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FLORAL AND FAUNAL WEALTH OF INDIA

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Dr. Vinayaka K. S. obtained his Ph. D. degree in Botany from the Kuvempu University. He is specializing in Taxonomy, Ecology, Cryptogammic Botany and Physiology. He has been teaching and conducting research in Botany for the past one decade. He has worked as head of Botany at Kumadvathi First Grade College and currently he is the Principal of Kumadvathi First Grade College, Shikaripura.

Dr. Vinayaka K.S research interest includes Biodiversity, Lichenology, Phytochemistry, Bioprospecting, Green energy and Phytomedicine. He has published over 120 research paper in National and international journals and has authored some books on Biological science. Dr. Vinayaka K.S has travelled abroad widely and has presented papers in many international conference and workshops. He has contributed several invited articles to many books and has done extensive research on lichens on which he has published about half dozen papers. Dr. Vinayaka K S has received many research awards and grants.

He has completed several projects funded by DST, KSTA, VGST, Rufford, IDEA wild, NSF, MBZ, KFD etc. He also severed as scientific adviser for several NGOs and Committees.

Prof. Dr. M. Bhaskar

Dr. M. Bhaskar is presently working as Professor of Zoology at S.V.University, Tirupati A.P. He was former rector & BOS Chairman in S. V. University, Tirupati. His area of specialization is greatly varied and it includes fields such as Biotechnology, Molecular Physiology, Bioinformatics, Molecular Genetics, Environmental Toxicology and Aquaculture. He completed 26 years of teaching and 34 years of research experience. Dr. Bhaskar has guided 23 Ph.D's, 7 M.Phil. students. He authored 3 books, contributed chapters for 7 books and published 164 research papers in National and International reputed Journals. He has presented his research works in International Conference on Acidic Precipitation held at Toronto, Canada during Sept. 1985 and Federation of American Societies for Experimental Biology Annual Meeting in USA (1988), besides presented his Research works in more than 100 papers in conferences. He was selected for Indian Govt. Fellowship to study at USA (1986-89) and received Rockefeller Foundation Biotechnology Career Award, USA in 1993.

Dr. M. Bhaskar has Visited various countries such as USA (1986-89;1994;1995;1996),Canada (1985), UK (1985;2010;2011), Scotland (2010;2011), Singapore (1995;1996), Sri Lanka (2016), Ukraine (2017), Malaysia (2017) and Brazil (2018) for Scientific training and research collaboration. He organized International satellite conference in Biotechnology (2003), Convener for South Zone Vice-Chancellor's Conference (2002). he worked as principal investigator on major projects and received Rs. 9.90 Crores grant on Medicinal Plants for two years (2018-2020) from DBT, New Delhi. He handled 5 projects funded by various funding agencies with a total cost of Rs. 111.46 lakhs.

Dr. Bhaskar is life member of many national and international research societies. He *recieved Doctorate Degree from Maharishi European Research University, Seelisberg, Switzerland for World Peace in 2018.* His research work on diabetes in relation to polymorhphism in Human Glucokinase enzyme was recognized by GenBank and *in silico* Pyrimidine derivatives designed by us by Pubchem.

Prof. Dr. Zahoor Ahmad

Dr. Zahoor Ahmad is presently working as Professor at Dryland (Karewa) Agriculture Research Station, Budgam, Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir. Dr. Zahoor Ahmad is leading expertise in Maize Breeding (Biotic/Abiotic Stress Resilience, Quality Improvement, Germplasm Enhancement) in india. His major research accomplishments contain mreation of broad germplasm base in yellow and white maize types for use in university maize breeding programe: Yellow (951), White (115), QPM (132), Pop Corn (40), and Sweet Corn (31). He executed successful pre release testing of 155 Private sector maize hybrids of companies Like Monsanto, Syngenta, Bayer, Pioneer, Kanchan, Bioseeds, Nuziveedu, etc. He is breeder of numerous pre release varieties in normal and specialty corn types under various stages of State and National testing.

Dr. Ahmad works as PI and C0-PI for more than 10 major research projects. He pubished 182 research papers and 22 review papers in various national and international journals. He also wrote 4 books in the field of agriculture. He delivered more than 17 guest lectures. He was awarded by many prestigious awards for his research contribution. Dr. ahmad is associated with Crop improvement Programme of SKUAST-Kashmir. A significant contribution was made in the development and release of varieties. The varieties have been released by State Varietal Release Committee and subsequently notified by Govt. of India for exclusive cultivation under temperate areas of Jammu & Kashmir and at all India Level.

Dr. Ahmad participated and presented his research work in more than 50 conferencs, symposia and workshops at national and international level. He is pioneer of various palnt breeding technologies like Hydropriming in Maize, Hybridpurity Validation, Planting Ratio for Seed Plot, Own Saved Seed Protocol, etc.

Prof. Dr. Ammani Kandru

Prof. Ammani Kandru is presently working in the Department of Botany and Microbiology, Acharya Nagarjuna University, A. P. Dr. K. Ammani has over 34 years of research and 30 years of teaching experience in various fields of Botany, Biotechnology and Microbiology. She isolated and identified more than 20 AM fungi. She successfully guided 13 Ph.D's and 10 M.Phil's in different fields of Botany, Biotechnology, Microbiology and Biochemistry and Food and Nutrition and supervising 12 students for their research degrees.

Dr. Ammani has been the recepient of FBS by Indian Botanical society (2013), Fellow of Applied Biotechnology (2009) and a Fellow member of Environmental Science and Biotechnology (2014) Fellow member of Academy of Plant Sciences, India (2018). She is also the recipient of an International award, EAES Award of excellence in Environmental Microbiology (2014). She received the honour of "National award of excellence" and "Best teacher" by Global Management council, Ahmedabad (2016) and "Woman of Excellence" in 2016. Also chosen for the Indian Icon, top 50 Indian achievers for her commendable achievement in the field of education and teaching (2017). Received "Honorary award" and a Special mention certificate for her outstanding research by EET Academic achievement awards, 2017. Very recently Academy of Plant sciences, India honoured with APSI Gold medal as a token of recognition of the rare distinction she has earned in her specialized field of research (Nov.2017). Also she received award for best research publications in the Foundation day celebrations of Acharya Nagarjuna University in 2011, 2012, 2013, 2014, 2016and 2018.

She organized workshops on Patenting and Nanotechnology. Dr. Ammani has published 86 technical papers in renowned International and National journals and communicated 5 papers. She presented more than 150 research papers in National and International conferences in India and abroad (USA, UAE, Sri Lanka, Nepal and Dubai). Recently she delivered a Key note address at an International conference of Advances in Biotechnology, held at Malaysia(July,2018) and Dubai,UAE(July,2017) an Invited lecture at International conference in Nepal(2014) SriLanka (2013) and at John Hopkin's University, Maryland, USA(2012) and chaired the sessions. Along with the publications she contributed several chapters in reputed books and one book entitled as —Flora of Gunadala hill Krishna district, A.P., India. Taxonomic studies of indigenous plants, published by Lambert Academic publishers, Germany.

Dr. Ammani is Member / Life Member of more than 20 reputed prestigious institutes and technical associations like ASM, AMI, BRSI, EAES, ISCA, IANCAS, , ISRS, IBS, SBA, SBTI etc and Fellow member in reputed Associations in Botany, Biotechnology and Environmental Sciences. . She is the Editorial board member for about 6 reputed journals and reviewer for several National and International journals.

Dr. Shakun Mishra

Dr. Shakun Mishra is working as Head Department of Botany, Govt. S. N.P.G.College, Khandwa (M.P.) INDIA. She is doing her research work for Ph. D. on the topic, "Ethnobotany of Korku, Gond and Nihal Tribes of East Nimar (M.P.)". She did her Ph. D. in the year 2011 from D.A.V.V. Indore (M.P.) India. She has 36 years of teaching experience at U. G. level and 26 years at P.G. level. She is actively engaged in research from two decades. Dr. Mishra published 56 research papers in various journals and proceedings (30 national and 26 international), 08 book chapters and associate editor for four books published by Bhumi Publishing, India. She attended and presented 45 research papers in various national and international conferences and also guest lecturer and chairperson in two national seminars. She is member of editorial board for two online journals namely, Journal of Science Research International (JSRI) and Asian Journal of Trandisciplinary Research (AJTR).

Presently, she is Fellow/Life Member of 10 National and International research societies such as Society of Life Sciences, Satna (M. P.), Indian Hydrobiology, Chennai and I.A.A.T., etc. She received some prestigious awards like F.I.C.C.E. in 2004, F.S.L.Sc. in 2005 and F.E.S. in 2013. She completed one M.R.P. funded by U.G.C. and Ex-Chairman of BOS in subject of Botany, Soil Sc., Seed Tech. and Horticulture in D.A.V.V.Indore and also same in Central University Bhopal. *Typhonium flagelliforme* (Lodd.) Blume(Araceae), is reported by Mishra for the first time for Burhanpur District from Madhya Pradesh forms an addition to the Araceae, Flora of Madhya Pradesh.

Dr. Sagar A. Vhanalakar

Dr. Sagar A. Vhanalakar is presently working as a Vice Principal and Head, Department of Zoology, Shri. Mouni Vidyapeeth's Karmaveer Hire Arts, Science, Commerce and Education College, Gargoti, Tal – Bhudargad, Dist – Kolhapur, 416209 M.S., INDIA. He did his Ph. D. in the year 2010 from Shivaji University, Kolhapur (M.S.) India. Dr. Vhanalakar has 10 years of teaching experience and 09 years of research experience. The main area of his research is aquaculture and fisheries, limnology and biodiversity.

There are 40 research papers, 08 book chapters and two books on the name of Dr. Vhanalakar. He attended and presented research papers in more than 50 national and international research conferences. Presently he is working as a principal investigator of one research project funded by University Grants Commission, New Delhi.

He worked as an organizing secretary for one international, one national and 06 university level conferences and seminars. He is presently working as a managing editor for Bhumi Publication, Kolhapur, M.S., India.

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A Review on Botany, Tissue culture and Phytochemical studies of *Celastrus paniculatus* Willd.

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Abstract:

Celastrus paniculatus Willd. is an important medicinal plant commonly known as Malkangani or Black oil plant. It belongs to family Celastraceae. Major parts of this plant are used as a traditional medicine in Ayurvedic system of medicine.This plant contains some important phytochemicals such as celastrol, celapanigin, malkangunin, paniculatine and celapanin. The seed oil of this plant hasintense medicinal properties and extensively used as a brain tonic, memory enhancer and as well as a nootropic. Excessive use of this plant for diverse medicinal purposes puts this plant in danger. For the conservation, it is must to take necessary steps for its mass multiplication. Plant tissue culture technique is widely used for the propagation and conservation of important medicinal plant species. In C*elastrus,* there are several literatures available on *in vitro* propagation for its multiplication. The present review is mainly focused on itsbotany, strategies for its conservation and phytochemical studies.

Keywords: *Celastrus paniculatus* Willd., brain tonic, phytochemicals, Celastraceae

Abbreviations: BAP- [6]Benzylamino purine, IAA- Indole-3-acetic acid, IBA- Indole-3-butyric acid, MS, Murashige and Skoog medium; NAA- 1-naphthaleneacetic acid

Introduction:

Plants have been a source of medicinally important phytochemicals for hundreds of years, which are used to produce natural drugs. These phytochemical constituents cause pharmacological action on human body [1]. Now days, Ayurvedic/herbal drugs are being used due to their minimal side effects. These ayurvedic or herbal drugs requiredocumentation and quality control for the acceptance as herbal medicines. So it becomes tremendously important to make an effort towards standardization of the plant material to be used as medicine [2]. *Celastrus paniculatus* Willd. is commonly known as "Jyotishmati", belong to family Celastraceae. It is distributed throughout India along sub-Himalayan tracts, up to 2000m and in South Indian Hills [3]. The species is vulnerable in the Western Ghats of South India [4]. The plant is useful in the treatment of epilepsy, cognitive dysfunction, rheumatism, insomnia, gout and dyspepsia [5]. The chief phytoconstituents in *C. paniculatus* are malkangunin (sesquiterpene polyster), celapanin celapanigin, celapagin (sesquiterpene alkaloids) and celastrol,

pristimerin, zeylasterone and zeylastral (quinine-methide and phenolic triterpenoids) [6]. The seeds are the main part of the whole plant which possesses the wide range of important phytochemicals. The seed oil obtained from seeds has been used in indigenous system of medicine to cure brain related disorders [7]. Because of its high medicinal importance, overexploitation, excessive harvesting & destruction of habitat, this species has faced the threat and in tropical forests of India and it has reached the stage of vulnerable [8]. This plantcan be propagated by seeds, but the percentage seed germination is very low due to inhibitory compounds present in the seed coat. Rooting of cuttings is also not successful [9]. Plant tissue culture offers the rapid and mass multiplication of important plant species. It refers to the *in vitro* propagation of all plant parts, whether a single cell, tissue or an organ under aseptic and optimal conditions [10].

Taxonomical Position [11]

Kingdom	**:**	**Plantae**
Division	**:**	**Angiosperms**
Class	**:**	**Dicotyledons**
Family	**:**	**Celastraceae**
Genus	**:**	***Celastrus***
Species	**:**	***paniculatus***


***Celastrus paniculatus* Willd**

Botanical description:

Celastrus paniculatus Willd. is a woody climber, with terete branches; the young shoots and branches are pendulous the leaves are glabrous, broadly ovate or obovate, acuminate or acute. The flowers are unisexual, yellowish-green, borne in terminal, pendulous panicles (flowering throughout the year). Fruit is capsule, globose, 3-valved, 3-celled, 3-6 seeded. Seeds are covered with complete orange-red arillus, ovoid, brown Theseeds, which grow inside capsules, number fromanywhere between 1-6 seeds per capsule withdark brown oil, known as celastrus oil or malkanguni oil [12,13].

Chemical Constituents:

A sesquiterpene ester called malkangunin sesquiterpene alkaloids named celapanin, celapanigin and celapagin have been isolated from the plant [14, 15]. The seed contains some important alkaloids such as celapanin, celapanigin, celapagin, celastrine and paniculatin. The seeds are highly rich in fatty acids. Percentage composition of four lipid fractions of the seeds viz. normal triglycerides, polar triglycerides, nonpolar nonglyceridic ester andpolar nonglyceridic Major component acids in these fractions arestearic, palmitic, linoleic, oleic and linolenic. The major molecular species constituting the normal triglycerides are: palmito-oleo-palmitin (6.8%), palmito-oleo-stearin (5.6%), palmitodiolein (14.7%), palmito-oleo-linolein (7.0%), stearo-diolein (6.1%), triolein (8.0%) and dio- leo-linolein (7.6%) [16]. Several sesquiterpene polyalcohols were reported to be present in the saponified 80% methanolic extract of seed oil and malkanguniol is one of the major constituent. Further, four related alcohols *viz.*, polyalcohol A, polyalcohol B, polyalcohol C, polyalcohol D were isolated from the extract along with malkanguniol [17]. Paniculatine A, paniculatine B and wifornine F have been isolated from the stem [18]. Root bark contains β-sitosterol, celastrol, pristimerin, zeylasterone, zeylasteral and terpenes [11]. The non-sapanifiable fraction of the CP seed oil contains paraffinic hydrocarbons, β-sitosterol, β-amyrin and a pentacyclic triterpene diol paniculatadiol. The triterpene diol was assigned structure as olean-12-ene-3β, 29 diol [19]. The sesquiterpene alkaloids are derived from a new sesquiterpene tetra-ol (celapanol) which is alternately esterified with acetic, benzoic, nicotinic and β-furoic acids [15].

Medicinal uses:

This plant has a remarkable reputation in the treatment of cognitive dysfunction, epilepsy, insomnia, rheumatism, gout, dyspepsia [20], edema, stomach disorders, nervous system disorders and as a brain tonic. Seeds of this plant are used in paralysis, leprosy, gout, rheumatism and sores [21, 22]. According to Ayurveda, the seed oil is intellect promoting & used for curing epilepsy seeds yield as much as 52% oil by weight which is also useful in abdominal disorders headache, joint pain, leucoderma, paralysis, ulcer etc. The oil is used as a stomachic tonic good for cough, asthmas and also used in leprosy and has a positive effect on the learning and memory process in mentally retarded children [22, 23]. The powdered root and root bark considered to be useful in the treatment of malaria and cancer [24].

Tissue culture studies:

Sterilization process:

Sterilization process is an essential step for starting the aseptic culture. It is necessary to establishing and maintaining the aseptic culture conditions. For the sterilization process, it is necessary to choose the harmless disinfectantto the soft tissue of explants. Table 1 shows the detailed protocols followed for several explants by several researchers. For *in vitro* propagation of *Celastrus*, the general methodology of sterilization involved the surface sterilization of explants with 70% ethanol for 30-35 s followed by 0.1% mercuric chloride for 5-10 min. and then three time rinses for 3-5 min. in sterile distilled water.

Table 1: Methods used for Sterilization of explants

Explants	Sterilizing agent and dosage	Reference
Leaf, Node, Shoot tips	10% Clorox^{TM}, 70% ethanol	[9]
Node	0.1% (w/v) mercuric chloride ($HgCl_2$)	[27]
Node	0.1% (w/v) mercuric chloride ($HgCl_2$) and Tween 20	[28]
Node	Sevelon, 1% Bavistin, 70% ethanol, mercuric chloride ($HgCl_2$)	[30]
Node	0.1 % (w/v) $HgCl_2$, 0.1 % (w/v) Bavistin,	[31]
Shoot tips, Node, Internodes	1% (v/v) Labolene, 0.1% (w/v) mercury chloride ($HgCl_2$)	[32]
Node	0.1% (w/v) mercuric chloride ($HgCl_2$)	[33]
Node	Teepol, 0.1% (w/v) mercuric chloride, absolute alcohol	[34]
Node	5% (v/v) Teepol, 0.1% (w/v) mercury chloride ($HgCl_2$)	[36]
Seed	0.5% Bavistin (Carbondazim), 70% ethanol, 0.1%(w/v) mercury chloride ($HgCl_2$)	[37]

Culture conditions:

Table 2 shows the culture conditions adopted for the tissue culture studies of *celastrus.* As the studies of previous literature indicate that the culture conditions Viz. light, temperature, humidity plays an important role in initiating the respective cultures.Generally, 40-80 μ $Em^{-2}S^{-1}$ is reported to be sufficient for somatic embryogenesis and shoot multiplication by using apical bud and auxillary bud culture. Further, 12-16 h per day photoperiod by using cool white fluorescent tube is also required for better growth and multiplication.

Table 2: Culture condition required for *in vitro* culture of *Celastrus*

Light intensity	Source	Temperature	Photo period	Study	Reference
3000 lx	-	25±1 ºC	16/8 h light/dark	Callus and shoot induction	[9]
36 μ $Em^{-2}S^{-1}$	-	28±2°C	10 h	Direct multiple shooting	[27]
35-40 μ $Em^{-2}S^{-1}$	Cool white fluorescent tube	24 ± 2°C	12 h	Direct shoot formation	[28]
3,000 lux	-	26±2◦C	16±1 h	Direct multiple shooting	[30]
40-60 μ $Em^{-2}S^{-1}$	Cool white fluorescent tube	28±2°C	14 h	Direct shoot formation	[31]
50-60 μ $Em^{-2}S^{-1}$	Cool white fluorescent tube	25 ± 2°C	12h	Direct shoot formation	[32]
3,000 lux	-	25±2◦C	16 h	Direct shoot formation	[33]
2000 lux	-	25 ± 2°C	16/8 h light/dark	Direct shoot formation	[34]
40 μ $Em^{-2}S^{-1}$	Cool white fluorescent tube	25 ± 2°C	12 h	Somatic embryogenesis	[36]
80 μ $Em^{-2}S^{-1}$	white fluorescent tube	22±3 ºC	16 h	Shoot formation	[37]

***In vitro* culture technique:**

At the present time, Biotechnological approaches are used to conserve many important medicinal plants, especially plant tissue culture. It plays major role to multiply potent species, which are used for production of herbal medicines.*C. paniculatus* have medicinal as well as therapeutic values. Earlier, several reports on *in vitro* multiplication are available in this particular plant which may help in re-establishment of this plant (Table 3). Successful protocol for Callus development in *C. paniculatus* was obtained in MS supplemented with BAP+ NAA. BAP along with IAAgives best result for Multiple shoot formation from shoot apex and node explants while best results for rooting of regenerated shoots were obtained in MS containing IAA+IBA. For acclimatization, a mixture of river sand:top soil:compost (1:1:1) was proved best potting mixture [9]. Similarly, plant regeneration from *in vitro* derived leaf explants of *C. paniculatus*. MS containing BAP was proved best for shoot differentiation.

Elongated shoot were successfully rooted by pulse treatment of IBA [25]. A protocol was developed using nodal shoot segments as explants for mass/clonal propagation of *C. paniculatus*. They achieved four to five shoots differentiated from nodal region within 15-20 days on Murashige and Skoog's [26] medium containing 1.5 mg/1 6-benzylamino purine (BAP) + 0.1 mg/1 naphthaleneacetic acid (NAA) + additives (50 mg/l ascorbic acid and 25 mg/l each of adenine sulfate, arginine and citric acid) [27]. Martin *et. al.*, 2006 reported *in vitro* regeneration of *Celastrus paniculatus* Willd. from node explants. Maximum five shoots were obtained in MS supplemented with BA and NAA [28].Likewise, a reliable and reproducible protocol for plantlets regeneration was achieved through callus cultures. Highest regeneration frequency was found when cotyledonary leaf of *Celastrus* cultured on MS+NAA+Kin. Best results for multiple shoot formation

wereobtained in MS+BA [29]. *In-vitro* effect of various plant growth regulators on propagation of *Celastrus paniculatus* was observed for *in vitro* protocol development [30].

Table 3: Tissue culture studies in *Celastrus*

Explants	Medium	Hormones	Remarks	Reference
shoot tip, Node, Leaf	MS	BAP, IAA	Callogenesis, multiple shooting	[9]
In vitro leaf	MS	BAP, Kin.	Direct shoot bud differentiation	[25]
Node	MS, B5 (Gamborg), SH (Schenk and Hildebrandt)	BAP, NAA	Direct shooting	[27]
Node	MS	BA, NAA	Direct shooting	[28]
cotyledonary leaf	MS	Kinetin, BA, NAA	Callogenesis, shoot formation	[29]
Node	MS	BAP, NAA, IAA	Direct multiple shooting	[30]
Node	MS	BAP, NAA, IAA	Direct multiple shooting	[31]
Nodes, shoot tips, internodes, leaf bases	MS	BAP, NAA, IAA	Callogenesis, multiple shooting	[32]
Node	MS	BAP, NAA, IAA	Multiple shooting	[33]
Hypocotyl segments	MS	BAP, NAA	Callogenesis, multiple shooting	[34]
shoot tip	MS	BAP	Micropropagation	[35]
Node	MS, Gamborg's	BAP, Kin.	Somatic embryogenesis, shooting	[36]
Seed, shoot tip, auxillary bud	MS	BAP, Kin., GA	Multiple shooting	[37]

Further, Nodal segments were used for micropropagation of *Celastrus* by using various plant growth regulators like BAP, IAA and NAA [31]. A rapid *in vitro* multiplication protocol of *Celastrus* was achieved using node explants when inoculated on MS medium supplemented with BAP and IAA/NAA [32, 33, 34].Another tissue culture study was done for its large scale multiplication shoot tip explants with reference to explanting season, which revealed maximum bud break was recorded during April-May [35]. The second way for *in vitro* propagation is via somatic embryogenesis. An efficient protocol has been developed for the induction, maturation and germination of somatic embryos from nodal explants of *Celastrus paniculatus* Willd [36], another protocol for high frequency shoot multiplication was developed using cytokinins in *Celastrus* [37].

Phytochemical studies:

Some important Chemical constituents are revealed by phytochemical analysis were sesquiterpene alkaloids like celapagine, celapanigine and celapanine [38]. Preliminary phytochemical studies in *C. paniculatus* were reported by many researchers with regard to seed and leaves [39, 40, 41]. Phytochemical analysis of *C. paniculatus* leaves was studied. It revealed the presence of carbohydrates, fixed oil, glycosides, cumarins,

tannins, flavonoids, saponins, steroids and triterpenoids [42]. Misra *et. al.,* 2012, reported qualitative analysis of different plant parts like Leaf, bark, fruit, fruit aril and seed of *C. paniculatus*. It revealed presence of different bioactive compounds like saponins, alkaloids, terpenoids, steroids, flavonoids and phenolic compound in most of all plant parts [43]. Martin *et. al.,* 2006 reported qualitative chemical similarity of *in vitro* regenerated plant and mother plant of *Celastrus* using HPTLC [28].A new validated HPTLC method was developed and used for the quantitation of β-sitosterol from the methanolic extract of dried root powder *Celastrus*[44]. Further, various researchers have studied the screening of various bioactive compounds from the different extracts of *Celastrus paniculatus* seed and leaves. Phytochemical screening of different extracts revealed the presence of reducing sugars, anthraquinones, phenols, flavanoids, alkaloids, steroids, terpenoids, phlobotannins, aldehydes /ketones, glycosides, saponins and tannins in Methanol extract, which could account for its varied medicinal properties [7, 45] and some chromatographic techniques like TLC and HPTLC were also used for its qualitative and quantitative analysis [46, 47, 48] .

Conclusion:

Celastrus paniculatus Willd. is now gaining attraction for one of its medicinal properties as a memory enhancer. The indiscriminate harvesting of seed and fruits may lead this plant to the endangered list. So, the biotechnological techniques like plant tissue culture would be very useful to develop a rapid and reliable protocol for multiplication and establishment of this important medicinal plant. Simultaneously, phytochemical study of this plant confirms that it contains important phytochemicals like celapanin, celastrol, malkangunine, celapanigine etc. Mainly the seeds are useful as a brain tonic, whereas the leaf and bark also should be studied experimentally and clinically for their medicinal properties. Ultimately, the research regarding the properties of other parts of this plant (stem bark, root, and leaf) is required to study in deep for its phytochemical properties.

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MAIZE LANDRACES OF KASHMIR: A REPOSITORY OF BIODIVERSITY

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Landraces are the primitive cultivars which are believed to be originated from the process of domestication without any systematic and sustainable breeding efforts. Landraces are highly variable crop populations that have been selected and cultivated by farmers to adapt to local environments and meet various needs. An important characteristic of landraces is that they display considerable genetic variation as compared to improved varieties. Besides good grain and straw quality genes, nature has bestowed these populations the ability or capacity to cope with new coming challenges and other socio-economic issues as they are reservoirs of useful genes having wider adaptability, wide resilience against many kinds of abiotic and biotic stresses such as cold, drought, insect pests and diseases. Plant breeders can use this variation to improve crop's resistance to stresses like cold, drought, heat and continuously evolving pests and diseases to increase yield directly thus meet the needs of increasing population. However, despite being the richest repositories of genetic diversity, source of valuable genes and unique resources for food security, they are becoming more threatened and suffering from genetic erosion. Therefore, there is need to conserve landraces because decrease in crop genetic diversity poses a risk to food security in the future, especially in light of a growing human population. The systematic, coordinated and integrated *in situ* (where the plant is continually grown, managed and harvested in its original agricultural environment) and *ex situ* conservation (where seeds, plants, plant parts, tissues or cells are preserved in an artificial environment. The most common form of ex-situ conservation is through storage of material in gene-banks. The seeds are typically stored in laminated packets which are placed in containers and kept frozen at -18°C) of Landrace diversity is thus described as crucial in preventing the extinction of many of these local ecotypes. The conservationist has to work closely together with farmers in order to manage and monitor their landrace populations aiming at the long term preservation by maintaining genetic richness and evenness of the landrace diversity.

Maize or corn (*Zea mays*) is derived from the ancient word *mahiz* from the Taino language is a plant belonging to the family of grasses (*Poaceae*). The miracle of maize's birth is widely debated in science. Scientists believe people living in Central Mexico Balsas River Valley developed corn at least 8,700 years ago (from where maize spread to other non-traditional areas and even to temperate belts of world and got established as a new crop). However, it is agreed that teosinte (a type of grass) is one of its genetic ancestors. What is unique is that maize's evolution advanced at the hands of farmers. Ancient Mesoamerican farmers realized this genetic mutation of teosinte resembled food and saved seeds from their best cobs to plant the next crop. Through generations of selective breeding based on the varying preferences of farmers and influenced by different climates and geography, maize evolved into a plant species full of diversity

Maize is cultivated globally being one of the most important cereal crops worldwide. The United States, China, Brazil and Mexico account for 70% of global production. India has 5% of corn acreage and contributes 2% of world production. Maize is not only an important human nutrient, but also a basic element of animal feed and raw material for manufacture of many industrial products. The products include corn starch, maltodextrins, corn oil, corn syrup and products of fermentation and distillation industries. It is also being recently used as biofuel.

In the state of Jammu and Kashmir particularly in Kashmir division, maize is the second most important crop after rice. It is a staple food of some tribal areas of Poonch, Rajouri, Bandipora, Badawah etc. where nomadic people such as Gujar and Bakarwall mainly depends on maize. In Kashmir, maize is grown as a sole crop at an altitude range of 1850-2300m above mean sea level. Generally maize is grown as rainfed crop on marginal lands particularly in hilly terrains of the Kashmir valley at longitude and latitude of 73.0-76.2E and 32.50-36.0N respectively. However, it is also found to occupy plain belts of the valley in few pockets where irrigation facility is either absent or inconvenient. In fact the plain belts of the valley (1450-1650m amsl), maize is usually grown as backyard /kitchen garden crop where maize plants are not allowed to go to seed development. The crop is usually consumed just before dough stage as roasted or boiled cob.

The maize landraces are usually genetically heterogeneous populations (each such population comprising a mixture of genotypes), and are typically selected by farmers for better adaptation to specific environment, prolificacy, flowering behaviour, yield, nutritive value and resistance to biotic and abiotic stresses. A maize landrace is mostly defined by the farmer in terms of ear characteristics; the ear type is usually maintained by the farmers through conservative selection in spite of considerable gene flow. In addition to farmer's management of maize landraces (e.g. sample size, selection decisions), the biology of the species (e.g. cross-pollination in case of maize) also plays a major role in structuring the maize populations

There has been significant decrease in maize genetic diversity in the last few decades due to replacement of maize landraces at a faster rate by cultivation of modern hybrids and by adopting modern agricultural systems. The use of a limited number of elite lines and synthetics heightens the risk of genetic uniformity in commercial maize production fields. Thus, maize breeders became more aware of the need for both maintaining genetic diversity among hybrid varieties and improving the management of genetic resources through the conservation of landraces. However, little impact was realized in Kashmir valley in the form of area enhancement under these modern varieties. The most important reason behind the fact was that hybrids are developed for more favourable environments which add non significant gain in the marginal environment. The expensive seed cost further aggravate the situation. In some cases diminishing returns were realized because of their poor adaptability under cold temperate conditions of Kashmir.

Some landrace populations of maize are still popular among the farmers of Kashmir because of their some desirable traits. Farmers are growing landraces from early times either as a sole crop or in some cases intercropped with pulse crops such as beans, green gram etc. to increase the cropping intensity. The farmers go for intercropping because through traditional knowledge system they know the positive impact on compatibility of two crops and soil health aspect. A number of landrace populations of maize have been documented from Kashmir valley but presently few are in the farmer's domain.

Reason of their Popularity:

The main reason of their popularity even in the circumstances of availability of high yielding varieties bred by public and private sector are:

- Good adaptation: Their adaptation to specific agro-ecologies and have usually assumed a niche status. They have very good population buffering.
- Wide resistance to natural factors: These land race populations have wide range of genetic variability and adaptability. They possess the genes for tolerance to various biotic and abiotic stresses. Most important to mention are drought, cold, insect, pest resistance etc.
- They are early maturing and thus vacate the field early and escape the cold injury risk at later stages of crop growth. Snowfall is likely to be expected in the month of September particularly in the hilly terrains when the crop is under dough stage.
- Their very good culm quality usually thin and succulent stems are highly relished by the cattle in the lean season when there is no other fodder crop available.

- As maize is grown usually on marginal lands and under low input environment and the areas where irrigation facility is absent. Since these landraces have much specific adaptability, they thrive best even under low input conditions. Known, locally-adapted, open-pollinated maize with its more variable flowering times is often a "safer" crop under marginal farming conditions.
- Good grain quality: Because of very good grain quality they are mostly preferred over hybrids and synthetics bred by Mountain Crop Research Station (SKUAST-K) meant for the purpose for different agro-ecologies of Kashmir and from outside sources of equivalent ecologies.
- Food and fodder value: These land races usually serve as a staple food of 15% of the population of Kashmir valley. The maize kernels are ground to fine flour (locally called *Makai* a*tta*). The unleavened bread is finally prepared of this flour which is much liked by the local people even the rice consumers of Kashmir. The bread is usually supplemented with locally prepared ghee which adds taste and aroma to the unleavened bread. The byproduct of the grinding process is rough maize flour (locally called *Satoo*) and is consumed with salt tea. It is used throughout Kashmir valley as a breakfast food and is cheaper alternative to bread made up of wheat for low income families. In some cases maize is consumed just like rice. After boiling maize grains a sticky dish is prepared and is supplemented with curd. This is highly relished by elderly people in the hilly areas and locally called makai wart. In the local system of medicine it is recommended to diabetic patients and those having urinary problems. *Satoo* (rough flour) used as breakfast food, *Atta* (fine flour) for bread making and *Makai wart* (boiled kernals of maize just like rice).
- The roasted and boiled cobs of local land races fetch a very good market rate because of very high taste and good sugary content. When fodder values of these landraces are concerned, their thin and succulent stems (culm) are highly relished by cattle and do not leave any part of it unconsumed. Since during winter the valley remains cut off for monthstogether from outer part of the world and these hilly terrains have no alternative except to use maize stover as cattle fodder.
- Conservation of biodiversity: Since farmers are continuously growing these landraces over years, they are conserving and utilizing the maize biodiversity.
- Resistance against climate change: Landraces of maize are best weapons to combat the challenge of climate change. These cultures conserve the tremendous genetic variability which can serve as wealth for overcoming future challenges like new biotic and abiotic stresses in the scenario of climate change. There shall remain no weapon, besides these allelic resources for the crop development.
- These landraces with so many potentials are losing their popularity and are gradually going out of farmers' domain and becoming extinct. These are facing a tough competition from newly developed hybrids and synthetic varieties. The main reasons of losing the farmer's expectations and few challenges before these erstwhile popular landraces are:
- Low yielding potential: Since maize landraces populations are generally low yielders when compared top modern varieties. As a result they are being replaced by high yielding hybrids and synthetic varieties although at a slow rate.
- Low resilience to some biotic stresses: These farmers varieties are showing low or no resistance to worldly famous maize diseases such as *Turcicum* leaf blight and common rust which are taking a heavy toll of the crop. In disease favourable years there is significant damage in terms of low yield production and reduction in straw quality.
- Lower sensitivity to inputs:- These land races are highly stable and adapted under specific agro-ecologies. These respond at a very slow rate to favourable environments and to costlier inputs such as inorganic and bio-fertilizers.
- Socio economic plight of the farmers: - People engaged with maize production are resource poor farmers and are socially and economically backward. They are not growing their landraces on modern

scientific lines. It is the need of hour to conserve these maize landrace populations. There is much probability of these maize cultures to become extinct by the very near future. Big challenge before plant breeders is therefore to collect conserve, genetically enhance and to utilize these populations so as to get themselves prepared for forthcoming challenges.

Utility of Maize Landraces in Crop Improvement:

The utilization of genetic diversity of landraces in breeding programs started with development of the first inbred lines in Yugoslavia form Ruma Golden Dent, Vukovar Dent, Šidski, Beljski and Novi Sad Golden Dent populations. Crosses of self pollinated landraces with American inbred lines, which expressed a high level of heterosis, were the base for development of line-hybrids. First Yugoslav maize hybrids were created from inbred lines of local origin and foreign inbred lines genetically divergent from local germplasm. In modern maize breeding program landraces are used for creation of broad base synthetic populations, development of core collections and as potential sources of favorable traits.

Agronomic performance:

Two objectives in evaluating maize landraces are (a) to identify the best local populations that could be used broadly and, (b) to identify populations that will be starting material for crop improvement. Broad based pools formed using promising landraces for specific traits are excellent material for population improvement programmes. Population improvement through recurrent selection aims at increasing the frequency of favourable genes in population progressively over successive generations, while maintaining reasonable levels of genetic variability. For example, at Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora Utranchal, landraces from Kashmir as well as from Utranachal were effectively utilized for developing a broad based gene pool. Using this germplasm, several inbred lines and hybrids that are well adapted to hill areas were derived. The popular hybrids include Him-129, (yellow, flint, 85-90 days maturity, highly tolerant to Turcicum leaf blight); Him-128 and several 'Vivek' hybrids.

Quality traits:

Characterization of genetic diversity of maize landraces aids efficient exploring of the allelic variation for genetic improvement of economically desirable traits, such as grain quality. Maize is a relevant food source, so the quantification of the nutritionally important grain constituents is important for the best exploitation of different genotypes. In this context, the landraces represent a good source of genetic variability and may help to identify the most suitable materials for the development of more nutritious foods. Many studies have documented genetic and phenotypic variability for grain composition traits in maize. Promising maize landraces with highest concentration of lutein, zeaxanthin and cryotoxanthin (precursor of Vitamin A) have been identified at the Institute for Agrobotany, Hungry and they are being utilized as a source material to transfer these valuable traits in improved elite hybrids and inbreds.

Drought tolerance:

Drought can be defined as the absence of adequate moisture necessary for normal plant growth and to complete the life cycle. It is a "single most common cause of severe food shortage" (FAO) in developing countries and predicted global warming will increase drought impact on crop production. Drought tolerance is the most difficult task for maize breeders to be solved. It is polygenic and complex trait with high genotype x environment interaction. Moreover, this stress occurs randomly in timing and severity, making identification of drought tolerant genotypes more difficult. Genetic Diversity of Maize Landraces as sources of drought tolerance were evolved and examined by CIMMYT for use in maize breeding programs and traits like flowering date

(anthesis-silking interval, ASI), ears per plant (bareness), leaf rolling, tassel size and stay green considering tremendous genetic diversity and importance of drought for maize production.

Source of Male Sterility:

Absence of pollen and plant inability to produce functional pollen grains is known as male sterility. Male sterility can be determined by nuclear (genetic male sterility) or cytoplasmic (cytoplasmic genetic male sterility – CGMS) genes. CGMS (onwards referred to as CMS) is successfully used in commercial production of hybrid seed, avoiding the drawbacks of hand or mechanical emasculation. Identification of CMS types is important because commercial production of maize hybrid seed today stands upon utilization of C and S cytoplasmic types, as self-pollination in plants can severely jeopardize its production. Detasseling (removal of flowers from maize plants by hand) can be replaced by introducing male sterility in maize. This reduces possibility of self-pollination and also saves seed producers millions of dollars per year in labor costs. Three main types of CMS were identified in maize: CMS-T, CMS-S and CMS-C. Male sterile cytoplasm is distinguished by specific nuclear genes (Rf genes) that restore pollen fertility. These genes, restorers of fertility, suppress the male-sterile effect of the cytoplasm, allowing the production of viable pollen. The use of uniform materials can be a threat in crop production and genetic vulnerability must be a constant concern in plant breeding for all species. An example is the extensive use of CMS-T in 1950s and 1960s, which showed to be extremely susceptible to *Helminthosporium maydis* race T. Severe yield losses occurred in the United States in 1970s and the next year in other regions of the world, due to the *Helminthosporium maydis* pandemic. For new CMS sources landrace genotypes worldwide were searched and one source was found within Maize Research Institute gene bank collection. Tester lines containing nuclear Rf genes are traditionally used for identification and classification of CMS types.

Collection and evaluation of maize land races are basic to maize improvement programs for sustainable agriculture. Adequate characterization for agronomic and morphological traits is necessary to facilitate utilization of landraces by breeders. To achieve this, landraces of maize need to be characterized for morphological, agronomic and other stress related traits of interest. There exists a wide genetic variability in maize, making process of selection promising for traits of economic importance.

Improvement of maize landrace populations:

- Since landraces are having wide genetic variability. Their genetic enhancement for yield and other morpho-agronomic traits can simply be obtained by mass selection. Few selection cycles can give a significant genetic gain over the base population. Thus various economic traits can be improved through this method.
- Population improvement programme: Few simple recurrent selection cycles can genetically improve the base population of these landraces because they possess broad spectrum genetic variability within the population for various economic traits. This not only improves the population *per se* but improved inbreds can be derived from the populations for hybrid development.
- Biotechnological interventions: Few economic traits available in maize landraces can be rectified by using the latest tool of biotechnology such as molecular selections and other tools. The current revolution in DNA technologies offers tremendous opportunities to understand the genetic relationships and diversity among maize landraces and improved cultivars. Molecular-marker-based diversity assessment has provided valuable information on the extent and distribution of genetic diversity in global maize germplasm. Next-generation sequencing and high density genotyping technologies, including GBS, will provide greater insights into the structure and organization of maize genome, and speed up the discovery and use of new and useful alleles available in maize landraces for maize improvement. Additionally, intensive and concerted efforts (e.g. LAMP and US-GEM) are needed for a

better understanding of the breeding value of the maize genetic resources available worldwide including landraces.

- Innovative approaches for crop improvement: - New scientific management technologies can be popularized in the farming community like proper crop husbandry practices for better production which in turn can improve socioeconomic plight of the farmers.
- Participating plant breeding (PPB) approaches: PPB will work with farmers aspirations and needs and develop the varieties as per the priorities of clients. This is because in formal breeding programme varieties are generally developed at favourable environments but are proposed for different environments. The released variety is in real practice not in multiplication chain and is thus not available. The expensive cost and long lag phase from development of variety and actual availability to farmers also play a role in slow adoption of good varieties. The resource poor farmers particularly in maize are generally located at marginal environments and such conditions are not being given due consideration. It is here these landraces can be popularized after genetic enhance and genetic purification right in the farmers fields. The community seed production units can be established for informal seed multiplication chain. Thus participatory role is needed where farmers can be directly involved and agro-ecology specific varieties can be designed. This will economize time and resources viz-a-viz maintain the maize genetic diversity in-situ.

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IN VITRO MICRO PROPAGATION OF CUCUMBER (*CUCUMIS SATIVUS* L.) FROM SHOOT TIP AND NODAL EXPLANTS

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Abstract:

A simple and efficient protocol for *in vitro* multiple shoot induction and plantlet regeneration was achieved from two different explants of *Cucumis sativus.* The explants viz shoot tip and Nodal explants were cultured on MS medium fortified with Benzyl Adeno Purine (BAP) in combination with GTA (1.0 mg/L)/Coconut Milk (3.0 to 25%) and Kinetin (Kn) (0.5-6.0 mg/L) in combination with GTA (1.0 mg/L)/Coconut Milk (3.0 to 25%) for multiple shoot induction. Multiple shoots proliferation was best observed at (3.0 mg/L) Kn in combination with (1.0 mg/L) GTA from all the two explants within four weeks of culture. The two different explants tested, Kn was found to be more effective than BAP for shoot multiplication. The highest number of shoots (10.0 ± 0.3) was achieved on MS medium augmented with 3.0 mg/L BAP+1.0 mg/L GTA. The medium supplemented with (3.0 mg/L) Kn better than all other media concentrations in Shoot tip and Nodal explants. Individual shoots were aseptically excised and sub cultured in the same media for shoot elongation. The elongated shoots were transferred to Indole Butyric Acid (IBA) (0.5-1.0 mg/L) and Indole Acetic Acid (IAA) (0.5-1.0 mg/L) for root induction. Rooting was observed within two weeks of culture. MS medium supplemented with (1.0 mg/L) IBA proved better with seventy percent rooting after 25 days of implantation. Most of the roots were long and healthy. Rooted plantlets were successfully hardened under culture conditions and subsequently established in the field conditions. The recorded survival rate of the plants was 76.3%. Plants looked healthy with no visually detectable phenotypic variations.

Key words: Shoot Tip; Nodal explants; Multiple Shoots; Rooting; Hardening

Abbreviations: Benzyl Adeno Purine (BAP), Kinetin (Kn), L- Glutamic Acid (GTA),Coconut Milk (CM), Indole Butyric Acid (IBA), IBA (Indole Buteric Acid)

Introduction:

Regeneration of whole plant through tissue culture is popularly called micro propagation "It is also a type of vegetative propagation in vitro and is rapidly expanding technique' *in vitro* micro propagation is an extremely space saving propagation method (1,2) following the successfully rapid multiplication of orchids by shoot meristem culture (3) there has been an increasing intrest in resent year in application of tissue culture techniques as an alter native means of asexual propagation of economically important plant shoot tip and bud culture are proffered over meristem culture in micro propagation when viral elimination is not part of the objective use of larger explants desirables they are easier to dissect and have much higher survival and growth rates then smaller explants

Cucumis sativus is a annualclimber growing to 2m (6ft 7in). It is hardy to zone (UK) 10 and is frost tender. It is in flower from July to September, and the seeds ripen from August to October. The species is monoecious (individual flowers are either male or female, but both sexes can be found on the same plant) and is pollinated by Insects. The plant is self-fertile. Suitable for: light (sandy), medium (loamy) and heavy (clay) soils and prefers well-drained soil. Suitable pH: acid, neutral and basic (alkaline) soils. It cannot grow in the shade. It prefers moist soil. In the present investigation a simple and reproducible procedure was devised to obtained multiple shoots, and regeneration of complete plantlets from shoot tip and nodal explants of *Cucumis sativus*.

Different plant growth regulators along with Coconut milk and amino acids were supplemented to MS medium and the impact of them were investigated.

A. Shoot tip culture:

Shoot regeneration from shoot apex / shoot tip is direct, relatively simple and is not prone to Somaclonal variation and chromosomal abnormalities. This is an elegant methodology of multiplying *in vitro* sterling from a single shoot with obivious potential when applied to crop plants (4).

Culture of shoot meristem, especially through enhanced branching, permits rapid clonal propagation land a high degree of genetic uniformity of the progeny (5). The meristem technology has been wide sprea practical application in producing virus free plants in *in vitro* in recent year (6 and 7) Although mainly used for virus elimination meristem tip culture has also enabled plants to be freed from other pathogens including viroids, mycoplasms, bacteria and fungi, also, meristem freeze preservation as a method of conservation of germplasam has made possible to utilize when needed (8). Successful generation of entire plants from frozen meristem of *Arachis hypogeas* and *Cicer aurietinum* has been reported (9).

The latest technologies for delivery of generate plant tissues is the biolistic gun which require regenerable tissues. So target tissues may be callus, suspension cells, leaves, meristem tips or any other regenerable explant. Recently, shoot meristem tips have also been used for direct delivery of desired genes in soybean cotton and sorghum (10 and 11) In view of the importance of mericlone technology in phyto pathology and genetic engineering experiment were conducted to achieve direct multiple shoot regeneration from shoot apex in *Cucumis sativus*

Methodology:

Young plants of *Cucumi sativus* collected from outside and were Department of Botany Kakatiya University Warangal. Were collected from one year old plants shoot tips comprising the apical dome and two or three leaf primordial were excised. The explants were washed thoroughly under running tap water, treated with 70% alcohol for 1 minute and washed four times with sterile distilled water, these were surfaced sterilized with 0.1% $HgCl_2$ for 4-5 minutes and washed thrice for 4 minutes each time in sterilized distilled water shoot meristems ranged from 0.6 cm to 0.8cm in length were cultured on MS medium containing different hormonal concentrations and combinations (Table 1, 2).

Culture media and culture conditions:

MS media containing 3.0% sucrose and supplemented with various concentrations and combinations of cytokinine (BAP/Kn) Coconut milk, Glutamic acid and Cytokinins viz. BAP (1.0-6.0 mg/L) and Kn (1.0-6.0 mg/L) in combination on with GTA (1.0 mg /L) + BAP (1.0 -6.0 mg/L) Coconut milk (10-25%) + BAP (0.5 mg/L) NAA (1.0 mg/L)+ BAP (1.0-6.0 mg/L) and GTA (1.0 mg/L) + Kn(1.0-6.0/L) Coconut milk (10 - 25%) Kn (0.5 mg/L) NAA (1.0 mg/L) + Kn (1.0 - 6.0 mg/L) were used. The initial pH of the culture media was adjusted to 5.8 before addition of 0.8 % (w/v) agar agar. The media was dispensed into culture tubes (25 X 150 mm) each containing 15 ml of the culture medium. Capable with non- absorbent cotton and was autocloved at 121^{o}C for 15 minutes. In each culture tube one shoot tip explant was implanted. The cultures were maintained under 16hrs light provided with white fluorescent tubes (40 µ mol m^{-2} s^{-1}) at 25 + 2^{o}C.

Results:

Data on multiple shoot induction from shoot tips cultured on MS medium fortified with different concentration of BAP and Kn, in combination with GTA CM and NAA is presented in (Table 1-2)

Table 1: Influence of BAP in Combination with L - Glutamic acid (GTA) / Coconut milk (CM) on direct multiple shoot induction from Shoot tip explant culture of *C. melo*

Treatment mg/L	% of cultures response	% of callus production	Average number of shoots /explant SE
BAP + GTA			
1.0+ 1.0	40	12	3.0 ± 0.2
2.0+ 1.0	46	13	5.0 ± 0.2
3.0 + 1.0	48	15	8.0 ± 0.2
4.0+ 1.0	55	12	4.0 ± 0.2
5.0+ 1.0	60	10	3.0 ± 0.4
6.0 + 1.0	53	08	2.0 ± 0.5
BAP + CM			
0.5 + 3.0%	48	35	2.0 ± 0.3
0.5 + 5.0%	50	30	3.0 ± 0.3
0.5 + 10%	57	40	4.0 ± 0.3
0.5 + 15%	50	25	2.0 ± 0.5
0.5 + 20%	58	20	3.0 ± 0.4
0.5 + 25%	53	10	1.0 ± 0.3

Effect of BAP + GTA:

The shoot tip explants cultured on MS medium supplemented with different concentrations of BAP (1.0 -6.0 mg/L) in combination with GTA (1.0 mg/L) are presented in (Table-1) and showed in (Fig- I) Direct multiple shoot proliferation was observed in shoot tip cultures in the above the treatment after 4 weeks of shoot tip culture, developed multiple shoots number of shoots increased with increased levels of BAP of the various treatment tested on MS medium fortified with GTA (1.0 mg/L) + (3.0 mg/L) BAP resulted in maximum number of shoots (8.0 + 0.2 shoots / explant) at 2.0 mg/L BAP + 1.0 mg/L GTA resulted in(5.0 + 0.2 shoots / explant) the minimum number of shoots/ explant were observed at (6.0 mg/L) BAP + (1.0 mg/L) GTA. As the concentration of BAP increased up to 3.0 mg/L the multiple shoots number was also increase but as High concentration of BAP (6.0 mg/L) resulted the number of shoots were reduced.

Effect of BAP +CM:

Both BAP and Coconut milk were added in the medium to observe the effect on shoot tip response in *in vitro* of the various treatments tested on MS medium BAP (0.5 mg/L) and CM (3.0-25 %) resulted in maximum number of shoots (4.0 + 0.3 shoots /explant) at BAP (0.5 mg/L+ CM 15 %) (Fig- B). As the percentage of CM increased up to 10% the production of multiple shoots number was also increased. The number of shoots per explants was reduced at high percentage of CM (25%).

Effect of Kn +GTA:

Shoot tip explants showed direct shoots formation on MS medium supplemented with different concentration of Kn (1.0 to 6.0 mg/L) + GTA (1.0 mg/L) 53% cultures responded on (3.0 mg/L) Kn +(1.0 mg/L) GTA with a shoot bud frequency was (10.0 + 0.3 shoots / explant). At (6.0 mg/L)Kn + (1.0 mg/L) GTA induced 40% cultures responded with (3.0 + 0.4 shoots /explant) As the concentration of Kn was increased to (1.0 and 3.0 mg/L) the number of shoots /explants were considerable increased to (6.0 + 0.2 and 8.0 + 0.4 shoots /explant) respectively (Table-2).

Table 2: Influence of Kn in Combination with L- Glutamic acid (GTA)/Coconut milk (CM) on direct multiple shoot induction from Shoot tip explants cultures of *C.melo*

Treatment mg/L	% of cultures response	% of callus production	Average number of shoots/ explant S.E*
Kn + GTA			
1.0+ 1.0	38	20	6.0+ 0.2
2.0+ 1.0	30	24	8.0+ 0.3
3.0 + 1.0	53	27	10.0 ± 0.3
4.0 + 1.0	58	30	7.0 ± 0.2
5.0 + 1.0	63	20	5.0 ± 0.3
6.0 + 1.0	50	10	3.0 ± 0.4
Kn + CM			
0.5 + 3.0%	32	24	3.0+ 1.0
0.5 + 5.0%	35	26	5.0+ 1.0
0.5 + 10%	60	25	6.0 ± 0.4
0.5 + 15%	40	20	4.0 ± 0.4
0.5 + 20%	38	18	3.0 ± 0.2
0.5 + 25%	30	10	1.0 ± 0.4

Effect of Kn + CM:

When Kn was taken in combination with Coconut milk shoot bud differentiation was observed at (0.5 mg/L) Kn + 10% Coconut milk induced (6.0 + 0.4 shoots/explant) with 60% frequency. Kn (0.5 mg/L) in combination with Coconut milk 20 and 25 % showed less number of shoots (3.0+ 0.2 and 1.0+ 0.4 shoots /explant) with 38% and 30% cultures responding.

Discussion:

The result of present investigation show that shoot tip explants from mature plants of *C. sativus* could be induced to produce multiple shoots *in vitro* maximum number of shoots were induced on MS medium fortified with combination of BAP + GTA, BAP +CM and Kn +GTA, Kn +CM(Table 1 and 2)these results are also in agreement with those on *Tectona grandis* (12) *Abizzia lebbeak* (13) multiple shoot induction was also observed in *ziziphus manritiana* (7) and *Vavilla plantifolia* (14) shoot tips cultured on MS+ cytokinin alone as it was observed in the present studies. (15) and (16) have also reported the requirement of both auxin and cytokines for induction of multiple shoots in *Eucalyptus tereticosvis* and Jack fruit respectively. Thus a combination of both auxin and cytokinin improved the efficiency of multiple shoots development although it depended on the combination and concentrations employed. (17) Have studied the effect of different cytokininss viz.BAP, Kn, 2-ip and Zeatin on multiple shoot induction from shoot tip culture in mulberry. According to their observation, BAP and Kn were superior to 2ip and Zeatin. The superiority of BAP over other cytokinins for multiple shoot formation has been reported as it was observed in the present inverstigation in Mulbery.

(19) have recorded the maximum number of shoots/explant culture (22.5) on MS medium containing 5.0 mg/L BAP in strawberry shoot tip culture. (19) Reported the multiple shoot bud induction from shoot apex cultured on MS medium containing BAP in *Gasipium* (20) have studied the shoot meristem culture in 16 cultures of cotton using several media formation. They observed the best shoot developmentation MS media containing Kn alone compared to other media with NAA/IAA in combination with Kn, these results are to the present observation in *Cucumis sativus* which cytokinin with L-Glutamicacid and Coconut milk showed increase number of shoots/explant. (21) have also observed the similar results when they have cultured the shoot tips of F1.hybrid of *Paulo whia.*They found the highest multiple shoot induction on MS +BAP/Kn alone.

In the present investigation direct shoot bud proliferation/ regeneration was found from the shoot apices with out on intervening callus stage which is advantageous because explants could be taken from selected elite plants.

B. Nodal culture:

The axillary / nodal bud induction is one of the most efficient method of micropropagation in plants since the emerging buds, especially from meristamatic organs and tissues posses a great potential for vigorous development (22 and 23) Axillary buds have been found to be most suitable for Clonal propagation in several species *Morus niger* (22) *Morus alba* (23) *Jasminum officinales*(24), *Ixora singaporensis* (25) *Vanilla planifolia (*26) *Ocimum sanctum* (27), *Melia azedarach (*28).

The present investigation describes a micro propagation technique using nodal bud/ Axillary bud culture as the source of direct production of multiple shoots in *Cucumis sativus.*

Methodology:

Plant material:

Nodal segments (1.0 cm -2.5 cm) of *Cucumis sativus* bearing an axillary bud were collected from healthy young branches of 3 months old plants grown in the Research field, Department of Botany, Kakatiya University the explants were washed under running tap water and followed by treating with 5% teepol for 5 minutes. These were washed thoroughly under running tap water and then surface sterilized with 0.1 % w/v Mercuric chloride ($HgCl_2$) for 3-4 minutes and later rinsed at least thrice with sterile distilled water. Sterilized nodal segments were dried on sterile filter paper before inoculation.

Culture media and culture conditions:

The explants were inoculated on MS medium containing 30 gm/L Sucrose fortified with different concentrations and combinations of cytokinins (BAP,/ Kn) and L Glutamic acid, Coconut milk Table (4 and 5) and solidified with 0.8 % agar, all media were adjusted pH 5.8 before addition of 0.8% agar and autoclaved at 121^{o}C under 15 ps for 15-20 minutes.

Culture tubes were maintained at 25+2^{o}C with 16hrs photo period under white fluorescent light (40-60 mol m-2 s-1) for subculture of differentiating explants MS+ BAP /Kn and also in combination with L- Glutamic acid /Coconut milk media was used. The proliferated axillary shoots were transferred to rooting medium after 4 weeks of culture.

***In vitro* shoot multiplication and rooting:**

Shoots developed from the nodal segments (axillary buds) were multiplied on the respective medium, the microshoots were transferred to MS Basal medium or ½ strength MS Basal medium containing IBA/IAA (0.1 -1.0mg/L)rooting was observed within 3-4 weeks.

Results:

The axillary/ nodal bud cultures on the development of multiple shoots and roots are shown in (Table 3 and 4). The nodal buds of *Cucumis sativus* on different hormonal combinations showed varied results. The axillary buds became active within weeks after inoculation and new shoots become distinct by the second and third week with leaves and internodes.

The explants survival from nodal segments of mature plant of *Cucmis sativus* varied with season. According to the present observations, the explants were collected from field grown plants throughout the year to determine the ideal season for culture establishment. Explant collected in August to November period showed

less time for sprouting and quick shoot bud proliferation and also recorded high percentage of explants establishment during this period

The result on nodal bud culture of *Cucumis sativus* culture on MS medium supplemented with Kn/BAP and GTA /CM are presented in Table (3-4).

Table 3: Influence of BAP in Combinations with L- Glutamic acid (GTA)/ Coconut milk (CM) on direct multiple shoot induction from Nodal explants cultures of *C. melo*

Treatment mg/L	% of cultures response	% of callus production	Average number of shoots/ explant S.E*
BAP + GTA			
1.0+ 1.0	42	20	3.0 ± 0.4
2.0+ 1.0	46	23	4.0 ± 0.4
3.0 + 1.0	50	25	8.0 ± 0.4
4.0 + 1.0	62	22	5.0 ± 0.9
5.0 + 1.0	56	18	3.0 ± 0.3
6.0 + 1.0	54	10	2.0 ± 0.4
BAP + CM			
0.5 + 3.0%	35	20	2.0 ± 0.4
0.5 + 5.0%	30	24	3.2 ± 0.4
0.5 + 10%	50	28	6.0 ± 0.3
0.5 + 15%	48	22	5.0 ± 0.4
0.5 + 20%	55	16	4.0 ± 0.3
0.5 + 25%	40	10	2.0 ± 0.4

Effect of BAP + GTA:

The nodal explants were cultured on MS medium with different concentrations of BAP (1.0 to 6.0) mg/L) and GTA (1.0 mg/L) at (1.0 mg/L) BAP + (1.0 mg/L) GTA induced 3.2 + 0.4 shoots / explant with 42% culture response were recorded at (2.0 mg/L) BAP + (1.0 mg/L) GTA produced 4.2 + 0.4 shoots/ explants with 46% cultures were responded. Maximum number of shoots were produced at (3.0mg /L) BAP + (1.0 mg/L) GTA, 8.0 + 0.3 shoots /explant as the concentration of BAP was increased up to (1.0 mg/L to 4.0 mg/L) gradually the shoot bud proliferation was also found to increased and when BAP concentration was increased above 4.0 mg/L or 6.0 mg/L the rate of shoot bud multiplication and elongation was reduced.

Effect of BAP + CM:

The medium containing CM (10% to 25%) more number of shoots were formed explants and also with longer shoots in the medium fortified with (0.5 mg/L) BAP + 10% CM induced maximum number of shoots (6.0 + 0.3) shoots /explant were recorded (Table-4) as the percentage of Coconut milk was increased up to 10% gradually the shoot bud proliferation was also found to be increased.

Effect of Kn +GTA:

Addition of L- Glutamic acid (1.0mg/L) to cytokinin, Kn (1.0 to 6.0 mg/L) tested maximum number of (6.0 + 0.4 shoots / explant) were produced at (1.0 mg/L) GTA and (3.0 mg/L) Kn with high percentage of responding (75%) (Table-4) cultures compared to all other combinations and concentrations tested. As the concentration of Kn was increased from (1.0 mg/L to 4.0 mg/L) gradually the shoot bud proliferation was also found to be increased and multiple shoots were reduced at (6.0 mg/L/Kn + (1.0 mg/L) GTA.

Effect of Kn + CM:

The result on nodal bud culture of *C. sativus* on MS medium fortified with Kn (0.5 mg/L) and Coconut milk (10% to 25%). The medium containing (0.5 mg/L) Kn + 20% CM induced maximum number of shoots

(4.5 + 0.4 shoots /explant) (Table-4) and also showed high percentage (58%) of responding cultures.

Table 4: Influence of Kn in Combinations with L- Glutamic acid (GTA)/ Coconut milk (CM) on direct multiple shoot induction from Nodal explants cultures of *C. melo*

Treatment mg/L	% of cultures response	% of callus production	Average number of shoots/ explant S.E*
Kn+ GTA			
1.0 + 1.0	53	27	3.0 ± 0.4
2.0 + 1.0	60	24	4.0 ± 0.5
3.0 + 1.0	75	30	8.0 ± 0.3
4.0 + 1.0	50	26	6.0 ± 0.2
5.0 + 1.0	40	20	4.0 ± 0.5
6.0 + 1.0	38	18	2.0 ± 0.2
Kn + CM			
0.5 + 3%	53	20	2.0 ± 0.4
0.5 + 5 %	47	26	3.0 ± 0.2
0.5 + 10%	58	28	4.0 ± 0.4
0.5 + 15%	43	22	3.0 ± 0.7
0.5 + 20%	40	20	2.0 ± 0.6
0.5 + 25%	33	18	1.0 ± 0.4

As the percentage of CM was increased up to 10% gradually the shoot bud proliferation was also found to be increased.

A **B** **C** **D**

Figure 1: *In vitro* Micropropagation of *Cucumber* (a) Formation of multiple shoots on MS+Kn (3.0) mg/L + GTA (1.0mg/L) from shoot tip, (b) Proliferation of multiple shoots on MS+BAP (3.0mg/L)+ GTA 1.0 mg/L) from shoot tip, (c) Multiple shoot induction on MS+ BAP (3.0mg/L)+ GTA (1.0mg/L) from Nodal explants (D) Rooting of individual shoots

Discussion:

Influence of explanting season on culture establishment was also noted in *Tridex Procumbense* (29) as we have observed in *C. sativus* similarly this was sown in other medicinal herbs including *Ocimum* species (30).

During the present investigations multiple shoots were induced on MS medium supplemented with various concentrations of cytokinins such as BAP/Kn alone and also in combination with GTA /CM. similarly (31 and 7) have observed the multiple shoot bud induction from nodal segments of *Ziziphus mauritiana* on MS medium supplemented with BAP alone. It was also recorded the same results in *Vanilla Planifolia* on MS+BAP

alone (26), when BAP and Kn Concentration was increased above (2.0) the rate of shoot multiplication and elongation was reduced in the present investigation. Similar results were obtained in *Canavalia nirosa (*31). *Vigna radiata* (32) and *Pisonia alba* (33) shoot tip and nodal were found to be the best explants for multiple shoot formation (21). In accordance with this in the present study also the shoot tip and nodal explants were found to be suitable for multiple shoot regeneration in *C. sativus*.

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ENUMERATIONS OF LICHENS IN SAGARA TALUK OF SHIMOGA DISTRICT

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Abstract:

Lichen morphology is extremely diverse; these organisms come in a fantastic array of colors and vary in size from very small individuals to large structures. There are about 20,000 species of lichens known and they are capable of living in environmental conditions that kill most other forms of life. India is represent by 1200 species and Karnataka represent by more than 750 species. The Sagar taluk in Shimoga district of Karnataka state, India lies between 14º 10' to 14º 17' N and 75º 03' to 75º 22'. The altitude ranges from 580 MSL in the lower part to 750 MSL at high altitudes. The study sites are randomly selected, they are Evergreen, Semi-evergreen, Scrubby forest, Grassland, Areca plantation and Acacia plantation. A total of 133 colonies of lichens belonging to 11 families with 19 genera and 19 species were recorded from 2500 m^2 area sampled. Among the 19 species 14 species were corticolous (on bark), one species is lignicolous (on wood), another one of the species is occurring on leafy substrate. Among these *Lepraria* is maximum in number with 22 colonies followed by *Heterodermia* (16 colonies) and *Lecanora* (14 colonies). *Leptogium chloromelum, Coccocarpia palmicola*, *C. erythroxyli* and *Collema* sp. were distributed in evergreen forest and *Bulbothrix isidiza, Phyllopsora* sp. *Heterodermia incana* and *Parmotrema stuppeum* were occurred in semi-evergreen forests of Sagara.

Keywords: Forest, Lichens, *Parmotrema,* Sagara

Introduction:

Lichens are the one of the simplest form of plants, consisting of green algal cells protected by the strands of fungi. These little plants are the most successful symbiotic organisms on earth and can grow on anything and anywhere. They have the capacity to live economically in the harshest of environmental conditions. These can absorb a small quantity of water from air or dew which helps them to keep metabolically active. They are the dominant life forms on earth, which constitute over as much as 8% of earth's surface [1]. Lichen morphology is extremely diverse, these organisms come in a fantastic array of colours and vary in size from very small individuals to large structures, the morphology of lichens, which is determined by the mycobiont, can be subdivided into main categories; crustose, foliose and fruticose.

The number of described species from India includes 2021 species of lichens [2]. Western Ghats is one of the two biodiversity hotspot in India and it harbours 949 lichen taxa belonging to 929 species, 20 varieties 150 genera and 54 families which is around 45 % of total lichens in India. The crustose lichen dominates in Western Ghats represented by 618 taxa followed by foliose and fruticose lichens which are represented by 269 and 62 taxa respectively. Tamil Nadu has the highest number of lichens with 657 taxa followed by Karnataka, Kerala and Maharashtra with 336, 288 and 91 taxa respectively [3].

The factors responsible for loss of lichen diversity in India include the change in the ecological conditions, forest cover, and loss of habitat and increase of the urban and industrial areas. The anthropogenic activities in hilly regions such as ‘Jhoom' cultivation, agriculture, mineral extraction, tourism, hydroelectric and road building projects are leading to the rapid deterioration of lichen rich habitats. Therefore the present work aims at the study of diversity and distribution of lichens of the Sagar Taluk.

Materials and Methods:

Study Area:

We selected Sagar taluk of the Shimoga District, Karnataka as our study area (Fig. 1). It starts from the crest line of central Western Ghats to the eastern plains and lies between 13°54' and14°18'N and between 074°36' and 075°18'E with an average altitude of 579m. It is a hill with plane land region. It includes several types of forests such as evergreen, semi evergreen, scrubby forests and grassland. The climate of study area is characterized by a monsoon regime. The average rain fall of the taluk ranges from 2000-2600mm per year. The annual mean temperature of this area varies from 15-25°C in the coldest season and 30-35°C in the hottest months. For most part of the year the average humidity of the area may be around 70%. The soil type of the taluk is predominantly lateritic. The total geographic area of the study area is 193,999ha of which 66,125ha (34%) is under the forest cover.

Methodology:

For convenience the study area is divided into 6 macro habitats such as (Evergreen forest, Semi-evergreen forest, Scrubby forest, Grassland, Areca plantation and Acacia plantation). In each macro habitat six 20x5m study sites are randomly selected. Three major substrates viz. Soil, rock and wood (tree trunks, branches, twigs, logs and stumps) are considered as micro habitats. Systematic survey was done regularly in different macro habitats.

Fig. 1: Map of the study area

The representative lichen specimens were collected along with their substratum irrespective of their growth form. Lichens were separated from the substratum with the help of a knife, care should be taken that the fixing organs (rhizine, hold-fast) remain attached to the thallus, as much as possible. The data collected in the field were recorded in the data sheet.

The specimens were identified with the help of morphological, anatomical and chemical characters by consulting recent literature. The identification of collected lichens is done by using standard manual [4].

Statistical analysis:

The data recorded from the every field survey will be maintained in the data sheet. The data will be used to calculate the density, frequency and abundance, the relative frequency, relative density index by referring Cottam and Curtis [5] and Importance Value (IVI) will be calculated by summing the relative values

for species (Species Importance Value- SIV) [6]. Shannon's diversity index was calculated based on the data of occurrence of the species in quadrates, other diversity indices such as Simpson's values (D) Shannon-Weinter equitability index (J). Simpson's equitability indexes (E), Jaccard similarity index were also calculated.

Results and Discussion:

A total of 133 colonies of lichens belonging to 11 families with 19 genera and 19 species were recorded from 2500m^2 area sampled (Table 1).

Table 1: Table showing the diversity of lichens in the study area

Species name	Family	Density	Abandance	Frequency	RD	RF	IVI
Heterodermia speciosa (Wulfen) Trevis	Physciaceae	0.762	2.29	0.33	0.57	9.20	9.78
Graphis scripta (L.) Ach.	Graphidaceae	0.429	1.80	0.23	0.32	6.57	6.89
Buellia indica S.R. Singh and D.D. Awasthi	Caliciaceae	0.333	1.75	0.19	0.25	5.26	5.51
Parmotrema tinctorum (Despr. ex Nyl.) Hale	Parmeliaceae	0.286	1.20	0.23	0.21	6.57	6.79
Lepraria coriensis (Hue) Sipman	Lepraraceae	1.048	1.83	0.57	0.78	1.79	1.58
Graphina norlabiata Patw. and C. R. Kulk.	Graphidaceae	0.048	1.00	0.04	0.03	1.31	1.35
Porina karnatakensis Makhija and al.	Thelotremataceae	0.238	1.67	0.14	0.17	3.94	4.12
Bulbothrix isidiza (Nyl.) Hale	Parmeliaceae	0.190	1.33	0.14	0.14	3.94	4.09
Trypethelium karnatakense R.C. Harris	Tryphetaliaceae	0.524	1.83	0.28	0.39	7.89	8.28
Opegrapha viridis (Pers. ex Ach.) Behlen and Desberger	Graphidaceae	0.381	2.00	0.19	0.28	5.26	5.54
Chrysothrix candelaris (L.) J. R. Laundon	Chrysothrixaceae	0.143	1.00	0.14	0.10	3.94	4.05
Myriotrema masonhalei (Patw. and C. R. Kulk.) Hale	Thelotremataceae	0.048	1.00	0.04	0.03	1.31	1.35
Parmelinella wallichiana (Taylor) Elix and Hale	Parmeliaceae	0.190	2.00	0.09	0.14	2.63	2.77
Lecanora indica Zahlbr	Lecanoraceae	0.667	2.33	0.28	0.50	7.89	8.39
Pyrenula astroidea (Fée) R. C. Harris	Pyrenulaceae	0.238	1.67	0.14	0.17	3.94	4.12
Partusaria sp.	Pertusariaceae	0.095	1.00	0.09	0.07	2.63	2.70
Pyxine cocoes (Sw.) Nyl.	Physciaceae	0.190	2.00	0.09	0.14	2.63	2.77
Dirinaria canfluens (Fr.) D.D. Awasthi	Physciaceae	0.143	1.00	0.14	0.10	3.94	4.05
Ramalina conduplicans Vain.	Ramalinaceae	0.381	2.00	0.19	0.28	5.26	5.55

These lichens are collected from the different substratum such as bark, twigs, logs and leaf. Among 19 species, 16 species were corticolous, 2 species are lignicolous and 1 is folicolous (Fig. 2).

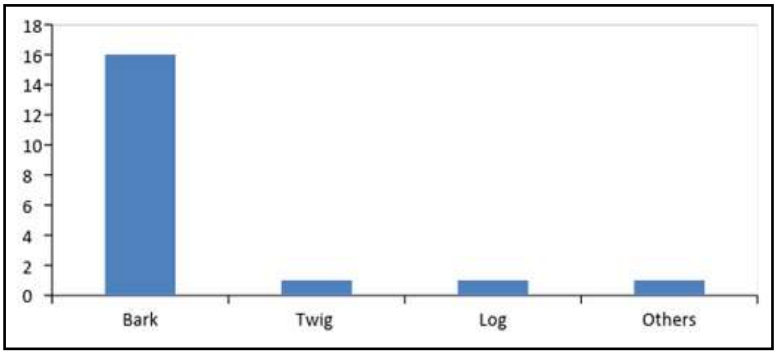

Figure 2: Graph showing substrate preference of lichens in study area

Among the collected lichens different growth forms are observed such as crustose, foliose and fruticose. Out of 19 species of collected lichens 14 crustose, 4 foliose and 1 fruticose are found (Fig 3).

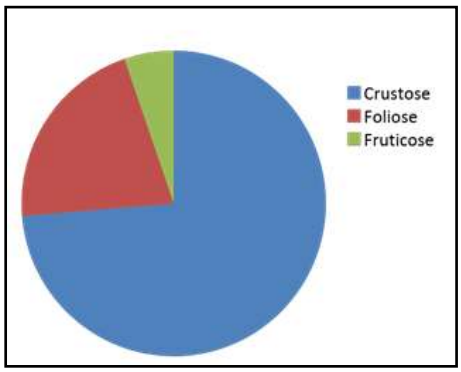

Figure 3: Pi - chart showing the diversity of growth forms in lichens

Based on the appearance lichens are grouped as micro and macro lichens. Among the collected lichens 14 are micro and 5 are macro lichens (Fig 4). The statistical analysis shows that the *Lepraria coriensis* has the highest density of 1.048 and *Myriotrema masonhalei* have the lowest density. *Opegrapha viridis*, *Parmelinella wallichiana*, *Pyxine cocoes* and *Ramalina conduplicans*, have the highest abundance of 2.00 and the lowest abundance of 1.00 is found in the species such as *Graphina norlabiata*, *Chrysothrix candelaris*., *Myriotrema masonhalei*, Partusaria sp. and *Dirinaria canfluens* (Table 1).

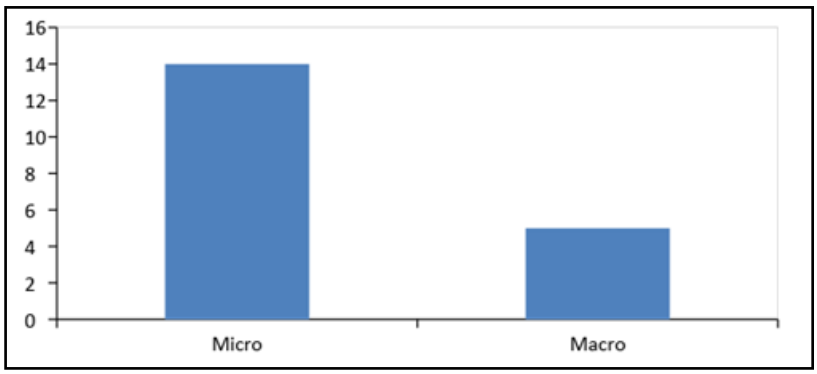

Figure 4: Graph showing the distribution of types of lichens

Negi and Gadgil [7] recorded 200 samples from 16 transects and reported 33 genera belongs to 19 families in comparison with the present study. We have reported 19 genera from 21 transects. When compared with total macrolichen diversity of Sagar our study constitutes 10 percent of the known Indian lichen flora. From Mehao wildlife sanctuary 177 species belongs to 71 genera and 35 families were reported [8], they also reported more species were found on tree bark, similar type of diversity is found in our study also.

Conclusion:

The presence of 133 colonies of lichens belonging to 11 families with 19 genera and 19 species reveals that the study area is rich in lichen diversity. Based on the results of the present study, the study area could be identified as micro climatically important area with lichen rich diversity and should be given a preference for conservation of lichens.

Acknowledgements

We are thankful to Dr. D.K Upreti and Dr. Nayaka S. National Botanical Research Institute (NBRI), Lucknow, U.P for their co-operation during lichen identification and encouragement to carry out the study. We also thankful to The Secretary, Swamy Vivekananda Vidya Samsthe, Shikaripura, Karnataka for providing necessary facilities.

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A SURVEY OF ETHNOMEDICINAL PLANT IN THE BACKWATER AREA OF HARSUD TEHSIL UNDER INDIRA SAGAR PROJECT

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Abstract:

It is presumed that many species of ethnomedicinal plants will be getting endangered / extinct by backwater of Indira Sagar project. Present study enumerates 25 taxa from Ethnomedicinal point of view. These plant parts are used by native and ethnic communities. Most important Taxa are *Achyranthus aspera, Adhatoda vasika*, *Cassia fistula, Pergularia daemia* and *Withania somnifera* etc. Some species have become rare in this region.

Keywords: Backwater, Ethnomedicinal, Indira Sagar, Khandwa

Introduction:

These forest of Madhya Pradesh have always been known for the rich and large varieties of their flora and fauna and were considered a paradise for both herbalists and fauniests. Forest area of Harsud lying between N 21^0 -31 'Latitude and 22^0 -25 'longitude and 303. 32 MSL. The Indira Sagar Project in being executed in the state of Madhya Pradesh which has 20. 81 percent of actual forest cover (64. 01 million ha) of India as per 1985- 87 landsat imageries where the actual forest cover left was only 85.7 percentage (1989 assessment) of 1,55, 414 Sq. Km. recorded as forest.

Materials and Methods:

The present survey was done during 2015 – 17. The study was based on Ethinomedico – botanical survey of nearby ranges of Khandwa Vanmandal viz. some patches of Balari range, some patches of Singaji range and some of Chandgarh. The medicinally important plant specimens where collected and preserved in the herbarium of Botany Department S.N. Govt. P.G. College Khandwa for future record. Important plants where identified by standard literature [1, 2, 3, 4].

Following is the alphabetical list of plants with their scientific names, local name, family and plant parts used in each case for particular disease.

Enumeration of Plants:

1. ***Abrus precatorius* L.(**Fabaceae**)** V. N. - Ghunchi
   Uses - Seeds used in nervous disorder and to cure cattle from poisoning.
2. ***Achyrnanthus aspera* L.(** Amaranthaceae**)** V. N.- Hathijhara
   Uses - Plant decoction is used in rheumatism.
3. ***Aegle marmelos* (L.) Corr. (**Rutaceae**)** V. N. - Bilva, Bel
   Uses - Aromatic pulp of fruit used as cooling and laxative.
4. ***Adina cordifolia* (Roxb.) Hook. (**Rubiaceae) V. N. - Haldu, Kadam
   Uses - Used to expel worms from sores.
5. ***Andrographis paniculata* (Burm.*f*) W Nees. (**Acanthaceae**)** V. N. - Kirayta, Kalmegh
   Uses - Used in debility and dysentery
6. ***Asphodelus tenuifolius* Linn.Cav. (**Liliaceae**)** V. N. - Piazi, Bokat
   Uses - Applied externally to cure ulcer and inflammation.

7. ***Asparagus racemosus*** **Willd.(** Liliaceae**)** V. N. – Sarsarmusli
Uses - Powder of root used as antiseptic and antidiarrhoeal.
8. ***Barleria prionitis*** **L (** Acanthaceae) V. N.- Devkatasla
Uses - 5 ml leaf juice is given twice a day for 7 days in catarrhal infection in children.
9. ***Bauhinia racemosa*** **Lam.** (Fabaceae) V. N.-Astara
Uses - Decoction of leaves used in Headache and Malaria.
10. ***Bauhinia purpurea,*** **L.** (Fabaceae) V. N. - Khairwal
Uses - 10 gm root powder is given twice a day for 1 month to cure septicemia.
11. ***Baliospermum montanum,*** (Willd.) Muell. (Euphorbiaceae) V.N. - Danti
Uses - 20 ml extract of leaves is used twice a day for 7 to 21 days to cure asthma and bronchitis.
12. ***Blumea lacera*** **(Burm.) f. DC. in Wight** (Asteraceae) V.N.- Kukkurdu
Uses - Half cup leaf juice is given twice a day as an anthelmintic. It is given in bleeding piles also.
13. ***Boerhavia diffusa*** **L., Sp. Pl.** (Nyctaginaceae) V.N.- Phathari
Uses - 2 teaspoon decoction of entire plant is given twice a day in oedema and dropsy.
14. ***Bombax ceiba*** **L., Sp. Pl. (**Bombacaceae**) V.N.-**Khatsawar
Uses - The feet are washed with lukewarm water and then the paste of powdered stem is applied on corns once at bedtime for 7 days to get fast relief.
15. ***Boswellia serrata*** **Roxb. (**Burseraceae**) V.N. -** Salai
Uses - 20 gm fine powder of stem bark is given orally twice a day to cure stomatitis and abdominal disorders till cured.
16. ***Bothriochloa pertusa*** **(L.) A.Camus (**Poaceae**) V.N. -** Saroti
Uses - Paste of entire plant is warmed in edible oil and massaged on inflamed parts.
17. ***Butea monosperma*** **(Lam.) Taub. (**Fabaceae**) V.N.-** Khakhari
Uses - 11 flowers are soaked in 200 ml water in a copper pot overnight and mashed next day in the morning and filtered. Filtrate is given as a single dose each day, on empty stomach, for 30 days to cure diabetes and also used to cure urinary complaints.
18. ***Ceropegia bulbosa*** **Roxb. (**Asclepiadaceae**) V.N. -**Gakerkund
Uses - 20 gm powder of tuberous root is given with 1 glass of cow's milk to cure digestion disorders.
19. ***Cheilanthes tenuifolia*** **(Burm. f.) Sw (**Cheilanthaceae**) V.N.-**Dodari
Uses - Rhizome paste with *Curcuma longa* powder is applied on sores.
20. ***Chenopodium album*** **(L.), Sp. (**Chenopodiaceae**) V.N. -** Bathuasag
Uses - Infusion of leaves is used as laxative and anthelmintic, 20 ml for adults and 5 ml for children, given at bed time, for 2 days.
21. ***Chlorophytum arundinaceum*** **Baker in J.Linn. (**Liliaceae**) V.N. -** Safed Musli
Uses - Scape is eaten as vegetable, as a tonic.
22. ***Chlorophytum tuberosum*** **(Roxb.) Baker in J.Linn. (**Liliaceae**) V.N.-**Safed Musli
Uses - Root powder is taken with milk as a tonic after child birth and to cure general debility, in nursing women.
23. ***Indoneesiella echioides*** **(L.) Sreemadh. (**Acanthaceae**) V.N. -** Ranchimani
Uses - 2 teaspoon juice of entire plant is given twice a day in fever for 3 days and only 7 times in jaundice, for a complete cure.
24. ***Iphigenia indica*** **(L.) A.Gray in Kunth (**Liliaceae**) V.N.-** Bharkalai
Uses - ½ cup juice of entire plant is given twice a day in stomachache and piles.
25. ***Lagerstroemia parviflora*** **Roxb. (**Lythraceae**) V.N.- Lendia**
Uses - Paste of stem bark is massaged in rheumatic pains.

The Narmada has a basin of 98, 796 square kms. of which 85, 859 square kms. (87%) is in Madhya Pradesh. A interesting feature is that the river drops from its highest point (1051 M above sea level) by 975 meters in Madhya Pradesh itself. As already mentions, the total forest area coming under submergence by I.S.P. is 40,332 ha. in the district of East Nimar. The Botanical Survey of India Ministry of Environment and Forest (India) which conducted a limited study of the area in 1985 have observed very rich vegetation in this area. The study revealed in all 25 taxa belonging to 23 Genera and 16 families. Further work in this direction is in progress.

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ECOFRIENDLY MANAGEMENT OF PATHOGEN CAUSING POST HARVEST LOSSES OF TOMATO (*LYCOPERSICUM ESCULENTUM M.)*

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Abstract:

Tomato (*Lycopersicum esculentum* M.) is important vegetable crop widely grown around the world and eaten raw in salad ,used in ketchups, sauce and pickles etc. Ripened fruits are great source of Ascorbic acid and minerals. Their large water content and soft endocarp make them susceptible to spoilage by fungi. The spoiled, rotten, often broken ones are usually preferred by low income earners because of their cheap prices. In present investigation, isolation and identification of fungi associated with rotten tomatoes were carried out, to determine fungi involved in tomato spoilage. A study was carried out to find out fungi associated with the spoilage of tomato fruits during their post harvest period. A total eleven strains of fungi were isolated and identified as *Aspergillus niger, Aspergillus flavus, Alternaria solan ,Alternaria solani , Fusarium oxysporum ,Penicillium italicum, Rhizophus stolonifer and Trichoderma spp*. Pathogenicity test of each fungal isolate showed that all fungi were capable of causing rottening of the fruit and most severe rottening was caused by *Rhizopus stolonifer* and *Aspergillus flavus* . Species of *Alternaria* and *Aspergillus* were found to be the disease causing organisms responsible for extensive damage to fruits in the markets of Aurangabad district of Marathwada region. The *in vitro* studies have been performed by using cup-plate method to examine the antifungal activity of some leaf extracts.

Keywords: Tomato, fungi, pathogenicity, *Alternaria solani*, post harvest, spoilage.

Introduction:

Post harvest disease control of fruits and vegetables is important to prevent spoilage of fruits and vegetables and so as to keep them available for long time. Although satisfactory control of the disease by using various chemicals have been documented in the literature [1, 2, 3] during recent years, global concern for protection of the environment has led researchers to investigate the use of natural flora as one of the sources for crop protection [4]. Plant products are an important source of agrochemicals used for the control various post harvest losses which include diseases as well as insect pests. The widely studied plants in this context are the neem tree (*Azadirachta indica*), chinaberry (*Melia azadrach*) and marigold (*Tagetes* spp.). It is observed that both are hydro extract but gives different results for phytochemicals and physicochemical properties. Carbohydrate, glycosides proteins, amino acid, phenolic compounds and tannins were present in both the extracts of *Hibiscus rosasinesis*. They are being used to manufacture natural or bio insecticides, which are environmental friendly and do not have any toxic effects on plants and soil. Moreover, they possess fungicidal and insecticidal properties. It was found that application of 0.2 per cent neem azal formulations papaya fruits resulted in retention of fairly good amount of juice contents and completely eliminate storage rots of fruits. Extract of Datura, *Azadirachta indica*, *ocimum gratissimum*, *Lantana camara* were found effective in reducing the mycelial growth and spore germination of *Alternaria alternate*, *Rhizophus* sp. The discriminate use of fungicides all over the world in general and in India particularly has badly damaged our environment. A large number of fungicides are being used in the form of dusting, slurry and soaking treatment [5]. Time has came to curtail the use of fungicides and option for control of disease by biological control which are target oriented and biodegradable. As compared to chemical control, biological control usually lasts longer and it may prove

economical. Green plants represent a reservoir of effective chemotherapeutants and can provide valuable sources of natural pesticides [6].

Materials and Methods:

Collection of Plants: Plants were collected from nearby Aurangabad region and In pre-sterilized cloth bags and brought to the laboratory for further study.The plants selected for further study were Withania somnifera (L.) Dunal., Ocimum sanctum L., Azadirachta indica A. Juss., Acacia nilotica (L.) The plant parts were collected, shredded and dried completely in oven at 50 0c for 72 hrs.

The control of pathogens is achieved by, such as, Leaf extracts Method

Effect of plant extract:

Medicinal plants have been used as a source of medicine from ancient times. The widespread use of herbal remedies and healthcare preparation are described in ancient text, such as the Vedas and Bible. These are obtained from commonly used traditional herbs and medicinal plants and have been traced to the occurrence of natural products with medicinal properties Meena et al. [8] also reported significant reduction in mycelial growth of Alternaria brassicae using aqueous extract of Allium sativum (bulb) and Acacia nilotica (leaf) in vitro.

Effect of leaf extracts:

Effect of leaf extract is studied by Food poisoned technique

Food poisoned technique:

Evidences for the antifungal activity in plant extracts using poison food technique have been provided by several workers [8, 9]. The effect of plant leaf extract was studied against the Alternaria solani . The leaves of these plants were separated and washed with sterile distilled water. 100 gram of leaves was crushed by using morter and pestle, using 10% alcohol. The extract was filtered using muslin cloth. The plant extract is added in 100 ml of 10% ethyl alcohol. The required concentration of plant extracts were obtained by taking 1.0, 2.0, 3.0, 4.0 and 5.0 ml in 100 ml of warm agar GNA media. The different concentration of plant extracts prepared were 1.0, 2.0, 3.0, 4.0 and 5.0 %. The media was poured in sterilized petriplates. These plates were inoculated by 4 mm disc of Alternaria solani, respectively in the centre aseptically. These plates were incubated at 28 + 10c. The observations were recorded in the form of linear growth of fungal pathogen in millimeter (mm). The linear growth was measured upto the growth in control plate when filled completely.

Results and Discussion:

Effect of Leaf extracts on the growth of Alternaria solani . The different plants used were as follows.

1. *Withania somnifera (L.) Dunal.*

The effect of leaf extract of Withania somnifera on the growth of Alternaria solani was observed. The growth was noted in the form of linear growth in mm. Results are depicted in table no.1. It was seen that, as the concentration of Withania somnifera increases the linear growth of pathogen decreases. In control the linear growth of Alternaria solani on 8th day was 65 mm and the petriplate was completely filled. At 1.0% concentration of *Withania somnifera* the linear growth of *Alternaria solani* was found to be 0,5, 10,12,14.5,17.5,25 and 30 mm on 1^{st} to 8^{th} day of incubation. The growth inhibition of *Alternaria solani* at 4.0% concentration was maximum i.e. 4 mm. At 5.0% concentration there was complete inhibition of the fungus.

2. ***Ocimum sanctum*** L.

Results in table no.2 indicate that linear growth of *Alternaria solani.* Was 6 mm on 8^{th} day of incubation when treatment of *Ocimum sanctum* was given at 4.0% concentration i.e. the maximum inhibition.

On the other hand, the growth of *Alternaria solani* on control plate on 8th day of incubation was 65 mm. At 1.0% it was 51 mm, at 2.0% it was 42 mm, at 3.0% it was 20 mm and at 4.0% it was 6 mm. This means that at 4.0% concentration, the maximum inhibition occurred. At 5.0% concentration there was complete inhibition of the fungus takes place.

Table 1: Effect of *Withania somnifera* (L.) Dunal on linear growth of *Alternaria solani*

Sr. No.	Leaf extract concentration (%)	Linear growth (mm)							
		Incubation period (Days)							
		1	2	3	4	5	6	7	8
1	1.0	00.00	05.00	10.00	12.00	14.50	17.50	25.00	30.00
2	2.0	00.00	00.00	09.00	11.00	13.00	15.00	17.00	20.00
3	3.0	00.00	00.00	06.00	07.00	08.00	12.50	16.00	18.00
4	4.0	00.00	00.00	00.00	00.00	00.00	00.00	03.00	04.00
5	5.0	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
6	Control	20.00	22.00	25.00	32.00	42.00	55.00	61.00	65.00
7.	S.E. ±	2.78	2.92	2.83	3.68	4.94	6.45	7.49	7.87
	C.D at P = 0.01	11.20	11.76	11.40	14.83	19.90	25.99	30.18	31.71
	C.D at P = 0.05	7.14	7.50	7.27	9.45	12.69	16.57	19.24	20.22

Table 2: Effect of *Ocimum sanctum* L. on linear growth of *Alternaria solani*

Sr. No.	Leaf extract Concentration (%)	Linear growth (mm)							
		Incubation period (Days)							
		1	2	3	4	5	6	7	8
1	1.0	12.00	16.00	20.50	27.50	40.50	46.50	47.00	51.00
2	2.0	10.00	14.00	19.00	25.00	30.00	32.00	35.00	42.00
3	3.0	00.00	09.00	11.00	13.00	15.00	17.00	19.50	20.00
4	4.0	00.00	00.00	00.00	00.00	00.00	00.00	05.00	06.00
5	5.0	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
6	Control	20.00	22.00	25.00	32.00	42.00	55.00	61.00	65.00
7	S.E. ±	2.38	2.30	2.70	3.59	5.06	6.40	7.67	8.26
	C.D at P = 0.01	9.59	9.26	10.88	14.46	20.39	25.79	30.91	33.28
	C.D at P = 0.05	6.11	5.91	6.93	9.22	13.00	16.44	19.71	21.22

3. *Azadirachta indica* A. Juss

The leaf extracts of *Azadirachta indica* was used against *Alternaria solani* t o study the effect on linear growth at different concentration. The results shown in table no.3 indicate that, there was maximum inhibition at 4.0% concentration. At this concentration the linear growth of *Alternaria solani* on 8th day was 8 mm in comparision with that of control which was 65 mm. As the concentration of *Azadirachta indica* increases there was decrease in linear growth upto 8th day for each concentration. The various concentration of *Azadirachta indica* such as 1.0%, 2.0%, 3.0%, 4.0% and 5.0% linear growth of *Alternaria solani* showed as 50 mm, 40 mm, 20 mm, 8 mm and at 00 mm respectively.

Table 3: Effect of *Azadirachta indica* A. Juss. on linear growth of *Alternaria solani*

Sr. No.	Leaf extract concentration (%)	Linear growth (mm)							
		Incubation period (Days)							
		1	2	3	4	5	6	7	8
1	1.0	10.00	15.50	26.50	30.00	40.50	46.00	48.00	50.00
2	2.0	09.00	12.50	24.00	26.00	28.50	32.00	36.50	40.00
3	3.0	00.00	00.00	00.00	11.00	11.50	13.00	16.00	20.00
4	4.0	00.00	00.00	00.00	00.00	00.00	00.00	07.00	08.00
5	5.0	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
6	Control	20.00	22.00	25.00	32.00	42.00	55.00	61.00	65.00
7	S.E. ±	2.36	2.67	3.65	3.89	5.32	6.68	7.74	7.98
	C.D at P = 0.01	9.51	10.76	14.70	15.67	21.43	26.92	31.19	32.15
	C.D at P = 0.05	6.06	6.86	9.35	9.99	13.67	17.16	19.89	20.50

Plate showing Infected Tomato

Conclusion:

From the above investigation it is clear that *Withania somnifera* (L.) Dunal is excellent botanical for control of pathogen as compare to other plants, *Alternaria solani* which is one of factor for post harvest losses of fruits and vegetables. Plants contain thousands of constituents which may be valuable source of new and biologically active antimicrobial compounds. Recent advances in the development of botanical fungicides offer opportunities for the worldwide exploitation of botanicals for as replacements for more hazardous and environmentally unacceptable chemical insecticides and for inclusion in integrated disease management programmes. Biologically active compounds present in plant products act as elicitors and induce resistance in host plants resulting in reduction of disease development [10]. Field trials are required to assess the practical applicability of the botanical fungicides and should be incorporated with other management strategies used for the management of plant diseases. It is very necessary part to be consider biosafety studies should be conducted to ascertain their toxicity to humans, animals and crop plants

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BIODIVERSITY AND CONSERVATION

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Abstract:

Biodiversity is a valuable natural resource for survival of human being. Many plants, animals and microbes on the earth contribute directly or indirectly in consumptive, productive, social, ethical and aesthetic values. The human population explosion created numerous ecological problems. The anthropogenic activities are responsible for threatening and extinction of thousands of plant and animal species. The decline in biodiversity graph leads to consciousness at national and international levels for conservation and management of biodiversity. The convention on biodiversity is meant for conservation of biological diversity, sustainable use of its components and the fair and equitable sharing of the benefits arising from the utilization of genetic resources. Sustainable development includes both the development and environmental needs of the present and future generations that are equitably fulfilled.

Introduction:

Ecosystems consist of organisms from many different species living together in a region and are linked by the flow of energy nutrients and interact with one another. Biodiversity is the total complexity of all life forms of organisms showing varying behavior and interactions. The term biodiversity is abbreviated word for biological diversity [1]. Scientist believe that the total number of species on earth is in between 10-80 million of which 1.4 million species have been established so far [2]. However we are losing this heritage of millions of years at a very fast rate. Diversity was probably best described as a mono concept because many sematic, conceptual and technical problems associated with its use [3]. Since 1980 people began working to preserve the biodiversity in the globe. The climax has reached in a major UN conference held in Rio de Janeiro, Brazil where 178 countries were participated. The meeting had a major impact to know and preserve flora and fauna of a country, since then biodiversity became the slogan for conservation of germ plasm [4, 5]. The concept of species diversity in community ecology has been intensely debated by ecologist over the years.

India is a country of vast biological, geographic and climatic diversity. A biological community has an attribute which is called species diversity. The Indian landmass extending over a total geographical area of about 3029 million hectares and is bounded by Himalayas in the north, the bay of Bengal in the east, the Arabian sea in the west and Indian ocean in the south. The landmass is quite rich in biodiversity with a sizable percentage of endemic flora and fauna. Due to rich in biodiversity, India is recognized as one of the world's top 12 megadiversity nation. In India two major centres i.e. the western ghats and eastern Himalayas are identified as the hot spots of biodiversity. The evolution may favour the present day species to become important in future, Moreover the significance of interactions among biota and their cumulative role in biogeochemical cycles can't be ignored [6].

Convention on biodiversity:

The importance of biodiversity is recognized with economic, environmental, scientific and medical point of view, so urgent need for conservation of biodiversity was felt in Rio conference (1992). Attention of general public was attracted at a global level and discussed to save the environment and biodiversity. The Rio convention has defined three levels of biodiversity namely multitude of ecosystems, the number of species and

the genetic variation within each species. The convention on biodiversity had 42 articles and article 8 and 9 are about *in – situ* conservation and *ex-situ* conservation respectively. Both conservations are complimentary to each other. In the convention a country has been declared as its sovereign rights (article 3) and a mechanism to asses and transfer of resources (article 15 & 16) with prior informed consent and mutually agrreable terms (article 15) has been suggested. United Nations has organized several conferences in different parts of the world like Stockholm (1972), Vienna (1985), Montreal (1987), Brazil (1992) to work out the action plan to conserve biodiversity. The world summit on sustainable development was held in Johanesburg in August 2002 and putforth that the conservation of biodiversity was necessary for the survival of human race on this earth.

Levels of biodiversity:

Biodiversity is usually analyzed at three levels such as ecosystem diversity, species diversity and genetic diversity. The ecosystem diversity includes different types of ecosystems like forests, grasslands, lakes, ponds, rivers, wetlands etc. The species diversity includes species of plants, animals and microbes which react and interact with each other and with other abiotic factors of environment. The species richness of each group showed positive correlation with abiotic factors [7]. The Drawin's theory of Natural selection and survival of fittest underlines this process. If two or more species exist in the same habitat ultimately all but one of them will be excluded [8]. It can be inferred that there is no universal relationship between species diversity and the prevalence of favorable condition [9].

The genetic diversity includes variety of genes within the organism. A species with a large number of races, strains or varieties is considered to be rich and diverse in the genetic organization. The conservation of biodiversity is necessary as it conserve genetic diversity as if once a species is lost then there is lose together with its a valuable gene pool. The biologist have argued that biodiversity value is likely to be associated with veriety of different genes that can be expressed by organisms as a potentially useful phenotypic traits or characters but we do not know yet precisely which genes or characters will be of value in the future, first they must all be treated as having value and second the greatest value for conservation will come from ensuring the persistence of as many different genes or characters as possible as a form of insurance [10]. A flowering plant and a giant tree can be seen represent a richer collection of characters in total and so greater diversity value than a pair of similar species of flowering plant [11]. Pursing this idea we will then need to maximize richness in the character currency within the conservationist bank of managed or protected areas.

Types of biodiversity

Healthy ecosystem supports high biological diversity but stressed, unhealthy or highly disturbed ecosystems do not. Whittaker [12] has classified biodiversity into three types such as:

1. **α - diversity:** It is the diversity of a species within a community of habitat.
2. **ß -diversity:** It is a measure of the rate and extent of change in a species along a gradient from one habitat to another. Beta diversity or habitat diversity changes along environment gradient.
3. **γ-diversity:** It is the species richness of a range of habitats in a geographical area. It is a composite of alpha and beta diversity and is the total number of species observed in all habitats within a region.

When each species is found in all habitats within a region then alpha and beta diversities are equal. Ecologists refer to the difference in species from one habitat to the next as beta diversity. The greater the difference or turnover of species between habitats, the greater will be the beta diversity. Environmental heterogenicity increases beta diversity but also has no such effect on alpha diversity [13].

Biodiversity of forest:

The forests are important terrestrial ecosystems on earth. They are vital to the ecological functioning of the planet and producing 60 % of the net productivity of all terrestrial ecosystems. They form the habitat for a

large portion of the earth's flora and fauna and providing the basis for the biodiversity which is essential for the future of the biosphere. They form the basis of range of industries and products. Use of forest produce imposes heavy pressure on forests, hunting of wild life, use of grass with some commercially important plants used as fodder. one square meter of forest soil may contain upto 1000 species of invertebrates and more than 200 species of arthropods, 1000 species of nematodes, 115 species of termites and 275 species of ants [14].

The changes in industrialization has made to the environment in the past 200 years have resulted in a major increase in the extinction rate of flora and fauna. Between 1600 – 1950 this rate went upto one in ten years and then to every year. With large scale destruction of tropical forests about 140 species of invertebrates are facing extinction every day, counting only the large and spectacular species we are responsible for the loss of 63 species of Mammals and 88 species of birds in the last 400 years. Perhaps around 10 % of the worlds plants are threatened with extinction [15, 16]. It is estimated that in the early 1980's tropical forests suggest 0.6 % is lost annually [17]. The 10 tropical forest hotspots characterized both by high level of plant endemism and by serious level of habitat loss [18]. The degradation of forest habitat may be due to tsunamis, forest fires, volcanic eruptions, glaciations and desertification, human related causes, agriculture, urban sprawl, unsustainable forestry practices, mining, petroleum exploration etc.

Biodiversity of Soil:

The density and diversity of soil biota is fragile and highly susceptible to anthropogenic factors. The biodiversity of soil includes all major groups of bacteria, fungi, algae and most of the animal phyla. Mesofauna and Macrofauna create microhabitats for others by reworking soil. The soil biota with an anticipated figure of more than 10 million invertebrate species occurs in soil [19]. A handful of fertile soil contains billions of microbes, millions of protozoan, thousands of nematodes, hundreds of enchytraeid worms, mites, collembolans, few earthworms, isopods, millipedes, centipedes, spiders, beetles, gastropods etc. [20]. Availability of nutrients is the main factor for species diversity in soil. The impact of soil erosion on crop productivity has recently received much attention. Even small losses of top soil can cause drastic reaction in crop productivity because of the nutrient concentrations in the top soil.

Global biodiversity:

The approximate floral and faunal diversity in the world is shown in table 1.

Table 1: Approximate number of major groups of flora and fauna [21]:

Sr. No.	Major groups	No. of species (in thousands)		Sr. No.	Major groups	Number of species (in thousands)
1	Angiosperms	250		8	Mammals	04
2	Gymnosperms	01		9	Reptiles	06
3	Bryophytes	17		10	Amphibians	04
4	Fungi	50		11	Crustaceans	40
5	Cyanobacteria	02		12	Insects	750
6	Bacteria	04		13	Molluscs	50
7	Birds	09		14	Teleost	19

The diversity of flora in India is shown in table 2.

Table 2: Plant diversity in India [22]:

Sr. No.	Plants	Wild relatives		Sr. No.	Plants	Wild relatives
1	Millets	51		7	Bamboo	Above 100
2	Pulses & Vegetables	55		8	Indigo, Tea, Coffee & Sugarcane	12
3	Spices	27		9	Trachaeophyta	50.9 %
4	Fibre crops	22		10	Chlorophyta	15.6 %
5	Coconut	104		11	Rhodophyta	25.6 %
6	Rice	12		12	Pheophyta	7.9 %

Biodiversity of wetland:

Wetlands are transitional zone that occupy intermediate position between dry land and open water. They are an area of marshes, peat land or water, whether natural or artificial, temporary or permanent, static or flowing, fresh, brackish or salt, including areas of marine waters. Wetlands are important repositories of biodiversity. However agricultural practices and urban and industrial expansion have pushed them to the brink in such a way that they have either dried up or have been degraded. Wetlands serve as the breeding ground for many migratory birds and fishes. Once a wetland is destroyed, the life cycle pattern of these organisms that has taken geological time to evolve would be disrupted. It is estimated that India has about 4.1 million of wetlands including natural and manmade. It harbors enormous diversity of floral and faunal species, many of which are endangered like bustard, crocodile, musk deer, blue whale, black buck, chinkara, wolf, nilgai, antelope, flamingo, crane etc.

Diversity of threatened plant and animal Species:

One of the major threats to biodiversity is space, food and raw material for expanding human and plant establishment. Raven [23] stated that out of 300000 species of vascular plants, 170000 are tropical and subtropical, of the 130000 tropical plant species about 60000 are threatened and at a risk of extinction and out of 80000 temperate plant species about 8000 are threatened. Due to human population and its impact on ecosystems thousands of species and subspecies become extinct every year. According to a global survey, we are losing 10000 organisms a year. Pimm [24] estimated that extinction rates of species are 100 to 1000 times their pre human levels. The deep sea benthic biota with a projected figure of more than 10 million invertebrates species are in danger. Ecosystem within the hot spots cover less than 2 % of earth's land surface, over 131,000 species are found within them as endemics. Population growth and migration in these species rich regions have made conservation efforts more urgent. At present every nation is conscious about its natural reserves and trying to catalogue local flora and fauna. The changes in industrialization has made to the environment in the past 200 years have resulted in a major increase in the extinction rate. Between 1600 – 1950 this rate went upto one in ten years and then to every year. Estimate is made in 1980's for subtropical forests suggest that about 20104 m^2area is lost every minute [25].

Conservation and management of biodiversity:

The geological history of biodiversity is about 3.5 to 4 billion years old. The first appearance of multicellular organism was perhaps a mile stone in the history of biodiversity. Conservation is one way to accomplish the goal of sustainable development [26]. Water economy is the first step in the conservation

process and the strategy requires creating awareness such as to save that drop of water among the people for the need of water conservation. The conservation methodologies include *In-situ* preservation and *Ex-situ* preservation. In last few years the world has awakened to realize the problems of environment. Ethical, utilitarian and ecological services can be also used for the conservation of soil biodiversity [6] .

India has framed laws for the protection of biodiversity through the wild life protection act (1972), The forest conservation act (1980) and The environment protection act (1986). These acts are formulated to stop the killing of wild animals and the destruction of forests. The first step in the conservation should be defining the categories of materials (Plants/genes) for preservation and the major methods preserving them. The Environment Impact Assesment (EIA) has now been made compulsory before any project is started. This covers the impact of any project on the environment and biodiversity.

***In-situ* conservation of biodiversity:**

In – situ conservation is a mode of conservation of flora and fauna in their native ecosystems or even in manmade ecosystems where they naturally occur. In 1970, UNESCO through its Man and Biosphere Programme (MAB) initiated a project to conserve natural areas throught the world by establishment of biosphere reserves. The main aim of the programme was to create sample ecosystems in a natural state in order to maintain biological diversity, conserve genetic resources, and provide education, research and continuous monitoring of biosphere. Development of gene sanctuaries, biosphere reserves, national parks, protected areas, reserve forest, national monuments, cultural landscape where wild life could grow and multiply constitute the vital form of *in-situ* conservation. The wildlife therein is regularly monitored and necessary management strategies for their perpetuation and preservation are formulated and implemented.

***Ex-situ* conservation of biodiversity:**

Ex-situ conservation is a mode of conservation of wildlife in captivity and under human care. It includes Zoo's, Aquaria, botanic gardens and germplasm banks. It contributes in many ways to the conservation of biodiversity. Botanic gardens, germplasm and seed banks are important tool for maintaining species and genetic diversity. The seeds of many species so called orthodox seeds can be stored in low temperature in containers. In this endangered plants and animals are collected and breed under controlled conditions in gardens, zoos, sanctuaries etc. Land races is innovative technique suggested for maintaining both genetic diversity and knowledge of farming systems where traditional varieties are being lost involves the use of village level landrace custodians. The wildlife management in captivity have the benefits like organisms are assured of food, water, shelter and security so can have longer life span of breeding activity thereby increasing the possibility of increase in number of offspring, chances of survival of endangered species increases and it offers the possibility of using genetic techniques to improve the species concerned

In India there are some important gene bank / seed bank facilities available in different organizations i.e. NBPGR (National Bureau of Plant Genetic Resources), NBAGR (National Bureau of Animal Genetic Resources), NFPTCR (National Facility for Plant Tissue Culture Repository), NBFGR (National Bureau of Fish Genetic Resource), National Crop Genetic resource centre, International centre for genetic engineering and Department of Biotechnology are also established for the purpose of conservation of biodiversity.

Sustainable development of biodiversity:

The idea of sustainable development was first used in the world conservation strategy by IUCN, 1980. The strategy of development includes the maintenance of ecological processes, sustainable use of resources and maintenance of genetic diversity. Sustainable development should emphasize on steps due to which both the economy and the environmental quality would be stabilized. Some measures can be taken such as reviving economic growth, changing the quality of growth, meeting essential needs for jobs, food, energy, water and

sanitation, ensuring sustainable level of population, conserving and enhancing the resource base, reorienting technology and managing risks, merging environment and economics in decision making processes and effective participation of the citizens in decision making processes. The successful development depended upon biodiversity conservation especially forest conservation, wildlife management, soil conservation and energy conservation. Life exists everywhere; even a drop of pond water offers a multitude of different microscopic plants, animals and less complex life forms. It is required to develop technologies to fully utilize our limited water resources and to safe guard those resources against pollution.

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DIVERSITY OF ANTS IN COFFEE AND ARECA NUT PLANTATION OF CHIKKAMAGALURU

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Abstract:

Insects form a major part of the animal biomass in the ecosystem. Ants are known to be ecologically significant invertebrates in many ecosystems. Ants can be effectively used in indicator studies because they immediately respond to any alteration in the surrounding environment. The main objective of this study was to find out ant diversity and distribution in two different habitats of Chikkamagaluru. The study was conducted in coffee plantation of Hirekolale and areca nut plantation of Kartipete in Chikkamagaluru. Ants was sampled during January 2015 to April 2015for the period of four months. Ants were collected with the help of pit fall trap, scented trap method and hand picking methods from sampling sites. From the two study sites total 22 species were collected belonging to 4 sub families. Among the subfamilies reported from study area Myrmicinae were dominant with 9 species (40.90%) followed by Formicinae with 8species (36.36%) Dolichoderinae with 3 species (13.6%) and Ponerinae with 2 species (9.09%).The coffee agro ecosystem is rich in diversity of ants than areca nut plantation due to its rich floral diversity.

Keywords: Diversity, ants, plantation, Chikkamagaluru.

Introduction:

Ants are known to be ecologically significant in many ecosystems. Ants belong to the family Formicidae included in order Hymenoptera. Ants are found everywhere, except in Iceland, Green land and Antarctica [1, 2]. Ants occupy a wide range of ecological niches, and are able to exploit a wide range of food resources either as direct or indirect herbivores, predators and scavengers. Because of their great abundance, functional importance and the complex interactions with the rest of the ecosystem, ants are often used as bio indicators. Ants play important role in predation, nutrient flow and soil improvement [3]. The family Formicidae contains 21 subfamilies, 283 genera and about 15000 living ant species of which 633 ant species belonging to 82 genera13 subfamilies are reported from India [4]. The main objective of this study was to find out ant diversity and distribution in two different habitats of Chikkamagaluru. The work regarding ants faunal survey is very least explored in this region. Our work provides list of ants located in the premises of Chikkamagaluru.

Materials and Methods:

The study was conducted in coffee plantation of Hirekolale and Areca nut plantation of Karkipete area of Chikkamagaluru during January 2015 to April 2015 for the period of four months. The ants were collected by using pit fall traps, scented trap method and hand picking methods from sampling sites. The pit fall trap consists of one litre plastic jar with an opening of 5cm in diameter and was placed in ground level. Each jar consists of 10 ml of 70% alcohol. In scented trap method, Plastic jar of 15 cm capacity was used to fabricate allowing gap of 3cms between the mouth of the jar and a plastic plate. Collected ants were photographed. Ants were identified up to the species level by using stereomicroscope. The collected ants were preserved in 70% ethyl alcohol.

Results and Discussion:

Ant diversity in coffee plantation of Hirekolale and areca nut plantation of Kartipete in Chikkamagaluru has been analysed in this study. In the present study, 22 species of ants belonging to 13 genera that spread over 4 subfamilies (Table 1) were recorded. Highest diversity was by the subfamily Myrmicinae with 9 ant species (40.90%), followed by Formicinae representing 8 species (36.36%) was the second dominant subfamily. Dolichoderinae with 3 species (13.6%) and Ponerinae with 2 species (9.09*%), Camponotus*was the most species rich genera. *Pheidologeton* were found in soil or under rocks. They feed on small insects. *Crematogaster* ants were arboreal and feed on other insects. *Monomorium* ants nested in the soil and under rocks. *Pheidole* ants or big headed ants build nest in soil and flower buds. *Tetramorium* ants nested in the soilor in decaying wood or in trees and they feed on insects and fruits. *Camponotus* or carpenter ant builds nests inside dead and damp wood. *Tapinoma* ants build nests under bark of logs and in plant cavities and they feed on insects and nectar. *Anoplolepis*or yellow crazy ant shows erratic movements when disturbed and build nests under leaf litter or in the ground and they feed on insects, seeds and nectar. *Solenopsis*or fire ant build nest in soil under logs and rocks and they feed on young plants and seeds. *Oecophylla* or weaver ants were arboreal and construct nests by weaving together leaves using larval silk and they feed on insects. *Technomyrmex* build nests under bark of trees and under rotten logs. *Leptogeny s*builds nest in the soil or under the leaf litter. *Diacamma* were nested in soil or under rotten logs. The high diversity of ants documented during this study is due to adequate nesting sites and availability of food in the study area.

Table 1: Ant species collected in coffee and areca nut plantation

Sr. No.	Sub Family	Genera	Species
1	Myrmicinae	*Crematogaster*	*scutellaris* *rothneyi*
		Monomorium	*scabriceps* *indicum*
		pheidole	*megacephala* *pallidula*
		Pheidologeton	*diversus*
		Solenopsis	*geminata*
		Tetramorium	*bicarinatum*
2	Formicinae	*Camponotus*	*compressus* *gigas* *saundersi* *irritans* *floridanus* *pennsylvanicus*
		Oecophylla	*smaragdina*
		Anoplolepis	*gracilipe*
3	Dolichoderinae	*Tapinoma*	*melanocephallum* *erraticum*
		Technomyrmex	*albipes*
4	Ponerinae	*Leptogenys*	*diminuta*
		Diacamma	*rugosum*

In Hirekolale coffee plantation, 12 species belonging to 4 subfamilies were recorded (Table.2).Among them 4species (43%) belonging to subfamily Myrmicinae. 3 species (26%) belonging to subfamily Formicinae. 2species (16%) belonging to subfamily Dolichoderinae and 2 species (16%) belonging to subfamily Ponerinae.

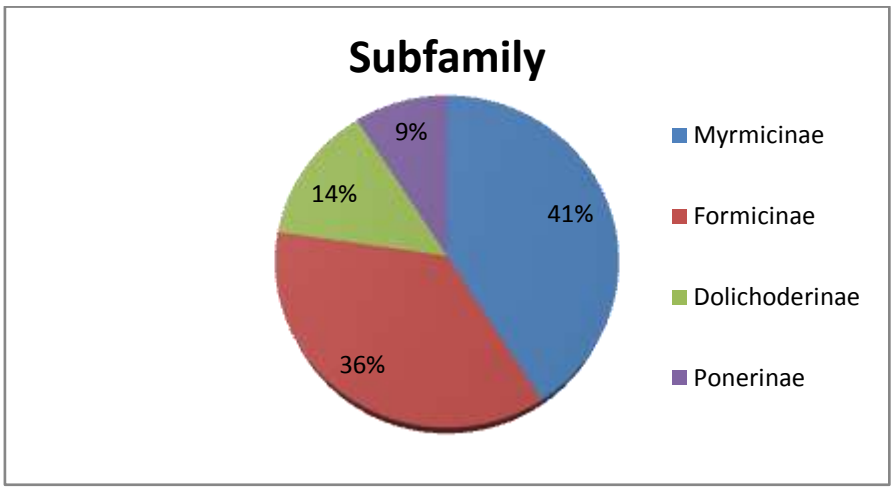

Figure 1: Distribution of ant species collected in coffee and areca nut plantation

In Areca nut plantation, 10 species belonging to 4 subfamilies were recorded (Table 2). Among them 5 species (60%) belonging to subfamily Myrmicinae. 4species (27%) belonging to subfamily Formicinae. 1 species (6%) belonging to subfamily Dolichoderinae and 1 species (6%) belonging to subfamily Ponerinae.

Table 2: Comparison of Ant species between areca nut and coffee plantation

Sr. No.	Sub families	No. of species	
		Areca nut	Areca nut
1	Myrmicinae	5	4
2	Formicinae	3	3
3	Dolichoderinae	1	2
4	Ponerinae	1	2

Totally 22 species representing 4 subfamilies were documented from coffee and Areca nut plantation. All four sub families were common in both areca nut and Coffee plantation. The coffee agro ecosystem is rich in diversity of ants than areca nut plantation (Fig. 2) due to its rich floral diversity.

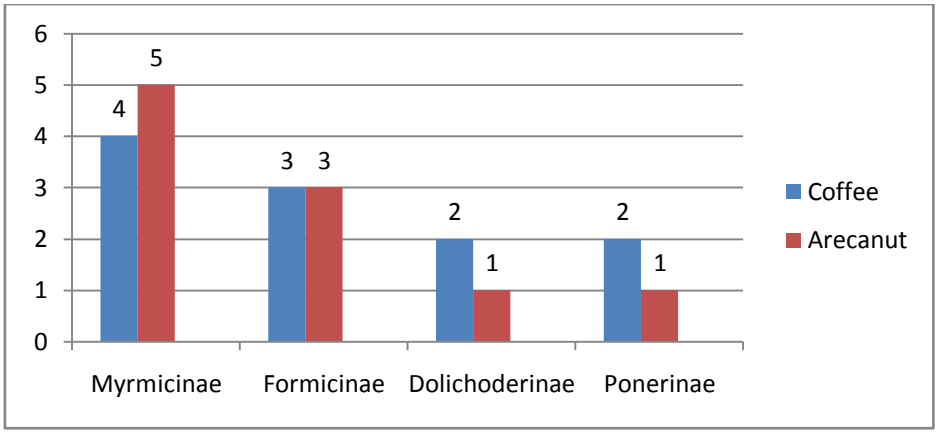

Figure 2: Comparison of Ant species between areca nut and coffee plantation

Conclusion:

Ants perform many ecological roles which are beneficial to human being. The present study will provide valuable information of ants available in this region. During this study 22 species were collected belonging to 4 subfamilies. The coffee agro ecosystem is rich in diversity of ants than areca nut plantation is due to its rich floral diversity. This study serves as the baseline for further study of ants in Chikkamagaluru area.

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COLONIZATION PATTERN AND GUILDWISE RELATIONSHIP BETWEEN SCARABAEID BEETLES

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Abstract:

The present study was carried to find out the population occurrence and density of coprophagous beetles in selected sites of Takali and Vakhari villages of Pandharpur Tahasil. In all, the study reports 10 species distributed within 7 genera belonging to one family of order Coleoptera *viz.* Scarabaeidae. The observations were also made on the dung insect community and their colonization pattern in relation with dung age from the sampling site Takali, Pandharpur.

Keywords: Colonization pattern, Scarabaeid Beetle.

Introduction:

Coprophagous entomofauna have been extensively studied because of their significant role in the recycling of organic wastes and enriching the soil with nutrients. Large sized dung pats of higher herbivore mammals are an ephemeral habitat of dung beetles and contribute to their relative abundance and diversity [1] [2] [3] [4]. Though several species of dung beetles are generalists and do not show any dung preferences, some are strict specialists with more or less degrees of specialization. Many species of dung beetles prefer coarse fibred dung of non ruminants mammals like elephants, while others prefer the more fluid and fine dung of ruminants and some others are attracted to the odoriferous dung of omnivorous animals [5] [6] [7] [8] [9].

Since dung pats can be tremendously irregular in space and time, resource partitioning and composition are prime features of dung beetle species assemblages [3]. Based on their nesting pattern and resource partitioning strategies dung beetles are largely divided into three functional groups *viz.* Rollers (telecoprid nesters), tunnelers (paracoprid nesters) and dwellers (endocorpid nesters) [1] [4].

Dung beetles are best and central species for studying how habitat disturbance and modifications impact animal communities due to their quick response to any ecological changes which is manifested as variations in their community structure, abundance, diversity and endemism [10] [11] [12] [13].

Nonetheless, ecology and community structure of dung beetles from the tropical ecoregions of Indian in general and dry zones (low rainfall areas) of Maharashtra in specific, have not received enough attention as their African, Neotropical and Indo Malayan/ South east Asian counterparts. Understanding more about the grassland dung beetles in low rainfall areas, is important not only to further our knowledge of dung beetles, but also in realising the role of larger herbivorous mammals or domestic cattle and their dung in maintaining the ground diversity at regional scale. Considering this importance of coprophagus beetles the present study was carried out in two villages of Pandharpur Tehsil to find out the colonization pattern related to the age of dung and guild wise relation in population of dung beetles.

Materials and Methods:

The present study was carried out in two phases from June 2016 to December 2017.

1. Field Phase
2. Laboratory Phase

During the sampling routine insect collection material was used. It includes plastic containers, phials, 70 % alcohol, field knife, Chloroform [14].

1. Field Phase:

A. Site selection and study of density of coprophagous beetles:

For the observation of density of coprophagous beetles two sites were selected for the study from Pandharpur Tahasil viz. Takali and Vakhari Villages. The grassland area (100 X 100 m) was selected for the observation of dung beetles. Ten dung pats of average 1 litre capacity were observed for the occurrence and density of coprophagus beetles from June to December 2017. The number of beetles from each genera were recorded during visits.

B. Site selection and study of colonization pattern in dung insect community:

The observations were also made on the colonization of dung insect community in the dung baited traps. For this study, grassland site at Takali village was selected. This observation was carried from the September 2017 to December 2017. For the dung baiting, plastic cups (7.5 cm diameter and 7cm height) were used during the study. These cups were filled with fresh buffalo dung and applied in grid squared (100 X 100 m). The baits were kept in the field for 6 days in the field and the observations were recorded daily to determine the colonization pattern.

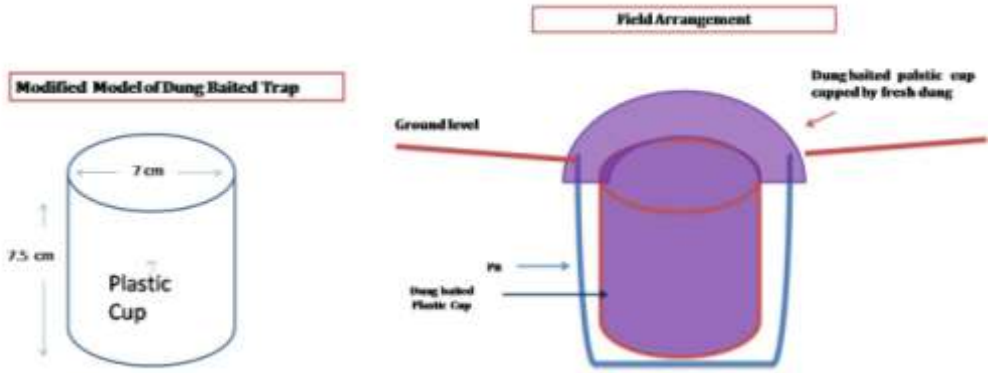
2. Laboratory Phase

A. Killing, preservation and labelling of Specimens:

One to two individuals were brought to the laboratory for identification. They were etherized and killed. After killing the specimens were cleaned in detergent to remove dung and mites. The specimens were pinned and preserved as per wet preservation method [14].

B. Identification:

The specimens were identified with the help of available literature [15].



Study Area:

Pandharpur tehsil of Solapur district geographically lies between 17°30′00″N to 18°05′00″N latitude 75°05′00″E to 75°35′00″E Longitude, which cover 1303.6 Sq. Km. area. There are 103 villages in Pandharpur tehsil. For the present study, the grassland patches of 02 different villages were selected. These villages are Takali and Vakhari. The land use pattern of Pandharpur tehsil shows 52% of the land is used for agriculture, 18 % represents fallow land, 17% barren land, 11% grassland and 2% land is occupied by water body [16]. For the sampling and colonization study a patch 100 m X 100 m was selected from both villages.

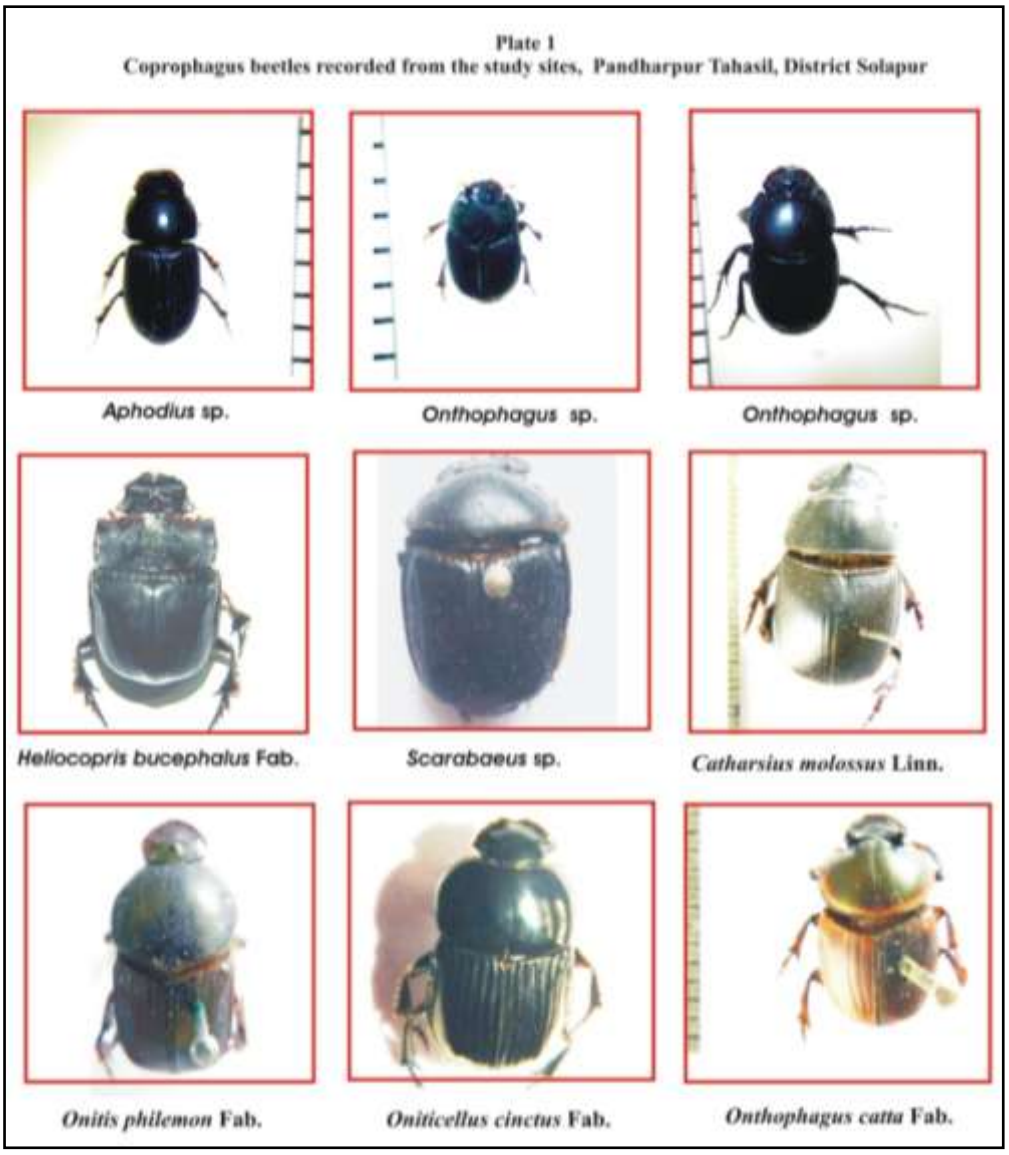
Results and Discussion:

A. Density of coprophagous beetles from the study area:

The present study was carried to find out the population occurrence and density of coprophagous beetles in selected sites of Takali and Vakhari villages of Pandharpur Tahsil. In all, the study reports 10 species distributed within 7 genera belonging to one family of order Coleoptera *viz.* Scarabaeidae (Table 1; Plate 1). The study was carried from the month of June 2017 to December 2017.

Table1: List of coprophagous beetles recorded during the study period

Sr. No.	Name of Species	Name of Family	Order
1	*Aphodius* sp.	Scarabaeidae	Coleoptera
2	*Aphodius* sp.		
3	*Onthophagus* sp.		
4	*Onthophagus* sp.		
5	*Onthophagus catta* Fab.		
6	*Onitis philemon* Fab.		
7	*Oniticellus cinctus* Fab.		
8	*Heliocopris bucephalus* Fab.		
9	*Scarabaeus* sp.		
10	*Catharsius molossus* Linn.		



B. Colonization pattern of dung insect community in the study area:

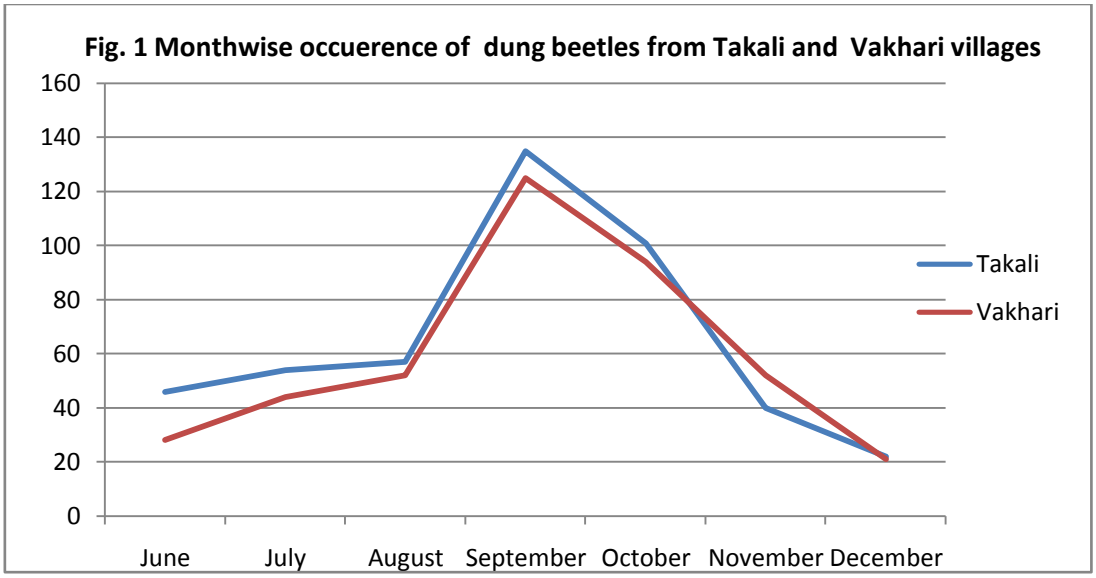
The observations were also made on the dung insect community and their colonization pattern in relation with dung age from the sampling site Takali, Pandharpur. The observations were made during September to December 2017. The colonization of insects in dung pats is related to the age of dung (Table 2).

Table 2: Colonization pattern of dung associated Insects in relation to the dung age

Sr. No.	Name of Family	Nesting G/S/P	Dung Age in days						
			1	2	3	4	5	6	7
1	Aphodidiae	D	+	+	+	+	-	-	-
2	Staphylinidae	P	+	+	+	+	+	-	-
3	Scarabaeidae	D T	+	+	+	+	-	-	-
4	Cetoniidae	S	-	-	-	-	-	+	+
5	Tenebrionidae	S	-	-	-	-	-	-	+
6	Termittidae	S	-	-	-	-	-	+	+
7	Histeriidae	P	+	+	+	+	+		
8	Muscidae	D	+	+	+	-	-	-	-

D- Dweller, P- Predatory, D T- Dweller Tunnelers, S- Shelter , + indicates presence - indicate absence

The data obtained from the dung baited traps on the colonization pattern of dung associated insects indicates that the members of family Aphodidiae, Staphylinidae, Scarabaeidae, Histeridae and Muscidae are attracted to buffalo dung at the age of first day i.e. immediately attracted after few hours of droppings. The members of these families utilize dung as food resource for both adult and young ones.



The members of family Cetoniidae attracted to dung at the age of 6th and 7th day. Similarly, the members of Family Tenebrionidae and Termittidae are attracted on 6th and 7th day. They utilise dung pat as a shelter only. The study on succession pattern of dung beetles in gaur dung pats in relation to dung age from Thirunelly forests in Waynad region of Western Ghats, India reports 28 species of coprophagus beetles with different nesting guilds which include tunnelers, rollers and dwellers [4]. This study states that most of the coprophagus beetles species are colonized in the gaur dung pats on same day of the dropping. But *Oniticellus cinctus, Catharsius sagax* and *Onthophagus andrewesi* are attracted from the 2nd day onwards after droppings.

The colonization of dung insects in the dung pats is also depending on type of dung. The total fibre amount in the dung pats plays a very important role in the colonization of dung beetles [4]. Outer crust formation in fine dung of herbivorous ruminants prevents loss of moisture from the lower layers and gives needed moisture for a prolonged stay of some dung beetles groups [17] [18] [19].

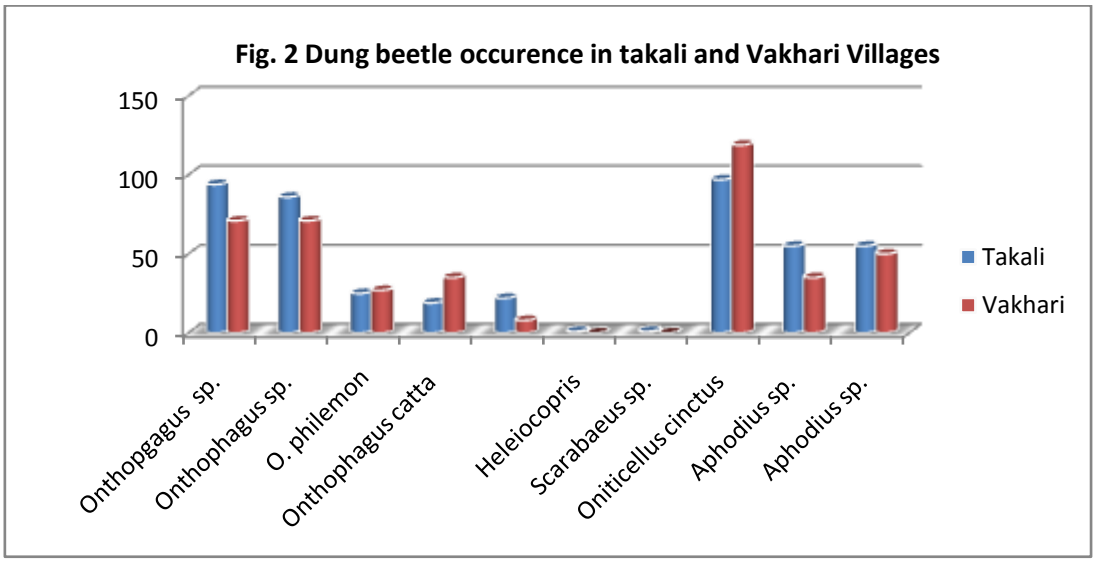
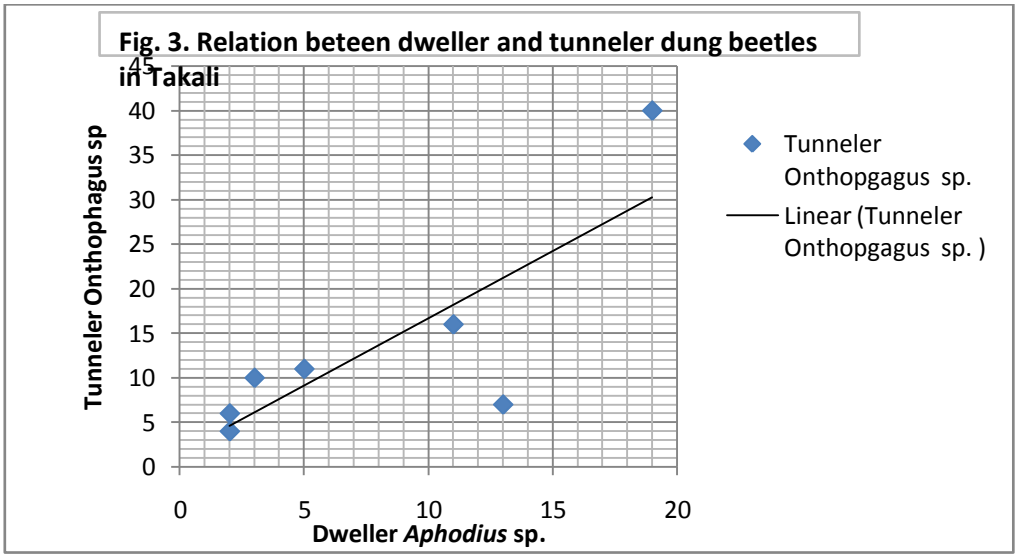


Fig. No. 1 and 2 shows month wise occurrence of dung beetles from Takali and Vakhari villages. From the graph, it appears that the takali site is more suitable than the Vakhari village site for the colonization of the dung insect community. This is due to availability of more nesting grounds and food in the takali village. In Vakhari village, maximum land surface is covered under agricultural area.

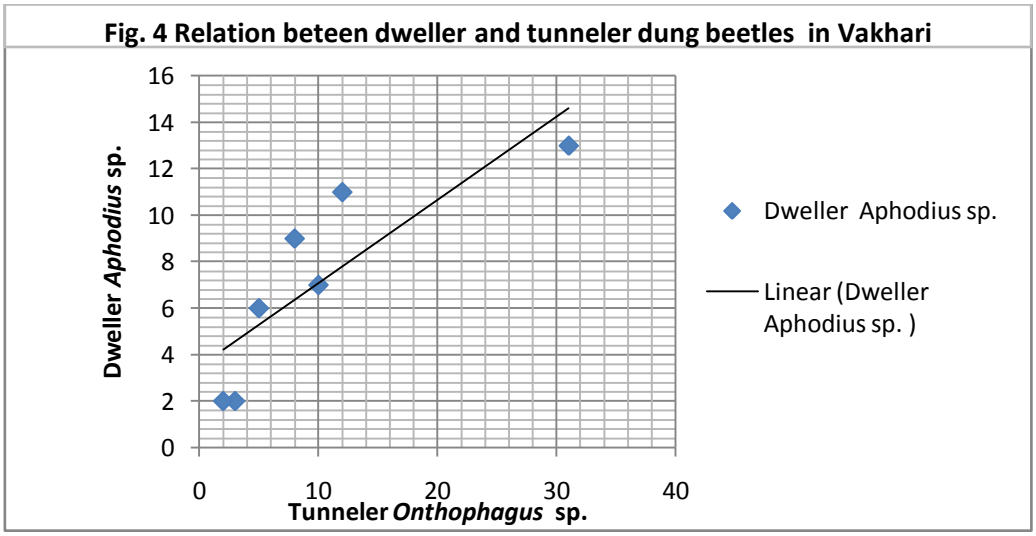
The observations are also carried on the nesting guilds of coprophagous beetles. The observation indicates the presence of dwellers and tunnelers.

The number of dwellers influences the number of tunnelers in the dung pats. It is directly related with rapid sorting and utilization of dung as food. This is because both the species utilize dung as food resource.

In the study site at Takali, there is a 65 % relation between *Aphodius* sp. (dweller) and *Onthophagus* sp. (Tunneler). In the sampling site at Vakhari Village, 70% relation is recorded in the between *Aphodius* sp. and *Onthophagus* sp.



During the study period, no roller (nesting guild) beetle was observed. This may be due to the dispersion behavior of dung beetles. Absence of rollers in the presence study sites is not an artifact of biased sampling methodology. Absence of the rollers is in the sampling sites is less likely to be related to soil hardness and difficulty in digging in hard soils [2] [20] [21].



Conclusion:

- The colonization of dung insect community is related to the age of the dung but not for all dung associated insects. It is highly related only with coprophagous insect species.
- Competition for the utilization of limited food resource influences the colonization of coprophagous beetles in dung pats.
- Colonization of coprophagous beetles is related with the type and nature of dung.

Acknowledgements:

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MUTUAL AFFILIATION OF HOUSE SPARROWS AND HUMANS

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Introduction:

The House Sparrow (*Passer domesticus*), is one of the commonest bird belonging to Passeriformes, the largest avian Order [1]. What makes the House sparrow a unique Passeridae is its association with humans. It is in actual fact a world widely Synurbic species i.e. it not only exploits but dependents on sources provided by humans [2]. It is so closely associated with humans that it got its scientific name based on this, "*Passer domesticus*", the Latin word *Passer* is a term for small active birds, coming from a root word referring to speed. The Latin word *domesticus* means "belonging to the house"[3]. The Middle East has been identified as the probable place of origin for the anthro-dependent house sparrows [4, 5]. The earliest fossil of house sparrows has been verified from Bethlehem, Israel, and is anticipated to be 4,00,000 years old [6]. Furthermore, all early house sparrow fossils (older than 10,000 years) are from the Middle East [6, 7], this indicates that the ancestral range of *Passer domesticus* first developed, some 10,000 years ago close to or in the region of human agricultural societies [4]. With the first establishment of sedentary, agricultural human societies in the Middle East about 10,000 years ago, a novel niche developed. This niche incorporated year-round supply of food due to storage of cereals and other food items and feeding of domestic animals and safe nest sites in cracks and cavities in human buildings. It is considered that some local house sparrow population with the ancestral 'bactrianus ecology' adapted to this novel niche and eventually became sedentary, anthro-dependent, obliged human commensals due to year round access to stored grain [8] and safe availability of nesting space. House Sparrows unlike the Parakeets, Doves, Kites and Hawks are undomesticated and untrained by man, yet they preferred to be intimately allied with human beings. In spite of a dull brown plumage, it has no inferiority complex instead has the assurance of a peacock and makes its presence all round the human build-ups be it houses, temples, monuments, market, gardens or agricultural fields (Figure 1).

House Sparrow is a non migratory species and don't like to move outside an area of 2-2.5 km [9]. It does not commit big theft like the House crow, but whenever a little grain falls to the floor, or when crumbs litter the kitchen floors, and then it presumes that all these tit-bits are all meant for it to feast on and enjoy them calmly and happily. As for houses and buildings, they are obviously built for the sole purpose of providing nesting sites for the sparrow [10]. Species able to live close to humans in urban habitats have often vastly expanded their abundance and distribution to the extent of having become cosmopolitan [11,12]. House sparrows in turn for all the favors that they take from humans return them by providing their ecological services. The French writer, Michelet shows the integrity of birds by saying "Birds might live on this earth even if there were no men, but men cannot live without birds". However, the recent declines in the population of House sparrows show their discontent to the statement. The little House sparrows reflect their affection and closeness towards man by living with them in their own houses. Almost every Indian adult has the childhood memories associated with House sparrows including the games of catching them and setting them free after coloring, getting enthralled by their dust baths and watching them construct their nests in the ventilators or fan holders.

Ornithologists were taken back by desolation at the sudden population declines in the commonest bird connected to them. Humans affected their survival, population structure, reproduction, and behaviour in urban, sub-urban and rural areas. Several causes have been attributed by Researchers for this decline, a significant one being the unavailability of nesting sites due to the changes in human lifestyle. The conservationists came forward to help the House sparrows during these difficult times and assured them for their survival by the provision of artificial nest boxes (Figure 2).

Figure1: Presence of House sparrows all round the human build-ups

Figure 2: Provision of artificial nest boxes for House sparrows

Changing land cover has a major influence on wildlife populations and communities across the globe and fragmentation, degradation and pollution are also known to have negative and positive consequences for the survival of animal and plant populations [13]. However, less is known about the extent to which human behaviour towards other organisms (intentional or unintentional) can affect urban plants and wildlife and subsequently affect their population viability and evolution. Humans are apt to form reciprocal associations with bionetwork natural system, including animals and birds. An excellent and familiar example is that of humans and House Sparrows [8]. This chapter documents on the mutual affiliation between House sparrows (*Passer domesticus*) and Man (*Homo sapiens*).

Taxonomic Position of House Sparrow

Phylum	Chordata
Sub-phylum	Vertebrata
Class	Aves
Order	Passeriformes
Family	Passeridae
Genus	*Passer*
Species	*domesticus*

Out of 26 Species of sparrows in the world, only 5 species are found in India which includes Migratory and Residential species.

Migratory Species	1.	Spanish Sparrow (*Passer hispaniolensis*)
Residential Species	1.	Sind Sparrow (*Passer pyrrhonotus)*
	2.	Russet Sparrow (*Passer rutilans*)
	3.	Eurasian Tree Sparrow *(Passer montanus*)
	4.	House Sparrow (*Passer domesticus*)

Worldwide decline in the population of house sparrows:

Although the decline in the House Sparrows gained attention from last decade onwards, the population retarding dates back to the early 1980s in several parts of the world, including a number of countries across Europe, North America and Australia [14,15,16,17,18]. In England the populations in rural areas have declined by 47% since the mid 1970s, whereas those in urban and suburban areas have declined by about 60% [14, 19, 20, 21]. In Europe, trends since 1980 show that populations has undergone a moderate decline, based on provisional data for 21 countries from the Pan-European Common Bird Monitoring Scheme [22]. Further to these declines the House Sparrow was added to the Red List of U.K. Endangered Species in 2002 and in Germany, it is classified as near threatened due to the large scale local declines [19, 23].

In India, noticeable declines in House Sparrows population have been reported from several states such as Karnataka, Maharashtra, Telangana, Panjab, Haryana, West Bengal, Delhi, Uttar Pradesh and Rajasthan. Indian Council of Agricultural Research conducted an ornithological survey on the Sparrow population that showed a drastic drop by 80% in Andhra Pradesh, sharp turn down of 70-80% in coastal areas while 20% fall out in Kerala, Gujarat and Rajasthan. Several surveys conducted at different places of India on the occurrences of House Sparrows suggest that their population has decreased considerably at present [24, 25, 26, 27, 9]. This scenario was unimaginable in the last 10 years that the House Sparrow would be the focus for discussions and conservational measures.

House sparrows in human dominated landscapes:

House sparrows show their presence in all the human dominated landscapes. To quote in the words of Ornithologist Salim Ali, it is "man's hanger-on". The benefits of staying in close human proximity include availability of resources (nesting space and feed) along with protection against predators. House sparrows tolerate human immediacy so they are better able to take advantage of resources close to their habitation, thus saving time and energy by skipping fleeing due to approaching humans. Key innovations that allow species to adapt to new environments include novel ways of obtaining food and fresh sites used for reproduction [28, 29, 30]. Indeed, a high rate of feeding advancement is a characteristic of bird species that have become urbanized [31].

The first priority is this species is to get a nesting space in man-made structures particularly their homes. House sparrows are habitat specialist species with small breeding territories and have a propensity to live within the houses. They are opportunistic in occupying the available spaces such as roof thatch, fan holder, electricity meters, tube light holders, unused pipes, wall holes, ventilators, earthen pots and even in spaces available between the household things kept undisturbed for a long period (Figure 3). Sometimes in absence of nesting place, they construct nest in unsafe and unusual places that lead to unsuccessful nesting (Figure 4). In few cases, nests have been located on trees and ornamental plants that are not in accordance to its breeding behavior (Figure 5). Apart from the spaces available within the houses, they construct nests in electricity meters, street lights, shutters of shops, space in historical buildings and temples (Figure 6). The little House sparrows have unshaken determination to fulfill its purpose of nesting and upbringing the chicks. So even if the house

owners remove the nesting material several times to keep their homes clean, the breeding pair overcomes all the odds and raise their young ones in the chosen corner of the house [10].

Figure 3: Nests of House sparrows in roof thatch and fan holders

Figure 4: Nest of House sparrow in hanging sack

Figure 5:Nest on Paper flower (*Bougainvillea)*

Populations of birds that breed indoors in barns and other buildings enjoy reduced nest predation rates, compared with outdoors, because human proximity eliminates corvids as nest predators from buildings with consequences for reproductive success. Birds that breed inside buildings have significantly higher reproductive success than nearby conspecifics breeding outdoors [30, 32].

Figure 6: Friendly interactions of House sparrows with humans

Next requirement of House sparrows is the foraging opportunity that varies during the breeding and non-breeding season. Even though variations can be observed between months and landscapes, the important habitats foraged are usually vegetation (>5m), brownfields, cattle sheds, and dumping sites [9]. The adult House sparrows are omnivorous feeding on all sorts of edibles available to them. However, they love to feed on grains such as rice, kakun and bajra. According to experimental observations by Akhilesh Kumar in 2018, it was found that in Lucknow the most preferred supplementary feed by House sparrows was kakun followed by rice and mixture (rice, bajra and kakun). The least preferred supplementary feed was bajra [9]. The preferred foraging sites for grains includes cow sheds, dung, grocery shops, roofs or patios with washed up grains spread out to dry [33].

Figure 7: Sparrows feeding on grains provided by the house owners

Figure 8: Sparrows enjoying water bath in garden pond

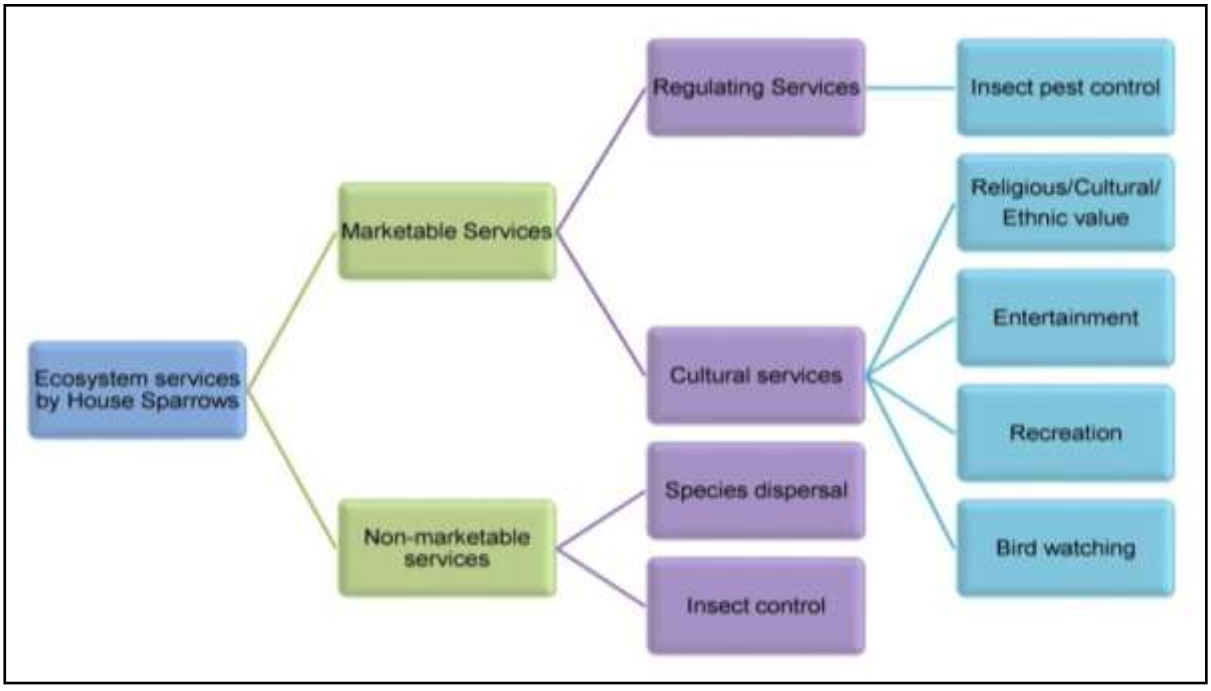
Supplementary feeding has also been used as a wildlife management technique to increase the survival and reproductive success of species [34, 35, 36] by saving the time and energy of the breeding pair. For other food items such as bread crumbs, chappatis, cooked rice, biscuits, they grab the opportunities around the kitchen floors, and even in utensils kept for washing or any restaurant or café with outdoor seating and leftovers attract sparrows and allow for friendly interactions (Figure 6) [37]. Bird lovers also feed the house sparrows by providing them grains at home (Figure 7). Bird watching in the garden has been coupled with amplified feelings of relaxation and connectedness to nature [38], while feeding garden birds endow people with a sense of contentment [39, 40].The artificial garden ponds are a favorite place of House sparrows, giving them immense pleasure in taking water bath. Anyone would enjoy the merry-making of these little birds in the water pools (Figure 8). Sometimes, House sparrows also feed on floral variety such as petals of flowers, seeds of sunflower, wild grasses, lantana fruits, mulberries, mustard, tulsi, bhang, lettuce, coriander, barseen etc. [9]

Changes in Human lifestyle	• Mordern architecture: no ventilators, more tiles • Traditional method of cleaning and drying of grains replaced by packed grains • Shopping from malls instead of the local grocery shops • Increased use of Air Conditioners • Paved gardens • Replacement of native plants by ornamental plants
Changes in Agricultural practices	• Unbalanced use of insecticides/pesticides • Reduced number of cattle • Replacement of bulls by tractors • Loss of bushes and tress due to agricultural intensification

During the breeding season, the first feeding priority of house sparrows is invertebrates. The invertebrates are a rich source of proteins that is needed for the chicks' growth. The House sparrows collect the invertebrates from gardens, agricultural fields, domestic drains, ditches and brownfields. Brownfield are also important foraging areas defined as "previously developed land, currently or previously occupied by a permanent dwelling". These sites are a rich source of invertebrates and plants [41, 42]. Brownfield are more common in urban areas. Brownfield sites are useful for nesting birds; they are only utilized heavily in areas where houses with gardens are relatively scarce. The commonly seen insects included flies, mosquitoes, grasshoppers, caterpillars, dragonflies, beetles, ants, termites etc. [9]. Therefore the current declines can be attributed to two main causes, first changes in human lifestyle and secondly changes in agricultural practices.

Ecological functions of house sparrows:

For all the favors taken from human beings, House sparrows play their role in balancing the ecosystems. They have several ecological functions that have positive effect in human life and his surrounding environment. Most of the activities carried out by House sparrows are of economic and ecologic value. Due to lack of sufficient information, the value of such supporting ecosystem services still remains complicated and unaccounted. Ecosystem services can be categorized into provisioning and cultural services that are well recognized with market values while pest control, seed dispersal, pollination, and scavenging animal carcasses come under the regulating and supporting categories with prospective non-market values. Birds serve all these four categories [43]. House sparrows provide both marketable and non-marketable ecosystem services (Graph 1).



Graph 1: Marketable and Non-marketable ecosystem services by House sparrows

House Sparrows have a significant link in food chain of ecosystem (Figure 9). It is a plinth food for most of the Birds of Prey. House Sparrow feeds on a variety of insects like beetles, caterpillars, dipterans, arthropods, aphids, grasshoppers and crickets (Figure 10). These are the most abundant food of nestlings so House Sparrow acts as important pest control species. If not controlled, these invertebrates may lead to devastating effect of crops leading to huge economic loses. Each nestling may consume as many as 3,000 to 4,000 insects during their growth period [44]. The relationship between food supply, avian growth and development is well-established [45].

In the past, there are incidences that reveal that the sparrows were considered as pests and enemies of farmers due to its dependency on grains in agricultural fields in rural areas. A well known iniquitous case is that of the 'Great Sparrow Campaign' or 'Kill a Sparrow Campaign', officially known as the 'Four Pests Campaign'. This was one of the first actions taken in the Great Leap Forward from 1958 to 1962 in China by Mao Zedong. Their absence lead to crop lost due to various pests, thus leading to food crisis in China. Swarming locusts coupled with bad weather led to the Great Chinese Famine, which killed 30 million people between 1958 and 1961. Mao later declared full-stop to the Great Sparrow Campaign, but it was too late [46]. In fact insectivorous birds bring to bear top down control on populations of invertebrates in many ecosystems, and crop yields are known to be higher in areas where birds control populations of herbivorous insects [47].

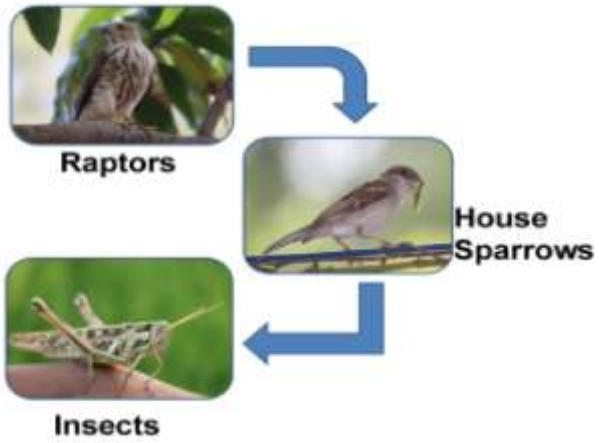


Figure 9: House Sparrows as significant link in food chain of ecosystem

Figure 10: House Sparrows with different types of invertebrates

The House sparrows are known to feed on the mosquitoes, thus contributes in preventing the diseases caused by mosquitoes. However no detail studies have been undertaken regarding this [9]. Mosquitoes are vectors for a number of diseases such as dengue, chikungunya, filaria and malaria. In 2010, over 1.2 million global malaria deaths were reported in both children and adults [48]. During the growth, the chicks of House

Sparrows eat insects that are collected from lawns, kitchen garden or agricultural fields, thus eradicating the harmful insects. This free service may lead to reduction of pesticides and insecticides that are harmful for the environment as well as human health. Severe health effects appear due to exposure to pesticides such as skin and eye irritations, headaches, dizziness and nausea, weakness, breathing difficulty, mental confusion and disorientation, seizures, coma, and death. In this way *Passer domesticus* is a friend to human beings. The humble House sparrows are also known to be good bio-indicators, as they occupy the top position at trophic level and have high metabolic rate. The effects of chemical pollutions expand well beyond city boundaries and once entered to the food chain they can be detrimental for a wide range of organisms, including birds [49, 50]. In urban areas enhanced levels of bioaccumulation of heavy metals has already been demonstrated in many common bird species and House Sparrow is one of them [51, 52, 53]. They also help in seed dispersal. They have verified various parameters well-suited for studies of general biological problems, such as evolutionary mechanisms, temperature metabolism and pest control [9]. The value of these ecosystem services provided by House sparrows are not undersized and should not be underestimated.

Cultural services provided by house sparrows:

The cultural services, defined as the non-material benefits people obtain from ecosystems Millennium Ecosystem Assessment-2005, delivered by House sparrows are of particular significance to the people. This is due to because of the universal dearth of opportunities for positive experiences of nature in urban areas [54, 40]. Undeniably, there is considerable evidence that since the childhood, interactions with House sparrows closely associate people to nature (Figure 11). In towns and cities these relations are known to provide the public with feelings of being connected to the natural world and can have optimistic effects on human well-being [54, 38, 55, 56]. House sparrows do not have any negative effect on human welfare, such as hostility, creating annoying twittering or smells, harming property and fecal deposition. Birds are also responsible for some important disservices, including disease transmission and the pollution of water supplies [57], but these do not pertain to House sparrows.

Figure 11: Interactions with House sparrows closely associate people to nature

Conclusion:

The relationship of House sparrows and man cannot be considered as commensalism, it is a strong mutual affiliation between the two species. The everyday interactions that connect the *Passer domesticus* and *Homo sapiens* are rather simple to understand yet quite complex to bring into action. For best understanding of the house sparrow-human mutual affiliation assessment of a combination of non-environmental (e.g., housing age and income) and environmental measurements is needed that may provide a more complete understanding of the factors influencing House sparrow population in an human dominated setting. Scrutinizing relationships between these variables and biological patterns, together with community structure of house sparrows, as well as flora and other animal taxa, will aid in understanding and predicting their patterns in human-dominated landscapes. The need of hour is to conduct awareness programmes for people of all age groups, all socio-economic status and from all areas. It is only through consideration of these couple interactions that humans can transform their actions positively to assist the House sparrows in their struggle to survive on the Blue Planet.

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NUTRITIONAL REQUIREMENT AND MANAGEMENT OF SUPPLEMENTARY FEEDING IN CULTURED FRESHWATER FISH AND SHELLFISH

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Feed is the most critical input in aquaculture constituting about 60-70% of total recurring cost. The importance of supplementary feeding has been greatly realized with the intensification of aquaculture from extensive to semi-intensive or intensive farming as the natural food produced through pond fertilization is not sufficient enough to sustain the standing crop of cultured species. Therefore, the use of artificial feeds balanced in protein, lipid, carbohydrate, vitamins, mineral with optimum dietary P/E ratio is required to improve the survival, growth, immunity and reproduction of fish.

Based on feeding habits the cultivable species have been categorized into herbivores, omnivores and carnivores. Despite the differences in feeding habits all aquatic organisms require five groups of nutrients. Among these, lipid and carbohydrate form primary energy sources for metabolism and protein in general is utilized for growth. Carnivores efficiently utilize lipids and herbivores carbohydrates while omnivores use both carbohydrates and lipids as energy sources. Protein on deamination can also serve as an energy source. Besides these, aquatic animals also require vitamins and minerals as components in their diets.

The basic knowledge on nutrient requirement of fish is the prerequisite to formulate the cost-effective practical diets of fish and shellfish.

Nutritional requirements:

About 40 essential nutrients are required by fish and shellfish in their diets for its better growth, survival and health.

Protein and amino acids:

Among the different nutrients in fish feed, the protein is considered to be the costliest one and is essentially required for growth, tissue repair, reproduction and health of fish. It is reported that about 40-80% of the feed cost is due to protein alone. As protein represents the most expensive component in fish feed, it is important to determine the optimal requirement level for growth and survival. The most recent approach to reduce the feed cost is to reduce the protein level a much as possible without compromising growth and health of fish. However, insufficient protein level in the diet results in reduction or cessation of fish growth. On the other hand, if too much protein is supplied in the diet, only part of it will be used to make new proteins and the remainder will be converted to energy.

Protein acts both as structural component as well as an energy source, its requirement for fish is 2-3 times higher than that of mammals. The protein requirement varies from 25-55 % for different fish species. The gross protein requirement decreases with increase in age and size of fish. Generally 25-30% protein is optimum for practical diets for herbivorous and omnivorous fishes for pond feedings. However, carnivorous fish requires higher 40-50% dietary protein.

Size, water temperature, dissolved oxygen, pH, and feeding rate are also some of the factors that affects protein requirement of fish. The protein requirement of different fish and shellfish is given in Table 1.

Table 1: Dietary protein requirement of some finfish and shellfish species for their optimum growth

Species	Protein source	Protein requirement (% dry weight of food)
Cyprinus carpio (spawn, fry and fingerlings)	Casein	45
C. carpio fingerlings	Fish meal	54
C. carpio juvenile	Casein	31-38
Labeo rohita fry	Casein	45
Labeo rohita fry	Fish meal and groundnut oilcake	40
L. rohita fingerlings	Casein and groundnut oilcake	30
Catla catla fry	Casein gelatin	47
Catla catla fingerlings	Casein gelatin	40
Mrigal fry and fingerlings	Fish meal and groundnut oilcake	40
Puntius gonionotus	Casein gelatin	32
Ctenopharyngodon idella	Leaf protein concentrate	36
C. idella fry	Casein	42
Trichogaster trichopterus	Casein -gelatin	35
Poecilia reticulate	Casein -gelatin	30
Xiphophorus hilleri	Casein -gelatin	40
Poecilia latipinna	Casein- gelatin	40
Pseudotropheus socolofi	Casein – Fish meal	36-40
Haplochromis ahli	Casein – Fish meal	36
Pseudoplatystoma coruscans	Practical diets	46
Tor tambroides	Fish meal – casein - gelatin	48.0
Xiphophorus helleri	Fish meal, hydrolysate, krill meal	30.0
Macrobrachium rosenbergii	Fish meal and groundnut oilcake, soybean meal	35
Channa striatus fry	Fish meal and groundnut oilcake	55
Anabas testidineus	Carcass waste and groundnut oilcake	40
Clarius batrachus fingerlings	Casein- gelatin	40
Tilapia aures fingerlings	Fish/soybean meal	36
T. niloticus fry	Casein/albumin	34-56
Oreochromis mossambicus fingerlings	Fish meal	35

The fish does not have true protein requirement but need a well balanced mixture of essential and non-essential amino acids. Gross protein requirement of a fish is the requirement of essential amino acids and some non-specific nitrogen to maintain metabolic activities. With hydrolysis of protein, about 20 different amino acids are released, out of which 10 are essential viz. arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine, which are not biosynthesized but required by fish. The amino

acid requirement of all the teleost fishes as percentage of protein is almost similar. The essential amino acid requirement of fish and prawn are given in Table 2.

Table 2: Essential amino acid requirements (% dietary protein) of some fish and prawn species

Amino acid	Rohu	Catla	Mrigal	Common carp	Tilapia	Prawn
Arginine	5.75	4.80	5.25	4.3	4.2	3.7
Histidine	2.25	2.45	2.13	2.1	1.7	0.7
Isoleucine	3.00	2.35	2.75	2.5	3.1	0.6
Leucine	4.63	3.70	4.25	3.3	3.4	1.0
Lysine	5.58	6.23	5.88	5.7	5.1	3.2
Methionine	2.88	3.55	3.18	3.1	2.7	1.2
Phenylalanine	4.00	3.70	4.00	6.5	5.5	1.7
Threonine	4.28	4.95	4.13	3.9	3.8	1.6
Tryptophan	1.13	0.95	1.08	0.8	1.0	0.5
Valine	3.75	3.55	3.50	3.6	2.8	2.0

Lipids:

Lipids are important nutrients in the diets of finfish as sources of energy, essential fatty acids and phospholipids. Dietary lipids supply energy and provide essential acids needed for structural maintenance of membranes and proper functioning of many physiological processes. Dietary lipids are a concentrated and highly digestible source of energy and are a source of essential fatty acids (EFA) which are necessary for normal growth and survival of all animals. Lipids, typically comprise about 15 per cent of fish diets, supply essential fatty acids (EFA) and serve as transporters for fat soluble vitamins.

Table 3: Essential Lipid requirements of some fish and prawn species

Fish / Prawn	Requirement (%)
Common carp	8-18
Indian and Chinese carp	5-8
Cat fish	10
Tilapia	6-10
P. indicus	6-10
M. rosenbergii	3-6
P. monodon	8-10
P. japonicas	8-10

The increase in dietary lipid levels, must, however, be carefully evaluated as it may affect the carcass composition, mainly due to an increase of lipid deposition. The localization and composition of lipid deposits also strongly influence the nutritional value, organoleptic properties, transformation yields and storage time of fish carcass. Lipid being highly digestible has greater sparing action than dietary carbohydrate or protein and playing a definite role in feed utilization. Excess lipid not only suppresses de novo fatty acid synthesis, but also reduces the ability of fish to digest and assimilate it, leading to reduced growth rate. Again, excess lipid in the diet may also result in the production of fatty fish ultimately having deleterious effects on flavour, consistency and storage life of the finished product. Excessive amounts of lipid in diet also possess problem in feed manufacturing.

Although, a wide range of variations, (4-15%) in gross lipid requirement has been estimated for several species, 7-9% dietary lipids are generally considered optimum for practical diets of carps and prawns.

Fish oil is the rich dietary source of PUFA viz. eicosapentanoic acid (EPA) and docosa hexaenoic acid (DHA). As in other vertebrates, fish cannot synthesize 18:3 n-3 (linolenic) and 18:3 n-6 (linoleic)

polyunsaturated fatty acids (PUFAs) but fish have a requirement of these two essential fatty acids that are to be provided from exogenous sources. Fish fed diets deficient in two of these PUFAs (18:2 n-6 and 18:3 n-3), usually develop deficiency sign such as retarded growth, low feed efficiency, fatty livers, increased water contents in whole body or muscle, high hepatosomatic index (HIS) and substantial accumulation of 20:3n-9 in tissue polar lipids. Freshwater fish, in general, requires either dietary 18:2n-6 (linoleic) or 18:3n-3 (linolenic) acids or both. Marine fish have dietary requirement of eicosapentaenoic acids (EPA, 20:5 n-3) and/or docosahexaenoic acid (DHA, 22:6 n-3). Dietary phospholipids have beneficial effects on growth and survival of fish and prawn larvae. The essential fatty acid requirements of some fish and prawn species are given in table 3.

Carbohydrates:

Carbohydrate is third most abundant group of organic compounds in the fish body. A dietary level of 22–30% of carbohydrate has been found to be optimum for the growth of Indian major carps. Carbohydrates not only serve as the least expensive source of dietary energy but also helps in improving the pelleting quality of practical fish diets. Dietary starches are useful in the extrusion manufacture of floating feeds. Therefore, some form of digestible carbohydrate should be included in fish diets. Feed cost per unit of fish produced can be minimized by optimal use of low-cost energy carriers such as carbohydrate-rich ingredients, ensuring that the use of costly protein is kept as low as possible. Replacing dietary protein by carbohydrate or lipid energy may result in a higher production per unit spent of costly protein sources such as fishmeal, and the effluent nitrogen can be reduced per unit of fish produced.

The carbohydrate utilization of the fish depends up on the feeding habit, structure and function of the digestive system. The capacity of fish to utilize carbohydrate varied by species and in response to variable such as digestibility and starch complexity. Cold water and marine species generally maintain adequate performance with carbohydrate levels in order of 20.0%. Apart from trout, the tolerance of freshwater and warm –water species is generally higher, up to a maximum of 40%.

The optimum dietary requirements of carbohydrates are 25-30% for India major carps and medium carps, 30-40% for common carp, less than 25% for rainbow trout and 6-15% as gelatinized starch for Salmon species. Carbohydrate levels generally do not exceed 40% in carp diets when the raw carbohydrate is being used. But when the carbohydrate is used in gelatinized form, the level of its incorporation may be increased up to 50% in the carp diet. The commercial diet of prawns normally contains 35-40% carbohydrates.

Energy:

Energy is defined as the capacity to work, but in biological definition, it refers to muscles activity, energy for chemical reactions in body, to enable movement of molecules against a concentration gradient and for other biological as well as physiological functions in the body. Fish do have a low energy requirement because no energy expenditure is involved for maintenance of body temperature and due to its neutral buoyancy. Other explanations for low energy requirements are less muscle activity to maintain their position as many fishes have swim bladders and less energy expenditure for excretion of ammonia, which is 85% of metabolic wastes that are excreted directly through gills into surrounding water. Physical activities like swimming, escaping from predators and stress, temperature, size, growth rate, species and food are some of the factors that affect energy requirements of fish. Proteins, lipid and carbohydrates contain 5.6, 9.4 and 4.1 kcal of GE/g respectively.

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HOLISTIC APPROACH TOWARDS INDIAN HERBAL MEDICINE AND THEIR IMPACT ON HEALTH AILMENTS

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Introduction:

Mother Nature is bestowed with diversified natural herbal plants which have medicinal properties to treat many ailments facing by mankind. Goods obtained from flora and fauna are used as medicines from ancient times. Many researches on plants revealed the importance of therapeutic properties of traditional medicine [1].

According to National Health Portal of India, the term "medicinal plants" consists of various types of plants used in herbalism (herbalogy or herbal medicine), i.e., the study of plants which were used in medical purposes. The word 'herb' is derived from a Latin word "herba", and an old French word "herb". In the contemporary times, the herb can be allude as any portion of the plant like, fruit, seed, stem, bark, flower, leaf, stigma or a root as well as non woody plant. These herbal medicinal plants are included in some sacred affairs as flavonoids, food, perfume or medicine.

Herbal medicine hinders or postpones the disease ailments. Now a day those herbal medicines which were researched for their bioactive compounds are widely used in treating various ailments suffering by the mankind. There are many utilitarian benefits were hided in the traditional herbal drugs. In India from the remote past itself the properties of herbal plants were used and mentioned in Ayurveda. Not only in Ayurveda were they also discussed in other branches of medicines like Siddha, Unani, Homeopathy, and Naturopathy also [2].

History of medicinal herbs:

Ancient period's history reveals that the plants were used for therapeutic intents since 4000 years. In remote past, manuscripts of Chinese, Unani, Ezyptian Ebers Papyrus narrated the herbal importance. Some native culture like Rome, Egypt, Africa, Iran and America also utilized the herbs in their therapeutic practices. Whereas advanced traditional medicinal methods established as Ayurveda Unani, Chinese medical systems, where the traditional herbs were utilized consistently.

India is one of the old civilizations which are well-known for its luxurious repertory of herbal medicines as well as aromatic flora. By using these enormous medicines and scents were prepared. In India, around 8000 herbal curatives have been systematized by AYUSH, in which Ayurveda and Unani drugs are extensively adopted. According to WHO (World Health Organization) 80% of world population relies on herbal medicine [3].

Herbal curatives or drugs also depicted in Bible and Vedas also [4]. In Ayurveda approximately 1200 diseases have been mentioned [5] .Charak samhita and sushruta samhita, Bela Samhita, Kashap Samhita, Agnivesh Tantra, Vagbhata's Ashtang hridaya , Madhava Nidan (700AD) are the famous Indian ayurvedic literature [6].

India's biodiversity comprises of various medicinal plants which shows anticancer, antifungal, anti-inflammatory including many curative properties. But it is not completely revealed to the world due to lack of

exposure towards international databases .India is enriched with biodiversity in medicinal plants distribution and hence India is called as Medicinal garden of the World.

Why the herbal medicine is preferable?

Unequivocally western medicine is very prompt in its activity and confine to that action only. And it causes more side effects also. But the herbal drugs are natural, bio friendly and have synergic action of various effective products. Hence they exhibit collective action on various metabolic levels of the body curing various health ailments. Their action is holistic on entire body including the transcendental levels also. In addition, they are more reasonable in price when compared to Allopathic medicine. They have lesser side effects. It fulfills the lust for individualized solubrity. Herbal drugs generally used for betterment of health and in the treatment of chronic diseases. In maximum cases these herbal therapeutic drugs are used when synthetic drugs are important in curing [7, 8].

Herbal medicines are very efficient in its activity and also affordable by public than synthetic drugs [9].

Traditional herbal drugs gained the importance due to their adequacy, assurance, afforadable, with few side effects and they have cultural approval [10].

Though various types of herbal treatment systems developed in progression, the conventional familiarity is missed due to lack of manuscript evidences and also due to lesser profits in practicing them. After acquiring the knowledge about their lesser side effects than synthetic drugs, again the interest of medicinal herbs is raised in the world population [11].

Though in remote past years itself, people used unrefined herbal medicinal plants or sources in medication without knowing the photochemical present in them. After the advancement of investigations on the utility of medicinal plants, the public interest focused on them [11].

Importance of conservation of medicinal plants:

Medicinal plants are Natures boon with effective therapeutically properties. At present days they are vanishing in alarming rate. International Union for conservation of Nature and the World Wild Life fund, portrayed that among the flowering plants (Around 50,000 to 80,000), 15000 species are facing the problem of extinction because of over grazing, over reaping and habitual devastation [12] and 20% of the indigenous varieties are enervated due to utilization as food and expansion. Importance of medicinal herbal curatives and their secondary metabolites requirements are rising prominently in day today life [13].

According to Shi-Lin Chen [14], in more than 50,000 plant species there is a disappearance or extinction of about 100 to 1000 times than expected and in the future it is estimated that there is a destruction of single potential chief drug for every span of 2 years. China and India are recorded with greatest number of medicinal herbs with 11,146 and 7,500 species. Hence it is essential to protect the disappearing medicinal plant species before losing in India.

Conservation strategies:

Herbal medicinal plants can be conserved by three methods. They are

1) In Situ Conservation
2) Ex Situ Conservation
3) Cultivation Practice

In Situ conservation can be done through wild nurseries and natural reserves. Ex Situ Conservation can be done through seed banks and Botanical gardens. In addition to the above Good agricultural cultivation practice should be adopted. In this respect, the govt. of India, established Department of Indian system of Medicine and Homeopathy (ISM&H) in March 1995 and it was renamed as Department of Ayurveda, Yoga,

Naturopathy, Unani, Siddha Homeopathy (AYUSH) in November 2003, aiming to focus on development of education and research in all medical systems. And Ministry of AYUSH was formed on 9th Nov 2014.

Compounds present in medicinal herbal plants:

As the life in the remote past is linked to the forest and they depend on it for food, shelter. In a meanwhile the therapeutic values of medicinal plants were discovered and gained importance and gradually they evolved as contemporary drugs. In progression of age, the traditional medicinal herbs were subjected to processing for their bioactive phytochemicals. Terpenoids, alkaloids, glycosides, flavonoids, tannins, polyphenols, steroids and volatile oils are some of the compounds present in medicinal herbs impart disease curative properties for it [15, 16, 17]. Actually treatment with medicinal herbs is not a quackery because they includes less weight primary and secondary metabolites which have splendid constitutional multiformity and they are common and essential for all plants. These metabolites allegedly involved in guarding and shielding the plants. In addition they are used in the treatment of maladies and other ailments regarding to human health. In addition, they serve as toxicants, spices and biocides.

Health ailments- herbal remedies:

Most of the Indians rely on medicinal herbs and their parts due to its precautionary, curing and remedial properties along with immunomodulatory effect. For example *Boerhaavia diffusa* is a traditional herbal medicine which is in the form of ethanolic extract decreases the proliferation of the cell. These herbal medicinal plants are the substitute to the chemotherapy regarding immune responses [18, 19].

Table 1: List of Plants with Immunostimulatory Property.

Plants	Common name	Property
Abrus precatorius	Gunja	Immunostimulant
Andrographis panoculata	Kalmegh	Immunostimulant
Aristolochia indica	Isharmul	Immunostimulant
Berberis aristata	Dar-haid	Immunosuppresor
Catharanthus roseus	Sada bahar	Immunostimulant
Clitoris ternatea	Aprajita	Immunostimulant
Cymbopogon martini	Gandh	Immunostimulant
Hyoscyamus niger	Parsikaya	Immunostimulant
Nardostachys jatamansi	Jatamansi	Immunostimulant
Picrorhiza kurruro	Kutaki	Immunostimulant

Diabetes-medicinal herbs:

Diabetes is one of the major human complaint distressing many lives all over the world. By using herbal drugs enriched with anti diabetic properties and antioxidant qualities are benficial in the treatment of diabetes.For example Galega officinalis is rich in guanidine, which is hypoglycemic.Based on this fact Metformin, a synthetic. Insulin production in the residual or renovated β-cells can be triggered by the extraction of Aloe vera [20, 21] .

Aloe vera extract stimulates insulin secretion from the remnant β-cells and/or from regenerated β- cells
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Aloe vera extract stimulates insulin secretion from the remnant β-cells and/or from regenerated β- cells

Anti diabetic medicinal herbs in india:

Numerous herbal curatives were found in India. The most useful medicinal herbs for the treatment of diabetes and its complications are as follows.

Rai [22] reviewed the following additional information regarding to the list of anti-diabetic herbal plants. They are *Abrus orecatorious, Berginia ligulata, Bombax pentandrum, Bougainvillea spectabilie, Butea*

monosperma, Caesalpinia crista, Carica papaya, Cassia occidentalis, Centratherum anthelminticum, Cinnamomum tamala, Citrullus colocynthis, Costus speciosus, Curcuma longa, Decalpia hamiltonii, Dioscorea bulbifera, emblica officinalis, Ichnocarpus frutescens, Inula racemosa, Melia azadirachta, Mangifera indica, Mangifera oleifera, Ougenia dalbergioides, Paspalum scrobiculatum, Phyllanthus amarus, Psidium guava, Pterocarpus santalinus, Rheum emodi, Solanum nigrum,Syzygium alternifolium, Strychnos potatorum, Swertia chirata, Talinium portulacifolium, Terminalia arjuna, T. chebula, Tinospora cordifolia, and Tribulus terrestris. He claimed that the subsequent medicine in the future can be rely on the scientific investigations on the crude form of herbal medicinal plants and in rotating them into refined form.

Table 2: Indian medicinal plants with anti-diabetic and related beneficial properties [21]

Scientific Name	Name/herbal formulation	Anti-diabetic and other beneficial effects
Annona squamosa	Sugar apple	Hypoglycemic and antihyperglycemic activities of ethanolic leaf-extract, Increased plasma insulin level
Artemisia pallens	Davana	Hypoglycemic, increases peripheral glucose utilization or inhibits glucose reabsorption
Areca catechu	Supari	Hypoglycemic
Beta vulgaris	Chukkander	Increases glucose tolerance in OGTT
Boerhavia diffusa	Punarnava	Increase in hexokinase activity, decrease in glucose-6-phosphatase and fructose bis-phosphatase activity, increase plasma insulin level, antioxidant
Bombax ceiba	Semul	Hypoglycemic
Butea monosperma	palasa	Anti-hyperglycemic
Camellia sinensis	Tea	Anti-hyperglycemic activity, antioxidant
Capparis decidua	Karir or Pinju	Hypoglycemic, antioxidant, hypolipidaemic
Caesalpinia bonducella	Sagarghota,Fevernut	Hypoglycemic, insulin secretagogue, hypolipidemic
Coccinia indica	Bimb or Kanturi	Hypoglycemic
Emblica officinalis	Amla Constituent of herbal formulation, Triphala Dhatriphala	Decreases lipid peroxidation, antioxidant, hypoglycemic
Eugenia uniflora	Pitanga	Hypoglycemic, inhibits lipase activity
Enicostema littorale	krimihrita	Increase hexokinase activity, Decrease glucose and fructose 1, 6 bisphosphatase activity. Dose dependent hypoglycemic activity
Ficus bengalenesis	Bur	Hypoglycemic, antioxidant
Gymnema sylvestre	Gudmar or Merasingi	Anti-hyperglycemic effect, hypolipidemic
Hemidesmus indicus	Anantamul	Anti-snake venom activity, anti-inflammatory
Hibiscus rosa-sinesis	Gudhal or Jasson	Initiates insulin release from pancreatic beta cells
Ipomoea batatas	Sakkargand	Reduces insulin resistance
Momordica cymbalaria	Kadavanchi	Hypoglycemic, hypolipidemic
Murraya koenigii	Curry patta	Hypoglycemic, increases glycogenesis and decreases gluconeogenesis and glycogenolysis
Musa sapientum	Banana	Antihyperglycemic, antioxidan

Phaseolus vulgaris	Hulga, white kidney bean	Hypoglycemic, hypolipidemic, inhibit alpha amylase activity, antioxidant. Altered level of insulin receptor and GLUT-4 mRNA in skeletal muscle
Punica granatum	Anar	Antioxidant, anti-hyperglycemic effect
Salacia reticulata	Vairi	inhibitotory activity against sucrase, α-glucosidase inhibitor
Scoparia dulcis	*Sweet broomweed*	Insulin-secretagogue activity, antihyperlipidemic, hypoglycemic, antioxidant
Swertia chirayita	Chirata	Stimulates insulin release from islets
Syzygium alternifolium	Shahajire	Hypoglycemic and antihyperglycemic
Terminalia belerica	Behada, a constituent of "Triphala"	Antibacterial, hypoglycemic
Terminalia chebula	Hirda	Antibacterial, hypoglycemic
Tinospora crispa		Anti-hyperglycemic, stimulates insulin release from islets
Vinca rosea	Sadabahar	Anti-hyperglycemic
Withania somnifera	Ashvagandha, winter cherry	Hypoglycemic, diuretic and hypocholesterolemic

Hepato protective herbal medicinal plants:

Sylibum maranum, Glycyrrhiza glabra, Picrorhiza kurroa, Phyllanthus amarus are some of the traditional medicinal herbs are very beneficial in liver protection, having, antilipidperoxidative, antifibrotic properties and Phyllanthus amarus works as protective herbal drug in the case of hepatitis B and C [23].

Chaudhary et al [24] reviewed that these herbal plants have bioactive hepatoprotective properties. They are *Punarnava (Boerhaavia diffussa), kutki (Picrorrhiza Kurrao), Chirata (Swertia chirayita), Amla (Emblica officinalis), Milk thistle (Silybum marianum L.), Shatavari (Asparagus racemosus), Dandelion (Taraxacum officinale), Nettle (Urtica parviflora), Jatamansi (Nardostachys jatamansi), Fire flame bush (Woodfordia Fruticosa), Kapur Kachri (Hedychium spicatum), Fire flame bush (Woodfordia Fruticosa), Daruharidra (Berberis aristata), Saussurea costus, Berberry (Berberis lyceum), Himalayan May Apple (Podophyllum hexandrum).*

India, particularly in Himalayan domains is rich in herbal medicinal plants which cure hepatic ailments [24].

Name of the Plants	**Family**	**Parts use**	**Hepatotoxicity inducing agents**
Astragalus polysaccharides	Magnoliaceae	Dried fructus	Carbon tetrachloride
Arachniodes exilis	Dryopteridaceae	Rhizomes	Carbon tetrachloride
Asparagus racemosus	Liliaceae	Whole plant	Γ-radiation
Apium graveolens	Apiaceae	Seeds	Paracetamol and thioacetamide
Aloe barbadensis Mill	Liliaceae	Dried aerial parts	Petroleum ether , chloroform and methanol
Artemisia absinthium	Asteraceae	Powdered aerial parts	Carbon tetrachloride and by injection of endotoxin
Azadirachta indica	Meliaceae	Leaf	Paracetamol
Acacia confuse	Leguminosae	Bark	Carbon tetrachloride
Baliospermum montanum	Euphorbiaceae	Roots	Paracetamol

Cassia fistula	Leguminosae	Leaf	Carbon tetrachloride
Calotropis procera	Apocynaceae	Flowers	Paracetamol
Decalepis hamiltonii	Asclepiadaceae	Roots	Carbon tetrachloride
Euphorbia fusiformis	Euphorbiaceae	Tubers	Rifampicin
Glycyrrhiza glabra Linn	Fabaceae	Root powder	Carbon tetrachloride
Ginkgo Biloba	Ginkgoaceae	Dried extract	Carbon tetrachloride
Gentiana asclepiadea L.	Gentianaceae	aerial parts, root	Carbon tetrachloride
Hygrophila auriculata	Acanthaceae	Root	Carbon tetrachloride
Halenia elliptica	Gentianaceae	Whole plant	Carbon tetrachloride
Juncus subulatus	Juncaceae	Powdered tubers	Paracetamol
Momordica dioica	Cucurbitaceae	Leaves	Carbon tetrachloride
Meconopsis integrifolia	Papaveraceae	Flowers	Carbon tetrachloride
Melochia corchorifolia	Malvaceae	aerial part	Carbon tetrachloride
Orthosiphon stamineus	Lamiaceae	Leaves	Acetaminophen
Ocimum snctum	Lamiaceae	Leaf	Paracetamol
Pterocarpus marsupium Roxb.	Papilionaceae	Stem bark	Carbon tetrachloride
Piper longum	Piperaceae	Fruits and roots powder	Carbon tetrachloride
Pittosporum	Pittosporaceae	Stem bark	Carbon tetrachloride
neelgherrense			galactosamine and acetaminophen
Phyllanthus amarus Schum	Euphorbiaceae	Aerial part	Ethanol
Rubia cordifolia Linn	Rubiaceae	Roots	Carbon tetrachloride
Ricinus Communis	Euphorbiaceae	Leaves	Carbon tetrachloride
Silybum marianum	Asteraceae	Leaves	Thioacetamide
Scoparia dulcis	Scrophulariaceae	Whole plant	Carbon tetrachloride
Spondias pinnata	Anacardiaceae	Stem heart wood	Carbon tetrachloride
Tylophora indica	Asclepiadaceae	Leaf powder	Ethanol
Trichosanthes cucumerina	cucurbitaceae	Whole plant	Carbon tetrachloride
Tridax procumbens	Asteraceae	Leaves	Carbon tetrachloride
Vitex negundo Linn.	Verbenaceae	Root, leaf, flower	Isoniazid, rifampin, pyrazinamide
Vitex trifolia	Verbenaceae	Leaves	Carbon tetrachloride
Withania somnifera	Solanaceae	Root	Carbon tetrachloride
Woodfordia fruticosa Kurz	Lythraceae	Flowers	Carbon tetrachloride
Zanthoxylum armatum	Rutaceae	Bark	Carbon tetrachloride

Conclusion:

Medicinal herbal plants have been utilized by mankind from remote past for various health ailments. Several communities used them as ancillary treatment after to synthetic drugs. It is also necessary to standardize the drugs for effective function. Due to side effects of the conventional drugs, now the public have been shifting towards traditional herbal medicine.

India was endowed with rich medicinal herbs, plants. Especially south Indian Eastern Ghats have wide variety of aromatic plants and traditional medicinal herbs. They gained recognition due to its lesser side effects. They are used not only as herbal drugs but also as cosmetics nutrient adjuncts. Bioactive compounds present in the medicinal herbs impart therapeutic activity to those herbs. As India is placed as one of the country among 12 top biodiversity countries rich in their records and therapeutic systems, there is a necessity to explore the medicinal properties of the diverse herbs so that they can be refined for the effective action.

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TAXONOMIC KEY FOR THE IDENTIFICATION OF LADYBIRD BEETLE

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Abstract:

Maharashtra, literally meaning the great state, with its rich biodiversity, is a huge irregular triangle with its base facing the Arabian Sea. Physico-graphically the state may be divided into four natural divisions - the coastal strip (the Konkan), the Sahyadri or the Western Ghats, the Deccan plateau, and the forests of North Maharashtra

Ladybird beetle is important group of beetles because they are important universal predatory and occupies important place in biological control. However, the ladybird beetle fauna of Nasik is not extensively explored area wise. In this connection, the present study was conducted to explore the Ladybird beetle fauna of district Nasik. Collection surveys were conducted in these areas at fifteen days interval in the active season. The identification of the collected specimens during the study revealed that there are Total 14 species belonging to 11 genera, under 5 tribes of the family Coccinellidae were recorded (Subfamily Chilocorinae, Subfamily Coccinellini, Subfamily Scymninae and Subfamily Sticholotidinae) were collected. These species are *Brumoides suturalis, Chilocorus nigrita ,Coccinella septempunctata, Coccinella transversalis A, C. transversalis B, Cheilomenes sexmaculata, Hippodamia variegate, Hippodamia convergens, Illeis cincta, Micraspis discolor, Propylea dissecta* A, *Propylea dissecta* B, *P. trinotatus, Scymnus latemaculatus, Pharoscymnus flexibilis, Pharoscymnus horni*.

Introduction:

The lady bird beetles have been associated with good fortune in many myth and leg end. The forms of scale insects and whiteflies usually encountered in the female and refer particularly to that sex. The host plants are extremely numerous and probably include representatives of all order of Phanerogams. Thus the group includes important pest of cultivated plants, especially in tropical and sub tropical areas and under glass house cultivation elsewhere. The San Jan scale Qudraspidiotus pernicious of deciduous fruits and red scale of citrus.

The lady bird beetle (Coleoptera: cocconellidue) is being exploited as a potent animal for the aphids, white flies decide other animal pests that cause colossal economic losses throughout Pakistan [1] many species of aphids attack difference croplands & thus , causes economic losses They also diseases in the standing crops, attack of whiteflies on the tomato fields on the cumulative in the developing countries. of the various predatory animals attack the aphids include the “Coccinellids” in the crop plants & when the beetles, due to their predacious nature are allowed to wonder in the selected vegetation, there is an overall reduction in the no. of white flies per food crop *Coccinella septempunctata* is considered to be an important bio-control agent for soft-bodies insects such as white flies, aphids, jessed and small lepidopterous curve which were among the first to be used in the fusion [2].

Materials and Methods:

Study Area

Maharashtra, literally meaning the great state, with its rich biodiversity, is a huge irregular triangle with its base facing the Arabian Sea. Physico-graphically the state may be divided into four natural divisions - the coastal strip (the Konkan), the Sahyadri or the Western Ghats, the Deccan plateau, and the forests of North Maharashtra. The Northern region of Maharashtra includes Nashik, Dhule, Jalgaon and Nandurbar districts. The Sahyadri or Western Ghats in this region run almost parallel to the sea coast; and the average height of 1,200 meters. The Western Ghats, also known as the Sahyadri Hills, are well known for their rich and unique assemblage of flora and fauna.

Nasik district, lying between 19^0 35' and 20^0 52' north latitude and 73^0 16' and 74^0 56' east longitude, with an area of 15,582'0 km. Rhomboidal in shape with the longer diagonal of near about 170 km. from south-west to north-east and an extreme breadth of about 170 km. from north to south, Nasik is bounded on the north-west by the Dangs and Surat districts of Gujarat State, on the north by the Dhulia district, on the east by the Jalgaon and Aurangabad districts, on the south by the Ahmadnagar district and towards the south-west by the Thana district. The district derives its name from that of its headquarters town of Nasik, for the origin of which two interpretations are given. The town is sited on the nine peaks or *navashikhara* and hence its name is Nashik.

Sample Collection:

Extensive year round surveys was conducted at different intervals in the active season of ladybird beetles, especially of vegetable fields, general vegetation was also searched for occurrence of ladybird beetles. The ladybird beetles of Nasik District were collected. The coccinellid specimens were collected by aerial netting and hand picking, and killed in a killing bottle containing ethyl acetate, with 1 cm thick filter paper at the bottom. The killing agent was pasted on a piece of cotton. After killing the specimens were pinned with stainless steel entomological pin. After proper drying ladybird beetles were placed in a collection box. Field data of each specimen was recorded. In the absence of adult, larvae and pupae were collected and were brought to laboratory for rearing to adult emergence.

The dead small sized beetles were mounted on a small rectangular piece of white card, a small drop of hydrosoluble glue was pasted on the card and the beetle was set on this with the legs and antennae spread out, the card was then supported on a stainless steel entomological pin. Very small specimens were mounted on points. Each specimen was labeled noting the place of collection, date of collection, collector's name and host plant species. Comparatively large specimens ware pinned on right elytra just behind pronotum. The specimens were then kept in wooden insect boxes.

Identification

The specimens were identified with the help of Kapur [3] Rafi *et al* .[4].

Results and Discussion:

Diversity of ladybird beetle was studies from four habitats viz. agriculture, grasslands, forest and human habitat in Nashik District, Maharashtra, India (table 1). During the present study 14 species belonging to 11 genera & 4 sub-families recorded from the study area. The sub-family Coccinellinae was the most varying and abundant sub-family than other three sub-families. Sub-family Coccinellinae represented with 8 species belonging 6 genera from all habitats. Sub-family, Sticholotidinae was occurring in all the habitat of study area with species belonging to 1 genera, Sub-family Scymninae was reported with 2 species belonging to 2 genus from two sites of the study area, whereas subfamily Chilorinae with 2 species belonging to 2 different genera from two sites of the study area (table 2).

Table 1: Number of ladybird species recorded within Nasik districts

Sr. No.	Site	No. of species recorded
1	Agriculture	11
2	Grass land	14
3	Forest	14
4	Human Habitat	11

Sub-family Chilocrinae was represented by two species viz. *Brumoides suturalis* and *Chilocorus nigrita* sub-family Scymninae was represent by two species *Pseudaspidimerus trinotatus* and *Scymnus (Pullus) Latemaculatus* Sub-family Sticholotidinae was represent by Two species viz. *Pharoscymnus flexibilis* and *Pharoscymnus hornil.* The most diverse and dominating sub-family was Coccinellinae represented by Eight species like *Coccinella septempunctata, Coccinella transversalis, Cheilomenes sexmaculata, Hippodamia variegate, Hippodamia convergens , Illeis cincta, Micraspis discolor, Propylea dissecta.* Coccinellinae and Scymninae are distributed randomly in Agriculture, Grassland, Forest and Human Habitat sites. Whereas two other sub-family like Chilorinae and Scymninae were found only in two habitats like Forest and Grassland. Similar pattern was same during both two years of the study period.

Table 2: Data illustration for taxons recorded from study area

Sr. No.	Name of Sub- family	Number of Tribe	Total Identified Specimens	Identification of specimens up to	
				Genus	Species
1	Chilocorinae	01	02	02	02
2	Coccinellinae	01	08	06	08
3	Scymninae	02	02	02	02
4	Sticholotidinae	01	02	01	02
	Total	**05**	**14**	**11**	**14**

Identification:

1) Clypeus strongly expanded laterally ; anterior margin of pronotum deeply, trapezoidally concave, lateral portions strongly descending below; elytral base distinctly broader than pronotal base; elytral epipleura broad or its inner carina reaching elytral apex; tibiae angulate externally. ……..…...…… **(Tribe Chilocorini)**

Body rounded, subglobose; antennae 8 segmented, elytra black, lateral expansions of pronotum reddish brown; elytra without spots; spermatheca sac-like with finger like projection anteriorly . . (Plate I-1)…….. ***Chilocorus nigrita*** **Fabricius.**

Body elongate, oval; each elytron with a sutural and discal broad longitudinal black stripe; elytra without reflexed margin; elytral epipleura not foveolate (Plate I-2) ……..……. ***Brumoide ssuturalis*** **Fabricius.**

2) Anterior margin of clypeus with an anterior projection on each side; antennal insertion rather approximating to the eyes; mandible always with a bifid tip anterior margin of pronotum usually deeply emarginate and with angulate anterior corners; maxillary galea conical ……..…….**(Tribe : *Coccinellini*)**

Each elytron with 3+½ roundish spots, spermatheca strongly hooked, nodulus and ramus clearly demarcated Post-coxal plates on abdominal vent rite one is incomplete with an associate oblique line . (Plate I-3)…..……***Coccinella septempunctata*** **Fabricius**

Each elytron with a large trilobed humeral spots (sometimes lacking); elytra with transverse band at apical 0.33, a second usually incomplete band just before apex and black. (Plate I-2)……..……..***Coccinella transversalis*** **Fabricius**

Antenna with basal segment broader than long, with a strongly convex innerside; lateral side of elytra not margined; inner carina of elytral epipeluron not strongly convergent, reaching apex; elytral epipeluron strongly inclined below; sipho thread like at apex. (Plat I-5)……

Cheilomenes sexmaculata **Fabricius.**

Variable spotting on elytra, 0-12 discal spots, with terminal 6 markings typically more persistent and likely to be present. Elytral ground color orange to red. Pronotum has white edging on anterior and lateral borders, two isolated white spots. Pronotum has raised margin on basal edge. (Plate I-6) ..……...……***Hippodamia variegate*** **Goeze-**

Scutellum is black in coloured. Body colour is an orange or red, with whitish/creamy yellow areas adjacent to scutellum and small thirteen black spots are present on elytra, one postscutellar spot and six on each elytron. Ventral side more or less completely black in color**.**(Plate I-7)…..……

Hippodamia convergens **Guerin-Meneville**

Pronotum with a pair of rounded black spots at posterior end; prosternum anteriorly expanded to cover the mouth parts . (Plate I-8)……

.***Illeis cincta*** **Fabricius.**

Sipho curved at basal, apically straight, apex of sipho spatula shaped with hooked process; spermatheca curved and C shaped. (Plate II-9) ……..……***Micraspsis discolor*** **Fabricius.**

Adult beetle measures about 4.5 to 4.8 mm in long and 5.0 mm in broad. They are attractive bright red, yellow, orange color. They are having a pair of prominent blackish spots on the posterior side of the elytra. Some specimen of *Propylea dissecta,* are without spots on elytra. Antenna are short, head is black in color, on ventral side of the beetle black line is present. (Plate II-10A& B)……***Propylea dissecta*** **Mulsant**

Eyes covered anteriorly by the expanded head capsule; antennae ninesegmented and very short, less than one-fourth the head width; eltyral epipluera very narrow with distinct foveae; trochanters elongate, femora broadly expanded concealing the compressed tibiae, tarsi true trimerous; abdomen composed of six segments, of which first convex posteriorly in an arc; dorsum pubescent and body medium to small . ……..(**Tribe Aspidimerini).**

Anterior margin of clypeus without an anterior projection, Prosternal carinae subparallel to slightly divergent towards anterior, enclose an area much longer than broad, subrectangular; male genitalia with median lobe of aedeagus broader than long, U-shaped and posteriorly sinuate in the middle; sipho stout, anteriorly bulbous. (Plate II-11)

…….…… ***Pseudaspidimerus trinotatus*** **Thunberg**.

Eyes usually moderate in size with or without a moderately deep or shallow post antennal emargination; antennae eight to eleven segmented and usually relatively short, at most shorter than two-thirds the head width. Labrum rather short; coxite of female usually elongate, rarely transverse. ……..……**(Tribe Scymnini)**

Viewed from below, the first segment of the abdomen has a slightly raised curved line which runs from the base of the back leg towards the rear of the segment and then curves back before stopping within the segment (Plate II-12). …….……**Scymnus *Latemaculatus* Mostschulsky**

Ground colour of elytra dark pitchy brownish, with two yellow to reddish spots on each elytron, distinctly separated or longitudinally fused at middle, forming an elongate, medially constricted marking, this marking

sometimes much wider, lateral borders of elytra occasionally lighter than disk. Ventral side uniform dark reddish to testaceous brown. Prosternal process large, quadrate and subtrapezoidal ……**Tribe: Sticholotidini**)

Head and pronotum are reddish or yellowish brown in color. Elytra are reddish or pale yellowish brown in color with four or five black spots, which are fused. . (Plate II-13) ……***Pharoscymnus flexibilis*** **Mulsant**

Round, strongly convex, dorsal side densely pubescent. Ground color dark brown, each elytron with a pair of reddish or orange yellow spots, anterior spot subquadrate and larger, posterior spot roundish.Ventral side uniformly dark brown in color. Head quadrate, clypeal margin narrowly extending laterally over eyes, eyes not emarginate around antennal insertions. (Plate II-14) ……***Pharoscymnus horni*** **Weise**

The Coccinellids, which are commonly called as lady bird beetles belong to the family Coccinellidae of the order Coleoptera. These are often brightly coloured with red, orange or yellow elytra frequently spotted black or yellow stripes. The great numbers of Coccinellid species are predaceous, beneficial from the viewpoint of biological control of pests, feeding during both larval and adult stages of aphids, scale insects, mites etc. The species composition under the relationship of many species to habitat can vary in different regions of their distribution and also in different ecosystems. In view of their importance in biological control of crop pests the accurate identification of Coccinellid fauna associated with a particular crop ecosystem and particular region is very much essential. Hence, the present investigation was undertaken with an objective to identify the Coccinellid species that are present in Nashik district with different ecosystem.

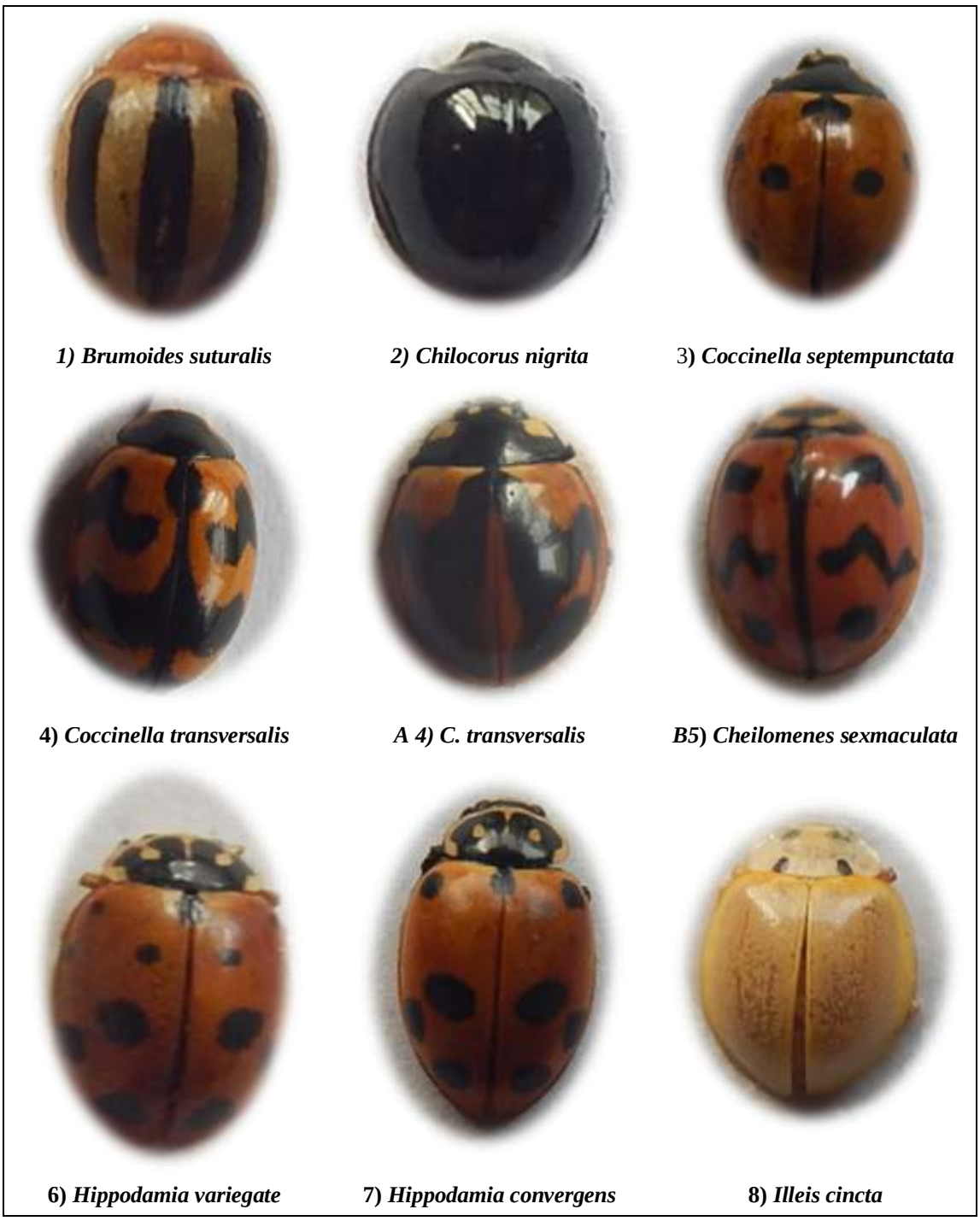
In the present investigation, the following 14 Coccinellid species predatory beetles belonging to 11 genera, under 5 tribes and 4 family Coccinellidae [5], Sub-family Chilocorinae [6], Coccinellinae [5], Scymninae [6], Sticholotidinae [7] were identified from the agricultural, grassland, forest and human habitat of Nashik district from February 2015 to January 2016. The subfamily Coccinellinae was the most varying and abundant subfamily than other three subfamilies. Subfamily Coccinellinae represented with 8 species belonging 6 genera from all habitats. Subfamily Sticholotidinae was occurring in all the habitat of study area with species belonging to 1 genera, Subfamily Scymninae was reported with 2 species belonging to 2 genus from two sites of the study area. Whereas subfamily Chilorinae with 2 species belonging to 2 different genera from two sites of the study area. Whereas all geneus are 14 *Brumoides suturalis* [8] ,*Chiocorus nigrita* [9], *Coccinella septempunctata* (Linnaeus1758), *Coccinella transversalis* [10], *Cheilomenes sexmaculata* [10], *Hippodamia variegate* [11], *Hippodamia convergens* [12], *Illeis cincta* [9] , *Micraspis discolor* [9], *Propylea dissecta* [13], *Pseudaspidimerus trinotatus* [14] *Scymnus (Pullus) Latemaculatus* [15], *Pharoscymnus flexibilis* [13], *Pharoscymnus horni* [7].

During present study 11 genera were recorded from the study area .Relative abundance of different genera was calculated during two study year. Relative contribution of genus *Coccinella* was high in Agriculture site 33.97% where as relative contribution of genus *Hippodamia* was found to be 19.37%, genus *Cheilomenes* was contributed 12.59%, Micraspis contributed about 11.22% whereas *Pharoscymnus* 8.78%, *Illeis* was 5.66%, followed by Propylea which was with 5.52% , *Pseudaspidimerus* with 2.88% the least relative contribution at Agriculture site of Nashik distribute.

It is important predator and feeds on different hosts like mites, psyllids, coccids and aphids and protects the cereal crops from the damage of these pests. Kapur [16] found *Brumoides suturalis* feeding upon three species of aphids, one species of mite and six species of coccids. Ullah *et al.* [17] recorded this species from Dir Lower of Malakand division. Subfamily Coccinellinae is comparatively group and hence also represent high number of species from Buner. The members of this subfamily are usually medium to large in size and some genera are cosmopolitan. Poorani [18], Slipinski [19] has used the name *Menochilus sexmaculatus* for this

species. Sharma and Joshi [20] named this species as *Cheilomene sexmaculata*. It is widely distributed throughout the country and reported almost by all previous workers.

Plate 1



1) Brumoides suturalis ***2) Chilocorus nigrita*** 3**) *Coccinella septempunctata***

4) *Coccinella transversalis* ***A 4) C. transversalis*** ***B5*) *Cheilomenes sexmaculata***

6) *Hippodamia variegate* **7) *Hippodamia convergens*** **8) *Illeis cincta***

Plate 2

9) Micraspis discolor

10) ***Propylea dissecta*** **A**

10) Propylea dissecta **B**

11) P. trinotatus

12) Scymnus latemaculatus

13) ***Pharoscymnus flexibilis***

14) ***Pharoscymnus horni***

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STUDIES ON MYCOBIOTA AND NATURAL INCIDENCE OF CITRININ IN *CAPSICUM* (*CAPSICUM ANNUUM* L.)

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Abstract:

Capsicum (*Capsicum annuum* L.), commonly cultivated and highly used in India were analysed for natural occurrence of toxigenic mycoflora and Citrinin (CTN) Aflatoxins (AFs) and ochratoxin A (OTA), contamination. *Aspergillus, Fusarium, Myrothecium,* and *Pencillium* were the most dominant Genera isolated from *Capsicum.* Red chilli samples were highly contaminated with citrinin (60.34%) from *Penicillium citinum* secondly *Aspergillus flavus* (53.85%) and produced aflatoxins and ochratoxin A, respectively. Qualitative detection and quantitative detection of mycotoxins in spices were analyzed by ELISA and further confirmed by LC-MS/MS. *Penicillium citrinum* produced citrinin in red chilli, dry samples. The highest amount of Citrinin was found in red chilli (219.6ng/g), Aflatoxins (AFs) and ochratoxin A (OTA) (154.1ng/g) and (104.1ng/g). The results of this study suggest that the chilies are susceptible substrate for growth of mycotoxigenic fungi and further mycotoxin production. This is the first report of natural occurrence of citrinin in chillies from India.

Keywords: Toxigenic microfungi, mycotoxins, chromogenic media, reagents, *Capsicum* (*Capsicum annuum* L.)

Introduction:

Capsicum (*Capsicum annuum* L.), a fruit vegetable, belongs to the family Solanaceae and is believed to have originated in South America. *Capsicum* or Cayenne takes its name from the Greek 'to bite' a reference to the hot, pungent properties of the fruits and seeds. The plant was originally described by Linnaeus as *Capsicum annuum* L. The crop is now being cultivated in many regions of the world, including India, China, Europe, Dominican Republic, Haiti, Hawaii, Mexico, Europe, Philippines and the United States. The largest producer of chillies in the world is India accounting for 13.76 million tonnes of production annually.

Mycotoxins:

Mycotoxins are secondary metabolites of moulds, contaminating a wide range of crop plants and fruits before and after harvesting. These contaminated crops are toxic to humans and animals, and therefore, it may be a major health issue for the consumer. Mycotoxins occurring in food commodities are secondary metabolites of filamentous fungi, which can contaminate many types of food crops throughout the world. Although hundreds of fungal toxins are known, a limited number of toxins are generally considered to play important roles in food safety. Aflatoxins are a group of mycotoxins produced by some strains of *Aspergillus.* The most potent are B1, B2, G1 and G2 all of which have been found in chilli (FACT SHEET,Chillies & the Aflatoxin contamination).

A fungus may produce different mycotoxins, and a mycotoxin may be produced by several different fungi [1]. Approximately 350 mould species are known to produce around 300 mycotoxins and related metabolites [2, 3, 4]. Mycotoxins have attracted worldwide attention due to their potent toxic nature and fairly common occurrence under natural conditions. The mycotoxin contaminants, which are subject to government regulation include aflatoxins, fumonisins, ochratoxins, citrinin, cyclopiazonic acid, deoxynivalenol, nivalenol, patulin and zearalenone [5].

Citrinin Historical aspects and producing fungal species:

Citrinin, a renal toxin, is produced by *P. citrinum,* and *P. verrucosum.* It has been reported to be produced by at least 20 other penicillium, but these claims require further investigation. *P. viridicatum* was reported as the main producer of citrinin [6, 7]. Citrinin affects domestic animals, including dogs [8] and pigs, where it causes porcine nephropathy [9]. Kidney degeneration is the cause, with similar kidney damage implicated in humans *P. citrinum* is another producer of citrinin. It is also a ubiquitous species and is therefore very commonly isolated from numerous foods, including cereals, milled grain and flour [10]. In cereals, *P. verrucosum* is the main producer of citrinin and ochratoxin A (OA). Citrinin and OA often co-occur, but it is OA which is isolated more frequently.

Citrinin synthesis:

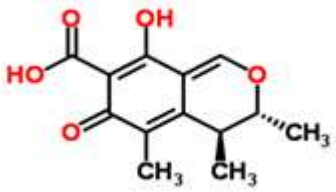


Figure 1: Chemical structure of citrinin (CTN) (C13H14O5), taken from Chem Spider

The synthesis of Citrinin was first reported by [11]. Initially, the laevorotatory form of 3-(4,6-dihydroxy-ortho-tolyl) butan-2-ol (I) is carboxylated to form the acid. (II; R=H) This product is subjected to the Gattermann reaction (conversion of the phenol to the aromatic aldehyde by reaction with hydrogen cyanide/ hydrogen chloride in the presence of a zinc chloride catalyst) to produce an intermediate (IV; R=H), which is subsequently cyclized with sulphuric acid to form Citrinin. (V;R=H) The crude product was then purified by crystallization from ethanol. [12]. However, it is still possible, that the acid (II; R=H), subjected under the Gattermann reaction, can form its methyl ester (III; R=Me), which is then cyclized with sulphuric acid to methyl Citrinin (V; R=Me). The interaction of the ester (II; R= e) with formaldehyde in the presence of aqueous sodium hydroxide was accompanied by hydrolysis of the carbomethoxy-group, giving dihydro citrinin (VII; R=H) in good yield, most likely by way of the intermediate type (VI) [11].

Management of mycotoxins:

Risk of mycotoxin contamination of food commodities, food and feeds in India is increasing due to environmental, agronomic and socio-economic factors. Environmental conditions especially high humidity and temperature favour fungal proliferation. Farming practices in India also sustain fungal and toxin contamination in food and feed. In view of widespread occurrence and health hazards induced by mycotoxins in animal and humans, intensive research on the hazards of mycotoxins has been initiated. Prevention, inactivation and detoxification strategies had been strategies adopted for the control of mycotoxins [13]. Because of the unpredictable, heterogeneous nature of mycotoxin contamination, 100% destruction of all mycotoxins in all food systems is not considered a practical option but, it is possible to minimize contamination by using effective risk management strategies [14]. The control of mycotoxin contamination of food feed and feed ingredients are subject of great concern. In recent times awareness of possible health hazards in man due to indiscriminate use of fungicides and pesticides forced man to search alternate methods for plant protection. Much attention is now being devoted to breeding lines of cereal plants that are resistant to fungal colonization and disease [15, 16, 17]. Control of mycotoxins often depends upon integrated approach, combining appropriate field application of different plant protectants to prevent infestation, packing and storehouse sanitation.

The ubiquitous nature of fungi makes food crops vulnerable to fungal contamination during pre-harvest and post-harvest conditions. In the field, the contaminating fungi are airborne or transmitted by insects, and damaged kernels often become infected. Stress conditions like drought, floods, insect infestation and delayed harvest increase the level of contamination. Post-harvest conditions such as inadequate drying warm humid environment during

storage lead to mould formation. The extent of contamination by fungi depends on various factors like geographic location, processing and storing periods of the crops. Environmental factors like temperature, water activity or pH, damage to crop by insects, crop densities, etc., influence the growth of fungi and mycotoxin production [18].

The present study was conducted to assess the association of toxigenic mycoflora in chillies and their mycotoxin producing potentiality.The natural contamination of AFs, OTA, and CTN was also examined in these spices. It has been observed that red chilli samples were highly susceptible to AFs, OTA, and CTN contamination.

Materials and Methods:

The experiments included in the present investigations were carried out in Toxicology laboratory, Department of Botany, Kakatiya University, Warangal during the period 2014-2017. Some of the experiments were also carried out in selective labs outside the department for the perfection of results. Standard protocols were followed throughout the experiments. All the chemicals used in the present study were of analytical grade (Himedia & Sigma-Aldrich) unless otherwise specified. Uniform laboratory conditions were maintained, all the experiments were carried out in strict aseptic conditions. Each experiment was carried with three replications each. All the glassware and equipments used are well sterilized according to standard protocols.

i. Selection of material:

For the present investigation, dried red chillies (*Capsicum annuum* L.) were selected. Chillies are famous for their pleasant aromatic flavour, pungency and high colouring substance. They are widely used in culinary, pharmaceutical and beverage industries throughout the world. Among the various spices cultivated in India, it has the highest domestic per capita consumption.

ii. Collection of samples:

During the investigation period, domestic, market and cold storage samples of dried red chillies (whole and ground) were collected in pre-sterilized polythene bags from Warangal district divisions. The sample bags were brought to the laboratory, sealed over flame to avoid external contamination and kept in the refrigerator at 5-7^{o}C to prevent undesirable changes till further studies were carried out.

iii. Studies on mycoflora:

Recovery of mycoflora associated with domestic and market samples of dried red chillies (Red chilli pericarp, seed and powder):

Mycoflora associated with domestic and market samples of dried red chilli pericarp, seeds and chilli powder was determined by following the method given by Harrigan (1998). In this method, 5 g of ground sample was taken in a 250 ml Erlenmeyer flask containing 45 ml sterilized distilled water and homogenized thoroughly on an electric shaker for 15 minutes. Ten fold serial dilutions were prepared and 1ml portion of suitable dilution was poured in petriplates by using a sterilized pipette.

For the recovery of maximum number of fungal propagules from each sample, three different media – Czapek Dox agar (CDA), Potato dextrose agar (PDA) and Asthana & Hawker's medium (AHM) were used, and for each medium five replicates were maintained. The medium was poured by making gentle rotational movement of petriplates so as to ensure uniform spreading of the sample. Petriplates thus prepared were incubated at 27 + 2ºC for 7 days. Finally, the colonies were counted and the results were expressed as average colony.

iv. Isolation and identification of fungi:

Isolation of the fungus was made from chilli pericarp, seed samples and powder samples by following the standard isolation procedure. Isolation of fungi associated with chilli samples were carried out by standard blotter method and Potato Dextrose Agar method [19].

Standard blotter method:

Three pieces of blotting paper of 90 mm size were moistened with sterilized distilled water after placing in 90 mm sterilized Petriplates and excess water was drained off. Ten seeds per Petriplate were placed at equi distance on three moistened sterilized blotters using sterilized forceps. After that Petriplates were incubated under12/12 hr alternating light and dark period at 25±2ºC for seven days. The plates were observed constantly during the incubation period. After seven days of incubation, the fungal growth was examined under stereoscopic binocular microscope. Plates were taken out and observations on type of fungus and number of fungi were recorded.

Dilution plate technique (Waksman, 1922):

10g. of each sample was taken in 250 ml conical flask containing 100 ml of 0.1% sterilized peptone water and subjected to horizontal shaking for 30 minutes and dilutions were made as desired. 0.5 ml of this suspension was poured aseptically into sterilized petri plates containing cooled Asthana and Hawker's medium A (KNO_3 3.5g, KH_2PO_4 1.75g, $MgSO_4$. $7H_2O$ 0.75g, glucose 5g, Agar-agar 16g and distilled water 1000ml).The medium was poured by making gentle rotational movement so as to ensure uniform spreading of the sample. Petri plates thus prepared were incubated in an inverted position at 27 ± 2ºC under light/dark condition. To suppress the bacterial growth and to restrict the fungal colonies streptomycin and rose bengal were added. The fungal colonies developing from the plates were isolated and later on purified by repeated sub culturing. Slides were made on lactophenol cotton blue from individual colonies and the fungi were identified based on morphological features.

Identification of fungi:

Identification of fungi was made on the basis of their colony characters on different culturing media (macroscopic) and microscopic characters [4, 20]. Different macroscopic characters used to identify included colony form, size, elevation, margin/border, surface, color (pigmentation), opacity, texture and margins (rim) of colony.

The percentage of incidence, frequency and abundance of individual fungus were calculated with the help of following formulae.

$$\%\ of\ incidence = \frac{Number\ of\ colonies\ of\ a\ species\ in\ all\ plates}{Total\ number\ of\ colonies\ of\ all\ the\ species\ in\ all\ plates} \times 100$$

$$\%\ of\ frequency = \frac{Number\ of\ observations\ in\ which\ a\ species\ appeared}{Total\ number\ of\ observations} \times 100$$

$$\%\ of\ abundance = \frac{Total\ number\ of\ colonies\ of\ a\ species\ in\ all\ observations}{Total\ number\ of\ colonies\ in\ all\ observations} \times 100$$

Results and Discussion:

Citrinin is produced by *Penicillium citrinum*, *P. expansum*, *Monascus purpureus*, *M. ruber*, *Aspergillus ochraceus*, and *A. niveus* [21]. Citrinin is known to be hepatotoxic and nephrotoxic to a number of animal species [22]. It has been associated with yellow rice disease in Japan Balkan endemic nephropathy was also implicated [23, 24]. The ubiquitous nature of fungi and mycotoxins make them unavoidable contaminants. (Plate-I).

Chemical nature and biological activity of citrinin:

Natural products and their beneficial effects are of key importance for the prevention and treatment of human diseases [25, 26]. Many milestone studies have proven their profound impact on human health over the past decades [26, 27, 28]. However, natural products sometimes also display dangerous toxic effects. Mycotoxins are the natural toxins produced as secondary metabolites by many fungi, particularly *Aspergillus* and *Penicillium* species, which are often having carcinogenic properties and represent an important group of contaminants on food commodities [29]. Many herbs are globally used for medicinal and culinary purposes [30, 31]. Their economic and

culinary importance can be readily undermined by contamination with mycotoxins [32]. Mycotoxins possess diverse mechanisms of toxicity which enable them to be widely used as highly potent antitumor agents [33].

Citrinin (CIT) is a polyketide mycotoxin produced by several species of the *Aspergillus, Penicillium* and *Monascus* [34]. Other species of *Penicillium* (*P. expansum* and *P. viridicatum*), and even of *Aspergillus* (*A. niveus* and *A. terreus*), have been subsequently confirmed to produce CIT [35, 36]. CIT is obtained from grains of the harvested plants, under typical storage conditions [37]. Other sources of CIT include beans, fruits, fruit and vegetable juices, herbs and spices, spoiled dairy products (EFSA Panel on Contaminants in the Food Chain (CONTAM), 2012), and it also represents a contaminant in red mold rice used as a food preservative and colorant in Asian foods [38]. Although CIT is mainly known for its toxic properties [27], there is increasing evidence supporting other biological activities of this mycotoxin especially anticancer [39] and neuroprotective [40]. This is provoking ongoing research interest in this natural product.

This review attempts to summarize the current status of CIT-related knowledge with a focus on its reported bioactivities and potential biomedical applications. Citrinin was first isolated from secondary metabolites of *Penicillium citrinum*. Other species of *Penicillium* (*Penicillium expansum* and *Penicillium viridicatum*), and even of *Aspergillus* (*Aspergillus niveus* and *Aspergillus terreus*), also were subsequently confirmed to produce these substances. Certain isolates of *Penicillium camemberti*, used in cheese production, and *Aspergillus oryzae*, used in the production of Asiatic foods such as sake, miso, and soy sauce, can also produce citrinin. More recently, citrinin was isolated from the metabolites of the fungi *Monoascus ruber* and *Monoascus purpureus*, the species that are used industrially in the production of red pigments.

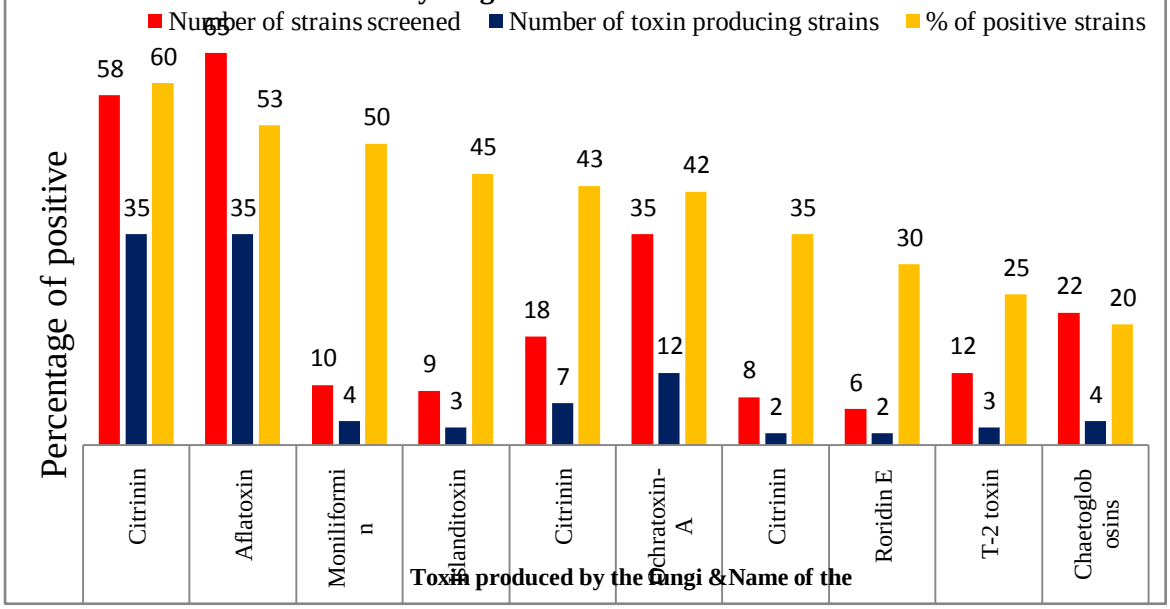
Table 1: Screening of toxigenic fungi and respective Toxins produced by fungi isolated from chillies

Name of fungus	Number of strains screened	Number of toxin producing strains	% of positive strains	Toxin produced
Aspergilus flavus	**65**	**35**	**53.00**	**Aflatoxin**
		3	4.62	Sterigmatocystin
		27	41.54	Citrinin
A. ochraceus	35	12	42.00	Ochratoxin-A
		6	17.14	Penicillic acid
A. terreus	18	7	40.00	Citrinin
		3	16.67	Territrem-B
Fusarium moniliforme	10	4	50.00	Moniliformin
		2	20.00	Nivalenol
		1	10.00	Zearalenone
F.solani	12	3	25.00	T-2 toxin
Myrothecium roridum	6	2	30.00	Roridin E
Chaetomium globosum	22	4	20.00	Chaetoglobosins
Penicillium citrinum	**58**	**35**	**60.00**	**Citrinin**
P.hirsutum	8	2	35.00	Citrinin
P.islandicum	*9*	3	45.00	Islanditoxin
Trichothecium roseum	*6*	2	33.00	Trichothecin

Citrinin ([3*R-trans*]-4, 6-dihydro-8-hydroxy-3, 4, 5-trimethyl-6-oxo-3*H*-2-benzopyran-7-carboxylic acid) is a benzopyran derivative**.** Various assays, including thin-layer chromatography (TLC), enzyme-linked immune sorbent assay (ELISA), and high-performance liquid chromatography (HPLC) has been developed to detect its presence in food and biological samples [37, 41, 42]. Citrinin is thermolabile. Its major decomposition products are temperature dependent and include citrinin H2, which is less cytotoxic, and citrinin H1, which is more cytotoxic [43,

44]. Citrinin is a benzopyran metabolite produced by the toxic strains of *Penicillium* spp. and *Aspergillus* spp. Some hepatotoxic effects have been reported for citrinin, but the lethal effects are largely due to the nephrotoxic effects. The specific mechanism of action in the kidney is not known. The primary effect is on the kidney and leads to acute tubular necrosis. In pigs, rat, and rabbit the proximal segments are affected. Experimental studies show that citrinin induces renal damage in turkeys and ducklings along with hepatic degeneration and lymphoid necrosis.

Figure 1: Screening of toxigeninc fungi and respective toxins produced by fungi isolated from chillies



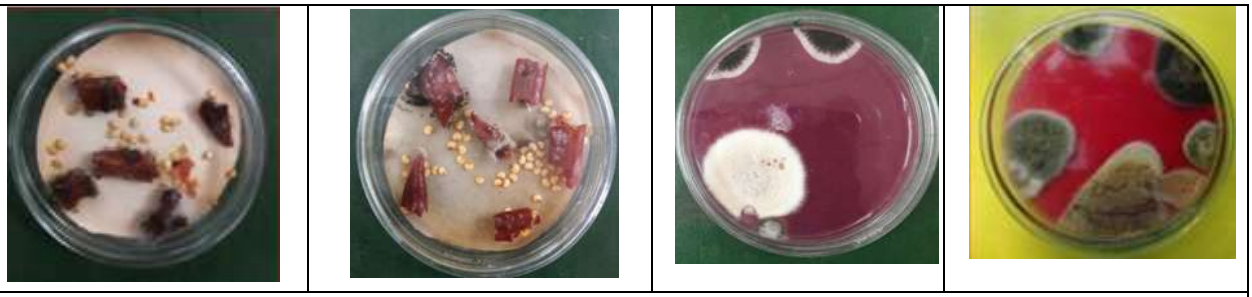


Plate1: Fungal association of toxigenic fungi in different spices. (a) Red chilli associated with *A. flavus* and *A. niger*, (b) *A. flavus*, *A. parasiticus*, *A. niger*, and the other fungal contamination in black pepper, (c) fungal contamination in Chillies, (d) Fungal associated with different fungi

Citrinin was first recognized as a promising antibiotic, but it was later found to cause kidney damage, retard growth, and eventually cause death in animals. Citrinin was isolated in the 1930s and produced by *Penicillium citrinum*; however, *P. verrucosum* is also known to produce the toxin. It is known as the yellow-rice toxin discovered in Japan in 1950–60 when hundreds of tonnes of rice imported from various parts of Asia were declared unfit for consumption. It was found in cereal products in parts of Europe, North America, and Canada and in maize samples from South-east Asia. A survey in Denmark detected both citrinin and Ochratoxin-A (OTA) in barley samples and it is usually a co-contaminant with OTA, causing damage to the kidneys.

Citrinin has been known to be nephrotoxic, hepatotoxic, and carcinogenic to humans and animals. Citrinin, like OTA, has been reported to be a potential risk factor for human Balkan endemic nephropathy, originally described as chronic tubulointerstitial kidney disease in southeastern Europe [45]. Citrinin was associated with yellow rice syndrome in Japan in 1971 because of the regular presence of *P. citrinum* in this food product. It has also

been considered responsible for nephropathy in pigs and other animals, although it's acute toxicity varies depending on the animal species. Oat, rye, barley, corn, and wheat grains are excellent substrates for the formation of citrinin [46]. This mycotoxin has also been found in products naturally colored with pigments of *Monoascus*, as well as sausages naturally fermented in Italy. Though there are several reports on citrinin production by different fungi isolated from foods, feeds and fodders very limited information is available on a succession of fungi on stored fodders [47]. Such studies were not undertaken from this region on the production of citrinin by *A. flavus and P. citrinum* isolated from chillies. Hence it is considered worthwhile to investigate the influence of various factors on the production of citrinin.

Influence of different incubation periods on the production of biomass and citrinin by *A. flavus and P. citrinum:*

This study was undertaken to determine the effects of incubation time on citrinin production by *A. flavus and P. citrinum* and the results are presented in Table 15 and Text figure 6. From the table it is evident that citrinin production by *A. flavus and P. citrinum* started only after a certain lag period, i.e., after 8 days. It is also evident from the table that citrinin production increased with the progress of incubation period and reached maximum production by 21st day. The amount of citrinin decreased marginally with the progress in the incubation period.

Conclusion:

On the basis of the present study, it may be concluded that the red chilli, substrate for fungal growth and subsequent mycotoxin productions. All spices were contaminated with AFs. This is the first report of CTN contamination in chillies contaminated spices in which AFs, OTA, and CTN were present in high concentration. Further research is needed to isolate the active ingredient or the essential oil of these Chillies, which plays a vital role in the growth of toxigenic fungi and further toxin production. It is very important to care in processing, handling, transportation, and modification in storage system to reduce the production of hazardous mycotoxins in spices.

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NATURAL RESOURCE (FLORA AND FUNA) ADAPTATION WITH TECHNOLOGICAL MANAGEMENT IN AGRICULTURE

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Technological change is possibly the single most important factor driving globalisation and the development of world agriculture.

The following observations can be made:

− the gap between rich and poor countries is often a technology gap;

− the changing relations between farmers and society are often a result of changes in technology used by farmers; and

− new technology is increasingly at the forefront of international trade conflicts.

The capacity of agriculture to continue providing food for rural and urban populations must be balanced with the capability of the land. Here, agriculture has an important role in protecting and improving natural resources (i.e., the land users' resource base) and the environment in such asway as to ensure the preservation of natural capital and to foster sustainable development.

Pressure on land leads to exploitation and degradation of natural resources. Land users frequently lack both the technology and the financial resources to apply sound appropriate land-management practices and to invest in effective resource maintenance and enhancement. (This is further exacerbated when farmers lack secure use or ownership rights of the land resources they use). As a result, agricultural activity, especially in marginal areas, frequently leads to the unsustainable over-exploitation of land resources. Stated simply, land users are often forced into this situation in order to ensure minimum daily needs and basic household livelihoods. Clearly, increasing population and concomitant consumption growth accentuates these pressures, particularly in fragile and marginal land areas. In instances in which no suitable alternatives are developed and applied, degradation of natural resources can quickly extend beyond recoverable thresholds.

Agricultural production frequently fails to match the needs and expectations of land users. In these cases, production and/or income alternatives have to be developed in order to safeguard the future development and well being of rural regions and their people. Solutions may also lie in non-conventional and/or non-agricultural use of land resources. The maintenance and, where possible, the enhancement of the natural resource base is one of the principal goals of research in the CGIAR System. Effective solutions to these and related problems will have to sensitive to the trade-offs between different goals and objectives. How for example, does one balance the demands of household food security with those of good environmental management? Similarly, questions of scale and time are important, raising issues such as the varied impact of practices through space (such as up-stream and down-stream impacts in a river system) and likewise, the balance between short and long-term needs and effects.

In many parts of the developing world, resource-poor farmers are both the causes and victims of inappropriate land-use practices. This can lead to a vicious cycle of degradation and natural resource depletion. Effective research can help to break this sequence. In the final instance, research should lead to solutions that benefit both producers and the environment. It is clear than, that effective research across a wide range of different ecosystems requires an adequate understanding of their characteristics and multifunctionality. Knowledge of the socio-economic and biophysical processes which govern resource husbandry (i.e., depletion and enhancement of the natural and human resources) is critical for developing sustainable land-use practices which both improve the livelihood of the rural population and ensure appropriate use of natural resources.

Individual land use scenarios and the most applicable management practices are location-specific within a larger environment. International research institutions cannot be everywhere. They must work on a

generic level, developing research mechanisms to permit the extrapolation and adaptation of technologies and methods to other regions. This means research scenarios have to be representative of other, larger areas with similar characteristics. The multi-scale characterisation of agro-eco-regions and their multifunctional particularities is therefore of great importance for appropriate natural resources management.

Effective agricultural research must be people-centred. If research in natural resource management is to contribute to development, the land users must play a central role. Instead, there is a tendency for researchers to perceive problems in their terms and to develop strategic solutions from their own point of view. This can often lead to an incongruence between real-world problems and research-based solutions. Instead, it should be recognised that, the conditions prevailing at the land-user level set the limits for, and the pace of the adoption of improved and more appropriate technologies. It is for this reason that land users are the focus for a substantial part of research throughout the CGIAR System. Indeed, recent experience shows that farmer participation leads to significant improvements in terms of both the suitability and effectiveness of research solutions, leading to benefits for both rural households and the natural resource base.

The challenge facing both the CGIAR System, and researchers in general, is to identify viable alternatives that deliver improvements in terms of production, economic and social benefits and land management so as to satisfy the competing demands of both rural livelihood improvement and sustainable natural resource use.

Sustainable agricultural productivity is not only dependent on the direct management of the natural resources. It also requires appropriate enabling environments in terms of both general socio-economic conditions and a supportive policy matrix. Enabling environments include the incentives that encourage producers to invest in the strategies necessary for improved land use. Domestic policies for example, may provide direct support to initiatives that deliver positive benefits to the environment. Similarly, functioning local markets will allow producers to benefit from increased production surpluses resulting from new agricultural practices. Indeed, it is widely recognised that access to factor input (finance, equipment, natural resources) and factor output markets is a decisive factor shaping the viability of new innovations. Secure and reliable access to necessary land resources for example, coupled with suitable marketing and adequate rural infrastructure all encourage land users to invest and care for their land. In such enabling environments, improved technologies developed through research will become more effective. When these conditions exist, research can help develop better production technologies and ways to optimise the management of natural resources for improved and more sustainable land productivity and environmental sustainability.

Sound agricultural practices not only involve better economic use of resources but also foster environmental protection. Downstream effects of, for example, increased water use, soil erosion, nutrient translocation and pesticide emissions are usually of national concern and of little interest to individual land users. Decreasing environmental hazards and building environmental resilience are overriding objectives at sub-regional (e.g., watershed), regional and national levels.

Socio-economic Conditions and Policy:

The multifunctional character of agriculture and land refers to the full range of goods and services resulting from agricultural activity and related land-use. The meaningful deployment of the MFCAL Approach into the decision and policy-making processes is therefore contingent on both the development of effective valuation tools and the understanding of the factors that influence the generation of these goods and services in specific contexts. These may include international as well as national public goods and services. Carbon sequestration through improved crop and soil management practices, provides an example of an international public good whilst increasing employment opportunities and improved health are best viewed as national (or sub-national) public goods. Sustainable rural livelihoods and poverty reduction are common goals throughout the world. Clearly, the relative value and importance of these objectives varies through time and space, and even

within countries themselves. Individual sectors within a single country for example, will benefit differently from improvements in rural livelihoods (and indeed, some sectors may decline as a result of these changes). Likewise, the value of these public goods may vary between urban and rural areas. Similarly, the relative importance attached to these goals in terms of overall policy priorities varies between developed and developing countries and between rural and largely rural societies. Research undertaken in the IARCs on issues including socio-economic conditions and processes and the policy-making process in general contribute to understanding the nature and significance of these differential valuations and can contribute to the eventual production of an improved and more effective mix of the goods and services that constitute the multifunctional character of agriculture and land. Several key issues for this type of research and its links with the multifunctional character are examined below.

Continuing this logic, it is clear that for most agricultural producers, the primary objective of agricultural activity is food production, for either domestic consumption or for sale in the marketplace. Socio-economic and policy research, guided by recognition of the multifunctional character of agriculture and land, examines how the mix of agricultural goods and services produced affect food security, the welfare of producers, sustainability of natural resources utilisation and the environment. Natural resources and environmental degradation have costs in terms of human health, pollution, and loss of natural habitats. The decisions producers make in choosing certain agricultural practices depend on the incentives and opportunities provided by markets and government policies. Socio-economic research sheds light through empirical studies on the effects of agricultural production systems on these negative externalities. Recently, bio-economic models have been used at community levels in assessing the complex interactions between population, agricultural practices, rural income, natural resources use, migration, and government policies. However, more work is needed particularly on assessing the impact of policies and consequent agricultural practices on the positive externalities of agriculture. Both macro- and micro-level studies are needed to answer questions at different levels of scale.

A range of methods are recognised for assessing the value of the goods and services that are produced by agriculture but not traded in the market.[72] Owing however, to the perceived limitations of these valuation methods and their limited application in developing countries, the contribution of agriculture on the non-income functions may be underestimated. This can lead to policy distortions. Likewise, the impact of agricultural technology on non-food benefits of agriculture is inadequately understood. The MFCAL Approach encourages the application of valuation methods to account for wide-ranging multiple functions of agriculture. Socio-economic and policy research of the CGIAR System contributes to understanding the impact of agricultural technology on these multiple functions.

A key function of agriculture refers to the contribution it makes towards poverty reduction. Similarly, the fight against poverty is the overriding goal of the CGIAR System. and is a cornerstone of the individual missions statements of all the constituent centres. The CGIAR centres aim to achieve this goal mainly through increased and sustained agricultural productivity, and an improved socio-economic and policy environment. In many ways, the Green Revolution attests to the record of the CGIAR in this regard.. But, in spite of this and similar successes, poverty remains prevalent throughout most rural areas in developing countries. Nonetheless, poverty is a complex problem and likewise, understanding of its causes and effects is evolving continually within development and research communities. There is little doubt however, that agriculture remains an important element in poverty reduction in rural areas throughout many parts of the world. Socio-economic research can lead to improved understanding of the role of agricultural research in poverty alleviation. The effects can be direct (in the case of improved nutrition and calorie intake) or indirect (through price effects and labour market) and are influenced by many factors. The first step in poverty alleviation is to understand the constraints and opportunities of the poor. Future socioeconomic research will deepen our understanding of the different dimensions of poverty and improve the efficacy of agricultural research in alleviating poverty.

Traditional agricultural research and extension approaches will not meet the needs of rural communities. Particularly in the less favoured environments, where agriculture is practised in difficult terrain, marginal soils and variable weather conditions, farmers have used indigenous knowledge and local skills over many centuries to develop ways to survive in these difficult environments. However, their production systems and the local institutional arrangements that govern the management of their natural resources are threatened by socio-economic changes. Development of sustainable production systems and rational use of natural resources and the environment therefore calls for a new research and extension approach with the participation of local communities. The MFCAL Approach illuminates many of the key issues that are important to both communities and the environment and provides a useful descriptive framework for their assessment.

Social scientists at the IARCs, in collaboration with biophysical scientists, are building new partnerships with producers, land users, NGOs, and NARES of the developing countries and advanced institutions. These partnerships will implement farmer participatory research involving producers as active partners rather than as mere recipients of information. This approach is expected to empower farmers with knowledge and skills that enable them to experiment with different options and choose those best for them. The CGIAR System's participatory research initiatives offer new opportunities for technology development and dissemination, helps to re-examine the roles of research, of extension and of producers, and helps to assess the impact of technology on the multiple functions of agriculture. For example, participatory poverty assessment is a powerful tool giving deeper and comprehensive understanding of poverty. However, this new approach is still in its infancy and its impact has to be fully evaluated.

An important element of the socio-economic research carried out by the centres concerns the evaluation of the impact of technology on agricultural systems and rural livelihoods. In the past, this focused mainly on the economic impact. Evaluation of the impact of agricultural technology on the other functions of agriculture such as food security, poverty alleviation, environmental husbandry (e.g. desertification, carbon sequestration), sustainability of local communities, and an array of other functions is still to be investigated fully. In spite of methodological problems, the impact of technology on these other functions has to be evaluated if the MFCAL has to be fully understood. The CGIAR centres' policy research contributes to evaluating policy options with differing impacts on the different functions of agriculture.

Institutional Strengthening

Addressing the multifunctional character of agriculture requires a multi-partnership approach, which forges active relationships among national and international research centres and other players in the development process, including government departments, NGOs and the private sector. It is important that multiple actors work together and contribute their respective comparative advantages in knowledge, skills and experiences, since no single organisation can educate and empower farmers to make changes that can fulfil the multifunctional character of agriculture. Moreover, since the capacity of institutions varies from country to country, a complementary mix of institutions may seem a better way to effect change.

Intensive collaboration and networking with NARES is crucial to adapting the generic research outputs of IARCs to local conditions. Where NARES do not have the full capacity to do this, institutional capacity building is an important tool to encourage and enhance appropriate adaptive research. This applies particularly to the importance NARES attach to the role the land users themselves have in research.

IARCs endeavour to strengthen local capacity through training, technology transfer, information exchange and helping to influence policy reform. Many national programs in developing countries do not have the capacity to provide technologies suited to local needs due to a lack of trained persons, weak institutional arrangements and limited research and extension capabilities. There is a consequent need for assistance to be provided from outside. Over the past three decades IARCs have been found to be well suited to provide much of that assistance in the following ways:

- Collaborative research efforts between IARCs and NARS focused on problems that are best solved through joint research. International centres have scientific expertise, modern equipment and research methodology for tackling researchable issues in countries of their mandate regions. These countries

provide testing ground for research outputs or technologies and through cooperative efforts gradually develop their own capabilities for independent research.

- Short-term professional training at country and regional levels for thousands of NARS staff. Sustainable agriculture approaches will not develop unless communities and institutions themselves develop through education and training.
- Longer-term degree training and research experience for more senior staff from national programs.
- Wide information dissemination through reports, and advisory services to farming communities, and to policy makers responsible for spreading knowledge and progress.
- Technical networks for exchanging insights and experience.
- Decentralised research and management through outreach programs that are focused on location-specific realities and needs.

The collaboration between IARCs and national programs have enabled more effective on-farm research, field demonstrations and training, which together could contribute to a better understanding of the multifunctional nature of agriculture and its impact on economic growth, food security and poverty alleviation in developing countries.

Organization for Economic Cooperation and Development (OECD) implication for agriculture

Technologies that more precisely target pests and diseases:

The need for medicines and pest control agents in agriculture is not likely to disappear any time soon, however. Technological advances in the science of pest control are expected to continue to produce chemical control agents that over time are at least as effective in controlling pests as the ones they replace, but which are also less toxic, less persistent and less mobile through the soil. The greater application of monitoring and knowledge-based systems, aided by reductions in the costs of electronic sensors and computers, should also enable farmers to be more economical in their use of pest control agents, especially insecticides: applying them only when and where necessary, rather than according to predetermined dosages and schedules.

Technologies that administer nutrients more efficiently:

Farmers have traditionally relied on two main practices to supply nutrients to root zones: manuring and burning. Inorganic fertilisers allowed the separation of crop production from animal husbandry, restored fertility to depleted soils, and contributed to the development of livestock production based on grain and other feed ingredients. Research into the specific needs of particular crop-soil combinations and livestock have led over the years to more scientifically formulated fertilisers and feeds. Wider application of technologies that administer fertilisers only at the times and in the amounts needed can be expected to increase crop yields further while reducing leaching and runoff of nutrients.

Technologies that administer water more efficiently:

Many of the technologies still used for irrigating crops are as old as civilisation itself. The problem — today just as in ancient Mesopotamia — is that conveying water through open channels and furrows is wasteful: much of the water evaporates before it reaches the root zone. In OECD countries, much of the water used in agriculture is carried to fields by pipes; but technical efficiency could still be improved through greater application of technologies that, like precision fertilisation, combine more accurate measurement of actual crop needs with means to deliver the water more accurately and in more precise dosages.

Technologies that reduce wastage following harvesting:

The demand for primary agricultural commodities is a derived demand, which is determined in part by wastage between producer and final consumer. Technologies used in OECD countries to harvest, transport, store, process and distribute farm commodities are already highly efficient, and result in much lower levels of wastage than in countries where the requisite capital and infrastructure is in much shorter supply. Virtually every part of most crops and animals are recovered for some commercial use — if only for feed, fertiliser or energy. Some further reduction in post-harvest losses is achievable, but the most wastage (in proportion to the quantity purchased) takes place at the point of final consumption.

Technologies that disseminate knowledge:

Historically farmers relied on their own experience and that of their neighbours with regard to adopting "good farming practices". Advice and information from publicly funded agencies and agri-food industries is increasingly focused on environmental effects. The Internet provides further developments in the dissemination of information on sustainable technologies.

Policy impacts:

The type and uptake of environmentally sustainable technologies is influenced by a range of policies, providing incentives or disincentives: − environmental policies (constraining what farms can do); − agricultural policies (encouraging expansion of output or requiring environmental conditions in return for support); − Trade policies (which influence the location and type of production, and appropriate technology); − structural policy (which affects the scale of farm, the type of technology applied and the specialisation); and − technology and R &D policy (which encourages research and dissemination of technologies in light of current priorities). Much of the recent debate has been on the kind of incentives and disincentives that policies should give. For example, if it is not profitable for a farmer to adopt environmentally sustainable technology, should the government encourage farmers with financial incentives? This question can also been explored in the context where environmentally sustainable management practices contribute to positive externalities in agriculture (e.g. enhance biodiversity). These issues give rise to a whole new paradigm — including debates on the joint links between agricultural production and environmental outcomes and public good aspects of agriculture — in that technologies have to serve both for increasing the efficiency of production and the environmental performance. The issues are less controversial when there is a mutual benefit to adopting a new technology — that is to say, when it is financially profitable to adopt it, and its adoption also improves the environmental performance of the farm.

Conclusions:

1. Dissemination of information related to technology is important. In general, farmers have conservative attitudes and need more time and information to be persuaded to adopt new technologies. It is therefore important that the public sector provides reliable and site-specific data. Issues related to information and technology are areas the OECD might look in more depth in the future. Smooth dissemination of new technology requires reliable data and technical guidance adapted to local conditions.
2. Demonstration plots in typical local conditions are useful because farmers like to get first hand information when deciding whether to adopt a new technology. Demonstration plots can provide this practical information to guide farmers in a smooth adoption of new technology. Farmers also need to have access to abundant and neutral information covering both technical and broader issues. With such detailed information and technical guidance, farmers can minimise the risk of implementing new technologies.
3. In addition, there will likely be great consumer trust knowing that farmers have received adequate technical guidance. Changing farming technology towards sustainable farming may sometimes result in a reduction of the quantity produced. It may thus be necessary to compensate farmers for loss in income during the transition period.
4. If we can achieve sustainability in agriculture in this century, it will be a century of sustainable primary industry. On the other hand, environment, population, food and energy are common issues throughout the world because the survival of human beings and the earth is a major concern. So technology must be ecofriendly and long lasting.

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FLORAL AND FAUNAL WEALTH OF INDIA

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