/03**	2001	pigeon pea	Cajanus cajan	Landrace	Gizari Tur	Devanand Mahadeo Patle	Zarli	Tumsar	536760		Bhandara	Colour is black dots on grain & size is bold.

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35	**GYPM**	**Gypm/Tu/Pigeon Pea/04**	2003	pigeon pea	Cajanus cajan	Landrace	Kesari Tur	Surekha Ganesh Meshram	Paraswada	Tumsar	536790		Bhandara	Grain colour is brown & size is medium.
36	**GYPM**	**Gypm/Tu/Pigeon Pea/05**	2006	pigeon pea	Cajanus cajan	Landrace	Dev Tur	Tara Parasram Kosare	Mohadi Khapa	Tumsar	536709		Bhandara	Grain colour is brown & size is bold.
37	**GYPM**	**Gypm/Tu/Pigeon Pea/06**	2004	pigeon pea	Cajanus cajan	Landrace	Kathi Tur	Usha Bandu Sonkusare	Shiora	Tumsar	536723		Bhandara	Grain colour is grey & size is medium.
38	**GYPM**	**Gypm/Pa/Field Pea/01**	2001	Field pea	Pisum sativum	Landrace	Barik Vatana	Shantabai Vasant Shahare	Wasela	Pauni	537311		Bhandara	Grain & pod size is small, colour white & tasty for eating
39	**GYPM**	**Gypm/Pa/Gram/01**	2001	Gram	Cicer arietinum	Landrace	Lakhya Chana	Laxi Gulab Lohare	Pahungaon	Pauni	537373		Bhandara	Grain cover is thick, grain Size Medium & colour Pink
40	**GYPM**	**Gypm/Pa/Gram/02**	2004	Gram	Cicer arietinum	Landrace	Kabuli Chana	Gopichand Khobragade	Kodurli	Pauni	537382		Bhandara	Grain cover is thick, grain size medium & colour white
41	**GYPM**	**Gypm/Tu/Gram/03**	2002	Gram	Cicer arietinum	Landrace	Pandhari Chanuli	Bhivram Rahangdale	Machera	Tumsar	536724		Bhandara	Grain size small, rounded & colour pink
42	**GYPM**	**Gypm/Bh/Red Lentil/01**	2005	Red Lentil	Lens culinaris	Landrace	Masur	Ashok Mankar	Pachkhedi	Bhandara	537023		Bhandara	Grain size small doted & colour is red & flower colour blue.
43	**GYPM**	**Gypm/Bh/Mung Bean/01**	2006	Mung bean	Vigna radiata	Landrace	Lutya Mug	Prabhakar Kuthe	Berodi	Bhandara	536992		Bhandara	Grain size short long, colour green & red.
44	**GYPM**	**Gypm/Bh/Mung Bean/02**	2007	Mung bean	Vigna radiata	Landrace	Hirva Mug	Shalu Sanjay Dhahake	Berodi	Bhandara	536992		Bhandara	Grain size medium, colour green & diifferent type of making recipes.
45	**GYPM**	**Gypm/Bh/Mung Bean/03**	2009	Mung bean	Vigna radiata	Landrace	Barik Kardya Mug	Sunanda Kalidas Vahane	Usaragondi	Bhandara	536990		Bhandara	Grain size is short & tasty for eating.
46	**GYPM**	**Gypm/Tu/Mung Bean/04**	2006	Mung bean	Vigna radiata	Landrace	Barik Kala Mug	Malata Ghansham Nanne	Chikhala	Tumsar	536793		Bhandara	Grain size is short, colour id black & tasty for eating.
47	**GYPM**	**Gypm/Tu/Mung Bean/05**	2003	Mung bean	Vigna radiata	Landrace	Mungati Mug	Rajkumar Jivanlal Samargade	Yedarbuchi	Tumsar	536669		Bhandara	Naturaly growth of plant & different types of colour yellow, green, reddish & grain size big.

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48	**GYPM**	**Gypm/Tu/Pulse/01**	2009	Pulse	Dolichos lablab	Landrace	Pandhari Popat	Yuvraj Gopichand Waghmare	Yedarbuchi	Tumsar	536669		Bhandara	Seed colour is white & different types of recipes (Usal)
49	**GYPM**	**Gypm/Tu/Pulse/02**	2009	Pulse	Dolichos lablab	Landrace	Kali Popat	Naresh Natthu Kahangar	Madgi	Tumsar	536785		Bhandara	Seed colour is black & different type of recipe (Usal)
50	**GYPM**	**Gypm/Tu/Mote bean/01**	2001	Mote bean	Vigna aconitifolia	Landrace	Mote	Raitabai Magoji Uikey	Chikhala	Tumsar	536793		Bhandara	Use in Different Type of receipe For e.g. Varan & Usal
51	**GYPM**	**Gypm/Tu/Black Gram/01**	2001	Black gram	Vigna mungo	Landrace	Udid	Asha Dilip Sapate	Sukli	Tumsar	536788		Bhandara	Seed colour is black , size is short & making different type of recipe
52	**GYPM**	**Gypm/Tu/Barnyyard Millet/01**	2005	Barnyyard Millet	Vigna unguiculata	Landrace	Barbati	Satybhama Dadaji Taywade	Sukli	Tumsar	536788		Bhandara	Seed of variety famous for Dal & Usal
53	**GYPM**	**Gypm/Tu/Cow pea /01**	2005	Cow pea	Vigna unguiculata	Landrace	Chavali	Geetabai Laxman Waghare	Rajapur	Tumsar	536666		Bhandara	Variety of long pod; used for making bhaji
54	**GYPM**	**Gypm/SA/Lakhori /01**	2001	Lakhori or Indian pea	Lathyrus sativus	Landrace	Lakhori	Anil Motiram Bhivgade	Kodamedhi	Sadak Arjuni	538128		Gondia	Zero cultivation,rainfed variety, high protein different type of recipe & use for animal fodder.
55	**GYPM**	**Gypm/Br/Lakh/01**	2000	Lakh or Indian pea	Lathyrus sativus	Landrace	Lakh	Pundalik Shiva Chouke	Bhagwanpur	Bramhapuri	540785		Chandrapur	Seed size is big, zero cultivation,rainfed variety, high protein different type of recipe & use for animal fodder.
56	**GYPM**	**Gypm/Bh/Flaxseed /01**	2001	Flaxseed	Linum usitatissimum	Landrace	Karda Jawas	Maroti Maske	Wakeshwar	Bhandara	537044		Bhandara	Seed Colour is Dark Brown, For use in cooking & medicine Oil.
57	**GYPM**	**Gypm/Bh/Flaxseed /02**	2000	Flaxseed	Linum usitatissimum	Landrace	Pandhara Jawas	Yograj Govind Neware	Papda	Bhandara	537156		Bhandara	Seed colour is golden, for use in cooking & medicine oil.
58	**GYPM**	**Gypm/Am/Sesame /01**	2001	Sesame, seasamum	Sesamum indicum	Landrace	Pandhara Til	Sundarlal Pardhi	Kosamtola	Aamgaon	537952		Gondia	Seed Colour is white, For use in cooking & medicine Oil & Use in Laduu & Khir.

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59	**GYPM**	**Gypm/Am/Sesame /02**	2001	Sesame, seasamum	Sesamum indicum	Landrace	Kala Til	Reshma Meshram	Kopitola	Aamgaon	537965		Gondia	Seed colour is black, oil is used cooking & medicine
60	**GYPM**	**Gypm/Am/Sesame /03**	2001	Sesame, seasamum	Sesamum indicum	Landrace	Karda Til	Anusaya Khotele	Gosaitola	Aamgaon	537913		Gondia	Seed Colour is brown, for use in cooking & medicine oil & use in Laduu & Khir.
61	**GYPM**	**Gypm/Gor/Oil Seed /01**	2000	Oil Seed	Ricinus communis	Landrace	Pandhari yerandi	Yogeshwari Patle	Babai	Goregaon	537694		Gondia	Seed Colour is white, oil is used in medicine
62	**GYPM**	**Gypm/Gor/Oil Seed /02**	2000	Oil Seed	Ricinus communis	Landrace	Kardi yerand	Sunita Raut	Ghoti	Goregaon	537568		Gondia	Seed colour is brown, & oil is used in medicine
63	**GYPM**	**Gypm/Gor/Oil Seed /03**	2006	Oil Seed	Brassica nigra	Landrace	Barik Mohari	Antakala Raut	Ghoti	Goregaon	537568		Gondia	For use as mixture crop, spices & medicine use.
64	**GYPM**	**Gypm/Gor/Oil Seed /04**	2006	Oil Seed	Brassica nigra	Landrace	Jadi Mohari	Sukhram Tekam	Gowaritola	Goregaon	537731		Gondia	Seed size is medium, for use as mixture crop, spices & medicine use.
65	**GYPM**	**Gypm/Gor/Chilli/01**	2004	Chilli	Capsicum frutescens	Landrace	Gavran Mirchi	Dwarkabai Dongarwar	Haushitola	Goregaon	537726		Gondia	chilli size big, used only spices.
66	**GYPM**	**Gypm/Gor/Chilli/02**	2004	Chilli	Capsicum frutescens	Landrace	Bhiwapuri Mirchi	Gangabai Rajram Meshram	Chopa	Goregaon	537720		Gondia	Vatiety is pest resilient, chilli size medium, colour of chilli is dark red, used only spices.
67	**GYPM**	**Gypm/MA/Chilli/03**	2003	Chilli	Capsicum frutescens	Landrace	Keshori mirchi	Radhabai Wadhive	Kelvad	Morgaon Arjuni	538246		Gondia	Chilli size long & slender, used only spices.
68	**GYPM**	**Gypm/MA/Coriander /01**	2000	Coriander	Coriandrum sativum	Landrace	Dhane	Puspa Hukre	Mahagaon	Morgaon Arjuni	538317		Gondia	Plant growth is tall, used only in spices
69	**GYPM**	**Gypm/MA/Turmeric /01**	2003	Turmeric	Curcuma amada	Landrace	Dogri Halad	Mahananda Sakhre	Mahagaon	Morgaon Arjuni	538317		Gondia	Used only in medicine, turmeric size is bigger other than varieties
70	**GYPM**	**Gypm/MA/Turmeric /02**	2002	Turmeric	Curcuma amada	Landrace	Ambi Halad	Indramata Ramteke	Janava	Morgaon Arjuni	538319		Gondia	Used only in medicine, turmeric size is small & slender.
71	**GYPM**	**Gypm/MA/Turmeric /03**	2003	Turmeric	Curcuma longa	Landrace	Vaygaon Halad	Duryadhan Khotele	Khambi	Morgaon Arjuni	538275		Gondia	Used in spices, cooking, famous in vidharbh.
72	**GYPM**	**Gypm/Ti/Ginger/01**	2003	Ginger	Zingiber officinale	Landrace	Aala	Gunwanta Bhagat	Arjuni	Tiroda	537520		Gondia	Ginger size medium, used in medicine & spices.
73	**GYPM**	**Gypm/Ti/Garlic/01**	2004	Garlic	Allium sativum	Landrace	Lasan	Kailash Raut	Khairbodi	Tiroda	537551		Gondia	Garlic size medium, used in medicine & spices.
74	**GYPM**	**Gypm/Ti/Onion/01**	2000	Onion	Allium cepa	Landrace	Kanda	Usha Rangari	Garada	Tiroda	537557		Gondia	Used in cooking, medicine & spices.

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75	**GYPM**	**Gypm/MA/Minor Milets/01**	2006	Minor Milets	Paspalum scrobiculatum	Landrace	Kodo	Lalita Shende	Kaneri	Morgaon Arjuni	538166		Gondia	Used in cooking bread, Khir & Laddu.
76	**GYPM**	**Gypm/MA/Minor Milets/02**	2005	Minor Milets	Panicum sumatrense	Landrace	Kutki	Ravindra Kuram	Chicholi	Morgaon Arjuni	538240		Gondia	Used specially for laddu.
77	**GYPM**	**Gypm/MA/Milets/01**	2000	Milets	Dolichos uniflorus	Landrace	Pandhara Kurtha	Usha Ramprasad Uikey	Mahagaon	Morgaon Arjuni	538317		Gondia	Seed colour white, naturaly growth of plant, Tribal people use for eating high protein, & crop guarantee in any soil
78	**GYPM**	**Gypm/MA/Milets/02**	2001	Milets	Dolichos uniflorus	Landrace	Karda Kurtha	Usha Ramprasad Uikey	Mahagaon	Morgaon Arjuni	538317		Gondia	Seed Colour brown, naturaly growth of plant , tribal people use for eating high protein, & crop guarantee in any soil
79	**GYPM**	**Gypm/Am/Brinjal/01**	2009	Brinjal	Solanum Melongena	Landrace	Pandhara Vanga	Manjusha Pardhi	Kosamtola	Aamgaon	537952		Gondia	This brinjal colour white
80	**GYPM**	**Gypm/Gor/Brinjal/02**	2008	Brinjal	Solanum melongena	Landrace	Gijara Vanga	Chanubai Tembhare	Zanjiya	Goregaon	537676		Gondia	Fruit colour mix white & green & tasty for eating & famous for cooking
81	**GYPM**	**Gypm/Gor/Brinjal/03**	2009	Brinjal	Solanum melongena	Landrace	Jabhala Vanga	Kamla Uikey	Zanjiya	Goregaon	537676		Gondia	Fruit colour voilet
82	**GYPM**	**Gypm/Gor/Brinjal/04**	2010	Brinjal	Solanum melongena	Landrace	Keli Vanga	Asha Raut	Gondekhari	Goregaon	537642		Gondia	Fruit size is long, slender, plant height id long & high production
83	**GYPM**	**Gypm/SA/Brinjal/05**	2005	Brinjal	Solanum melongena	Landrace	Bhatai	Anantrao Sonwane	Birhi	Sadak Arjuni	538088		Gondia	production only in summer, size is rounded, small & colour is dark brown
84	**GYPM**	**Gypm/ SA/Lady's Finger/01**	2006	Lady's Finger	Abelmoschus esculentus	Landrace	Chodhari Bhendi	Chandubai Sirsat	Heti	Sadak Arjuni	538079		Gondia	Lady finger size is long slender & outer part four, plant height is long
85	**GYPM**	**Gypm/SA/Lady's Finger/02**	2009	Lady's Finger	Abelmoschus esculentus	Landrace	Sahadhari Bhendi	Rekha Puram	Girola	Sadak Arjuni	538084		Gondia	Lady finger size is long slender & outer part six, plant height is long
86	**GYPM**	**Gypm/SA/Lady's Finger/03**	2009	Lady's Finger	Abelmoschus esculentus	Landrace	Aath DhariBhendi	Sima Arkhode	Khadipar	Sadak Arjuni	538105		Gondia	Lady finger size is long slender & outer part eight, plant height is long
87	**GYPM**	**Gypm/SA/Lady's Finger/04**	2006	Lady's Finger	Abelmoschus esculentus	Landrace	Lal Bhendi	Salik Wadhai	Sawangi	Sadak Arjuni	538094		Gondia	Lady finger size is long slender & colour is red, plant height is long
88	**GYPM**	**Gypm/SA/Lady's Finger/05**	2007	Lady's Finger	Abelmoschus esculentus	Landrace	Pivli Bhendi	Hirkanth Vaidhya	Bhusaritola	Sadak Arjuni	538106		Gondia	Lady finger size is long slender & colour is yellow, plant height is long

Sr No	Partner ID	Accession No (Organization name/Taluka/Crop name/Accession no)	Year of Collection	Crop name English	Crop name Scientific	Biological status (Landrace/Farmers variety/Selection)	Name of accession ( )	Name of seed conservator	Village	Taluka	Village code	Pada/ Wadi/ Tola	District	Base line Information
89	**GYPM**	**Gypm/SA/Tomato/01**	2009	Tomato	Solanum lycopersicum	Landrace	Kashi Bhedra	Yogita Bisen	Potekura	Sadak Arjuni	538107		Gondia	Tomato size is big & tasty for eating
90	**GYPM**	**Gypm/SA/Tomato/02**	2010	Tomato	Solanum lycopersicum	Landrace	Tichkya Bhedra	Devkanya Tayde	Girola	Sadak Arjuni	538084		Gondia	Tomato size is small & sour for eating & making fot chutani
91	**GYPM**	**Gypm/SA/Hyacinth Bean/01**	2012	Hyacinth Bean	Lablab purpureus	Landrace	Pandhara Val	Shanta Kedkar	Khadipar	Sadak Arjuni	538105		Gondia	Pod colour is white, pod size is long & tasty for eating
92	**GYPM**	**Gypm/SA/Hyacinth Bean/02**	2011	Hyacinth Bean	Lablab purpureus	Landrace	Vatnya Val	Rekha Parsuramkar	Khadipar	Sadak Arjuni	538105		Gondia	Pod colour is white, pod size is short & tasty
93	**GYPM**	**Gypm/SA/Hyacinth Bean/03**	2012	Hyacinth Bean	Lablab purpureus	Landrace	Butkya Val	Manda Bansod	Sawangi	Sadak Arjuni	538094		Gondia	Pod colour is green, pod size is short & tasty for eating.
94	**GYPM**	**Gypm/SA/Hyacinth Bean/04**	2010	Hyacinth Bean	Lablab purpureus	Landrace	Daseri Val	Geeta Waghade	Birhi	Sadak Arjuni	538088		Gondia	Short time production
95	**GYPM**	**Gypm/SA/Hyacinth Bean/05**	2010	Hyacinth Bean	Lablab purpureus	Landrace	Kashi Val	Lata Meshram	Ghatbori	Sadak Arjuni	538091		Gondia	The pod is flat, & the seed is used for eating
96	**GYPM**	**Gypm/SA/Hyacinth Bean/06**	2010	Hyacinth Bean	Lablab purpureus	Landrace	Chudhari Val	Anusaya Katre	Potekura	Sadak Arjuni	538107		Gondia	Pod size is long, colour is green, pod outer part four
97	**GYPM**	**Gypm/SA/Bitter gourd/01**	2000	Bitter gourd	Momordica charantia	Landrace	Karla	Pramila Neware	Khadipar	Sadak Arjuni	538105		Gondia	Small size, tasty for eating
98	**GYPM**	**Gypm/Gor/Pumpkin /01**	2001	Pumpkin	Cucurbita sp	Landrace	Kohla	Sarasvati Belge	Mhasgaon	Goregaon	537689		Gondia	Size is big , rounded, colour is light brown, used for different types of recipes
99	**GYPM**	**Gypm/Ti/Pumpkin/02**	2001	Pumpkin	Cucurbita sp	Landrace	Kashi kohla	Madhuri Shirsagar	Chikhali	Tiroda	537559		Gondia	Size is medium, colour is brown, used for special type of recipes
100	**GYPM**	**Gypm/Gor/Pumpkin /03**	2003	Pumpkin	Cucurbita sp	Landrace	Kohla hirwa	Savita Rahangdale	Kanhartola	Goregaon	537715		Gondia	Size is big, rounded, colour is green, used for different types of recipes
101	**GYPM**	**Gypm/Gor/Bottle Gourd/01**	2009	Bottle gourd	Lagenaria siceraria	Landrace	Gol dudhi	Nirmala Bhoyar	Gowaritola	Goregaon	537731		Gondia	Size in rounded, colour is light green & used for cooking
102	**GYPM**	**Gypm/Gor/Bottle Gourd/02**	2010	Bottle gourd	Lagenaria siceraria	Landrace	Lamba Dudhi	Vimala Kurve	Gowaritola	Goregaon	537731		Gondia	Size is long, colour is light brown & used for cooking
103	**GYPM**	**Gypm/Gor/Ridge Gourd/01**	2001	Ridge gourd	Luffa acutangula	Landrace	Jhumki Dodhaka	Kanchan Yerne	Ghoti	Goregaon	537568		Gondia	Size is small, rounded, colour is green & used for cooking
104	**GYPM**	**Gypm/Gor/Raddish /01**	2012	Raddish	Raphanus sativus	Landrace	Barik Mura	Sona Devanand Bokde	Tumkheda	Goregaon	537644		Gondia	Size is small & slender, colour is white

Sr No	Partner ID	Accession No		Crop name		Biological status	Name of accession ( )	Name of seed conservator	Village	Taluka	Village code	Pada/ Wadi/ Tola	District	Base line Information
		(Organization name/Taluka/Crop name/Accession no	Year of Collection	English	Scientific	(Landrace/Farmers variety/Selection)								
105	**GYPM**	**Gypm/SA/Raddish /02**	2012	Raddish	Raphanus sativus	Landrace	Thoker Mura	Mahnanda Janardhan Borkar	Lendezari	Sadak Arjuni	538067		Gondia	Size is thick & long, colour is white
106	**GYPM**	**Gypm/Ti/Sweet Potato/01**	2009	Sweet potato	Ipomoea batatas	Landrace	Lal Saknara	Gayatri Murlidhar Domde	Paraswada	Tiroda	537525		Gondia	Size is medium, long, colour is red, used for eating & different types of recipes
107	**GYPM**	**Gypm/SA/Sweet Potato/02**	2010	Sweet potato	Ipomoea batatas	Landrace	Pandhara Saknara	Damina Surendra Walde	Khodshivani	Sadak Arjuni	538086		Gondia	Size is medium, long, colour is white, used for eating & different types of recipes
108	**GYPM**	**Gypm/SA/Fenugreek leaves/01**	2000	Fenugreek leaves	Trigonella foenum-graecum	Landrace	Methi	Ruplata Namdeo Dongare	Kolargaon	Sadak Arjuni	538151		Gondia	Plant size is small & used for cooking

Annexure 5

Environment Education Program (CEE) Year 2014-19

Name of School	No of students participated (from class 8th to 12th)	Name of Project	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	No of village participated
	Total No		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		
Tirupati Vidyalaya, Madgi, Tal+ District - Bhandara	64		4	5		9	11		5	3		4	5		4	3		2	5		4	3		3	4		1
Sushil Adivasi Ashram Vidyalaya, Madgi, Tal+ District - Bhandara	40	Seed Collection	6	4	Nursery and Plantation	14	16	Demonstration of Dashparni (ark) extracts (organic kit control extracts)	4	2	Transact Walk in Village	6	4	Herbarium Collection in Village	3	2	Village Natural Resources Map	4	4	My Food Plate diversity and Recipe	3	2	Agriculture and Livestock Keeping practices documentation	3	3	Village Biodiversity	1
Vittal Prasad Dube Vidyalaya, Gunthara, Tal+ District - Bhandara	45		6	6		23	22		3	2		4	6		3	2		3	3		3	2		4	3		1
Gandhi Vidyalaya, Pahela, Tal+ District - Bhandara	76		7	7		20	15		6	4		5	7		5	3		4	2		5	3		3	2		1
Adharsh Vidyalaya, Davadipar, Tal+ District - Bhandara	68		5	5		10	10		4	3		5	5		4	3		2	5		4	3		2	5		1
Chaitanya Vidyalaya, Manegaon, Tal+ District - Bhandara	79		6	6		20	20		3	2		6	6		3	2		3	6		3	2		3	4		1

Name of School	No of students particip ated (from class 8th to 12th)	Name of Project	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	Students Participated		Project Name	No of village partici pated
	Total No		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		Boys	Girls		
Vanvaibhav Adivasi Ashram Vidyalaya, Koka, Tal +District - Bhandara	74		7	8		12	13		5	3		5	6		5	3		4	5		5	3		5	5		1
Vinod Vidyalaya, Tekepar, Tal+ District - Bhandara	58		4	6		14	14		6	4		4	6		6	4		3	6		6	4		3	6		1
J. J. High school, Bhilewada , Tal+ District - Bhandara	44		3	2		11	11		7	5		3	2		5	5		3	2		5	5		4	2		1
Jilha Parishad High school, Dhargaon, Tal+ District - Bhandara	74		4	4		13	14		2	3		4	4		2	3		4	4		2	3		4	4		1
Prakash Highschool, Kardha , Tal+ District - Bhandara	91		6	5		28	27		5	3		6	5		5	3		5	5		5	3		5	6		1
Devi Sarsawati Vidyalaya, Shingori, Tal+ District - Bhandara	42		8	5		12	8		6	4		7	5		5	4		6	5		5	4		4	5		0
Navprabhat Vidyalaya, Amgaon, Tal+ District - Bhandara	32		6	5		13	12		4	5		6	4		4	3		4	2		3	2		3	2		0
Total	**787**		**72**	**68**		**199**	**193**		**60**	**43**		**65**	**65**		**54**	**40**		**47**	**54**		**53**	**39**		**46**	**51**		**11**

Annexure 6

Modules followed during the project

Module details	Activity done so far	Outcomes
Module 1: At least 10 farmer biodiversity conservators (BDC) per district were actively involved in promotion of local crop varieties.The project envisaged that identified farmers (BDC) will be catalysts and models for the conservation of biodiversity in the districts. This requires active knowledge sharing among the farmers and with other stakeholders together with demonstration of practices in conservation of biodiversity on their farms.	1. Selection of farmer BD conservators in each of the 3 districts and 6 blocks 2. Knowledge sharing on good practices for BDC. Workshops were conducted for participatory learning and sharing of traditional knowledge in the conservation of biodiversity. The focus was on the utility, properties, and marketability of traditional varieties. During the workshop, methods for conservation and propagation of the crops were discussed. 3. Development of demonstration farms.	1. 10 farmer BDC involved in traditional farming practices were identified in each of the three selected districts. 2. At least three workshops per year were conducted in each district to share knowledge among the farmers and with relevant stakeholders of the respective district. 3. The farmer biodiversity conservators of the 3 districts have started using organic inputs and cultivate identified traditional local varieties in demonstration plots at their farms.
Module 2: Local varieties to be documented for utilities & properties. One local variety per district - identified based on their superior quality and prevalence in the district. Participatory learning & documentation of their utilities and properties help conserve & propagate varieties.	1. Facilitate participatory learning through farmer meetings and documentation. 2. Specialist in botany and/or environment will build on the knowledge of the traditional farmers to document the utilities and properties.	A compiled documentation of utilities and properties of two local varieties was made available.
Module 3: Minimum of value added food products introduced to the selected farmers. The propagation of traditional local varieties encouraged with the increasing markets for consumption of produce from such varieties. Currently, the variety of value added food products from local traditional varieties is limited. Efforts made to study and promote value added food products based on local varieties.	1. Knowledge sharing on value addition to local varieties of crop produce. 2. Workshops will be Conducted every to share knowledge on value addition to food produce from local varieties of crops.	1. Farmer biodiversity conservators prepared two value added food products (Rice and Poha) from the local varieties which is marketable at the local markets towards the end of the project. 2. Workshops were conducted annually (since last 3 years) to share knowledge on value addition to food produce from local varieties of crops.
Module 4: New seed banks will be established – one in each district particular to promoting the identified crop varieties.	1. Capacity building of farmers in establishment of seed banks. Selected farmers from each district trained on the establishment & operation of seed banks. They learnt to treat, preserve, package, document seeds in the seed bank through seed registers. The farmers also provided with the necessary materials inputs to operate seed bank.	Seed banks is operational at central level in Bhandara-based GYPM office operated by at least one farmer with the knowledge and materials required to manage the seed bank.

Module details	Activity done so far	Outcomes
Module 5: Documented knowledge on cultivation of two local varieties of crops	1. Knowledge sharing at district level on sustainable practices for cultivation of local varieties. 2. Validate and compile the knowledge from the districts. 3. Prepare and disseminate the documented knowledge.	1. 3 workshops per District were conducted on sowing, management and harvesting, resulting in documentation of the cultivation of local varieties of crops specifically identified for the respective district. 2. Additional workshops on documentation from the districts on cultivation practices of local varieties. 3. Preparation & dissemination of 2 booklets of documented knowledge on characterization of seeds, ranbhaji cultivation and Lakhori pulses.
Module 6: A well-defined documentation process based on data requirements for PPVFR act is maintained by the farmer biodiversity conservators. (Application process initiated for 2 varieties)	1. Development of a format and process for documentation based on data requirements for PPVFR act. 2. Training of farmer biodiversity conservators in documentation formats and process. 3. Prepare and document the crop varieties in the agreed formats.	1. Selected farmer biodiversity conservators documented the specified local varieties of crops as per the agreed formats and process of documentation to fulfil data requirements for PPVFR. 2. Application is in process
Module 7: At least 4 schools in each of the selected districts have learning opportunities and practices for environment and biodiversity enhancement.	1. Demonstration on 16 topics (including seed sowing and management) 2. Capacity building for demonstration plots 3. Competition for demo plot execution.	We could reach out to 16 schools in three districts.

Annexure 7

Seed Data Collection

In five years during project period, we had ensured 499 traditional rice seeds (paddy) demonstration plots. We had selected varieties like Luchai, Hirranakki, Dhubraj and Kalikammo in 6 talukas of 3 districts. We had collected last year progress Luchai (Rice) 6844 Kg Hirranaki (Rice) - 6375kg for seed

138 demonstration plots of jawas (oilseeds) were completed in 6 talukas of 3 districts. We have collected 251 kg of white variety jawas and 12520kg of brown variety of jawas.

153 demonstration of Lakhori (pulses) were completed in 6 taluka and 3 Districts (Bhandara, Chandarapur and Gondia) in 125.96acres of land. We collected 20220 kg of lakhori seed of two varieties.

S. No.	Seed Variety	Number of Demonstration plots	Areas covered	Quantity of seeds procured
1.	PiwliLuchai (Paddy)	135	18 talukas (6 in each of the three districts) 56.71 (acre)	9982 Kg
2.	Hiranakki (Paddy)	274	18 Talukas (6 in each district) 81.81 (acre)	12495 Kg
3.	Dhubhraj(Paddy)	62	12.4 (acre)	6400 Kg
4.	Kalikammo(Paddy)	28	5.6 (acre)	2080 Kg
5.	Jawas (Oil seeds)	138	18 talukas (6 in each district) 115.13 (acre)	11256Kg
6.	Lakhori (pulses)	153	18 talukas (6 in each district) 125.96 (acre)	30957 Kg

We have developed central level Seed Bank in Bhandara at our GYPM organization Office, Where we have 29 varieties of paddy, 2 varieties of jawas (oilseeds) and 2 varieties of Lakhori (pulses), 5 pulses varieties, 4 spices varieties, 10 varieties of vegetables and also 12 varieties of FABIA beans

Report

2.2

Crop Genetic Diversity

Sanskriti Samvardhan Mandal, Sagroli, Nanded

Background

Maharashtra is administratively divided into six divisions viz., Konkan, Nashik, Pune, Amravati, Nagpur and Aurangabad. The Aurangabad division is known as Marathwada region. It was formally a part of Hyderabad province. Martahwada region consists of eight districts of Maharashtra State namely Aurangabad, Jalna, Parbhani, Hingoli, Beed, Nanded, Latur and Osmanabad.

Geographically Marathwada region is situated between 170.35'N and 200.40'N latitude and 740. 40' E and 780.15' longitude. The region is bounded by Jalgaon, Buldhana and Akola districts on the north, by Nasik and Ahmednagar districts on the west, Solapur district on south side and Andhra Pradesh on the east. The total geographical area of Marathwada region is 64525 sq. kms. with 57.0 lakh hectares suitable for agriculture. However, net sown area is only 75 percent of total geographical area. This is 12 per cent of Maharashtra. In Marathwada district-wise geographical area is Aurangabad 10100 sq. kms, Beed 10693 sq. kms., Nanded 12442.08 sq. kms., Latur 7157.00 sq. kms., Jalna 7718.00 sq. kms., Hingoli 8056.05 sq. kms., Parbhani 6511.58 sq. kms., and Osmanabad 7512 sq.kms.

The Soil: Most of the region is comprised of deep black cotton soil derived from the Deccan trap volcanic rock. However, the soils vary greatly in texture and depth. The deep black soils are found along the river banks of Godavari, Manjara, Purna, Dudhana and Penganga and their tributaries and the soil is capable of retaining moisture. In the years of favorable rainfall rabi crops are grown in these areas. The soils are, however, coarse, shallow and relatively poor, along the hill slopes and foot-hills. The major portion of the region is covered by medium black soil. The medium and deep soil in the region is rich in plant nutrients and can support good kharif or rabi crops like jowar, bajra, wheat, pulses, cotton, and sugarcane.

Agro-climatic Zones: Maharashtra State has been divided into nine broad agro climatic zones. Marathwada region of the Maharashtra state falls under three zones, I) Scarcity zone, II) Assured rainfall zone and III) Moderate to moderately high rainfall zone. Southern part of Nanded district and remaining part of Aurangabad district, Beed and Osmanabad districts come under assured rainfall zone. Moderately high rainfall zone includes northern part of Nanded district. Bhoom and Paranda talukas of Osmanabad districts come under the scarcity zone.

Rivers: There are three important river basins in the Marathwada region viz., the Godavari, the Purna and the Penganga basin. Major portion of the region lies in the Godavari basin. Therefore, 'Godavari' is the most important river in the region. 'Purna' which is the biggest tributary of Godavari is the second important river in the region. The Godavari river enters the region through Aurangabad district, runs on its southern boundary, separating it from Beed distrct, flows through Jalna, Parbhani and Nanded districts to enter Andhra Pradesh. The Purna basin comprises of the whole taluka of Sillod of Aurangabad district, Jafrabad taluka of Jalna district, northern part of Kannad taluka, eastern part of Khultabad taluka of the Aurangabad district and Bhokardan Taluka of Jalna district excluding small north-eastern portion forming a salient feature between Jalgaon and Buldhana district. The Purna enters the region from the north-west corner of Parbhani district and flows in south-east direction to merge into the Godavari about 15 miles up stream from the Nanded district. The Penganga, after collecting the waters of the southern belts of the Buldhana and Akola districts drains the north eastern margin with the aid of its tributary, the Kayadhu river. The other important rivers are Shivna, Dheku, Kham in Aurangabad district, Manjra, Bindusara and Sindphana in Beed district, Penganga, Manyad, Ashna and Lendi in Nanded district, Manjra and Terna in Osmanabad district, Manjra in Latur district and Kayadhu, Karpara and Dudhana in Parbhani district.

Rainfall: Marathwada region receives annual rainfall of 740.37 mm. The annual average rainfall is not uniform in all district of Marathwada region. In last 15 years annual average rainfall is 651.07 mm. in Aurangabad, 806.8 mm. in Parbhani, 706.74 mm. in Beed, 879.27 mm. in Nanded, 701.6 mm. in Osmanabad, 696.64 mm. in Jalna, 784.6 mm. in Latur and 744.86 mm. in Hingoli. In last fifteen years highest annual average rainfall was in Nanded district and lowest in Aurangabad district. (Reference-Data source- http://sodhganga.inflibrent)

Figure 1 depicts the deviations of annual rainfall from average rainfall spanning years 1987-2016. The region has seen deficit rainfall in ten years and excess rainfall in two years. The maximum deficit year or negative deviation from the average rainfall was recorded in year 1996 with more than 60% less rain. The trend line is a steep upward rising one indicating irregular pattern in rainfall occurrence.

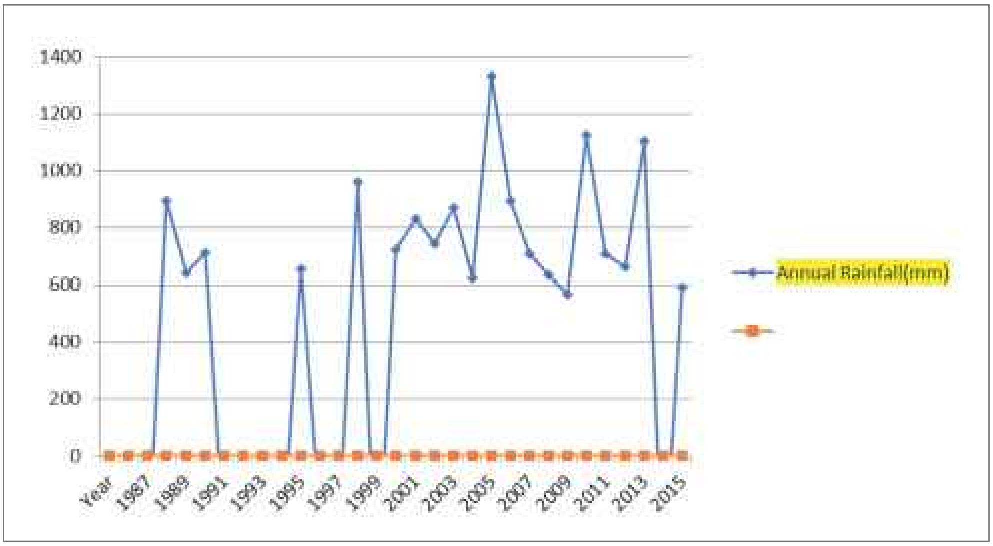


Figure 1 Deviation of Annual rainfalls from the average of last 30 years.

Data source: IMD Pune.

Cropping Pattern: In Nanded, most of the areas are situated on the banks of rivers Godavari, Manjara, Asana, Lendi that helps in maintaining the moisture and fertility of soil. This is very beneficial for Kharif (Cotton, sorghum, green gram, black gram and soyabean) as well as Rabi Crops (sorghum, safflower, chilli and gram). Earlier this area was mostly dominated by mix cropping pattern like cotton, sorghum, pulses and spices. The chilli called as Shevali mirchi, Jowar varieties like Dukari, Talki, Pivali and Dagdi and Safflower ***(Carthamus tinctorius***) Kardi are the predominant varieties in this area.

The crop details are given in Table-1. This information is gathered during meeting with local farmers. During the discussion with farmers, chilli and Kardi seeds are found to be popular cash crops. Jowar varieties like Dukari, Dagdi are main staple food and fodder crops. The livestock is also a big support system to farmers, but, now it is very difficult to maintain it, as the area under fodder Jowar is decreasing day by day.

Table 1. Cropping Diversity of Marathwada (Nanded, Latur and Osmanabad)

S.No.	Category of crops	Crops	Season
1	Cereals	Rice, Jowar – (Pivali and Kamlapuri)	Kharif
		Jowar- (Talki, Dukari, Dagadi), Maize	Rabi
2	Pulses	Tur (Red and white), Mung (Chamki mug and rough mug), Udid, Masur	Kharif
		Gram	Rabi
3	Oil seeds	Soyabean, Ambadi, Jawas, Til, Mohari	Kharif
		Safflower, Sunflower	Rabi
		Groundnut	Rabi and Kharif
4	Spices	Shevali Chilli	Rabi
5	Commercial crop	Cotton	Kharif

MGB project area of operation

SSM is working in 3 districts, eight blocks and 20 villages in Marthwada. The details of working area are given in Table 2.

Table 2. SSM working area

Sr.no	Name of Districts	Blocks	Number of Villages	Rainfall	Major Crops	Focused Crops	Varieties
1	Nanded	Biloli Dharmabad Naigaon	6 2 2	701.6 mm	Sorghum Pulses Oil seeds Cotton Chilli	Sorghum Chilli	Talki, Dukari, Pivali and Shreekhandi; Shevali Chilli
2	Latur	Jalkot Udgir	2 2	744.86 mm	Oil seeds Plases	Safflower	Kardi
3	Osmanabad	Tuljapoor Kalamb	4 2	676.64 mm	Sorghum	Sorghum	Dagadi

Community profile

Sanskriti Samvardhan Mandal, Sagroli is working in three districts of Marathwada Region. We are reaching to 240 farmers in which 30 farmers are women and 210 are men covering 20 villages. In this project different types of stakeholders like farmers groups, Government departments, social groups and students are involved.

Journey with MGBP

SSM arranged many field visits in Nanded, Latur and Osmanabad area to know the farmers' views and experience regarding traditional seed conservation. Durring this meeting and discussions with farmers, it is revealed that very few farmers are having their own traditional seeds. Most of them depend on hybrid seeds and high yielding seeds available in market. But still few farmers grow the traditional seeds and conserve them. As per their experience, the traditional seeds have good taste and are very good for health. Like local sorghum Dukari and Dagdai have better taste as compared to hybrid one. The Bhakri made from traditional sorgum is softer and sweeter. The Bhakri is more nutritional as compared to wheat, as many farmers expressed experience of stomach pain if they consume wheat. Their livestock also like to eat local sorghum fodder as compared to hybrid sorghum and gives more milk. The Shevali chilli has high pungency taste and red colour. Many local pickles and different types of chutnies are prepared and consumed by these farmers. The safflower (Kardi) oil is used to cook their food and they prefer using Kardi oil than Soyabean or groundnut oil.

Based on the discussions with farmers and their experiences, SSM initiated the dialogue with farmers for conservation of local seeds. Initially we followed following steps:

1) Survey to find out the quality seeds from farmers.

2) Encouraged other farmers to distribute and exchange.

3) Motivate farmers through Demo plots and exposure visits regarding regeneration of local seeds.

The key issues addressed

1) MGB project formed local seed saver groups and facilited the local Seed conservation activities.

2) Trained farmers on seed selection and seed storage through demo plot exposure visit.

3) Motivated farmers to exchange local seeds through community seed bank.

4) Aware farmers about the PPVR Act through workshop and trainings.

5) Establised local crops importance through nutritional analysis.

6) Identified the common diseases in crops like chilli leaf curly disease and root rot.

7) Systematic inventory of local crop genetic resources.

Objectives

1. To build up a systematic inventory of crop genetic resources of Nanded, Latur and Osmanabad districts of the Maharashtra.

2. To identify one variety in each district for pilot scale efforts for on farm conservation, upgradation, value addition, marketing and registration.

3. To establish district level seed bank focusing on traditional cultivars of superior quality.

4. To engage with educational institutions in study and promotion of crop genetic resources.

From above objectives we planned and implemented following activities:

1. Formation of a systematic inventory of crops genetic resources from Nanded, Latur and Osmanabad.

2. We identified three varieties in three districts for pilot scale efforts, *in-situ* conservation, and upgradation as follows:

A. Nanded- Chilli- Shewali Chilli

B. Latur- Oil Seed- Kardi

C. Osmanabad- sorghum- Dagadi

3. Motivated local seed saver groups; formed one seed bank producing quality seed and practicing exchanges of seeds on regular basis. There are 18 crops and 30 varieties that are conserved in this seed bank.

Sampling methods

Methods involved conducting both survey and semi−structured interview with 240 farmers all of whom practiced different forms of traditional seed saving.

Table 3. Seed selection and seed storage methods as revealed during farmer meetings

Sr.No.	District	Crops	Seed Selection	Seed Storage
1	Nanded	Chilli- Shevali Chilli	Tagging healthy plant. Select the first flowering fruits with long length and dark red colour as mother seed.	Stored in plastic drum, Jute bags, Mudpot or Bamboo or shindi Kangi with mixing with Neem leaves
		Sorghum- Talki, Dukari	They tag the healthy plant with big comb. Many times, they harvest all the crop and select big comb as seed.	The whole comb is stored at dry place.
2	Latur	Oil seed- Kardi	Select good quality of Kardi seeds	Stored in Mud pot mixed with Ash and neem leaf
3	Osmanabad	Sorghum- Dagadi	They tag the plant with bags and protect from birds with the help of plastic bag or colorful cloths	The big size comb is selected by farmers and kept aside as seeds for next year. Before storage it is well dried in bright sunlight for 2 to 3 times.

A representative sample of sorghum, chilli and safflower seeds were collected from each of these farms and grown in farmer's farms *in-situ* conservation to test the efficacy and germination rates of seeds stored using different practices.

Major work done under MGBP

We engaged with local farmers through group meetings for gathering basic information regarding the local seeds, soil type, market value as well as the average production. After this, we identified local seed saver farmers at village level. This local seed saver farmers provided the mother seeds. Through these seed saver group meetings, we created awareness about need of conservation of local seeds through demonstration and seed exchange activities. We collected the details about crop genetic resources, package of practices and common challenges during the project implementation.

1. 1 Community level seed bank conserving 18 crops and 30 varieties

2. 5 Years observation data through DUS guidelines for three crops.

3. Documentation of traditional package of practices for these crops.

4. Improved awareness - Before MGB intervened, the farmers didn't know about the PPVFR Act as well as the need and importance of seed registration. During interaction with Maharashtra Gene Bank working groups, farmers became well aware about the legal support through The Protection of Plant Varieties and Farmers' Rights Act (PPVFRA).

5. In the beginning we were working with 60 farmers but now we are connected with more than 240 farmers in conservation of traditional seeds in three districts.

6. The Shevali chilli seed is very rare but after 5 years we have 60 Kg of seed production. We visited many villages and identified farmers who are having the Shevali Chilli seeds. Then we encouraged these Shevali cultivators for demonstration as well as multiplication of Shevali seeds. After this we promoted Shevali demonstration plots with these farmers only as well as involved in data collection, to train new farmers for seed selection and seed storage methods. In the demo plots we observed two diseases, leaf curly disease and root rot adversely affecting the crop. We used Trichoderma to avoid the root rot problem and used healthy plants for replantation to avoid leaf curly disease. We collected the seeds for further breeding purpose.

7. Nutritional analysis has been done for all the three accessions of jowar . (Table 4)

Table 4. Nutritional analysis of sorghum genotypes

Nutrient (per 100g)	Piwali	Dagdi	Dukari
Fat (g)	02.47	01.90	03.41
Protein (g)	08.80	10.60	07.70
Carbohydrate (g)	76.40	75.00	75.90
Calicum (mg)	24	25	22
Phosphorus (mg)	221	222	218
Iron (mg)	4.2	4.2	4.1
Magnesium (mg)	166	168	164
Sodium (mg)	7.0	7.3	6.8
Potassium (mg)	126	131	130
Energy (Kcal)	363	359	365

8. For value addition and minimizing the input cost we encouraged the farmers to learn about low cost organic practices that enhance the fertility as well as get the benefit of organic market. The farmers visited IIRD, Aurangabad and Natural farming model by Shree Subash Sharma at Yavatmal during the exposure visit to Organic vegetable market as well as organic shop at Sangamner Lokpanchyat area. Thus, farmers got inspired and were willing to adopt low input organic farming and marketing.

9. After visiting IIRD, farmers surveyed the block level market and built a local channel for marketing their crops. Community based marketing leaders were engaging with taluka level customers for better income as well as services. The community leaders facilitate and engaged with District and block level Dhaan Mahostav. During this event they collected the interested customer details, collected contact numbers and formed a WhatsApp group for marketing.

10. Two women farmer groups consisting of 30 members are working for seed conservation & marketing of Chilli powder in Nanded area.

11. 10 schools actively engaged with us through different activities and participation.

Impact of MGBP work

Availability of Quality seeds

Indigenous traditional methods of saving and storing seeds are often seen as viable alternatives. But from last two decades farmers moved towards cash crops and highly depend on market seeds. This also reduced the knowledge of seed selection method and availability of quality traditional seeds. The farmers' seed bank motivated the local farmers to regenerate the quality seed as well as influence exchange of local seeds among themselves. From last 5 years the farmers produced near about 360 to 600 kg seeds and exchanged it with more than 400 farmers.

In-situ conservation

MGBP is a first initiative in which inclusion of farmers is actively done through recognition of the importance of on-farm conservation, mainly as a complementary practice to ex-situ conservation, because not only the genetic resources are conserved but also the processes of evolution and spatial-climatic adaptation. Local traditional seed saver farmers and professionals exchange knowledge and experiences regarding the seed selection, pest management as well as collecting data from the field. From last 5 years we are involved and engaged with 60 demo plot in-situ conservation from Nanded, Latur and Osmanbad area. The local KVK, students and farmers came together in seed selection, crop management, pest management and seed storage process for Talki (sorghum) and Shevali Chilli. The details of major charteristics are given in Table 5. This information is collected from farmers in field visit and meetings.

Table 5. Details of Focused Crop Characterstics

SN	Crop	Local name	Important character
1	Chilli	Shevali Chilli	Maturity-110-120 days, tolerant to drought, resistant to rust disease. Specially used for making pickles owing to its pungent taste. 1. Availability of quality seeds. 2. 120 days rabi crop. 3. average crop production 5 to 7 quintals per acre. 4. Water resistant as well as pest resistant. 5. Good market value or income Rs. 20,000/ 1Quintal.
2	Safflower	Kardi	Safflower (kusum, kusumbha, kardi) is one of the oldest cultivated annual oilseed crops. Safflower is a thistle-like plant with a central branch stem, a varying number of branches and a tap-root system. Each branch has 1 to 5 yellow or orange flowers and contains 15 to 20 seeds. This safflower oil (golden yellow coloured) is largely used for cooking purposes. Added advantage is the oilcake after oil extraction used as cattle feed. Plant is well adapted to dry regions. Midlate maturity 95-100 days, resistance to sucking pests, non lodging, drought resistant. Specially used in pest management & fencing crop. Farmers use its oil in daily cooking. The tender leaf is used as vegetable. 1. Availability of home seeds. 2. Dry area crop. 3. The green leaves are used as vegetable. 4. Good fodder for livestock. 5. The oil is very healthy and costly 150 Rs/ Kg.
3	Sorghum	Talki	Shiny yellow colour seed, plant height up to 6 ft, resistant to drought condition ;used as good fodder source. 1. Availability of home seed. 2. Very low input cost for crop management. 3. Water resistant as well as pest resistant. 4. Assured production 7 to 8 quintals per acre. 5. Very good source of quality fodder for livestock. 6. Prime food in daily consumption of Bhakari. 7. Highly nutritional as well as having good taste.

Quantitative Impact

The quantitative impact of the MGB project after 6 years of working with farmers, is summarized in Table 6.

Table 6. Quantitative impact

Sr. no.	Parameter	Before MGB intervention 2013-14	After MGB intervention 2018-19
1	Seed Bank	0	1 (Talni, Nanded)
2	Farmers involved in seed conservation	60	240
3	Nutritional Analysis Data	0	Available for 3 crops
4	Farmers Groups	0	10 specially working on traditional crops
5	Area under seed production	5 hectares	15 hectares
7	Seed availability	60 farmers	240 farmers
8	Income per acre Rs. for chilli we had a group discussion on this. We used income re-pedicure fool for this purpose	Rs.6000/-	Rs.14,000/- gross income

Community participation in MGBP

The community engagement is initiated by regular meetings. Initated exchange of experiences and knowledge by focussed group discussions on conservation of local seeds. Farmers' cultivated 10 to 15 acres of Shevali Chilli. This crop fetches good income with minimal inputs. During this period other workers from adjoining area migrate to this area for employment. They could build their homes and purchased new lands due to good income from this crop. But from year 2007 the Shevali Chilli is slowly replaced by other crops due to diseases outbreak. The local Safflower Kardi fulfil their oil requirements and sorghum fulfill the need of staple food as well as fodder to the livestock. It helped them to earn extra income and savings. But recently due to over investment in Soyabean and cotton with low production the income is reduced. In each village there are few farmers still cultivating the traditional crops. Thus, the traditional seeds are conserved from generations.

Workshops and trainings

To make the farmers aware about Farmers Act, PPVFR Act 2002, and the Biodiversity Act 2000 we facilitated various training programs with farmers. In the last 5 years, we conducted 12 workshops with 240 farmers. Now these farmers are well aware about the Farmers Rights, PPVFR Act and willing to register their crop varieties under PPVFR Act. Our staff member and farmers also participated in Nagpur and Nadurbar Beej Festival as well as training program at Yashada, Pune.

We arranged four field exposure visits to ideal seed bank at Dhmangaon, Sangamner to create awareness among farmers about the collective process in seed conservations. 48 farmers participated in exposure visits. Through this visit's farmers and project staff learnt from each other regarding the importance of local seed conservations, shared their experience in cultivation as well as challenges. Thus, the exposure visits motivate our farmers for better participation and involvement in seed conservation.

The farmers also visited Yavatmal natural farming training program to know about different tools and technique in natural farming like land leveling, preparation of organic compost, bio control, improving soil moisture, pest management and cropping methods. Five farmers willingly adopted to natural farming for chilli in 2019. Details are given in Table 7 below:

Table 7. Details of activities

Sr. No	Activity Name	Year	Number of activities	Number of participants
A	PPVFR Act	2015-16	2	26
	PPVFR Act	2016-17	2	32
	Biodiversity Act 2002	2017-18	2	28
	PPVFR Act	2018-19	3	48
	PPVFR Act	2019-20	3	46
B	Organic Farming and Certification	2018-19	2	40
		2019-20	2	40
C	Traditional Seed Conservation	2015-16	1	11
		2016-17	1	13
		2017-18	2	12
		2018-19	1	12
		2019-20	1	12
D	Exposure visits	2015-16	1	12
		2016-17	1	12
		2017-18	1	12
		2018-19	1	12
E	Krushi Mahostav	2015-16	1	30
		2016-17	1	30
		2017-18	1e	30
		2018-19	1	30
F	Seed Exhibition	2016-17	1	2
		2017-18	1	2
		2018-19	1	2

Value addition & marketing

The local farmers are more concerned about the availability of good market place and rate. To mitigate this, we arranged trainings on Organic Farming and marketing with the help of IIRD and other resource persons. The exposure visits to Sangamner Organic shop added positive attitude for approaching Organic marketing process. Last year we facilitated Barbada Village farmers to form a Farmers Producer Company with the help of KVK, Sagroli.

Role of community in designing and reshaping the work

The communities played a vital role in designing the project in aspects of selection of varieties. The information collected for specific landraces during exhibition was validated during in situ conservation. After discussing with community for each landrace, 9 best landraces each of chilli, safflower and sorghum were selected for further in situ conservation. Farmers' fields served as in-situ conservation plots. Ten in-situ conservation plots were identified for cultivating traditional landraces.

The seed saver groups trained other farmers in traditional farming practices and seed selection. Women farmers play a leadership role in seed storage, maintained seeds as well as uses of traditional crops in food system. They were also engaged in crop harvesting and seed selection process. During the harvesting process they identified the quality seeds, followed all the cleaning, drying and storage methods.

The whole process of participatory revival, conservation and replication of traditional landraces is helping farmers from this drought prone belt regain their food sovereignty. The seed saver farmers exchange their methods and knowledge regarding the seed selection, land development and other cultivation and crop management practices with other farmers. The demo plot exposure visit facilitated focused group discussions related to crop and disease management. Thus, the farmers are able to consume Shevali, Dukari as food, which was not affordable earlier due to limited production and high rate.

The community involved in the conservation process, also actively participated in varietal selection on the basis of their physical performance. The members of seed saver committee, knowledgeable farmers along with MGB staff visited each and every in-situ plot during growing stage and before harvesting. Members were trained on pure line selection using scientific methods. Farmers have their own ways of selecting a pure line. The members selected landraces based on certain characteristics – like grain size, grain color, plant height, lodging resistance, pest and disease resistance, drought tolerance, structure of panicle etc. For morphological characterization, the project staff collected data as per DUS guidelines of ICAR, completed the morphological characterization of 1 landrace of chilli, 1 landrace of Safflower and 1 landrace of sorghum.

Seed Bank

The selected seed savers from different villages are the members of seed saver committee. They are actively involved and play an important role of executing the plan at the field level. The committee conducts its monthly meeting in the field. The plan is discussed along with field visit to in-situ plots. The committee is responsible for storing the seed and exchanging with other farmers. Each group nominates its representatives for the block level seed saver Bank named as "*Godavari Gavran Biyane Sanvardhan Bank*".

The block level committee has 10 members. There are about 10 women farmers as seed savers, who have conserved seeds of various vegetable crops. Three village level seed banks are established which are managed by farmers. The seed saver committee provides seed material to interested farmers on exchange. The farmer has to return double the quantity of seed procured from the seed bank. We maintained seed distribution register at each seed bank. While the distribution of seeds, name of the farmer and the quantity of seed is registered in this register and it is referred at the time of seed harvesting as well as the seed is collected from the field with trained seed savers. In the year 2018-19 seed saver committee has distributed 250 kg seed (32 Kg Shevali chilli, 93 kg Safflower and 150 Kg of sorghum local landraces). Last year, we recollected the seeds (20 kg of Shevali, 15 kg of safflower and 45 kg of sorghum).

Seed Selection & Seed Storage

Villagers in Marathwada preserve some of their harvested crops for use as seeds for the next season. The best crop in terms of productivity is preserved for the purpose. The crop is preserved in traditional storage tools like Mud pot or Bamboo Kangi with the addition of Neem leaves. Some farmers tie selected cob to the house roof. The seeds are first dried in sunlight and then tied together in cloth. This prevents the seeds from decaying. Dukari sorghum crop panicle is selected and stored at home called as "Kalshache kanis" mainly used in marriage celebration in this area. The Ambil recipe is very famous and mostly offered to God or Nature in every festival and celebration in rural Area.

The farmers use different types of seed selection and seed storage methods as follows:

Seed Selection

1. Chilli- The healthy plant is marked, the plant with healthy flowering and number of fruits. The fruit from

first flowering is picked up and used as mother seed for next seasons.

2. Sorghum- The farmer tags healthy plant by colored cloth. The cob is protected from birds as well as animals. Then after harvesting they used this as mother seed.

3. Safflower- The farmer chooses seed from healthy plant as mother seed.

Beneficiaries of the project

Although the project is primarily geared to developing a national strategy for the conservation of plant genetic resources, the key beneficiaries are local farmers, cultivating local crops for their livelihoods and food security.

Farmers received following benefits :

1. A collective platform like Seed Bank, farmers club as a support system

2. Availability of quality seed and low input crop management techniques like Dashparni extract, organic farming as well as organic pest management.

3. Awareness and understanding about Farmers PPVR Act, Biodiversity Act etc.

4. Improved document on local landraces, nutritional value and its importance in sustainable farming.

People's selection criteria for local landraces

Farmers from Marathwada cultivated chilli, sorghum and safflower. Each crop has nutritional and medicinal purposes. Theses native varieties were the result of years of dedicatiated efforts to develop and conserve crops suitable for the local condition. The production output of chilli, sorghum and safflower is rather stable and they are highly risk resilient. Moreover, these varities meet local tastes and food preferences. The following data is gathered from farmers through field visit and meetings.

Table 8. Economics of growing local varieties

Sr. no.	Name of Crop	Economics	Other benefits
1	Shevali chilly	Home seed no cost No use of pesticides and fertilizers 5 to 7 Quintal / acre 10000-15000 Rs / Quintal 50000-60000 Rs/ Acre	drought resistant. No need of irrigation. Adapted to local climate. Pungent taste. Used in many pickles gives unique taste as compared other chilli.
2	Sorghum Talki	Home Seed. No seed cost. No use of fertilizers and pesticides. 7 to 8 quintal per acre 1000 to 1200 pendi fodder	No need of irrigation. Used as good fodder resource to livestock. Used as good staple food in daily intake. Low requirement of human resources. Its unique taste as compared to other sorghum vareties.
3	Safflower Kardi	Home seed No use of fertilizers & pesticides 3 to 4 Quintal per acre Used as plant fencing as well as plant protection crop due to its colorful flowers.	Oil purpose Fodder for livestock Used as vegetable in early stages

Experience of Seed bank

The seed bank is a common platform where farmers deposit their seeds as savings and other farmers borrow the seeds from this place. Initially MGBP project provided structural input as well as seed storage systems to seed bank. The land is owned by farmers without any rent. Then for its record keeping and management MGBP supports INR 500 per month to the labor for its maintainance. The seed bank has its own informal body and rules. This informal seed bank keeps proper records.

List of Publications

- Book on MGB focused crops from Marathwada
- 2000 Leaflets are published and circulated.
- Article is published in Agrowan on Shevali Mirchi

Networking with other MGBP

MGBP network gives us identity as MGB partner at State and regional level. This identity helped us networking with Maharashtra State Biodiversity Board and RRA network. We participated in Nagpur and Nadurbar KVK Seed conservation festivals. In these festivals we displayed our local seeds and shared our experiences with other seed saver groups and networks.

Collaborations and Outreach

While working with this project we collaborated with local schools, institutes as well as many forums working in seed conservation. We joined wth Nagpur Seed conservation groups, Beej Swaraj Manch. This platform enriches our knowledge about legal aspects like State and National Seed policy and marketing.

In future we are looking for more collective action in organic farming as well as seed marketing.

Knowledge Outcome

1. Women play the key role in crop harvesting as well as nursery preparation in Shevali chili. Parvatibai Jadhav from Barbada village having traditional recipes like prepration of 4 types pickles and chatni.

2. For Shevali, farmers use Athwad cultivation method to maintain soil health and yield.

3. Sorghum local varieties having good source of Iron and other minerals.

4. Harvesting of safflower and sorghum crops is more expensive and labour intensive. So there is need to research on new mechnical harvesting techniques.

Stories emerged

Farmers from Naigaon area adopted specific method for Shevali cultivation called as "Adthwad". The Shevali cultivator farmers reserved separate land for Chilli cultivation. Only Shevali chilli crop is taken in whole year. In the month of May they plough the land and leave it open to absorb the heat in summer. As the rain starts in the month of June they don't take any other crop but the whole rain water seeps into the soil so that the moisture is maintained till the month of August and in this month they replant the seedlings of Shevali Chilli. The crop is ready to harvest in the month of Jan to Feb.

Conservation Stories

Talki Jowar is the major crops in Rabi in Osmanabad and Nanded area. Even today the recipe Ambil is the primary food offered in all the festivals and celebration and daily diet. Thus, the farmers have a moral attachment with this crop. At the time of harvesting many birds migrate to this area and the main source of their food is Jowar. So many farmers engaged in protection of their crops from these birds. But some farmers still follow the way not to hurt the birds "Pakhre Khaun urlele aple" (whatever remains after birds eat, is ours). Many farmers hung the comb and water pot to the trees or roof for the birds. Many farmers worried and expressed their concern about the reduction of house sparrow from their area.

Staff details

Name	Post	Date of Joining	Date of relieving
Rohit Deshmukh	Project Investigator	4-01-2014	31-04-2020
Madhav Tate	Research Associate	4-01-2015	31-04-2020
Dinesh Jadhav	Research Fellow	9-12-2018	31-04-2020
Santosh Kotnod	Project Assitant	4-01-2015	31-04-2020
Ravin Yennawar	Paryavaran Shiksak	4-01-2015	31-04-2019
Rupesh Kulkarni	Research Fellow	4-01-2015	30-11-2015

Activities

Training & demonstration program

To make aware and capacity building among the farmers on organic and sustainable farming we conducted training and demonstration program on various subjects like organic farming, natural farming, seed conservation and importance of local seed banks. We also encouraged farmers and local youth for Organic farming through practical demonstration on Zero Budget farming and compost.

Workshop and conference

Farmers are dealing with different acts and rules but still there is low awareness on these acts. So we conducted workshop and conferences on Acts like PPVFR and Biodiversity Act 2002.We also facilitated workshop on need and importance of traditional/local seed conservation, organic farming and the process of organic certification, farmers' producer company etc.

Demonstration plot

This year we organized two demonstration plots for observation and seed collection for local Shevali (chilli) & Kardi (Safflower) at KVK. This year we facedcurly leaf disease problem on Chili.

Group meetings

At village level we facilitated Seed Saver group formation and till now we formed 10 groups. The main objective of this group is to create an open platform for sharing and exchange of seed related practices like old Seed storage systems, seed selection and Seed banks.

Seed Exhibition

To make aware and share knowledge about local traditional seeds we organized seed exhibition at different platforms like KVK . This activity is a best platform to connect with larger group who are working with farmers. This platform also enrich our knowledge related traditional Seed Conservation. Many farmers willing to cultivate the traditional crops but due to unavailability of traditional seed force them to market for improved seeds. In this exhibition we also thinking of intervening the Seed exchange program as we have enough seeds.

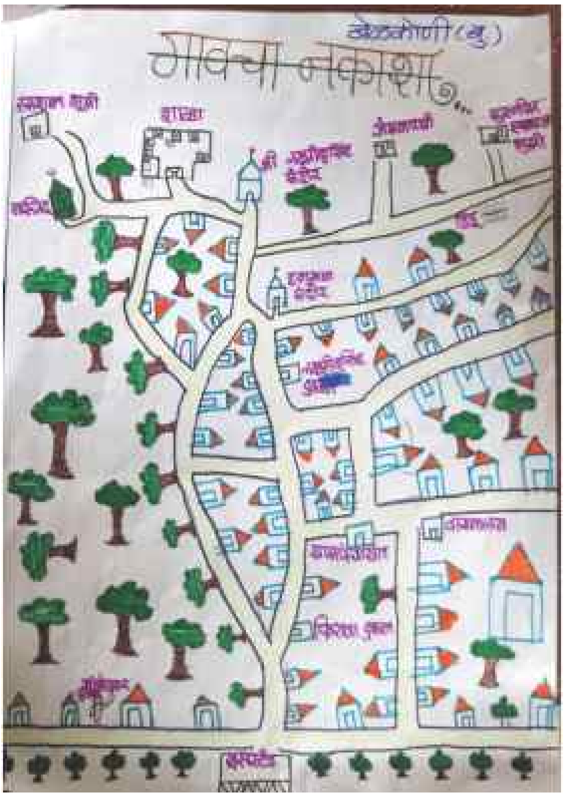
Sr. No.	No of programs	Participants Male	Subject
1	Exposure visits- 4	60	Demonstration & training on Zero Budget farming.
2	Workshop-2	36	Organic Farming, Organic certification, Seed conservation & farmers act.
3	Demo plots	2	Crop- chilli & Safflower
4	Group meetings- 4	30	Seed conservation & community seed bank
5	Seed exhibition- 1	60	Sharing traditional seeds with farmers.

CEE component:

Under CEE component we selected 20 schools from Nanded district. The main objective of this project is to generate interest, data collection & facilitate various environmental educational activities. At initial stage this year we strengthened our relationship with school & students. It is observed that traditional Agricultural knowledge is passed down from one generation to next generation is on the decline and preservation of this knowledge is most important. The Maharashtra government is carried out many changes in educational system now each student having outdoor activities & small projects that reconnect with this knowledge.

During the project we engaged with schools with activities like

1. About 10 Shivarferi- In this activity student from crop science carried out data collection of local wild trees and crops.
2. Village mapping: In 10 schools we encouraged students to prepare their village maps. In this activity students interact with local villagers & map out the available resources in their area.
3. Nursery formation: In shivarferi student collected seeds of 25 types of local trees. In continuation of this activity students prepared a small nursery in which they learned about the mother bed preparation, seed treatment and primary care of seedlings.
4. Daily meal: With this activity we facilitate the students to map out about the daily food intake at home. Student prepared maps " AAJ mayzya Tali madhe Kay aahe?"



Result Based Indicator Management Report

Output /S	Indicators	Baseline at the start of the project	Target set for the reporting period	Achievements during reporting period	Achievements cumulative till date
Output 1 - *In-situ* conservation of crop landraces	1. Number of *In-situ* conservation sites	2	40	27	27
	2. The number, type, and area of crops and land races cultivated	0	3	3	3
Output 2 - Community Seed Banks Established	1. Number of community seed banks	0	1	1	1
	2. Number of crops and landraces seeds available in the seed banks	0	30	26	26
Output 3 - Developed package of practices.	1. Number of farmers demonstrating the documented package of practices	0	30	30	30
	2. % increase in yields of identified crops"	0	15%	10%	10%
Output 4 - Morphological and nutritional, traditional knowledge data generated.	1. Selected crops and landraces documented as per DUS guidelines is available.	0	3	3	3
	2. Number of traditional practices documented	0	10	10	10
Output 5 - Protocol developed for value addition.	1. Information available on traditional value addition	0	5	3	3
	2. Number of value added produce	0	2	0	0
Output 6 - Increased number of farmers involved in cultivation of crop landraces.	1. % increase in total number of farmers involved in cultivation of crop landraces	0	30%	24%	24%
Novel/Unexpected Observations		0	0	0	Heavy rain at the time of harvesting damaged crop quality
New questions raised/discussed		0	0	0	Viral disease on Chilli
Unforeseen problems encountered		0	0	0	0

Annexure 1

A	Seed bank data						
Sr. No.	**Name of seed bank/seed saver organization/seed saver group**	**Contact person**	**Village**	**Pada/ Hamlet/ Tolla**	**Taulka**	**District**	**No of landraces conserved crop wise**
A	**Seed banks (community level & Organizational Level)**						
Sr. No.	**Name of farmer**	**Village**	**Pada/ Hamlet/ Tolla**	**Taluka**	**District**		**No of landraces**
	Sharad Joshi farmer group	Talni		Biloli	Nanded		17
B	**Field conservation centres**						
Sr. No.	**Name of farmer**	**Village**	**Pada/ Hamlet/ Tolla**	**Taluka**	**District**	**Name of crop**	**No of landraces**
1	Sahebrao Powar	Barbada		Naigaon	Nanded	chilli	1
2	Nilkhant Patil	Talni		Biloli	Nanded	Sorghum	2
3	Rajesh Kapratwar	Sawli		Biloli	Nanded	Sorghum	1
4	Ramesh Jamdade	Rudrapur		Biloli	Nanded	Mung	1
5	Balaji Soge	Bhabli		Dharmabad	Nanded	Udid	1
6	Hanmant Maymaule	Talni		Biloli	Nanded	Red gram	2
7	Shankar Jadhav	Biloli		Biloli	Nanded	Safflower	1
8	Ram Bodke	jahur		Mukhed	Nanded	yellow sorghum	1
9	kamlesh Kamble	Lohgaon		Biloli	Nanded	tommato	1
10	Nagesh Powar	Sagroli		Biloli	Nanded	Brinjal	1
11	Nagesh Powar	Sagroli		Biloli	Nanded	Rice	1
11	Babu Shevale	Barbada		Naigaon	Nanded	Udid	2
12	Ramrao Jadhav	Talni		Biloli	Nanded	Wheat	1

Kardi- Demo plot 1

Kardi- Demo plot 2

Kardi-Flower

Farmers demo plot visit

Seed Bank

Seed Distribution

Seed Exibition at Pune

Publication

Maharashtra Gene Bank, Project.

Name of the organization: Sanskriti Samvardhan Mandal.

A collective step - Regeneration of shevali Mirchi

Background :

Shevala village is located in Degloor block District - Nanded
Soil Type : Black Soil
Area : River bank (Godvari, Lendi and Manjra)
Crop : Sheval Chili - Cash Crop
Duration - 210 days
Yield - 7 to 8 quintal /acre
Resilience - Only need soil moisture to resilience to pest control and drought condition.

Problem :

Leaf curl viral disease
Changes in temperature & long dry spell.
Low production & high input cost on pesticide & insecticide.
Interventions
Germ plasam collection through participatry method & group discussion.
Information collected regarding cultivation.
Demostration plot on farmers Land for insitu conservation
Regenrated "Athwad" cultivation method
Farmers Training on seed selection method distribution of healthy seedling

Success Story :

Rs 23500 Income (Form 30 Gunta land crop Shevali Chilly)
Farmers Name : Nilkanth Patil
Village Name : Baroda, Block, Naigaon District - Nanded
Land Area : 30 Ghunta
Crop Verity : Sheval Chilli Crop Duration : 120 Day
Cultivation Method : Athwad (Local Method)
Input Cost : 6500 (land preparation, cultivation and harvesting) Production : 10 Quintal
Market price : Rs. 300 x 100 = 30,000
Total Income : Income - Input Cost
30,000 - 6500 = 23500

Shevali- Plant

Farmer- Mr. Sainath Pawar

Fruit- Shevali

Chilli drying

Demo plot- Dukari (2)

Dukari- Demo plot

Dukari- Kanis

Dukari-kanis2

Sorghum- Dagadi

Sorghum- pawali kanis

Sorghum-shreekhandi

Report 2.3

Crop Genetic Diversity

Institute of Integrated Rural Development (IIRD)
Aurangabad

Background

Since the beginning, IIRD has always believed that social, economic, and environment justice is intertwined. Hence, the organization works with the communities to improve their livelihoods in an inclusive and participatory manner while also conserving the biodiversity and the environment.

During the past two decades, the organization has held several village-level workshops on the conservation of biodiversity. This has led to trials in community based seed banks and development of community registers (that include information on communities and their environment) in Aurangabad. Further, the organization trained representatives from the villages of Aurangabad district as biodiversity volunteers (paryavaran sevaks/ sevikas). In the Maharashtra Gene Bank (MGB) project, the organization was able to facilitate and train biodiversity volunteers in other five districts of Maharashtra – Beed, Hingoli, Jalgaon, Jalna, and Parbhani. These trained biodiversity volunteers have now established biodiversity registers and seed banks in the six districts under the MGB project. Presently, about 200 seed varieties of food crops are available at these seed banks and are exchanged among the farmers in the villages. Biodiversity committees have also been formed in 69 villages in the six districts. These committees help the communities in the villages to evaluate the biodiversity resources in the villages and plan steps in the conservation of the same.

The MGB project is being undertaken in the six districts that are predominantly rainfed and has been affected by successive years of drought. The crops that were chosen for the MGBP are the traditional varieties that were once very dominant in the region and now facing a diminishing trend. In this project, 843 farmers from 69 villages are actively involved in the conservation of selected 16 varieties of 6 crops.

Journey with MGBP

Key issues

- In-situ biodiversity conservation and protection
- Livelihood strengthening
- Community based biodiversity conservation and management efforts

Area of operation

S No	District	Talukas/ Blocks
1	Aurangabad	Paithan
2	Jalna	Jalna
3	Parbhani	Jintur
4	Hingoli	Hingoli
5	Beed	Ambejogai
6	Jalgaon	Pachora

- Community education on policies and regulatory frameworks for management and protection of biodiversity
- Environment awareness among children

Objectives of work

i. To build up a systematic inventory of crop genetic resources of the Aurangabad, Jalna, Hingoli, Parbhani, Beed and Jalgaon districts of the Maharashtra state

ii. To identify one variety in each district for pilot scale efforts at in situ conservation, upgradation, value addition, marketing, and documentation

iii. To establish district level seed banks focusing on traditional cultivars of superior quality

iv. To engage educational institutions in study and promotion of crop genetic resources

Sampling methods

In the six selected districts, 60 biodiversity conservators [Annexure-1] were selected for in-situ conservation and documentation of 16 varieties of 6 crops – Sorghum, Green Gram, Pigeon Pea, Wheat, Sesame, and Safflower. These varieties were chosen as they were once available in abundance in the villages but now show a decreasing trend. Besides, these crops are traditionally known for their nutritional and medicinal values. It is also observed that the selected crops are more resilient to effects of climate change. Currently, there are 843 farmers [Annexure-2] involved in the cultivation of the selected varieties. The seed selection process is as follows –

Select 10 good quality plants of crop from every plot of the field. Selection of good quality plant is a first essential step to get good seed. Plant selection is a careful and systematic process. Farmers follow the following steps when they are selecting plants for seeds:

- Select strong and vigorous plants, based on height, size and color of leaves etc.
- Select plants that are resistant to insects and diseases
- Select plants that can cope with adverse conditions such as drought and adverse weather conditions.
- Select plants that mature at the right time.
- Select plants that are more productive and give more yield.
- Select plants having healthy seeds, based on seed size, color and glossiness.
- Tie red or white threads to the selected plants, so that the seeds from these plants will not get mixed with other seeds at the time of harvesting.

In addition to the selection of good quality seeds, there are peer appraisals, focus group discussions, and group observation on the crops to ensure the purity and quality of the selected varieties grown in the fields.

The bio-diversity conservators were selected by the communities in acknowledgement of their knowledge and experience in these varieties. The crops and their varieties were selected based on their dominance in their traditional cultivation practices and after focus group discussions with the farmers. The villages selected were from those regions where the selected crops were traditionally dominant but show a significant diminishing trend in the recent years.

Seeds of crop varieties on display for discussion

Major work done under MGBP

During the past five years, following activities were conducted at the field level:

i. Villages were selected from the six chosen districts. These villages were once rich in plant biodiversity but now have fragile ecosystems. For instance, during the Participatory Rural Appraisal (PRA) conducted in the village Jambli of Aurangabad district, it was known that the village was so named because of the prevalence of Jambli Tur (pigeon pea) once upon a time which had almost disappeared when the MGB Project began. The MGBP revived this variety in the village.

ii. Village level meetings and focus group discussions were conducted for the selection of crops and varieties that are to be documented and conserved.

iii. Seed banks were established in each of the six districts with seeds of different crop varieties but specifically focusing on the crops that are selected in the MGBP.

iv. Linkages were established with Maharashtra State Biodiversity Board. Biodiversity Management Committees (BMC) were established in 69 villages. Training of the representatives from the BMCs – including Sarpanch, Government Agriculture Assistants, and progressive farmers - were conducted by Maharashtra State Biodiversity Board and IIRD staff.

v. About 843 farmers are involved in the cultivation of indigenous and traditional varieties of crops.

vi. Environment education is being conducted in 22 schools of Aurangabad [Annexure-3] and Jalna districts. Each of these schools have formed environment clubs and are involved in the conservation and management of local biodiversity. The activities conducted by these clubs include – tree plantation, survey of local biodiversity, and discussions within the schools on

Documentation of Mango Varieties in Aurangabad District biodiversity. For instance, with the participation of the school children, survey was conducted in Aurangabad and Jalna districts to document the varieties of mangoes in these two districts. The survey has shown that there are 49 types of mangoes. [Annexure-4]

vii. Three Hundred (300) families in Aurangabad and Jalna districts were surveyed in relation to their dietary pattern, consumption, and relevance to local biodiversity. The survey concluded that there is a serious lack of knowledge on local biodiversity among the younger generation. For instance, the millets were a predominant part of the diets of the generation born in the 50s and 60s but have almost gone out of the plates in the generations that were born in the 80s and later. It is observed that the younger generation only consumes 20% of the varieties that were in the plates of the preceding generation.

viii. An information book in Marathi on conservation of traditional crop varieties was prepared in participation with farmer biodiversity conservators.

ix. Focus group discussions and consumer meetings were held with consumers in the city to assess and analyze the food demands of the consumers.

x. The farmers were trained on the value addition of 13 farm products that include – processed dal, papads, khurdai, chilly powder, masalas, etc.

xi. Regular seminars and trainings were conducted in-house to enhance the knowledge of staff on in-situ and community based conservation and management of biodiversity.

xii. At least 1000 farmers involved in the cultivation of traditional indigenous varieties of crops have benefitted from the sale of their produce through Organic Sale Outlets and networks, exhibitions, organic bazaars, and through the Farmers' Cooperative – Mahagreen Producer Company Ltd. In Aurangabad alone, at least 800 Kg. of vegetables are sold on each of the weekly markets – which comes to approximately 41 tonnes of vegetables per year. Similar are the figures for the organic bazaar in Hingoli district. During the last financial year, about 16 lakh Rupees worth of grains have been sold through the Mahagreen Producer Company and Organic Link Outlet.

xiii. 502 children from various schools have spent at least one entire day at an organic farm with various activities – sowing of vegetable/ crop seeds, preparation of organic manures, feeding bio-gas units, and exploring dairy and poultry activities. [Annexure-5]. These activities enhanced their interest in farming with a "hands-on" experience in the farm.

xiv. Four exhibitions were organized at the IIRD campus in Aurangabad district to spread awareness on local traditional crop seeds. These exhibitions were inaugurated by prominent personalities that include Rajendra Singh (water man of India), Dr. Sudhirkumar Goel (Principal Secretary, Agriculture (Maharashtra State)), Umakant Dangat (Commissioner, Aurangabad) and Dr. Ashok Kumar Yadav (Former Director of National Centre for Organic Farming). Each of these exhibitions were participated by at least 1000 farmers. The Biodiversity corner was inaugurated by Dr. Ashok Kumar Yadav [Annexure-6] .

xv. IIRD had facilitated the celebration of important environment related days – like International Seed Day, Environment Day, International Day for Biodiversity, along with community members and school children. Also, a religious relevant day like Akshay Tritiya was celebrated with worship of seeds. These events provided opportunities to raise awareness on local biodiversity.

xvi. Two "Anand Shaalas" were facilitated by Centre for Environment Education (CEE) where IIRD staff, school children, and teachers learned about environment through games and an active learning environment. The staff of IIRD were trained by CEE on ways to conduct environment education in the schools.

xvii. The staff of IIRD improved their skills on research methodologies and data collection with the coordination and training support provided by IISER.

xviii. IIRD has facilitated 98 Local Groups (LGs) of organic farmers in the project area to obtain Participatory Guarantee Systems (PGS) certification under the PGS-India programme coordinated by National Centre for Organic Farming (NCOF), Ministry of Agriculture. This will enable these farmers to sell their produce as organic products anywhere within India. Further, another 69 LGs are registered with PGS-India with the technical support of IIRD and these groups are also expected to be certified in another year. Each of the LGs have between 5-10 farmers.

xix. 214 PGS group members from Aurangabad district were trained on agriculture-allied enterprises.

xx. Two-day training was conducted in Bidkin (Aurangabad) twice from 11-12 Nov 2019 and 10-11 Jan 2020 on agro-based enterprises using the seed money of the programme. 72 PGS Group Members attended these trainings and 35 enterprises were initiated as a result in 7 Villages - Shekta, Wahegaon, Borgaon, Taherpur, Takli, Gidhada, and Mudhalwadi. The enterprises are as follows –

Sr. No.	Name of Enterprise	No. Of Enterprises
1.	Dairy Unit	31
2.	Vermicelli production	2
3.	Flour Mill	2
	Total :	**35**

Unintended outcome

Generally, farmers and grassroots organizations are of the opinion that urban school children have very little interest of rural life and farms in particular. Our experience has shown that urban school children who have visited rural farms in Aurangabad have shown great interest and even expressed that this was their best part of their exposure tour away from their home city - Hyderabad.

The area under pigeon pea has increased by over 30% in some of the villages selected in this project. This positive trend of moving from cotton crop to pulses was not expected to this extent.

Qualitative impact of the work

- There has been a progressively growing interest on biodiversity conservation and management among school children and farmers in the selected district, as evidenced by the increased number of related actions. For instance, activities such as tree plantation, preparation of natural colours from different plants for Holi festival, compost making, and surveys of local biodiversity, were almost non-existent among the selected schools before this project began.
- The farmers and biodiversity conservators have greater confidence and knowledge on organic cultivation practices and conservation of traditional varieties. The increasing area under local variety of pigeon pea and other varieties cultivated organically is evidence of this.

Quantitative impact of the work

Sr. No.	Particulars	Indicators	Before Project	After Project Intervention – May 2018	Details
1]	In-situ conservation of crop landraces	Number of In-situ conservation sites	18	172	These are the farmers who are involved in the conservation of the selected land race varieties which are traditionally grown in the respective districts.
		The number of land race varieties cultivated	19	26	The details of the land race varieties and the districts where conserved is in the Species lists/inventory towards the end of the report.
2]	Community Seed Banks established	Number of community seed banks	1	6	The first seed bank was already established in Aurangabad. The remaining 5 seed banks are in each of the 5 districts – Beed, Jalgaon, Jalna, Hingoli, and Parbhani
		Number of crops and landraces seeds available in the seed banks in all the seed banks.	26	205	The seeds of these varieties are available in the six seed banks
3]	Developed package of practices	Number of farmers demonstrating the documented organic practices.	0	60	The farmers follow the organic farming practices as documented in the “Sendriya Sheti Pustika” (Organic Agriculture Manual) prepared by IIRD
		13% increase in yields of identified crops	2% from previous year	13%	This is only the increase in yield from the baseline gathered in 2013.

Sr. No.	Particulars	Indicators	Before Project	After Project Intervention – May 2018	Details
4]	Morphological and nutritional, traditional knowledge data generated	Selected crops and landraces documented as per DUS guidelines is available.	0	Yes	The documentation is available for 16 varieties and is in progress for another 10 varieties.
		Number of crop varieties for which local practices in cultivation of landrace varieties are documented	0	22	The local practices of cultivation, storage, and utilization of 22 of the 26 selected crops are documented.
5]	Protocol developed for value addition	Knowledge available on traditional value addition among field extension workers	Yes	Yes	The field workers are involved in the promotion of value addition among farmers entrepreneurs.
		Number of value added products	0	13	Value added products like chilli powder, papad, khurdi, shevai, pickles etc.
6]	Increased number of farmers involved in cultivation of crop landraces	20% increase in total number of farmers involved in cultivation of crop landraces	0	20%	Based on focus group discussions and informal surveys conducted in the villages.

Community participation in MGBP process

· Initiation of community participation: Village level meetings were conducted to raise awareness on environment and biodiversity conservation. These meetings resulted in increased knowledge and interest among the participants which resulted in the participation of the communities to plan and implement biodiversity conservation activities.

· Community's role in designing or reshaping the work:

The communities participated in

1. the selection of varieties of different crops, selection of the farmers/ sites, and documentation of the crops as per DUS guidelines.

2. the establishment of the Biodiversity Management Committees and facilitating the role and functions of this committee.

Crop Observation and In-Situ Learning

3. The community members established the seed banks and facilitated the collection and documentation of the various seeds available at these seed banks.

Traditional conservation practices: Seed storage, purity, breeding practices

The traditional practices are mentioned below:

Seed Selection

- o Identifying ten healthy plants in each row.
- o Plants that have not been infected by diseases
- o Not attacked by insects
- o Greater resistance
- o Timely bud and flower stages
- o Greater yield
- o Tie black or red ribbons on selected healthy plants. Harvest ripened seeds from those plants

Storage system

- o Keep seeds away from pests and infected plant materials. They are mixed with neem leaves, rock salt, wood ash, and chillies and kept in earthen pots.
- o Sun drying of high moisture seeds

Seed Treatment

- o Any one among Neem oil, cow pat peat (CPP), Rhizobium, or Azotobacter can be used for seed treatment. The seeds are treated about 2-4 hours before sowing.

Seed Storage

- o Apply ash or neem oil on seeds and store in mud pots with at least 20% open space available for air. The seeds can be stored for up to 2 years. If neem oil is applied on the seeds, it lasts longer – up to 5 years.
- o Use neem leaves for preservation of grain seeds for up to one year.
- o Store the seed in stack of mud pots

Sustainable harvest practices

Traditional practices of harvesting are followed by majority of the farmers in the region. These include manual plucking and threshing.

Beneficiaries

- The beneficiaries are farmers and school children from 67 villages in 6 districts of Maharashtra – Aurangabad, Beed, Hingoli, Jalgaon, Jalna, and Parbhani. The details are as below:
- Among the 60 biodiversity conservators, at least 80% of them have farms less than 5 acres of land, 15% have lands between 5 acres to 10 acres, and less than 5% of these conservators have lands greater than 10 acres. Most of them are involved in rainfed farming with lack of any irrigation.
- Among the 843 farmer households involved in the cultivation of indigenous traditional varieties, most of the cultivation activities are done by the women. Women play an active role in the conservation of seed varieties.

Seed Germination Testing

- Less than 3% of the beneficiary farmers belong to the tribal communities.
- The project focuses on the environment education among the children from 8th std to 10th std (13-16 years age) in 22 schools of Aurangabad and Jalna district. Roughly, 1400 students fall within this age group in the 22 schools.

Long term Benefits

- Increased knowledge on organic farming and biodiversity conservation practices through trainings, field demonstrations, exposure visits to KVK and agriculture universities, and expert guidance. This increased knowledge is demonstrated by the growing number of farmers who cultivate traditional crops using organic means.
- Increased awareness on biodiversity conservation among children and youth through the environment education programmes. The number of biodiversity conservation activities – such as tree plantation, survey of traditional flora, and others - conducted by the children in schools have increased from almost none before the project period.
- Established 69 Biodiversity Committees; institutional support from the Ministry of Environment and Forests at the state and national level are expected to further incentivize the biodiversity conservation efforts.

Short term Benefits

- Incentives for organic farm inputs – initial funds for the construction of vermicompost units, and supply of biodynamic preparations and manures.
- Linkages with markets at the local and regional level through farmers cooperatives, agriculture exhibitions, and organic bazaars have resulted in sale of at least 40 tonnes of vegetables and 100 tonnes of grains with prices at least 10% over the market price.

Right based benefits

The farmers are aware of their rights under the Protection of Plant Varieties and Farmers Rights (PPVFR) Act. This awareness has led to DUS documentation of 16 traditional crop varieties.

Measures to reassure that benefits to the community continue after MGBP

IIRD will continue to facilitate knowledge exchange among organic farmers, incentives for establishment of organic compost production units, linkages with markets, and collaboration with Ministries and departments for available assistance.

Organic Bazaar in Aurangabad

What decides market value?

- The market value is decided mainly by the following factors –
- The prices prevailing in the market for the respective farm produce.
- The location of the market- urban or rural. The prices in the rural areas are generally lower than in the cities.
- The nature of production – organic or conventional. The organic produce fetch a better value (>15%) when sold as "organic" in urban markets. The environmentally and socially conscious consumers are willing to pay the premium for the produce.
- The demand for the produce. Greater the demand, the higher the price of the produce.

Relationship with PPVFRA and NBPGR

- New varieties reported and registered, Raanbhajya and other non-commercial food
- The documentation of landrace crops and their varieties are being done as per DUS guidelines. So far, there has not been any varieties reported and registered.

Economics of Seed Banks

- Each seed bank would need an investment of Rs. 1.0 lakh for the purchase of wooden boxes, glass bottles, cup boards, and registers.
- The maintenance costs are about Rs. 40,000 per seed bank per year for cleaning, purchase of seed preservation materials, electricity, etc.
- Currently, the seed banks are supported by the project and by IIRD.
- As sale of seeds do not take place at the seed banks, there are no economic profits that are envisaged.
- The establishment and management of the seed banks are done by the Biodiversity Management Committee (BMC). The interests and incentives (monetary and recognition) are important for sustenance of the seed banks.
- The demand for traditional crop varieties (such as millets) are on the increase with the growing awareness on the health benefits. There are therefore possibilities for increased incomes from these crops. Besides, the cost of cultivation of these traditional crops are lesser than for other crops if done by organic or traditional methods.

Economics of traditional varieties

- The traditional varieties do not find much place in conventional markets. However, there is an increased participation of farmers in organic bazaars indicating that there is a scope for premiums and better market values in targeted markets. The number of farmers participating in the organic bazaar in Aurangabad has increased from 10 farmers once every week to the present 25 farmers in each week.
- The traditional crops are known for their resilience rather than productivity particularly in the rainfed areas. For instance, it is observed that in many of the villages in Aurangabad district, the farmers have turned from cotton cultivation to millet and pulses cultivation after having faced successive years of drought, hail storms, and pest incidence in cotton. In some of the villages, it is observed that there is at least 30% increase in area under pulses and millets and a reduction in the area under cotton. Though profits may not be as significant as in the commercial crops, the resilience of the crops makes it less risky.

Relevance of history in conservation practices

Cultural methods of selection of crop varieties are slowly losing their significance. For instance, Ghatasthapana Puja determined the crops that were to be sown in Rabi but this practice is slowly on the decline. During this puja, only traditional crop seeds are used.

List of Publications and presentations at conferences-

- Four of the women farmers presented at the International Federation of Organic Agriculture

Movements (IFOAM) World Congress that was held from November 1-3, 2017 at New Delhi. The presentations were on traditional seed selection, organic farming, pest management, and conversion planning of conventional farms to organic farms.

- https://owc.ifoam.bio/program?utf8=%E2%9C%93&category_filter=workshops
- The programme staff of IIRD, Vilas Patil, shared the experiences of the MGBP at the Agro-Biodiversity Conferences that were held in Kerala and in Iran. http://agriculturalbiodiversitycommunity.org/files/7th-annual-meet.pdf
- The farmer representatives of the region participated in the Maharashtra state level seed conference that was held in Wardha in July 2017.

Networking with other MGBP groups

- The networking with other groups has led to exchange of seeds, knowledge, and expertise in different areas. For instance, farmer representatives from Sangamner Taluka of Ahmednagar district participated in training on organic farming and organic certification systems at the IIRD campus in Aurangabad. Seeds were also exchanged among the groups. IIRD had also benefitted with the visits to various other areas and acquired new knowledge on community-led efforts in biodiversity conservation.
- The informal and formal information exchange within the groups has led to better access to markets for the small and marginal farmers.
- The collaboration with IISER has built our capacity in action based research and documentation. IIRD expects to continue this collaboration even after the MGBP.
- The CEE has enabled the staff at IIRD to facilitate environment education in the rural schools. The intervention among the children is key to sustenance of the biodiversity conservation measures in the future. IIRD will continuously collaborate with CEE on this intervention.

Seed Exhibition Organized in Bidkin, Aurangabad District

- Regional theme based workshops at least once in a year will enable the organizations to share ideas, mobilize resources, and continue the biodiversity conservation activities.

Outreach

- IIRD is a member of related networks such as International Union for Conservation of Nature (IUCN), International Federation of Organic Agriculture Movements (IFOAM) and Agro-biodiversity Community (ABC). These networks facilitate our sharing of knowledge and information with national and international members interested in the conservation of biodiversity. The farmer representatives involved in the MGB project shared their experiences at the IFOAM World Congress that was held in New Delhi from Nov 1-3, 2017. The coordinator of the MGB project also had the opportunity to share the learning's with wider ABC community in Iran.
- IIRD is a member of the task force for implementation of the organic agriculture policy in the country. This has enabled us to influence policies and government interventions in favour of organic agriculture in the state.

IIRD Seed Exhibition

- IIRD has pioneered the Participatory Guarantee Systems (PGS) – a community based participatory method of organic agriculture certification. In the recent years, the organization has promoted PGS at the national levels and international levels.

Knowledge Outcomes

Interesting / unrealized facts that emerged during the work

- It is observed that spraying of ashes of Parthenium mixed with water deters the growth of Parthenium. This practice is followed in our IIRD campus at Bidkin and among some of the farmers. In IIRD campus, this was done once during a year for 3 consecutive years and since then, there has not been any Parthenium in the IIRD campus for the past 10 years.

- Seed treatment with biodynamic Cow Pat Peat (CPP) and spraying of CPP in the farm increases the germination rate and resilience of the crop to drought like conditions. This has been observed by many of the farmers. During the farmers group discussions, it was expressed by the farmers who had sprayed CPP in the farms that their crops had endured drought conditions better than the neighbouring farms.
- Seeds coated with neem oil and kept in wooden containers have a longer shelf life and may even germinate after 5 years. This is an actual observation of pulses seeds that were kept in IIRD.

Stories emerged

- Dagadi Jowar (local variety of Sorghum) – This is easily digested by elderly people and infants. Traditionally, the soup of this variety is believed to treat urinary infections. Boiled grains are also used to control fever.
- Traditionally, pigeon pea (Jambli variety) is used to treat acidity. As this takes less time to cook as compared to white variety, it would require less fuel.

Realizations about human nature/ human- nature relationship

- It is usually generalized that children from the cities are averse to working with soil and cow dung. However, we have observed during our interactions with school children and the regular visits of school children from Aurangabad and Hyderabad that children can actually love farms, cows, and feel close to the soil. Children of NRI families from reputed international schools of Hyderabad who have visited our farms have danced on cow dung heaps, made manures with their bare hands, and have caught earthworms in the farms.
- We believe therefore that the society should nurture a child close to nature as far as possible for the child to grow up and become environmentally responsible citizens.

Workshop on PPVFR

Observations about ecology- regeneration/ depletion/ conservation

- Despite many tree plantation projects undertaken by the government, NGOs, and communities, the number of overall trees seems to be on the decreasing trend. The successive droughts and lack of perseverance among the various stakeholders are possible reasons for this scenario.
- The ground water levels are on the increase in the areas where water conservation efforts have been conducted. With the focus on water conservation and management by various sector actors, it is expected that there will be positive impacts on the local biodiversity.

New understandings/ philosophy/ realizations emerged

- The relationship of an individual or a society to nature is closely linked with their relationship to culture, religion, and traditions. As they deviate from culture, religion, and traditions, their relationship with nature also decreases.

Impact

- Communities have become aware of their rights in biodiversity conservation and management and take responsible actions towards its conservation.
- Small and marginal farmers have reduced their cost of cultivation through organic farming methods. This has further resulted in increased income and improved livelihoods. In the case of pulses cultivation, the cost of cultivation through organic methods is Rs. 33,000 per hectare while the conventional farming costs Rs. 51,000 per hectare. The reduced cost of cultivation with almost similar production results in increased profits.
- The reduced use of chemicals in the farms has improved the quality of the soil, water, air, and the ecosystem.
- Schools are increasingly involved in facilitating student activities to conserve the biodiversity and the environment.
- There is a trend for policies in favour of Participatory Guarantee Systems (PGS) for local certification of organic produce, and incentives to promote organic farming.

Failure stories

Successive droughts have led to farmers losing their traditional seeds. For instance, a wheat variety that was grown locally known as "Potha gahu" and grown in Aurangabad district of Maharashtra has completely vanished. The unique characteristic of this wheat variety is that this could grow in just soil moisture without much irrigation. The seeds of this variety is no longer available with any farmer in the district. Similar is the case with Jhingri variety of Sorghum.

IIRD is now working with the farmers to prepare an inventory of such varieties that are endangered. The biodiversity conservators are now involved in the conservation and preservation of the existing seeds in traditional ways. By doing so, it is expected that the seeds of the traditional varieties are available for future generations.

Way forward

- The organization feels that interventions for each of the objectives of this project are to be continued. Further, we need to also focus on market linkages that will favour organic and traditional farm produce.
- Resources are expected to be mobilized through the linkages with Maharashtra State Biodiversity Board, government departments, research institutions, and other government institutional structures.
- The achievements from the MGBP will be shared at various forums and networks where IIRD is a member. The same will be integrated as lessons learned and foundations for other development interventions. For instance, the availability of a diverse range of traditional food produce is an added advantage to the farmers producer company/ Cooperative that IIRD has facilitated. Similarly, increased biodiversity will complement the water conservation and management interventions of the organization.

List of staff involved in the project

Sr. No.	Name	Position	Qualification	Date of Joining	Date of Reliving
1	Mr. Joy Daniel	Project Investigator	Master in Inrformation Management	01.03.2014	31/03/2019
2	Mr. Vilas Madhavrao Patil	Project Coordinator	BCom: MSW (RD)	01.04.2014	31/03/2019
3	Mrs. Alka Ramrao Najan	Botany Specialist	BSc Agriculture	01.06.2015	31/03/2019
4	Mr. Kiran Vitthal Kakade	Project Assistant	BSc Agriculture	01.03.2014	31/03/2019
5	Mr. Balaji Parasram Uchitkar	Botany Specialist	MSc Agriculture	25.04.2014	01/06/2015
6	Mr. Akashaya Chandraprakash Kharad	Project Assistant	BSc Agriculture	01.03.2014	31/03/2016
9	Mrs. Sharda Murlidhar Kadam	Research Information Assistant Aurangabad	Diploma in Agriculture	01.03.2014	31/03/2016
10	Mr. Datta Namdev Wadekar	Research Information Assistant Jalna	Diploma in Agriculture	01.05.2014	31/03/2019
11	Mr. Ramprabhu Govardhan Sonwane	Research Information Assistant Ambejogaie	BA BEd	01.03.2014	31/12/2017
12	Mr. Ram Kandhare	Research Information Assistant Hingoli	BA	01.03.2014	31/12/2016
13	Mrs. Kusumavati Nikalje	Research Information Assistant Parbhani	HSC	01.03.2014	31/03/2019
14	Mr. Parsuram Mahajan	Research Information Assistant Pachora	MSW	01.01.2014	31/03/2019
15	Mr. Kishore Gaikwad	Research Information Assistant Jalna	MSW	01.01.2014	01/05/2014
16	Mr. Sachin Babanrao Paikrao	Research Information Assistant Hingoli	BA	01.01.2017	31/03/2019
17	Mrs. Nurjaha Ashpakh Shaikh	Research Information Assistant Aurangabad	Diploma in Agriculture	01.04.2016	31/03/2019

Result Based Management indices

Output /S	Indicators	Baseline (at the start of the project)	Target (set for the reporting period)	Achievements cumulative till date
Output 1 - In-situ conservation of crop landraces	Number of In-situ conservation sites	18	120	172
	The number, type, and area of crops and land races cultivated	19 Number 0 Area	24 Number 142 Acre	26 Number 142 Acre
Output 2 - Community Seed Banks Established	❖ Number of community seed banks	1	6	6
	❖ Number of crops and landraces seeds available in the seed banks	26	51	205
Output 3 - Developed package of practices.	· Number of farmers demonstrating the documented package of practices	0	60	60
	· % increase in yields of identified crops"	0.00%	10.00%	15.00%
Output 4 - Morphological and nutritional, traditional knowledge data generated.	i. Selected crops and landraces documented as per DUS guidelines is available.	No	Yes	Yes
	ii. Number of traditional practices documented	0	26	26
Output 5 - Protocol developed for value addition.	i. Information available on traditional value addition	Yes	Yes	Yes
	ii. Number of value added produce	2	13	13
Output 6 - Increased number of farmers involved in cultivation of crop landraces.	_% increase in total number of farmers involved in cultivation of crop landraces	5.00%	10.00%	13.00%
Novel/Unexpected Observations				
New questions raised/discussed	SEED MARKETING. PORDUCTION LABLE			
Unforeseen problems encountered				

Appendix : Species lists/inventory

Sr. No.	Crop Name	Variety Name	Botanical Name	District of In-situ Conservation
1	Sorghum	Dagadi	*Sorghum bicolor*	Aurangabad
2	Sorghum	Pivali	*Sorghum bicolor*	Beed
3	Sorghum	Manthi	*Sorghum bicolor*	Parbhani
4	Sorghum	Abhaya Manthi	*Sorghum bicolor*	Jalna
5	Sorghum	Maldandi	*Sorghum bicolor*	Jalgaon
6	Sorghum	Gunjavali	*Sorghum bicolor*	Hingoli
7	Amaranthus	Gavran	*Amaranth*	Aurangabad
8	Maize	Gavaran	*Zea mays*	Beed
9	Pigeon Pea	Jambhali	*Cajanus cajan*	Aurangabad
10	Pigeon Pea	White	*Cajanus cajan*	Aurangabad, Jalgaon
11	Pigeon Pea	Red	*Cajanus cajan*	Parbhani, Jalgaon
12	Somo or jungle rice	Bhagar	*Echinochloa frumentacea*	Beed
13	Green gram	Hirava	*Vigna radiata*	Jalgaon, Jalna
14	Green gram	Chamki	*Vigna radiata*	Jalgaon, Jalna
15	Black Gram	Gavran Udith	*Vigna mungo*	Hingoli, Jalna
16	Chickpea	Gavran Harbara	*Cicer arietinum*	Jalna
17	Safflower	Gavran Khardi	*Carthamus tinctorius*	Beed
18	Sesame	Pandri Til	*Sesamum indicum*	Jalgaon
19	Sesame	Kaala Til	*Sesamum indicum*	Parbhani
20	Sesame	Gofani Til	*Sesamum indicum*	Hingoli
21	Linseed	Gavran Jawas	*Linum usitatissimum*	Beed
22	Mustard	Gavran Mohri	*Brassica*	Aurangabad, Jalna
23	Wheat	Kali Kusali	*T. aestivum*	Parbhani, Hingoli
24	Cluster Bean	Gavran Gawar	*Cyamopsis tetragonoloba*	Aurangabad
25	Tomato	Cherry Tomato	*Solanum lycopersicum*	Aurangabad, Jalgaon, Hingoli
26	Spiny Gourd	Kartul	*Momordica dioica*	Hingoli

Annexure 1

Biodiversity conservators list

Sr. No.	Farmers Name	Village Name	Block & Dist Name	Crop Nam	Varieties
1	Mrs. Laxmibai Gorakh Neel	Porgaon	Paithan / Aurangaba	Sorghum	Dagadi
2	Mr. Appasaheb Ramnath Lagha	Shekta	Paithan / Aurangaba	Sorghum	Dagadi
3	Mrs. Radhabai Kalyan Shelke	Tondoli	Paithan / Aurangaba	Sorghum	Dagadi
4	Mrs. Mangal Narhari Bobade	Borgaon	Paithan / Aurangaba	Sorghum	Dagadi
5	Mr. Sonwane Govardhan Tatyra	DigholAmba	Ambajogai / Beed	Sorghum	Pivali Jawar
6	Mrs. Vijaymala Navnath Kendr	Umrai	Ambajogai / Beed	Sorghum	Pivali Jawar
7	Mr. Santosh Nivruti Pawar	Kodhari	Ambajogai / Beed	Sorghum	Pivali Jawar
8	Mr. Smpati Nivruti Munde	Sangaon	Ambajogai / Beed	Sorghum	Pivali Jawar
9	Mr. Rambhau dagadu da	Kanha	Jintur / Parbhani	Sorghum	Manthi Jawar
10	Mr. Manik Bapurao Ban	Chandaj	Jintur / Parbhani	Sorghum	Manthi Jawar
11	Mr. Sanjay Dhondiba K	Halvira	Jintur / Parbhani	Sorghum	Manthi Jawar
12	Mr. Dinkarrao Shamra	Charthana	Jintur / Parbhani	Sorghum	Manthi Jawar
13	Mrs. Savitrabai S.Gajar	Gundewadi	Jalna / Jalna	Sorghum	Abhaya Manth
14	Mrs. Jaishri R. Kulkarni	Jamwadi	Jalna / Jalna	Sorghum	Abhaya Manth
15	Mr. Namdev Wadhekar	Shrikrushna	Jalna / Jalna	Sorghum	Abhaya Manth
16	Mr. Vijay Tanpure	Rohanwadi	Jalna / Jalna	Sorghum	Abhaya Manth
17	Mr. Sanjay Babulal Shinde	Khadkdevla	Pachora / Jalgaon	Sorghum	Maldandi
18	Mr. Sunil Bhika Patil	Khedgaon	Pachora / Jalgaon	Sorghum	Maldandi
19	Mr. Raju Bhosale	Pungaon	Pachora / Jalgaon	Sorghum	Maldandi
20	Mr. Shriram Vikram Pawar	Anturli	Pachora / Jalgaon	Sorghum	Maldandi
21	Mr. Dattarao Waghamare	Bori-Shikari	Hingoli / Hingoli	Sorghum	Gunjavali
22	Mr. Sanjya Paikrao	kalmkonda	Hingoli / Hingoli	Sorghum	Gunjavali
23	Mr. Shankarao Chavhan	Khanapur	Hingoli / Hingoli	Sorghum	Gunjavali
24	Mr. Baliram Chotmal	Isapur	Hingoli	Sorghum	Gunjavali
25	Mr. Suleman Shaikh Farid	Jambhali	Paithan / Aurangaba	Pigeon Pea	Jambhali
26	Mr. Appa Asaram Kalskar	Jambhali / Chinc	Paithan / Aurangaba	Pigeon Pea	Jambhali
27	Mrs. Kantabai Raosaheb Wagh	Takli	Paithan / Aurangaba	Pigeon Pea	Jambhali
28	Mr. Sakharam Ambadas Naikh	Ranjangaon	Paithan / Aurangaba	Pigeon Pea	Jambhali
29	Mrs. Kesarbhai Vitthal Shinde	Farola	Paithan / Aurangaba	Pigeon Pea	White
30	Mrs. Chandrakalabai Jaganah B	Dhangaon	Paithan / Aurangaba	Pigeon Pea	White
31	Mrs. Shahanaj Auyb Shaikh	Lohagaon	Paithan / Aurangaba	Pigeon Pea	White
32	Tukaram Bhanudas Laghane	Ranjangaon	Paithan / Aurangaba	Pigeon Pea	White
33	Mr. Sanjay Haribhahu Chavan	Mankeshwar	Jintur / Parbhani	Pigeon Pea	Red

Sr. No.	Farmers Name	Village Name	Block & Dist Name	Crop Nam	Varieties
34	Mr. Manik Allaappa Survesurve	Gondge pimpri	Jintur / Parbhani	Pigeon Pea	Red
35	Mr. Raghu Apparao Aghav	Jambhrun	Jintur / Parbhani	Pigeon Pea	Red
36	Mr. Kausabai Apparao Bhutkar	Sawargaon	Jintur / Parbhani	Pigeon Pea	Red
37	Mr. Sachin Gaware	Kumbephal	Jalna / Jalna	Green Gra	chamki mug
38	Mr. Vitthal Bhandvale	Solgwan	Jalna / Jalna	Green Gra	chamki mug
39	Mr. Bharatbau Nagve	Wandgaon	Jalna / Jalna	Green Gra	chamki mug
40	Mrs. Pushapabai Savant	Bapkal	Jalna / Jalna	Green Gra	chamki mug
41	Mr. Arun Shanaram Joshi	Sanjgaon	Pachora / Jalgaon	Green Gra	Hirva Mug
42	Mr. Dharmraj Govinda Mahaja	Mohadi	Pachora / Jalgaon	Green Gra	Hirva Mug
43	Mr. Vasant Kisan Patil	Pungaon	Pachora / Jalgaon	Green Gra	Hirva Mug
44	Mr. Harish Bapurao Patil	Khadkdevla	Pachora / Jalgaon	Green Gra	Hirva Mug
45	Mr. Rambhau Gavardhan Ratho	S.Gaon Tanda	Jintur / Parbhani	Wheat	Kali Kusali
46	Mr. Digambar Datrao Gite	Pimpri Gite	Jintur / Parbhani	Wheat	Kali Kusali
47	Mr. Manik Bapurao Bansode	Chandaj	Jintur / Parbhani	Wheat	Kali Kusali
48	Mr. Baban Amruta Dhale	Mankeshwar	Jintur / Parbhani	Wheat	Kali Kusali
49	Mr. Trimbak Mahadev Kadam	Kodhgaon	Kaij / Beed	Safflower	Kardai
50	Mr. Balasaheb Mohan Ghobaile	Hoal	Kaij / Beed	Safflower	Kardai
51	Mr. Sangita Vikram Shinde	Dipewadgaon	Kaij / Beed	Safflower	Kardai
52	Mr. Govind Fulchand Jadhav	Bansarola	Kaij / Beed	Safflower	Kardai
53	Mr. Sidharth Paikrao	Bori-Shikari	Hingoli/ Hingoli	Sesame	Dhavadi Til
54	Mr. Tushiram Sontakke	Pimrakhed	Hingoli/ Hingoli	Sesame	Dhavadi Til
55	Mr. Namdev Kandhare	Yeli	Hingoli/ Hingoli	Sesame	Dhavadi Til
56	Mr. Shayam Madhavrao Deshpa	Halvira	Jintur / Parbhani	Sesame	Kali Til
57	Mr. Baban Amruta Dhale	Mankeshwar	Jintur / Parbhani	Sesame	Kali Til
58	Mr. Bhimrao Ashroba Nikalje	Gondge Pimpri	Jintur / Parbhani	Sesame	Kali Til
59	Mr. Devram Dasharadh Mahale	Pahan	Pachora / Jalgaon	Sesame	Pandhari Til
60	Mr. Prabhakar Namadev Patil	Pardhade	Pachora / Jalgaon	Sesame	Pandhari Til

Annexure 2

Farmers' survey of crop cultivation

Sr. No.	Village Name	Block & Dist Name	Crop Name	Varieties	Crop Cultivation Area In Acres	N0. Of farmers
1	Shekta	Paithan / Aurangabad	Pigeon Pea	Jambhali	14.0	9
2	Jambhali	Paithan / Aurangabad	Pigeon Pea	Jambhali	13.0	11
3	Jambhali	Paithan / Aurangabad	Pigeon Pea	White	4.0	3
4	Jambhali/Jambhali Wadi	Paithan / Aurangabad	Pigeon Pea	Jambhali	8.5	10
5	Jambhali/Jambhali Tanda	Paithan / Aurangabad	Pigeon Pea	Jambhali	11.0	7
6	Jambhali/Chincholi	Paithan / Aurangabad	Pigeon Pea	Jambhali	11.0	6
7	Tondoli	Paithan / Aurangabad	Pigeon Pea	Jambhali	15.0	13
8	Farola	Paithan / Aurangabad	Pigeon Pea	Jambhali	7.5	8
9	Porgaon	Paithan / Aurangabad	Pigeon Pea	Jambhali	4.0	5
10	Takli	Paithan / Aurangabad	Pigeon Pea	Jambhali	12.5	8
11	Wahegaon	Paithan / Aurangabad	Pigeon Pea	Jambhali	7.0	6
12	Borgaon	Paithan / Aurangabad	Pigeon Pea	Jambhali	9.5	9
13	Ranjangaon	Paithan / Aurangabad	Pigeon Pea	Jambhali	9.0	7
14	Lohagaon	Paithan / Aurangabad	Pigeon Pea	Jambhali	12.5	9
15	Aliyabad/Aurangpurwadi	Paithan / Aurangabad	Pigeon Pea	Jambhali	2.5	4
16	Dhangaon	Paithan / Aurangabad	Pigeon Pea	Jambhali	11.0	7
17	Pangara	Paithan / Aurangabad	Pigeon Pea	Jambhali	5.0	4
18	Mudalwadi	Paithan / Aurangabad	Pigeon Pea	Jambhali	2.0	1
19	Bidkin / Bangala Tanda	Paithan / Aurangabad	Pigeon Pea	Jambhali	2.0	2
20	Gundewadi	Jalna / Jalna	Green Gram	Chamki Mug	4.5	3
21	Jamwadi	Jalna / Jalna	Green Gram	Chamki Mug	4.25	3
22	Shrikrushna Nagar	Jalna / Jalna	Green Gram	Chamki Mug	1.0	3
23	Pansendra	Jalna / Jalna	Green Gram	Chamki Mug	3.25	3
24	Shindhi-Kalegaon	Jalna / Jalna	Green Gram	Chamki Mug	1.75	3
25	Rohnwadi	Jalna / Jalna	Green Gram	Chamki Mug	4.0	4
26	Bapkal	Jalna / Jalna	Green Gram	Chamki Mug	2.75	3
27	Wandgaon	Jalna / Jalna	Green Gram	Chamki Mug	2.50	3
28	Solgwan	Jalna / Jalna	Green Gram	Chamki Mug	2.75	3
29	Kumbephal	Jalna / Jalna	Green Gram	Chamki Mug	1.0	3
30	Digholamba	Ambajogai / Beed	Sorghum	Pivali Jawar	14.75	10
31	Sangaon	Ambajogai / Beed	Sorghum	Pivali Jawar	12.85	10
32	Kodhari	Ambajogai / Beed	Sorghum	Pivali Jawar	13.2	10
33	Umrai	Ambajogai / Beed	Sorghum	Pivali Jawar	11.8	10

Sr. No.	Village Name	Block & Dist Name	Crop Name	Varieties	Crop Cultivation Area In Acres	N0. Of farmers
34	Kodhgaon	Kaij / Beed	Sorghum	Pivali Jawar	14.05	10
35	Hoal	Kaij / Beed	Sorghum	Pivali Jawar	11	10
36	Dipewadgaon	Kaij / Beed	Sorghum	Pivali Jawar	14.9	10
37	Bansarola	Kaij / Beed	Sorghum	Pivali Jawar	10.75	10
38	Varpgaon	Ambajogai / Beed	Sorghum	Pivali Jawar	14.75	10
39	Somnathboargaon	Ambajogai / Beed	Sorghum	Pivali Jawar	14.25	10
40	Pungaon	Pachora/ Jalgaon	Jwari\ Tilh	Maladandi Jari\Gavarani	2.0	1
41	Pungaon	Pachora/ Jalgaon	Tur	Lal, Gavarani	2.7	2
42	Pungaon	Pachora/ Jalgaon	Udid	Gavarani	5.5	2
43	Pungaon	Pachora/ Jalgaon	Mug	Gavarani	4.0	2
44	Pungaon	Pachora/ Jalgaon	Jwari	Maladandi Jari\Gavarani	1.0	1
45	Pungaon	Pachora/ Jalgaon	Chavali	Gavarani	4.5	2
46	Pungaon	Pachora/ Jalgaon	Udid\ Tilh	Gavarani	4.0	1
47	Anturli	Pachora/ Jalgaon	Tur	Lal, Gavarani	2.5	2
48	Anturli	Pachora/ Jalgaon	Mug	Gavarani	4.5	1
49	Anturli	Pachora/ Jalgaon	Jwari	Maladandi Jari\Gavarani	1.0	1
50	Anturli	Pachora/ Jalgaon	Chavali	Gavarani	1	1
51	Anturli	Pachora/ Jalgaon	Til	Gavarani	0.5	1
52	Anturli	Pachora/ Jalgaon	Udid	Gavarani	1.5	1
53	Anturli	Pachora/ Jalgaon	Mug	Gavarani	2.0	1
54	Anturli	Pachora/ Jalgaon	Jwari	Maladandi Jwari	5.0	1
55	Sajgaon	Pachora/ Jalgaon	Chavali	White	1.5	1
56	Sajgaon	Pachora/ Jalgaon	Tilh	Lal, Gavarani	3.0	2
57	Sajgaon	Pachora/ Jalgaon	Udid	Gavarani	3.0	2
58	Sajgaon	Pachora/ Jalgaon	Tur	Lal, Gavarani	1.5	2
59	Sajgaon	Pachora/ Jalgaon	Mug	Gavarani	2.0	1
60	Sajgaon	Pachora/ Jalgaon	Jwari	Maladandi	4.0	2
61	Sajgaon	Pachora/ Jalgaon	Chavali	White	0.5	1
62	Veruli	Pachora/ Jalgaon	Chavali	White	2.0	2
63	Veruli	Pachora/ Jalgaon	Tilh	Lal, Gavarani	2.0	2
64	Veruli	Pachora/ Jalgaon	Udid	Gavarani	3.0	2
65	Veruli	Pachora/ Jalgaon	Tur	Lal, Gavarani	2	1
66	Veruli	Pachora/ Jalgaon	Mug	Gavarani	3	1
67	Veruli	Pachora/ Jalgaon	Jwari	Maladandi	1	1
68	Khadakadevala	Pachora/ Jalgaon	Tur	Lal, Gavarani	3.0	2
69	Khadakadevala	Pachora/ Jalgaon	Mug	Gavarani	3.0	2

Sr. No.	Village Name	Block & Dist Name	Crop Name	Varieties	Crop Cultivation Area In Acres	N0. Of farmers
70	Khadakadevala	Pachora/ Jalgaon	Jwari	Maladandi	5.0	2
71	Khadakadevala	Pachora/ Jalgaon	Chavali	White	3.0	2
72	Khadakadevala	Pachora/ Jalgaon	Tilh	Lal, Gavarani	1.0	1
73	Khadakadevala	Pachora/ Jalgaon	Udid	Gavarani	2.0	1
74	Duskheda	Pachora/ Jalgaon	Tilh	Gavarani	1.0	2
75	Duskheda	Pachora/ Jalgaon	Udid	Gavarani	5.0	2
76	Duskheda	Pachora/ Jalgaon	Tur	Lal, Gavarani	3.0	2
77	Duskheda	Pachora/ Jalgaon	Mug\ Jwari	Gavarani\Malad Andi	1.0	1
78	Duskheda	Pachora/ Jalgaon	Chavali	White	3.5	2
79	Duskheda	Pachora/ Jalgaon	Mug	Gavarani	3.5	2
80	Pahan	Pachora/ Jalgaon	Tilh	Gavarani	3..5	2
81	Pahan	Pachora/ Jalgaon	Udid	Gavarani	2.25	2
82	Pahan	Pachora/ Jalgaon	Tur	Lal, Gavarani	2.5	2
83	Pahan	Pachora/ Jalgaon	Jwari	Maladandi	1.5	2
84	Pahan	Pachora/ Jalgaon	Chavali	White	2.0	1
85	Pardhade	Pachora/ Jalgaon	Chavali	White	5.0	2
86	Pardhade	Pachora/ Jalgaon	Tilh	Gavarani	4.0	2
87	Pardhade	Pachora/ Jalgaon	Udid	Gavarani	3.5	2
88	Pardhade	Pachora/ Jalgaon	Tur	Lal, Gavarani	3.0	2
89	Pardhade	Pachora/ Jalgaon	Mug	Gavarani	3.5	2
90	Pardhade	Pachora/ Jalgaon	Jwari	Maladandi	1.5	1
91	Khedgaon	Pachora/ Jalgaon	Jwari	Maladandi	0.5	1
92	Khedgaon	Pachora/ Jalgaon	Chavali	White	2.5	2
93	Khedgaon	Pachora/ Jalgaon	Tilh	Gavarani	1.0	1
94	Khedgaon	Pachora/ Jalgaon	Udid	Gavarani	2.0	1
95	Khedgaon	Pachora/ Jalgaon	Tur	Lal, Gavarani	1.5	2
96	Khedgaon	Pachora/ Jalgaon	Mug	Gavarani	1.5	1
97	Khedgaon	Pachora/ Jalgaon	Jwari	Maladandi	2.0	1
98	Vadgaon	Pachora/ Jalgaon	Mug	Gavarani	4.0	2
99	Vadgaon	Pachora/ Jalgaon	Tilh	Gavarani	4.0	2
100	Vadgaon	Pachora/ Jalgaon	Chavali	White	3.5	3.5
101	Vadgaon	Pachora/ Jalgaon	Jwari	Maladandi	4.5	2
102	Vadgaon	Pachora/ Jalgaon	Tur	Lal, Gavarani	1.5	1
103	Vadgaon	Pachora/ Jalgaon	Udid	Gavarani	0.5	1
104	Kalamkonda Bk	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	14	10
105	Bori Shikari	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	11.5	10
106	Khanapur	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	9.5	10

Sr. No.	Village Name	Block & Dist Name	Crop Name	Varieties	Crop Cultivation Area In Acres	N0. Of farmers
107	Isapur	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	14.5	10
108	Ambheri	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	16.5	10
109	Pimparkhed	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	12	10
110	Yeli	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	9.0	10
111	Lasina	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	18.0	10
112	Pimplekhuta	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	12.5	10
113	Maldhamni	Hingoli / Hingoli	Wheat	Kali Kusali Gahu	12.5	10
114	Charthana	Jintur / Parbhani	Pigeon Pea	Lal Tur	12.0	10
115	Kanha	Jintur / Parbhani	Pigeon Pea	Lal Tur	16.0	10
116	Sawargaon	Jintur / Parbhani	Pigeon Pea	Lal Tur	12.5	10
117	Halvira	Jintur / Parbhani	Pigeon Pea	Lal Tur	12.0	10
118	Chandaj	Jintur / Parbhani	Pigeon Pea	Lal Tur	12.5	10
119	Mankeshwar	Jintur / Parbhani	Pigeon Pea	Lal Tur	17.5	10
120	Pimpri (Kh)	Jintur / Parbhani	Pigeon Pea	Lal Tur	11.0	10
121	Jambhrun	Jintur / Parbhani	Pigeon Pea	Lal Tur	10.5	10
122	Sawargaon Tanda	Jintur / Parbhani	Pigeon Pea	Lal Tur	13.0	10
123	Shingthala(Pimpri)	Jintur / Parbhani	Pigeon Pea	Lal Tur	18.5	10
124	Kanha	Jintur / Parbhani	Sesame	Til	0.75	2
125	Chandaj	Jintur / Parbhani	Sesame	Til	0.75	2
126	Halvira	Jintur / Parbhani	Sesame	Til	0.75	2
127	Charthana	Jintur / Parbhani	Sesame	Til	0.75	2
128	Sawargaon	Jintur / Parbhani	Sesame	Til	1.0	2
129	S.Gaon Tanda	Jintur / Parbhani	Sesame	Til	1.5	2
130	Jambhrun	Jintur / Parbhani	Sesame	Til	1.5	2
131	Pimpri Gite	Jintur / Parbhani	Sesame	Til	0.8	2
132	Gondge Pimpri	Jintur / Parbhani	Sesame	Til	1.0	2
133	Mankeshwar	Jintur / Parbhani	Sesame	Til	1.0	2
134	Kanha	Jintur / Parbhani	Sorghum	Manthi Jawar	2.5	2
135	Chandaj	Jintur / Parbhani	Sorghum	Manthi Jawar	2.0	2
136	Halvira	Jintur / Parbhani	Sorghum	Manthi Jawar	3.0	2
137	Charthana	Jintur / Parbhani	Sorghum	Manthi Jawar	2.0	2
138	Sawargaon	Jintur / Parbhani	Sorghum	Manthi Jawar	1.0	2
139	S.Gaon Tanda	Jintur / Parbhani	Sorghum	Manthi Jawar	2.5	2
140	Jambhrun	Jintur / Parbhani	Sorghum	Manthi Jawar	2.25	2
141	Pimpri Gite	Jintur / Parbhani	Sorghum	Manthi Jawar	2.0	2
142	Gondge Pimpri	Jintur / Parbhani	Sorghum	Manthi Jawar	1.50	2
143	Mankeshwar	Jintur / Parbhani	Sorghum	Manthi Jawar	3.5	2
144	Gundewadi	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	4.0	3

Sr. No.	Village Name	Block & Dist Name	Crop Name	Varieties	Crop Cultivation Area In Acres	N0. Of farmers
145	Jamwadi	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	3.0	3
146	Shrikrushna Nagar	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	4.0	3
147	Pansendra	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	3.0	3
148	Shindhi-Kalegaon	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	5.0	3
149	Rohnwadi	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	3.0	3
150	Bapkal	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	5.0	3
151	Wandgaon	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	3.5	3
152	Solgwan	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	3.0	3
153	Kumbephal	Jalna / Jalna	Sorghum	Avalhmanthi Jwari	2.5	3
154	Digholamba	Ambajogai / Beed	Safflower	Kardai	10.0	10
155	Sangaon	Ambajogai / Beed	Safflower	Kardai	15.7	10
156	Kodhari	Ambajogai / Beed	Safflower	Kardai	13.3	10
157	Umrai	Ambajogai / Beed	Safflower	Kardai	11.0	10
158	Kodhgaon	Kaij / Beed	Safflower	Kardai	12.25	10
159	Hoal	Kaij / Beed	Safflower	Kardai	11.8	10
160	Dipewadgaon	Kaij / Beed	Safflower	Kardai	14.2	10
161	Bansarola	Kaij / Beed	Safflower	Kardai	10.25	10
162	Varpgaon	Ambajogai / Beed	Safflower	Kardai	12.00	10
163	Somnathboargaon	Ambajogai / Beed	Safflower	Kardai	10.0	10
164	Kalamkonda Bk	Hingoli / Hingoli	Sorghum	Gunjavali	10.0	10
165	Bori Shikari	Hingoli / Hingoli	Sorghum	Gunjavali	15.7	10
166	Khanapur	Hingoli / Hingoli	Sorghum	Gunjavali	13.3	10
167	Isapur	Hingoli / Hingoli	Sorghum	Gunjavali	3.0	2
168	Yeli	Hingoli / Hingoli	Sesame	Dhavdi Til	12.5	10
169	Shekta	Paithan / Aurangabad	Sorghum	Dagadi	12.0	8
170	Jambhali	Paithan / Aurangabad	Sorghum	Dagadi	15.5	11
171	Jambhali/Jambhali Wadi	Paithan / Aurangabad	Sorghum	Dagadi	10.5	8
172	Jambhali/Jambhali Tanda	Paithan / Aurangabad	Sorghum	Dagadi	5.0	4
173	Jambhali/Chincholi	Paithan / Aurangabad	Sorghum	Dagadi	17.5	14
174	Tondoli	Paithan / Aurangabad	Sorghum	Dagadi	12.0	9
175	Farola	Paithan / Aurangabad	Sorghum	Dagadi	14.0	10
176	Porgaon	Paithan / Aurangabad	Sorghum	Dagadi	6.0	5
177	Takli	Paithan / Aurangabad	Sorghum	Dagadi	6.0	3
		Total				843

Annexure 3

Schools participating in CEE activities

Sr. No.	School Name	Dist.
1.	Sandipan Vidyalay, Shekta Tq. Paithan	Aurangabad
2.	Marotirao Pail Vidyalay, Dhupkheda Tq. Paithan	Aurangabad
3.	Laxmibai Vidyalay, Nilajgaon Tq. Paithan	Aurangabad
4.	Ramdas Naik High School, Bokudjalgaon Tq. Paithan	Aurangabad
5.	Z.P. Primary School, Sompuri Tq. Paithan	Aurangabad
6.	Z.P. Primary School, Tondoli Tq. Paithan	Aurangabad
7.	Z.P. Primary School, Jambhali Tq. Paithan	Aurangabad
8.	Z.P. Primary School, Takli Tq. Paithan	Aurangabad
9.	Z.P. Madhyamik Vidyalay, Lohagaon Tq. Paithan	Aurangabad
10.	Z.P. Madhyamik Vidyalay, Dhorkin Tq. Paithan	Aurangabad
11.	Z.P. Madhyamik Vidyalay, Karkin Tq. Paithan	Aurangabad
12.	Indira Gandhi Vidyalay, Ramnagar Tq. Jalna	Jalna
13.	Laxmibai Madhyamik Vidyalay, Mujpuri Tq. Jalna	Jalna
14.	Rangnathrao Patil Madhyamik Vidyalay, Jamwadi Tq.	Jalna
15.	Saraswati Madhyamik Vidyalay, Gondegaon Tq. Jalna	Jalna
16.	Kai. Kisanrao Gorantyal Vidyalay, Pachan Wadgaon, Tq. Jalna	Jalna
17.	Z.P. Primary School, Kumbefal Tq. Jalna	Jalna
18.	Z.P. Primary School, Sarwadi Tq. Jalna	Jalna
19.	Z.P. Primary School, Rammurti Tq. Jalna	Jalna
20.	Z.P. Primary School, Bhilpuri, Tq. Jalna	Jalna
21.	Z.P. Primary School, Gundewadi, Tq. Jalna	Jalna
22.	Z.P. Primary School, Shindhikalegaon, Tq. Jalna	Jalna

Annexure 4

Mango varieties collected by school children

Sr. No.	Variety	Marathi Name
1	Shefaya Amba	शेफ्या आंबा
2	Narali Amba	नारळी आंबा
3	Khobaraya Amba	खोबऱ्या आंबा
4	Goti Amba	गोटी आंबा
5	Vadadya Amba	वदाड्या आंबा
6	Telya Amba	तेल्या आंबा
7	Najukya Amba	नाजूक्या आंबा
8	Sakhar Amba	साखर आंबा
9	Tambe Amba	तांबे आंबा
10	Dashrya Amba	दशऱ्या आंबा
11	Gotya Keshar Amba	गोट्या केशर आंबा
12	Kakadi Amba	काकडी आंबा
13	Nilam Amba	निलम आंबा
14	Khari Amba	खारी आंबा
15	Ratna Amba	रत्ना आंबा
16	Madvya Amba	मडव्या आंबा
17	Payari Amba	पायरी आंबा
18	Lal Amba	लाल आंबा
19	Lalbag Amba	लालबाग अंबा
20	Pandya Amba	पांड्या अंबा
21	Golya Amba	गोल्या आंबा
22	Gulya Amba	गुल्या आंबा
23	Gulane Amba	गुळाने आंबा
24	Chincha Amba	चिनंच्या आंबा
25	Pivanti Amba	पिवंती आंबा
26	Badami Amba	बदामी आंबा
27	Kelya Amba	केळ्या आंबा
28	Saroli Amba	सरोली आंबा
29	Papaya Amba	पपया आंबा
30	Lendi Amba	लेंडी आंबा
31	Pavsarya Amba	पावसऱ्या आंबा
32	Laldeth Amba	लालदेठ आंबा
33	Popat Chonchya Amba	पोपट चोंच्या आंबा
34	Gavaran Lambhul Amba	गावराण लांभुळ आंबा
35	Raghu Amba	राघु आंबा
36	Barik Dhunki Amba	
37	Gavaran Amba	गावराण आंबा
38	Ghati Amba	घाटी आंबा
39	Gavran Barik Amba	गावराण बारीक आंबा
40	Kala Amba	काळा आंबा
41	Dudhi Amba	दुधी अंबा
42	Gavran Bhavra Amba	गावराण भवरा आंबा
43	Ambati Amba	
44	Nakadya amba	नाकाड्या आंबा
45	Mugasya Amba	मुगस्या आंबा
46	Gavran motha Amba	गावराण मोठा आंबा
47	Pithya Amba	
48	Kektadya Amba	केकताड्या आंबा
49	Rasal Amba	रसाळ आंबा

Annexure 5

Organic Farm Visit of School Children Report

IIRD has initiated efforts to encourage school children from urban areas to get the real "feel" of organic farming. About 500 children of 4th and 5th standard from Future Kids School in Secunderabad and also from various schools visited the organic farm managed by IIRD to learn about organic farming. During their visit, the students made compost (vermicompost, and biodynamic compost), planted vegetable seeds, and operated the biogas. This was a first time experience for all of them but was enjoyed by all the students.

Annexure 6

Report of Biodiversity Corner inauguration

IIRD has been in the forefront in the promotion of organic farming and biodiversity conservation since its inception. In 2009, IIRD has been the recipient of Maharashtra's Krishi Bushan award for its role in the promotion of organic farming and biodiversity. IIRD now partners with 14 other organizations throughout Maharashtra and Goa to document the genetic biodiversity. (Maharashtra Gene Bank (MGB) programme. This MGB programme is coordinated by Indian Institute of Science and Education Research (IISER) based in Pune). In the MGB programme, IIRD along with selected farmers and schools are involved in the documentation of crop biodiversity in six districts of Maharashtra – Aurangabad, Jalna, Beed, Hingoli, Parbhani, and Jalgaon.

Mass Communication activities have hold on the occasion of IIRD Founder Day celebrated on 13th April 2018. Six stalls (one from each district) were set up with seeds of native crop varieties and related information. farmers from the different districts participated in the gathering and visited the stalls to know about the importance of biodiversity and to exchange native seeds. Each of these exhibitions were participated by at least 1000 farmers. The Biodiversity corner was inaugurated by Dr. Ashok Kumar Yadav (Former Director of National Centre for Organic Farming and he discussed with organic farmers on their challenges and opportunities.

Report

2.4

Crop Genetic Diversity

Sheti Pariwar Kalyan Sanstha, Atpadi, Sangli

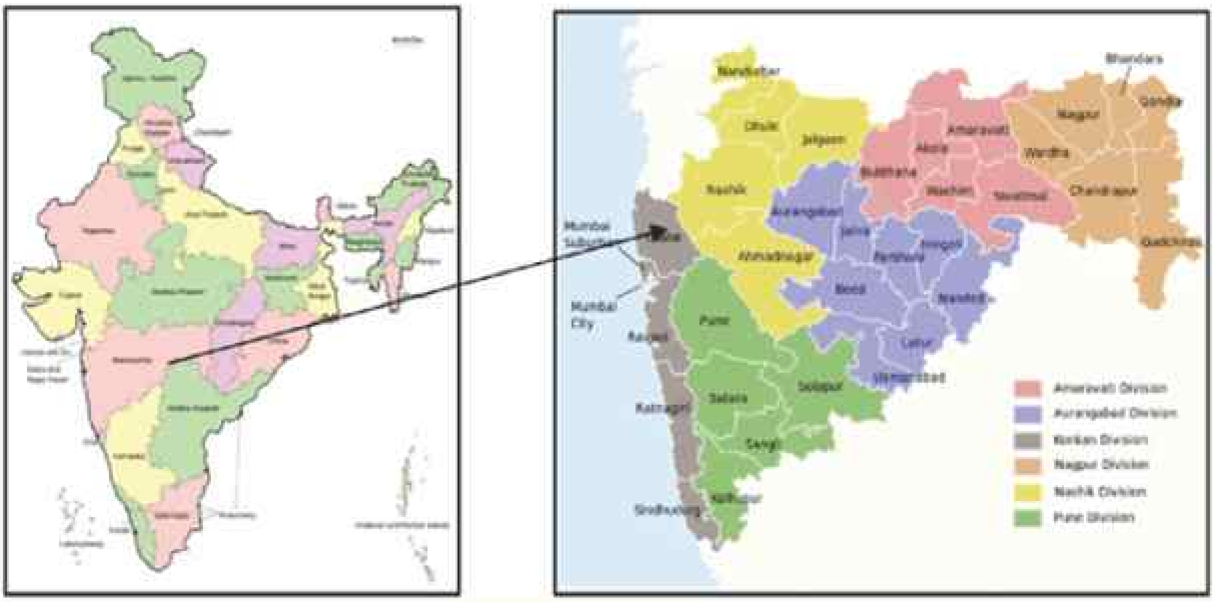
Background

Biodiversity conservation of crops is a very important factor in the context of food security and climate change. There is a large area in Maharashtra, where cereals, legumes and oilseeds are cultivated under rainfed conditions. The traditional varieties of crops, and the varieties saved by the farmer i.e. farmers' varieties, are the varieties which can tolerate the climate change conditions. These varieties are still preserved by some farmers in spite of the onset of improved high-yielding varieties which are designed for optimum input conditions. Some farmers are eager to plant these varieties. The increase in the production of these crops is related to the classical method of seed conservation. Also, the nutritional value of these varieties also seems to be higher as per the experience of farmers and consumers. Therefore, conserving the traditional varieties for future use is of immense value.

Journey with MGBP

Area of operation of the organization

Sheti Pariwar Kalyan Sanstha is functioning in Kolhapur, Sangli, Satara, Solapur and Pune districts of Western Maharashtra. According to the administrative structure of Government of Maharashtra, the work area is in the Pune administrative division.. This area is in the jurisdiction of Mahatma Phule Agricultural University, Rahuri. There are five agricultural science centers in this area. It is the region from west to east that is considered to be having extreme weather, region of scanty precipitation or drought prone area.



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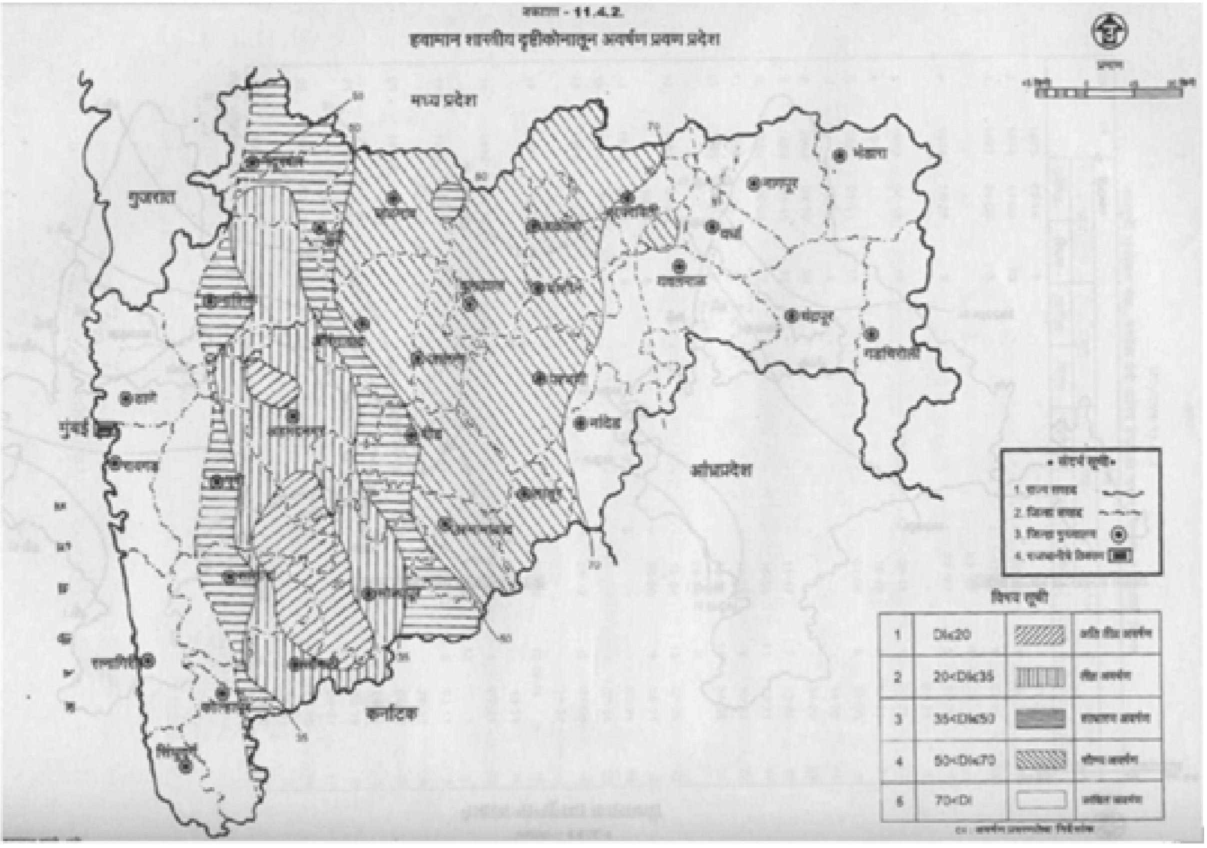

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Community profile

Mostly small and marginal farmers under rainfed conditions are involved in project.

a) District-wise farmers list

Sr.no	Dist Name	Taluka Name	Village Name	Farmer's Name
1)	Satara	Maan	Dahivadi	20
		Koregoan	Pimpode brk	30
2)	Pune	Velhe	Kelad	25
			Jorkarwadi	05
		Mulshi	Uravade	23
3)	Solapur	Mohol	Sohale	34
4)	Kolhapur	Ajra	Dabhil	54
			Aradala	18

Sr.no	Dist Name	Taluka Name	Village Name	Farmer's Name
5)	Sangli	Jat	Valsang	32
		khanapur	Renavi	35
			Bhadakewadi	12
			Bhikvadi Brk	10
		Atpadi	Atpadi	16
			Chinchale	02
	Total	316		

Key issues addressed

In MGB project Sheti Pariwar Kalyan Sanstha works in Sangli, Satara, Kolhapur, Sholapurand Pune district of Maharashtra. Various type of cropping pattern is available in this area. But the organization concentrated on jowar, wheat and rice crop under MGB project .

Crop	Variety	Main aspect
Jowar	Gidgap	Rainfed long duration kharif variety. Good for food & fodder
	Kawali	Good for pop purpose i.e. lahya
	Gulbhendi	Good for hurda
	Dagadi	Rainfed long duration rabi variety, Good for food & fodder
Wheat	Khapali	Long duration irrigated variety good for daliya; chapati & shevaya
	Shetgahu	Rainfed variety; resistance to drought
Paddy (Rice)	Dabhil ghansal	Fragrant variety; good in taste
	Tamsaal	Good in taste
	Hawala Warangal	Good for chirmura making

Objectives

1) To enlist local varieties of jowar, wheat, and paddy.

2) To find out farmers who are already conserving these varieties

3) To find out farmers who are interested in these local varieties

4) To organize farmer's club of these farmers

5) To make farmers aware about biodiversity, conservation of local germplasm and scientific method of upgrading of these varieties

6) To train farmers about processing of the farm produce and value addition

7) Capacity building and technology transfer to farmers

Objectives fulfilled

1) Enlisted various varieties of jowar, wheat, rice and vegetables (Annexure 1)

2) to find out farmers who are already conserving these varieties, and who are interested conserving the local varieties, a survey of 1002 farmers in project area was conducted (Annexure 2)

3) Nine seed saver groups were established. Five are registered & four are not registered.

*** Farmer's seed saver group information***

Sr.no	Address of farmer's seed sever group s	Number of members	Crop name
1	Late Adikrao Patil farmer Mandal, Renavi	11	Gidgap jowar
2	Utkrash self help group Renavital – Khanapur Dist – Sangli	16	Gidgap Jowar
3	Dabhil Ghansal Utapadak Shetkari Mandal, Dabhiltal-Ajara Dist, Kolhapur	39	Rice
4	Kenchraya Farmers Self-Help Group, Valsang , Tal- Jat; Dist- Sangli	15	Kavali
5	Tamsal Rice Utpadak Group, Kelad, Velhe, Dist- Pune	10	Rice
6	Havala Rice Utpadak Group Aradal, Tal- Ajara; Dist – Sangli	12	Rice
7	Khapali Gahu Utpadak Group Sohale; Tal- Mohol; Dist – Solapur	08	Wheat
8	Shet Gahu Utpadak Group Sohale; Tal- Mohol; Dist – Solapur	05	Wheat
9	Kavali Jawari Utpadak Group Valsang; Tal- Jat; Dist – Sangli	10	Jowar

4) Created awareness in farmers about straight variety, composite variety, hybridization, Genetically Modified seeds and importance of conservation of local breed and scientific method of upgrading of these varieties. Trainings of farmers about isolation distance, roguing, seed selection, harvesting, germination test, and storage was conducted with help of experts and KVK (Krishi Vdynan Kendra).

5) To train farmers about processing and value addition – Trainings of value addition i.e. Lahya, Hurda, Shevaya, Kheeret were conducted

6) Capacity building and technology transfer to farmers – Guidance on seed bank maintenance, distinctness, uniformity and stability (**DUS**) technique, The Protection of Plant Variety and Farmers Right **Act**, 2001 (**PPVFR Act**) were carried out.

Sampling methods Samples were collected by PRA (Participatory Rural Appraisal), Beejrath survey and some random sampling (Annexure 3)

No	Name of tool	Findings
1	Timeline	History of village or crops since last 70 years to know trend of crop diversity, seed conservation method etc.
2	Transact walk	Survey of village for keen observations.
3	Natural Resource Map	To know cluster area in which traditional varieties are conserved
4	Social Map	To know community involved in seed conservation
5	Seasonality	Yearly timetable of cultivation, harvesting and conservation of seeds
6	Chapatti diagram	Situation of resource person and resource institution about seed.
7	Survey	To find out farmers involved in seed conservation.
8	Voting	To find out interest of farmer in seed conservation.
9	Gram Sabha	To establish seed saver group.

Major work done under MGBP

Comparative assessment report on puff, hurda and fodder jowar.(Annexure 4)

Nutritional evolution of 9 varieties of Jowar, wheat, paddy. (Annexure 5)

Community level seed production of 30 tons by 42 farmers (Annexure 6)

Established 5 seed saver group for in situ seed conservation

Direct selling of 51 quintals of Aajara Ghansaal Paddy

Documentation of farm activities by scientific methods with the help of Krishi Narayan Dainandini (Annexure 7).

Farmers producer company has been registered for market linkage

Qualitative impact of the work:

Paddy variety Kala Jiraga & Tamssal are comparatively rich in iron.

Community participation in MGBP process

Community's participation

The stakeholders of this project are mainly rainfed and drought prone area farmers. Mostly they are low income farmers . For seed conservation purpose and for market linkage purpose they organize and contribute their share. For scientific activities like rouguing, isolation distance, harvesting they cooperate with each other.

Community's role in designing or reshaping the work

All the stakeholders participated in discussion for designing and reshaping the work. Conclusion is to establish three tier system of farmers seed conservation committee. Seed conservation board and seed conservation corporation which have three dimensions research, extension and marketing for farmers' local varieties.

Beneficiaries

The stakeholders of this project are mainly rain fed and drought prone area farmers. Mostly they are small and marginal farmers.

Benefits they have received

- Training of seed selection, value addition, market linkage.
- Help for exchange in seeds
- Demonstration plots
- Education and training of documentation of farm activities with the help of Krishi Narayan Dainandini Short term benefits – Increase in farm production
- Long term benefits – Market linkage, sustainable seed production of their own seed.

Sale of seed and grains in exhibition, religious celebrations

Sr. no	Date	Name and place of exhibition	Seed and Grains Details	Sale
1	15/08/2015	R.R. Patil Krushi Pradarshan, Atpadi	1) Vhandi Jawari 2) Kavali Jawari 3) Khapali Gahu 4) Shet Gahu 5) Ghansal Rice 6) Tamsal Rice 7) Havala Rice	Only for motivation of local, traditional seed conservation purpose.
2	Date missing+	Krushi Pradarshan, Tasgoan	1) Vhandi Jawari 2) Kavali jawari 3) Khapali gahu 4) Shet gahu 5) Ghansal Rice 6) Tamsal Rice 7) Havala Rice	Ghansal rice -5000 kg sale with help of Shetkari group Velvati
3	26/07/2017	Nag Panchami yatra	1) Kavalibjawari pop corn	Kavali jawari pop corn 75 kg
4	Dec 2017	Kisan Pradarshan, Pune	1) Vhandi Jawari 2) Kavali Jawari 3) Gulbhendi Jawari 4) Khapali Gahu 5) Shet Gahu 6) Ghansal Rice 7) Tamsal Rice 8) Havala Rice	Ghansal rice - 50 kg. Sale done by farmers of Dabhil Utapak Group.
5	13 to 17 Dec 2018	Kisan Pradarshan, Pune	1) Kavali Jawari 2) Gulbhendi Jawari 3) Khapali Gahu 4) Shet Gahu 5) Ghansal Rice 6) Tamsal Rice 7) Havala Rice	Ghansal rice - 150 kg Dagadi jawari - 15 kg Gulbhendi -15 kg Kavali -15 kg Kavali pop corn - 5 kg Khapali Gahu - 27 kg Shet Gahu - 20 kg Havala Rice - 5 kg Havala Chirmura - 5kg

Measures to reassure that benefits to the community continue even after conclusion of MGBP

Strengthening of community seed bank, capacity building of seed saver group & follow up of organization for market linkage. (Annexure 13)

Currently sorghum is used only for making bread (Bhakari). The current market price of sorghum is very low at Rs. 20 per kg. When we compared it with Kawali sorghum, sorghum and rosemary sorghum interesting observations were made. When 1 kg of crow sorghum was sown, it weighed 800 gms and it was sold at Rs.100 per kg, while Gulbhendi sorghum was sold at Rs.150. Dried hurdha costs Rs. 200 per kg.

Comparitive study of value added Jowar

	Maldandi (control)	Kawali	Gulbhendi
Production per acre	861kg	333kg	322kg
Market value Rs. 20 per kg	Rs.17220	Rs.6660	Rs.6440
Value addition	Flour	Puff	Hurda
Product after process loss	817kg	293kg	122kg
Rate per kg	Rs.25	Rs.100	Rs.150
Income after value addition	Rs.20425	Rs.29300	Rs.18300

As seen above although production of grain is much less in Kawali and Gulbhendi as compared to Maldandi, but after processing and good market linkage income tends to equal to variety Maldandi.

Relationship with PPVFRA and NBPGR

Organization has approached regional office of PPVFR at Pune for registration of following varieties on 22-11-2017

Jowar - Gidgap, Kar, Kawali, Gulbhendi, Vandi, & Dagadi

Wheat – Khapali, Shet gahu

Paddy – Ghansaal, Hawala Varangal, Tamsaal

Economics of seed banks, economics of traditional varieties

In each district of project area there are seed saver groups. These seed saver group maintains the seed bank. The initial cost for establishment of seed bank has been offered from this project. All seed saver group have bank account like SHG Self-help Group) or CIG (Common Interest Group). Market linkage training has been given to these groups. Marketing of seed and grain both takes place through them.

List of Publications and presentations at conferences

Local newspapers viz. Tarun Bharat, Sakal, Agrowon accepted articles on MGBP

No	Name of news paper	Date	Author	Remark
1	Puddhari	10 July 2014	Reporter Atpadi, P.P. Bhandare	Beej Rath In Ashadhi Vari
2	Tarun Bharat	27 Nov 2014	Suraj Mulla, Atpadi	Mul Pikanchi Januk Japanyachi Chalval Ubhi
3	Sakal	19 March 2015	Ranjit Kalekaar, Ajara	Ghansaal, Vangal Januk Koshat
4	Tarun Bharat	7 Nov 2015	Sangli Reporter	Nandani Krut Biyane
5	Agrowan	27 March 2016	Prasad Deshpande	Projects of Sheti Pariwar Kalian Sanstha
6	Tarun Bharat	11 April 2016	Suraj Mulla, Atpadi	Paramparik Deshi Biyane Vitaran

मूळ पिकांची जनुक जपण्याची चळवळ उभी

कोकण ते मराठवाडा अन् राज्यात राबतेय कार्यकर्त्यांची फळी | संशोधन, संघटन, प्रबोधनाने पारंपरिक पिकांचे वाण होणार जतन

आटपाडीत पारंपरिक देशी बियाणांचे वितरण

शेती परिवार कल्याण संस्थेचा उपक्रम : 'महाराष्ट्र जनुक कोश'ची संकल्पना

आटपाडी : देशी बियाणांचे वितरणप्रसंगी दिनेश देशमुख, संजय शेळके, सत्यवान देशमुख, सचिन लवटे आदी.

प्रतिनिधी
आटपाडी

पौष्टिकता आणि सकसपणा असणाऱ्या पारंपरिक देशी बियाणांचा ऱ्हास होत असल्याने त्याचा विपरीत परिणाम लोकांच्या खाण्यावर झाला आहे. पारंपरिक व देशी बियाणे जतन करून ही चळवळ वाढविण्यासाठी शेती परिवार कल्याण संस्थेने शेतकऱ्यांना काही जातीचे देशी बियाणे वितरित केले. या बियाणांद्वारे जातीचे उत्पन्न घेऊन जास्तीत लोकांना देशी बियाणांबाबत जागृत करण्याचे काम यानिमित्ताने हाती घेण्यात आले आहे.

देशपातळीवर आणि राज्यातही देशी बियाणांबाबत जनजागृतीची मोहीम सुरू आहे. राज्यात महाराष्ट्र जनुक कोशच्या माध्यमातून पारंपरिक बियाणांचे जतन करून त्याद्वारे उत्पन्नासाठी लोकांना आग्रह केला जात आहे. महाराष्ट्र जनुक कोशच्या उपक्रमात आटपाडीतील प्रसाद देशपांडे यांची शेती परिवार कल्याण संस्थाही अग्रक्रमाने जनजागृतीचे काम करत आहे.

लोकांना देशी बियाणे पुरविणे, ते जतन करण्यासाठी प्रोत्साहित करणे, त्याचे फायदा विषद करणे, या बियाणांची उपयुक्तता असल्याने त्याचे महत्त्व लोकांना पटवून देणे, विविध प्रयोग करून तयार केलेल्या बियाणांचा मानवी आणि जनावरांच्या शरिरावर होणारा विपरीत परिणाम याची माहिती देण्याचे काम त्यानिमित्ताने होत आहे. देशी बियाणांचे जतन करण्यासाठी त्याची लागवड गरजेची आहे.

ही लागवड करण्यासाठी शेतकऱ्यांना देशी बियाणे वितरीत करण्याचे काम शेती परिवार कल्याण संस्थेने केले. जनावरांच्या चाऱ्यासाठी उपयुक्त असलेल्या काही जाती सध्या नामशेष होत आहे. पूर्वी सरास उपलब्ध असणारी काही जाती पोषक होती. पण, आता ती दुर्मीळ झाली आहे. त्यातील पौष्टिकता खूप असल्याने त्याची गरज जनावरांना आहे. त्यामुळे जनावरांना सकस चारा मिळण्यासह या देशी वाणांचे संवर्धनही होणार आहे.

शेती परिवार कल्याण संस्थेचे अध्यक्ष प्रसाद देशपांडे, दिनेश देशमुख, संजय शेळके, सत्यवान देशमुख, सचिन लवटे आदींच्या उपस्थितीत संभाजी पाटील, रघुनाथ सागर, सचिन देशमुख, भारत जाधव आदी शेतकऱ्यांना पारंपरिक व देशी बियाणांचे वितरण करण्यात आले. देशी बियाणांचे रक्षण करून त्यामध्ये वृध्दी करण्यासाठी हे बियाणे वितरीत करण्यात आले. सध्या शेती परिवार कल्याण संस्थेने ज्वारी, गहू, भाताचे विविध देशी वाण जतन करून ठेवले आहेत.

सध्या दिलेल्या देशी वाणांबाबत तज्ज्ञांमार्फत संबंधित शेतकऱ्यांना मार्गदर्शन करणे, भेटी देणे, जास्तीत जास्त लोकांपर्यंत देशी वाणाचे महत्त्व पटवून देणे आदी उपक्रम राबविले जाणार असल्याचे शेती परिवार कल्याण संस्थेने स्पष्ट केले. तर शेतकऱ्यांनीही आता पारंपरिक व देशी वाणासाठी एक पाऊल पुढे येऊन सकस, पौष्टिकता असलेल्या देशी बियाणांसाठी समृद्ध चळवळ निर्माण करावी, असे आवाहनही यानिमित्ताने करण्यात आले.

Networking with other MGBP groups

Networking of thematic group is very useful for interaction of ideas and other activities. There are six NGO partners in crop thematic group. Regional meeting has been arranged in every NGO partners campus. It was very helpful for correct direction for our work in MGBP.

List of the institutes who participated in the work:

1) Walchand Engineering College, Sangli

2) Rajgadh Toarana Samajonnati Nyas, Velha, Dist. Pune

3) Krishi Vgyan Kendra, Kalawade, Dist. Satara

Collaborations that were meaningful for overall impact

IISER Pune, RGSTC and NBPGR & all that participated NGO is well homogenized group all are helpful for each other. As our part is concern crop thematic group is meaningful for us. RGSTC & NBPGR will be helpful for next programme.

Collaborations you would prefer to continue after MGBP

First & last preference to IISER Pune& RGSTC for collaborations.

Otherwise BAIF or Agharkar institute

Third will be CSR funds or IFAD

Persistance Systems Company which is leading IT company in Pune offered us space in their campus for direct sale of these crop varieties to urban consumers.

Outreach

Connection with people beyond beneficiaries

During the MGB project, organization established contacts with Dr. Narayan Jambhale, Dr. Balkrushna Jamdagni, Dr. Rahul Mungikar of Biodiversity board and Dr. Nilesh Malekar from KVK Kalawade as experts.

For market linkage, Niranjan Deshpande and Atul Marne of Kisan Forum Pvt. Ltd. helped us. For market linkage of traditional and farmer's local varieties Sevavardhini, Pune has helped us.

Educational aspect – to and from

We have conducted workshops with five schools

1) Ashram Shaala, Atpadi.

2) Renavi High School, Renavi.

3) Rajgadh Toarana Vidhyarthi Vasatigruh.

4) Sohale High School, Sohale

5) Dabhil High School, Dabhil.

Concept of germination test activity has been shared with other components of crop diversity group.

Policy level interventions

Policy and awareness about seed conservation is most important for sustainable agriculture development. During MGB project, organization has given thrust on awareness about seed act, PPVFR act and the Biodiversity act etc. While in-situ seed conservation will help them to feel liberal and independent, loss of biodiversity means danger to our livelihood, our progress and prosperity. Hence there is a need to introduce these concepts in the education system.

In 2018-19, Sheti Pariwar and Krishi Vigyan Kendra conducted demonstration of seed germination test by farmers and students at Kalwade. Improved or hybrid seeds available in the market are tested for germination but seeds from farmers are not tested for germination, so the demonstration implemented under this project was well received by the farmers and students.

Knowledge Outcomes

Traditional farmers has their own method of farming which they have been following since years. Farmers form Renavi. tal – Khanapur, Dist – Sangli sow their Gidgap variety of Jowar on Ardra nakshatra, while Varangal Hawala Paddy of Ardalatal, Ajara is sown on Rohini nakshatra. Recommendation of agriculture university of wheat sowing is the last week of November to first week of December but farmers of Bhadakewadi sow Shet Gahu in the month of October.

We also observed Fajja crop. It is identified as Vigna unguiculata. It is a leguminous crop and has two types of seed, one is yellow and the other is blackish. It is used as vegetable and some time as a fodder also.

Stories emerged

There is one interesting story from community about Kala Jiraga and Tamsaal variety of rice. During surveys it was noticed that varieties like Indrayani, Ratnagiri etc. have health benefits and are thus good for lactating and pregnant women. When we analysed rice of these varieties we find that these varieties are rich in iron. See Annexure 5.

There is one festival Nagpanchami in which farmer use puffed Jowar called "lahya" for worship as well as in diet also. Puffed Jowar or Lahya is considered good to get rid of acidity and constipation.

Conservation stories: *In-situ* seed conservation by people's participation is traditional method. In some villages after harvesting of crop farmer offers good seeds in temples or common community centers that can be used as seed for next year.

New facts noticed

There is increasing awareness about health and nutrition. Demand of organically cultivated traditional and farmer's varieties has increased. This demand is from urban area, as from last 3 years, in Kisan exhibition at Pune, there is more demand of our traditional and farmers' varieties. After exhibition, urban consumers place their demands and farmer of seed saver group fulfill it sending through transport. This type of situation may help to encourage farmers for increasing production of organically cultivated traditional and farmer's varieties. Support of innovative but easily available technology of in-situ seed selection and seed conservation and market linkage helps to conserve the traditional and farmer's varieties.

Realizations about human nature/ human- nature relationship

Traditional farmer thinks he is co-partner of nature. Every farm activity starts with the giving thanks to nature. There so many traditional festivals which are helpful for human – nature relationship. At the time of Sankranti Festival (14 January) rural women organize *Wan – wasa* karyakram ("Wan" means crop varieties and "Wasa" means technique of how to cultivate it). There are earthen pots in which all type of local seeds are collected and they interchange with each other.

New understandings/ philosophy/ realizations emerged

Yield of traditional farmer's and local varieties decreases due to lack of in-situ seed selection method and lack of package of practices to increase yield. Value addition and market linkage is second factor which causes decrease in cultivation of these varieties.

Database generated

Data has been submitted for use in database.

Impact-on community

Now farmer community is interested for growing indigenous traditional farmer's local varieties with organic method. But they want help of technology transfer and market linkage.

on academic circle

Due to part of CEE in MGB project students and teachers were made increasingly aware about local crop varieties, their nutritive value and biodiversity. They collected samples and put them in herbarium.

on policy level interventions

We met agriculture department but they do not have any specific agenda for conservation of farmers' indigenous local varieties. But Protection of Plant Varieties and Farmer's Right Authority helps to register their varieties in PPVFR Register.

Way forward

- Strengthening of Seed saver group and capacity building of farmers about in-situ seed selection.
- Improvement in local level seed bank
- PPVFR Registration of crop varieties
- Research on in-situ upgrading of crop varieties
- Documentation of daily farm activity in Krishi Narayan Dainandini.

Staff associated with the project

Name of the Staff	Qualification	Post	Date of joining	Date of relieving
Prasad Narayan Deshpande	B.Sc. (Agri)	Principle Investigator	1 Jan 2014	31 March 2020
Sanjay Pandurang Shendage	MSW	CO- PI	1 Jan 2014	31 March 2019
Prasad Bhalchandra Sirshikar	B.Sc.	CEE component	1 Jan 2014	31 March 2017
Swati Sanjay Shendage	B.A.	CEE component	1 April 2017	31 March 2020
Sachin Lavate	H.S.C.	field worker	1 Jan 2014	31 March 2017
Sandeep Rghunath Sawant	H.S.C.	field worker	1 April 2017	31 March 2020

Honarary & voluntary

1) Dr. Narayan Jambhale - Retd. Director of NBPGR

2) Dr. Balkrushna Jamadagni - Retd. breeder of Jowar, MPKV, Rahuri

3) Dr. Rahul Mungikar - senior scientist, Biodiversity board

4) Dr. Nilesh Malekar

5) Sanjay Jayant Bhagwat

6) Santosh Patkar

7) Pramaod Jagtap

8) Chinmay Kuber

9) Bharat Shinde

10) Satywan Deshmukh

Annexure 1

List of crops conserved by farmers

1- Black Peas

2-Red kidney beans

3-Yellow lentil

4-white corn

5-Mustard

6-White onion

7-French Bean

8-Red Brinjal

9-black horse gram

10- green chickpeas

11-kenaf

12-flax seeds

13-safflower

14-black sesame

15-Black-eyed pea

16-Finger millet

17-horse gram

18-pigeon pea

19-White goosefoot

20-White Pea

21-carrot

22-cucumber

23-moth bean

24-Corn

25-the black gram

26-Pop Corn

27-Soyabean

28-beatroot

29-sesame

30-Tinda

31-Hyacinth bean

Result based indicator wise report – Sheti Pariwar Kalyan Sanstha, Atpadi

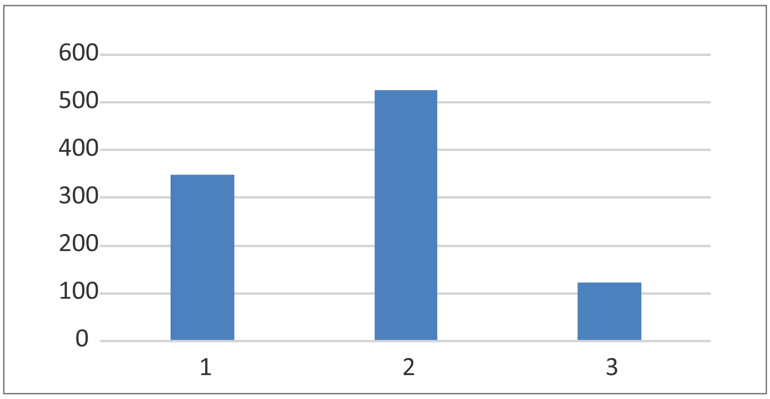
Output /S	Indicators	Baseline at the start of the project	Target set for the reporting period	Achievements during reporting period	Achievements cumulative till date
Output 1 - *In-situ* conservation of crop landraces	1. Number of *In-situ* conservation sites	1	Project area is five districts of western Maharashtra. Five blocks are selected Solapur. --- Mohol, Barshi. Mangalvadha. Sangli ----- Atpadi, Khanapur, Jath. Kolhapur --- Ajara, Gadhinglaj. Satara ------ Maan, Satara, Koregaon. Pune ------ velha.	Solapur. --- Mohol (sohale) Sangli ----- Atpadi (Atpati, Shetphale) Khanapur. (Renavi, Bhikawadi.) Jath (Valsang Madgyal) Kolhapur --- Ajara, Dabhil, Ardala. Pune ------ Velha, Kelad	Three farmer groups are established Renavi - 2 for Gidgap Jawar Atpadi - 1 for Vandi Jawar Valsang - 2 for kawali Jawar Dabhil -1 for Ghansal paddy. Ardala - 1 for Havala varanga l paddy Kelad - Tamsaal paddy 1 for Shet gahu
	2. The number, type, and area of crops and land races cultivated	1	Renavi - Gidgap Jawar - 3 Farmers 0.20 R each, Atpadi - Vandi Jawar - 5 Farmers 0.20 R each Valsang - for kawali Jawar Dabhil - Ghansal paddy. 2 Farmers 0.20 R each	completed	completed
Output 2 - Community Seed Banks Established	1.Number of community seed banks		5	5 completed – Dhabil, Atpadi, Mohol, Dahiwadi, Velha	Development of seed bank is in process
	2.Number of crops and landraces seeds available in the seed banks		Jawar - 9 Paddy - 9 Wheat - 1 Agroforestry - 2	**Jawar - 6** Gidgap, Gatti, Kawali, Vandi, Gulbhendi, Maldandi, Dagadi-bendri **Paddy - 8** Tamsal, hawala, Shirala, Jondhala, Ambhemohor, Ajara Ghansal, Jada tandul, Daptri. Kali masad. **Wheat - 2** Khapali, shet ghau, Bakshi ghau **Bajara** Local bajara of 5 months **Maize** Local maize of 5 months **Agroforestry - 2** Ramkathi babhul. Limbara. **Vegetables** Fajja, varun ghevada	Cumulative target completed
Output 3 - Developed package of practices.	1. Number of farmers demonstrating the documented package of practices		Renavi - Gidgap Jawar - 3 farmers 0.20 R each, Atpadi - Vandi Jawar - 5 farmers 0.20 R each, Valsang - for kawali Jawar, Dabhil - Ghansal paddy - 2 farmers 0.20 R each		

Output /S	Indicators	Baseline at the start of the project	Target set for the reporting period	Achievements during reporting period	Achievements cumulative till date
	1. % increase in yields of identified crops			7% increase in Dhabil Ghansal	
Output 4 - Morphological and nutritional, traditional knowledge data generated.	1. Selected crops and landraces documented as per DUS guidelines is available.		Renavi - Gidgap Jawar Atpadi- Vandi Jawar Valsang - kawali Jawar Dabhil - Ghansal paddy Sohale - Khapali wheat Kelad - Tamsal Upale dumala - gulbhendi. Ardala - Hawala varangal	Renavi - Gidgap Jawar Atpadi - Vandi Jawar Dabhil - Ghansal paddy These are in process	
	1. Number of traditional practices documented		1) Sowing of gidgap jawar is at the time of *Aradra nakshtra* 2) Sowing of shetghau is at the time of *Navratri (dasara)* Sowing of ghansaal rice on *Rohini nakshtra* Seeds for next season are stored in ash.		
Output 5 - Protocol developed for value addition.	1. Information available on traditional value addition		Kawali - lahya, Gulbhendi - hurda, Khapali - daliya, noodles (shevaya), kuravadi Jawar - Bhatodi		
	2. Number of value added produce		Fodnichya lahya, Tak lahya i.e. Buttermilk & Fodanichya lahya Dry Hurda, Hatasadicha Tanul (rice)		
Output 6 - Increased number of farmers involved in cultivation of crop landraces.	1. % increase in total number of farmers involved in cultivation of crop landraces		Renavi - Gidgap Jawar - 100 to 125 Atpadi - Vandi Jawar - 50 Valsang - kawali Jawar - 20 Dabhil - Ghansal paddy - 85 to 100 Sohale - Khapali wheat Kelad - Tamsal - 13 Upale dumala - gulbhendi.	No increase in new farmers	
Novel/ Unexpected Observations				In Dhabil village Ghansaal is cultivated in one part of village. Farmer told that this Ghansal is not giving good result when it is cultivated in other part of village	
New questions raised/ discussed			Role of different components on distinctness of plant variety specially aroma & taste, i.e. Is distinctness changes due to soil, local environment, organic or chemical nutrition of plant		
Unforeseen problems encountered			There is one leguminous crop with local name faja. …. Sheti pariwar find out its scientific name . It is Cow pea variety viz. Vigna unguiculata (L)Walp		

Annexure 2

District wise farmer's list covered in the Survey

Sr. no	Dist name	No. of farmers
1	sangli	124
2	kolhapur	108
3	pune	143
4	satara	41
5	solapur	83
6	sindudurg	1
7	Thane	3
8	Osmanabad	29
9	Ahamadnagar	82
10	Akola	19
11	Amravati	6
12	Aurangabad	18
13	Beed	19
14	Belgav	4
15	Buldhana	14
16	Chandrapur	3
17	Dhule	3
18	Gadchiroli	1
19	Gulbarga	1
20	Goa	3
21	Hingoli	6
22	Jabalpur	1
23	Jalana	15
24	Jalgoan	22
25	Latur	20
26	Mumbai	4
27	Nanded	16
28	Nagpur	5
29	Nandurbar	4
30	Nashik	21
31	Palghar	7
32	Parbhani	15
33	Raigad	3
34	Ratnagiri	5
35	Thane	3
36	Wardha	6
37	Vasai	1
38	Washim	4
39	Yavtamal	8
40	not known Dist	131
	Total farmer's No of survy	1002



1. No. of farmers who plant indigenous varieties
2. No. of farmers who know about indigenous varieties but do not plant
3. No. of farmers who do not know about indigenous varieties

Annexure 3

एकत्र रिपोर्ट

ज्वारीचा एकत्र रिपोर्ट										
अ. क्रं.	पिकाचे नांव	शेतकऱ्याचे नांव	सन	क्षेत्र	पेरणी दिनांक	काढणी दिनांक	बियाणे वजन	मिळालेले ध्यान उत्पादन	कडबा वजन	भूसकट वजन
1	गुलभेंडी ज्वारी	दादासो पाटील	2015-16	671 चौ.मी	29/9/2015	12/2/2016	800 ग्रॅम	50 किलो	283 किलो	13 किलो
2		प्रदीप नारायण देशपांडे	2016-17	2067 चौ.मी	14.10.2016	14.03.2017	4 किलो	166.5 किलो	920 किलो	30 किलो
3		सिद्धेश्वर नाईकनवरे	2016-17	217 चौ.मी	29.10.2016	11.03.2017	0.5 किलो	60 किलो	105 किलो	6 किलो
1	कावळी ज्वारी	दादासो पाटील	2015-16	671 चौ.मी	29/9/2015	12/2/2016	1000 ग्रॅम	35 किलो	236 किलो	13 किलो
2		प्रदीप नारायण देशपांडे	2016-17	2721 चौ.मी	14.10.2016	14.03.2017	2.5 किलो	227 किलो	990 किलो	51.5 किलो
3		सिद्धेश्वर नाईकनवरे	2016-17	250 चौ.मी	9.10.2016	11.03.2017	0.5 किलो	24 किलो	65 किलो	6 किलो
4		श्यामजी प्रकाश कुलकर्णी	2016-17	70 चौ.मी	05.10.2018	20.02.2018	150 ग्रॅम	12.5 ग्रॅम	5 किलो	3.2 किलो
1	दगडी / गटटी ज्वारी	दादासो पाटील	2015-16	671 चौ.मी	29/9/2015	12/2/2016	1000 ग्रॅम	32 किलो	283 किलो	11 किलो
2		सिद्धेश्वर नाईकनवरे	2016-17	520 चौ.मी	9.10.2016	11.03.2017	1 किलो	112 किलो	732 किलो	34 किलो
3		शीतल बाळकृष्ण देशपांडे	2017-18							
भाताचा एकत्र रिपोर्ट										
1	तामसाळ तांदूळ	नामदेव विष्णु पाटील	2017-18	5 गुंठे	29/6/2017	16/10/2017	5 किलो	188 किलो भात	450 किलो	50 किलो
2		नामदेव विष्णु पाटील	2018-19							
1	घनसाळ तांदूळ	सदाशिव बबन सावंत	2017-18	6 गुंठे	10/6/2017	15/11/2018	5 किलो	260 किलो भात	590 किलो	60 किलो
2		भरत लक्ष्मण शिंदे	2017-18	5 गुंठे	07/7/2018	14/11/2017	1.5 किलो	40 किलो	135 किलो	7 किलो
3		k.v.k. Karad	2018-19	10 रोप पेंडया						

ज्वारीचा एकत्र रिपोर्ट										
अ. क्रं.	पिकाचे नांव	शेतकऱ्याचे नांव	सन	क्षेत्र	पेरणी दिनांक	काढणी दिनांक	बियाणे वजन	मिळालेले ध्यान उत्पादन	कडबा वजन	भूसकट वजन
4		शिवाजी जोकर	2018-19	50 रोप पेंडया						
5		लव्हू कडू	2018-19	40 रोप पेंडया						
6		नवनाथ रायरेकर	2018-19	40 रोप पेंडया						
खपली एकत्र रिपोर्ट										
1	खपली गहू	राजाराम रघुनाथ गुंड	2017-18	5 गुंठे	20/11/2017	10/3/2017	2.5 किलो	200 किलो खपली	0	50 किलो
			2017-18							

Annexure 4

Chemical Analyses of fodder/straw

Nikhil & BAIF analysis lab (वैरणीसाठी)

farmer's name	Add	sample	Date	moisture	total Minerals	Crude protein	crude fat	cruder fiber	carbohy drate	Energy
Shrirant Ramu Muchandi	At post-Valsang tal-Jat Dist - Sangli	vhandi plant	17/08/2018	41.54%	4.42%	4.09%	0.46%	18.81%	30.68%	143.22%Kcal
		Gidgap	17/08/2018	61.49%	2.42%	4.35%	0.62%	6.62%	24.32%	120.26%Kcal
Shivaji Janu Dhumal	At/post. Kelad tal-Velhe dist - Pune	Tamsal rice bhusa	17/08/2018	8.53%	13.99%	8.73%	3.22%	19.54%	45.99%	247.86 %Kcal
Prasad Naranay Deshpande	At/post/ tal-Atpadi dist - Sangli	vhandi plant	2/8/2016	78.98%	7.71%	6.33%	1.47%	29.78%	54.71%	257.39 %Kcal
		jawar plant	2/8/2016	75.26%	19.04%	7.11%	2.87%	23.28%	47.70%	245.07 %Kcal
		khapali gahu bhusa	27/05/2015	9690% DM	Don't cheak	9.03%	8.87%	Don't cheak	47.70%	0.21%
Bharat Naste		vhandi plant	2/8/2016	77.68%	12.01%	9.05%	1.25%	28.76%	48.93%	243.17 %Kcal
		vhandi plant	2/8/2016	72.01%	11.07%	7.79%	00.96%	33.93%	46.99%	227.76 %Kcal
Sachin Deshumukh		vhandi plant	2/8/2016	67.11%	19.15%	4.62%	0.76%	15.57%	59.90%	264.92 %Kcal
Raghunath Sagar		vhandi plant	2/8/2016	63.74%	20.63%	4.85%	0.39%	29.70%	44.43%	200.63 %Kcal

Annexure 5

Chemical Analyses of wheat and rice

Nikhil & BAIF analysis lab (Rice & wheat) 2016

Sr. no	farmer's name	Add	sample	Date	total Minerals	Crude protein	crude fat	cruder fiber	sand silica	phosporous	calcium	iron	Zinc
1	Shri Namdev Patil	At/post -Dabheeltal- Ajara dist-kolhapur	Ghansal Rice	2/8/2016	1.47%	15.36%	0.83%	1.54%	0.11%	71.80 mg	18.42 mg	31.04 ppm	27.36 ppm
2	Shri Bhairu Powar	At/post-Aradala tal-ajra dist-kolhapur	Havala Rice	2/8/2016	5.22%	4.28%	1.42%	7.76%	3.42%	172.99 mg	73.19 mg	30.33 ppm	15.63 ppm
3	Shri Pramod Jagtap	At-post -sohale Tal-mohol dist- solapur	Khapali Gahu	2/8/2016	0.52%	6.46%	0.64%	0.58%	0.05%	200.12 mg	22.18 mg	58.80 ppm	50.35 ppm
4	Shri Kisan Barkade	At-post -bhikavadi Tal-khanapur dist- sangli	Khapali Gahu	2/8/2016	1.82%	14.91%	1.27%	0.67%	0.14%	266.93 mg	30.21 mg	45.61 ppm	44.67 ppm
5	Shri Ankush Jadhav	At-post -bhadakewadi Tal-khanapur dist- sangli	Khapali Gahu	2/8/2016	1.78%	8.92%	1.57%	3.35%	0.12%	292.74 mg	56.32 mg	35.20 ppm	73.09 ppm
6	Shri Kamalakar Patil	At/post -Dabheeltal- Ajara dist-kolhapur	Fajja Pulses	11/8/2016	3.61%	33.43%	1.00%	8.76%	0.19%	272.08mg	64.88 mg	12.62 ppm	26.70 ppm
Nikhil lab (jawar) 2016													
1	Dhanaji Bhimrav Pawar	At-post -Revani Tal-khanapur dist- sangli	Gidgap Jawar	2/8/2016	1.70%	2.53%	2.83%	1.70%	0.17%	240.43 mg	32.07 mg	35.28 ppm	29.40 ppm
2	Promod Kadam	At/post-pimpode brk tal-koregoan dist-satara	Gatti Jawari	2/8/2016	1.66%	2.01%	2.28%	1.04%	0.17%	153.58 mg	32.83 mg	43.44 ppm	30.95 ppm
3	Shri Sarjerao Gaiwad	At/post -shetphale tal-Atpadi Dist - sangli	Kavali Jawari	2/8/2016	1.67%	11.46%	2.77%	0.76%	0.13%	262.83 mg	18.96 mg	25.34 ppm	38.34 ppm

BAIF analysis lab (Rice) 2015

Sr. no	farmer's name	Add	sample	Date	DM %	CP %	CF%	EE %	ASH %	Silica %	Ca %	p %	Fe mg %	zn mg%
1	sheti pariwar kalyan sanstha Atpadi	At/post-tal- Atpadi Dist - sangli	Ratnagiri	10.07.2015	90.19%	9.61%	2.12%	2.04%	1.03%	1.31%	0.29%	0.19%	12.31	1.1
2			Indrayani		90.84%	8.07%	2.16%	2.41%	1.24%	0.27%	0.19%	14.23%	14.23	1
3			Ajra Ghansal		89.91%	7.59%	2.89%	3.05%	1.28%	0.25%	0.28%	0.18%	15.21	1.8
4			kala jirga		89.51%	8.14%	1.85%	3.05%	1.12%	0.19%	0.31%	0.20%	29.15	1.7
5			Ambe mohar		89.60%	7.59%	2.05%	0.73%	0.73%	0.34%	0.24%	0.18%	16.71	1.3
6			Daptari		89.27%	8.75%	1.75%	1.96%	0.67%	0.17%	0.26%	0.21%	15.37	1.2
7			jada		89.62%	7.82%	1.64%	2.24%	0.48%	0.30%	0.28%	0.22%	10.13	1
8			Dabhil ghansal		88.54%	7.57%	1.53%	1.94%	0.66%	0.37%	0.30%	0.23%	17.18	1.1
9			Havala churmure		93.84%	6.82%	1.03%	1.18%	1.14%	0.14%	0.19%	0.11%	8.36	0.6
10			Amrut churmure		97.84%	6.13%	1.07%	1.50%	1.39%	0.45%	0.17%	0.10%	7.26	0.7
11			Indrayani	22/09/2018	91.1	10.04	0.98		0.41	0.02	78.64	62.32		24.25
12			Tamsal		92.66	8.5	1.84		0.48	0.08	85.3	76.67		21.15
13			ghansal		88.39	12.1	1.38		0.6	0.02	95.35	113.25		18.49

BAIF analysis lab (Rice) 2015

Sr. no	farmer's name	Add	sample	Date	DM %	CP %	CF%	EE %	ASH %	Silica %	Ca %	p %	Fe mg %	zn mg%
1	Shri Prasad N Deshpande	At-post/tai- Atpadi dist sangli	khapli gahu	27.05.2015	96.72%	10.83%	3.91%	1.24%	1.76%	0.19%	0.22%	0.17%	49.8	4.9
2	Bharat Goanwadi	At-post- bharatgoan wadi /tai-Atpadi dist sangli	khapli gahu		95.61%	14.17%	5.44%	1.22%	1.22%	0.19%	0.21%	0.16%	29.8	4.3
3	Ankush Pandurang Jadhav	At-post -bhadakewadi Tal-khanapur dist- sangli	shetgahu		94.46%	13.55%	5.37%	1.01%	1.07%	0.19%	0.18%	0.10%	20.06	3.5
4	Bhau Hajare	At-post/tai- Atpadi dist sangli	Vhandi jawar		95.84%	11.75%	6.69%	0.78%	0.24%	0.18%	0.18%	0.90%	14.8	1.6
5	Sarjerav Gaikwadi	At/post -shetphale tal-Atpadi Dist - sangli	kavali jwari		96.97%	7.01%	5.10%	0.78%	1.05%	0.21%	0.12%	0.09%	14.1	1.3
6	Shri Dhanaji Bhimarav Pawar	At-post -Revani Tal-khanapur dist- sangli	Gidgap Jawar		95.72%	6.79%	3.84%	0.67%	1.36%	0.25%	0.10%	0.11%	17.2	1.4

Annexure 6

Grain yield and seed production

Year	No. of farmers	total Yield grain	seed production
2014-15	36	26049	11840
2015-16	38	23462	12290
2016-17	39	28091.7	13700
	Total	77602.7	37830

Note - Total Measurement of grain and seed yield in kilogram

seed production 2015-16

Crop Name	Name of variety	Year	Area under seed production (In acres)	No. of families	Good yield kg Per acre	For seed purpose kg/acre	Total yield (Kg)	Germination (percentage)	sale of seeds (Kg)	Price per kg	Other additional information if any
Jawari	Kavali jawari	2015-16	11.5 gunte	3	500kg	3kg	133kg	75-80	90kg	30 rs	
Gahu	Khapli gahu	2015-16	25 gunte	2	1000kg	25kg	650kg	80-85	200kg	70rs	
Gahu	Shet gahu	2015-16	4 acre	1	200kg	25kg	700kg	80-85	0	40rs	
Gahu Sohale	Khapli gahu	2015-16	10 gunte	1	1200kg	25kg	300kg	80-85	50kg	80rs	
Rice	Ghansal	2015-16	6.27 Gunte	8	1100kg	45kg	6400kg	80.85	5340kg	36rs	
Rice	Havala	2015-16	4 Acre 31 Gunte	8	1600	45kg	7270kg	80-85	6600kg	27rs	
Jawari	Gidgap	2015-16	9 Acre 10 Gunte	6	500	5kg	3175kg	80-85	0	25rs	
Rice	Tamsal	2015-16	1 Acre 35 Gunte	3	1500	60kg	1650	80-85	130	60	
Jawari	Dagadi	2015-16	5 Acre 20 Gunte	5	1200	5kg	3200	80-85	0	30	
Jawari	Gulbhandi	2015-16	671 sq.meter	1		5kg	298	80-85	0	30rs	
Jawari	Kavali	2015-16	671 sq.meter	1		5kg	208	80-85	0	30rs	
Jawari	Dagadi	2015-16	671 sq.meter	1		5kg	190	80-85	0	30rs	

seed production 2014-15

Crop Name	Name of variety	Year	Area under seed production (In acres)	No. of families	Yield kg	For seed purpose kg/acre	Total yield (Kg)	Germination (percentage)	sale of seeds (Kg)	Price per kg	Other additional information if any
Jawari	Kawali jwari	2014-15	12 Gunte	3	600 kg per acre	3 kg	114 kg	75-80	90 kg	30 rs	
Gahu	Kapali gahu	2014-15	35 Gunte	1	1000 kg	25 kg	800 kg	80-85	-	80rs	
Gahu	Shetgahu	2014-15	4 Acre	1	200 kg	12.5 kg	800 kg	80-85	200 kg	40rs	
Gahu sohale	Kapali gahu	2014-15	35 Gunte	2	1200 kg	25 kg	1100 kg	80-85	25 kg	80rs	
Rice	Ghansal	2015-16	5.22 Gunte	8	1100 kg	45 kg	6550 kg	80.85	5375 kg	36rs	
Rice	Havala	2016-17	4 Acre 15 Gunte	8	1600 kg	45 kg	6850 kg	80-85	6600 kg	27rs	
Jawari	Gidgap	2016-17	9 Acre	6	500 kg	5 kg	4525 kg	80-85	6050 kg	25rs	
Rice	Tamsal	2016-17	1 Acre 35 Gunte	3	1500 kg	60 kg	1500 kg	80-85	100 kg	60rs	
Jawari	Dagadi	2016-17	7 Acre	5	1200 kg	5 kg	3800 kg	80-85	-	30rs	

Varieties 2016-17

Sowing Month (Marathi)	Sowing Nakshatra	Other additional information if any
Bhadrapad	Utra	To femouse jwari for popcorn and making poffcorn
Ashvin	Utra	Long and small type grain
Ashvin	Vijaya Dasmi	Do not give single irrigation to this varieties
Ashvin	Utra or Chitra	Long and small type grain
Jesth	Adra	Scented varities
Jesth	Rohini	Good variety for Chirmura
Jesth	Adra	Good fodder for animal
Vaishakha	Rohini	High paddy fodder and good qulities fodder for animal
Ashvin	Hast	Good fodder for animal
Ashvin	Hast	Good fodder for animal
Ashvin	Hast	To femouse jwari for popcorn and making popcorn
Ashvin	Hast	Hurda quality is good

Annexure 7

knd_mgb_ajara

मजको अंतर्गत वितरीत केलेल्या कृषी नारायण दैनंदिनी लिहिल्यामुळे खालील मुद्दे मिळाले.

शेतकऱ्याचे नाव – श्री. ज्ञानदेव पुंडलिक पाटील, दाभील, ता.आजरा, जिल्हा–कोल्हापूर

क्षेत्र– १० गुंठे, घरचे बियाणे– ५किलो

तारीख			
२७/०५/२०१५	शेतामध्ये शेण टाकणे	पहिला दिवस	२१००
२९/०५/२०१५	शेत फोडणे	२ दिवसांनी	६००
२५/०६/२०१५	पूर्व मशागत	२८ दिवसांनी	६००
२६/०६/२०१६	मोड तयार करणे	१ दिवसांनी	
२८/०६/२०१५	बीज पेरणे (मळक तयार करणे)	३६ तासांनी	९५०
२२/०७/२०१५	पुर्नलागण	२५ दिवसांनी	२३००
१४/०८/२०१५	भांगलणी	२४ दिवसांनी	३००
२१/०८/२०१५	कोळपणी	७ दिवसांनी	३००
१५/११/२०१५	भात कापणी	७ दिवसांनी	३००
१७/११/२०१५	मळणी	८७ दिवसांनी	७००
		एकूण दिवस १४२	
	वाहतूक		२००
	एकूण खर्च		८३५०
हिशोब–	घरी आणलेला भात– ६.५ मण–४१६किलो		
	तांदूळ उतारा– ६५%		
	भाताचा व्यापारी दर –३६/किलो (व्यापारी गावात येऊन घेऊन गेला)		
	मिळालेले उत्पन्न (४१६*३६)=	१४९७६	
	एकूण झालेला खर्च वजा	८३५०	
	निव्वळ आर्थिक नफा	६६२६	
	इतर फायदा (गवत मिळाले)	१५००	
	एकूण नफा	८१२६/–	

इतर बाबी – राईस मिल कोंड्याच्या बदल्यात भाताचा तांदूळ मोफत करून देतो

अन्यथा ४५ रुपये प्रत्येक मणाला राईस मिल वाला घेतो व कोंडा ४ रुपये किलो विकतो.

घरात एक मण भात खायला घेतला

एकमेकांच्या शेतात मजुरीला जावे लागते

इतर शेतकऱ्यांशी चर्चेअंती निरीक्षण व सूचना

१ प्रथमतः इतका सविस्तर खर्च व नफा लक्षात ठेवून लिहिला व पाहिला

२ दुसऱ्या शेतकऱ्यास एकूण खर्च जास्त झाला असे वाटले पण कुठे व कसा हे सांगता आले नाही त्या शेतकऱ्यास आता लिहूनच बोलले पाहिजे हे कळाले.

३ पूर्व मशागत लवकर केली असे एकाला वाटले.

४ संकरीत भाताच्या पिकांचे हिशोब निव्वळ नफा किंवा तोट्यात गेलेले आढळले पण घरात खाण्यासाठी व क्षेत्र आहे म्हणून काहीतरी पेरत होतो हि भावना.

५ निवडक शेतकऱ्यांना कृषी नारायण दैंनदिनीचे महत्व व उपयोग पटला.

६ श्री. कमलाकर पाटील या शेतकऱ्याने संशोधनात्मक निरीक्षणं नोंदी लिहिल्या.

शेतकऱ्याचे नाव – श्री. ज्ञानदेव पुंडलिक पाटील
एकूण क्षेत्र– ६ गुंठे (२ गुंठे दप्तरी व ४ गुंठे फुलेराधा)

दप्तरी		फुलेराधा
१किलो	बियाणे	४किलो
१००	बियाणांची किंमत	१२०
१२०	किती दिवसाचे पिक	१२५
दोन्ही मिळून	अंदाजे खर्च	६४००
६४किलो	भात	२८०किलो
६५.००%	उतारा	५५.००%
४२किलो	तांदूळ	१५४किलो
४०	तांदळाचा व्यापारी दर	३०
१६८०	विकून आलेली रक्कम	४६२०

एकूण रक्कम	६३००
खर्च	६४००
निव्वळ नफा	वजा १००/–
इतर फायदा (गवत)	१०००
एकूण फायदा	९००/–

शेतकऱ्याचे नाव – श्री. ज्ञानदेव पुंडलिक पाटील
एकूण क्षेत्र– ६.५ गुंठे
तीन वर्षे बियाणे तयार होतात.
सारथी

बियाणे	१०किलो
बियाणांची किंमत	७००/–
किती दिवसाचे पिक	१२०
अंदाजे खर्च	६०००
भात	३३६किलो
उतारा	५८.००%
तांदूळ	१९५किलो
तांदळाचा व्यापारी दर	२५
विकून आलेली रक्कम	४८७५
गवत	१०००

शेतकऱ्याचे नाव – श्री भैरू पवार आर्दाळा, ता. आजरा, जिल्हा–कोल्हापूर
वाण–हावळा(वरंगळ), क्षेत्र– २० गुंठे, घरचे बियाणे– ६ पायली – ३०किलो

तारीख	शेतातील कामे
०५/०६/२०१५	टोकन पद्धतीने पेरणी
१० वेळा	कोळपणी
२ वेळा	भांगलण
०२/१०/२०१५	रासायनिक खत २ वेळा
१६/०९/२०१५	कापणी

खर्च	
शेणखत (१ ट्रोली)+मशागत	३८००
पेरणी (४ माणस*१५०)	६००
कोळपणी १० वेळा *३००/– १ पु. + १ स्त्री.	३०००
भांगलण २ वेळा (१० माणस*१००)	१०००
कापणी (१० माणस)	१०००
मळणी (१० माणस)	१०००
वाहतूक	२००
एकूण	१०६००

हिशोब– घरी आणलेला भात– ८००किलो
तांदूळ उतारा– ५० %
भाताचा व्यापारी दर –२७/किलो

मिळालेले उत्पन्न (८००*२७)=	२१६००
एकूण झालेला खर्च वजा	१०६००
निव्वळ आर्थिक नफा	११०००
इतर फायदा (गवत मिळाले)	२४००
एकूण नफा	१३४००/–

निरीक्षण रोहिणी नक्षत्रास पेरणी करतो, पण यावेळेस आधीच पाऊस पडला त्यामुळे ५ जून ला पेरणी केली हे पिक १२० दिवसाचे आहे पण यावेळेस १०४ दिवसांनी हातात आले.
पोसव्याच्या अगोदर तांबूस रोग पडला होता, करपा असावा

चुरमुरे ३ दलालानंतर चुरमुरे कारखान्यात भात जातो. १ किलो चुरमुरे चा दर ८० ते ९० रुपये किलो

Report 2.5

Crop Genetic Diversity

Lokpanchayat, Sangamner, Ahmednagar

Background

Status of crop biodiversity in the area before 2014

Lokpanchayat has conducted Agro –Biodiversity baseline survey in selected area under MGBP before start of the project in 2014. During this survey, information was collected about current status of agro-biodiversity. Major finding of survey are as follows: Details are given in Annexure 1.

1. Type of land and use of indigenous seed – According to the study, out of 230 farmers, 115 farmers i.e. 50% farmers use indigenous seed.

2. Scope of Agro-biodiversity theme- Out of 230 farmers, only 22 farmers are aware of agro- biodiversity.

3. Farmer's selection of indigenous seed and distribution of agricultural produce- depends on whether it is for personal use or for marketing purpose. According to survey, 42% farmers are using indigenous seeds for only personal use, 36.36% farmers for selling purpose, and 21.64% are using for both purposes.

4. Farmers' opinion about seed conservation- Majority of the farmers are interested in conservation of indigenous seeds and are sentimental about their traditional knowledge. According our survey, 190 out of 230 (82.60%) farmers are interested in conservation and 40 out of 230 (17.40%) are not. Distance from market also affects farmer's seed selection process.

4. Availability of Krishi Seva Kendra- In 75% villages Krishi Seva Kendra (KSK) is not available.

Krishi Seva Kendra	Farmers	Indigenous seed cultivator farmers	Percentage (%) of farmers
Unavailable	173	91	52.60
Available	57	24	42.10

It is seen from the data that in those villages where KSK are available there is less use of indigenous seed. This could be because of the promotion of improved varieties and hybrid varieties by KSK. Apart from that, the distance from market also affects the decision to grow native varieties.

Distance from Market (km)	Farmers using indigenous seed	Percentage (%) of farmers
0 to 10	13	5.62
11 to 20	52	22.5
More than 21	50	21.64

As can be seen from the data, availability of market place and use of indigenous seeds are inversely proportional. Due to the better yields of improved varieties, the farmers are in favour of them resulting in loss and extinction of the indigenous germplasm. In the background of traditional knowledge and understanding, it is necessary to conserve indigenous varieties of crops by improving their yielding ability with the use of better agricultural practices.

6. Climate and Rainfall- Agriculture is entirely dependent on rainfall and climate. Farmers must have to think about climate and rainfall while selecting seed variety.

Rainfall	Number of farmers using indigenous seed	Percentage of farmers
Heavy rainfall (more than 3000mm)	63	27.39
Medium rainfall (1500 to 3000)	21	9.13
Less rainfall (Less than 1500)	31	13.47

Observations made by Lokpanchayat over last 20 years have revealed that area under cultivation of some of these valuable genetic types, mainly minor millets, has gradually declined because of modernization of agriculture, process of conversion of natural habitats for agriculture, process of industrialization, migration of people for their livelihood, unavailability of pure seed etc. Indigenous crop varieties are more nutritious as compared to other varieties. Indigenous local varieties (land races) are backbone of tribal community. Lokpanchayat started agro-biodiversity conservation work in Sangamner block with marginalized farmers.

Journey with MGBP

Key issue related to MGBP

- Cultivating indigenous crop variety, with maintaining purity in that variety, by using their traditional methods to collect pure line seed.
- Promotion program regarding conservation of indigenous crop variety.
- Introducing agriculture history and agro-biodiversity subject in school and college curriculum.
- Implementation of right to farmers for their Indigenous variety legislation under Protection of Plant Variety and Farmers Right Act 2001. Indigenous varieties have their own identity, have unique characteristics and also demand in market, but there is also lack of linkages to develop market or fair trade.
- Making Farmers aware about community based seed bank concept.

Key Issues Addressed

i) Indigenous crop varieties are vanishing and there is lack of pure seed in the existing varieties

ii) Men farmers are not giving priority to indigenous variety. However, women farmers are trying to conserve some varieties. Due to availability of seeds of improved variety in Krishi Seva Kendra farmers are giving priority to readily available seeds. Due to these reason farmers refuse to grow indigenous crop varieties.

iii) Participation of community youth leadership in cultivation, development and conservation of local land races is very less.

iv) Decreasing fertility of soil and pollution issue in irrigated area.

v) Participation of women farmers in cultivation of local land races is limited. We noticed that women will play crucial role in conservation process. Traditionally women are sowing indigenous seeds in small area near home and selecting seeds from that crop, as well as older women in the family taking initiative for indigenous crop, storing seeds in ash and earthen pots. We observed these things while working with women self -help groups who are working for conservation of indigenous seeds. Their activities typically include producing agricultural crops, tending animals, processing and preparing food, and working in agricultural fields for wages.

vi) Conservator farmers / tribal farmer's migration for livelihood to be restricted for increasing interest in cultivation, conservation, pure line seed production and marketing through proper channel.

vii) Methodology for value addition for yield and marketing channel for indigenous farmers' variety for increasing area under cultivation is limited.

viii) Fight against drought and sudden changes in climatic conditions. Uneven distribution and huge loss of agriculture production because of uncertain rainfall.

Geographical location

Sangamner and Akole block of Ahmednagar District

Lokpanchayat Villages

Districts	Pune	Ahmednagar	Nasik
Taluka	Junnar	1. Sangamner 2. Akole	1. Igatpuri 2.Trimbakeshwar
Villages	Taleran, Talmachi, Amboli, Ambehatvij	1. Pimpalgaon Matha, Pokhari Baleshwar, Saykhindi,Nannaj, Rankhamb 2. Somalwadi, Satewadi, Dhamanvan, Terungan, Waki	1. Khadked, Manjargaon, Ambewadi, Kurungwadi 2. Deorgaon, Rohile

Villages from Akole block are located in the Sahyadri region. 120 villages are directly benefited by the organization. We are working with diverse type of farmers group viz, Adivasi, Dalit, Nomad and OBC. We are focusing women farmers from the above groups because rural women depend on agriculture for their livelihood. We are working with farmers who have small land and doing rainfed agriculture.

Participants

The farmers who are directly working with the organization are participants of the organization. There are 415 shareholders of Baliraja producer company from Akole and Sangamner Block. In addition to this there are 150 farmer members of Krishak Panchayat, 715 women members of SHGs, children and youth, 60 conservator farmers who are associated with us since last four years. Lokpanchayat has reached out to approximately 6500 people during different events like community meeting, fairs, awareness programs, etc. 1500 indirect beneficiaries have participated in seed exhibition awareness program of *"Chalisgaon Dangani Kalapathak"* of Lokpanchayat.

Lokpanchayat organization has conducted awareness program with the help of local artists specially Adivasi group comprising of 13-14 people. We have organized street plays in village, street, vadis or at market place. This group has been named as per the name of local landscape i.e. Chalisgaon Dangani Kalapathak.

Objectives

- In situ conservation of Deothan Bajari (Pearl millet), Kalbhat (Paddy), Kadava Waal (Bitter Bean) in Ahmednagar District, Ambemohor (Paddy) in Pune and Mutaki Nachani (Finger Millet) in Nashik Districts.
- Develop pure line seed of above selected crop varieties as per National Bureau of Plant Genetic Resources (NBPGR) guidelines.
- Awareness building along with school children and rural community especially in new generation group of farmers.
- Process documentation of crop cultivation with assessment of its properties and characters and registration of local cultivars and farmers.
- Organize a system of market support for local cultivars.
- Building network of NGOs, KVK, farmers clubs and individuals working in the field of organic farming and indigenous seed conservation.
- Baseline and pre-work for district level seed bank of local cultivars.
- Formation of community based seed banks.

Objectives fulfilled

In situ conservation of five selected crops at selected areas i.e. Deothan bajra, Kadwa Wal, Ambemohar, Kalbhat, Nagli.

S. No.	Crop	Number of farmers	Area
1.	Devthan Bajra	13	6.5 Acres
2.	Ambemohar	10	4.6 Acres
3.	Kalbhat	13	4.9 Acres
4.	KaduVal	3	1.1 Acres
5.	Nagli	15	5 Acres

- Developed pure line seed of selected crops by demonstrating concept of seed plot.
- Awareness created in rural community and in youth about indigenous crop varieties through various awareness programs, exhibitions, trainings, and meetings. Due to these awareness programs the number of conservator farmers increased and demand of indigenous varieties also increased.

- Established indigenous crop documentation, pure seed selection and linkage with Baliraja Producer Company. Baliraja Company also encourages exchange of indigenous seed.
- Two block level seed banks were established for seed exchanges among farmers. The seed banks have 45 types of seed at Pimpalgaon Matha beej bank and 85 types of seeds at Dhamanvan seed bank (Annexure 2).
- District level seed bank is formed.
- Market support provided to cultivators through Baliraja Krushak Producer Company.

Major work done under MGBP

- Process of documentation of crop cultivation is completed- Seed Selection code and nutrient analysis has been done for Aroma of Kalbhat (Annexure 3- Adarsh Biyane Niyamavali and Annexure 4. Report on Aroma of Kalbhat.)
- In situ conservation of farmer's variety (Indigenous Crop Landraces).
- Documentation of local knowledge and wisdom regarding land races and value addition. Collection of all types of indigenous seed from every cluster of district to form Seed Bank at district level.
- Pure line seed production of Kalbhat, Deothan Bajara, Mutaki nagali and other varieties.
- In situ conservation as a demo plot in each cluster and awareness programs conducted for conservation of farmer's variety. Community based seed banks established.
- Value addition and developing niche market developing process with Baliraja Krushak Producer Co. Sangamner. The data is for the year 2018-2019.

There are more than 400 regular customers connected with Baliraja.

Crop	Sold (in kg)	Amount in INR
Devthan Bajra	1648	39552/-
Kalbhat	3260	2,60,800/-
Nagali	840	33,600/-
Kadu Val	52	6,240/-

- Alliance and linkage with different government and non-government institute. e.g. Agriculture University –Mahatma Phule Krushi Vidnyan Kendra, Rahuri, Bhabha Atomic Research Centre, Mumbai, Indian Institute of Technology, Mumbai.
- Agro-biodiversity appreciation activities done with school children as given below.

Sr. no.	Activities	Number of schools	Frequency	Number of children
1.	Shivar Pheri	6	1	238
2.	Water Testing	20	1	904
3.	To make Dashparni Erk	2	1	40
4.	To collect indigenous seed variety and identification	11	1	348
5.	To draw village map	6	1	60
6.	Training on making seedlings	11	1	348
7.	Tree plantation	6	2	308
8.	Dangi cattle name collection	4	1	110
9.	Anandshala shibir	13	2	35
10.	Agro biodiversity education projects	6	2	120
11.	Seed Germination Study	10	2	275

- Awareness created about conservation of indigenous varieties in the community.
- Developed pure line seed of five selected crop varieties as per the guidelines of National Bureau of Plant Genetic Resources (NBPGR) guideline.
- Collected data on traditional knowledge and conservation of local varieties from women farmers-conservators
- Most of the people are interested in value addition but they are not aware about scientific way and marketing channel. Lokpanchayat provided market linkage to conservator farmers through Baliraja Producer Company.
- Morphological characterization of selected crop varieties as per DUS guidelines done.
- Nutritional evaluation or analysis of selected focus crop (Kalbhat, Devthan bajri, Ambemohar, Nagli and Kaduval.) has been done by TUV lab, Pune, (Annexure -6).

Sampling methods

Participatory project implementation was initiated from survey and mapping activity.

After finalizing working area and their village clusters, we started survey and mapping process in Ahmednagar, Nashik and Pune district. Survey was conducted in 37 villages and hamlets from five blocks of North Western Ghats. Participatory Rural Appraisal (PRA) tools were used to assess the status of local land races (Crop) and Agro-biodiversity.

Qualitative impact of the work

A study on shifting cultivation in Akole block of Ahmednagar district was completed. Shifting cultivation results in destruction of forest and effects the ecology of the region.

Community participation in MGB process

Number of farmers' involvement in cultivation is increasing since last two year due to the awareness programme and model of demonstration. The organisation is promoting organic farming with conservation of indigenous crop varieties by organising farmer's workshops on crop conservation. Lokpanchayat successfully organised seed festivals in the community. There is active participation and positive response for this activity. Seed bank could be established through community participation. Farmers actively participated in morphological characterization. 415 farmer members are connected to Baliraja Krishak producer company. Number of shareholder farmers in the Baliraja increased from 415 to 515 in the year 2018-19. Two village level community based seed banks were developed at Dhamanvan Village (Akole) and Pimpalgaon Matha (Sangamner).

Traditional conservation practices

Seed storage

Farmers are storing seeds with traditional methods such as keeping seeds in ash, in gunny bags, and in some containers covered at one end with leaves and cattle dung.

○ Sustainable harvest practices– Maliv and Irvad are traditional mixed cropping patterns totally dependent on rainfall. Agro bio-diversity conservation work was promoted with small farmers and women to establish a sustainable livelihood in traditional agricultural practices.

○ Women SHG organized seed exchange program at Dhamanvan village.

Beneficiaries

Selected conservator farmers of the area and school children were selected for agro biodiversity activities. Women of SHGs are direct beneficiaries. They have actively participated in all project activities. Women SHG members have developed seed exchange centres at village level. Organization took initiative to guide them with trainings and motivate them through exhibitions of their conservation activities. These women are collecting indigenous seed from neighboring villages and exchange their seeds with them. In this way they improve their seed system. School children actively participated in agro biodiversity activities conducted by CEE (Annexure 5).

Beneficiaries	Number
Conservator Farmers	54
Children	904
Women members of SHG	2190
Total	3148

Benefits they have received

- As a part of MGBP, traditional seed banks have been established in Sangamner at block level and at district level. So, now it is easy for community to collect the seed. This also helped in increasing traditional seed cultivation. Characterization of selected land races is useful in creating database that will be helpful for large scale promotion of selected landraces. The selected landraces have been promoted for sale in commercial market through good quality seed, and value added products.
- Agro biodiversity appreciation activity has started in 20 schools. So, children have developed interest and new perspectives towards village farms (Annexure 5).
- Children participated in various projects such as fodder study, study of local farming, local recipes, grasses in the village, what's on my plate, stones and soil in the village area, seed collection, seed exhibition etc.
- The majority of conservator farmers and selected farmers are from Adivasi community. Within a span of 4 years they were made sufficiently aware about importance of cultivation of farmer's variety. Now farmers are aware about indigenous seed and also demanding seeds for cultivation. After support of marketing channel through Baliraja Krushak Producer Company, initiated through Krushak Panchayat program of Lokpanchayat, conservator farmers got fair price for their commodities and after that they started their own selling market at village level.
- During conservator meeting, rice aroma survey and field visit it was observed that use of chemical fertilizer affects the taste and aroma of rice. Tillering and production is more in System of Rice Intensification (SRI) method of rice plantation than regular method of rice plantation. Grain and fodder quality of Deothan bajara is better than other improved and hybrid varieties..
- Lokpanchayat provided long-term benefits to farmers through Baliraja Producer Company. Baliraja collecting yield from conservator farmers and processing it in company. They provide market price to farmers, provide assurance of market and motivated farmers for selection of pure seed. For this purpose pure line seed code was developed and Lokpanchayat guided farmers how to select pure line seed.

Relationship with PPVFRA and NBPGR

Lokpanchayat's representative participated in Farmers Right Act Workshop at Babhleshwar.

Economics of seed banks

Seed banks mainly established on seed exchange programme. Seed banks are usually managed by women's groups. At local level, seeds are distributed to the farmers and the recipient has to return twice the quantity. But to the farmers who are from other districts or states, the seeds are sold with proper market value. These women participate in agricultural exhibitions, business expos and sell their agri-produce for empowering their groups and maintain seed banks economy.

In 2019 they sold seeds to 14 farmers and distributed in 10 villages; in return they collected twice the quantity. In 2018 there is an income of INR 7475.

List of Publications and presentations at conferences

Report on Study of Kalbhat Aroma, Mountain Millet shifting cultivation study report, Pure line seed code in Marathi (*Adarsh Biyane Niyamavali)*.

Presented a paper **Community based traditional**

agro-biodiversity and seed conservation practices in North Western Ghats of Maharashtra.

National Conference at Nandurbar organized by Akshay Krishiparivar on 13 January 2019.

Networking with other MGBP groups

Networking with BAIF helped in nutritional analysis and morphological characterization of selected crops

Achievements accomplished through conducting workshops:

1. Study of shifting cultivation, Soil Testing.

2. Development of pure seed code (Adarsh Biyane Niyamavali),

3. Nutritional analysis of selected crops.

4. Study of Kalbhat aroma.

5. Assurance of market linkage through Baliraja Krishak Producer Company.

6. Promotion of organic farming and its implementation through different workshops with farmers.

7. Lokpanchayat participated in farmers workshop on organic farming and indigenous crop varieties in IIRD at Aurangabad with 15 conservator farmers. Visit to organic market, viz. Mahagreen Producer Company was also organised. We collaborated with Dr. Vijay Shelar, Rahuri to develop pure seed code. (Adarsh Biyane Niyamavali).

We worked on conservation of indigenous varieties, promotion of organic farming and to provide market linkage to producer farmers for their organic produce.

Outreach

Connection with people beyond beneficiaries

Region	Number of People	Quantity of seed	Variety
Rajasthan	1	10 kg	Devthan Bajra
Pune	2	85 kg 200 kg	Kalbhat, Ambemohar
Jalgaon	1	5 kg	Devthan Bajra
Nanded	1	20 kg	Kalbhat
Rahuri	1	10 kg	Devthan Bajra
Nasik	1	10 kg	Devthan Bajra

Knowledge Outcomes

- Aroma of rice varieties are not stable from people perception but Kalbhat landraces of paddy from Akole block has good market potential because of its taste and starch content.
- The preservation of traditional forms of farming knowledge and practices help maintain biodiversity, enhance food security, and protect the world's natural resources. We fear such traditional methods are not trickling down the subsequent generations. We need to empower those who hold traditional knowledge, support local groups, and introduce new techniques only when easily appropriable and harmonious within surrounding nature and customs.
- Morphologically close varieties have a greater possibility of being confused. It was observed that the confusion can happen when one farmer acquires cuttings from another farmer.
- Kadwa Wal grows on residual moisture after rice harvesting without any irrigation facilities.
- Deothan variety of pearl millet which is grown for grain and fodder purpose is drought resistant.
- Ambemohar is aromatic deep water growing variety with low shattering capacity.
- Yield and crop condition is better in land under forest due to the "Kohan Khat", i.e., naturally made manure by leaf litter in forest. It has been useful to improve soil fertility.

Impact

on ecology- According to human nature relationship human activities affects ecosystems. Due to the conservation of indigenous crop varieties it makes strong relationship between nature and human being. Theses varieties are appropriate for climate change as compared to hybrid varieties. It has been observed by farmers indigenous crop varieties doesn't need chemical fertilizers so it plays very important role in soil fertility. Avoiding chemical fertilizers plays important role in maintaining soil structure.

on community- due to conservation people get food security because local varieties are climate resistant varieties. Deothan variety of pearl millet which grown for grain and fodder purpose and drought resistant this ability not seen in other variety. Like that in all local crops we find such results. Now women farmers are aware about seed exchange mechanism through their SHG's. They are facilitating village level seed exchange centres. Local varieties give good fodder for cattle.

on academic circle - It will be helpful in awareness regarding biodiversity, conservation and basic understanding about nature and agricultural biodiversity concepts. Schools play an important role in developing a positive attitude among the new generation about preservation of indigenous species. Writing articles, case studies, research papers, preparing poster in local languages will be good document for conservation and research activity. Through agro-biodiversity activities students are making projects on their local surroundings, they are able to understand their own areas biodiversity through seed collection, and Shivarpheri activities.

Failure stories

1. In crop conservation we worked for 5 indigenous crop conservation i.e. Kalbhat, Ambemohar, Devthan Bajri, Nagli and Kadwa Wal. In this conservation work we face problems in conservation of Devthan Bajri and Kadwa Wal. In case of Devthan Bajri farmers of Rankhamb and Pokhri Baleshvar village are not continuing the conservation of this variety. Reason is less crop yield compared to hybrid variety, birds attack is more and uncertain rainfall in these two villages. Kadwa Wal is not in much demand due to bitter taste, therefore farmers are growing it in mixed cropping pattern in small quantity for their own utilization. Production is not in large quantity.

2. We are not able to convince more farmers for cultivation of indigenous crop varieties. Agriculture departments provide different type of seeds to farmers which gives more production. Local crop varieties or farmers' varieties can be essential to the food, nutrition and economic security of many people particularly smallholder farmers and farming communities in rural and marginal areas. The diversity in these varieties can provide insurance against crop failure and wide cropping windows, while the crop produce may be central to traditional local cuisine and specific dietary requirements. Furthermore, these diverse varieties are an important source of locally adapted genes for the improvement of other crops.

3. Ambemohar is long durational variety and required lot of water. Less water or extreme heavy rainfall affects yield.

4. In grain filling stage and at the time of maturity, Devthan Bajara variety is attacked more than other varieties of Bajara. This affects the farmers choice since the final production is affected due to damage by birds

5. Community perceptions are different in some cases like Pearl millet, Dhevthan Bajara, Ambemohor Rice. Due to the drought condition conservator farmers are migrating for income to nearer block so participatory research process could be disturbed.

6. Aroma of indigenous rice variety is not stable.

7. In quality seed program other farmers ignore pollination distance due to which more time is required for quality seed program. As well as some farmers are small and marginal land holders so they cannot maintain proper distance of crop.

Novel/Unexpected Observations

1. Women farmers are interested in conserving traditional variety. Women farmers after attending agricultural exhibitions, and agricultural business fairs realize that the benefits of exhibiting include raising awareness. Exhibiting at industry events is a good way to raise profiles and generate brand awareness.

2. Insect and pest attack is increasing day by day on Finger millet and thus creates low market. Due to this, percentage of land for production of finger millet is decreasing. Farmers have observed Finger Millet crop

is more laborious and the yield is lesser than other crops. The youth is hardly interested in growing finger millet and those who work in family farms or are in some other way involved in farming are also doing so with compulsion.

New questions raised/discussed

1. Due to the drought condition conservator farmers are migrating for income to nearer block so participatory research process could be disturbed. At the same time it is difficult to recover all varieties of seed in seed bank because of climate variation or due to crop failure because of heavy rainfall in the community seed bank area.

2. Aroma of indigenous rice variety is not stable.

3. In quality seed program other farmers ignore isolation distance due to which more time is required for quality seed program.

4. Documentation and technical support for morphological characters. Participatory seed selection process and increase indigenous crop area Migration and inadequate people participation affects the activities.

5. Advanced technical knowledge of Value addition product development from crop landraces and marketing.

Way forward- On the whole there is a significant need to strengthen sustainable practices in producing crops using local varieties of crops.

1. To strengthen community level seed exchange centers and district level seed bank where exchange seed in large quantity. Also develop strong network of conservator farmers.

2. To develop state level and all India level linkage in conservation.

3. To increase local crop based value addition with Baliraja Producer Company and with Nirmity Bakery. To provide market for indigenous crop through Baliraja Producer Company. For value addition of Nagli, Kalbhat and Varai by making cookies in Nirmity Bakery.

4. To continue conservation of crop with women farmers group. We are interested to work on medicinal plants, fodder species, and fuel wood species.

5. Organisational level- Community participation in conservation. To search more indigenous varieties of crop and conserve them with community. The work done under MGBP is used for community awareness for conservation, will help us to strengthen ground level work like participation of farmers in various activities of conservation. It will also strengthen community level seed exchange centre. It will be helpful for us to recognize other indigenous varieties that are on the verge of extinction.

List of staff involved in the project

Name of the Staff	Qualification	Post	Date of Joining	Date of Relieving
Sarangdhar K. Pande	B.Com. diploma in Development and Planning	Principal Investigator	01/04/2014	31/03/2020
Jayshree Kiran Jadhav	B.Sc.(Botany), B.Ed., MSW	Co-Principal Investigator	01/01/2018	31/03/2020
Kishor Tambe	M.Sc.Agri.	Co-Principal Investigator	01/04/2014	31/12/2017
Haibhau Medhe	B.A., D.Ed	Paryavarn Shikshan Mitra	1/8/2016	15/8/2018
Baburao Gaikwad	B.A., D.Ed.	Paryavarn Shikshan Mitra	22/11/2018	31/03/2020

Result Based Management report

Output /S	Indicators	Baseline (at the start of the project)	Target set for the reporting period	Achievements during reporting period	Achievements cumulative till date
Output 1 – In-situ conservation of crop landraces	Number of In-situ conservation sites	Nil	5 Conservation Site for 5 Selected crops i) Sangamner block-Devthan Bajara-7 Conservation Plot ii) Akole block-Kalbhat,Kadva wal-3 conservation plot iii) Junnar block-Ambemohar-5 conservation plot iv) Igatpuri Block-Finger millet-5 conservatation plot; Kalbhat-4 conservation plot v) Trambakeshwar (Nasik) Block-Finger millet, Kalbhat- 3 conservation plots Total 20 demo plots in 5 In-situ Conservation sites	5 Conservation site competed More than 80 men and women farmers are involved in situ Conservation site 30 farmers selected for seed plot activity. All activity and sub-activity are completed Completed	5 Conservation sites completed 85 conservation plots in 5 conservation site completed up to the current year. 20 In situ Conservation sites completed. Completed
	The number, type, and area of crops and land races cultivated	Farmers cultivating all selected types of crops from long ago.	Selected Crops:- Paddy-2, Pearl millet-1, Bean-1, Finger millet-1 i) Sangamner block-Devthan Bajara (5 demo)- 3 ii)Akole block-Kalbhat paddy -3.0 ha (4 demo), Kadva wal, god wal (2 demonstration)-1 ha. iii) Junner block-Ambemohar paddy (5 demo)-4.0 ha. iv) Igatpuri Block-Finger millet (5 demo)-2 ha. v) Trambakeshwar (Nasik) Block-Fingermillet (4 demo)- 2.5 ha.	Not complete achievement (Because of short rainfall crop yield decreases)	Cumulative target Completed
Output 2 - Community Seed Banks Established	Number of community seed banks-3	Nil	4 block level community seed bank formed. Seed Exchange program was conducted at both community seed banks initiated by women farmers of both villages,Pimpalgaon Matha, Dhamanvan, Lavhali, Ratanwadi.	Established Indigenous Seed Bank and updated (working with Baliraja Company)	District level Seed Bank formed at Adwa Odha, Sangamner. Seed conserved in earthen pots and exchange process continues.
	Number of crops and landraces seeds available in the seed banks	30 crops 52 landraces (First year + period before project initiated)	Local seed collection of cluster wise four focused crops and other crops.	3 crops 23 landraces collected of Paddy, Millet crops, pulses and other seed	115 farmers varieties collected

Output /S	Indicators	Baseline (at the start of the project)	Target set for the reporting period	Achievements during reporting period	Achievements cumulative till date
Output 3 - Developed package of practices.	Number of farmers demonstrating the documented package of practices	Local level package of practices.	Kharif:-15 farmers Rabi:-5 farmers	Not done	Not done
Output 4 - Morphological and Nutritional, traditional knowledge data generated.	Selected crops and landraces documented as per DUS guidelines are available.	Nil Farmers hypothesis:- All this Indigenous selected crops are nutritious than new hybrid variety Morphological characteri-zation (Crop wise) -Nil	4 crops and 5 farmers variety documentation as per DUS guideline Kharif:- Kalbhat paddy, Devthan bajara, Ambemohar paddy, Finger millet Rabi:- Kadva wal Nutritional analysis of 5 selected crops Genetic Analysis of 5 selected crops 1) Preparation of characterization formats for focus crop in process. (Marathi Formats) 2) To Prepare posters of five selected crops. 3) Networking process with various Likeminded Institute, Organization, State level and country level networks and as well green farmers cum activist (MPKV, Rahuri, KVK, Bhabaleshwar, BARC Mumbai, Save the Western Ghats campaign, National Seed Savers Network and other institutes)	Following crops are documented for 3rd year but this is ongoing process upto the final characterization of this crop upto next year Kharif:- Kalbhat, Devthanbajara, Ambemohar, Finger millet Rabi:-Kadvawal Nutritional analysis is done Will analyze in current year Completed Developed In process Linked with Akshay Sheti Parivar, Annadata Pune, Kalpvriksh Pune etc.	From 3rd year characterization process initiated From Kharif:-Kalbhat, Devthanbajara, Ambemohar, Finger millet Rabi:- Kadvawal 5 crops seed analyzed- Completed In process
	Number of traditional practices documented	Nil	3 traditional practices documentation	traditional practices documented 1. Helpful information about dung manure fertilizer 2. Neem oil for the purpose of insecticide. 3. Female farmers conserving indigenous seed with various methods i.e. keeping seed with ash. Seed treatment for one year conservation suggested by Mr. Debal Deb. We guided female farmers in seed conservation in earthen pots; before storing seed, it should be treated with Neem oil. First dry seed continuously 4 days in sunlight then apply neem oil then keep seed in earthen pot. Proportion of neem oil is 2 drops for 1 kg seed.	Ongoing activity

Output /S	Indicators	Baseline (at the start of the project)	Target set for the reporting period	Achievements during reporting period	Achievements cumulative till date
Output 5 - Protocol developed for value addition.	Information available on traditional value addition	Nil	3 types value addition product of Nagali, Bajara,Rrice and Bean . Value addition of Nagali and rice linking with Baliraja producer company and Nirmity bakery.	1. Hand Dehusking of rice which is rich in nutrient status 2. Bajarapeg for small children and pregnant woment. 3. Kadvawal dal (Bean Pulse) use as a *varan*is healthy food for particularly older persons.	This is ongoing process
	Number of value added produce	Baliraja Producer Company, Nirmity bakery and Lokpanchayat involved in various activity of value addition and marketing Nil Nil	3 value added product- Nagali Biscuit, Nachani Papad and Brown kalbhat Rice (Hatsadicha Tandul) Lab analysis of 5 grain sample of project specific Nutrtional and Genetic lab analysis of 5 crops. Participation of seed conservator farmers- Two women conservator farmers participated in indigenous seed exhibition organized by Kalpvriksh at Bhorgiri (Bhimashankar).	From Finger Millet prepared Nagali Biscuit andNagaliPapad From Dehusking machine prepared hatsadicha Kalbhat Nutritional analysis of five crops completed in TUV lab Pune. Genetic analysis not done. 2 seed conservator woman farmers participated in National Conference at Nandurbar and Exhibited seed in the exhibition. 80 conservator farmers participated in workshop organised by organisation from 5 blocks.	We prepared formula for value added product of nagali, rice and other indigenous crop like batu crop and three products prepared. Prepared cumulative 3 value added product Previous lab analysis inference didn't get. This year we got analysis report from Lab. Task completed
Output 6 - Increased number of farmers involved in cultivation of crop landraces.	% Increased number of farmers involved in cultivation of crop landraces.	Nil \No Data\following data based on past status of this landraces after discussion with people. Before 8 year………Kalbhat-farmers 18 from 5 villages Deothan bajara-5 farmers from 3 villages	This is research based project. Indirectly involved in increased number of farmers involved in cultivation of crop land races which is non-targeted activity	Now…… Kalbhat rice- avg. 170 farmers. Devthon Bajara-avg.50 farmers are cultivating both farmers variety	Number of farmers' involvement in cultivation increasing in process.

Annexure 1

Agro-biodiversity baseline survey report

कृषी जैवविविधता पायाभूत सर्वेक्षण अहवाल

लोकपंचायत च्या माध्यमातून महाराष्ट्र जनुक कोश आणि विज्ञान व तंत्रज्ञान विभागाच्या साह्याने संगमनेर व त्रिंबकेश्वर मधील काही गावांमध्ये कृषी जैवविविधता व तिची सध्यस्थिती अभ्यासण्यासाठी पायाभूत व सर्वंकष अभ्यास केला गेला या अभ्यासादरम्यान प्रत्यक्ष शेतकऱ्यांबरोबर चर्चा करून विविध मुद्द्यांवर माहिती संकलन करण्यात आली. मुख्यत्वे करून पारंपारिक बियाणे त्याचा वापर, सध्यस्थिती व बियाणे पुनरुज्जीवन करण्यासाठी उपयुक्त असणाऱ्या बाबी वर भर ठेवण्यात आला.

सर्वेक्षणाची अभ्यासाची प्रमुख उद्दिष्टे

1. कृषी जैवविविधतेची सध्यस्थिती नोंदणे.

2. विविध वाणांची नोंदणी करणे

3. स्थानिक वाणांच्या कमी / जास्त होणाऱ्या वापराची कारणमीमांसा करणे

4. स्थानिक वाणांच्या वापर वृद्धी साठी योग्य उपाययोजना सुचवणे.

सर्वेक्षण कार्यक्षेत्र

लोकपंचायतचे कार्यक्षेत्र असलेल्या जुन्नर, अकोले, त्रिंबकेश्वर व संगमनेर तालुक्यातील प्राथमिक माहिती च्या आधारे ज्या भागात सर्वसाधारणपणे स्थानिक वाणांचे उत्पादन घेतले जाते अशा गावांचे सर्वेक्षण करण्यात आले.

सर्वेक्षण पद्धती

प्राथमिक उद्दिष्टांच्या आधारे तयार केलेला सर्वेक्षण फॉर्म (परिशिष्ट 1 पहा) या कामासाठी वापरण्यात आला. हे सर्वेक्षण stratified random sampling पद्धतीनुसार करण्यात आले. या साठी स्थानिक वने ज्या गावांमध्ये वापरली जातात अशी प्राथमिक माहिती असलेली गावे निवडण्यात आली प्रत्येक शेतकऱ्याशी चर्चा करून सर्वेक्षण फॉर्म भरण्यात आला व संपूर्ण गावाची माहिती संकलन, गट चर्चेच्या साह्याने गोळा करण्यात आली.

अहवाल

या अहवालामध्ये कृषी विविधतेवर प्रभाव टाकणाऱ्या काही बाबींचा विचार केला आहे.

1. जमिनीचा प्रकार व स्थानिक बियाण्याचा वापर

अभ्यासामध्ये 50% (115/230) शेतकरी स्थानिक बियाणे वापरतात असे आढळून आले आहे मात्र जर जमिनीच्या प्रकाराशी सांगड घातली तरी 53.33% (16/30) बागायती, 49.65% (72/145) जिरायती आणि 49.09% (27/55) पडीक जमीन धारक स्थानिक बियाणी वापरतात. म्हणजेच बागायती जमीन धारकांमध्ये स्थानिक बियाणे वापरण्याचे प्रमाण थोडेसेच जास्त आहे. मात्र जमिनीचा प्रकार व स्थानिक बियाणे वापर यांचा फारसा थेट संबध प्रस्थापित करणे योग्य होणार नाही.

2.पशुधन

जवळपास 100 टक्के शेतकऱ्यांकडे कुठल्यातरी प्रकारचे पशुधन उपलब्ध आहेच त्यामुळे त्याचाही स्थानिक बियाण्याशी संबंध प्रस्थापित करता येत नाही.

3.बियाण्याबद्दल मार्गदर्शन

बियाणे निवडीमध्ये 'सल्ला' या प्रमुख निकष असू शकतो. मुख्यत्वे तीन स्त्रोतामधून सल्ला घेतला जातो

1. नातेवाईक, गावातील लोक

2. सामाजिक, शासकीय व बिगरशासकीय संस्था

3. स्वतः कुणाचाही सल्ला न घेणारे.

या अभ्यासामध्ये खालील नोंदी झाल्या :-

सल्याचा स्त्रोत	एकूण शेतकरी	स्थानिक बियाणे वापरणारे (टक्केवारी)
मित्र, नातेवाईक	20	10 (50%)
सामाजिक, शासकीय व बिगर शासकीय संस्था	28	18 (64.28%)
स्वतः कोणाचाही सल्ला न घेणारे	182	87 (47.80%)

या मध्ये सामाजिक व इतर संस्थाकडून सल्ला घेऊन स्थानिक बियाणे वापरण्याचे प्रमाण सर्वात जास्त आहे. त्यामुळे स्थानिक बियाण्यासंदर्भातील प्रसार व माहिती लोकापर्यंत पोहोचवण्याची गरज लक्षात येते.

4. कृषी जैवविविधता संकल्पनेची व्याप्ती

एकूण 230 शेतकऱ्यांपैकी फक्त 22 शेतकऱ्यांना या संकल्पनेचा अर्थ माहित आहे म्हणजेच हि संकल्पना त्याचे महत्व जास्तीत जास्त लोकांपर्यंत पोहोचवणे गरजेचे आहे.

5. स्थानिक बियाण्याचा वापर /कृषी उद्पादानाचा विनियोग

बियाणे निवडताना उद्पादानाचा वापर किंवा विनियोग काय करायचा ह्यावर ते कुठले निवडायचे हे शेतकरी ठरवत असतो आणि खालील आलेखावरून आपल्याला हे लक्षात येते कि जवळपास 41.55% शेतकरी स्थानिक बियाणे हे फक्त स्वताच्या उपयोगासाठी करतात. तर 36.36 विक्रीसाठी व 21.64% शेतकरी याचा वापर दोन्ही साठी करतात.

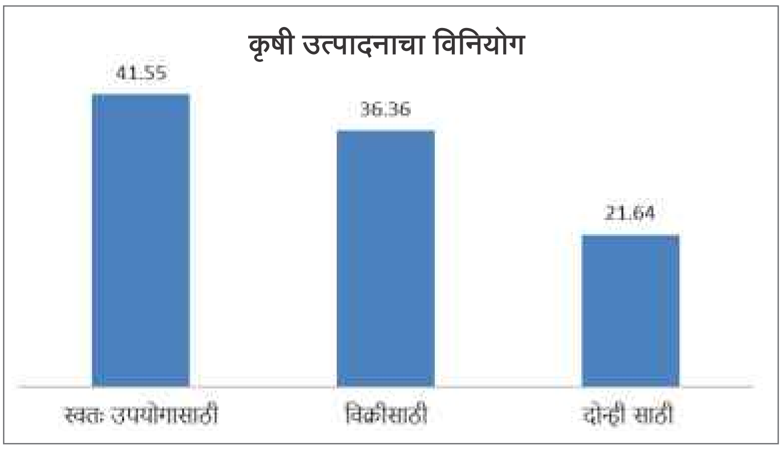
त्यामुळे स्वताच्या वापरासाठी /खाण्यासाठी बियाणे निवडताना शेतकऱ्याचा स्थानिक बियाणे वापरण्याकडे कल असतो. निव्वळ विक्रीसाठी उत्पादकता, मागणी आणि बाजारमूल्य हे घटक कार्यरत असतात त्यामुळे विक्रीसाठी बियाणे निवडताना प्रत्येक वेळी स्थानिक बियाणे निवडले जाते असे नाही. यासाठी योग्य विपणन व्यवस्था लावणे हा एक उपाय असू शकतो.

6. बियाणे संवर्धन करण्याविषयीचे मत

बहुतांश शेतकऱ्यांना पारंपारिक ज्ञान व बियाणे या विषयी जिव्हाळा असतो व त्यांचे संवर्धन व्हावे असंच त्यांना वाटत असते आपल्या अभ्यासात 82.60% (190/230) जणांना पारंपारिक बियाणे संवर्धन करावे असे वाटते तर 17.39% (40/230) जणांचे मत तसे नाही

7. बाजारपेठे पासुन अंतर

प्रवासाचे साधन तसेच बाजारपेठे पासूनचे अंतर हे नेहमीच शेतकऱ्याच्या निर्णय प्रक्रीये वर परिणाम करत असते गेल्या काही वर्षात दळणवळणाची साधने जास्त प्रमाणात उपलब्ध आहेत मात्र रस्त्यांची स्थिती व आवश्यक तेव्हा वाहतूक उपलब्धता होतेच असं नाही. त्याच बरोबर त्या वाहतुकी साठी लागणारा पैसा दरवेळी उपलब्ध होतो असं नाही. त्यामुळे मुख्य बाजारपेठेच्या अंतरावर आधारित काही नोंदी घेतल्या गेल्या

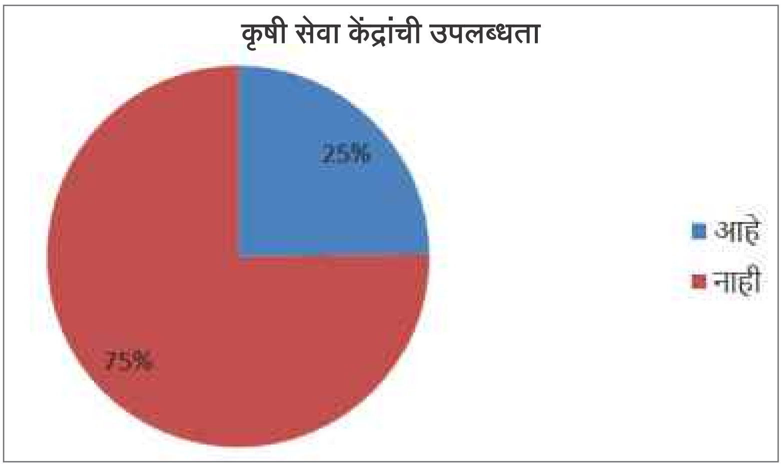


बाजारपेठे पासून अंतर (किलोमीटर मध्ये)	स्थानिक बियाणे वापरणारे शेतकरी	प्रमाण %
0 ते 10	13	5.62
11 ते 20	52	22.5
21 पेक्षा जास्त	50	21.64

वरील नोंदी वरून आपण सहज अंदाज करू शकतो कि बाजारपेठेची उपलब्धता/ सहजता व स्थानिक बियाणे वापर याचे प्रमाण व्यस्त आहे. याचे एक महत्वाचे कारण हे दुकानदारांनी केलेला प्रगत बियाण्यांचा प्रचार व स्थानिक बियाणे वापरण्याच्या संदर्भात सरकारी व संस्थात्मक अनास्था असू शकते.

8. कृषी सेवा केंद्राची उपलब्धता

या आलेखावरून आपल्याला सहज लक्षात येईल कि कृषी सेवा केंद्र हे जवळपास 75 टक्के गावात उपलब्ध नाही आहे पण याच माहितीला जर आपण स्थानिक बियाणे वापराशी पडताळून बघितले तर आपल्याला खालील नोंदी आढळतात.



कृषी सेवा केंद्र	शेतकरी	स्थानिक बियाणे वापर करणारे शेतकरी	प्रमाण (%)
नाही	173	91	52.60
आहे	57	24	42.10

या वरून असा अंदाज बांधता येतो कि ज्या गावामध्ये कृषी सेवा केंद्र आहे त्या गावांमध्ये स्थानिक बियाणे वापराण्यारांचे प्रमाण कमी आहे. या मध्ये परत उन्नत बियाण्यांची केलेली जाहिरात व प्रसार कारणीभूत असू शकतो.

9. हवामान आणि पाऊसमान

पाऊसमान व हवामान यावर शेतीचे सर्व गणित अवलंबून असते त्यामुळे स्थानिक बियाण्याच्या बाबतीत विचार करताना या बाबीकडे विशेष लक्ष द्यावे लागते. अभ्यास परिसरामध्ये पावसाचा विचार करता मुख्यत्वे करून 3 गट पडतात

1. जास्त पाऊस 3000 मिमी पेक्षा जास्त
2. मध्यम पाऊस 1500 ते 3000 मिमी
3. कमी पाऊस 1500 मिमी पेक्षा कमी

या आलेखावरून, पावसाचे प्रमाण आणि स्थानिक बियाणे वापराचा एकत्रित विचार करताना काही निरीक्षणे नोंदवता आली.

पावसाचे प्रमाण	स्थानिक बियाणे वापरणारे शेतकरी	प्रमाण (%)
जास्त	63	27.39
मध्यम	21	9.13
कमी	31	13.47

या नोंदीवरून असं लक्षात येते कि जास्त पावसाच्या भागात स्थानिक बियाणे वापरणाऱ्या शेतकऱ्यांचे प्रमाण उल्लेखनीय जास्त आहे यांचे एक कारण असू शकते ते म्हणजे नवीन जास्त उद्पादक जाती या कधी कधी हवामानाच्या चढ उतारांना किंवा तीव्रतेला सहन करत नाहीत या उलट चर्चेमध्ये हे नेहमी जाणवते कि स्थानिक बियाणी अशा हवामानाला तग धरून राहतात

10. बियाणे कायद्या विषयी

बियाणे विषयक कायद्या विषयी शेतकऱ्यांमध्ये बरीचशी अनास्था आणि ज्ञानाचा अभाव आढळतो आणि ते प्रत्यक्ष अभायासात दिसतेही एकूण शेतकऱ्यांपैकी फक्त 5.21% (12/230) जणांना या विषयी काही कल्पना आहे मात्र उरलेले 94.78% (218/230) जणांना या विषयीची काहीही माहिती नाही.

निष्कर्ष

वरील अभ्यासामध्ये स्थानिक बियाण्याच्या संवर्धन संरक्षण व सद्यस्थितीचा अभ्यास करण्यात आला या मध्ये काही महत्वाचे निष्कर्ष आले

1. शेतकऱ्यांमध्ये स्थानिक बियाण्याविषयी खूप जिव्हाळा आहे व त्यांना बियाणे संवर्धन करण्यात रस आहे याचा वापर करून काही गोष्टी करता येतील.

2. शेतकऱ्यांना विविध प्रकारचे प्रशिक्षण आवश्यक वाटते जसे बियाणे विषयक कायदा, स्थानिक बियाणे संवर्धन फायदे, पेटंट कायदा, पारंपारिक ज्ञान व कार्यपद्धती नोंदणी, सेंद्रिय शेती अशा विषयावर क्षेत्र भेटी व प्रशिक्षण यांच्या मदतीने मार्गदर्शन आवश्यक वाटते.

3. स्थानिक स्वराज्य संथ व सरकारी यंत्रणे बरोबर एकत्रित काम करून जास्तीती जास्त लोकांपर्यंत हा विषय पोहोचवणे आवश्यक आहे

4. शेती माल प्रक्रिया व मूल्यवर्धन शिकवून, तयार मालाच्या विपणना ची सोय करणे आवश्यक ठरते.

Annexure 2

बियाणे यादी

पिंपळगाव माथा बीज बँक

अ.नं.	धान्य प्रकार	तेलबिया	कडधान्ये	पालेभाज्या बियाणे	वेलवर्गीय	फळभाज्या / शेंगा	इतर
1.	देवठाण बाजरी	खुरसणी	मठ	पालक	भोपळा	गवार	ओवा
2.	गहू	जवस	मुग	शेपू	घोसाळे	वांगी	धने
3.	बटू	पांढरे तीळ	हुलगे	अंबाडी	दोडके	भेंडी	वाळूक
4.	मालदांडी ज्वारी	काळे तीळ	हरभरा	मेथी	कारली	चवळी	काकडी
5.		करडई	वाटाणा	माठ	गोल डांगर	तुरमुड्या वाल	
6.		खंद्या भुईमुग	उडीद	आंबट चुका	लांब डांगर	चपटा वाल	
7.		घुंगरया भुईमुग	तूर	राजगिरा	अबई	गोड वाल	
					घेवडा	श्रावण वाल	
एकूण–46	4	7	7	7	8	9	4

धामणवण बीज बँक

अ.नं.	धान्य बियाणे	तेलबिया	कडधान्ये	पालेभाज्या बियाणे	वेलवर्गीय	फळभाज्या	वण उपज / कंद / रानभाज्या	इतर
1.	गहू (कल्याण सोना)	खुरसणी	मठ	पालक	घोसाळे	भेंडी	करंजा	ओवा
2.	काळभात	मोहरी	मुग	मेथी	दोडका	वांगी	कोंबड कंद	लसून
3.	तामकुडई	हावरी (सफेद)	उडीद	शेपू	भोपळा	गवार	बिलाईत	राजगिरा
4.	वरंगळ	भुईमुग (घुंगऱ्या)	हुलगा	अंबाडी	कारली	टोमॅटो	चील्हारी	मिरची
5.	नागली	एरंड	हरभरा		पताड्या घेवडा		बेहडा	पपई
6.	वरई	सुर्यफुल	कडू वाल		गोड वाल		हिरडा	वाळूक
7.	काळा वाटाणा	खंद्या भुईमुग	मसूर		श्रावण घेवडा (लाल)		निरगुड	काकडी
8.	दिट भात				चवळी		बहावा	कांदा

अ.नं.	धान्य बियाणे	तेलबिया	कडधान्ये	पालेभाज्या	वेलवर्गीय बियाणे	फळभाज्या	वण उपज /कंद /रानभाज्या	इतर
9.	सफेद वाटाणा				काळा वाल		गाजर	धने
10.	उतवळी				डांगर (गोल)		सायर	डिंगरया
11.	तूर				पेरवेल घेवडा		अळू	म्हाळुंग
12.	आंबेमोहर				अबई		फांगुळना	सताफा
13.	मदुओपी भात				वालवड		हळद	
14.	मका				श्रावण घेवडा (काळा)		बाळ हिरडा	
15.	बाजरी				डांगर (लांब)		तोरणा	
16.	भादुली				रान भेंडी		करंजी	
17.							बडदा	
18.							हाड चंदन	
19.							अर्जुन सादडा	
एकूण=85	16	7	7	4	16	4	19	12

Annexure 3

Annexure 4

काळभात सुवासिकपणा (कमी होत आहे कि नाही) सर्वेक्षण अहवाल

लोकपंचायत संस्था,संगमनेर

लोकपंचायत च्या माध्यमातून महाराष्ट्र जनुक कोश आणि विज्ञान व तंत्रज्ञान विभागाच्या साह्याने अकोले समूहातील गावांमध्ये काळभात सुवासिकपणाची (कमी होत आहे कि नाही) सध्यस्थिती अभ्यासण्यासाठी पायाभूत व सर्वंकष अभ्यास केला गेला या अभ्यासादरम्यान प्रत्यक्ष शेतकऱ्यां बरोबर चर्चा करून विविध मुद्द्यांवर माहिती संकलन करण्यात आली. मुख्यत्वे करून सुवासिक भात लागवड करण्यामागची उद्दीष्टे, बियाणाचा स्त्रोत, सुवासिकपणावर परिणाम करणाऱ्या प्रत्यक्ष व अप्रत्यक्ष विविध अशा घटकांचा व उपयुक्त असणाऱ्या बाबीवर भर ठेवण्यात आला आहे.

सर्वेक्षणाची / अभ्यासाची प्रमुख उद्दीष्टे

1. काळभाताचा सुवासिकपणावर रासायनिक खते, बियाणाची शुद्धता व इतर परिणाम करणाऱ्या घटकांचा शोध व सबंध शोधणे.

2. काळभाताचा कमी/जास्त होणाऱ्या वापराची कारणमीमांसा करणे

3.काळभात वापर वृद्धीसाठी योग्य उपाययोजना सुचवणे.

सर्वेक्षण कार्यक्षेत्र

लोकपंचायत मध्ये उपलब्ध असलेल्या अकोले तालुक्यातील प्राथमिक माहिती च्या आधारे ज्या भागात सर्वसाधारणपणे काळभात या स्थानिक वाणांचे उत्पादन घेतले जाते अशा अकोले तालुक्यालीतील 7 निवडक गावांचे सर्वेक्षण करण्यात आले जसे सोमलवाडी, सातेवाडी, धामणवण, तेरुंगण, वाकी व ब्रामणवाडा समूह.

सर्वेक्षण पद्धती

प्राथमिक उद्दीष्टेच्या आधारे तयार केलेला सर्वेक्षण फॉर्म (पहा– परिशिष्ट 1) या कामासाठी वापरण्यात आला. हे सर्वेक्षण stratified random sampling पद्धतीनुसार करण्यात आले. यासाठी ज्या गावामध्ये स्थानिक काळभाताची लागवड केली जाते व खाण्यासाठी वापरली जातात अशी प्राथमिक माहिती असलेली गावे निवडण्यात आली त्यातून काळभात करत आहे किवा करत होते अशा निवडक 100 शेतकऱ्याची निवड करण्यात आली. प्रत्येक शेतकऱ्याशी चर्चा करून सर्वेक्षण फॉर्म भरण्यात आला व संपूर्ण शेतकऱ्याची माहिती संकलन वयक्तीक व गट चर्चेच्या साह्याने गोळा करण्यात आली. अहवाल :–

या अहवालामध्ये काळभात पिकावर प्रभाव टाकणाऱ्या काही बाबींचा विचार केला आहे.

1) काळभात लागवडीचा कालावधी

पाऊसमान व हवामान यावर शेतीचे सर्व गणित अवलंबून असते त्यामुळे स्थानिक बियाण्याच्या बाबतीत विचार करताना या बाबीकडे विशेष लक्ष द्यावे लागते.खालील तक्त्यावरून पावसाचे प्रमाण आणि काळभात वापर याचा एकत्रित विचार करताना काही निरीक्षणे नोंदवता आली.

पावसाचे प्रमाण	काळभात बियाणे वापरणारे किवा वापरात होते असे शेतकरी	प्रमाण (%)
जास्त	20	20.00
मध्यम	65	65,00
कमी	15	15.00

या नोंदीवरून असं लक्षात येते कि जास्त पावसाच्या भागात काळभात उंच वाढण्याचे व पाणी, धुके, जोराची हवा यामुळे नुकसान होण्याचे प्रमाण जास्त असल्यामुळे लागवडी खालील व काळभात बियाणे वापरणाऱ्या शेतकऱ्यांचे प्रमाण मध्यम आहे, कमी पावसाच्या भागात पाऊस कमी पडत असल्यामुळे तेथे काळभात प्रमाण कमी आहे याउलट मध्यम पावसाच्या भागात हे प्रमाण बऱ्यापैकी टिकून आहे. या तिन्ही पावसाच्या समूहामध्ये पाण्याची उपलब्धता पावसानंतर पुरेसी राहत नसल्यामुळे फक्त खरिपातच (100 टक्के) भात केला जातो.तसेच जवळपास 98 टक्के शेतकरी पावसाच्या पाण्यावर शेती करतात व 2 टक्के शेतकरी विहिरी, बोअरवेल आणी पाणी साठवण साधनांचा उपयोग करतात त्यामुळे त्याचाही काळभाताच्या सुवासिकपणाशी संबंध प्रस्थापित करता येत नाही.

2) बियाण्याबद्दल मार्गदर्शन व स्त्रोत

बियाणे निवडीमध्ये 'सल्ला' व खात्रीशीर स्त्रोत प्रमुख निकष असू शकतो. मुख्यत्वे चार स्त्रोतामधून बियाणे घेतले जाते किवा काळभात बियाणाची देवाण–घेवाण केली जाते.

1. सामाजिक संस्था,मित्र,नातेवायिक
2. शासकीय व बिगरशासकीय संस्था
3. परंपरागत स्वताचे
4. कृषी सेवा केंद्र / दुकानातून

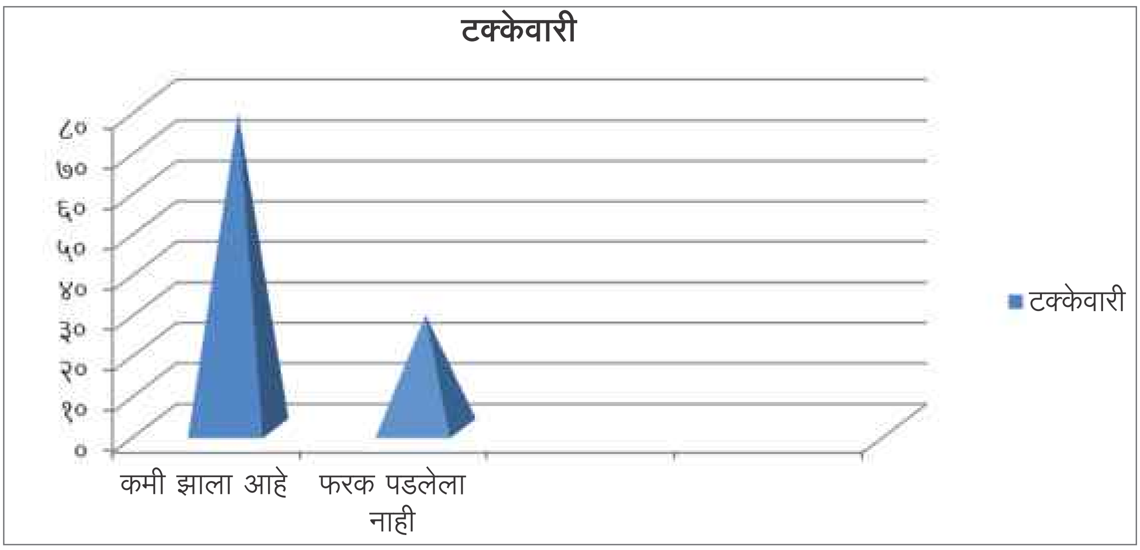
या अभ्यासामध्ये खालील नोंदी झाल्या :-

बियाणे स्त्रोत	एकूण शेतकरी	टक्केवारी
सामाजिक संस्था, मित्र, नातेवाईक	20	20
शासकीय व बिगर शासकीय संस्था	0	0
परंपरागत स्वताचे	80	80
कृषी सेवा केंद्र / दुकानातून	0	0

या मध्ये सामाजिक संस्था,मित्र,नातेवायिककडून व परंपरागत स्वताचे स्थानिक काळभात बियाणे देवाण – घेवाण स्त्रोत प्रमाण सर्वात जास्त आहे. त्यामुळे त्याचा प्रसार व माहिती लोकापर्यंत पोहोचवण्याची गरज लक्षात येते.

3) सुवासिकपणावर परिणाम करणाऱ्या घटकांचा अभ्यास

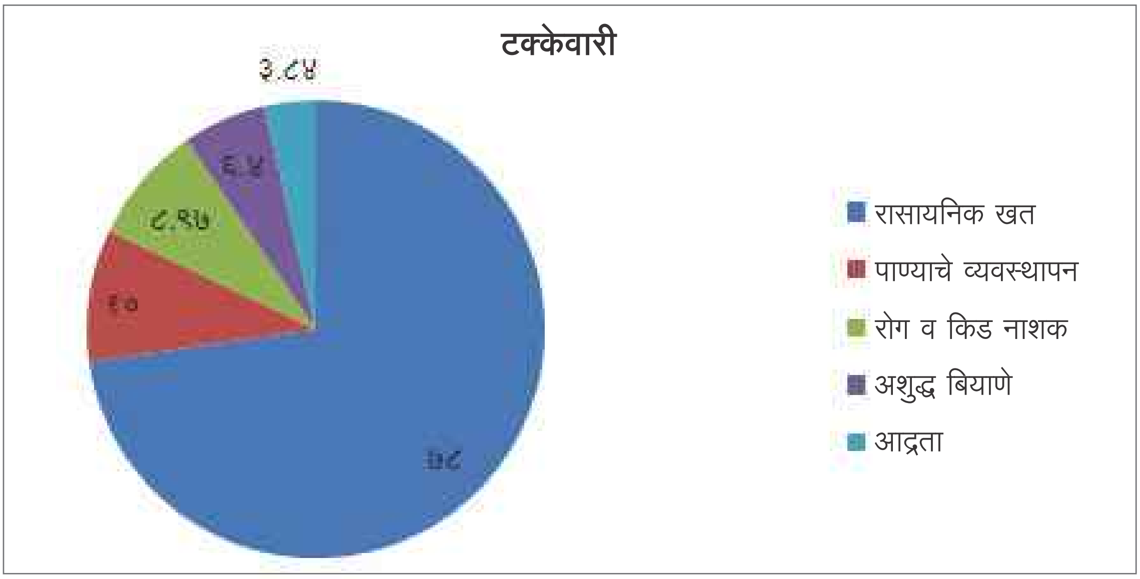
बहुतांश शेतकऱ्यांना पारंपारिक ज्ञान व काळभात बियाणे या विषयी जिव्हाळा आहे व त्यांचे संवर्धन व्हावे असंच त्यांना वाटत असते आपल्या अभ्यासात 72.00% (72/100) जणांना काळभाताचा सुवासिकपणा कमी असे वाटते तर 28% (28/100) जणांचे मत तसे नाही.



गावरान काळभाला सुवासिक मूल्य असल्यामुळे बाजारात खूप चांगली मागणी आहे.परंतु निवडक संवर्धक शेतकरी व स्थानिक ग्राहक या मते काळभाताचा सुवासिकपणा या विषयी अनेक मतप्रवाह समोर आले व त्या अनुसांगणे काही प्रत्यक्ष व अप्रत्यक्ष बाबीचा अभ्यास व नोंदी घेतल्या. त्यातून असे दिसून आले कि सर्व शेतकऱ्यांमध्ये रासायनिक खात व पारंपारिक खात यावरून जरी मतभिन्नता असली तरी वापरण्याची पद्धत एकच आहे फक्त त्याचा वापर कमी अधिक ठरतो. रासायनिक खत वापरण्याऱ्यापैकी 90% शेतकरी फेकून, 8% पाभरीने व 2% गोळीखत या माध्यमातून रासायनिक खत देतात. 78% लोकांच्या मते सुवासिकपणा हा गेल्या 10 ते 12 वर्षापासून रासायनिक खताच्या वापरामुळे व सेंद्रीय पदार्थाचा वापर अत्यल्प असल्यामुळे कमी झाला आहे.

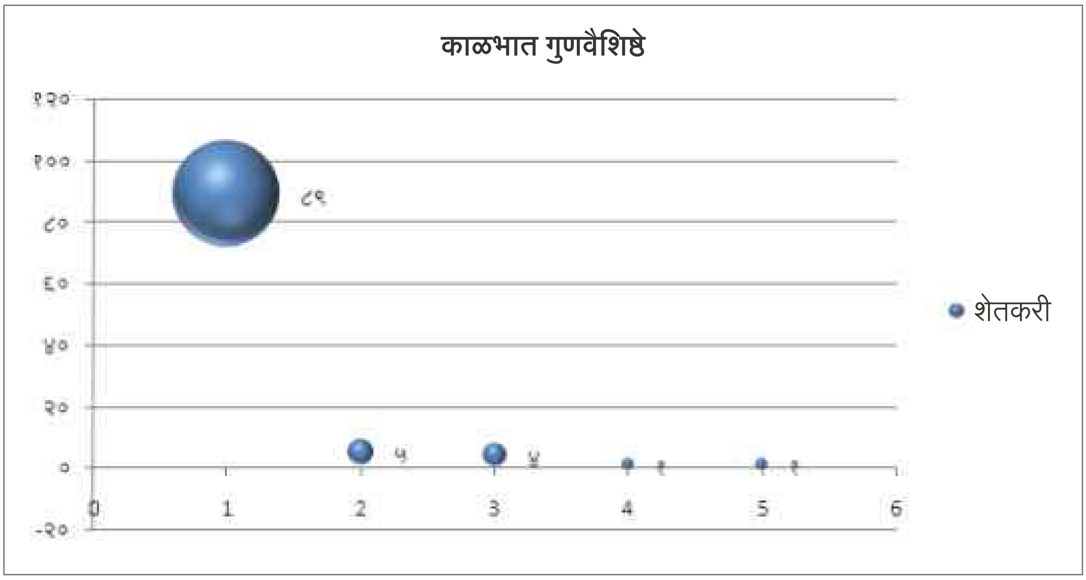
काळभात सर्वेक्षण करतेवेळी अनेक पिक व्यवस्थापन व हवामान निगडीत घटकांचा सुवासिकपाणाशी संबध जोडला गेला त्याचबरोबर खालील तक्त्यावरून व आलेख वरून इतर घटकांचा काय व किती परिणाम होतो हे लक्ष्यात येईल.

घटकाचे नाव	संवर्धक शेतकरी	टक्केवारी
रासयनिक खत	55	78
पाण्याचे व्यवस्थापन	08	10
रोग व किड नाशक	07	8.97
अशुद्ध बियाणे	05	6.4
सापेक्ष आद्रता	03	3.84



4)आवड,निवडी किवा लागवडीमागे काळभाताची गुणवशिष्ठे– गेल्या अनेक दशकापासून काळभात हा सुवासिक गावरान वाणाचे सवर्धन शेतकरी आहे. सर्वेक्षण करतेवेळी असे दिसून आले कि तो सुवासिक असल्यामुळे जास्त किमतीला विकल जातो, कमी पावसात टिकाव धरतो, रोग व किडींना कमी बळी पडतो, भूक भागते तशेच हा भात मोकळा होतो अशा व इतर अनेक गुणवैशिष्ठेमुळे आजपर्यंत कमी अधिक प्रमाणात शेतकरी सवेर्धन करीत आलेले आहे. खालील दिलेल्या तक्ता वरून असे दिसून येते की काळभात हा सुवासिक गावरान जात असून तो जास्त किमतीला विकला जातो या गुणधर्मामुळे शेतकरी व ग्राहकांच्या तो जास्त पसंतीला पडला आहे.

काळभात गुणवैशिष्ठे	शेतकरी	टक्केवारी
सुवासिक असल्यामुळे जास्त किमती	89	89
कमी पावसात टिकाव धरतो	5	5
रोग व किडींना कमी बळी पडतो	4	4
भूक भागते	1	1
भात मोकळा होतो	1	1



निष्कर्ष

वरील अभ्यासामध्ये स्थानिक बियाण्याच्या संवर्धन संरक्षण या अनुषंगाने काळभात सुवासिकपणाचा अभ्यास करण्यात आला या मध्ये काही महत्वाचे निष्कर्ष आले

1) काळभाताचा सुवासिकपणा त्याच्या संवर्धनाच्या अनुषंगाने अतिशय महत्वाचा आहे. रासायनिक खताचा वापर व अशुद्ध बियाणे हे दोन महत्वाचे कारणामुळे बहुतांशी शेतकऱ्यांच्या मते काळभाताचा सुवासिकपणावर परिणाम झालेला आहे असे प्रथमदर्शनी दिसते त्यामुळे सेंद्रिय खात वापरणे किवा एकात्मिक खत व्यवस्थापन या पद्धतीचा जास्तीत जास्त वापर केल्यास जमिनीचा पोट सुधारून सेंद्रीय पदार्थाचा प्रमाण वाढेल व सुवासिकपणासाठी कारणीभूत असणाऱ्या घटकाला नवसंजीवणी मिळेल.

2) काळभात बियाणे संवर्धन फायदे, पारंपारिक ज्ञान व कार्यपद्धती नोंदणी, सेंद्रिय शेती, रासायनिक खताचे तोटे, शुद्ध बियाणे निर्मिती अशा विषयावर शेतकऱ्यांना क्षेत्र भेटी व विविध प्रकारचे प्रशिक्षण देणे आवश्यक वाटते.

3) जास्त बाजारभाव हा महत्व पूर्ण निकष यामध्ये असल्यामुळे जास्तीत जास्त मार्केट उपलब्ध करून देणे महत्वाचे ठरते.

4) पुढील काळात गावरान वाण सवर्धन करणाऱ्या सेवाभावी सस्था यांची भूमिका महत्वाची ठरणार आहे.

परिशिष्ट 1

काळभात सुवासिकपणा या संबंधी प्रश्नावली

अ) शेतकऱ्याचे नाव :– ब)पत्ता :–गाव:– क) गाव सांकेताक(Village ID):–

ड) तालुका :– जिल्हा :–

1)पिकांची लागवड :–(विशेषत: गावरान वाण)

अ.क्र	पिकाचे नाव :–भात वाणाचा प्रकार:– काळभात जात :–	
खरीप	रब्बी	उन्हाळी
1		

2) किती वर्षापासून सुवासिक भात लागवड करत आहात ? याची कारणे(गुणवैशिष्ठे) काय आहेत ?

3) भात लागवडीसाठी बियाणे कुठून मिळविता (पूर्वी व आत्ता) ?–

4) तुमच्या मते, 20 वर्षापूर्वी, 10 वर्षापूर्वी व सद्यस्थितीत सुवासिकतेवर काही फरक पडला आहे का?–

5) पाण्याची व्यवस्था:–

अ.क्र	विहीर	बोअरवेल	कालवा	इतर
1				

I) पाण्याचा बिघडलेल्या व्यवस्थापणामुळे काळभाताच्या सुवासिकपणावर काही परिणाम झाला आहे का? होत असल्यास किती टक्के परिणाम झाला आहे?.

6)खते:–

अ.क्र	खताचे प्रकार व वापर	खते साठवण्याची पद्धत (रासायनीक व पारंपारिक)	खते देण्याची पद्धत

ळ) जमिनीत रासायनीक व पारंपारिक यापैकी कोणते खत वापरतात व का?–

II) खताच्या व्यवस्थापणामुळे (रासायनीक किवा पारंपारिक) सुवासिकपणावर काही परिणाम होत आहे का? कसा व किती टक्के?–

7) रोग व किटकनाशक रासायनीक औषधामुळे काळभाताच्या सुवासिकपणावर काही परिणाम दिसून येत आहे का? पारंपारिक किवा जैविक रोग व किटकनाशक म्हणून तुम्ही काय वापरतात–

8) तुमच्या बियाण्याची शुद्धता कशी आहे? शुद्ध बियाणे व सुवासिकपणा यांचा संबध आहे का?.–

9) हवामान बदलामुळे (पाऊस व इतर करणे) काही परिणाम होत असल्यास, विशेषत: पावसावर सुवासिकपणा अवलंबून आहे का?–

10) सुवासिकपणा अवलंबून असणाऱ्या इतर घटकांची माहिती (शेतकऱ्याकडून)

शेतकऱ्याची सही माहिती संकलकाचे नाव व सही

Annexure 5

पर्यावरण शिक्षण उपक्रम अहवाल, लोकपंचायत

पर्यावरण शिक्षण उपक्रम अहवाल

प्रस्तावना – महाराष्ट्र जनुक कोश कार्यक्रमांतर्गत निवडलेल्या प्रकल्प परिसरातील शाळा ह्या जिल्हा परिषद व शासकीय आश्रम शाळा आहेत. संगमनेर तालुक्यातील 7 शाळा सोडून उर्वरित सर्व शाळा या शासकीय आश्रम शाळा आहेत. आश्रम शाळांमध्ये मोफत शिक्षण, भोजन व निवास अशा वसतिगृहयुक्त आहेत. जिल्हा परिषद प्राथमिक शाळांमध्ये मोफत शिक्षण व मध्यान्न भोजन योजना राबविली जाते. प्रकल्प परिसरातील संगमनेर तालुका वगळता उर्वरित 4 तालुके हे आदिवासी विभागात येतात. आदिवासी भागातील मुले –मुली शिक्षणापासून वंचित राहू नये म्हणून आश्रम शाळा सुरु करण्यात आल्या. आश्रमशाळां ची स्थापना व्यावसायिक शिक्षणावर झाली आहे पण प्रत्यक्षात उद्दिष्ट साध्य होताना दिसत नाही. आश्रम शाळांमध्ये विविध उपक्रम राबविण्यात यावे यासाठी विविध उपक्रमांची यादी समाविष्ट करण्यात आली आहे. परंतु शाळांमध्ये पाठयपुस्तकावर आधारित औपचारिक शिक्षण दिले जाते. अभ्यासक्रमात मुलांसाठी उपक्रम दिलेले आहेत, परंतु ते फक्त माहितीच्या स्वरुपात केले जातात. गुणवत्तापूर्ण शिक्षण ही एक व्यापक संकल्पना आहे. त्यासाठी विद्यर्थ्यांना प्रत्यक्ष अनुभव मिळणे आवश्यक आहे.

शाळा यादी– Annexure-1.

शाळा निवडी मागचे धोरण–

महाराष्ट्र जनुक कोश कार्यक्रमांतर्गत स्थानिक पिकाचे वाण संवर्धना सोबतच स्थानिक जैवविविधता संवर्धन व त्याविषयीची जाणीव भावी पिढीला व्हावी यासाठी काही शाळांची निवड करण्यात आली होती. लोकपंचायत संस्थेचे पिक वाण या थीम वर काम सुरु करण्यासाठी तीन (पुणे, नासिक, अहमदनगर) जिल्ह्यातील 20 गावांची निवड केली त्याचप्रमाणे पर्यावरण शिक्षण केंद्र पुणे अंतर्गत जैवविवधता शिक्षण उपक्रमांसाठी याच जिल्यांमधील एकूण 20 शाळांची निवड केली. निवडलेली गावं ही सह्याद्रीच्या पायथ्याला असलेली असल्यामुळे तेथील जैवविवधता अभ्यास व त्याचे संवर्धन या विषयी या मुलांमध्ये जाणीव निर्माण व्हावी त्याच बरोबर स्थानिक शेती, पर्यावरण, वेली, झाडे, पक्षी, प्राणी यांविषयीचे पारंपारिक ज्ञान लोप पावत चालले आहे, त्यासाठी शालेय शिक्षण व पर्यावरण शिक्षणाच्या माध्यमातून पारंपारिक ज्ञान व संवर्धनासाठी तेथील शाळांची निवड करण्यात आली. विद्यार्थ्यांसोबत विविध उपक्रम राबविण्यात आले.

प्रशिक्षण कार्यशाळा – आनंदशाला शिबिर–

महाराष्ट्र जनुक कोश कार्यक्रमांतर्गत पिक वाण प्रकल्पामध्ये लोकपंचायत संस्थेद्वारे एकूण 20 शाळांसोबत जैवविविधता परिचय उपक्रम राबविले गेले. पर्यावरण शिक्षण केंद्र पुणे यांच्या मार्गदर्शनाखाली अनेक शाळेमध्ये उपक्रम घेतले गेल. ते उपक्रम घेण्यासाठीची क्षमता बांधणी होण्यासाठी आनंद्शाला शिबिर हि एक कार्यशाळा आहे. पर्यावरण शिक्षण केंद्राने तीन दिवशीय क्षमता बांधणी कार्यशाळेचे मोडूल विकसित केले .

आनंदशाळा शिबिर ही एक नाविन्यपूर्ण कार्यशाळा आहे. पाठ्यपुस्तक केंद्रित शिक्षण पद्धतीमुळे विद्यार्थ्यांना मिळणारे पारंपारिक आणि अनुभव आधारित ज्ञान हळूहळू लोप पावत आहे. शाळा, पाठयपुस्तक आणि शिकणाऱ्यांच जीवन, आजूबाजूचा परिसर यांच्यामधल तुटलेपण हे गुणवत्तापूर्ण शिक्षणासाठी एक आव्हान आहे. सध्याची शिक्षण पद्धती याला जबाबदार आहे. मुलांसाठी अभ्यासक्रमात प्रकल्प दिलेले आहेत, परंतु प्रकल्प करताना फक्त माहितीच्या स्वरुपात प्रकल्प केले जातात, त्यातून शिकण्याची, अनुभवाची प्रक्रिया होत नाही. गुणवत्तापूर्ण शिक्षण हि संकल्पना व्यापक आहे. कुठल्याही गोष्टीचे शिक्षण हे प्रत्यक्ष अनुभवातून प्रभावीपणे होते, या आधारावर पर्यावरण शिक्षण केंद्र यांनी आनंदशाळा शिबिर या प्रतिकृती ची निर्मिती केली आहे. विद्यार्थ्यांचा सर्वांगीण विकास होण्यासाठी आनंददायी शिक्षण पद्धती असायला हवी आणि शिक्षणाचा त्याच्या परिसराशी संबध जोडला तर विद्यार्थी आनंदाने शिकतो.

आनंदशाळा हे फक्त विद्यार्थ्यांपुरते मर्यादित न राहता शिक्षकांनाही यात सहभागी करून घ्यावे असा एक विचार संस्था पातळीवर झाला होता . म्हणून शिक्षकांसाठी आनंद शाळा शिबिर घ्यावे असा निर्णय झाला होता. लोकपंचायत संस्थेसाठी पर्यावरण शिक्षण केंद्र ,पुणे यांच्यामार्फत 3 आनंदशाळा शिबिर घेण्यात आले. प्रशिक्षण कार्यशाळांचा तपशील खाली दिलेल्या तक्त्याप्रमाणे,

अ. नं.	प्रशिक्षण कार्यशाळा	कार्यशाळा संख्या	सहभागी पर्यावरण शिक्षण मित्र /कार्यकर्ते	ठिकाण
1.	आनंदशाळा शिबिर	3	1. ज्ञानेश्वर वाळे (शिक्षक)	
2.	रोकडे कैलास सर 3. शिंदे धनंजय सर 4. वाकचौरे सर 5. हरिदास पांडे सर 6. संतोष भालेराव सर 7. हरिभाऊ मेढे 8. जयश्री जाधव	1.डिंभे 2.हिवरेबाजार, 3. कुरकुंडी		
2.	लेखन कार्यशाळा	1	किशोर तांबे	आयसर, पुणे
3.	शॉर्ट फिल्म मेकिंग	1	हरिभाऊ मेढे	आयसर, पुणे
4.	फोटो स्टोरी	2	जयश्री जाधव	चाळीसगाव
5.	शिवारफेरी कार्यशाळा	1	हरिभाऊ मेढे, किशोर तांबे	हिवरे बाजार
6.	बियाणेउगवण क्षमता अभ्यास कार्यशाळा	1	जयश्री जाधव, हरिभाऊ मेढे	हिवरे बाजार

पर्यावरण शिक्षण केंद्र , पुणेयांनी शेती थीम साठी एकूण 34 विषय निवडून प्रकल्प पुस्तिका तयार केली. आनंद शाळा शिबिरांमधून शिक्षक व विद्यार्थी यांनी हे प्रकल्प कसे करावे याचे प्रत्यक्ष अनुभवाद्वारे शिक्षण दिले.

आनंदशाळा शिबिर –लोकपंचायत संस्थेतील शिक्षक व विद्यार्थी यांच्यासाठी 3 आनंद शाळा शिबिरं आयोजित करण्यात आली होती. डिंभे, हिवरेबाजार, व लोकपंचायत चे आय.टी.आय. कॉलेज कुरकुंडी या ठिकाणी शिक्षक व विद्यार्थी आनंद शाळा शिबिरं घेण्यात आली. शिबिरासाठी किमान 13 शाळांचे नियोजन एकावेळी केलेले असायचे परंतु प्रत्यक्षात 8–9 शाळा सहभागी झाल्या होत्या. उपस्थित विद्यार्थी व शिक्षक यांचे गट केले जायचे. प्रकल्प पुस्तिकेतील एकूण 34 प्रकल्पांमधून प्रत्येक गटासाठी 1 प्रकल्प निवडले जात. (बाई, बापय, व जैवविवधता, आई बाबा दिवसभर काय काय करतात, दशपर्णी अर्क तयार करणे, गाव शिवारतील दगड माती, गावातील जनावरांना होणारे आजार, गावातील जनावरांना होणारे आजार, माझ्या ताटात काय काय, इ.) प्रकल्प पुस्तिकेत आपापले प्रकल्प बघून प्रत्येक गटाने आपापलल्या शंका विचारत. प्रकल्पासाठी लागणारे साहित्य सर्वांना देणे आणि त्या प्रमाणे प्रत्येक गटाने चर्चा करून मुद्दे तयार करणे .

प्रत्येक गटाने त्या मुद्द्यांच्या आधारे सादरीकरण करणे. त्यामुळे आणखी शंका सोडवल्या जाऊन प्रकल्पाचे नियोजन करण्यासाठी मदत होते. नियोजनामध्ये प्रकल्पांसाठी लागणारी माहिती मिळवण्यासाठी शिक्षकव विद्यार्थी यांनी गावातील लोक व परिसर भेटी घेणे.त्यासाठी काय प्रश्न विचारायचे याचे प्रत्येक गटाने नियोजन करणे. आपापल्या प्रकल्पासाठी गावातील काही कुटुंबांमध्ये जाऊन माहिती घेणे. या गोष्टी यात समाविष्ट होत्या. सी.ई.ई. च्या सहकाऱ्यांनी वेळोवेळी प्रत्येक गटाला भेट देऊन ते प्रश्न कसे विचारतात, प्रकल्पाचा हेतू स्पष्ट होतो कि नाही, माहिती योग्य प्रकारे घेतली जाते कि नाही याकडे लक्ष दिले आणि त्याप्रमाणे गटांना सूचना केल्या. मिळालेल्या माहितीनुसार प्रत्येकाने सादरीकरण केले. प्रत्येक गटातील विद्यार्थ्यांनी प्रकल्पाचे सादरीकरण केले. एका गटाचे सादरीकरण सुरु असतांना इतर गटांनी शंका विचारल्या व सादरकर्त्या गटाने त्या शंकांचे निरसन केले. शिक्षकांना हि कार्यशाळा खूप आवडली आणि त्यांनीसर्व प्रक्रिया समजून घेतली. अशा प्रकारे आनंद शाळा शिबिर नियोजनानुसार पूर्ण झाले.

शिक्षक अभिप्राय – कन्हेश्वर विद्यालय – श्री. ज्ञानेश्वर वाळे.

आम्हाला आमच्या विषयाचे अनेक प्रशिक्षण दिले जातात. त्या अनुभवावरून मी या शिबिरासाठी जाण्यास उत्सुक नव्हतो. मला शाळेबरोबरच घरची गार्यीची जबाबदारी असते. हे शिबिर निवासी असल्यामुळे मी आलो नव्हतो. परतू संस्थेचे कार्यकर्ते मुलांना ज्या प्रकारे प्रकल्प माहिती देत होते, शाळेत उपक्रम घेत होते त्यामुळे मी यासाठी

विद्यार्थ्यांना मार्गदर्शन करू लागलो. माझा प्रतिसाद बघून मला त्यांनी आग्रह केला व मी या शिबिरात सहभागी झालो. आम्हाला मिळणारे प्रशिक्षण व या शिबिरात खूपच तफावत होती, मुलांसोबतच शिक्षकही प्रकल्पांमध्ये एकरूप होऊन गेले. मला या शिबिरामार्फत खूप गोष्टी शिकायला मिळाल्या. शालेय शिक्षण कस असायला हवं हे कळले. मी पर्यावरण शिक्षण केंद्र व लोकपंचायत संस्था यांचा आभारी आहे की मला प्रकल्प कसे असावे व ते अनुभवातून करावे हे समजले. मी विज्ञानाचा शिक्षक असल्यामुळे मला व माझ्या विद्यार्थ्यांना याचा निश्चित फायदा होईल .धन्यवाद.

शिवार फेरी–

हा राबविलेल्या अनेक उपक्रमांपैकी एक अतिशय महत्वाचा उपक्रम. शिवार म्हणजे भोवतालचा परिसर आणि फेरी म्हणजे त्या परिसारत जाऊन येणे. CEE मार्फत राबविल्या गेलेल्या उपक्रमांमधला हा विद्यार्थ्यांच्या आवडीचा एक उपक्रम. विद्यार्थी जेव्हा पाठ्यपुस्तकातून शिकतो त्यावेळी तो शिक्षकांचे फक्त ऐकणे या भूमिकेत असतो. त्याला प्रत्यक्ष अनुभव या प्रक्रियेत मिळत नाही. त्याला ते शिक्षण कंटाळवाणे वाटते. परंतु शिवारफेरी हा असा एक उपक्रम आहे ज्यातून विद्यार्थी व शिक्षक मोकळेपणाने संवाद साधू शकतात. विद्यर्थ्याला आपल्या परिसरातील झाडे, वेली, फुलपाखरू, पक्षी, किडे, साप, माती, खडक याविषयीचे प्रत्यक्ष ज्ञान मिळते. पर्यावरण शिक्षण केंद्र ,पुणे यांनी जैवविवधता कीट विकसित केले. त्या कीट चा उपयोग शिवार फेरी करताना वनस्पती, प्राणी, पक्षी, कीटक, साप यांची ओळख होण्यासाठी झाला. या उपक्रमामधून विद्यार्थ्यांना आपल्या परिसरातील शेती व पिके यांची जैवविवधता काय आहे, तिचे संवर्धन कसे करावे यासाठी उपयुक्त ठरेल. विद्यार्थ्यांनी शिवारफेरी आधारित विविध प्रकल्प केले, जसे माझ्या ताटात काय, आमच्या गावचा इतिहास, गाव शिवारातील दगड –माती, शिवारातील जनावरांना होणारे आजार, गाव शिवारातील पिक किडींचा अभ्यास यासारखे अनेक प्रकल्प विद्यार्थ्यांनी केले.

PSM चा अभिप्राय–

मजको अंतर्गत एकूणच पर्यावरण शिक्षण केंद्र ,पुणे यांनी खूपच अभ्यासपूर्वक प्रत्येक थीम नुसार उपक्रम तयार केले. शिकण्याच्या प्रक्रियेत विद्यार्थी केंद्रस्थानी ठेऊन त्याचे शिक्षणाबरोबरच परिसराशी नाते निर्माण व्हावे. त्याला आपल्या परिसरातील जैवविवधतेची जाणीव व्हावी व त्या बद्दल त्याला आपुलकी वाटावी अश्या पद्धतीने या उपक्रमांची निर्मिती करण्यात आली आहे. विद्यार्थ्याला त्याच्या आवडीनुसार प्रकल्प निवडीचे स्वातंत्र्य मिळाले. शिक्षकांनी या प्रकल्प पुस्तीकेचा वापर करून विद्यार्थ्याला अनुभवातून शिक्षण द्यावे .

आनंद शाळा शिबिरांमधून प्रत्यक्ष प्रकल्प कसे करावे, त्यातून काय शिक्षण झाले, प्रकल्प सादरीकरण कसे करावे व त्याबद्दल काय अडचणी निर्माण झाल्या असे अनेक अनुभव मांडण्याची संधी विद्यार्थ्यांना मिळाली त्यामुळे त्यांचा आत्मविश्वास वाढला.

प्रचलित शिक्षण पद्धतीत अशा उपक्रमांचा समावेश व्हावा.

शिक्षणाची भूमिका –

महाराष्ट्र जनुक कोश कार्यक्रमांतर्गत शेतीतील जैवविवधता संवर्धनाचे काम करत असताना शाळांसोबत जे उपक्रम राबविले गेले त्यातून विद्यर्थ्यांचे अनुभवाधारित शिक्षण झाले. खरंतर पाठ्यपुस्तक केंद्री शिक्षण पद्धतीने विद्यार्थ्याचं जीवन व परिसर याचं नातं तुटलं आहे. स्थानिक संदर्भ रहित शिक्षण वपाठांतर केंद्री शिक्षण पद्धतीमुळे मुलांच्या भाषा, विज्ञान विकासाचा स्थर खालावताना दिसतो. अशा शिक्षण पद्धतीत विद्यार्थ्यांना आवड राहत नाही. विद्यर्थी जेव्हा स्वत: अनुभव घेतो तेव्हा त्याची विचार करण्याची क्षमता वाढते.

पाठ्यपुस्तकातील आशय व त्याचा विद्यर्थ्याच्या सभोवतालचा परिसर याची सांगड घालून त्याला प्रत्यक्ष अनुभवातून शिक्षण द्यायला हवे. यातूनच त्याचा सर्वांगीण विकास होईल.शालेय शिक्षण पद्धतीमध्ये परिसर अभ्यास हा विषय समाविष्ट केला गेला आहे. परंतु पुन्हा हा अभ्यास प्रत्यक्ष अनुभवातूनच विद्यार्थ्याला मिळाला तरच परिसराच आणि शिकणारच नातं निर्माण होईल व त्या परीसराच्या संरक्षणाची जबाबदारी भावी पिढीला होईल.

मजको अंतर्गत केलेल्या कामाच्या अनुभवावरून स्थानिक जैवविविधता संवर्धनाच्या कामात या शिक्षण पद्धतीचा उपयोग होईल. कारण लहानपणापासून जर आपल्या परिसरातील जैवविवधता चे महत्व मुलांना समजले तर भावी पिढी त्याचे संवर्धन करू शकेल.

शाळा यादी

सहभागी शाळा – अकोले, संगमनेर, इगतपुरी, त्रंबकेश्वर व जुन्नर येथी एकूण 20 शाळा या पर्यावरण शिक्षण उपक्रमांमध्ये सहभागी झाल्या होत्या.

अ.नं.	शाळेचे नाव	तालुका	जिल्हा	अंतर
1.	कऱ्हेश्वर माध्यमिक विद्यालय, कऱ्हे	संगमनेर	अहमदनगर	15 km.
2 .	प्रगती विद्यालय, पोखरी बाळेश्वर	संगमनेर	अहमदनगर	30 km.
3.	शिवछत्रपती माध्यमिक विद्यालय, रणखांब	संगमनेर	अहमदनगर	25 km.
4.	काशेश्वर विद्यालय, कसारा दुमाला	संगमनेर	अहमदनगर	5 km.
5.	बाळेश्वर आदर्श विद्यालय, पिंपळगाव माथा	संगमनेर	अहमदनगर	20 km.
6.	जवाहरलाल नेहरू विद्यालय, पेमगिरी	संगमनेर	अहमदनगर	25 km.
7.	प्रवरा माध्यमिक विद्यालय, सावरगाव तळ	संगमनेर	अहमदनगर	15 km.
8.	शासकीय माध्यमिक व उच्च माध्यमिक विद्यालय, केळी	अकोले	अहमदनगर	65 km.
9.	शासकीय आश्रमशाळा, मुतखेल	अकोले	अहमदनगर	65 km.
10.	शासकीय आश्रमशाळा, शिरपुंजे	अकोले	अहमदनगर	60 km.
11.	शासकीय माध्यमिक आश्रमशाळा, कोथळे	अकोले	अहमदनगर	80 km.
12.	शासकीय माध्यमिक आश्रमशाळा, पळसुंदे	अकोले	अहमदनगर	65 km.
13.	सर्वोदय विद्यामंदिर, राजूर.	अकोले	अहमदनगर	45 km.
14.	प्राजक्ता माध्यमिक विद्यालय, धामणवण	अकोले	अहमदनगर	60 km.
15.	अनुदानित, प्राथमिक व उच्च माध्यमिक आश्रमशाळा, तळेरान	जुन्नर	पुणे	102 km.
16.	शासकीय माध्यमिक आश्रमशाळा, खिरेश्वर	जुन्नर	पुणे	107 km.
17.	शासकीय माध्यमिक आश्रमशाळा, आंबे	जुन्नर	पुणे	108 km.
18.	शासकीय माध्यमिक आश्रमशाळा, सोनावळे .	जुन्नर	पुणे	140 km.
19.	शासकीय माध्यमिक आश्रमशाळा, देवरगाव	नासिक	नासिक	120 km.
20.	शासकीय माध्यमिक आश्रमशाळा, खडकेद	इगतपुरी	नासिक	95 km.

Annexure 6

Chemical analysis of crops under study

	Kalbhat Rice	Deothan Bajra	Kadu Wal	Ambemohar Rice	Nachani
Energy (Kcal/100g)	366	377	353	355	351
Total Fat (g/100g)	3.28	6.42	0.65	0.69	2.31
Total sugar (g/100g)	<0.4	<0.4	<0.4	<0.4	<0.4
Carbohydrate of which Sugar	<0.4	<0.4	<0.4	<0.4	<0.4
Protein (g/100g)	9.03	10.49	22.31	6.74	4.88

Conservation of Dangi - an Indigenous Cattle Breed of Northern Western Ghats

Report

3

Conservation of Dangi – an Indigenous Cattle Breed of Northern Western Ghats

Lokpanchayat, Sangamner, Ahmednagar

Background

- Dangi cattle are crucial for the local livelihood
- Dangi cattle are reared by tribal communities like Mahadeo Koli, Thakar and Konkana who inhabit the area.
- Rainfed agriculture is the mainstay of the local livelihood.
- Average land holding in this area is not more than 4 acres per family.
- Farm mechanization is negligible.
- Dangi cattle provide all cultivation and transport related services for the agriculture in this area.
- It is a common experience of the tribal farmers in this area that crossbreds and other cattle breeds do not survive in this area. The farmers attribute this to poor survival of the cross breeds or the other cattle breeds under heavy rainfall and undulating terrain.
- Dangi breed with its oily skin and tough hooves has successfully adapted to the eco-geographical conditions i.e., a terrain with heavy rainfall and remote mountainous situation

Decline in the population: Earlier Dangi was spread over quite large area covering five to six districts of Maharashtra and three districts of adjoining Gujarat state. From Junnar block of Pune district to Thane, Ahmednagar, Palghar, Nashik and Ahawa Dang district of south Gujarat. Presently the breed is found in just two blocks of two districts (Ahmednagar and Nasik) and some parts of adjoining Dang district of Gujarat.

Discussion with the farmers during reconnaissance visit to Ghoti - Igatpuri area revealed that population of the breed has decreased considerably. Even some of them shared that they demanded semen of Dangi bulls with BAIF instead of crossbred usually provided in the extension service.

Discussion with the farmers during reconnaissance visit to Kumshet –Pachnai area in Akole block revealed that over last eight years (2001-2008) almost 80% of the cattle population has got wiped out due to mainly calcium and phosphorus deficiency, polluted water and fodder scarcity. Because of these factors cattle become weak in the summer season and then unable to face heavy rainfall situation in the monsoon. These farmers even described symptoms of the epidemic. In 2005-06, the situation was the worst with high number of cattle deaths.

Geographical location

Fifteen tribal villages from Akole block of Ahmednagar district

1. Phofasandi 2. Satewadi 3. Kothale 4. Lavhali Otur 5. Lavhali Kotul 6. Pachnai 7. Pethechiwadi 8. Kumshet 9. Janewadi 10. Ambit 11. Shirapunje 12. Dhamanvan 13. Ratanwadi 14. Samrad 15. Lavhalwadi

Lokpanchayat Villages - Dangi Cattle Study

Community profile

Mahadev Koli & Thakar are the major Adivasi communities rearing Dangi cattle. Other traditional forest dweller communities are also rearing the Dangi cattle.

Key issues

- Absence of pure breed in Dangi- Characters of *Boss indicus* (Zebu) were reducing in every generation of Dangi cattle. There is also an inadequacy of service bull in villages and remote hamlets.
- Dangi keepers have superstitions and misunderstanding about Artificial Insemination technique.
- Dangi rearing families live in heavy rainfall terrain. So, fodder scarcity is main problem.
- Primary health services are inadequate.
- Seasonal vaccination is not being done in right time.
- Lack of fodder information especially about wild fodder species.

All the above issues were identified in baseline study of Dangi cattle with 125 Dangi keeper families in 18 selected villages (Annexure 1).

Objectives

1. Socio-economic and ecological research to fine tune understanding of the Dangi system
2. Capacity building of the tribal farmers in the context of maintaining good quality Dangi cattle
3. Strengthen backward and forward linkages for healthy Dangi animals
4. Policy advocacy and information dissemination for the Dangi breed

Dangi livestock conservation project was implemented on the basis of above specific objectives. First three objectives are totally fulfilled.

Sampling methods

Participatory project implementation was initiated from survey and mapping activity. After finalizing working area and their village clusters, we started survey and mapping process in Akole block of Ahmednagar dist. Survey was conducted in selected 25 villages and more than 75 hamlets. PRA (Participatory Rural Appraisal) tools were used to assess the status of local Dangi breed and allied systems.

Major work done under MGBP

Participatory research

Lokpanchayat has been facilitating participatory research process with selected 30 Dangi keeper families. We organized field demonstrations to diagnose disease symptom of Botulism called as *Thandya* in local language. In selected six villages, we tried to develop package of practices to control the disease and got adequate success.

Package of practices: First, practitioner gets temperature of sick cattle. If temperature is low, then start treatment to maintain normal body temperature. In this disease, calcium and phosphorus levels become low. So treatment is started to maintain calcium and phosphorus levels. It is advised to give jaggery with water every day and pulses mixture also. We have been emphasizing to all Dangi keepers the need to give vaccination every year. Drinking water must be pure and adequate, and well balanced fodder and mineral mixtures too.

Simultaneously, we focused on documentation of wild fodder. Through a study conducted for two years, we documented wild fodder plants from working area, which is a unique work. More than 200 fodder plants were documented and 53 grasses were also identified. *Rakhanraan* (a small meadow of grassland) a community conserved area (CCA) was newly identified in the north Western Ghats. Till date, we could not find such type of uncultivated fodder related documentation or any secondary data. Fodder processing and value addition demonstration was done in all the 15 project villages (Phofasandi, Satewadi, Ratanwadi, Samrad, Shinganwadi, Kumshet, Janewadi, Kothala, Lavhali Otur, Lavhali Kotul, Pethewadi, Pachanai, Ambit, Shirapunje and Dhamnvan). Domestic processing of dry fodder like rice straw has been organized. More than 400 families were trained and initiated fodder processing. Fresh and dry fodder processing skill was adopted by local Dangi keepers. Comparative study of natural and artificial insemination was initiated in working area. Last two years, comparative data collection was started through 19 parameters from 10 families.

Awareness and capacity building

Through this project, awareness regarding seasonal vaccination was created among Dangi keeper community. Traditional keepers have some misunderstanding and superstitions about vaccination. Our team (Co-PI and village level Animal Health Workers (AHW) डांगी-मित्र) created concrete consciousness in the keepers by using

Kala-pathak, regular meetings, workshops, and formal conversation and organized vaccination drive with state veterinary department. For the first time, vaccinations reached up to remote hamlets and mountain caves, where cattle are living in monsoon and post monsoon period. In the 15 villages AHW are working as a Para-vet/barefooted practitioner. Project areas are remote in hilly Sahyadri mountain terrain and road access is also inadequate. So, health services could not reach in time. As per Dangi keepers' demand, Lokpanchayat has selected youth in every village (Total 15) as *Dangi-Mitra* as Animal Health Worker (AHW). Lokpanchayat provided training about primary treatment. We also provided medicine-kit in village for emergency treatment. AHW are working with state animal husbandry department in vaccination drive and regular health camp. Some of them are interested in Ethno-Veterinary practices. A new alternative health system was initiated as per requirement of villages.

For the first time, Lokpanchayat has started Artificial Insemination Service (AIS) using semen tube of Dangi, made by BAIF Semen Bank in the project village where Dangi service bull is absent. In the beginning people were not ready to use AI. With sustained efforts total 68 AI are done. 26 calves (15 female and 11 male) were born. Dangi keepers from nearby villages have started taking help from our practitioner for AI and other primary treatment. Lokpanchayat reached up to 26 villages (15 project villages and 11 new villages).

Two training workshops were held for Dangi keepers and AHW every year. We also organized training workshop and exposure visit for women and youth Dangi keepers to build non-milk produce based livelihood and to develop cow dung and urine centric product. Ethno-veterinary based learning program was also planned to promote local herbal medicine practices. Two learning workshops were held for women and youth from 15 villages. More than 120 Dangi keepers participated in the workshops.

A pilot program of Livestock Insurance was started in two villages through which keepers got compensation after death of cattle and goat.

Lokpanchayat participated in yearly Dangi exhibition at Rajur (central market place). Our conservation message spread to all stakeholders related to Dangi cattle. We reached up to minimum two thousand keepers through exhibition and *Kalapathak* program. At closing stage of project Dangi keepers have pro-actively decided to form **Dangi Breeders Association (DBA)**. 11 member promoters' body was formed to develop governance system and associated legal compliances.

Documentation and publication

Lokpanchayat has published a small book both in English and Marathi named *Samagra Dangi* giving basic information about overall 'Dangi System'. Detailed report on wild fodder study in 2016-17 with GIS mapping of selected grazing areas and separate survey report on *Rakhanraan* were also prepared.

Networking

Lokpanchayat has given importance to develop linkages with various networks, academicians, conservation practitioners, like-minded organizations from north Western Ghats and research institutes. Initially we got associated with BAIF, Dangi Research Station Igatpuri, MAFASU Nagpur, and Veterinary colleges from Shirval and Paral.

Lokpanchayat has become a member of League for Pastoral People (LPP), an international network working for strengthening pastoral community.

Community participation in MGBP process

Since last 10 years, Lokpanchayat had closely worked with tribal community of Akole block in Ahmednagar district. In the beginning, Lokpanchayat initiated some forest based livelihood activity mainly associated with wild honey, Karonda, Mango, Jamun etc. After around two years, local community started talking about the problems of their Dangi cattle and requested to initiate work on Dangi cattle and its diseases. Before MGBP, we initiated basic activity like arranging learning program on importance of quality fodder, water in summer, seasonal vaccination and made them aware about good rearing of cow and bull, particularly service bull.

When MGBP started, we got advantage of some field level preparation and about Dangi issue. Local people proactively participated in designing project activity. In finalizing number of activity, local Dangi keepers suggested collecting the information of local wild fodder resources. In every village, there is local livestock healer (वैद्) who use their traditional knowledge to treat cattle. They also participated in the implementation of project. Total three healers were working as AHW in different villages. When we engaged in the documentation of wild fodder resources, youth from Phofasandi village told us about *Rakhanraan* practices, and from this we got a new concept of CCA (Community Conserved Area) in the working area. They have preserved customs from hundreds of years to manage *Rakhanraan* sustainably, just as they were traditionally conserving sacred groves.

Beneficiaries

- More than 300 Dangi keeper families from 15 villages are the direct beneficiaries of the project. They have received following benefits-
- Regular primary health service reached up to 1500 keepers' families from 26 remote villages and hamlets.
- 14 animal health workers are giving village level service in selected 15 villages.
- In 15 villages vaccination services also provided by our team with the support of state veterinary department.
- Artificial Insemination service initiated for the first time with minimum fees.
- Capacity building process of Dangi centric livelihood was commenced.
- Lokpanchyat took responsibility of facilitating Dangi Breeders Association.

Measures taken to reassure that benefits to the community continue after MGBP

Practical demonstration of processing of wild fodder or farm fodder in scientific manner created a positive environment in community. Traditionally good bulls are cultivated for farming and selling. Cows are considered as goddess*'Lakshmi'*, but there are no conscious efforts done for its conservation. Various events, meetings and, visits were held to emphasize that 'Good cows should be cultivated to maintain good quality bulls'. A new generation of cattle grazers responded well to this and the effort gave good results. People started taking help from *Dangi-Mitra* (AHW) and veterinarians whenever needed. Special care is given to pregnant cows. This enthusiasm at the villages gives us hope that the dangi desi cattle conservation work will continue even with the absence of outside influence of Lokpanchayat.

People's selection criteria regarding cattle

Locals describe nine types of strains according to the color and pattern of cattle. Their names are as follows: Bahala, Vanera, Khaira, Manyara, Tambada, Para, Gavala, Kala. Bull or calf with large black dots on white skin is Bahala. It has the highest demand and the price in the market. 'Masuri' is important pattern in cows. 'Masuri' has small black dots on the white skin. In addition, breed selection is done based on following selection criteria- at least half a foot wide forehead, large tusks, long tail, strong legs, short belly button and agility.

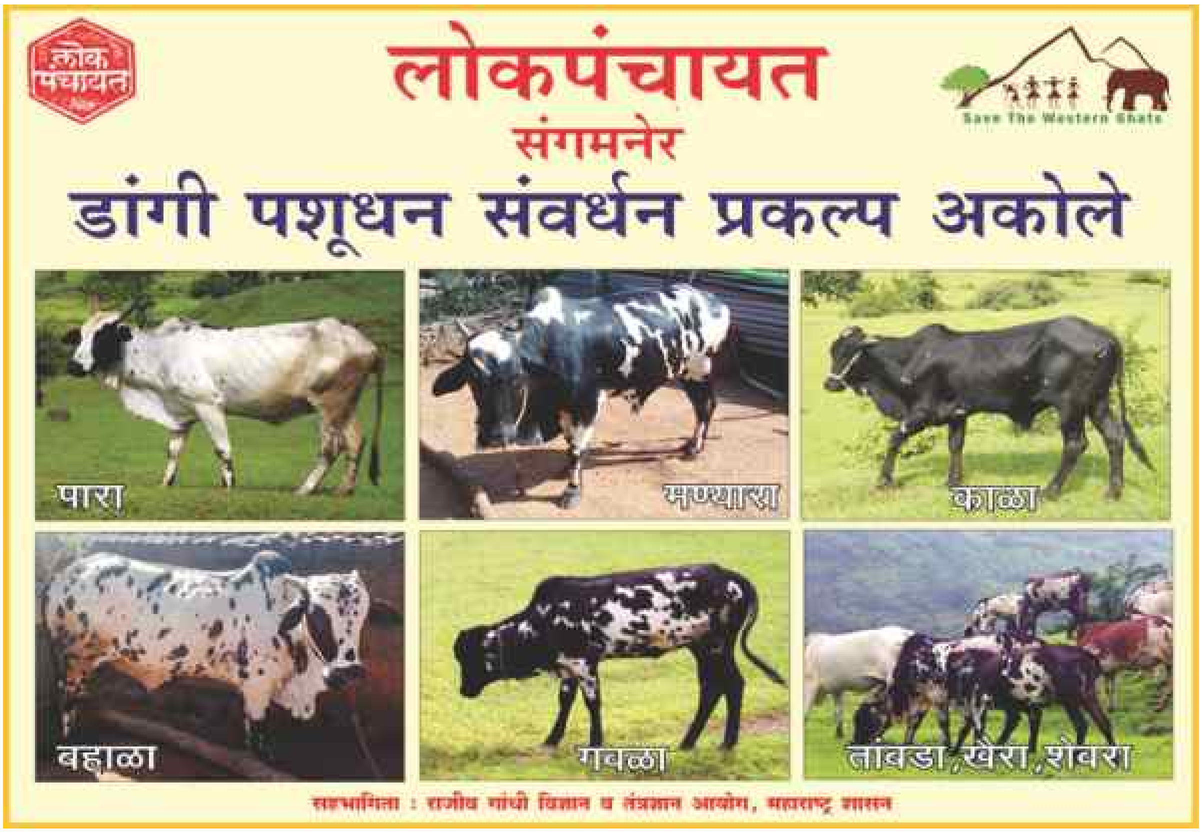
List of community identified cattle strains

Sr No	Dangi strain	Description
1	Bahala	Big black dots on white skin.
2	Manyara	White dots on black.
3	Wanera	Face shape as like monkey
4	Khaira	Red dots on white
5	Tambada	Total body red colour
6	Para	Small black dots on white skin.
7	Gavla	Small white dots on black skin
8	Kala	Total body is black
9	Masuri cow	Small black dots on white.

Relevance of history in conservation practices

Bombay Veterinary College was started in 1886 to maintain pure breed and promoting research. In 1946 Dangi Research Station was formed in Igatpuri in Nashik district. Fundamental work was initiated through this research station. Production of pure service bull, fodder demonstration, research for diagnosis of various diseases etc. were done through the station. Farmers training centre and cattle breeding activity are continued.

In 1979 this station was transferred to Mahatma Phule Agriculture University and later to Maharashtra Animal husbandry and Fishery Science University, Nagpur.



Economics of breeds: Mahadev Koli and Thakar tribal community live in the area of the Lok Panchayat's conservation work of Dangi cattle. Among them, Mahadev Koli community is traditional cattle-grazer. According to the elderly, Mahadev Koli migrated from Bhimashankar area to Chalisgaon Dangan region with their animals. Along with the rearing of the cattle, small and large farming was started. They can be called Agro-pastoral community. Dangi animals are the mainstay of the livelihood of this tribal community. Only Dangi are useful for cultivating the paddy field on the hill slopes. Knowledge of rearing these bulls and bull breeding skills are developed in tribals. Sale of bulls can yield at least Rs. 20,000 to Rs. 50,000 to the family. Lokpanchayat conducted a sample survey of 125 Dangi foster families in 18 villages. According to this, 33% of the households said that they cultivate Dangi for farming and cow dung manure purposes. 11% domesticate Dangi for sale. The remaining 41% said that they domesticate Dangi for its sturdiness to survive in the hills and heavy rains. Rajur is nearby market place for sale of Dangi milk and Khawa. The Kandi pedha (milk sweet) of Rajur is famous. This is one of the important economic factors for breeders. After rainy season, abundant water and forest fodder can be purchased at low cost. Only three months of summer season are troublesome. Overall, cattle's rearing was affordable in the larger joint family system. If the family is small, it is not possible to take care of large numbers of Dangi herds. Due to agriculture and other engagements, a small family of 3-5 people cannot domesticate the herds.

Threats to certain breeds: disease

Diseases of Dangi breed

1. Black Quarter: This disease, caused by anaerobic bacterium, *Clostridium chauvoei* especially occurs at the onset of monsoon. Symptoms are high fever, swelling of leg and fleshy area, and black watery discharge from broken wounds.

2. Foot and Mouth Disease: It is an infectious disease. This disease is seen during weather changes occurring before winter and summer. Sticky saliva drooling; White sores appear on the gums, mouth, nose, tongue and on breast. Wounds in the hooves of animals. Abortion may occur in pregnant cows.

3. **Diarrhea:** During the rainy days, the disease is caused by infected fodder and water. Fever, thin bloody diarrhea, filthy secretions through nasal passages, non-tolerance to light-these are the main symptoms of this illness.

4. **Anthrax:** This disease occurs in extreme rains and drought conditions. Symptoms are high fever, shortness of breath, tremors, weight loss, bleeding from nostrils when the animal dies.

Along with the aforementioned diseases, snake and dog bites are a threat to the survival of animals. Most of these diseases have preventive vaccines available.

Fodder species and their nutritive values

About 200 fodder plants have been reported from the wild fodder study. Out of which 51 types of grasses were also documented. From the cattle grazer's perspective, *Cacia torta, Meytenus rothiana, Carvia callosa*, Hooda bamboo, *Oxytenanthera monostigma* are useful as booster types. The research for nutritional value of selective fodder is in progress.

(ref. Annexure 2: species list)

List of Publications

1. Published a research paper named " Unfolding the "Rakhan Raan" – A livelihood based conservation tradition of tribals around Kalsubai Harishchandragad Wild Sanctuary, Journal of Ecological Society.

2. A small report on the Carbon Sequestration of the *Rakhanraan* has been prepared.

Networking with other MGBP groups

Networking with other organizations of Maharashtra Gene Bank and their experience in the work definitely benefited us. BAIF Institute in particular has a long history of experience in Livestock. The artificial insemination methods of the cattle and the papers they published were used in our ground level work. The people's participation of Lamkani village in the area of Vasudha organization of Dhule, inspired us.

Lok Panchayat has decided to stay connected with the community working on local crop varieties, livestock and fodder development in future. The academic knowledge and skills related to the work involved are important. Experienced organizations and experts will help with methods to use when working with local people.

Outreach

Connection with people beyond beneficiaries

While working on the Dangi conservation, there was a close association with various organizations and individuals working on the topic of local livestock. From the Dangi Research Center of Igatpuri to experts and students from veterinary colleges were contacted. Various issues were discussed. The new generation Dangi keeper Sayaji Aswale, Kumshet and Vijay Sambre gave concrete suggestions on 'what measures should be taken to save the Dangi' at the government at the Deshi Govansh Parishad in Nagpur.

People and organizations working on domestic livestock outside Maharashtra also met. Kangayam in Tamil Nadu, activist-researcher working on the Toda buffaloes in Nilgiris, Ilse and Hanumant Singh, who worked on camels in Rajasthan and Gujarat. Vijay Sambre of the Lok Panchayat participated in the write shop to write book on the Guideline for Community Bio-cultural Protocol.

Stories emerged

a) Rakhanaran is a story about a community conserved area (CCA) (Annexure 3).


GREEN COVER DRIVE

Pune ready to take a leaf out of tribal model of conserving grasslands

Raakhan Raan, grassy patches of land treated as sacred groves in Ahmednagar district, impresses Pune's forest officials

ANURADHA MASCARENHAS

Villagers and forest officials at Raakhan Raan

The Indian EXPRESS

b) Realizations about human nature/ human- nature relationship

While working on conservation of Dangi, there were some new realizations of human and nature bio-cultural relationship. On the main festival of Dangi- *'Pola'*- bull is decorated. On this day they are adorned with the name of '*Navardev*' (New bridegroom). Roots of fig tree are mashed and its color is applied to bulls. It is called *'Chavar'* in local language. It has special significance. Dangi keepers are aware of the medicinal properties of the fodder types present in the area. For example, if weak cattle is fed Liana leaves for eight-days, it becomes healthy. Karavi (*Carvia callosa*) flowers once in seven years and its pods and sweet and intoxicant. The locals call them ***'karvicha kaif'***. They believe that after consuming these pods, Dangi strength lasts for the next seven years. Milching cows fed with yellow colored wild flower locally known as *Baraki* (*Smithia purpurea)* plants, their milk has a yellowish color, ghee also looks more yellow. Same is experienced when cattle is fed on blue flower plants. The tradition of using various herbal medicines for the disease of Dangi is still observed today. According to a sample survey of 2014-15, 83% of cattle grazers seek treatment from local *Vaidu* (healers) for their cattle.

c) Observations about ecology- regeneration/ depletion/ conservation

Dangi is a native cattle breed with strong hooves and oily skin and got established for many generations in the high rainfall mountainous region of North Sahyadri (Pune, Ahmednagar, Thane, Nashik and Dang district in Gujarat). Mainly Mahadev Koli, Thakar and other livestock farmers keep Dangi. Semi evergreen to dry deciduous forest and grassy strips are useful for grazing animals. For the past 2-3 years, the practice of keeping the pasture for the protection of fodder has been customary. Due to this, a large number of grasslands are being conserved. The Chalisgaon Dangan in the Akole taluka hosts cattle in the hill caves in the Harishchandragad-Kalsubai belt during monsoon. It helps protect against cold storms and colds. In the rainy season, the cave deposits alkaline salts on the stone, cattle lick these salts and deficiencies are reduced.

Impact on community

- Dangi keeper's families spontaneously participated in all activities.
- Awareness regarding primary treatment, preventive mechanism like vaccination has been started through our intervention.
- Keepers are ready to use Artificial Insemination
- Keepers understood importance of livestock insurance scheme run by state government.
- Village level para vet / AHW known as Dangi Mitra playing a key role in health and allied issues.

Impact on academic circle

Through the Maharashtra Gene Bank program, Lok Panchayat is implementing an action research project for conservation of Dangi cattle in Akole taluka. This project could be attributed to the fact that in the last five years, the Dangi population was reduced rapidly in selected five villages. In a remote village, the animals got sick and if there was infectious disease, there was no timely treatment. Due to lack of fodder, inadequate and impure water, non-vaccination, animals here are constantly getting sick. The Lok Panchayat team tried to find a solution to the problem. For this, the Animal Husbandry Department of the Government of Maharashtra, Dangi Research Center at Igatpuri, Veterinary Colleges at Paral and Shirwal, MAFASU, Nagpur; and the BAIF Institute were contacted. Due to this, various mechanisms could be reached regarding the problem of canoe rearing in the most remote areas of Sahyadri. A team from Shirval Veterinary College was sent to Akole and work on the disease started.

Impact on policy level interventions

Maharashtra Government's policy "Anonymous, 2006. Livestock Policy of Maharashtra-2006. GR No.LVS 102003/CR-467/ADF-4, Commissioner of Animal Husbandry, Government of Maharashtra, 17 July 2006." of maintaining livestock is good, but there is a lack of coordination between the concerned departments and the system and various programs are not implemented till village and hamlets. The project provides an opportunity to reduce the gap between local Dangi keepers and the related governing body.

Failure stories

1) Artificial insemination facility was started as a remedy to as the best bulls are not available on time in the village of Dangi Conservation Project. Artificial insemination has started for the last two years. Although local Dangi keepers have little faith in technology, we have continued to experiment. But after the artificial insemination of the cows, herds goes to open grazing area and service bull from other flock can mate with the artifically inseminated cows. Therefore, it seems that

there are many limitations on artificial insemination in flock herds.

2) Fodder management is important in cattle breeding. So efforts began at that point. We demonstrated some grass types on fields and farm bunds and discussed with local Dangi keepers. In Pachanai, Kumshet, Dhamnvan villages we experimented with planting grasses and horticultural farming in the forest. Napier grass did not survive here because of scarcity of water in summer. On

the contrary, the local *Ghona* grass harvested from the high hills survived. Efforts to germinate the grass seeds on a plot were unsuccessful.

3) Policy advocacy process could not go forward properly. Policy / Advocacy is a collective process. Any single NGO or person could not do it effectively. Hence if all partners of MGB initiate the policy advocacy process collectively and frequently, there should be a possibility of some change.

Way forward

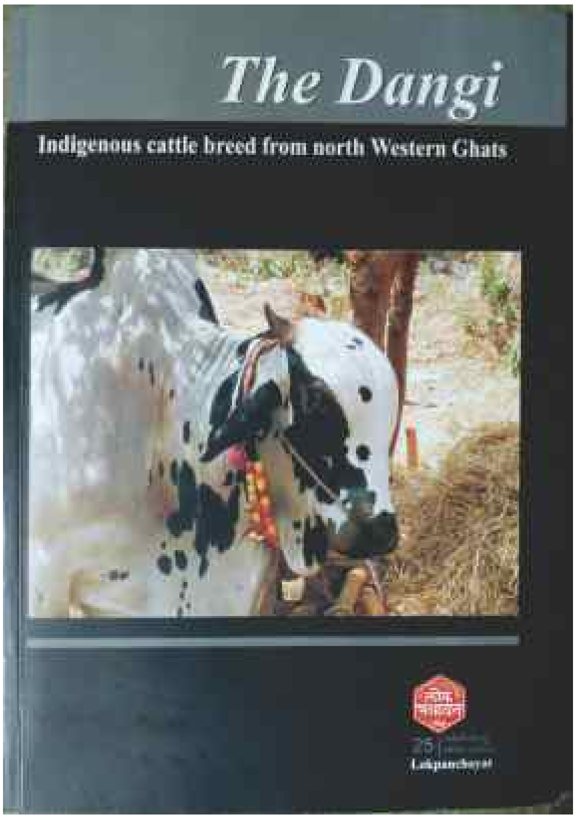
Concrete program for revitalizing Dangi System and developing pure line of Dangi breed process should be continued in the working area.

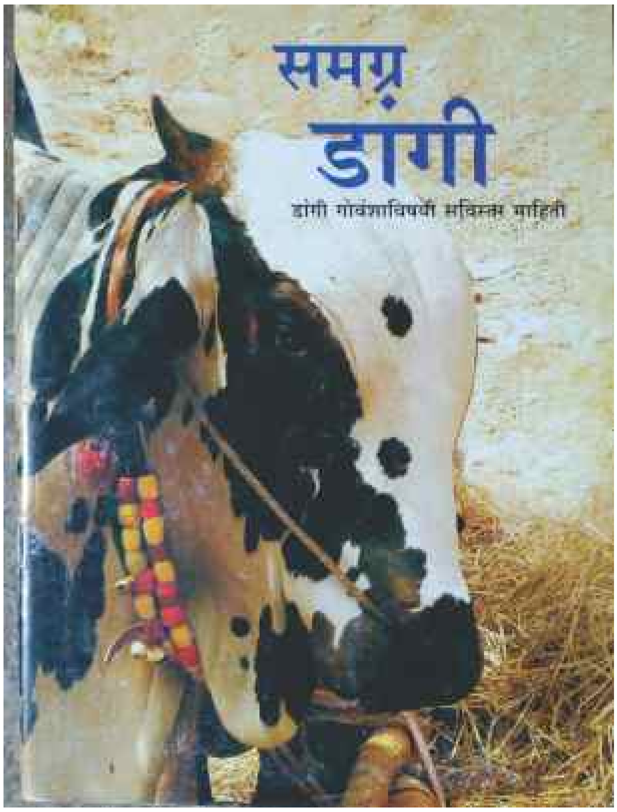
Dangi cattle conservation work was started through the MGB program. There was opportunity for work on the basics and the foundation was laid. At the village level, the path of research based conservation with local people has evolved. In order to strengthen the system, Lok Panchayat has decided to work with modern veterinary science and traditional knowledge. Considering the bio-cultural heritage related to Dangi cattle and developing community Bio-Cultural Protocol, this work will include six districts in North Sahyadri and Dangi keepers in at least 4 talukas.

List of staff involved in the project

Vijay Pralhad Sambare, Principal Investigator - He is working as a conservation practitioner in Agro-biodiversity and organic farming.

Dr. Pandurang Tukaram Khot, Co-Principal Investigator: He is veterinary doctor and engaged in community centric health practices.





Annexure 1

Study of Dangi cattle in Akole Block of Ahmednagar District, Maharashtra

Introduction

This report is a part of an action research project on in situ conservation of Dangi cattle breed being conducted in Akole block of Ahmednagar district in Maharashtra state. Dangi is one of the indigenous cattle breeds in India. Its native tract is in Nasik and Ahmednagar districts of Maharashtra and the Dangs district in Gujarat.

In this report we present some socio-economic aspects of Dangi cattle system in the project area consisting of 18 villages in Akole block of Ahmednagar district. This information was collected through questionnaire based survey. In the initial two sections of the report, basic information of Dangi breed and its native tract is provided. In the later sections, we present analysis of the primary information collected through the survey. The report concludes with discussion and future course of action in the project.

Rationale

Intrinsic Importance and Significance from Climate Change Point of View

Indigenous cattle breeds are evolved over millennia due to conscious efforts of livestock keepers and they are important for posterity in the wake of climate change. Crop production and livestock production are two important types of production systems in rural India. These systems have evolved over millennia in a given region depending on climate and land conditions of the region. High productive lands were utilized for crop production. In the regions with low productive lands, livestock dominant systems evolved. Keeping animals is a most efficient and economical way of utilizing these areas. Milching animals are important in conversion on agriculture waste and un-edible wild biomass into utilizable products. Thus cattle breeds found in these low productive regions have evolved over with mechanisms that provide them to survive and reproduce despite of harsh environmental conditions. These breeds are therefore less prone to physiological breakdown because of environmental stress.

Population of Indigenous Cattle Breeds Is Declining

It is reported that population of indigenous cattle breeds in India is declining over the year. An analysis of livestock Census Data of five decades (1960 to 2003) has shown that there was 15 percent drop in indigenous cattle population. More so the decline in male indigenous cattle was sharper than female indigenous cattle. The reasons for decline in indigenous cattle stocks in India are traced in increasing substitution of draught animals with mechanical power and low milk yield for these stocks of livestock.[1]

In the project area, over last 10 years, we have been hearing from local community that number of Dangi cattle is decreasing. In the past, two-three decades back, it was very common to find cattle keeper families with more than 20 Dangi cattle. Over last few years this has changed. Average number of cattle per family has drastically lowered to 2-3 per family. Local people attribute this noticeable change to reasons like change in family structure – from joint families to nuclear smaller families, increase in seasonal and permanent migration in search of employment to industrial or industrial agriculture areas, availability of technology and devices that substituted use of cattle.

A Brief Description of Dangi

Dangi is an indigenous cattle breed of Maharashtra and Gujarat.The name of the breed is supposed to be derived from local word *Dang* meaning hilly area with thick forests. Topographically native tract of Dangi is hilly area with thick forests. Therefore the breed is called 'Dangi'.

Native tract of Dangi breed is spread over four adjoining districts in Maharashtra state and one district in Gujarat State (Table 1).

Table 1: Native Tract of Dangi Cattle

SN	Taluka	District	State
1	Akole	Ahmednagar	Maharashtra
2	Igatpuri	Nasik	
3	Trimbak		
4	Peth		
5	Sinnar		
6	Surgana		
7	Jawhar	Palghar	
8	Mokhada		
9	Vada		
10	Vikramgad		
11	Shahapur	Thane	
12	Murbad	Thane	
13	Junnar	Pune	Maharashtra
14	Ahwa	The Dangs	Gujarat

[1]Shah, D. (2009). Evaluation of Five Decades of Livestock Development in Maharashtra and Threats and opportunities in WTO Regime. Agro-Economic Research Centre, Gokhale Institute of Politics and Economics, Pune, India.

Two States Six Districts Fourteen Blocks

Geography and Climate of Dangi Tract

The Dangi tract lies along the main range of the Western Ghats. The average elevation of Dangi tract is 500 to 1000 meter above mean sea level. It is an undulating terrain consisting of basalt as parent rock. It is a mosaic of basaltic plateaus devoid of any soil layer and patches of land with usually shallow soil layer. Average annual rainfall in Dangi tract is between 2000 and 3000 mm (minimum1000 mm and maximum 6000 mm[2]). The region experiences minimum temperature as low as 7°C in winter and maximum temperature around 39°C. Colour of the soil in this region varies from black to grey. It is susceptible to erosion. The soils are slightly acidic to neutral in reaction.

Distinct Characters of Dangi[3]

Dangi cattle are primarily medium-slow draft animals. They are known for their quality to work in challenging conditions like heavy rainfall, in the rice fields and hilly tracts. They are hardy animals. They subsist mostly on grazing[4].

Dangi cattle have distinct white coat colour with red or black spots distributed unevenly over the body[5]. Horns are short (12-15 cm) and thick with lateral pointing tips. Forehead is slightly protruding. General characteristics and types of Dangi cattle are mentioned below (Table 2 and Table 3)

Table 2: Characteristics of Dangi cattle

SN	Particulars	Male	Female
1	Average Height (cm)	117	113
2	Average Body Length (cm)	129	122
3	Average Weight (kg)	317	228
4	Average Birth Weight (kg)	18.2	16.8

To describe different types of Dangi cattle individuals, in Akole taluka of Ahmednagar district of Maharashtra, following terminology is used (Table 3[6]). According to this terminology there are seven types. *Para* type male having complete white colour with few black spots is more valuable among all.

Table 3: Types of Dangi cattle

SN	Type	Description
1	Para	Complete white colour with few black spots
2	Bahala	Combination of white and black colour
3	Pandharabahala	White colour prominent
4	Kala bahala	Black colour prominent
5	Maneri	Complete black with very few white spots
6	Lal	Red colour prominent with very few white spots
7	Lalbahala	Combination of red and white

Suitability of Dangi Cattle as Explained by Local DangiKeepers

Dangi is the most suitable breed in this tract. Its short size provides for maneuverability while working in the small sized terraced fields on the hill slopes. The hooves of the breed are tougher than other cattle. Tougher hooves are important for cattle used in paddy

[2]http://ahmednagar.nic.in/gazetteer/gen_geography.html

[3]Executive Summary of the Final Report of the Network Project on Survey, Evaluation and Characterisation of Dangi cattle breed, BAIF, Pune. (Undated)

[4]http://bvc.org.in/?page_id=1343

[5]http://www.nbagr.res.in/(Online database of descriptors of various livestock breeds http://210.212.93.85/agris/brid Description.aspx)

[6]Executive Summary of the Final Report of the Network Project on Survey, Evaluation and Characterisation of Dangi cattle breed, BAIF, Pune. (Undated)

cultivation. The animals remain in water for considerable time during paddy cultivation which makes them prone to hoof damage. Another peculiarity of *Dangi* breed is, its skin is dotted with oil glands. This is important in high rainfall region. During rainy season and in winter, it is often cold and chilly. Secretion of oil glands saves Dangi cattle from cold and chill. Most important is common experience of the livestock keepers that cattle other than Dangi hardly survive in the hilly region.

Objectives of the Study

The project on in situ conservation of Dangi is mainly about participation of local Dangi keepers in the breed conservation. The project would build on introducing appropriate adaptations and changes in the existing practices of the cattle keepers. Therefore it is important to know the existing practices. Two major objectives of this study were,

- To know major livelihood activities of the Dangi keepers in the project area
- To understand common practices of Dangi keepers like feeding of cattle, housing of cattle and veterinary practices.

Methodology

The primary data were collected through a household level survey conducted in August 2009 in 18 villages in Akole block. These villages constitute intervention area of Lokpanchayat. The in situ conservation of *Dangi* breed is being carried out in these villages. Each village has a village level volunteer. These volunteers conducted household level questionnaire based survey. The number of households interviewed in a village was approximately 5% of the total number of householdsas per the Census 2001. The survey questionnaire was prepared with help of village level volunteers and *Dangi* keepers. Before the questionnaire preparation, three focus group discussions with*Dangi* keepers from the project villages were conducted. The questionnaire was in Marathi (Annexure I). It covered aspects like economic situation of the respondent households, number of *Dangi* cattle and various practices, daily chores and processes followed in *Dangi* rearing.

The secondary data consisted of information collected from online sources like population information of census 2001 from the Census of India website, livestock census information from Government of India's Agriculture Ministry's website ec.

Project Area

The project area consists of 18 villages in western part of Akole block (Figure 1). These villages are situated on the ridge of Western Ghats. It is an undulating terrain with lateritic plateaus interspersed with land patches of shallow soil layer. These patches and the hill slopes with shallow soil layer are cultivated by the villagers. Average annual rainfall in the study region is more than 3000 mm. The study region has infrequent patches of semi-evergreen forest and moist deciduous forests. The project villages are part of scheduled area in Ahmednagar district.

Traditional occupations of most of the households in the project area are agriculture, collection and sale non-timber forest produce and Dangi rearing. In the last two-three decades, seasonal migration to adjoining area in the plains to work as casual labour in tomato cultivation or floriculture or grape farms has come up as an income generation option

Figure 1: Project Area in Akole Block of Ahmednagar District

Figure 2:Topography of the project area

Discussion

Population

All project villages are tribal villages. Scheduled Tribe population in these villages, except one, is 90% or more of the total population. Majority of the population in the project villages belongs to Mahadev Koli tribe.

As per Census 2001, minimum total population in a project village is 271 and the maximum is 1695. Number of households in the project villages ranges between 56 and 286. Average number of females per thousand males in the project villages is 959.

Table 4: Population in the Project Villages

SN	Village	Number of Households	Population	ST Population	% of population	Male	Female	Number of females per 1000 males
1	Samrad	106	597	550	92	312	285	913
2	Ratanwadi	167	972	941	97	480	492	1025
3	Dhamanvan	221	1353	1286	95	674	679	1007
4	Shirpunje Bk.	219	1383	1323	96	716	667	932
5	Koltembhe	88	429	427	100	219	210	959
6	Kumshet	107	631	613	97	296	335	1132
7	Shirpunje Kh.	56	271	270	100	129	142	1101
8	Shiswad	140	710	679	96	340	370	1088
9	Ambit	120	702	530	75	360	342	950
10	Pachanai	108	514	514	100	236	278	1178
11	Wagdari	130	553	516	93	266	287	1079
12	Lavhali Kotul	71	478	454	95	248	230	927
13	Lavhali Otur	86	506	401	79	291	215	739
14	Kothale	98	632	608	96	319	313	981
15	Palsunde	214	1249	1160	93	618	631	1021
16	Phophasandi	130	635	615	97	309	326	1055
17	Umbarwadi	57	307	301	98	157	150	955
18	Satewadi	286	1695	1614	95	845	850	1006

Table 5: Minimum and Maximum Population in the Project Villages

	Number of Households	Population	Average number of persons in a households	Number of females per 1000 males
Minimum	56	271	5	739
Maximum	286	1695	6	1178
Mean	171	983		959

Number of Family Members in a Household

A common saying in the study region is that number of family members is decisive in number of cattle maintained by a household. Joint families with three generations staying together were common in the study region in the recent past. However, in the study region, local people often say that joint family system is gradually disintegrating. Our survey of 126 households in 18 villages revealed that75% of the respondent households have 6 or less family members. In a way our survey corroborates reduced family size.

Table 6: Family Size in the Project Villages

SN	Number of family members in a HH	Number of HHs	% of total HHs surveyed
1	1	1	1
2	2	13	10
3	3	22	17
4	4	21	17
5	5	23	18
6	6	17	13
7	7	11	9
8	8	7	6
9	9	6	5
10	10	5	4
	Total	126	100

Landuse

Umbarwadi has smallest (241 H) while Kumshet has largest (3028 H) total geographic area among the project villages. It is observed that 12 out of 18 project villages have 30% or more of the total geographic area of the village as forest area. The forest area is not necessarily under tree cover. It is the area under ownership of the state forest department.

Three villages namely, Shirpunje Kh., Pachnai and Kumshet have more than 80% of total geographic area under forest. Satewadi and Umbarwadi do not have any forest area.

In case of cultivable area in the project villages, five out of 18 have 70% or more of total geographic area under cultivation. Satewadi and Umbarwadi have more than 80% of their total geographic area under cultivation. 10 out of 18 villages have 50% or less of total geographic area under cultivation.

Table 7: Land use in the Project Villages

SN	Village	Geographic Area (GA) (H)[7]	Forest (H)	% of GA	Cultivable area (H)[8]	% of GA	Area not available for culti. (H)[9]	% of GA
1	Samrad	1841	1345	73.06	436	23.68	60	3.26
2	Ratanwadi	1776	715	40.26	587	33.05	474	26.69
3	Dhamanvan	619	99	15.99	499	80.61	21	3.39
4	Shirpunje Bk.	1154	424	36.74	669	57.97	61	5.29
5	Koltembhe	1290	742	57.52	439	34.03	109	8.45
6	Kumshet	3028	2689	88.80	333	11.00	6	0.20
7	Shirpunje Kh.	1116	936	83.87	162	14.52	18	1.61
8	Shiswad	622	75	12.06	507	81.51	40	6.43
9	Ambit	870	420	48.28	408	46.90	42	4.83
10	Pachanai	2558	2193	85.73	337	13.17	28	1.09
11	Wagdari	428	52	12.15	345	80.61	31	7.24
12	LavhaliKotul	1140	855	75.00	228	20.00	57	5.00
13	LavhaliOtur	443	165	37.25	241	54.40	25	5.64
14	Kothale	802	578	72.07	214	26.68	10	1.25
15	Palsunde	879	166	18.89	626	71.22	87	9.90
16	Phophasandi	1534	996	64.93	465	30.31	73	4.76
17	Umbarwadi	241	6	2.49	224	92.95	11	4.56
18	Satewadi	838	0	0.00	702	83.77	136	16.23

[7] Census 2001
[8] ibid
[9] Op.cit.: Census 2001

Occupation

Agriculture is a main occupation in the project area. Dangi rearing, collection of forest produce and working as casual labour, especially in the summer season are other important occupations in the project area.

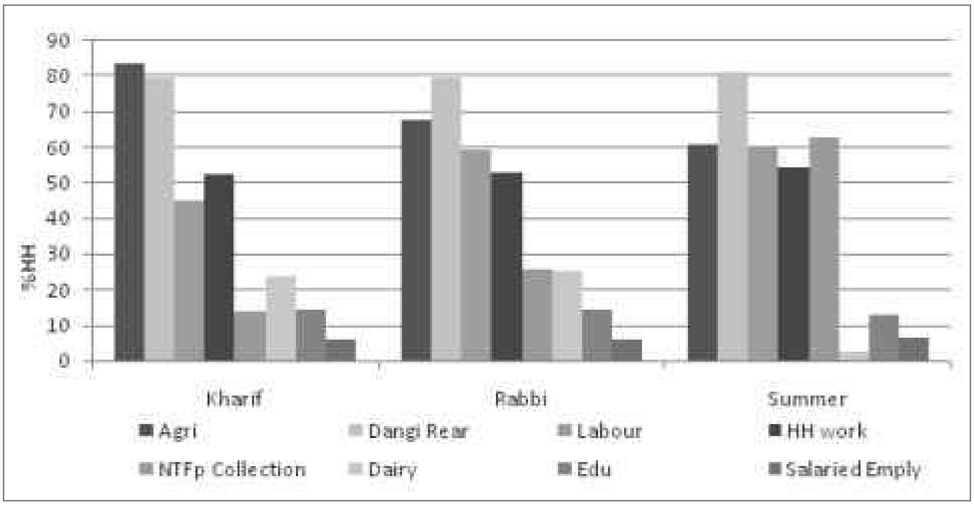


Figure 3: Main Occupations in the Project Villages

Milk production is a significant occupation in Kharif and Rabbi season, perhaps due to ample availability of natural fodder. Around 5% respondents households have a member or two in salaried employment. Education is also reported to be a major occupation.

In case of agriculture, as we will see in the following section, it is mostly rainfed. It is a common practice in the project area to cultivate wheat and chickpea in the harvested paddy fields. These rabbi crops, mostly opportunistic, grow on the natural humus left over in the land. Some farmers have a short term irrigation facility lasting up to 8 months.

Dangi rearing as a significant occupation is reported by 80% respondents. Casual labour is also reported to be a major occupation by more than 50% households. Collection of forest produce is also a significant occupation, especially in summer season.

Seasonal variation is noticeable in collection of forest produce. It peaks in summer due to paucity of other income generation activities and reasonable availability of saleable forest produce like Hirda (Indian Myrabolan) (हिरडा).

Type of Cultivable Lands

In local terminology, there are four types of cultivation. They are, (a) cultivation in the land with some source of irrigation (बागायत), (b) cultivation in the rainfed land (जिरायत), (c) rainfed land on the plateau or hill slopes with shallow soil layer (माळ) and, (d) the cultivation on forest land (फॉरेस्ट).

In case of land with a source of irrigation, it Irrigation is not through canal but through well or percolation tank or natural pools. The irrigation in almost all cases is limited to 8 months, up to January at the most. Out of the total respondent households, only 42% have land with some irrigation source. Mostly such land holding is less than a hectare. These households cultivate wheat, chickpea and red gram after paddy harvesting.

Most of the land holders own rainfed land. Majority of them (77%) own not more than 2H land. 12% of the respondent households do not own any land while the same percentage of respondent households own more than 2H land.

In case of cultivation on the forest land, 57% of the total respondent households do not practice any cultivation on forest land. 24% practice it on the area less than 1H.

Table 8: Land with some source of irrigation

	Number of Households	%
Surveyed	126	
Data not available	17	
Data available	109	
Land without irrigation source	63	58

	Number of Households	%
Land with some source of irrigation		
< or = 1 H	36	33
> 1H and < or = 2 H	6	6
> 2 H and < or = 3 H	1	1
> 3 H and < or = 4 H	1	1
> 4 H and < or = 5 H	0	0
> 5 H and < or = 6 H	0	0
> 6 H	2	2

Table 9: Rain fed Land

	Number of Households	%
Surveyed	126	
Data not available	17	
Data available	109	
Without any rainfed land	13	12
Own rainfed land		
< or = 1 H	50	46
> 1H and < or = 2 H	34	31
> 2 H and < or = 3 H	6	6
> 3 H and < or = 4 H	3	3
> 4 H and < or = 5 H	1	1
> 5 H and < or = 6 H	0	0
> 6 H	2	2

Table 10: Cultivation on forest land

	Number of Households	%
Surveyed	126	
Data not available	17	
Data available	109	
Not practicing cultivation on forest land	62	57
Practicing cultivation on forest land		
< or = 1 H	26	24
> 1H and < or = 2 H	12	11
> 2 H and < or = 3 H	3	3
> 3 H and < or = 4 H	0	0
> 4 H and < or = 5 H	1	1
> 5 H and < or = 6 H	0	0
> 6 H	5	5

Cultivation Season

More than 70% of respondent households mentioned that they cultivate in both, kharif and rabi season. However in Summer, 91% households reported that cultivation is not possible. It corroborates with the observation in the earlier section that rainfed kharif cultivation and rabi cultivation based on seasonal natural irrigation sources are the mainstay of households in the study region.

Table 11: Number of crops cultivated in a year

Number of crops cultivated	Kharif	%	Rabi	%	Summer	%
0	1	0.79	32	25.40	115	91.27
1	23	18.25	8	6.35	6	4.76
2	15	11.90	17	13.49	5	3.97
3	22	17.46	32	25.40	0	0.00
4	45	35.71	27	21.43	0	0.00
5	16	12.70	7	5.56	0	0.00
6	4	3.17	3	2.38	0	0.00
more than 6	0	0.00	0	0.00	0	0.00

Major Crops

It is important to note that in both cultivation seasons, 70% households practice multi cropping. In Kharif, mostly 4 crops are cultivated whereas in Rabi, 3 crops are cultivated. The rabi season crops dependent on soil moisture than on the irrigation source.

Table 12: Major Crops

Season	Crop	Surveyed HH	DNA	Y	%
Kharif	Bhat	126	1	125	100
	Nachani	126	1	89	71.2
	Warai	126	1	91	72.8
	Khurasani	126	1	67	53.6
	Udid	126	1	17	13.6
	Kulith	126	1	13	10.4
	Other	126	5	1	0.83
Rabi	Gahu	126	1	85	68
	Harbara	126	1	79	63.2
	Wal	126	1	74	59.2
	Watana	126	1	14	11.2
	Chavali	126	1	7	5.6
	Masur	126	1	39	31.2
	Other	126	1	1	0.8
Summer	Bhuimug	126	1	8	6.4
	Jwari	126	1	1	0.8
	Bajari	126	2	7	5.69
	Other	126	2	0	0

Reasons for Dangi Rearing

In the Focus Group Discussions conducted before the survey, local people had explained seven main reasons for Dangi rearing. Out of these, four are direct utility - dung, milk, bullock for sale and suit climate. The last refers to Dangi as most suitable draft animal as compared to cattle brought from outside the Dangi region.

Table 13: Reasons for Dangi Rearing

	Number of HH	%
Surveyed	126	
Data Not available	4	
Data Available	122	
Reasons for Dangi rearing		
Dung	40	33
Religious	0	0
Milk and dairy	2	2
Hobby	2	2
Tradition	13	11
Bullock for sale	15	12
Suits the climate	50	41

Three are cultural - hobby, tradition and religious. Climate suitability and dung seem to the most preferred reasons for Dangi rearing. More than 70% respondents mentioned them as the preferred reasons. It is very clear that milk is not an important consideration for Dangi rearing.

Number of Cattle in the Households

As far as total number of cattle in the households is concerned, 52% have 10 or less. Almost a third (37%) of the total number of households surveyed has more than 10 cattle. It is interesting to note that 10% households have more than 20 cattle. In case of bullocks, none of the households have more than 5 whereas in case of cows, the maximum number is 15. In case of calves, like bullocks, 83% households do not have more than 5 calves.

Table 14: Number of cattle in the households

Number of cattle in a HH	Number of HHs having							
	Total Cattle	**%**	**Cow**	**%**	**Bullock**	**%**	**Calves**	**%**
0	3	2	2	2	15	12	6	5
1	0	0	12	10	7	6	22	18
2	1	1	17	14	75	60	27	22
3	6	5	11	9	8	6	25	20
4	12	10	14	11	11	9	19	15
5	5	4	10	8	0	0	8	6
6 to 10	42	34	27	22	0	0	11	9
11 to 15	24	19	24	19	0	0	3	2
16 to 20	23	19	3	2	0	0	0	0
21 to 25	4	3	0	0	0	0	0	0
26 to 30	2	2	2	2	0	0	0	0
31 to 35	1	1	1	1	0	0	0	0
36 to 40	1	1	0	0	0	0	0	0
41 to 45	2	2	0	0	0	0	0	0
More than 45	1	1	1	1	0	0	0	0

Crops as Fodder

Almost all major crops are used as fodder for the cattle. Bhat, Nachani, Wari of Kharif and Gahu, Wal and Harbara of Rabi are used as fodder. For *in-situ* conservation of Dangi, it is important to study existent practices of fodder use, storage and scope for improvement.

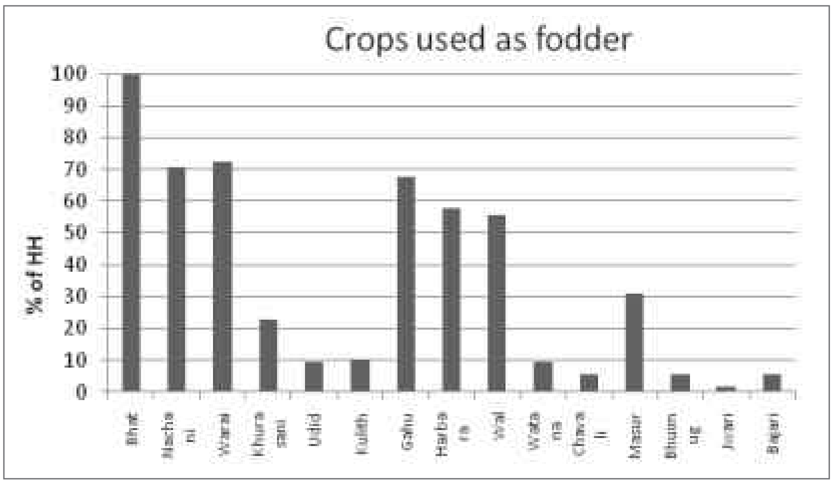


Figure 4: Crops used as fodder

Area of Cattle Shed

In local terminology, the area is explained in a unit called *Khan*(खण).A Khan equals approximately 5 feet length. In the study region, 70% respondents have cattle shed not exceeding 3 *Khan*. Most common size of the cattle shed is 3 to 5 *Khan.* Usually breadth is 4 or 5 feet and height is around 5 to 6 feet.

Table 15: Area of cattle shed

	Number of HH	%
Surveyed households	126	
Data not available	32	
Data available	94	
Area of cattle shed in *Khan*		
1	1	1
3	66	70
5	19	20
7	2	2
>7	1	1

Roofing of Cattle Shed

In the study region, in majority of cases roofing of cattle shed is not permanent. 55% respondents have thatched roofing on the cattle shed. This underlines direct dependence of the local people on the natural resources in the study region. 28 % have tiled roof whereas only 6% have tin roof. Significant proportion of (14%) respondents mentioned that there are not any separate cattle shed.

Table 16: Roofing of cattle shed

Particulars	Number of HH	%
Surveyed	126	
Data not available	4	
Data available	122	
Roofing of cattle shed		
Thatched	67	55
Tin	7	6
Mangalore tiles	34	28
Within house	14	11

Cleaning of Cattle Shed

Cleaning of cattle shed is mainly done by the women of the household. 52 % respondents mentioned it as a work for women. Only 2% mentioned that it is done by men. Interestingly 38% mentioned that it is done by both.

Watering of Cattle

There are four options of watering the cattle – at home (H), at public well in the village (W), water hole in the forest (F) and river or stream (R). River is the main watering source in all seasons. In summer, public well in the village is an important water source for cattle (40%).

Table 17: Watering of cattle

No. of HH	Summer	%	Rainy	%	Winter	%
Surveyed	126					
Data not available	103					
Data available	23					
Watering						
At home	18	17	1	1	1	1
At public well	41	40	0	0	6	6
In Forest	15	15	2	2	2	2
River	59	57	47	46	92	89

Frequency of Cleaning

In majority of households in the study region (59%), cleaning of cattle is done once in a month. 37% households mentioned that it is done once in a week.

Disease and Injury

In case of disease or injury to the cattle, majority of households (83%) rely on local healer or treating within the household. Only 16% mentioned that they approach government veterinary facility.

Table 18: Disease and Injury

	Number of Households	%
Surveyed	126	
DA	122	
DNA	4	
Disease or injury is dealt by		
Govt Vet	20	16
Local Healer	53	43
Within HH	49	40

Vaccination

Out of the total respondent households, 56% vaccinate the cattle regularly whereas 44% respondents mentioned they do not vaccinate regularly.

Summary

The National Livestock Policy as well as Maharashtra State Livestock Policy explicitly mentionthe need to conserve indigenous cattle breeds. These breeds are the result of meticulous efforts of the cattle keepers over several generations. Apart from their intrinsic importance, these breeds are important in the context of climate change adaptation efforts. The indigenous breeds perform well in demanding conditions like severe rainfall or dryness and cope up well with conditions like reliance on open grazing and less nutritious feed.

Dangi cattle in Akole block is a kind of identity of the local community in this area. None other cattle breed could survive in this heavy rainfall region. In the past, the local community was characterized by inaccessibility and isolation due to difficult terrain. Major occupations were rice and millets cultivation in the rainy season, cattle rearing and collection of forest produce. Over the time, due to some improvement in communication, especially all-weather roads, casual labour in neighbouring prosperous regions also developed as a major occupation. As of now, increase in population, nucleation of families and out migration have resulted in decrease in man power needed to look after the cattle. Consequently number of Dangi cattle per family has decreased. Senior members of local community shared that decrease in number of cattle in the household in the village is striking. Our in situ conservation project is conceived on this background.

In this preliminary study, information was collected on certain socio-economic aspect of Dangi keeper households in the project villages. Majority of the households are engaged in rain fed rice cultivation as the main occupation. Other occupations include forest produce collection and seasonal migration in summer to other areas. Reason for Dangi rearing, as shared by the respondents, were suitability and as a source of dung that serves as domestic energy source (dung cake) and also as source of manure. In the past the number of cattle per household was more due to less penetration of mechanical energy sources for irrigation (diesel engine and electric motor) and for tilling (tractor or power tiller). Similarly up to late 90s penetration of chemical fertilizers was very negligible. In such a situation, traction power of cattle was important. At the same time the cattle were valued as a source of dung.

Decline in the number of cattle per household and in general number of Dangi cattle in the project villages is a combined effect of a mix of root causes discussed above. For in situ conservation of Dangi cattle it is therefore necessary to take into these consideration the root causes. Project interventions have to planned on the basis of sound understanding of the existing socioeconomic condition of the cattle keepers in the project area. This study is an important contribution in this context.

The information collected in this survey on area of cattle shed, its roofing, cleaning, watering of cattle and veterinary health is quite revealing and important in planning household level interventions.

Annexure 2 List of fodder species

Sr	Botanical Name	Common Name	Families
1	*Carvia callosa*	Karav	Acanthaceae
2	*Pleocaulis Ritchie*	Gulai	Acanthaceae
3	*Cyanarospermum asperrimum*	Vikhara	Acanthaceae
4	*Lepidagathis clavata*	Akhra	Acanthaceae
5	*Rostellularia*		Acanthaceae
6	*Hygrophila seripyllum*	muthari, mathuri	Acanthaceae
7	*Cynarospermum asperimum*	Vikhara	Acanthaceae
8	*Justicia betonica*		Acanthaceae
9	*Asystasia dalzelliana*	ran til	Acanthaceae
10	*Rungia pectinata*	Sarambol	Acanthaceae
11	*Hemigraphis latebrosa*		Acanthaceae
12	*Hemigraphis hirta (Vahl) T.Anderson*		Acanthaceae
13	*Rungia repens*		Acanthaceae
14	*Blepharis asperrima Nees*		Acanthaceae
15	*Eranthemum roseum*		Acanthaceae
16	*Amaranthus spinosus*		Amaranthaceae
17	*Alternanthera sessilis*		Amaranthaceae
18	*Celosia argentia*	kurdu	Amarnthaceae
19	*Amaranthus viridis*	Math	Amarnthaceae
20	*Crinum latifolium*		Amaryllidaceae
21	*Pimpinella adscendens Dalzell*		Apiaceae
22	*Carissa congesta Wight.*	Karvand	Apocynaceae
23	*Colocasia esculanta*		Areceae
24	*Ceropegia bulbosa*	khurpudi	Asclepediaceae
25	*Ceropegia oculata*	khurpudi	Asclepediaceae
26	*Bidens biternata*		Asteraceae
27	*Sonchus arvensis L*		Asteraceae
28	*Emilia sonchifolia (L.) DC.*		Asteraceae
29	*Ageratum conyzoides*	Vangya jharud	Asteraceae
30	*Ageratum houstianum*	Vangya jharud	Asteraceae
31	*Eclipta prostate*	maka	Asteraceae
32	*Lannea ???*	pathri	Asteraceae
33	*Conyza stricta*		Asteraceae
34	*Senecio bombayensis*	sonki	Asteraceae
35	*Senecio dalzellii*	sonki	Asteraceae
36	*Laggera alata*		Asteraceae
37	*Spilanthes paniculata*	akkalkadha	Asteraceae
38	*Tridax procumbens*		Asteraceae
39	*Gynura nitida*		Asteraceae

Sr	Botanical Name	Common Name	Families
40	*Gynura bicolor*		Asteraceae
41	*Tricholepis amplexcaulis*		Asteraceae
42	*Tricholepis radicans*		Asteraceae
43	*Sphaernthus indicus*	Mendhra	Asteraceae
44	*Pulicharia ??*		Asteraceae
45	*Bombax ceiba*	Kate Sawar	Bombicideae
46	*Cynoglossum malabaricum**	jhinjharti	Boraginaceae
47	*Paracaryum lambertianum*	jhinjharti	Boraginaceae
48	*Cordia dichotoma*	Bhokar	Boraginaceae
49	*Cardamine capitata*		Brassicaceae
50	*Cassia fistula L.*	bavha	Caesalpiniaceae
51	*Cassine glauca*	bhuskut	Caesalpiniaceae
52	*Cassia tora*		Caesalpiniaceae
53	*Bauhinia racemosa*		Caesalpiniaceae
54	*Bauhinia purpurea*		Caesalpiniaceae
55	*Tamarindus indica*	Chinch	Caesalpiniaceae
56	*Meytenus rothiana*	bhalvan	Celastraceae
57	*Terminalia chebula Retz.*	Hirad	Combretaceae
58	*Terminalia belirica*	Yela	Combretaceae
59	*Combretum ??*		Combretaceae
60	*Commelina benghalensis L.*	Keni	Commelinaceae
61	*Commelina hasskarlii C.B. Clarke*	Keni	Commelinaceae
62	*Commelina paleata Hassk.*	Keni	Commelinaceae
63	*Rivea laotica Oeststr.*	Phanji	Convolvulaceae
64	*Solena amplexicaulis*	gomet	Cucurbitaceae
65	*Trichosanthes tricuspidata*	indarwan	Cucurbitaceae
66	*Momordica dioica*	kartule	Cucurbitaceae
67	*Diplocyclos palmatus (L.) C. Jeffrey*		Cucurbitaceae
68	*Cyperus sp*		Cyperaceae
69	*Dioscorea pentaphylla*	chai	Dioscoreaceae
70	*Eleagnus conferta*	ambal	Elagnaceae
71	*Cajanus sericeus (Baker) Maesen*	rantur	Fabaceae
72	*Flemingia strobilfera*	Kanphuti	Fabaceae
73	*Crotolaria filipes*	undri	Fabaceae
74	*Vigna vexillata*	Hainda	Fabaceae
75	*Paracalyx scariosus*		Fabaceae
76	*Alysicarpus belgaumensis*		Fabaceae
77	*Desmodium trifolium*		Fabaceae
78	*Desmodium ritchei*	chichundri	Fabaceae
79	*Cullen corylifolia*		Fabaceae
80	*Vigna radiate*		Fabaceae

Sr	Botanical Name	Common Name	Families
81	*Crotolaria sp*	undri	Fabaceae
82	*Smithia purpurea*	barki	Fabaceae
83	*Smithia bigemina*	kaula	Fabaceae
84	*Geissaspis cristata*	satpuda	Fabaceae
85	*Teramnus mollis*		Fabaceae
86	*Crotolaria calycina*	Ghaturli	Fabaceae
87	*Zornia gibbosa Span.*		Fabaceae
88	*Crotalaria vestita Baker*	Choti ghaturi	Fabaceae
89	*Crotalaria triquetra Dalzell*	Mothi Ghaturli	Fabaceae
90	*Crotalaria vestita Baker*	Choti ghaturi	Fabaceae
91	*Exacum*		Gentianaceae
92	*Swertia densiflora*		Gentianaceae
93	*Hypoxis aurea Lour*	lahan bhugida, musal kand	Hypoxidaceae
94	*Anisomeles heyneana Benth.*		Lamiaceae
95	*Anisomeles indica (L.)*		Lamiaceae
96	*Careya arborea Roxb.*	Kumbha	Lecithydaceae
97	*Asparagus racemosus*	shatavari	Liliaceae
98	*Chlorophytum sp*	kolu	Liliaceae
99	*Chlorophytum glaucoides*		Liliaceae
100	*Iphegenia indica*		Liliaceae
101	*linum mysorensis*		Linaceae
102	*Woodfordia fruticosa Kurz*	Dhayti	Lythraceae
103	*Lagerstroemia parviflora Roxb.*	bondara	Lythraceae
104	*Sida acuta*	Chikna	Malvaceae
105	*Sida ovate*	Chikna	Malvaceae
106	*Sida rhombifolia*	Chikna	Malvaceae
107	*Acacia torta (Roxb.) Craib.*	sambrat	Mimosaceae
108	*Ficus Racemosa Linn*	Umbar	Moraceae
109	*Ensete superbum*	Kavdhar	Musaceae
110	*Jasminum malabaricum Wight*	Kusar	Oleaceae
111	*Plumbago zeylanicum*	Chitruk	Plumbaginaceae
112	*Striga asiatica*	agya	Orobanchaceae
113	*Sesamum orientale*	Ran til	Pedaliaceae
114	*Bridelia retusa (Linnaeus) A. Jussieu*	Ashind	Phyllanthaceae
115	*Phyllanthus emblica L.*	awalkanthi	Phyllanthaceae
116	*Flueggea leucopyrus Willd.*	kharmati	Phyllanthaceae
117	*Dendrocalamus stocksii*	velu	Poaceae
118	*Bambusa bambos*	kate kalak	Poaceae
119	*Digitaria longiflora*	बिलहा गवत	Poaceae
120	*Pseudanthistiria heteroclite*		Poaceae

Sr	Botanical Name	Common Name	Families
121	*Pennisetum pedicellatum*		Poaceae
122	*Chloris virgata*		Poaceae
123	*Apluda mutica*		Poaceae
124	*Mnesithea clarkei*		Poaceae
125	*Eulalia trispicata*		Poaceae
126	*Dichanthium oliganthum*	मोठी सुकळी	Poaceae
127	*Ischaemum sp*	रोहीडा	Poaceae
128	*Arthraxon lanceolatus var meeboldii*	तुरडा	Poaceae
129	*Eulalia fimbriata*		Poaceae
130	*Heteropogon ritchei*	कुसळी	Poaceae
131	*Oplismenus burmannii*	वेलगुंडी	Poaceae
132	*Heteropogon contortus*	कुसळी	Poaceae
133	*Themeda laxa*	काहांडळ	Poaceae
134	*Themeda tremula*	सुकव्या बेर	Poaceae
135	*Arundinella metzii*	कथुरी	Poaceae
136	*Ischaemum timorens*	तांबडकांडी	Poaceae
137	*Jansanella neglecta*	रान जोंधळा	Poaceae
138	*Eragrostis aspera*	मोठी कथुरी	Poaceae
139	*Paspalum scorbiculatum*	लहाना रोहीडा	Poaceae
140	*Sehima sulcatum*		Poaceae
141	*Arundinella pumila*	रान तुरी	Poaceae
142	*Ischaemum indicum var villosum*	बेर	Poaceae
143	*Ischaemum zeylanicolum*	बेर	Poaceae
144	*Elusine indica*	नागला	Poaceae
145	*Setaria pumila*	कोंढूळा, कोलवा	Poaceae
146	*Digitaria bicornis*		Poaceae
147	*Digitaria stricta*	नीळ	Poaceae
148	*Isachne swaminathanii*		Poaceae
149	*Arthraxon lanceolatus var lanceolatus*	तुरडा	Poaceae
150	*Ischaemum tumidum*	तांबड कांडी	Poaceae
151	*Jansanella graffithiana*	रान जोंधळा	Poaceae
152	*Tripogon filiformis Nees ex Steud. Pl. Glum.*		Poaceae
153	*Paspalum canarae var fimbriatum*		Poaceae
154	*Andropogon pumilus*	तांबड कांडी	Poaceae
155	*Digitaria abludens*		Poaceae
156	*Paspalum canarae var canarae*		Poaceae
157	*Themeda triandra*	काहंडळ	Poaceae
158	*Dichanthium annulatum*	मारवेल	Poaceae
159	*Ischaemum impressum*		Poaceae
160	*Ischaemum rugosum*		Poaceae

Sr	Botanical Name	Common Name	Families
161	*Ischaemum dalzellii*		Poaceae
162	*Glyphocloa forficulata*		Poaceae
163	*Digitaria ciliaris*		Poaceae
164	*Cyandon dactylon*	दुर्वा	Poaceae
165	*Arthraxon jubatus*		Poaceae
166	*Arthraxon hispidus*		Poaceae
167	*Un ID-1*	Kathuri	Poaceae
168	*Un ID-2*		Poaceae
169	*Anagallis arvensis. L.*		Primulaceae.
170	*Ziziphus rugosa Lam.*	Toran	Rhamnaceae
171	*Ziziphus glaberimma*	Ghat bor	Rhamnaceae
172	*Ventillago madraspatena*		Rhamnaceae
173	*Meyna laxiflora Robyns*	Alu	Rubiaceae
174	*Hymenodictyon obovatum Wall.*	Kadvai	Rubiaceae
175	*Pavetta crassicaulis*	aswali	Rubiaceae
176	*Tamilnadia uliginosa*		Rubiaceae
177	*Neanotis calycina*		Rubiaceae
178	*Hedyotis nagporensis*		Rubiaceae
179	*Flacourtia indica*	tambat	Salicaceae
180	*Schleichera oleosa*	koshimb	Sapindaceae
181	*Sopubia trifida*		Scrophulariaceae
182	*Striga densiflora*		Scrophulariaceae
183	*Torenia indica*		Scrophulariaceae
184	*Centranthera indica*	Undir kani	Scrophulariaceae
185	*Kixia*		Scrophulariaceae
186	*Buchnera hispida*		Scrophulariaceae
187	*Smilax zeylanica. L.*	tamboli	Smilacaceae
188	*Triumfetta rhomboidea Jacq.*	chikna	Tiliaceae
189	*Triumfetta sp*	chikna	Tiliaceae
190	*Grewia tilaefolia*	dhaman	Tiliaceae
191	*Chorchorus*	Chuchu	Tiliaceae
192	*Clerodendrum serratum (L.) Moon.*	bharang	Verbenaceae
193	*Ampelocissus latifolia (Roxb.) Planch.*	Ran draksh	Vitacae
194	*Cissus elongate*		Vitacae
195	*Cissus repens*	nandan vel	Vitacae
196	*Cissus repanda*		Vitacae
197	*Curcuma pseudomontana*	Raan Halad	Zingiberaceae
198	*Curcuma nilghiriensis*	Raan Halad	Zingiberaceae
199	*Lepidagathis cristata*	Bbhui gend	Acanthaceae
200	*Dendrocalamus strictus*	Manvel	Poaceae

Lokpanchayat | Dangi Livestock Conservation Project, Akole Year 2016-19

Result based Management report

Results	Baseline	Target Y1, Y2, Y3, Y4, Y5	Indicators	Data source	Collection method	Frequency
Output 1 : Participatory Research of Wild fodder Species	No any Wild Fodder study was conducted in the same field	Y2 - Wild Fodder Resorce Study completed	1. Study Report 2. Selected Fodder specie's nutritional testing Lab Report	Using References & Reporting	1) Quadract method 2)Survey 3) Field Survey	Yearly
Output 2: Trained group 15 Animal Health Worker (AHW) & 15 Women Dangi Keeper		Y-2 Training of AHW & selected women organized on the subject of First Aid for Dangi using traditinal & scientifical knowledge	1. Training report 2. Proceeding 3. Photo & VDO Recording	Using Preparation Module or Formula	Pre meeting & dialogue	Half yearly
Output 3 : Quality Fodder Demonstration		Y-2 Organized 5 demonstration in 5 cluster level	1. Fodder value addition demonstration model 2. Prcocess documentation	Using Preparation Module or Formula	Pre meeting & dialogue	Half yearly
		Y-3 Organized 5 demonstration in 5 clusterlevel village	1. Fodder value addition demonstration model 2. Prcocess documentation	Using Preparation Module or Formula	Pre meeting & dialogue	Half yearly
Output 4 : Exposure visit for capacity building		Y-2 Visit to Devani Local Breed Conservation work in Latur District	1. Visit Report with Photographs			Yearly
		Y-3 Visit to Karnataka & Kerla, where Vechur trust & Dr. Raviraj Udupa working	1. Visit Report with Photographs			Yearly
Output 5: Maintaining Pure Breed line of Dangi	Dangi Breed character documentation & Socio-Economic survey of Lokpanchayat	Y-2 Comparative study of Natural Insemination & Artificial Insemination	1. Profile of 20 conservator Dangi Keepers 2. Process Doccumentation	Reports	Meetings	Monthly
		Y-3 Comparative study of Natural Insemination & Artificial Insemination	as above	as above	as above	as above
		Y-4 Comparative study of Natural Insemination & Artificial Insemination	as above	as above	as above	as above
		Y-3 Developing Pure Breed Module	Developed Pure Breed module			

Results	Baseline	Target Y1, Y2, Y3, Y4, Y5	Indicators	Data source	Collection method	Frequency
Output 8: Awareness, Publication & Policy Advocacy		Y-2 Kala pathak & Street play of chaaligaav dangani Troup, Samagra Dangi....booklet, Calender, Brouchers published, Research Paper & Articles published in mainstream Journal, Newspaper, Magazines & in Electronic Media	1. Published Booklet, Articles & VDO clip etc 2. Photo Docu,emtation			Yearly
Year 2019: Outcome 1: Established Conservation Model of Dangi Cattle with the active participation of Dangi Keepers & create common understanding of Dangi system in selected 15 villages		Y-5	Established replicable model document	Reorts	Colloberated Reports	Yearly
Outcome 2: Using appropriate insemination (natural & artificial) Pure Dangi Breed maintained in selected viilages			Self sustained Artificial Insemination Centre established on block level	Colloberated Reports	Daily updates	Yearly
Outcome 3: Trained AHW will become champion related to Dangi Health issue			Profile of villagelevel AHW, Monitoring Report			Monthly
Outcome 4: Quality fodder will be created through Community Fodder Bank in 5 cluster villages & Keepers will be started better management of grazing land & also Rakhan Raan.			Wild Fodder Report, Process documentation of Fodder Bank		Meetings	Monthly
Outcome 5: Women centric entrepreneurship group (Dangi keeper group) formed in selected village			Product developed from Dangi Milk, Urine & Dung		Meetings	Monthly

Results	Baseline	Target Y1, Y2, Y3, Y4, Y5	Indicators	Data source	Collection method	Frequency
Outcome 6: Dangi livestock associated scientific documentation published in Marathi & English language			No.of Published documents in form of Hard & Soft copy			Yearly
Year 2025 Impact: Community lead Dangi Livestock conservation & sustainable livelihood model will become applicable, scalable in native Dangi track in North Western Ghats occupying 6 district in Maharashtra & Gujrat state.			Inclusion of Dangi Project experiences & laearning inthe policy of Local Breed Conservation	State Animal Husbandary Dept.		

Annexure 3 Report on Rakhanran

Digging into the relatively young livelihood based conservation tradition of Adivasis around Kalasubai Harishchandragad Wildlife Sanctuary in Akole block of Ahmednagar dist.

Introduction

26 villages mentioned below are considered as a part of Kalsubai Harishchandragad WLS. The population comprises of major tribal and minor scheduled caste communities. The tribal communities being Mahadev Koli and Thakar, are amongst the last communities conserving local breed of cattle, namely, 'Dangi'. Along with conserving important cattle diversity they also conserve forest and grasslands through traditions such as 'Sacred Groves-Devrai' and 'Raakhan Raan'.

'Raakhan Raan' is unique conservation tradition followed for improving availability of fodder during times of scarcity. This practice indirectly conserves and protects the much neglected grass species in semi-evergreen forest patches of KHWLS. This study is an effort to dig into this conservation tradition which has not been documented anywhere else in the Western Ghats *(P*

Methodology

A detailed questionnaire was developed with a view to understand the tradition of Raakhan Raan in relation to the various socio-cultural and occupational perspectives. This survey was undertaken in selected hamlets of the KHWLS. The selection was based on stratified random sampling method. All the hamlets and village panchayats in KHWLS were classified on the basis of:

1.Community constitution

2.Eco-location of the hamlets

Once classified, hamlets from each category were selected proportionally. Survey was conducted in 11 villages and 13 hamlets have been selected through stratified random sampling method. The pre-structured interview was conducted in all the households in a door-to-door manner (100% households of each selected hamlet)

(The survey form has been attached along with the report Anex.1)

Results

Baseline data was collected for 72 hamlets from 26 village panchayats. 56 hamlets had majority *Mahadev Koli* tribes, 17 had *Thakar* tribes and 35 had a SC population. The hamlets were distributed throughout the KHWLS which is an altogether hilly terrain. Hamlets were located in varying 'Eco-location' like mountain top, mid-slopes and valleys. Eco-location of a certain area affects the wind speed, temperature, sun light and its intensity, precipitation etc. With varying physical conditions, floral and faunal composition of the area also varies significantly. Eco-location of a certain hamlet would thus also affect the fodder availability, major and minor herbivore species dependant on them, etc. Out of the studied villages 41 belonged to Mountain tops, 24 to Mid-slopes and 7 to valleys.

9 villages (7 hamlets and 2 main villages) were selected through the process of stratified random sampling as mentioned above. All households in the selected villages/hamlets were surveyed for this purpose. In all 269 families were surveyed in the process of data collection regarding the tradition of Raakhan Raan.

Social composition of the studied sample

8 families belonged to the Scheduled caste category and 261 belonged to the Scheduled tribes. The scheduled tribes that is the Adivasi community (ST) was constituted by 2 tribes the dominant being Mahadev Koli which contributed as many as 198 families in the study. Thakar community of Scheduled Tribes comprised of 62 families in the current study.

Occupational classification:

268 out of 269 families had access to farmland either rainfed or irrigated. Only 1 family was landless (0.4%). 264 families also reared cattle or animals in addition to Agriculture. Only 3 families had outside financial support through job or service. Jobs/service and other opportunities like small businesses, etc did not come out as a significant source of income for people in the area.

Trends in Land ownership:

Total private land holdings from the selected sample was 636 acres and the average landholding per family being 2.49 acres per family. 102 acres of forest lands 'Palat' are being cultivated which makes an average of 0.38 acres per family. 10 years earlier the average private land holding was 2.27 acres per family and that of palat was 0.36 Acres/family.

14 out of 269 families (5.2%) did not have privately owned lands. These were mostly Mahadev Koli tribal families. 10 families belonged to the Kumshet Village Panchayat, 2 to Ratanwadi and one each in Ambit and Janewadi. Out of these landless families 11 cultivated encroached forest lands locally referred to as 'Palat'. Thus there were only 3 families (1.1%) which were totally land less and did not have any land to cultivate.

According to the interactions with the local families, 10 years back there were 25 families (9.3%) who did not have their owned lands and 13 families (4.8%) who were totally landless. Out of the 25 families, 1 was a scheduled caste, one was of scheduled tribe thakar and remaining all were Mahadev Kolis only. Most of the people without land 10 years back also belonged to the village Kumshet (10 families), 8 and 5 families belonged to Ratanwadi and Fopsandi villages respectively. There were 1 each family in Janewadi, Koltembhe and Ambit villages without own land.

Village	Hamlet	Total HH	Major community	Other community	Agriculture	AnimaR earing	Private land holders	Private land holding (Acre)	Forest land holders	Forest land occupied (Acre)	Landless
Ratanwadi	Tirthachiwadi	23	M. Ko	SC	22	20	21	41	6	7	2
Janewadi	Bherushi	11	M. Ko	-	11	11	10	22	9	14	0
Kumshet	Gaothan	34	M. Ko	-	34	33	27	68	29	53	1
Kumshet	Mudhachi wadi	7	M. Ko	Thk	7	7	7	17	1	2	0
Kumshet	Thakarwadi	21	Thk	M. Ko	21	20	19	62	2	6	0
Koltembhe	Koltembhe	51	M. Ko	Thk	51	51	51	148	13	14	0
Ambit	Payalichiwadi	16	Thk	M. Ko	16	16	15	49	1	2	0
Satewadi	Jambhalewadi	15	M. Ko	-	15	15	15	35	0	0	0
Vihir	Vihir	17	M. Ko	SC	17	17	17	43	0	0	0
Tale	Tale	17	M. Ko	-	17	17	17	37	0	0	0
Murshet	Gavthan	18	M. Ko	Thk	18	18	18	37	0	0	0
Fopsandi	Fopsandi	17	M. Ko	SC	17	17	17	36	0	0	0
Shingawadi	Shingawadi	22	Thk	SC	22	22	22	39	1	2	0

Inferences from the table

11 villages and 13 hamlets were studied. 269 families were interviewed during the process. 268 families were involved in farming. One and only nonfarm family was from Ratanwadi (Tirthachiwadi). 264 families were involved in animal rearing. 5 families not into animal rearing belonged to Ratanwadi (Tirthachiwadi) and Kumshet (Gavthan and Thakarwadi).

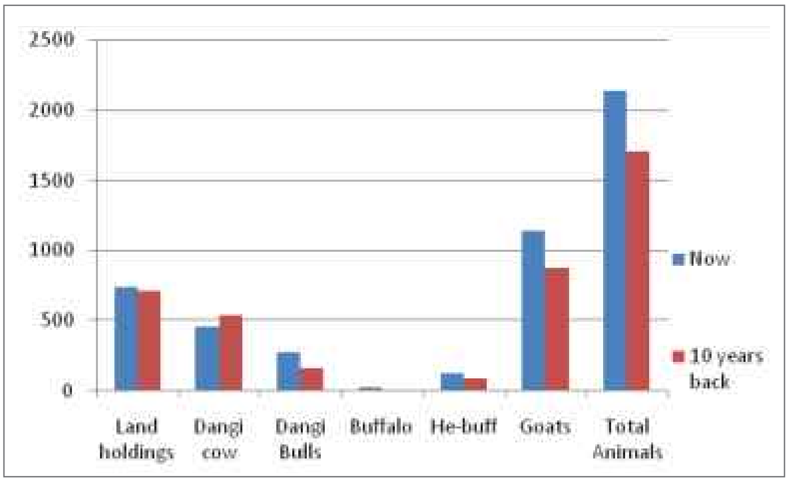
256 families owned private land (95.2%) and they owned as much as 634 acres of land totally. Koltembhe had a maximum private land holding of 148 Acres with an average private land holding of 2.9 Acres/family. Mudhachiwadi had the least private land holding reaching to 17 Acres and average land holding being 2.43 Acres/family. Maximum average private land holding was observed in Ambit (Payalichiwadi) (3.27 acres/family) while least was observed in Shinganwadi (1.77 acres/family).

5 hamlets out of 13 did not have any forest encroachments for cultivation. 62 families from 8 hamlets (23%) had been using land under forest ownership. The average forest land holding was 1.61 Acres/family.

Number of landless in the area was very negligible. Only 3 families from 2 hamlets (1.1%) did not have access to any land what so ever.

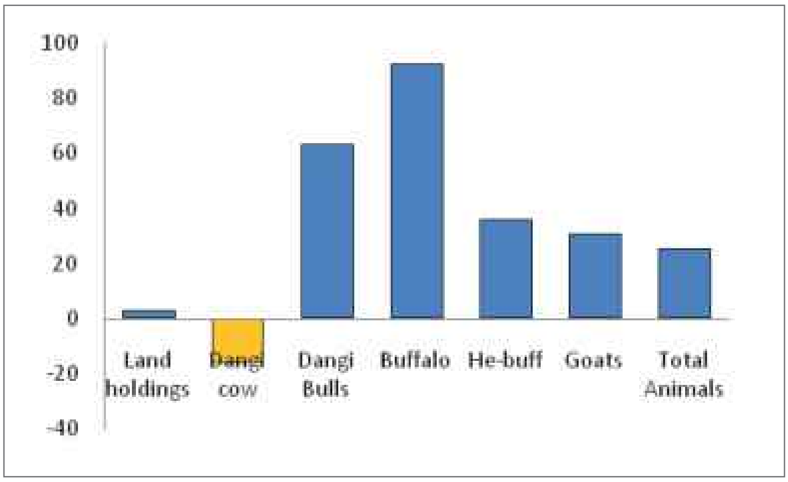
Dynamics in Animal population

	Now	10 years back	Change	% ch
Land holdings	**738**	**716**	**22**	**3.1**
Dangi cow	457	542	**-85**	**-16**
Dangi Bulls	274	168	**106**	**63**
Buffalo	25	13	**12**	**92**
He-buff	125	92	**33**	**36**
Goats	1144	877	**267**	**30**
Total Animals	2138	1704	**434**	**25**



Graph shows changes in agricultural assets (land holdings and reared animals) of the studied families in the past decade. There has been very minor increase in land holdings of the families. But changes in category wise animal population are remarkable. The graphical representation below indicates clear increase in most reared animals. Especially, Buffalos are seen to have doubled in the past decade with 92% increase in their number. Dangi Bulls also show increase by 63% since the past 10 years. He buffaloes and goats have also increased by 36% and 30% respectively in the past decade.

The only category which has reduced in numbers in the past decade are the Dangi Cows. They have reduced by as much as 16%. The main cause of this decrease may be the reduced livelihood dependence of communities on cattle, increase in accessibility through which trade has taken up, forced migration of family members for employment in drought months, etc.



The Raakhan Raans

Raakhan Raan are sections of privately owned grassy meadows which are protected and managed for securing fodder to be used during months of scarcity. These meadows have been left undisturbed since past few generations. This system is followed by the traditional forest dwellers in the study area. Fodder is carefully harvested after completion of its lifecycle and dispersal of seeds thus ensuring healthy regeneration of local grass diversity and providing food security for the local cattle.

This is a very ecologically sustainable approach as against the modern science which recommends harvesting fodder at flowering stage for maximum nutrition. But extensive harvest of wild grasses at flowering will hamper its regeneration and eventually exhaust the local fodder resources. Contrary to this unsustainable modern day approach, the age-old Raakhan Raan tradition safeguards regeneration potential of the fodder species and at the same time provides fodder security to the cattle dependant local communities.

This tradition provides fodder security to local cattle especially during the draught months while on the other hand provides safe, grazing free habitats for grass species to flourish. Raakhan Raan are thus a **sanctuary**

for grass species in this semi evergreen forests around KHWLS. Not only grasses, they also support the avifaunal, amphibian, reptilian and lesser mammal diversity dependant on these species for food and shelter. Thus Raakhan Raan play a significant role in conservation of native, rare and unstudied biodiversity.

This is the first instance of studying and recording this conservation tradition. However, the study limits itself to socio-economic perspective of these special conservation areas.

The enumerator collected information regarding the Raakhan Raan, their areas, tenures, age of the tradition, etc. From the data collected, it was seen that 56 households out of 269 households practiced the tradition of Raakhan Raan. These households were distributed in villages namely;

1.Vihir

2.Murshet

3.Shinganwadi

4.Janewadi

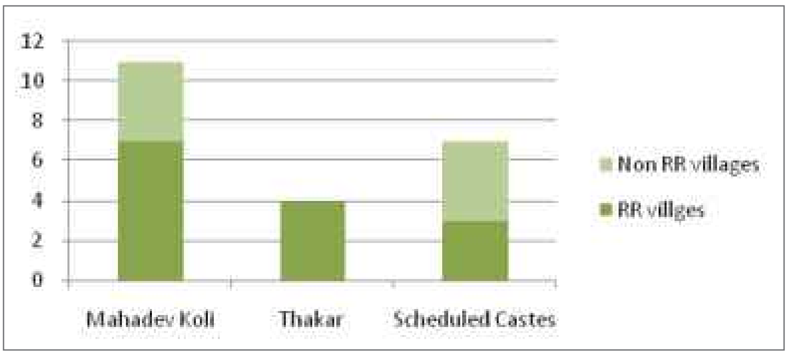
5.Kumshet

6.Koltembhe

7.Ambit

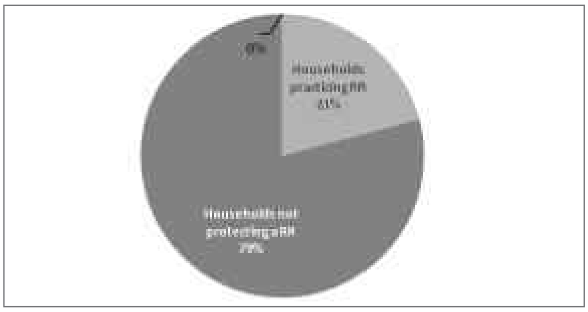
Sr. No	Village Name	Hamlet	Ecolocation	Community	Other conservation Tradition	Raakhan Raan Tradition
1	Janewadi	Bherushi	Mid Slope	MK	Yes	Yes
2	Kumshet	Gavthan	Top	MK	Yes	Yes
3	Koltembhe	Gavthan	Top	MK TK	No	Yes
4	Aambit	Payalichi wadi	Valley	TK	No	Yes
5	Vihir	N/A	Mid Slope	MK SC	No	Yes
6	Murshet	Gavthan	Top	MK SC	No	Yes
7	Shinganwadi	Gavthan	Top	TK SC	Yes	Yes
8	Kumshet	Thakarwadi	Top	TK	No	Yes
9	Kumshet	Mudachi wadi	Mid Slope	MK	Yes	Yes
10	Ratanwadi	Tirthachiwadi	Valley	MK SC	No	No
11	Satewadi	Jambhlewadi	Top	MK SC	No	No
12	Tale	N/A	Top	MK SC	Yes	No
13	Fopsandi	kondarwadi	Mid Slope	MK SC	No	No

This conservation tradition was followed in 9 of the 13 studied hamlets. Sampling was based on the eco-location and dominant community in the hamlet. It would therefore be important to note that, 5 hamlets belonged to the mountain tops, 3 to the mid slope area and 1 in the valley. All the hamlets which had a population of Thakar community were found to be practicing this tradition. 6 villages with Mahadev Koli community, 4 with Thakar and 3 with scheduled caste population were observed to be following this practice. 3 villages with only Mahadev Koli population and 2 with only Thakar population were found to be following this tradition.

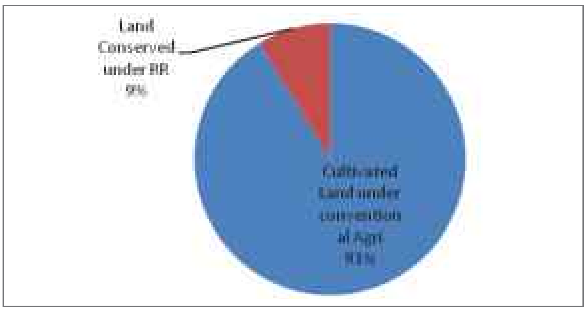


This tradition of sustainable use of wild resources was not limited to villages that have background of other conservation traditions (like Sacred groves) as well. Out of the 9 hamlets, where Raakhan Raans were found to exist, 4 villages also practiced conservation tradition od Sacred groves while 5 did not have any other conservation tradition.

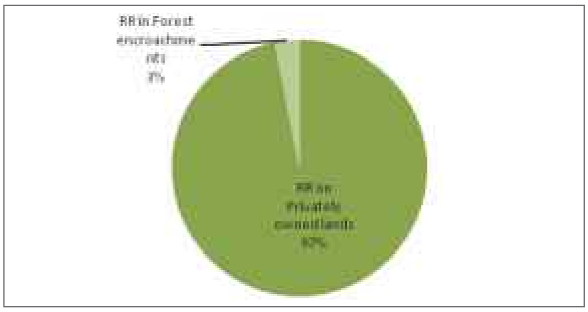
Similarly, amongst those villages which did not have Raakhan Raans, 3 did not also protect sacred grove but one village did.



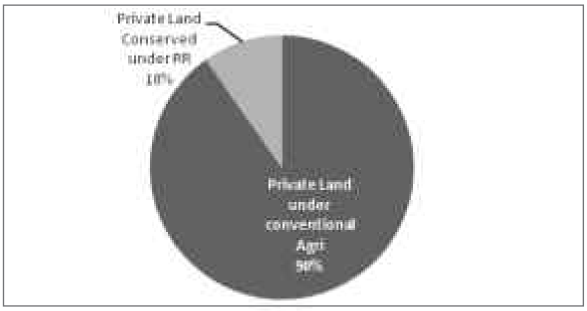
These 56 families in the area which made up 21% families in the study area were instrumental in conserving Raakhan Raan. They protected as much as 64.5 acres of land out of the 738 acres of total cultivated land in the area around the Kalsubai Harishchandragad WLS and allowed grass species to flourish and reproduce without disturbances like grazing, fires, invasive species etc. Thus 9% of the total land under cultivation has been conserving Grass diversity indirectly for numerous decades.



The study of tenures (ownerships) of these Raakhan Raans revealed interesting data. It was peculiarly noted that most of the Raakhan Raans are situated in private lands (97%). Only 3% of the total land under RR were under Forest Encroachments or 'Palat's

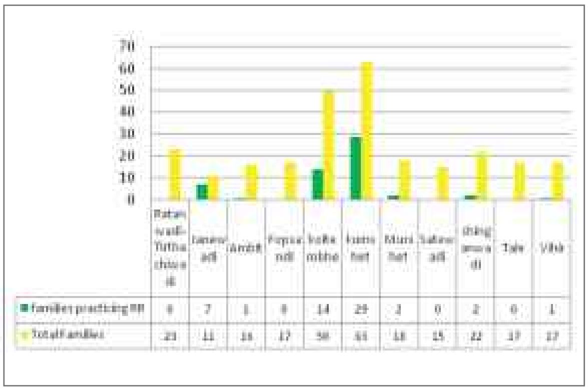


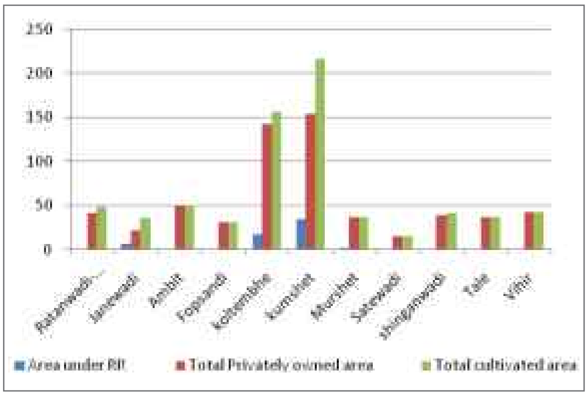
As much as 10% of privately owned lands of local communities was conserved under RR. These private ownership lands were thus supporting grass diversity in semi evergreen tracts and indirectly also supporting like, lesser herbivores, avifaunal species, wild burrowers, and their predators etc.



Regarding individual villages/ hamlets studied, Ratanwadi (Tirthachiwadi), Tale, Satewadi (Jambhlewadi), Fopsandi (Kondarwadi), did not practice the Rakhan Raan tradition anymore. Vihir village did have 1 family practicing the tradition amongst total of 17 families and conserved 2.32% of their total privately owned and cultivated land.

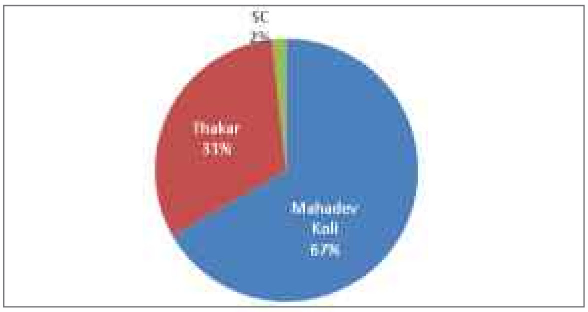
Remainders of the villages are represented in the following chart;

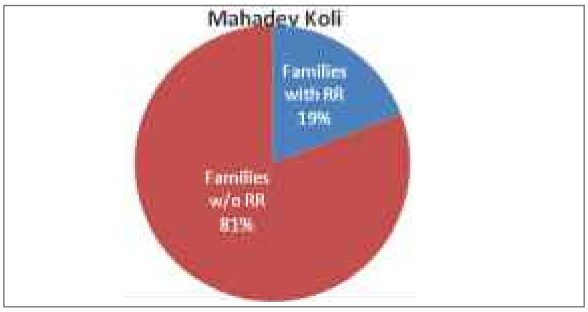


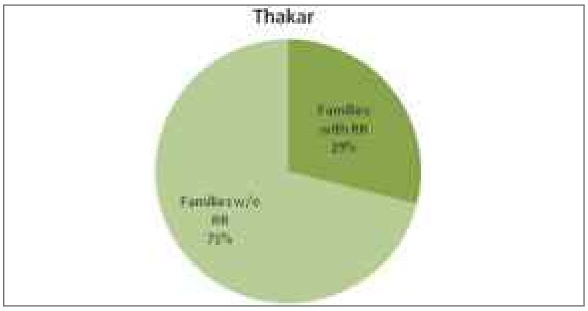


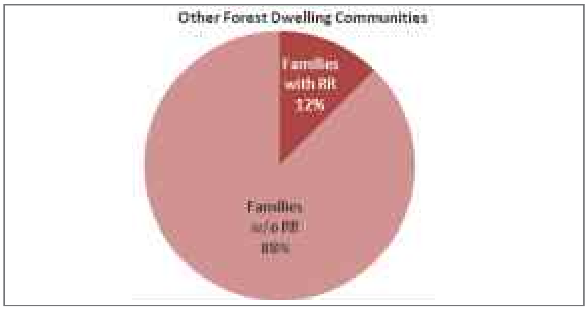
Amongst the families practicing the conservation tradition most belonged to the Mahadev Koli tribe followed by the Thakars and lastly the Scheduled Caste families

Study of the population dynamics showed that only 19% of the Mahadev koli population in the area currently practices this tradition while 29% of the Thakar tribe population had Raakhan Raans. 12% of the other traditional forest dwellers also practiced this unique tradition.

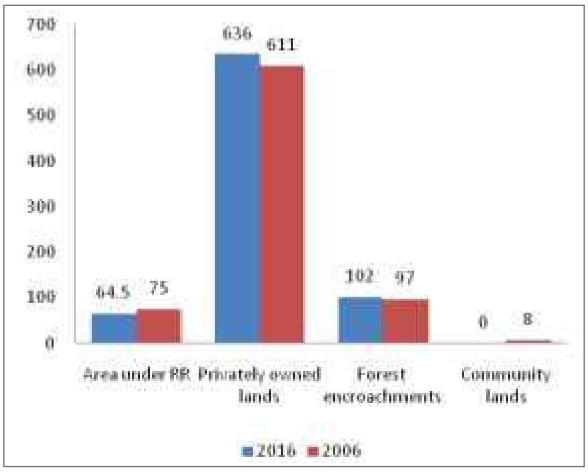








Pressures like land use changes, unemployment, changing climate and its impact on cattle health, failure of village economies to provide the much needed cash for sustenance of various families may have caused families to discontinue animal rearing as a livelihood option. With cattle rearing losing its livelihood potential, important conservation traditions like the RR are also losing their contexts.

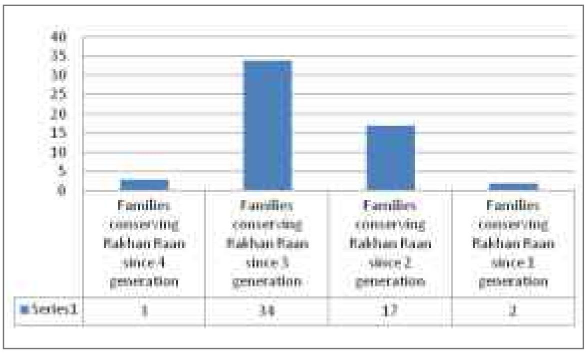


Cattle and RR

During initial discussions with the local communities' regarding the RR, it was mentioned that RR are maintained and harvested mainly for securing fodder during dry and drought months. This survey also provides insights regarding this assumption.

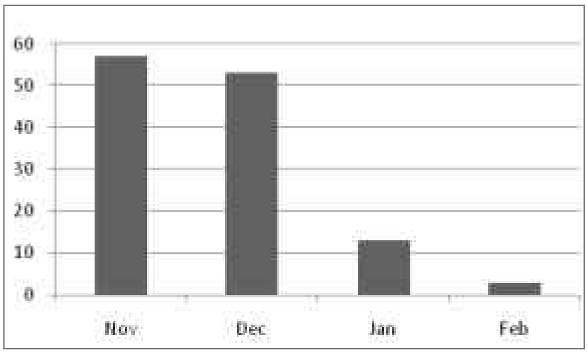
Maximum cattle was reported in Village Murshet where the family cared for 49 animals. There were 238 families rearing animals ranging between 1 and 49. 31 families had no animals at all. There were only 2 RR amongst the families which did not rear any animals at all. While 54 RR were distributed amongst families who looked after animal herd.

Family herds were classified into 5 categories based on the herd size



The grassy meadows are protected from fires and open grazing through community regulations and mutual understanding. Biomass of grasses is harvested but only after completion of their lifecycle and dispersal of its seeds, thus reassuring regeneration of the species. These areas with vigorous grass growth and huge species diversity act as seed banks for this neglected diversity which provides vital support to the entire ecosystem.

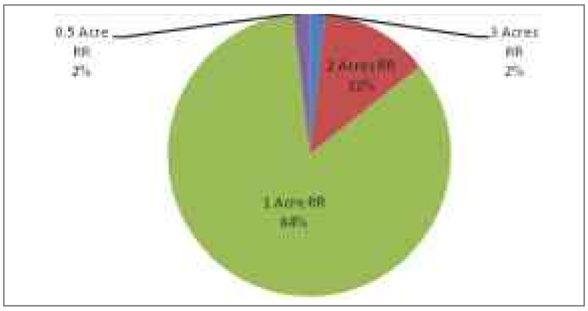
Communities prefer harvesting Raakhan Raans in the month of November for optimum palatability. The families harvesting in the later months reduces with only 3 families having harvested in February month.



There were 235 families involved in selling various animal produces like milk, milk products, dung, calves, etc. 55 RR families out of the total 56 RR families were found to earn income out of sale of various animal products. RR thus supports livestock based income generation activity amongst the marginal tribal communities in the area.

Households reported an income ranging from 1000 to 10000 annually from animal rearing. This was divided into 2 catagories, 1000-4999.00 as low and 5000-10000 as high. Amongst the 56 RR families in the studied sample, 37 RR families (66%) earned annual income in the higher category. There were 24 Mahadev kolis, 13 Thakars amongst these higher earning families.

Most families practicing the tradition preferred to protect as much as 1 acre of RR. 3 acres was the maximum area conserved through this practice while 0.5 Acre was the minimum. Average landholding was 1.015 Acre currently.



Comparative study of RR landholding in the past decade shows that average land holdings have reduced from 1.36 Acres per family to 1.015 Acres per family.

On the background of increasing cattle population in the area reducing RR area may indicate increasing pressure on surrounding forest areas.

Fish and Shellfish Diversity in Freshwater Ecosystems

Report 4

Fish and Shellfish Diversity in Freshwater Ecosystems

Bhandara Nisarga va Sanskruti Abhyas Mandal
BNVSAM, Arjuni-Morgaon, Bhandara

Background

Bhandara and Gondia districts are known as lake districts of Maharashtra. There are thousands of traditional lakes, built around two to three centuries ago, during the reign of Gond rulers. These tanks are known as ex-malgujari tanks. These traditional water bodies are used for many purposes at village level. Irrigation and fishery are the major economic activities going on since many years. The current management practices of these tanks at village and at the departmental level are focused on these two uses only. The green and blue revolution has promoted monoculture of species. All these aspects contributed in the depletion of the tank-associated biodiversity and hence reduced the productivity of the tank, which further leads to livelihood problems of the dependent communities.

On this background, the fisher folk, Dhiwar community, is at the receiving end of the imbalance in the tank ecosystem. At the same time, the knowledgeable individuals of community, on the basis of their traditional knowledge and experience strongly feel that the revival of the aquatic flora for habitat development will improve the local fish diversity and the production of introduced species also. On this background, we have planned to experiment the hypothesis of revival of freshwater habitat. This work was done in a tank in Jambhali village, near Nawegaon Bandh, with the support of Small Grants Programme of UNDP, GEF, MoEFCC. We have taken help of the botanists and zoologists for documenting the diversity, whereas the revival techniques and methods were finalized with the help of fisherfolks, as the application related knowledge was available only with them. This work was successful. The aquatic habitat developed and the indigenous fish species diversity and production also improved. The water birds activity also improved in the tank. This activity was undertaken by the SHG of fisherfolks in 2009 to 2011. After that, we have started the exploration of the idea of aquatic habitat development with the fishing cooperative societies in Bhandara and Gondia districts. We have conducted meetings with 60 fishing cooperative societies in both the districts. Out of them, the members of 12 cooperatives were also thinking on the same line of habitat development for sustainability of fishery. Aquatic habitat development and conservation of local fish species were the two identified objectives. During the phase of district consultations of MGBP, we have organized the consultation for Bhandara and Gondia districts. After that, the project for freshwater biodiversity conservation was designed with the 12 fishing cooperative societies in these two districts.

Journey with MGBP

Key issues addressed: The major uses of ex-malgujari tanks are irrigation and fishery. The concerned departments manage these tanks in relation to these two uses. This approach was different in the management of malgujari tank as, then, community used to manage them, recognizing all local level uses. Irrigation department has looked over the maintenance, repair and improving storage and distribution. They even have not *marked and mapped the catchments of these tanks, over last sixty years, although,* catchment management is also the part of the department's work. On the other hand, fishery department was focused on improving fish productivity and for this, they have not explored the indigenous species, but imported the high yielding species of aquaculture. Both these limited approaches of management and development contributed to the loss of freshwater biodiversity, and further, the role of tanks as life supporting structure at local level was also reduced. The rights of irrigation have been secured through the provision of Nistar rights, under the “Maharashtra Land Revenue Code”. Therefore, the traditional farmers get free of cost water for irrigation. On the other hand, cooperatives have been formed in 60's for fishing, and though the fisher folk are also traditional users, their rights have not been recognized. So, they are facing the challenges of low level of production, habitat destruction and for getting the tanks on lease, in the competitive business model of aquaculture. We have focused our intervention for improving the condition of tanks, based on community's knowledge and their aspirations regarding sustainable fishery.

Objectives

- Documentation of people's knowledge of freshwater biodiversity
- Preparation and implementation of freshwater biodiversity management plans through fishing cooperative societies

- Conservation and sustainable use of freshwater biodiversity
- Advocacy for biodiversity and fishery inclusive policy

Sampling methods

The field and supervisory staff members of BNVSAM were engaged in the data collection. Formats for data collection have been designed by BNVSAM based on their field experience and observations, and with the help of IISER, Pune.

Initially, GPS mapping was done and GPS points were marked for study of flora by quadrate method. Local expert of plant identification, village level workers and supervisory staff have done the study after proper training. Herbarium sheets of the plants have been prepared with the help of plant taxonomist. The expert has also helped us to derive the abundance, frequency, density, and important value indices of flora species.

The data of water quality for pH and DO have been taken on field on monthly basis by carrying the instruments on the spot. The timetable for bird watching was prepared and the children from local schools were involved. The data of birds was collected from fixed point as well as by trekking around the wetland on foot.

Data on farming in catchment, practices of use of fertilizers and cropping and land preparation patterns has been collected by person to person visit. Data on fish production for marketable and local fishes have

been collected from fishing cooperative society, as well as from fishermen. Livestock data has been collected from the herd keepers, who bring their herd to the wetlands for grazing.

A training for part time paid volunteers and workers of BNVSAM has been done. The formats prepared for data collection were discussed in detail with them. 15 workers have participated in this training on 26th May 2016. A kit for documentation is provided to the part time workers. It contains 13 different types of formats for wetland area, agriculture and forest area in catchment, documentation of diversity in all these area related to wetland.

Training of staff workers on data collection

Field training for quadrat study method of plants in water body area

Jars with the 10% solution of Formaldehyde have been provided to the fishing society; separate jars for separate tanks. A list of local names of fishes found in their tank has also been provided to them. They have been told to put two samples of each species in the jar when they undertake fishing in that tank, by including the data in the attached list. This stock is brought back to office and stored in separate containers for each society, in plastic bags for each tank, and in a container. Through this method we have prepared the lists of fish diversity in the tank and also have maintained fish repository for fishes of Bhandara and Gondia districts. We will be depositing these samples with Zological Society of India.

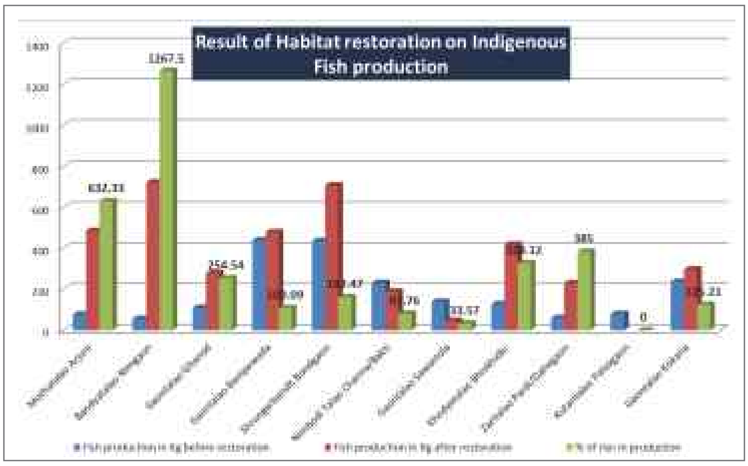
The aquatic plants survey has been done by using quadrat method. The data has been collected from the GPS marked quadrats, once in three months. Samples of plant species have also been collected to prepare the herbarium. This herbarium and fish repository is being used to exhibit them in the schools in the project area for identification and as learning tool for the students.

Activity of GPS mapping of wetland catchment area

Major work done under MGBP

12 tanks with a water spread area of 208.94 Ha has been reserved for freshwater biodiversity conservation.

Aquatic Habitat Development: Aquatic habitat development activity has been carried out in 11 tanks in the area of 281.80 Ha. This activity includes ploughing of tank bed in summer season. The area, which is under water in rainy season and suitable for the growth of aquatic and peripheral plants is ploughed. After the rains, when this area has the depth of water from 1 to 3 feet, the selected species of plants are transplanted. The plants which were existing in the tank in the past, are selected for regeneration. Mainly, the submerged plants like *Hydrilla verticilata*, *Ceratophyllum demersum, Vallisneria spiralis,* floating plant like *Nymphoides indicum, Nymphoides hydrophylla, Nymphaea cristata* and partly submerged plant *Eliocharis dulcis* and peripheral plants like *Oryza rufipogon, Vetiveria zizanoids* are transplanted. These plants in the area of water body are the important parts of aquatic habitat in the project area. For this activity, the expert from community, the expert from organization and the members of local fishing cooperative society, jointly visit the tank to assess the need of work. Together, they prepare the list of works to be carried out and the estimated cost of work. Following activities are part of this plan- like ploughing, de-weeding, requirement of plants/ saplings and tubers of selected species, bringing required plants from nearby tanks, estimating cost of transportation, labour requirement for transplantation work, and inclusion of women in this work. This estimate is then signed by the office bearers of cooperative society and subject experts. After receiving this along with the letter of society for undertaking the activity in their tank for biodiversity conservation, we implement the plan of habitat development in the selected tank.



In the above graph, it can be seen that the production in Nimbodi tank in village Channa is reduced, as the tank is situated far from village and the cooperative society members have not paid proper attention towards protection of the plantation area, during the first 4 months of plantation.

In the case of Sawartola Gaon talao, in last two years, four new bore wells have been dug in the command area of tank, whereas 7 already existed in the command. Due to over-exploitation of ground water, this tank dried up early. Before this, the tank used to have water availability till February but after this development, it now dried up in November, therefore the production is minimal.

In Kutantalao of Palasgaon, in the year 2018-19 there was the outbreak of Epizootic Ulcerative Syndrome (EUS) in the tank and fish mortality of indigenous species was very high, so they have not carried out the fishing activity in this year.

In other 8 tanks, the habitat restoration activity has yielded good results. The rise in the indigenous fish production is ranging from 125% to 1267%. According to the community members, this is a win-win situation as the approach of habitat development not only conserved the indigenous species but also raised the production and all of it is the net profit. Also, they don't have to invest regularly but the developing habitat is increasing profit year by year.

The wetland management plans for 12 reserved tanks have been prepared. Rules and regulations, according to the plans have been formulated and resolutions of those regulations have been passed in the general body meetings of the fishing cooperative societies. These resolutions, further submitted to the village level Biodiversity Management Committees to resolve and implement the rules. Six BMCs have passed these resolutions.

The advocacy for biodiversity inclusive fishery and malgujari tank management was going on constantly with the district administration. An experiment of Ipomoea extraction has been carried out in five tanks. The advocacy for including this activity under MREGS is going on, but it has been found that the administration needs the evidence of asset development. Because, in MREGS if community assets are developed or strengthened, it can be undertaken under MREGS. From the data that we have collected, we are preparing the note on asset development to attach it to the following details of the Ipomoea extraction activity.

Ipomoea extraction: The *Ipomoea fistulosa* extraction activity has been carried out at five sites by the joint efforts of women SHGs, fishing cooperative members and BMC members. This plant species is exotic and it covers the peripheral area of every water body, which is actually the area of local plant species in wetland area. These local plants are not only the important element of habitat for the aquatic life forms, but the peripheral plant species are also the source of fodder for livestock in the summer season and many plant resources are used by communities also as food or for household uses. It was a common belief that this plant cannot be eradicated by using human labour and machines need to be used for the purpose. At the same time, it has been observed by the local people that, at the places where Poclain machines were used, natural succession of the local plant species is hampered. On the other hand, in the field area, MREGS or other kind of labour work is the major source of income for about 51% of the fisherman community members (Baseline survey of fisherman community carried out by our organisation). On this background, the community members decided to do it through *shramdan* in the selected area of the water body. This activity was aimed for checking the hypothesis of use of human labour and to assess its effectiveness. Another major objective is to use the findings for inclusion of this work under MREGS, which will be important for clearing Ipomoea and allow spread of the local species to increase the diversity and the benefits from it to the wetland system and community.

Following are the results documented after the activity:

Pre monsoon condition:

At places, where Ipomoea is dense, no other species is found on the ground, but where it is scattered, grasses like *Vetiveria zizanoids* or *Oryza rufipogon* are found. On the sites where the soil texture is loose, plants have been uprooted, but this may not be the case at all sites, as this activity has to be undertaken in the month of May, which is very dry season. The plants were cut by sickle or axe and were stacked at the same place. After seven days of drying on the site, the heap is burnt under the supervision of community members, as there are no other plant species on that part of wetland. Some people use these dry sticks for heating the water. But using it as fuel is reducing due to complaints of unhealthy smoke by the women.

Post Monsoon condition:

Plots of 10 metre x 10 metre are measured for assessing the natural succession and rate of survival of *Ipomeoa*. Out of the five sites, post monsoon study was carried out on four sites, as the other site was submerged, and the depth of water restricted the access.

This area of 10 x 10 metres is divided into 16 parts of 2.5 x 2.5 metres each and count of total species and number of individuals in each plot has been taken. This data was analysed to derive the abundance, density, and frequency of each plant species. Importance Value Indices were derived. On the same plots, count has been taken in the second year also to measure the results.

Name of Wetland	Total plant species in plot area		Total individuals of all species		Proportion of Ipomoea regeneration (based on IVI)	
	2017	2018	2017	2018	2017	2018
Gaon Talav, Bhivkhidki	10	24	985	13113	1.97	0.98
Gaon Talav, Sawartola	12	34	1775	12454	0.98	1.26
Gaon Talav, Khamkhura	24	29	824	4476	7.63	1.36
BandyaTalav, Nimgaon	16	7	5085	7265	3.23	00
Gaon Talav, Kokna	--*	9	--*	4176	--*	2.24

*In 2017, the plot from which Ipomoea was extracted was under water and it was not possible to carry out the study.

Therefore, it is clear from the study, that regular monitoring and extraction of Ipomoea is needed for at least 3 years through MREGS for providing the work to village laborers and to conserve the freshwater biodiversity. It will be the win-win situation for villagers and the biodiversity.

Database

With the help of MGB coordination team, Prof. Madhav Gadgil, Dr. Vijay Edlabadkar and the partners in MGBP, we have developed the formats for documentation and data collection. The formats were ready for data collection, in 2017. Till that time, we have prepared the tank-wise lists of fish, birds, and aquatic plant diversity, uses of tanks etc. Also documented the reasons of diversity loss, according to the local communities.

The data has been collected in following formats and has been shared with the IISER coordination and has been included in the portal, which will be soon in public domain.

1. Tank information: This Excel sheet contains the information of location of tank with village ID from census code, water spread area, names and number of inlets, seasonal durations of flow from inlet and the source of inlet, i.e. forest, agriculture, human habitation etc. This is a one-time data.

2. Water Spread: This sheet contains information on the quarterly variation in water levels in the tank, which is measured with the GPS tracks. This is a Quarterly data.

3. Flora Diversity: Names of quadrats (with GPS location) local and scientific names of plants, number of species and number plants in quadrats, abundance, frequency and density of each plant and Importance Value Indices (IVI). Data collection was on quarterly basis.

4. Fish Diversity: Local names and scientific names of fishes found in the particular year in tank, their category, i.e. indigenous or exotic. The data was collected on annual basis.

5. Bird Diversity: List of local and scientific names and number of birds. The data was collected on quarterly basis.

6. Water Quality: pH, DO, TDS, EC, turbidity and temperature data is mentioned in this sheet on monthly basis.

7. Use of Wetland: Local level uses of wetland in the village were documented in this sheet along with number of families, social group wise, using the wetland for that particular use.

8. Livestock: Livestock herds information containing number and type of animals, which are using the wetland for fodder and drinking water or cleaning purpose.

9. Catchment farm details: tanks having agricultural land in catchment, crops planted, chemicals used and if they are practicing fire for cleaning of land.

10. Farm Biodiversity: Fishes, snakes, birds found in the agriculture land in catchment area and farmers' perception about whether they are harmful or useful.

11. Catchment Use pattern: Area under forest, agriculture, and village habitation in the catchment area. This data was collected to find linkage between land use pattern of catchment and biodiversity in tanks.

12. Total fish production data: all fishes caught by the cooperative society from tank; data has been collected on annual basis. It shows the impact of conservation activity on fish production and fish diversity.

13. *Ipomoea* extraction data- This sheet contains the data of 10 metre x 10 metre plots, where *Ipomoea fistulosa* has been extracted and data on number of indigenous plants and diversity of plant species. This activity was for the advocacy purpose for inclusion of *Ipomoea* extraction in MGNREGA.

Table giving number of records in each table of EXCEL file:

Sr. No.	Name of Table	Number of Records
1	Tank info	588
2	Water Spread	140
3	Flora Diversity	28121
4	Fish Diversity	6795
5	Bird Diversity	11028
6	Water Quality	3240
7	Use of Wetland	1660
8	Livestock	607
9	Catchment farm details	2404
10	Farm Biodiversity	13175
11	Catchment Use pattern	84
12	Total fish production data	1008
13	*Ipomoea* extraction data	40

For details, visit http://mgb.iiserpune.ac.in

Education Initiative

School based activities have been done with nine government schools and three private schools in the project area in Bhandara and Gondia districts. Students of 5th to 10th Std. have participated in the activities. A detailed program based on studies and projects related to freshwater biodiversity has been designed by our organization and CEE team. Teachers training was organized by CEE in cascade training mode. Activities like, Shivar pheri, Majhi thali, and testing seed germination rate are common at all project sites along with the projects based on themes. 1178 students and 21 teachers participated in 84 activities. Students have prepared 76 projects. They have been exhibited at school level in the year 2019. This initiative was helpful for the students to connect with the biodiversity around them and for teachers to improve on the teaching methods.

Unintended Outcomes

- Women participation in decision making through Mahila Gramsabha has played crucial role in maintenance of biodiversity, which is threatened by the mechanized desilting of tanks.
- Formation of Seed Bank of Aquatic Plants- It is one of the major and unexpected outcome, which will ensure the availability of seeds to communities and Government departments for habitat restoration work. It also ensured that the habitat restoration work be will continued after the project period. This activity was done under Seed Money grant of MGBP.

Quantitative Impact of Work

- Eleven fishing cooperative societies have resolved to impose ban on fishing during reverse migration for allowing the local fishes to breed. These resolutions were further given to village BMCs and they have also passed the resolution for ban on fishing in this season. This was the traditional practice but after the fish production decreased, reverse migration season, locally called '*chadhan*' was considered as the high fishing season.
- No. of fish species, plant species and bird species in reserved tanks and in other tank which is under same cooperative society.

Community participation in MGBP process

Perspective of Dhiwar community and their institution

The population of Dhivar community is 15% of the total population of the project area villages. Fishing cooperative societies were formed during 1960 to 70 and the fishing community households became the shareholders of these societies. Dhivar community got these tanks on lease for fishing, on priority, from the state government. During this same period, the high yielding species like Rohu, Catla and Mrigal, known as Indian Major Carps (IMC), were introduced in the tanks. When this production has improved due to these species, the role of women in marketing has stopped and the trader came in picture, as the fish produced needs to be sold in big markets.

Usually, the area of 5 square km is the jurisdiction of the fishing cooperative society. All tanks in this area, covering 2 to 3 villages and 2 to 5 tanks, fall under the jurisdiction of one society. All the male members of community are the shareholders of the society.

After the introduction of IMC, fishing techniques also changed. Drag net came into practice. The aquatic plants are considered as obstacle in dragging the net. The fishery department has also seen no role of these plants in production of IMC and introduced Grass Carp as the scavenger species of these plants.

Community Learning

Year after year, releasing IMC seed or fingerling and fishing after a year, became the practice. When the aquatic habitat was lost and the fish production went down, due to non-availability of food, some of the knowledgeable community members, realized that aquatic plants are important in maintaining the habitat for growth of fish and for natural food availability. They also realized the key role of indigenous fish species for their own consumption. With this realization by community, we have initiated dialogue with the fishing cooperatives in Bhandara and Gondia districts. The traditional knowledge of the community regarding the biodiversity elements in water body was crucial in the process of conservation and habitat development. We have also formed an informal group of 12 fishing cooperative members. Three members from each society and the project team is in this group. The discussion about crucial project activities and, decisions regarding community level work are taken in the meeting of this group. Earlier, this meeting was taking place once in a quarter, and now it is organized once in six months.

The women Self Help Groups of Dhivar community have been formed for the participation in Mahila Gramsabha for the governance of water and other natural resources at village level. They have also taken decisions for proper implementation of MGNREGA, as employment is important factor for them. When the work has been started, other women SHGs have also joined Mahila Gramsabha. The male members of villagers also became aware, due to the lead of women in Gramsabha and they also started attending the Gramsabha. This awareness and community organization has helped a lot for undertaking the project activities at village level.

We further prepared poster exhibition on MREGS and the booklet for distribution to the labourers for effective implementation of MREGS. This has been done to help people get employment at village level, and to plan the tank related work through MREGS and strengthen the asset. Twelve (12) such exhibitions have been organized in the villages. The booklet on provisions of MREGS and roles and responsibilities of Gram panchayat and related office bearers and the rights and facilities for labourers has been prepared and 50 booklets has been distributed in every village to women SHG members, BMC members and labourers.

Role of Women in Freshwater Biodiversity Conservation

The approach of women leadership development from Dhivar community has also proved successful and unique in nature. This has revealed the role of women in the management of malgujari tanks, which was never explored or identified. Through another programme of organization on community leadership development, we have promoted the leadership of young women of the Dhivar community. Initially, they have formed the SHGs of women from Dhiwar community to organize them. For them, the issue of getting employment in village was important and we have supported the women groups for establishing the right to employment through MREGS. Tank desilting work has been demanded by them. Desilting by using labour is beneficial for the biodiversity also, as the heavy machines destroys the floral diversity in tanks. In six villages, the work under MREGS have been done where all the villagers got the work. Then women from other communities have also joined the women organization of Dhivar community. The leadership that emerged from Dhivar community has become the leadership of village. Mahila Gramsabhas are taking place now and women from all classes and communities are actively participating in them. They are planning the work of MREGS through gramsabhas and during implementation they play the crucial role of monitoring the governance at local level in the Gram Panchayat. This has boosted the confidence among women, from the experience of decision making for village resources and governance of same. They now participate in each decision of the village, through Gramsabha. During this process, we have discussed the problem of Ipomoea in tanks and low productivity due to diversity loss. They have come forward for the *Shramdaan* in five villages, where we have measured the plots for giving supporting data, for inclusion of the activity in the MREGS. The plantation of aquatic plants is also done by them, as they know the techniques of planting rice plants in mud and partial submerged areas. The data collected through the formats in the project has also been shared with the women organisations. They have participated in framing the rules for uses of tanks at village level. Now, the women have worked as pressure groups also to include them in the seven developmental committees at Gram Panchayat level. They are now becoming the decision makers of village. This process has also introduced another aspect to the management of malgujari tanks and associated biodiversity. Currently, four villages have strong organisations of women, and we are expanding the work in this regard in more villages in the project area.

Four fishing cooperative societies have passed the resolutions to include women as shareholders in the society as they are identifying the role of women in the management of tanks and development of fishery-based livelihood.

Beneficiaries

- The Dhivar community is the direct beneficiary of the project. The habitat development and conservation and sustainable use of the freshwater biodiversity activities are beneficial for 1283 families.
- Through the planning and implementation of MREGS in the area of water bodies, total 5320 families have got the employment in the project area. The work is going on through the informal labour organisations in the villages, who are engaged in planning and execution through Gram Panchayat.
- **Measures to ensure long term benefits**

  The production in the reserved tanks is improving every year, after the habitat development activity. The societies are also following the self-imposed ban on use of Grass carp and common carp in the reserved tanks. This measure along with regulation on the use of drag net is proving beneficial for the aquatic habitat. People are also witnessing the change visually and in form of occurrence of more numbers of indigenous fishes and improved production also. This self-learning of community will assure the sustainability of the work done. Apart from it, the village level regulations by BMC will also be the additional measure for controlling the exploitative activities in the tank area.

Till now four Mahila Gramsabhas have passed the resolution, which later was resolved in the village gramsabha also, that heavy machines will not be allowed for desilting in their reserved tanks, as the weight of the machines, hampers the growth of aquatic plants and the labourers also do not get work.

People's selection criteria for commercial and indigenous fish species

The fishing community and other communities in East Vidarbha (5 districts) know the nutritional value of indigenous fish species and therefore there is high demand for the local fishes in the market of rural as well as urban areas.

Another factor is the rates of local fishes; they are 3 to 4 times higher than the commercial fish rates.

Still the community thinks that IMC should also be there with the indigenous fishes, as commercial fishes give money in bulk, once in a year and indigenous fishes provides monitory support every week for the weekly market and it also provides cheap nutritional food, in comparison with agricultural products.

Therefore, the habitat development approach has been taken up by the community to conserve the indigenous fish diversity along with the production of IMC.

Observations about Water Quality

It has been observed during the project period that the pH of water is not varying, as it used to before four to five years. This factor is very crucial in terms of the spread of Epizootic Ulcerative Syndrome (EUS) which is a disease caused by bacterial infection during low pH period.

It has been observed that the plant diversity, which was restored, might be playing crucial role in controlling the pH but it has impacted positively, as there are no reports of the infection and mortality due to EUS in 11 tanks in last 4 years. Only one tank reported mortality due to EUS in 2018. There is the need of further study in this regard.

List of Publications and presentations

- A paper on "Freshwater Fish Diversity of Nawegaon Bandh" is published in Journal of Indian Fisheries Association in 2017. This study has been started after the submission of proposal of Gene Bank, but before the actual project started, the work of sampling has been started. Authored by Mr Swapnil Ghatge and Sachin Belsare from Fisheries Science College, Nagpur, Mr Shrikant Jadhav from ZSI, Pune and Mr Manish Rajankar.
- An article on the work of malgujari tanks has been published in the Special edition book, "*Maharashtrache Sanskruti Sanchit- Part 2*" by the web portal, Think Maharashtra.com in 2017.
- An article on work under MGB has been published in the World Water Day edition of Vanraai magazine in 2018.
- A research paper on role of women in water management has been presented in the workshop on Collective Knowledge Building Process, organized by Tata Institute of Social Sciences and CORO in Mumbai in 2018, authored by Manish Rajankar, Shalu Kolhe and Sarita Meshram
- A booklet as guide for villagers for effective implementation of MGNREGS has been published in Marathi as part of the community capacity building under MGBP.
- An article on Aquatic habitat development, Community Approach is published in the March 2019 edition of LEISA magazine. of LEISA India article.

  https://leisaindia.org/aquatic-habitat-development-a-community-approach/
- A research paper on The Mighty small indigenous freshwater fish species, jointly authored by Kanna K Siripurapu and Manish Rajankar, published in the RRAN journal in June 2019.
- An article, Fishing for a difference, has been published on the website of Vikalp Sangam, written by Tanya Majmudar, Kalpvriksh, Pune in February 2020.

  http://vikalpsangam.org/article/fishing-for-a-difference/
- An article, Returning to traditional practices to save lake district of Maharashtra, written by Nivedita Khandekar on Mongabay in December 2020.

  https://india.mongabay.com/2020/12/returning-to-traditional-practices-to-save-vidarbhas-lake-district/
- The following paper is under preparation.

Nets and gears used in fishing in Gondia and Bhandara districts and their impact on freshwater biodiversity

Outreach

Through the regular interactions with the District level BMC of Gondia district, the forest officials were convinced, and they have planned the activity of freshwater biodiversity conservation in Navegaon Nagzira Tiger Reserve. In 2018, our team and community experts have guided them to extract Ipomoea and for plantation of aquatic plants for development of habitat to improve aquatic biodiversity. It is planned to work jointly in 32 tanks in the buffer area of project tiger.

Secretary, Animal Husbandry and Fishery Development Department, Maharashtra State, who was formerly the Regional Commissioner of Nagpur is convinced about the approach of indigenous fish diversity conservation and development of aquatic habitat for sustainability. With his help, it is planned to design the policy for Malgujari tanks in the five districts.

The PI of the Freshwater biodiversity project of MGBP (Manish Rajankar) is the expert member of State level Study group on Livelihoods of PVTGs. We are engaged in documentation of the traditional knowledge and practices of PVTGs, i.e. Madia, Kolam and Katkari, related to freshwater fishery. We are also developing the plan of fishery-based livelihood development with the support from Mumbai School of Economics and Public Policies and Tribal Development Department of Maharashtra.

We have participated in the National and State Network of Revitalising Rainfed Agriculture Network (RRAN) and PI is the theme leader of the theme of freshwater fishery.

We are also coordinating the theme of Wetlands and Rivers for South Asia region in the Indigenous and local Community Conserved Areas (ICCA) Consortium.

Knowledge Outcomes

We are preparing the manual for aquatic habitat restoration, based on community knowledge and our experiences of past five years. We have experienced that if we plant any species, which was not existing in the tank earlier, that species did not survive. So, it is essential to do retrospective documentation with community before planning the habitat development activity.

The floating plant species *Nymphae indicum and Nymphae hydrophylla* have important role in the tanks in our area. The flowers of these plants attract insects on large scale, due to its scent, and the small indigenous fishes come there to feed. The insect eating birds and fish-eating birds also congregate at those sites in the tank.

Mere clearing of Ipomoea is also important. We have witnessed that without doing anything, other than clearing the Ipomoea, the natural succession of local plant species is accelerated on the cleared area and in a span of two years, the landscape is totally changed, which helps to maintain the diversity in tank and also provides fodder for livestock.

Leaning-Leading– It was our hypothesis earlier, that the habitat development activity in tanks will improve the fish production, indigenous as well as the production of Indian major carps. The diversity and production of indigenous fish species has certainly increased. The production of IMCs also increased but we have found that adequate stocking of seed has not been done by the society, therefore significant rise in production is not evident in IMC. But the growth period is minimized. Earlier it was one and half to two years for the growth of one kg, but now in the period of ten to twelve months , they are growing to the size of one kg.

For improving fish production in tanks, there is no need to introduce fishes like Cyprinus or Pangasius. They grow fast as they are voracious eaters. But they damage the freshwater habitat, which is already threatened. So improving habitat for providing natural food to fishes is more important than introducing more aggressive exotic fishes for fishery development.

It has been observed that, many other government departments and community organizations also want to adopt the approach of freshwater habitat restoration and conservation of biodiversity. For that purpose, we are providing guidance to them with our experience and community resource persons. Along with that, there is the need to establish the seed banks of the aquatic plant species, so we are proposing to establish these two seed banks in two villages, through the women self help groups. The other departments or community organizations will directly purchase the seed from these groups.

Excessive growth of vegetation has occurred in six reserved tanks after protection and plantation, therefore the use of Grass Carp fish in controlled manner was essential. This has emphasized on the need of management of biodiversity along with the protection.

Failures

The habitat restoration activity has been done in 11 tanks, but it was not successful in two tanks, namely Bampewada and Injori tank. The red laterite soil was dominant in these tanks, which restricted the plant development and the local society members have not guarded the tank after plantation for 2 to 3 months to prevent the livestock from entering in the water in plantation area.

The PBR activity for village has not been possible, only the water scape PBR has been done.

Way forward

- The aquatic habitat restoration is the unique approach of the project, which is very much relevant in the field of freshwater biodiversity conservation, sustainable fishery, and management of water resources. Another aspect of women leadership development in the field of water resource management and development is equally important. We are intending to take forward both the important aspects of the work that have been carried out through the MGBP.

- SWISS AID, India has funded the project for taking forward the work we are engaged within 18 villages in Gondia, Gadchiroli and Chandrapur districts. The aquatic habitat development activity will be carried out in these districts by fishing cooperative societies and by the Gramsabhas having rights over tanks under Forest Rights Act (FRA).
- Organisation of State level workshop of all the traditional fishing communities of Maharashtra for submission of the draft of public policy on freshwater fishery to the Maharashtra State Government.
- Preparation of the fishery-based livelihood development plan for PVTG communities in Maharashtra.
- Providing guidance to WASSAN, RRA network in the state of Andhra Pradesh and Odisha, to the State tribal departments for developing habitats for improving fish production through biodiversity conservation approach.
- There is a need of Habitat management approach in different regions of India and South Asia, as felt during the consortium of Indigenous and local Community Conserved Areas (ICCA).

Annexure 1

Wetland Management Plans

Introduction

The Wainganga basin is known for the traditional water management system. The traditional tanks are called Maji Malgujari tanks in all the government records. The tanks played a vital role in supporting the rice crop of the region and also provided support to the marginal farmers or landless people through fishery and the other resources of tanks. After acquisition of these tanks from Malgujars, by the state irrigation department, other departments also came in the picture in the catchment and command area of tanks. Holistic approach of water management was fragmented in the programmes and policies of these different departments, which further resulted in deteriorating condition of these tanks and the dependent communities. Mere revival of the traditional structure is not enough as state government is trying to do this since last five decades, and still the tanks are not in very good condition and the benefits from it also remained limited for some of the traditional users only.

Bhandara and Gondia districts are known as "lake districts" of Maharashtra. Thousands of traditional water bodies are existing in these districts, constructed by communities in past. These water bodies were created to ensure protective irrigation to the rice crop of the area. These districts are also known as "Rice Bowl" of Maharashtra. The water bodies, existing from centuries, not only provided the irrigation facility, but it also supported communities around it, from fish production and many plant varieties as source of food and raw material for items of day to day use. Along with it, many local and migratory bird species are also using them.

In post-Independence period, these traditional tanks were acquired by the State departments. To promote more production per hectare in the water bodies, high yield fish species were introduced, which are called IMCs (Indian Major Carps). In later period, Grass Carp, from China was also introduced as scavenger specie to clear the vegetation growth in these tanks. Then Common Carp and Tilapia was also introduced for captive fishing, but without any stringent rules for control over them, and these species escaped in the natural waters and destroyed the ecological balance of the wetlands. On the other hand, the seed of IMCs were also released in the wetlands, but the management aspect was not given that much importance, therefore, their growth was adequate, till there was natural food available, but now after the deteriorating condition of the tanks, growth of these species is also minimal. Dhiwar, the traditional fishing community, is now on the receiving end of this blow, and the communication with them was initiated.

Assessing the status and trends of biodiversity use is essential for sustainable development strategies at all levels, from village to nation. Biodiversity is crucial for the wellbeing of people and the Earth. Ecology maintains the evolutionary processes that sustain life. These are necessary to moderate climate, renew soil and conserve species diversity. Plant, animal and other species have intrinsic worth. They are also the source of all biological wealth- supplying food, raw material, medicines, recreational resources, and a store of other goods and services per year.

Assessment need to be useful for decision making. This entails ensuring they relate directly to current or imminent policy concerns, and can be readily translated into proposals for decision and action. The components of biodiversity are innumerable, span a wide range of spatial and taxonomic levels, and interact with each other and with human societies and economies in intricate and ever changing ways. Determining the status and trends of the components, and of the flow of threats and benefits, is potentially extremely expensive and time consuming. Human and financial resources are at a premium even in wealthy countries. Therefore, assessments need to rely on a small, manageable and cost effective set of indicators, and on a practical information system.

Therefore, topics to be covered by assessment should be according to the article 7 (a) and 7 (b) [Chapter 2, section B] of the Convention on Biological Diversity ***"Components of biodiversity especially those requiring urgent conservation measures or which offer the greatest potential for sustainable use"***and according to the article 7 (c) [Chapter 2, section C] ***"Processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biodiversity"***

On the basis of these guidelines, set by CBD and described by IUCN, following aspects are focused for this study-

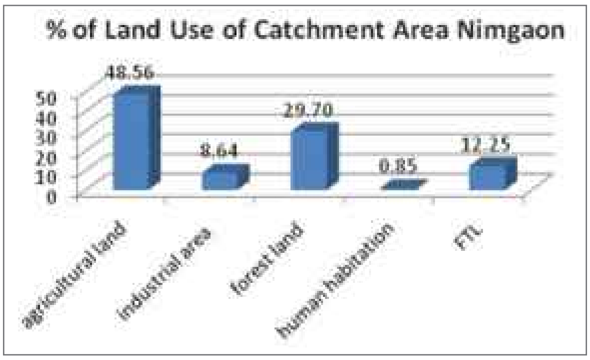
- Wetland area plants: These plants are the important aspect of the habitat of all the species and the contributor in the ecological goods and services, provided by wetland.
- Water birds: local and winter migratory birds are the indicator species.

- Fishes: local and introduced fish species are also the indicators and have direct relation with the economical and nutritional support from wetland.
- Management and use practices of the natural and manmade resources in the catchment, water spread and command area of the wetland.

Following are the rules prepared after data sharing with the community- plans for five tanks, out of twelve are mentioned below.

Wetland Management Plan of Bandhya Talao Nimgaon

The area of Bandhya Tank of Nimgaon is 11Ha. It provides protective irrigation to 43.7 Ha. agricultural land for rice crop. This tank has the catchment area of 89.8 Ha. Total population of the village is 2409 (556 Households).

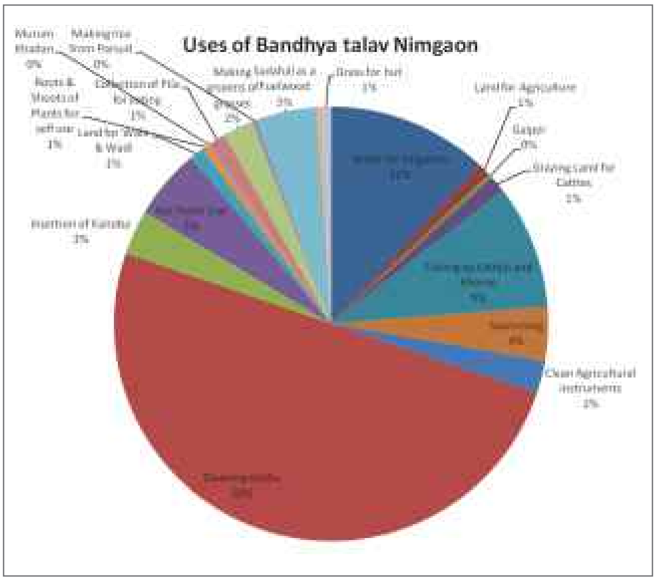


Catchment area map of Bandhya Tank, Nimgaon, prepared by using GPS

Important Fish species from community's point of view

Clarius Magur

Heteropneustis fossilis



Distribution of species according to area and water depth: Nimgaon

	% of species on Tank Periphery	% of species in Shallow water	% of species in Deep water
Plants	53.49	20.93	25.58
Fishes		60.6	39.4
Birds	64	16	20

43 plant species, 33 fish species, 5 introduced and 28 indigenous fish species and 26 bird species are documented on this wetland.

Out of the 43 plant species 32 are mentioned as NA (Not Assessed) and 3 are Least Concerned (The IUCN Red List of Threatened Species. Version 2017-1. <www.iucnredlist.org>. Downloaded on **05 May 2017**.) and 7 are reported as not available in the Catalogue of life maintained by ITIS.

Similarly, 21 bird species are reported as Least Concerned (The IUCN Red List of Threatened Species. Version 2017-1. <www.iucnredlist.org>. Downloaded on **27 May 2017**.) and 5 are NA.

Out of the recorded fish species, 19 are Least Concerned, 3 are Near Threatened (The IUCN Red List of Threatened Species. Version 2017-1. <www.iucnredlist.org>. Downloaded on **03 May 2017**.) 1 is Data Deficient and and 10 are Not Assessed.

We have then communicated with the community for their point of view about the importance of the species, based on their knowledge and experiences in the wetland of their village, as they are the most concerned persons, as the managers and beneficiaries of this system.

According to community members, out of 43 plant species, 11 are threatened, 3 are Near Threatened and 29 are Least Concerned. Similarly, out of 33 fish species, 4 are Threatened, 6 are Near Threatened and 23 are Least Concerned.

They were not able to assess the bird species as direct benefits/ usefulness from birds are not known to them.

The birds observed on this site, have their food ranges from fish, tadpoles, insects and other invertebrates. Out of the total species, 35% have fish as their staple food.

Rules and Regulations

From the discussions based on the documentation following rules have been framed for Bandhya Tank-

There is a newly started practice of catching reverse migration of fishes in July and August every year. In this season, the fish climb upwards and goes out of the tank, through the inlets. All the villagers, including women and children, go to catch the fishes, in the water channels. This practice not only reduces the brood stock, but it also stops the process of auto stocking of the fish seed in the tank. It results in less production and loss of fish diversity also. Therefore, it is resolved that no villager will be allowed to catch fishes during the season of reverse migration of fishes. The fishing cooperative society and Biodiversity Management Committee of Nimgaon has jointly taken this decision.

The agricultural area in the catchment of Bandhya Tank is 57.20%. All the farmers are using pesticides and weedicides, the doses are also very high, due to lack of knowledge about them. The pesticides and weedicides can are available in 0.5 or 1 litre, so irrespective of the area and requirement, the can once purchased from market is used in the farm land. These chemicals should be banned. But the transformation from chemical to organic is not easy. Therefore, there is need to access different schemes of agriculture department as buffer to minimize losses. For marketing of organic produces, help will be needed from the district network of organic farmers. The loss of fish diversity is very high due to the use of these chemicals in farms, as the agricultural land is adjacent to water storage, and the fishes go to the agricultural area during reverse migration and high mortality is observed due to the use of chemicals. Though, the villagers, including farmers and the fishermen, know that these chemicals are resulting in loss of indigenous fish diversity and the production, they are not able to move away from the practices in agriculture. The Gramsabha, especially the women organizations, are planning to tackle the issue through organic farming. For this purpose, it has been decided that the scheme of agriculture department for promotion of organic farming will be accessed.

Forest area is 29.69% in the catchment. The traditional tank management committee comprises of the farmers, who are getting irrigation from the tank, will repair and maintain the water channels, coming from forest, in the tank. The possibility of including members from fisherman community in this committee has also been discussed but the decision is pending.

8.64% area of agricultural land is converted to industrial area. The MIDC (Maharashtra Industrial Development Corporation) of Arjuni Morgaon is established here. The process of selling plots to different small and medium units is going on. Effluents or sewage from this area will be the future problem. There is the need that general rules for treating the waste should be laid down through gramsabha resolution and need to be sent to the district administration and to the MIDC offices of district and region.

The seed of Tilapia should not be released in the tank. Cyprinus (Common carp) and Grass carp should also be used for management of aquatic vegetation only, and not for production. According to vegetation cover observed in the period of September to December, the decision of releasing 5 to 10 number of fishes per hectare should be taken by the fishing cooperative society. The fishing cooperative society is willing to introduce this regulation as the fish production of this tank is reducing due to habitat loss.

The aquatic plants diversity will be conserved in this tank to provide habitat for the small indigenous fish species. *Mystus cavasius*, *Chanda nama*, *Ompok bimaculatus*, *Wallago attu*, *Clarius magur* and *Heteropneustis fossilis* are the rare and threatened species. They are economically important also for the fishing society. Though species-wise habitat studies of these local species is not available, the observations and experiential knowledge of the community plays important role in the conservation.

Cutting and taking away Sedges will not be allowed for burning as fuel or for stall feeding to animals. Grazing of livestock in tank itself will be allowed.

Cow dung cakes collection from the Bandhya tanks and selling will not be allowed by anybody. The fishing society will collect the cow dung and throw it in shallow waters.

Open defecation in the area of water body is banned. If found, fine of 500/-Rs will be collected by the gramsabha.

Desiltation activity will be carried out, only through the MREGS, (by labourers) use of machines will not be allowed. According to MREGS rules, the desiltation by labourers is carried out, once in five years. And if the machines are used, then another desiltation by machines is carried out after ten years. But, it proposed that, the tank which is big in size, should be desilted in stages. Desiltation in one area of tank in first year, and then another area in next year and so on. The proposal for this activity, clubbed with plantation of aquatic plants through MREGS will be sent to the district administration.

Ipomoea extraction activity needs to be taken up regularly for atleast three years to eradicate it completely. This activity should be proposed through MREGS.

Plantation of aquatic plants for habitat development should be done through MREGS.

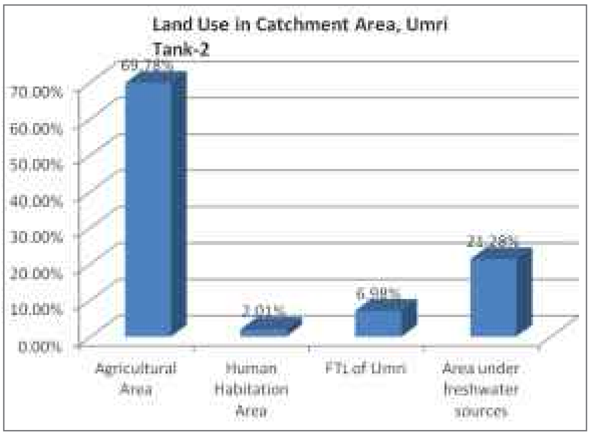
Construction of bore wells, in the downstream of the tank is not allowed, as the tank goes dry and only limited persons, with bore wells gets the benefit of it. Water for fishes and for livestock in the summer season is also important.

The cloth washing activity is carried out by half of the users of tank. This needs to be regulated as chemical detergents are released and pH value goes high. For this purpose, the women groups have asked for more time to decide upon, for alternate solutions.

Mining of red laterite from this tank has been done in past, therefore that area, which amounts to about 10% area of the tank has no vegetation and unnecessarily deep, at the left corner of the tank. No such mining of minerals will be allowed from the tank.

Wetland Management Plan of Umri Talao No.2 Sawartola:

The area of Umri Tank No.2 of Sawartola (Bid Tola) is 4.64Ha. It provides protective irrigation to 80 Ha agricultural land for rice crop. This tank has the catchment area of 8.11 Ha. Total population of the village is 243 (51 Households). There are 1 tank and two small tanks in the catchment area of Umri tank. So even if the tank area is small, excess water from upstream tanks stores here, therefore the irrigated area is larger.



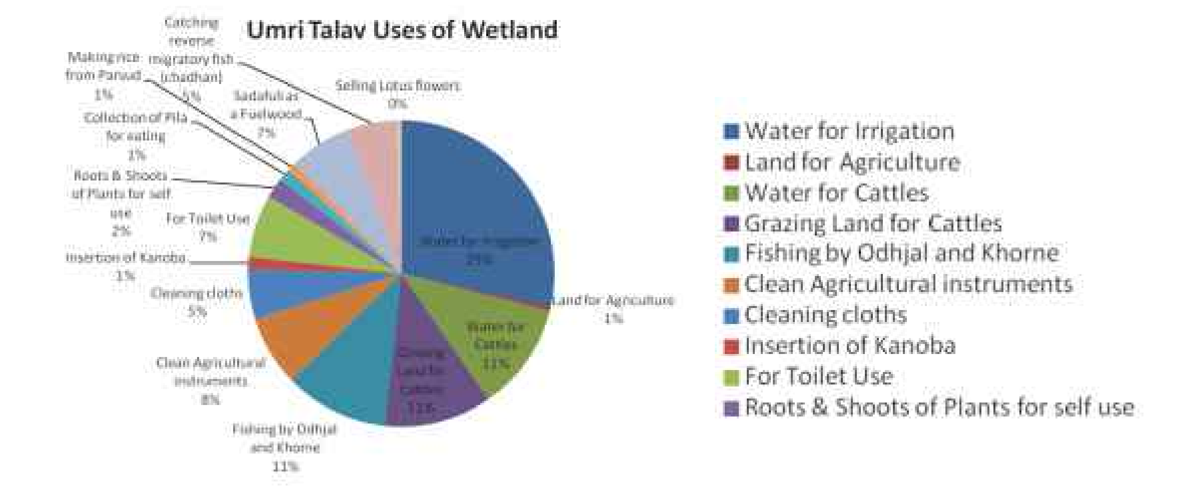
Catchment area map of Umri Tank No.2, Sawartola, prepared by using GPS

Today, total area of the catchment of Umari Talav-2 is 94.5 Hectare. Out of this 65.95 Ha is agriculture land of farmers of Bidtola village. Human habitation area is 1.90 Ha and FTL of the tank is 6.60 Hectare. Two small tanks and two water channels are in the catchment area of Umari talav.

Distribution of species according to area and water depth: Umri, Sawartola

	% of species on Tank Periphery	% of species in Shallow water	% of species in Deep water
Plants	63.51	16.21	9.45
Fishes		60	40
Birds	46	23	31

74 plant species, 15 fish species and 13 bird species are recorded on Umri-2 tank.



Rules and Regulations

From the discussions based on the documentation following rules have been framed for Umri Tank No.2:

The agricultural area in the catchment of Umri Tank is almost 70%. All the farmers are using pesticides and weedicides. Out of 71 farmers in the catchment only 4 farmers practice organic farming for self-consumption. But they are big farmers. Small and marginal farmers are not able to shift from chemical to organic, due to losses and extra labour work in organic farming methods. There is the need for awareness and also accessing schemes for organic farming and market linkages with these farmers.

The use of Cyprinus (Common carp) and Grass carp is needed for management of aquatic vegetation as the vegetation growth is excessive. 20 number of fishes per hectare needs to be released here, according to the fisherman, but they agreed to take overview of the decision every year for deciding the number of fishes to be released.

The aquatic plants diversity will be conserved in this tank to provide habitat for the small indigenous fish species. *Clarius magur* and *Heteropneustis fossilis* are the rare and threatened species. *Puntius chola*, *Salmophasia bacaila*, *Mystus bleekeri*, *Channa gachua*, *Channa punctatus*, *Channa striatus* are the fish species, which have high demand in local market but the production is going down. For this reason also, there is the need to minimize the use of chemicals in the agricultural land in the catchment.

Cow dung cakes collection will not be allowed by anybody. The fishing society will collect the cow dung and throw it in shallow waters.

Open defecation in the area of water body is banned. If found, fine of 500/-Rs will be collected by the gramsabha.

Desiltation activity will be carried out, only through the MREGS, (by labourers) use of machines will not be allowed.

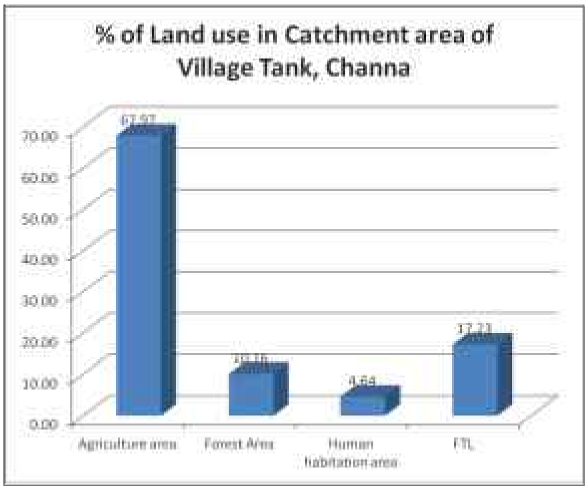
Ipomoea extraction activity needs to be taken up regularly for atleast five years to eradicate it completely. This activity should be proposed through MREGS. The bund area and the left side of the tank, adjacent to village is totally covered by Ipomoea. The BMC has also supported the demand for further follow up.

Plantation of aquatic plants for habitat development should be done through MREGS, after the desiltation activity and Ipomoea extraction.

The control over bore wells in command area needs to be adopted in all tanks in Sawartola as it is emerging as major problem. But people also think that strong act or order from Government can control this as the economically and politically strong people constructs the bore wells, not the common people, and they are not able to stop them.

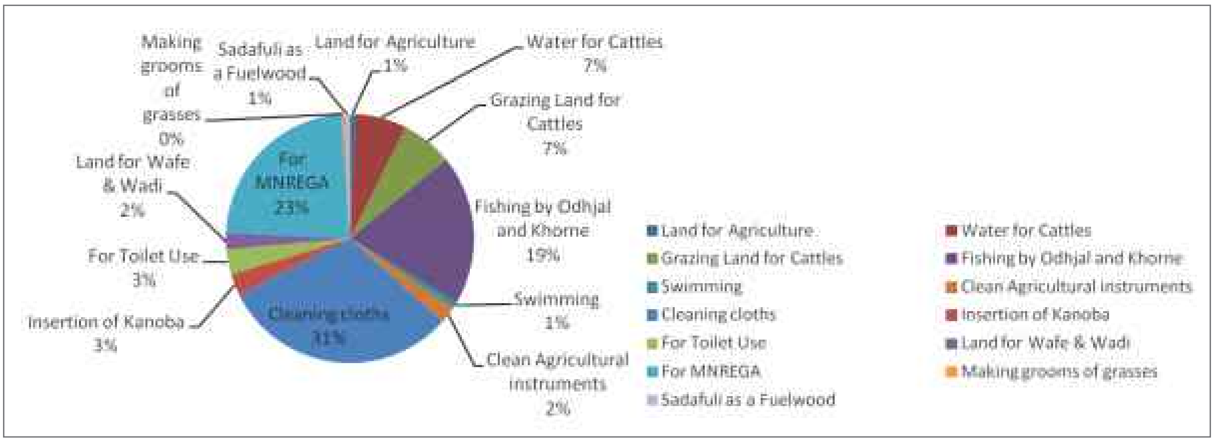
Wetland Management Plan of Gaon Talao Channa

The area of Village Tank of Channa is 32.6 Ha. It irrigates to 178.7 Ha. agricultural land for rice crop. This tank has the catchment area of 253 Ha. Total population of the village is 2156 (516 Households).



Catchment area map of Village Tank, Channa, prepared by using GPS

Use of Wetland Channa Village Tank



Distribution of species according to area and water depth: Channa

	% of species on Tank Periphery	% of species in Shallow water	% of species in Deep water
Plants	79.68	12.51	7.81
Fishes		64.11	35.89
Birds	50	20	30

Rules and Regulations

From the discussions based on the documentation following rules have been framed for Channa Village Tank:

The agricultural area in the catchment of Channa Tank amounts to 68%. Almost all the farmers are practicing the use of fertilizers and pesticides. The people think that this is a long term issue. Awareness generation and motivation for organic farming is needed. As many of the farmers in catchment belong to other village, therefore convincing them is not easy.

Forest area is 10.16% in the catchment. Aforestation activity needs to be undertaken here as the tree cover is vanishing due to illicit felling. The forest protection and plantation of local species needs to be undertaken here. For this purpose, the help of Forest department and Village forest committee will be taken.

The seed of Tilapia has been released in the tank by the fishing cooperative executive members of last regime. They have released those as no other fish was giving the production. There is the need to undertake the plantation of aquatic plants activity in this tank to develop the habitat for rise in the production. This plantation work should be proposed through MREGS.

Desiltation has been carried out in 2017 in this tank through MREGS. But this work also needs to be carried out in other areas of tank.

Ompok bimaculatus, *Ompok pabda*, *Wallago attu*, *Clarius magur* are the rare and threatened species. Habitat development activity for these species needs to be adopted in this tank through MREGS.

Desiltation activity will be carried out, only through the MREGS, (by labourers) use of machines will not be allowed.

Ipomoea extraction activity needs to be taken up regularly for three years to eradicate it completely. This activity should be proposed through MREGS

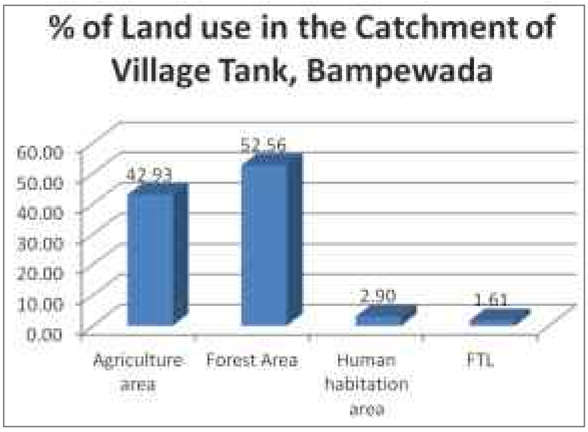
There are already 36 bore wells, and 33 dug wells constructed in the command area. The use of water through them for summer crop needs to be regularized. But here also people think that there should be strong regulation from the Government to implement it at village level.

The cloth washing activity is carried out by 31% of the users of tank. This needs to be regulated as chemical detergents are released and pH value goes high. The means for reducing this or the alternatives are not yet explored as no one has put such data before us. It needs to be addressed through the Gram Panchayat for providing alternative.

The construction of fish rearing tank is needed in this village for improving the production. It should be proposed through MREGS.

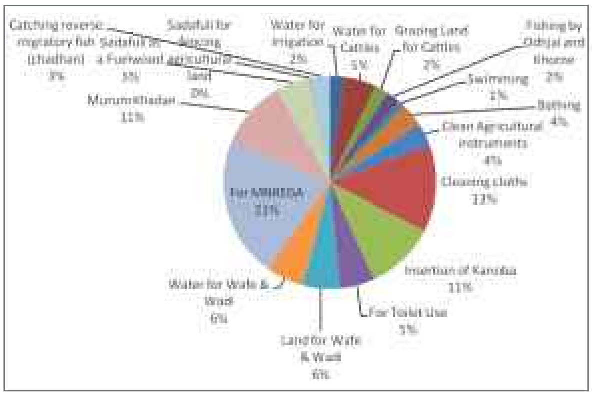
Wetland Management Plan of Gaon Talao Bampewada

The area of Village Tank of Bampewada is 6.96 Ha. It provides irrigation to 176 Ha. agricultural land for rice crop. This tank has the catchment area of 586 Ha. Total population of the village is 2315 (650 Households).



Catchment area map of Village Tank, Bampewada, prepared by using GPS

Use of Wetland Bampewada Village Tank



Distribution of species according to area and water depth: Bampewada

	% of species on Tank Periphery	% of species in Shallow water	% of species in Deep water
Plants	95.23	4.77	00
Fishes		69.23	30.77
Birds	75	16.66	8.34

42 plant species, 26 fish species and 12 bird species are recorded on Bampewada tank.

Rules and Regulations

From the discussions based on the documentation following rules have been framed for Bampewada Tank:

The water distribution of tank for irrigation will be done in accordance with the rules laid down by the water distribution committee of farmers. Use of engine or electrical pump will not be allowed in the tank. Water distribution will be done through the gates only. Dead stock will remain in the tank for fishery purpose.

If anybody wants to use galper land they have to inform it to the fishing society and pesticides will not be allowed to be used in the tank FTL area.

Livestock grazing and water drinking is allowed, but the buffalo owners should follow the restrictions of the fishing cooperative society, as plantation of aquatic plants has been carried out for last years in this tank by the fishing cooperative society.

No villager will be allowed to catch fishes during the season of reverse migration of fishes, as it reduces the fish diversity and also affects the fish production of local species. The fishing cooperative society and Biodiversity Management Committee of Bampewada has jointly taken this decision.

The agricultural area in the catchment of Bampewada Tank is 43%. Though the forest area is 52.56% in the catchment, the water is not coming directly to this tank. It has been stored in a annicut and from there it was diverted towards the tank. Therefore the humus is not coming to tank, along with the water, which reduces the growth of natural fish food. And a trader has the contract of this tank in past, he has introduced Tilapia here, and it is the problem of society to eradicate it. The society has decided to net all the Tilapia and then use lime powder in this summer, as there was very low rainfall this year, so the water spread will be minimal. And after that, the plantation activity will be carried again through MREGS.

The aquatic plants diversity will be conserved in this tank to provide habitat for the small indigenous fish species. *Mystus cavasius* and *Clarius magur* are the rare and threatened species in this tank. They are economically important also for the fishing society.

Desiltation activity will be carried out, only through the MREGS, (by labourers) use of machines will not be allowed.

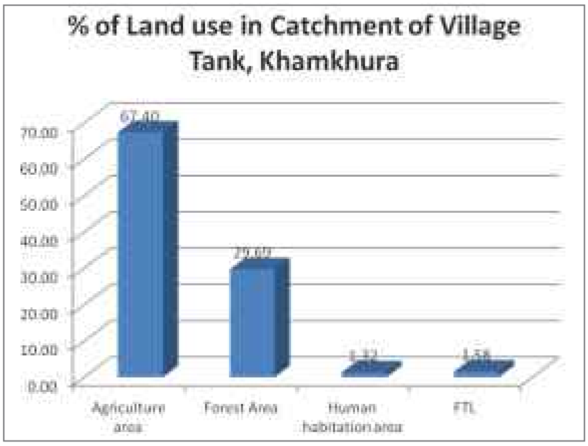
Ipomoea extraction activity needs to be taken up regularly for atleast three years to eradicate it completely. This activity should be proposed through MREGS.

Mining of minerals will not be allowed from the tank. The red laterite soil was taken away from the tank before two years, but it has to be stopped now, as in the absence of top fertile soil, plants growth is affected.

The use and throw material of plastic, after the household programmes in village is banned, as the plastic waste depletes the condition of tank and reduces vegetation growth on ground. The BMC will look over the issue and will display the board of notice on the tank.

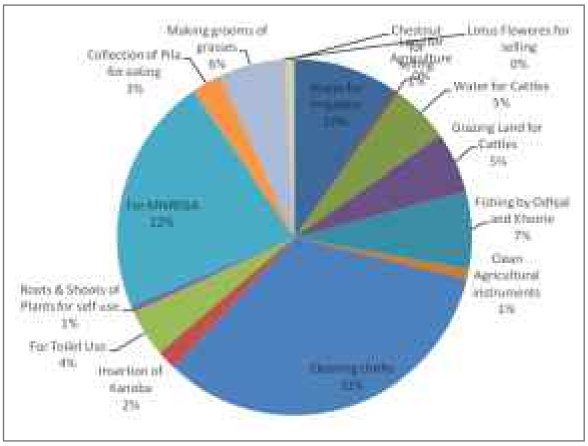
Wetland Management Plan of Gaon Talao Khamkhura

The area of Village Tank of Khamkhura is 6.73 Ha. It provides protective irrigation to 320 Ha. agricultural land for rice crop. This tank has the catchment area of 521 Ha. Total population of the village is 1680 (387 Households).



Catchment area map of Village Tank, Khamkhura, prepared by using GPS

Use of Wetland Khamkhura Village Tank



Distribution of species according to area and water depth: Khamkhura

	% of species on Tank Periphery	% of species in Shallow water	% of species in Deep water
Plants	68.29	17.07	14.64
Fishes		68.42	31.58
Birds	57.89	26.31	15.8

41 plant species, 38 fish species and 19 bird species are recorded on Khamkhura tank.

Rules and Regulations

From the discussions based on the documentation following rules have been framed for Khamkhura Village Tank:

Catching of fishes during the season of reverse migration of fishes is banned by the fishing cooperative and the BMC of this village. Fine of 500/-Rs will be imposed, if anyone catches the reverse migration.

The agricultural area in the catchment of Village Tank is 67.40 %. All the farmers are using pesticides and weedicides, but here also people think that this issue needs to be addressed strategically, as returns from organic farming are not high enough, in comparison with current trend of farming.

Forest area is 29.69% in the catchment. Plantation activity needs to be carried out in forest area. But it falls in the jurisdiction of another village panchayat. Coordination with Wadegaon is needed for this purpose.

The aquatic plants diversity will be conserved in this tank to provide habitat for the small indigenous fish species. 37 indigenous fish species have been recorded in this tank. Out of it *Parambasis lala* is the most threatened species and it is the first report of this species occurrence in Maharashtra. The fishing society has therefore banned the use of very small mesh size in the tank, as this full grown fish is about 5cm.

Encroachment in the tank area should be reported by anybody to the BMC or the fishing society and they will remove it to maintain the area under water body, as it is.

Open defecation in the area of water body is banned. If found, fine of 500/-Rs will be collected by the gramsabha.

Desiltation activity will be carried out, only through the MREGS, (by labourers) use of machines will not be allowed.

Ipomoea extraction activity needs to be taken up regularly for atleast three years to eradicate it completely. This activity should be proposed through MREGS.

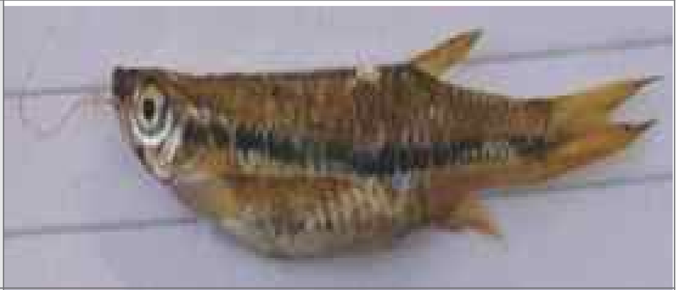
The cloth washing activity is carried out by 35% of the users of tank. This needs to be regulated as chemical detergents are released and pH value goes high. But no proper solution was known, but the issue needs to be addressed.

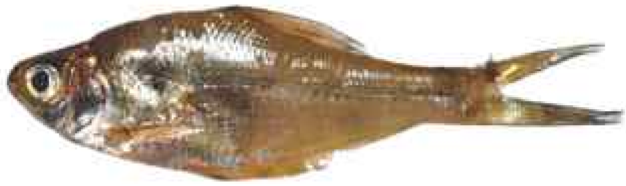
The implementation of these plans will be done through BMC, with the lead from fishing cooperative society. The communication with water distribution committee and inclusion of all stakeholders in decision making is the crucial aspect to form tank management committee. The common topics of interest for farmers and fisherfolks needs to be focused for the consensus. Work in this regard is already going on.

Annexure 2

List of fish species recorded

Fish Species		Status	
I.	**Anguillidae**		
1.	*Anguilla bengalensis*	Indigenous	
II.	**Notopteridae**		
2.	*Notopterus notopterus*	Indigenous	
III.	**Cyprinidae**		
3.	*Amblypharyngodon mola*	Indigenous	
4.	*Catla catla*	Introduced	
5.	*Cirrhinus mrigala*	Indigenous	

Fish Species		Status	
6.	*Danio rerio*	Indigenous	
7.	*Devareo devario / aequipinnatus.*	Indigenous	
8.	*Devareo*		
9.	*Esomus danricus*	Indigenous	
10.	*Labeo gonius*	Indigenous	
11.	*Labeo rohita*	Introduced	
12.	*Labeo calbasu*	Indigenous	
13.	*Oreichthys cosuatis*	Indigenous	

Fish Species		Status	
14.	*Osteobrama cotio peninsularis*	Indigenous	
15.	*Puntius gelius*	Indigenous	
16.	*Puntius sarana subnastus*	Indigenous	
17.	*Puntius sophore*	Indigenous	
18.	*Puntius ticto*	Indigenous	
19.	*Pethia conchonius (Gadad)*	Indigenous	

Fish Species		Status	
20.	*Puntius chola*	Indigenous	
21.	*Rasbora daniconius*	Indigenous	
22.	*Salmophsia bacaila*	Indigenous	
23.	*Garra mullya*	To be identified	
IV.	**Cobitidae**		
24.	*Lepidocephalus guntea*	Indigenous	
V.	**Bagridae**		
25.	*Mystus bleekeri*	Indigenous	

Fish Species		Status	
26.	*Mystus vittatus*	To be identified	
27.	*Mystus cavasius*	Indigenous	
28.	*Sperata seenghala*	Indigenous	
VI.	**Siluridae**		
29.	*Ompok bimaculatus*	Indigenous	
30.	*Ompok pabda*	Indigenous	
31.	*Wallago attu*	Indigenous	

Fish Species		Status	
VII.	**Clariidae**		
32.	*Clarias magur*	Indigenous	
VIII.	**Heteropnustidae**		
33.	*Heteropneustes fossilis*	Indigenous	
IX.	**Belonidae**		
34.	*Xenentodon cancila*	Indigenous	
X.	**Ambissidae**		
35.	*Parambassis ranga*	Indigenous	
36.	*Parambassis lala*	Indigenous	

Fish Species		Status	
XI.	**Nandidae**		
37.	*Nandus nandus*	Indigenous	
XII.	**Badidae**		
38.	*Badis badis*	Indigenous	
XIII.	**Gobiidae**		
39.	*Glossogobius giuris*	Indigenous	
XIV.	**Anabantidae**		
40.	*Anabas testudineus*	Exotic	
XV.	**Osphronemidae**		
41.	*Trichogaster fascita*	Indigenous	

Fish Species		Status	
XVI.	**Channidae**		
42.	*Channa marulius*	Indigenous	
43.	*Channa gachua*	Indigenous	
44.	*Channa puntatus*	Indigenous	
45.	*Channa striatus*	Indigenous	
XVII.	**Mastacembelidae**		
46.	*Macrognathus pancalus*	Indigenous	
47.	*Mastacembalus armatus*	Indigenous	
48.	*Macrognathus aral*	Indigenous