

Exploring the Animal World: From Cells to Ecosystem

Chief Editor

Sanjay Nagarkar

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Pratima Pawar

Pritesh Gugale



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Exploring the Animal World: From Cells to Ecosystems

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and Computer Science departments of Dada Patil
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Preface

The study of the animal world, spanning from microscopic cellular structures to complex ecosystems, represents one of the most fascinating and essential domains of biological sciences. In recent years, rapid advancements in research methodologies, ecological awareness, and interdisciplinary approaches have significantly enriched our understanding of animal diversity, physiology, behavior, and environmental interactions. The present edited volume, “Exploring the Animal World: From Cells to Ecosystems,” is a comprehensive effort to bring together contemporary research and insights that reflect these evolving trends.

This book comprises a diverse collection of scholarly contributions that explore various dimensions of animal biology. The chapters included in this volume cover a wide range of topics, beginning with cellular and biochemical studies such as the effects of secondary metabolites, toxicological impacts of heavy metals, and biochemical analysis of locally available species. These studies provide a foundational understanding of how cellular processes influence the health and survival of organisms.

A significant portion of this volume is dedicated to parasitology and invertebrate biology, including detailed studies on gregarine parasites, cestode infections in domestic chickens, and the entomotoxic effects of plant-based compounds. These contributions highlight the importance of understanding host-parasite interactions and the potential of natural products in pest management and disease control.

The book also emphasizes biodiversity and ecological studies conducted across different regions of Maharashtra. Research on frogs, ants, beetles, butterflies, zooplankton, and insect diversity provides valuable insights into species distribution, habitat preferences, and ecological dynamics. Such studies are crucial for conservation planning and for maintaining ecological balance in changing environmental conditions.

Another key theme of this volume is the interaction between animals and their environment. Chapters addressing the effects of polluted water on molluscan diversity, pesticide-induced stress in fish, and the impact of

microplastics on animal health underscore the growing environmental challenges faced by aquatic and terrestrial organisms. Additionally, discussions on invasive species such as tilapia highlight the ecological threats posed to native biodiversity.

The integration of applied and technological approaches is also evident in this collection. Contributions such as smart apiary systems for beekeeping and studies on avian roles in sustainable agriculture demonstrate how scientific knowledge can be utilized for practical and sustainable development.

Furthermore, the book includes studies focusing on human-animal-environment interactions, particularly in the context of public health and community awareness. Research on anemia, blood pressure, lifestyle patterns, and nutritional awareness reflects the broader implications of biological sciences in improving human well-being.

The editors believe that this volume will serve as a valuable resource for students, researchers, educators, and environmentalists interested in animal biology, ecology, and applied life sciences. It aims to bridge the gap between theoretical knowledge and field-based research while encouraging a holistic understanding of life systems.

We express our sincere gratitude to all the contributors for their dedicated research efforts and to the reviewers for their valuable suggestions. We also acknowledge the support of our institution and organizing committee in successfully bringing out this publication.

It is our hope that this book will inspire further research, promote environmental consciousness, and contribute to the conservation and sustainable management of the rich diversity of the animal world.

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Exploring the Animal World: From Cells to Ecosystems

Table of Content

Sr. No.	Title and Authors	Page No.
1	Entomotoxic Potential of <i>Senna auriculata</i> Against the Red Flour Beetle (<i>Tribolium castaneum</i>) <i>Nikeeta Babar, Pritesh Gugale, Mawiyanaaz Shaikh, Mayur Ransing, Pratima Pawar</i>	01 - 05
2	A Review on Intestinal Cestode <i>Raillietina tunetensis</i> in Domestic Chickens: Distribution, Pathogenesis and Control Strategies <i>Trupti S. Barve, Sunil N. Pokale</i>	06 - 11
3	Plant Botanicals as Controlling Agents Against Pests <i>Ashwini Bedre</i>	12 - 15
4	Deep Breathing as a Therapeutic Modality for Physiological and Psychological Regulation: A Comprehensive Review <i>Suvarna Pol, Amruta Padule</i>	16 - 20
5	Morphology of Wasps from India: A Comprehensive Review <i>Shaikh M. I., Pawar P. A., Gugale P. R., Babar N. B., Ransing M. N.</i>	21 - 25
6	<i>Gregarine Parasites of Invertebrates</i> <i>Mrs. Neha Maruti Bansode</i>	26 - 30
7	Diversity of Frog in and Around Karjat, Ahilyanagar <i>Gade Sayali Balu, Pawar P.A., Ransing M.N., Shaikh M.I.</i>	31 - 35
8	Diversity of Local Ants in Chincholi Kaldat Karjat, Ahilyanagar <i>Gaikwad A. P., Gugale P. R., Tapkir P., Shaikh M. I., Babar N. B</i>	36 - 42
9	Inventory and Diversity of Insect Species in Kuldharan, Karjat Tehsil, Ahmednagar District (Maharashtra, India) <i>Gadekar Pradnya Tulsidas</i>	43 - 47
10	Diversity of Beetles (Coleopteran) within the Three Different Localities of the Ahmednagar District, Maharashtra <i>Prajakta Balasaheb Katrajkar</i>	48 - 54
11	Synoptic Study on Zooplankton Diversity in Bhima River, Maharashtra, India <i>Supriya Waykar</i>	55 - 59
12	Diversity of Helminths in the Gut of Fishes of the Pravara River, Ahilyanagar District, Maharashtra <i>S. A. Kawade</i>	60 - 66

13	An Insight into the Diversity of Odonata - A Case Study of Karjat Tehsil, Ahmednagar District, Maharashtra, India <i>Punekar Kavita, Pawar P. A.</i>	67 - 70
14	Observations on the Life cycle, Mating, Oviposition and Cannibalism of genus <i>Hierodula</i> Burmeister, 1838 <i>Raut G. A., Gaikwad S. M.</i>	71 - 75
15	Study of Agricultural Crop Pest in and Around Alsunde Village, Karjat <i>Gugale P. R., Salunkhe P. S., Pawar P. A., Babar N. B., Shaikh M. I, Ransing M. N.</i>	76 - 80
16	Feathered Farmers: Avian Contributions to Sustainable Agricultural Landscapes <i>Mrunal Dattatray Pardeshi, Dr. C.V. Sirsat</i>	81 - 85
17	Ecology and Distributional Dynamics of Butterflies in Satara District (MS) <i>Shweta R. Sutar, Pratima A. Pawar, Sunil H. Bhoite</i>	86 - 90
18	An Insight into the Life Cycle of Butterflies: A Case Study of Karjat Tehsil, Ahmednagar District, (MS), India <i>Mulani A.S., Pawar P.A.</i>	91 - 94
19	Smart Apiary: Leveraging Effective Technology for Beekeeping <i>Dr. Neha Nitin Patil</i>	95 - 98
20	Biology, Phylogeny and Morphology of Odonata <i>Pawar P. A., Gugale P. R., Babar N. B., Shaikh M. I, Ransing M. N.</i>	99 -103
21	Effect of Polluted Water on Molluscan Diversity in Ahilyanagar District, (MS), India <i>Pandit R. N., Pawar P. A.</i>	104 -108
22	Evaluation of Pesticide Induced Stress Responses in Economically Important Fish, <i>Oreochromis niloticus</i> <i>Padmini Sandip Pawar</i>	109 -113
23	Physiological and Ecological Impacts of Microplastics on Animalia <i>Mayur N. Ransing, Mawiyazan I. Shaikh, Nikeeta. N Babar, Dr. Pritesh R. Gugale, Dr. Pratima A. Pawar</i>	114 -117
24	Effect of Secondary Metabolites on Animals <i>Manjusha Vijay Ingawale</i>	118 -121
25	A Tale of Alien Species <i>Tilapia (Oreochromis Spp.)</i> As A Major Threat to Indian River Ecosystems <i>Varsha S Kasurde</i>	122 -125
26	Toxicological Effects of Heavy Metals and Curative Role of Ascorbic Acid in Freshwater Bivalve <i>Lamellidens corrianus</i> <i>S. P. Nawale</i>	126 -129
27	Hydrochemical Stress and Renal Health: A Study of High TDS Water in Karjat, Ahilyanagar	130 -133

	<i>Ukirde Shamal S., Pawar P. A.</i>	
28	Relationship between Fingerprints and Blood Groups among Females <i>Hinakausar Amin Shaikh, Mohamed Rizwan Khan</i>	134 -138
29	Haemoglobin status and Awareness for Anaemia Prevention: A Community Survey in Karmala <i>Javheri R., Gugale P.R., Babar N. B., Shaikh M.I., Ransing M. N</i>	139 -145
30	Healthy Lifestyle & Nutritional Awareness Survey Among Karjat Community <i>Narsale P. V., Gugale P. R., Babar N.B.</i>	146 -154
31	A Case Study of Screen Time and Its Effects on Lifestyle of People from Dada Patil Mahavidyalaya Karjat Campus and Tehsil Karjat, Dist. Ahilyanagar <i>Kale S. S., Wagh S. S., Ranmal D. B., Pawar P. A., Gugale P. R., Ransing M.N.</i>	155 -159
32	Unlocking the Biochemical Potential of Locally Available Crab Species: A Study on Estimation of Protein, Carbohydrates and Ascorbic Acid <i>Tanpure V.D., Gugale P. R., Babar N. B., Shaikh M. I</i>	160 -167
33	A Review on Economic Importance of Whey <i>S. S. Mahadik, S. S. Gaikwad</i>	168 -172
34	A Case Study of Blood Pressure Awareness <i>Pathade R. S., Gugale P. R., Nale M. M., Doltade, P. R., Ransing M. N.</i>	173 -178
35	Resting Pulse Rate and Anxiety: A Community-Based Study in Karjat Region, Maharashtra <i>Bagwan Bushra K, Kutwal Snehal H, Phalke Pratiksha B</i>	179 -183

Entomotoxic Potential of *Senna auriculata* Against the Red Flour Beetle (*Tribolium castaneum*)

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Abstract

Stored grain pests damage the protein content of seed grain & percentage of seed germination too which are controlled by use of chemical pesticides, which are responsible for pollution and a number of health problems in humans and animals. So, scientists are always searching for alternative ways to control pests that impair sustained agriculture. (Mahmood-Ur-Rahman, Tayyaba Shaheen, 2014).

Table No.1 Types of stored grain insect pests Based on feeding habits

Primary pest	Secondary pest
Internal feeders	External feeders
Penetrate & infest grains	Feed on cut or broken seeds
specialized mouthparts & feeding habits to pierce the outer layer of grain or seed and feed on their inner contents	Mouthparts are adapted for chewing and grinding food particles
Example- Indian meal moth larvae and flour beetles	Example- Weevils, saw-toothed grain beetle
Damage- loss of quantity, quality, and loss of germination	Damage- ball formation and webbing besides the deterioration of grains, fungal activity and moisture migration

(Weaver et al., 2005; Harush et al., 2021; Atanda et al., 2018; Maciej Serda et al., 2022; Tripathi, 2018; Deshwal et al., 2020; Edde, 2012)

Storage pests deteriorate grains by reduction in weight, quality, vigour and the germination of the grains causing loss of its market value. An estimated one third of global agricultural production is destroyed annually by over 20,000 species of insect pests in field and storage (Mariapackiam and Ignacimuthu, 2008).

Farmers are mainly depending on insecticides for their crop protection endeavours (Dhaliwal and Koul, 2010). This over and improper use has developed genetic resistant pest species and many harmful effects like, toxic residues, environmental pollution, health hazards and reduction in non-target organisms (M.Ramanan, N.Muthukumar, 2019).

Use of plant derivatives can be an alternative strategy to control pest and disease. [Talukder F. A. 2006], because of faster degradation, less toxicity to mammals, easy and inexpensive production as crude, or as partially purified extracts [T. Apondjou, L. A. Adler 2002].

Plants produce a wide variety of phytochemical constituents, which are secondary metabolites and are used either directly or indirectly in the pharmaceutical industry. *Senna auriculata* is a multipurpose plant. Following image shows properties of *Senna*.

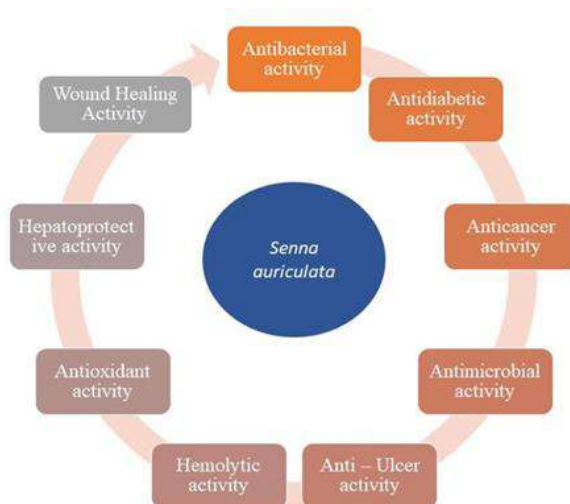


Figure 1. Pharmacological Activities of *S. Auriculata* Plants

Material Methods

Selection of the *Senna auriculata* plant is due to easy availability. Harvested Leaves of the plant are shade-dried for fifteen days, then a fine powder was prepared from leaves and extracted in ethanol using the Soxhlet apparatus -

- 5gm powder were extracted with 200ml ethanol and 3 cycles of Soxhlet method were run.
- Extracted solution was kept in water bath for evaporation of solvent for

complete drying and stored in refrigerator for further process.

- A stock solution at concentration of 200 mg/ml is prepared.
- Following table shows the concentration and volumes of doses applied, number of insects exposed to dose and mortality.



Figure 2. Plant Parts of *S. auriculata*

https://www.texilajournal.com/thumbs/article/37_TJ3009.pdf

Observation

Table No.2 concentration and volumes of doses applied, number of insects exposed to dose and mortality

Concentration & volume of extract applied		Insect mortality				
		1 st day	2 nd day	3 rd day	4 th day	5 th day
Control -0.5 ml ethanol (3 jars with 50 individuals each)		00	02	00	01	00
		01	01	02	01	01
		03	00	01	00	00
5mg/ml	3 jars with 50 individuals each and 0.5 ml extract	07	10	07	12	14
		05	08	07	11	19
		08	12	11	19	-
10mg/ml		07	09	06	10	18

		08	13	13	16	-
		08	11	14	17	-
25mg/ml		10	15	18	07	-
		15	15	20	-	-
		12	15	18	05	-

Result

The mortality of *Tribolium castaneum* increased with concentration and exposure time. At concentration of 5mg/ml, mortality was gradual over five days. At 10mg/ml, higher mortality was observed, especially toward the fifth day. The highest mortality occurred at 15mg/ml, particularly during the first three days. Comparatively, the 25mg/ml, concentration showed the greatest insecticidal effect, indicating dose-dependent toxicity.

Conclusion and Discussion

The present study was carried out on the *Tribolium castaneum* to check the efficacy of *Senna auriculata* as an insecticide. *Senna auriculata* leaves extract showed a higher level of insecticidal activity against *Tribolium castaneum*. The traditional plant products have proved to be highly effective in controlling the stored grain pest *Tribolium castaneum*. The use of extract is an inexpensive and effective method. But further study is needed to isolate and identify the active principal component of the product, and to assess both its cost-benefit ratio and its ability to control insect stored grain. [Ms.C. Shunmugadevi, 2018]

Also, *Senna Auriculata* leaves extract shows toxicity against *Tribolium castaneum*. Hence it may have insecticidal property.

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A Review on Intestinal Cestode *Raillietina tunetensis* in Domestic Chickens: Distribution, Pathogenesis and Control Strategies

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Abstract

Helminths as a parasite can cause serious challenges to the poultry birds across the world, mainly in backyard and raw farming areas, where the poultry birds can directly or indirectly come in contact with eggs or cysts via intermediate hosts of tapeworms like snails, beetles, bugs, etc. One of the most common species that infects poultry hens *Gallus gallus domesticus* is *Raillietina* species which reported worldwide. *Raillietina tunetensis*, a tapeworm belonging to the family Davaineidae, parasitizes not only the small intestine but in severe infection also can invade into other muscular organs of domestic chickens (*Gallus gallus domesticus*) which results in reduction in productivity in infected birds.

Frequent and heavy infection of *Raillietina tunetensis* in poultry birds can cause intestinal discomfort, weight loss, reduction in egg production, weakness, can also harm the immunity of poultry birds so can easily catch other infections as well. Due to such infection economic loss is occurring in poultry business. The morphological identification can be done by studying its morphometry; this study can be supported by molecular study by using DNA- Barcoding of gravid proglottids. This review includes available information on the taxonomy, history, morphology, life cycle, epidemiology, and pathogenicity, of *Raillietina tunetensis*, mainly focusing on its significance in poultry health.

Keywords: *Raillietina tunetensis*, *Gallus gallus domesticus*, Cestode, DNA-Barcoding, Poultry birds, Gravid proglottids, Morphometry.

Introduction

Cestode belonging to phylum Platyhelminthes and class cestoda are commonly known as tapeworm because of their flattened, segmented and long ribbon like appearance. These parasites mainly reside in small intestine of their vertebrate host and absorb nutrients directly from host body (Soulsby, 1982; Smyth & Mc

Manus, 1989). The genera of class cestoda like *Raillietina*, *Davainea*, *Choanotaenia*, and *Hymenolepis* responsible to cause major helminth infection in poultry birds, out of that most common species of genera is *Raillietina tunetensis*, which is found in small intestine of the poultry birds and attaches to the mucosal lining of the intestine and absorbs nutrition directly from the host body and their infection in *Gallus gallus domesticus* leads to a major reduction in productivity of meat and eggs in chickens (Permin & Hansen, 1998).

Poultry farming is one of the fastest growing businesses worldwide, in some cases also supports the agriculture sector as a side business, this is due to the high demand as food, gives high protein content and unsaturated fat which is most essential macronutrients for the human health. However, the production rate of meat and eggs by poultry birds can be directly affected by cestode infection like *Raillietina tunetensis*. (Jensen & Pandey 1989). Infection of helminths from family Davaineidae cause serious infections to the poultry birds are characterised by having rostellum surrounded by hooks, and presence of egg capsule in mature segments (Khalil et al., 1994). The prevalence of the parasites can be altered by habitat change, climate change, and host- parasite relationship, although the host parasite relationship is also responsible to change the ecology of parasites including tapeworm as well (Bush and Lafferty, 1997).

History and Origin

In early time cestode parasites were found infecting the avian hosts later on also noted down in domestic birds like *Gallus gallus domesticus*. At initial, description of cestode parasites based on observation of morphological characters like numbers of rows of Hooks around the rostellum, number of testis and ovaries present in gravid segments and reproductive anatomy (Diamare V. 189). The name of genus *Raillietina* was given to cestode in honour of great parasitologist Louis-Joseph Alcide Railliet who's contribution is vast in the field of parasitology.

Raillietina species are found in the small intestine parts like jejunum and ileum of the definitive host such as *Gallus gallus domesticus* and make a impact on birds growth, emaciation, weakness, and digestive tract obstruction (Permin & Hansen, 1998), whereas their cysticercoid larval stages reside in invertebrate intermediate hosts, such as ants, beetles, small mini wasps, or termites, snails, etc. (Alenyorege and et al. 2011).

Recently molecular studies support morphological study making the identification of parasites clearer. Molecular studies include DNA- Barcoding using specific markers for 18S rDNA or CO-I genome of mitochondria, which gives more accurate identification of tapeworm species (Makwanise and Dube, 2020). This molecular study can also help to generate the phylogenetic tree so one can easily correlate between identified species with other species.

Morphologically identified species can be different at molecular level, hence the molecular tools are important for species identification (Chan and Chaisiri, 2021)

Morphology and Structural Characteristics

The body of *Raillietina tunetensis* exhibits the typical dorsoventrally flattened which appears like a ribbon with segmented organization which is a general characteristic of cestode parasites. Like other tapeworms, the body is divided into three distinct regions: the scolex, neck, and strobila, this structural organisation supports the parasite's survival in the host intestine (Yamaguti, 1961). The scolex forms the anterior attachment organ of the tapeworm. It generally possesses four well-developed muscular suckers and a protrusible rostellum surrounded by rows of with hooks (Heyneman, D.1996). With these structures, the parasite firmly attaches itself with the mucosal intestinal wall of the host, preventing its displacement due to intestinal peristaltic movements and hence allowing efficient absorption of nutrients from the host. The neck is a very short and unsegmented region located immediately behind the scolex. It acts as the growth zone of the parasite since it is responsible for the continuous formation of new body segment. Newly formed segments gradually move posteriorly as they develop and mature, called proglottids (Castro, 1996).

The strobila of the body of cestode mainly consists of mature segments known as proglottids arranged in a chain-like pattern. These segments undergo progressive maturation as they move away from the neck region, eventually becoming mature and gravid segments containing numbers of reproductive structures like testis and ovaries and fertilized eggs. Since each mature proglottid possesses both male and female reproductive organs, hence shows hermaphroditic nature of the parasite. This reproductive adaptation allows self-fertilization or cross-fertilization between adjacent segments, which results in the production of a large number of eggs that are released into the host's intestinal lumen, thereby facilitating transmission to new hosts.

Life Cycle

The life cycle of *Raillietina tunetensis* is completed within two hosts; one is the intermediate host and the second is the definitive host. Eggs are released into the environment via droppings of infected chickens. These eggs are then ingested by arthropod intermediate hosts such as ants or beetles while feeding on contaminated material (Soulsby, 1982). Within the body of the intermediate host, the oncosphere emerges from the egg and penetrates the intestinal wall, where it subsequently develops into a cysticercoid larval stage. Chickens acquire the infection when they consume infected insects during their scavenging activities. After ingestion, the cysticercoid larvae are released in the digestive tract of the chicken and develop into adult tapeworms in the small intestine. Arthropods such

as ants, beetles, and occasionally houseflies act as important intermediate hosts for *Raillietina* species and play a crucial role in the transmission and maintenance of the parasite's life cycle in poultry populations (Al-Badrani & Al-Muffti, 2023).

Epidemiology and Prevalence

The prevalence of *Raillietina* infections varies depending on environmental conditions, like climate change, weather change, and poultry management and hygiene practices. Investigations conducted in free-range poultry settings have documented remarkably high prevalence rates of cestode infections (Radfar and et al. (2012). For example, research in rural Algeria reported cestode infections in over 88% of examined chickens, with several species of *Raillietina* being identified (Ilyes Medjouel & Benakhla Ahmed Dec.2013). Similarly, molecular studies in Bangladesh found that 72% of chickens were infected with *Raillietina* species, demonstrating the widespread occurrence of these parasites in rural poultry systems due to low hygiene practices and lack of awareness in backward areas (Nalubamba and et. al. 2015). The seasonal variations, presence of intermediate hosts, and poultry management practices significantly influence infection rates (Patil & Bhamare, 2018).

Pathogenesis and Clinical Effects

Although light infections may remain asymptomatic, heavy infestations can cause significant health problems in chickens. Heavy infection by parasite can cause inflammation of the intestinal mucosa, which can interrupt with normal digestive functions. In cases of heavy parasite burdens, infected chickens often show signs of intestinal inflammation, poor nutrient absorption, loss of body weight, general weakness, and reduction in egg production, thereby affecting poultry productivity. Infected birds may further exhibit signs of weakness and anaemia due to prolonged parasitic stress. In severe cases, heavy worm infection can lead to intestinal obstruction and the formation of nodular lesions in the intestinal wall (Mukaratirwa and Hove, 2009).

Diagnosis of *Raillietina tunetensis* infection can be performed using several laboratory and observational techniques. Microscopic examination through fecal flotation methods is commonly used to detect the presence of eggs or proglottids in fecal samples of infected chickens. In addition, post-mortem examination of infected birds allows the direct recovery and identification of adult worms from the small intestine during necropsy. In recent years, molecular diagnostic approaches have become increasingly important for accurate species identification. Polymerase chain reaction (PCR)-based methods targeting ribosomal DNA markers is used to confirm the identity of *Raillietina* species and to study their phylogenetic relationships.

Control and Prevention

Effective control of *Raillietina tunetensis* infections in poultry involves the implementation of helminths management practices and preventive measures. Providing anthelmintic drugs after regular intervals can help, deworming of chickens, one can reduce parasite burden. Maintaining proper sanitation and hygiene in poultry houses helps to control environmental contamination with parasite eggs. Focusing on the control of intermediate hosts such as ants and beetles is also essential, as these arthropods play a key role in the transmission of the parasite. Proper waste management and disposal of infected hen's droppings can further reduce the chances of parasite development and spread. Additionally, providing balanced nutrition and adopting improved poultry management practices can enhance the overall health and resistance of birds to parasitic infections.

Economic Importance

Cestode infections can lead to significant economic losses in poultry production due to decreased growth rates, reduced egg production, and increased susceptibility to other diseases. Backyard poultry systems are particularly vulnerable because birds often scavenge freely and consume infected insects.

Conclusion

Raillietina tunetensis signifies an intestinal tapeworm parasite which infects domestic chickens across many parts of the worlds. The parasites involving arthropods as a intermediate host, has an indirect life cycle and which is particularly prevalent in free range poultry systems. Recently because of the advanced techniques, the molecular diagnostics have improved species identification and understanding of its epidemiology. To reduce the impact of these parasites on poultry health and productivity, effective parasite management strategies should be implemented.

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Plant Botanicals as Controlling Agents Against Pests

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Abstract

Nematodes, invasive weeds, and a variety of insects and pests have a negative impact on agriculture. Five percent of the world's food output is reduced in yield, and low-quality grains are produced. The main reason for declining grain weight, quality, seed viability, and economic value is stored grain pests. Chemical insecticides and pesticides turned shown to be more cost-effective and efficient. By altering soil fertility, causing genetic changes in pests that lead to resistance, and increasing harmful residues, the use of chemical pesticides and insecticides damages the ecosystem. Eco-friendly, biodegradable, and reasonably priced are botanical pesticides. Although they can't completely replace the manufacture of synthetic pesticides, botanical insecticides may be able to address issues related to their use. This book chapter summarises the use of plant botanicals as controlling agents against pests.

Introduction

Unwanted plants that are non-native because they come from various geographic areas are known as invasive weeds (IPM, 2014). The ability of invasive species to spread quickly, reproduce more quickly, and have an adaptable character that depletes resources are the reasons for their successful establishment (Dhole, 2013; Ghayal, 2011). Because they compete with soil nutrients, space, water or moisture, sunshine, and harm on nearby plants and wildlife, weeds are regarded as serious pests in ecosystems and agriculture. Plants utilize secondary metabolites, also known as allelochemicals or eco chemicals, as a means of communication and protection against herbivores, predation, and repellence. These molecules are non-nutritive. Numerous pests, diseases, nematodes, and invasive weeds negatively impact agri-culture, resulting in lower yield and low-quality grains that account for 5% of global food output. (Aneja, 2016). Pests are the primary cause of decreased quality, seed viability, and grain weight leading to low commercial value (Kazmi, 2017).

Coleoptera belongs to class Insecta mainly affects stored grain pests from a different group of families such as *Sitophilus oryzae* (*Curculio-nidae*),

Callosobruchus chinensis (Bruchidae), *Tri-boliumcastaneum* (Tenebrionidae), *Trogoderma granarium* (Dermestidae). The most destructive and pervasive cereal pest in tropical warm climates is *Sitophilus oryzae*, sometimes referred to as the rice weevil, which mostly infests cereal crops including wheat, rice, maize, barley, and sorghum (Kazmi, 2017). A common beetle species in the bean weevil subfamily, *Callosobruchus chinensis* is recognized to be a pest of many stored legumes, including garden peas, mung beans, and chickpeas. (Thein, 2013). Spraying and fumigation are two examples of management techniques that are hazardous to pests because they penetrate the insect's body through its cuticle or respiratory system. Harding (1985) recommended binding plant derivatives with certain liquid or solid carriers, such as paraffin, lacquer, or sodium sulfate, as a pest control method (Soon II Kim, 2001).

Botanical Insecticides

Vrikshyavurveda, an ancient traditional method, emphasized the use of *Azadiracta indica* or Neem as an effective botanical pesticide and insecticide (Das, 2015; Dutta, 2015; Rahman, 2006; Regnault-Roger, 2008). In Indian and Chinese literature, other medicinal plant sources including eucalyptus, *Murayyakoenegii*, garlic, turmeric, tulsi, cinnamon, and mustard oil were employed as pesticides. In the past, chemical pesticides and insecticides containing carbamates, organochlorines, organophosphates, and synthetic pyrethroids were more cost-effective and efficient than botanical insecticides (BI). By altering soil fertility, causing genetic differences in pests to become resistant, and producing more harmful residues, the use of chemical pesticides and insecticides has had a major detrimental effect on the ecosystem (Dutta, 2015). After a few decades, research has concentrated on the formulation and standardization of botanical insecticides due to the negative impacts of the ongoing use of chemical pesticides. Eco-friendly formulations of botanical pesticides are made from naturally existing materials including plants, animals, and microorganisms (bacteria, fungus, and viruses) (Aneja, 2016).

As per US-EPA, botanical pesticides have been classified based on active ingredients derived source (Mazid, 2011).

Plant Incorporated Protectants (PIP) as BT- protein

Microbial as bacteria, fungi, viruses

Plant (Botanicals) as *Azadiracta indica* or Neem, Ipomoea, Triphala, Pinus kesia, Limonene, Linalool, Rotenone Pyrethrum and Pyrethrins, Sabadilla, Rynia plant botanicals used as biopesticides, which are specific on target organisms as aphids, fleas, beetles, thrips. (Mazid, 2011). Pyrethrins are secondary metabolite compounds derived from *Chrysanthemum* flowers are potential insecticide to date, less toxic to mammals, and rapidly degrading. Abamectin is a macrocyclic

lactone produced by *Strepto-mycosavermitilis* active against few pests but developed resistance in Tetranychid mites (Chandler, 2011). Nicotine and Rotenone are highly toxic even to humans with comparable potential or strength to that of synthetic chemical insecticide. Thus, incorrect concentrations such as BI can disrupt pest control in a natural (eco-friendly) way.

Biochemical pesticides include insect sex-pheromones.

Few pesticides incorporated under the Insecticide Act, 1968 are commercialized and widely used are

- Biofungicide: *Trichoderma*
- Bioherbicide: *Phytophthora*
- Bioinsecticide: *Bacillus thuringiensis* (BT)
- PIP: BT gene, Protease inhibitor, Lectines, Chitinase.

As per revised data available amongst various plant and animal sources, there are 835 active substances which contribute their application worldwide are 680 synthetic pesticides (82%), 69 Insect pheromones (8%), 61 Plant extracts (7%) and 25 Microbial (3%) (Redbond, 2003) National Farmers Policy, 2007 has strongly recommended the exploration of biopesticides to control pests in an eco-friendly manner (Aneja, 2016).

Advantages of Using Biopesticides

- Available natural source.
- Selective or producing little or no toxic residue hence less harmful to the environment as decomposing quickly,
- Target organism-specific.
- Cost production lower than chemical pesticide.
- Proven component property under Integrated Pest Management program.

Conclusion

In order to combat insect pests in an environmentally friendly manner that can control pest populations, it is necessary to investigate naturally occurring botanicals, such as plant extracts, insecticidal plants, and plant essential oils, which can be used as effective repellents, antifeedants, insecticides, fungicides, weedicides, nematocides, molluscicides, etc. Though they could look for issues related to the use of synthetic pesticides, BI can never completely replace the manufacture of synthetic pesticides. The benefits of BI have been outlined, along with key elements that highlight its practical application constraints.

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Deep Breathing as a Therapeutic Modality for Physiological and Psychological Regulation: A Comprehensive Review

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Abstract

Controlled deep breathing, often termed diaphragmatic or slow breathing, is increasingly recognized as a scientifically supported, non-pharmacological strategy for enhancing both physical and mental health. Growing empirical evidence demonstrates its capacity to regulate the autonomic nervous system, reduce stress-related physiological activation, stabilize cardiovascular function, optimize respiratory efficiency, and support emotional regulation. Through stimulation of vagal pathways and attenuation of sympathetic overactivity, slow breathing promotes systemic equilibrium. This review critically examines current literature regarding the biological mechanisms, psychological outcomes, clinical applications, and research limitations associated with deep breathing practices. The evidence strongly supports incorporating structured breathing interventions into preventive medicine, mental health treatment, and rehabilitative care.

Keywords: Deep breathing, Diaphragmatic breathing, Autonomic regulation, Stress reduction, Vagal tone, Mind–body intervention

Introduction

Contemporary lifestyles characterized by chronic stress exposure, sedentary behavior, and environmental pressures have contributed significantly to the global burden of non-communicable diseases and mental health disorders. Conditions such as hypertension, anxiety disorders, sleep disruption, and metabolic abnormalities are strongly associated with prolonged autonomic imbalance and sustained stress activation (Jerath et al., 2015).

Deep breathing techniques, rooted in traditional contemplative disciplines including yogic pranayama, have gained increasing acceptance within modern clinical settings. Unlike shallow thoracic respiration, diaphragmatic breathing actively engages the diaphragm, facilitating greater lung expansion and more

efficient pulmonary ventilation (Ma et al., 2017).

Emerging research indicates that paced breathing particularly at approximately six respiratory cycles per minute maximizes heart rate variability (HRV), strengthens baroreflex sensitivity, and promotes parasympathetic predominance (Lehrer & Gevirtz, 2014). This review synthesizes findings on the physiological foundations, psychological benefits, cardiovascular implications, and therapeutic applications of deep breathing interventions.

Physiological Mechanisms:

- **Modulation of the Autonomic Nervous System**

One of the primary mechanisms underlying the therapeutic effects of deep breathing involves its influence on autonomic nervous system (ANS) balance. Slow, rhythmic breathing enhances vagal afferent activity, increasing parasympathetic output while reducing sympathetic arousal (Brown & Gerbarg, 2005).

Elevated heart rate variability serves as a measurable indicator of improved autonomic flexibility and cardiovascular adaptability (Lehrer et al., 2020). Enhanced vagal tone is consistently associated with improved emotional stability and reduced physiological stress reactivity.

- **Respiratory Efficiency and Gas Exchange**

Diaphragmatic breathing increases tidal volume while lowering respiratory frequency, thereby improving alveolar ventilation and oxygen delivery (Russo et al., 2017). This breathing pattern counters inefficient shallow respiration commonly observed during anxiety and hyperventilation states.

Improved oxygen-carbon dioxide balance contributes to greater physiological stability and reduced somatic tension.

- **Neuroendocrine Effects**

Slow breathing practices appear to modulate activity within the hypothalamic–pituitary–adrenal (HPA) axis. Evidence suggests reductions in cortisol secretion and other stress mediators following structured breathing exercises (Perciavalle et al., 2017).

Such hormonal adjustments may contribute to decreased systemic inflammation and enhanced immune resilience.

Psychological and Cognitive Outcomes

- **Reduction of Stress and Anxiety**

Controlled breathing interventions have demonstrated significant reductions in perceived stress and anxiety symptoms across diverse populations (Ma et al.,

2017). Neurophysiological mechanisms likely involve decreased amygdala activation and enhanced prefrontal cortical regulation of emotional responses.

- **Mood and Emotional Regulation**

Breathing-based therapies show promise as complementary approaches in managing mild to moderate depressive symptoms. Improvements in mood stability may be mediated by enhanced autonomic regulation and neurochemical balance (Brown & Gerbarg, 2005).

- **Cognitive Performance**

Slow breathing has been linked to improved attention, working memory, and executive functioning. Enhanced cerebral oxygenation and reduced mental fatigue are proposed mechanisms (Zaccaro et al., 2018).

As a result, structured breathing exercises are often recommended prior to high-stakes tasks such as examinations, presentations, and athletic performance.

Cardiovascular and Metabolic Implications

- **Blood Pressure Control**

Evidence indicates that paced breathing improves baroreceptor responsiveness and contributes to reductions in both systolic and diastolic blood pressure (Brook et al., 2013). Consequently, it is frequently recommended as an adjunctive therapy in hypertension management programs.

- **Enhancement of Heart Rate Variability**

When combined with HRV biofeedback training, slow breathing significantly improves cardiac autonomic regulation and stress resilience (Lehrer et al., 2020).

- **Inflammatory and Metabolic Effects**

By attenuating chronic stress activation, breathing exercises may reduce inflammatory biomarkers and potentially improve insulin sensitivity (Jerath et al., 2015). These findings suggest possible benefits for metabolic syndrome management, although further research is required.

Applications in Respiratory Health and Rehabilitation

Deep breathing exercises strengthen respiratory musculature and enhance overall lung capacity. Clinical applications include support in:

- Asthma management
- Chronic obstructive pulmonary disease (COPD)
- Postoperative pulmonary rehabilitation
- Post-viral respiratory recovery

Regular practice has been associated with reduced dyspnea and improved oxygen utilization efficiency (Russo et al., 2017).

Sleep and Relaxation Benefits

Breathing protocols such as the 4-7-8 method and alternate nostril breathing activate parasympathetic pathways conducive to sleep initiation. By reducing nocturnal sympathetic activation, these practices may alleviate symptoms of insomnia and improve overall sleep quality.

Clinical Integration and Public Health Implications

Deep breathing techniques are currently incorporated into various healthcare and wellness settings, including:

- Cardiac rehabilitation programs
- Pulmonary rehabilitation services
- Oncology supportive care
- Chronic pain management strategies
- Workplace wellness initiatives
- Educational mental health interventions

Due to their minimal cost, safety, and ease of instruction, breathing-based interventions are well-suited for large-scale preventive health strategies.

Limitations and Future Research Directions

Despite promising evidence, several limitations remain:

- Lack of standardized breathing protocols
- Variability in frequency and duration across studies
- Small sample sizes in certain trials
- Limited long-term outcome data

Future investigations should prioritize large-scale randomized controlled trials, standardized frequency guidelines, neuroimaging studies, and molecular biomarker analyses to further clarify mechanisms and optimize therapeutic protocols.

Conclusion

Deep breathing represents a scientifically grounded, non-invasive intervention capable of enhancing both physiological stability and psychological well-being. Through autonomic regulation, stress hormone reduction, improved cardiovascular performance, and strengthened respiratory function, it offers a comprehensive approach to mind–body health.

Integration of structured breathing programs into preventive healthcare, mental health treatment, and rehabilitation frameworks is strongly supported by current evidence. Continued research will refine best-practice guidelines and further establish its long-term benefits.

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Morphology of Wasps from India: A Comprehensive Review

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Abstract

Wasps are among the most diverse and ecologically significant insects belonging to the order Hymenoptera. In India, they inhabit a wide variety of ecosystems ranging from dense forests and agricultural landscapes to urban habitats. Their structural organization reflects a high degree of specialization that supports their varied lifestyles as predators, parasitoids, and social insects. The present chapter provides a detailed and descriptive account of the morphology of Indian wasps, emphasizing the structural adaptations that contribute to their survival, ecological roles, and evolutionary success.

Introduction

Insects represent the most abundant and diverse group of organisms on Earth, and among them, wasps occupy a unique and highly evolved position. Found in almost every ecological niche across India, wasps exhibit remarkable adaptability, which is largely reflected in their morphology. Unlike bees, which are primarily associated with pollination, or ants, which are predominantly social, wasps display a combination of predatory, parasitic, and social behaviors. These behavioral patterns are closely linked to their structural organization. The morphology of wasps is not merely a matter of form but a reflection of function. Each anatomical feature, from the sensory organs on the head to the specialized structures of the abdomen, plays a crucial role in ensuring survival and reproductive success. In India, where environmental conditions vary greatly across regions, wasps have evolved diverse morphological traits that enable them to thrive in different habitats.

General Body Structure

The body of a wasp is characteristically divided into three distinct regions: the head, thorax, and abdomen. This tripartite organization is typical of all insects, but in wasps, it is particularly well-defined and functionally specialized. One of

the most striking features is the narrow constriction between the thorax and abdomen, commonly referred to as the “wasp waist” or petiole. This structural adaptation provides flexibility, allowing the abdomen to move freely, which is especially important during stinging or egg-laying.

The overall body is elongated and streamlined, facilitating efficient movement and flight. The exoskeleton, composed primarily of chitin, provides both protection and structural support while minimizing water loss—an important adaptation in the varied climatic conditions of India.

Head Region

The head of a wasp is a highly specialized structure that houses essential sensory and feeding apparatus. It is equipped with a pair of large compound eyes that occupy a significant portion of the head. These eyes consist of numerous ommatidia, each contributing to a mosaic image, enabling the wasp to detect movement and navigate its environment with precision. In addition to compound eyes, most wasps possess three simple eyes, or ocelli, located on the dorsal surface of the head. These ocelli are sensitive to light intensity and assist in maintaining orientation during flight. Projecting from the head are the antennae, which are segmented and serve as vital sensory organs. They are capable of detecting chemical signals, vibrations, and environmental cues. In many Indian species, the antennae show sexual dimorphism, with males often having more segments or differently shaped antennae compared to females.

The mouthparts of wasps are of the chewing type, well-adapted for a predatory lifestyle. The mandibles are strong and capable of cutting, crushing, and manipulating prey or nesting materials. Associated structures such as the maxillae and labium assist in handling food and feeding. This combination of sensory and feeding structures makes the head a central hub for interaction with the environment.

Thorax and Locomotion

The thorax forms the central region of the body and is primarily responsible for locomotion. It is divided into three segments—prothorax, mesothorax, and metathorax—each bearing a pair of legs, while the latter two segments also support the wings. The thoracic muscles are highly developed, particularly in flying species, enabling powerful and sustained flight. Wasps possess two pairs of membranous wings. The forewings are larger than the hindwings, and both are connected by minute hook-like structures known as hamuli. This connection allows the wings to function in unison during flight, providing stability and efficiency. Wing venation patterns are often complex and serve as important taxonomic characters for identifying species.

The legs of wasps are long, jointed, and versatile. Each leg consists of several

segments, including the coxa, femur, tibia, and tarsus. The terminal claws enable the wasp to grip surfaces securely. Depending on the species and lifestyle, the legs may be adapted for digging, grasping prey, or manipulating nest materials. For example, ground-nesting wasps in India often have forelegs adapted for burrowing, while social wasps use their legs to construct intricate nests from plant fibers.

Abdominal Structure and Specialization

The abdomen of a wasp is perhaps the most functionally diverse part of its body. Connected to the thorax by the narrow petiole, it exhibits a high degree of mobility. This flexibility is essential for various activities such as stinging, oviposition, and grooming.

The abdominal segments house vital internal organs related to digestion, excretion, and reproduction. However, the most notable feature of the abdomen in female wasps is the presence of a sting, which is a modified ovipositor. This structure is connected to venom glands that produce toxins used for defense and for subduing prey. Unlike bees, most wasps can sting multiple times, as their stingers are not barbed. In parasitoid wasps, the ovipositor may be highly elongated and specialized for depositing eggs inside host organisms. This adaptation allows the wasp to exploit a wide range of hosts, including insects hidden within wood, soil, or plant tissues.

Exoskeleton and Coloration

The external body covering of wasps is formed by a chitinous exoskeleton, which provides both protection and rigidity. This exoskeleton is often smooth and shiny but may also bear fine hairs that serve sensory functions. Coloration in Indian wasps varies widely, ranging from dull browns and blacks to bright combinations of yellow, red, and metallic hues. Bright coloration often serves as a warning signal to potential predators, indicating the presence of a sting. This phenomenon, known as aposematism, is common among many wasp species.

Internal Organization

Internally, wasps possess well-developed organ systems that support their active lifestyle. The digestive system is adapted to process both solid and liquid food, reflecting their omnivorous or predatory habits. The respiratory system consists of a network of tracheae that deliver oxygen directly to tissues through spiracles located along the body.

The nervous system is relatively advanced, enabling complex behaviors such as navigation, hunting, and social interaction. In social wasps, this complexity is evident in their ability to communicate, coordinate activities, and maintain colony structure.

Morphological Adaptations and Ecological Significance

The morphology of Indian wasps is closely linked to their ecological roles. Predatory species exhibit strong mandibles and agile flight mechanisms, enabling them to capture and subdue prey efficiently. Parasitoid wasps possess specialized ovipositors that allow them to exploit hidden hosts, while social wasps show adaptations related to nest building and colony defense.

These structural adaptations highlight the evolutionary success of wasps and their ability to occupy diverse ecological niches. Their morphology not only supports their survival but also contributes to ecosystem balance by controlling pest populations and participating in pollination.

Conclusion

The morphology of wasps from India reveals a remarkable degree of specialization and diversity, reflecting their ecological versatility and evolutionary advancement. From the sensory-rich head to the highly flexible abdomen equipped with a sting or ovipositor, each structural feature serves a specific and essential function. Understanding these morphological characteristics is crucial for taxonomic identification, ecological studies, and applied research in biological control. As India continues to be a hotspot of biodiversity, further studies on wasp morphology will contribute significantly to our knowledge of insect diversity and ecosystem dynamics.

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Gregarine Parasites of Invertebrates

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Abstract

Gregarine parasites represent one of the most widespread and diverse groups of protozoan parasites found in nature. They belong to the phylum Apicomplexa, a large group of obligate parasitic protists that includes several medically and veterinary important organisms. Gregarines primarily infect invertebrates and are especially common in annelids and arthropods. Among insects, orthopterans such as grasshoppers and crickets and odonates such as dragonflies and damselflies are frequently reported hosts. Other insect groups that harbor gregarine infections include cockroaches (order Blattodea), mosquitoes and flies (order Diptera), and beetles (order Coleoptera). Although these parasites are widely distributed in nature, only a small proportion of invertebrate species has been systematically examined for gregarine infections. As a result, scientists believe that the actual diversity of these organisms is vastly underestimated.



<https://share.google/YxFW4nqvoKUrTaQCO>

Current estimates suggest that there may be more than one million gregarine species worldwide, making them one of the most diverse groups of parasitic organisms associated with invertebrates.

Taxonomy & Systematic

The taxonomy and systematics of gregarines have historically been complicated and continue to evolve as new morphological and molecular data become available. Traditional classifications have been based largely on morphological characters and host associations. According to current understanding, approximately 1,656 species of gregarines have been formally described within 244 genera under the order Eugregarinorida. These parasites have been recorded from more than 3,124 host species. Nevertheless, many species remain undescribed, particularly in regions where parasitological studies of invertebrates are limited. Even in well-studied areas such as North America, numerous species are known to exist but have not yet been formally characterized.

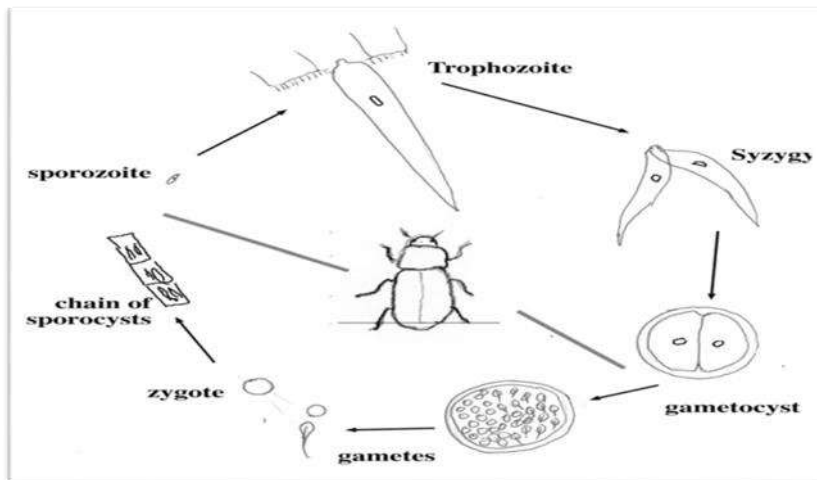
Gregarines are classified within the phylum Apicomplexa, a group of unicellular eukaryotic organisms characterized by specialized structures that enable parasitic lifestyles. Members of this phylum generally lack locomotory organelles such as cilia or flagella, although flagella may be present in certain gamete stages. According to the classification proposed by Roberts and Janovy (2005), the phylum Apicomplexa includes three major classes: Perkinsasidea, Aconoidasida, and Conoidasida. Gregarines belong to the class Conoidasida and are further placed within the subclass Gregarinasina. The species most commonly studied in invertebrates belong to the order Eugregarinorida. These parasites usually inhabit the intestinal tract of their hosts, although they may also occur in the hemocoel, reproductive organs, or other internal cavities.

Gregarines are widely distributed in both terrestrial and aquatic habitats wherever suitable invertebrate hosts occur. Their ecological distribution closely follows that of their hosts, which include insects, earthworms, crustaceans, molluscs, and echinoderms. In insects, gregarines are most commonly found in the digestive tract, where they attach to epithelial cells lining the intestine. However, in some hosts they may inhabit other regions of the body such as the coelomic cavity, Malpighian tubules, or reproductive organs. Infection generally occurs when a host ingests infective spores present in contaminated food, water, or soil. Once inside the host, the parasites develop and complete their life cycle.

The morphology of gregarines is distinctive and often easily recognized under the microscope. They are typically elongated, worm-like unicellular organisms that may reach several millimeters in length, which is relatively large for protozoan parasites. Their body structure is usually divided into distinct regions that perform specialized functions during the parasitic life cycle. The anterior region of the parasite forms a specialized attachment organ known as the epimerite. This

structure allows the parasite to anchor itself securely to the host's epithelial cells. The epimerite plays an important role in maintaining the parasite's position within the host's digestive tract while it absorbs nutrients

Behind the epimerite lies the protomerite, which forms the front portion of the parasite's main body. The protomerite participates in the feeding stage and contributes to the overall structure of the trophozoite. The largest and most prominent region of the body is the deutomerite, which contains the nucleus and most of the cytoplasm. Together, the protomerite and deutomerite form the trophozoite stage, which represents the active feeding and growing phase of the parasite. The surface of the gregarine body is covered by a thick pellicle that often shows longitudinal folds. This pellicle provides structural support and protection against digestive enzymes within the host's gut. Another interesting feature of gregarines is their mode of movement. Unlike many other protozoa, they do not possess cilia or flagella for locomotion. Instead, they move by a characteristic gliding motion along surfaces. Nutrient uptake occurs directly through the body surface by absorption from the surrounding intestinal contents or host fluids. This method of nutrition allows them to survive without a specialized digestive system.



The life cycle of gregarines is generally simple compared to that of many other apicomplexan parasites. Most species exhibit a monoxenous life cycle, meaning that all developmental stages occur within a single host. The cycle begins when an invertebrate host ingests oocysts containing infective sporozoites. These oocysts are usually present in the environment as a result of contamination by the feces of previously infected hosts. A characteristic event in the gregarine life cycle is the process known as syzygy. In this stage, two mature trophozoites come together and align themselves in a head-to-tail arrangement. This association forms what is known as a gamont pair. The gamont pair becomes

enclosed within a cyst wall, forming a structure known as a gametocyst. Within the gametocyst, the paired organisms undergo sexual reproduction. The cells differentiate into gametes, which subsequently fuse to form zygotes.

Gregarines are traditionally divided into several major groups based on morphological and biological characteristics. One of the earliest groups is the archigregarines, which are primarily found in marine environments. These parasites are considered relatively primitive forms because their trophozoites resemble the infective sporozoites in shape and structure. Phylogenetic analyses suggest that archigregarines may represent a paraphyletic group that requires further taxonomic revision.

Another large group is the eugregarines, which are widely distributed in marine, freshwater, and terrestrial habitats. These species possess large trophozoites that differ significantly from the sporozoite stage in both morphology and behavior. Eugregarines represent the majority of known gregarine species. They are often classified into septate and aseptate forms depending on whether a transverse septum divides the trophozoite body into two regions.

Certain specialized forms of eugregarines include urosporidians, which infect the coelomic spaces of marine hosts. Unlike many other gregarines, urosporidians usually lack attachment structures and their gamont pairs move freely within the host's body fluid. Another group, the monocystids, infects the reproductive vesicles of terrestrial annelids such as earthworms. These parasites typically produce eight sporozoites in each spore and share evolutionary relationships with neogregarines.

Neogregarines represent another important group of gregarine parasites and are found mainly in terrestrial hosts, particularly insects. In comparison with eugregarines, neogregarines tend to be more pathogenic. They possess a reduced trophozoite stage and often infect tissues other than the intestine. An important difference is that neogregarines include an additional stage known as merogony, or schizogony, during which asexual multiplication occurs within the host.

Numerous species of gregarines have been described from different invertebrate hosts. Some well-known examples include *Gregarina niphandrodes*, *G. polymorpha*, *G. cuneata*, and *G. steini*, which commonly infect the beetle *Tenebrio molitor*. Species belonging to the genus *Stylocephalus* are also frequently encountered in insect hosts. Other genera such as *Rhynchocystis*, *Hirmocystis*, and *Sphaerocystis* are reported from earthworms and other invertebrates. In termites, species such as *Gregarina macrotermis* and *Steininaoptotermi* have been documented. Marine invertebrates may harbor gregarines belonging to genera such as *Lankesteria* and *Lecudina*.

Although many gregarine infections appear relatively harmless, heavy infections can have noticeable effects on the health of the host. Insects heavily infected with gregarines may show reduced growth rates, decreased reproductive capacity, and

increased mortality. In some cases, larvae infected with large numbers of parasites may exhibit reduced body size or delayed development. Because of these effects, certain species of gregarines have been investigated as potential biological control agents for insect pests.

In conclusion, gregarine parasites constitute a highly diverse and ecologically significant group of protozoans that infect a wide range of invertebrate hosts. Their unique morphology, specialized life cycle, and remarkable host specificity make them fascinating subjects for biological research. Despite the large number of described species, much of their diversity remains unexplored. Continued investigations using modern microscopic and molecular techniques are likely to reveal many new species and improve our understanding of their taxonomy, evolution, and ecological roles. As research progresses, gregarines will continue to provide valuable insights into the complex relationships between parasites and their hosts in both terrestrial and aquatic ecosystems.

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Diversity of Frog in and Around Karjat, Ahilyanagar

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Abstract

Amphibians represent one of the most fascinating and ecologically significant groups of vertebrates. Among them, frogs are the most diverse and widely distributed organisms, inhabiting a variety of ecosystems ranging from tropical forests to agricultural landscapes. Their dual life, involving both aquatic and terrestrial phases, makes them uniquely sensitive to environmental changes. Because of this sensitivity, frogs are widely recognized as bioindicators, reflecting the health of ecosystems. The region of Karjat in Ahilyanagar district of Maharashtra provides a suitable habitat for a variety of amphibian species. Characterized by seasonal rainfall, agricultural fields, ponds, and temporary water bodies, the region supports breeding and survival of frogs, especially during the monsoon season. However, increasing human activities such as urbanization, deforestation, and excessive use of agrochemicals are posing significant threats to amphibian populations.

This chapter aims to describe the diversity of frogs observed in and around Karjat, their ecological roles, habitat preferences, and the factors influencing their distribution.

Amphibian Diversity in India

India is one of the biodiversity-rich countries in the world and harbors a significant proportion of global amphibian diversity. More than 200 species of amphibians have been reported, including frogs, toads, caecilians, and salamanders. A large number of these species are endemic, particularly in the Western Ghats, which is recognized as a global biodiversity hotspot. Frogs belong to the order Anura, which is characterized by the absence of tails in adults, long hind limbs adapted for jumping, and moist glandular skin. Their life cycle includes metamorphosis from aquatic larvae (tadpoles) to terrestrial or semi-aquatic adults. This complex life cycle requires both aquatic and terrestrial habitats, making frogs highly dependent on environmental conditions.

Study Area: Karjat Region

Karjat, located in Ahilyanagar district of Maharashtra, is primarily a semi-arid region that experiences moderate rainfall during the monsoon season. Despite its dry climate for most of the year, the monsoon transforms the landscape into a suitable habitat for amphibians. Temporary ponds, flooded agricultural fields, irrigation canals, and small streams provide ideal breeding grounds for frogs. Villages such as Alsunde and surrounding areas were selected for the present study. These locations include a mix of natural and human-modified habitats, allowing for observation of both common and adaptable frog species. The presence of water bodies, vegetation, and suitable microhabitats such as leaf litter and soil crevices contribute to amphibian diversity in the region.

Habitat and Ecology of Frogs

Frogs occupy a wide range of habitats depending on their ecological adaptations. In the Karjat region, frogs were observed in aquatic, semi-aquatic, and terrestrial habitats. Aquatic habitats include ponds, lakes, and slow-moving streams where frogs breed and lay eggs. Semi-aquatic species are found near water bodies but may move onto land for feeding and shelter. Terrestrial frogs inhabit fields, gardens, and forest floors, while arboreal species are adapted to life in trees and shrubs. Frogs are primarily nocturnal and become highly active during the rainy season. Their breeding activity is closely associated with rainfall, which provides suitable conditions for egg laying and development of tadpoles. Male frogs produce characteristic calls to attract females, and these vocalizations are often species-specific. The diet of frogs mainly consists of insects such as mosquitoes, flies, beetles, and other small invertebrates. By feeding on these organisms, frogs play an important role in controlling pest populations. At the same time, they serve as prey for birds, snakes, and mammals, forming an essential link in the food chain.

Observed Frog Species in Karjat

During the present study, several frog species were observed in different habitats. These species belong to different families and exhibit diverse ecological adaptations. One of the species recorded was *Fejervarya limnocharis*, commonly known as the Asian grass frog. This species is widely distributed and commonly found in agricultural fields and grasslands. It is highly adaptable and thrives in human-modified environments. Another species observed was *Duttaphrynus melanostictus*, which is frequently found near human settlements. This species is characterized by its rough skin and tolerance to dry conditions. It is often seen in gardens, roadsides, and near water sources. The *Fejervarya cancrivora* is notable for its ability to tolerate saline environments. Although more common in coastal regions, its adaptability allows it to survive in

varied habitats. This physiological adaptation makes it unique among amphibians. Another interesting species recorded was *Quasipaa spinosa*, which is typically associated with rocky streams and forested areas. It is recognized by its relatively large size and spiny projections in males. These species collectively represent the diversity of amphibians in the Karjat region and highlight the ecological variability of the area.

Seasonal Variation in Frog Diversity

Seasonal variation plays a crucial role in determining frog diversity and abundance. In Karjat, the monsoon season (June to September) is the most favorable period for amphibian activity. During this time, increased moisture and availability of water bodies create ideal conditions for breeding and development. Frogs emerge in large numbers during the rainy season, and their calls can be heard throughout the night. Temporary water bodies formed by rainfall serve as breeding sites for many species. After the monsoon, as water sources dry up, frog activity decreases significantly, and many species either migrate to suitable habitats or enter a state of dormancy.

Threats to Frog Diversity

Despite their ecological importance, frog populations are declining worldwide due to various environmental and anthropogenic factors. In the Karjat region, several threats have been identified. Habitat destruction due to agricultural expansion and urban development is one of the major threats. The use of chemical pesticides and fertilizers contaminates water bodies, affecting both adult frogs and their larvae. Pollution from domestic and industrial sources further degrades amphibian habitats. Climate change is another significant factor influencing amphibian populations. Changes in rainfall patterns and temperature can disrupt breeding cycles and reduce survival rates. Additionally, diseases such as chytridiomycosis, caused by fungal pathogens, have been responsible for global amphibian declines.

Ecological Importance of Frogs

Frogs play a vital role in maintaining ecological balance. As predators, they help control insect populations, including pests that affect crops and vectors that transmit diseases. By reducing mosquito populations, frogs indirectly contribute to human health by limiting the spread of diseases such as malaria and dengue. Frogs also contribute to nutrient cycling and energy flow within ecosystems. Their presence indicates a healthy environment, as they are highly sensitive to pollution and habitat changes. Thus, studying frog diversity provides valuable insights into ecosystem health and environmental quality.

Conservation Measures

Conservation of frog diversity requires a combination of habitat protection, pollution control, and public awareness. Protecting wetlands, ponds, and natural water bodies is essential for sustaining amphibian populations. Reducing the use of harmful pesticides and promoting eco-friendly agricultural practices can help minimize environmental impact.

Community participation plays a crucial role in conservation efforts. Educating local people about the importance of frogs and encouraging them to protect amphibian habitats can lead to sustainable conservation outcomes. Establishing protected areas and conducting regular biodiversity surveys are also important steps toward preserving amphibian diversity.

Conclusion

The study of frog diversity in and around Karjat highlights the ecological richness and importance of amphibians in the region. Despite environmental challenges, the presence of diverse frog species indicates that suitable habitats still exist. However, increasing human activities pose a threat to their survival. Understanding and documenting frog diversity is essential for biodiversity conservation and environmental management. Protecting amphibians not only preserves ecological balance but also supports human well-being by controlling pests and maintaining ecosystem health. Therefore, immediate and sustained conservation efforts are necessary to ensure the survival of frog populations in the Karjat region.

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Diversity of Local Ants in Chincholi Kaldat Karjat, Ahilyanagar

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Abstract

Ants are one of the dominant and important insects in terrestrial ecosystems. They play a vital role in ecological balance by aerating the soil, breaking down organic matter, and controlling pests. The main goal of the present study was to study the diversity and distribution of ant species in different habitats of Karjat Taluka. The study was carried out in different habitats such as agricultural fields, gardens, residential areas, roadside areas, and grasslands by employing different sampling techniques such as hand collection, bait trapping, and pitfall trapping. The collected ant species were identified based on different morphological characteristics such as body size, color, segmentation, and antennae. In current work, we observed five species of ants in the study area. The study revealed that different ant species were present in different habitats. The ant diversity was high in areas with high vegetation density compared to urban areas. The study revealed the ecological importance of ant species as bioindicators. The study can be useful in future biodiversity studies in the region.

Keywords: Ant, diversity, local etc.

Introduction

Ants are small but highly organized social insect belonging to the family Formicidae under the order Hymenoptera. They are among the most successful and dominant groups of terrestrial arthropods, found in almost every habitat across the world except extreme polar regions. Ants live in well-structured colonies that exhibit a high level of social organization, division of labour, and communication. A typical ant colony consists of a queen, workers, and males, each performing specific roles essential for the survival and growth of the colony. Ants are ecologically important organisms and are often considered ecosystem engineers. Through their nesting and foraging activities, ants improve soil structure by increasing aeration and water infiltration. They contribute to nutrient cycling by decomposing organic matter and transporting food materials within the soil. Many ant species act as predators and scavengers, thereby controlling

populations of other insects and helping maintain ecological balance. Some species also play a crucial role in seed dispersal (myrmecochory), which aids in plant regeneration and biodiversity maintenance.

India is a country with a wide range of climatic and geographical variations. Such variations in temperature, rainfall, vegetation type, etc., are known to affect the ant fauna. The ant fauna is known to reflect the local habitats. The presence or absence of ants is a significant factor that helps us understand the quality of habitats. Therefore, the ant fauna is generally considered a significant tool for understanding the local habitats.

Karjat Taluka is a region in the Ahilyanagar district of Maharashtra. This region is known to contain a variety of habitats such as agricultural fields, gardens, roadside vegetation, residential areas, etc. Such variations in habitats are known to create a suitable environment for the survival of various ant species. However, the impact of urbanization and agricultural practices may affect the biodiversity. Therefore, the ant fauna is significant in this region.

The current project under the title Diversity of Local Ants in Chincholi Kaldat, Karjat, (Ahilyanagar) intends to explore the diversity of local ants found in the region. This project not only increases the knowledge of the diversity of local insects found in the region; it also increases the awareness of the importance of conserving even the smallest of creatures such as ants. By exploring the diversity of local ants found in the region of Karjat, this project can be helpful to the region. This is because the project can be helpful to the region in the future.

Materials & Methods

Study Area

The present study was conducted in Chincholi Kaldat, Karjat Taluka, District Ahilyanagar Maharashtra. The study area includes a mixture of agricultural fields, gardens, residential areas, roadside vegetation, grasslands, and open lands. The region experiences a semi-arid climate with moderate rainfall and high summer temperatures. Different habitats were selected to observe variation in ant diversity across environmental conditions.

Duration of Study

The survey was carried out over a period of August 2025 to February 2026. Observations were made during morning and evening hours when ant activity was maximum.

Materials Used

Forceps, Soft brush, Collection bottles, 70% alcohol (for preservation), Hand lens / Magnifying glass, Notebook and pen, Camera/mobile phone (for photographs)

Sampling Methods

To study the diversity of ants, the following collection methods were used

- **Hand Collection Method**

Ants were directly collected from the ground, walls, tree trunks, leaf litter, and nests using forceps or a soft brush. This method was useful for collecting visible and active species.

- **Baiting Method**

Small quantities of sugar solution and edible oil were placed on paper or leaves at selected locations. Ants attracted to the bait were observed and collected after a fixed time interval (15–30 minutes). This method helped in identifying food preferences and dominant species.

- **Pitfall Trap Method**

Plastic cups were buried in the soil with their rim at ground level. These cups acted as pitfall traps to capture ground-dwelling ants. A small amount of preservative (70% alcohol) was added to prevent escape and preserve specimens. Traps were left for 24 hours and then examined.

Preservation of Specimens

Collected ants were transferred into labeled vials containing 70% alcohol. Each vial was labeled with date, location, habitat type, and method of collection.

Identification of Species

Specimens were examined using a hand lens or magnifying glass. Identification was based on morphological characteristics such as:

Body size and color, Number of body segments, Antennae structure, Presence of spines, Nesting habits

Standard identification keys, textbooks, and online reference materials were used to classify ants up to genus or species level wherever possible.

This methodology helped in systematically documenting the diversity of local ants in Karjat and analyzing their distribution across different habitats.

Results / Observations

Sr. No.	Common Name	Subfamily	Genus	Species
1	Tropical fire ant (Little red ant)	Myrmicinae	Wasmannia	auropunctata
2	Asian Weaver ant (Medium size red ant)	Formicinae	Oecophylla	smaragdina
3	Florida carpenter ant (Big size brown ant)	Formicinae	Camponotus	atriceps
4	Longhorn crazy ant (Small size black ant)	Formicinae	Paratrechina	longicornis

5	Big headed ant (Medium size black ant)	Myrmicinae	Pheidole	megacephala
6	Carpenter ants (Big size black ant)	Formicinae	Componotus	compressus
7	Pharaoh ant (Small whitish yellow ant)	Myrmicinae	Monomorium	pharaonis
8	Red imported fire ant	Myrmicinae	Solenopsis	invicta

The present study on the Diversity of Local Ants revealed that the study area supports a moderate diversity of ant species belonging to different genera and ecological groups. Based on morphological observation and habitat preference, eight major types of ants were identified.

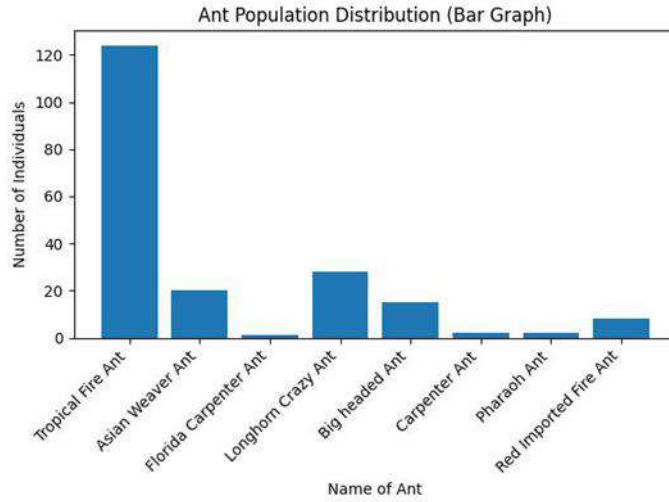
During the field survey conducted in Chincholi Kaldat, Karjat (Ahilyanagar), different types of ants were observed and recorded. The observations were based on body size and color characteristics. A total of 200 individual ants belonging to seven different categories were recorded in one day.

The small red ants were found to be the most abundant species with 124 individuals, indicating their high population in the study area. Small black ants (Longhorn crazy ants) were the second most abundant with 28 individuals, followed by medium red ants (Asian Weaver ants) with 20 individuals. Medium size black ants (big headed ants) were also moderately present with 15 individuals. Red Imported fire ants were also present with 8 individuals.

In contrast, large ants were comparatively less common in the study area. Only 1 big brown ant (Florida carpenter ant) and 2 big black ants (Carpenter ants) were recorded during the observation period. White ants (Pharaoh ants) were also rarely observed, with only 2 individuals recorded.

The results indicate that smaller ant species dominate the local habitat, possibly due to their better adaptability, faster reproduction, and ability to utilize available food resources efficiently. The presence of different sizes and types of ants suggests moderate diversity of ant fauna in the study region.

Sr. No	Name of Ant	No. of individuals
1	Tropical Fire Ant	124
2	Asian Weaver Ant	20
3	Florida Carpenter Ant	1
4	Longhorn Crazy Ant	28
5	Big headed Ant	15
6	Carpenter Ant	2
7	Pharaoh Ant	2
8	Red Imported fire Ant	8
	Total	200



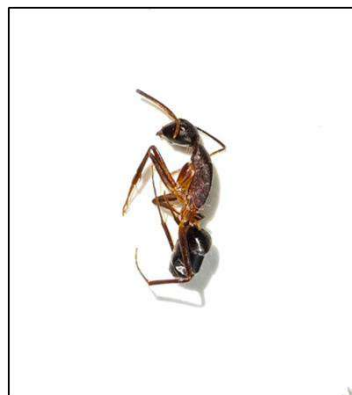
Tropical Fire Ant



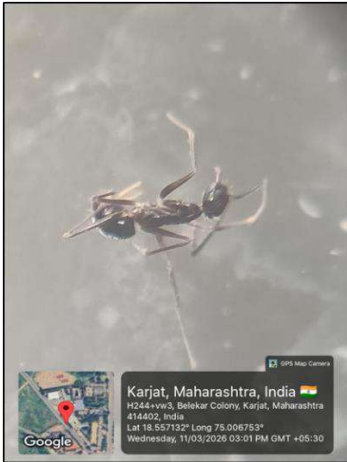
Asian Weaver Ant



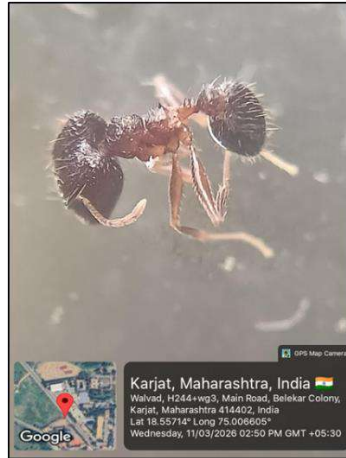
Florida Carpenter Ant.



Carpenter Ant



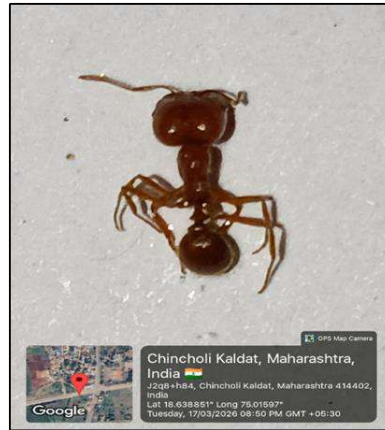
Longhorn Crazy Ant



Big Headed Ant



Pharaoh Ant



Red imported fire Ant

Conclusion

The present study on “Diversity of Local Ants in Chincholi Kaldat, Karjat, (Ahilyanagar)” revealed that Karjat Taluka supports a considerable diversity of ant species across different habitats such as agricultural fields, gardens, roadside vegetation, grasslands, and residential areas. The variation in species richness and abundance observed during the survey indicates that habitat type, vegetation cover, availability of food resources, and level of human disturbance significantly influence ant distribution.

The study showed that areas with dense vegetation and organic matter supported higher ant diversity compared to highly disturb urban or roadside locations. Ants were observed performing important ecological roles such as scavenging, predation, soil aeration, and nutrient recycling. Their presence reflects the ecological health of the study area, confirming that ants can serve as reliable bio-indicators of environmental quality.

Overall, this project successfully documented baseline information on local ant diversity in Karjat. The findings emphasize the need to conserve natural and semi-natural habitats to maintain insect biodiversity. This study not only enhanced knowledge about local biodiversity but also created awareness about the ecological importance of small yet significant organisms like ants.

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Inventory and Diversity of Insect Species in Kuldharan, Karjat Tehsil, Ahmednagar District (Maharashtra, India)

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Abstract

Insects constitute the most diverse group of organisms on Earth and play indispensable roles in ecosystem functioning. The present study provides a comprehensive inventory and assessment of insect diversity in Kuldharan village, located in Karjat tehsil of Ahmednagar district, Maharashtra, India. Field surveys were conducted across different habitats including agricultural fields, grasslands, water bodies, and human settlements. A wide variety of insect taxa were recorded, representing multiple orders such as Lepidoptera, Coleoptera, Hymenoptera, Diptera, Orthoptera, and Odonata. The study highlights species richness, habitat preferences, and ecological significance of the recorded insect fauna. The findings emphasize the importance of conserving local biodiversity and provide baseline data for future ecological and conservation studies in semi-arid regions of Maharashtra.

Introduction

Insects are the most abundant and diverse group of animals, representing more than half of all known living organisms. They occupy nearly every ecological niche and contribute significantly to ecosystem stability and productivity. Their roles range from pollination and decomposition to serving as food for higher trophic levels. Despite their ecological importance, insect diversity in many rural and semi-urban regions of India remains under-documented.

The Ahmednagar district of Maharashtra, characterized by semi-arid climatic conditions, supports a variety of ecosystems including agricultural landscapes, scrublands, and seasonal water bodies. Karjat tehsil, in particular, exhibits a mosaic of habitats that are conducive to insect diversity. Kuldharan village, situated within this region, presents an ideal site for studying insect fauna due to its varied microhabitats and relatively low industrial disturbance.

This chapter aims to document the diversity of insect species in Kuldharan and analyze their ecological roles. The study also seeks to create awareness regarding the importance of insects and the need for their conservation.

Study Area

Kuldharan village is located in Karjat tehsil of Ahmednagar district in Maharashtra, India. The region experiences a semi-arid climate with hot summers, moderate monsoon rainfall, and mild winters. The average annual rainfall ranges between 400–600 mm, primarily during the monsoon season. The study area comprises diverse habitats such as cultivated fields (sugarcane, wheat, and pulses), fallow lands, roadside vegetation, water bodies like ponds and canals, and residential areas. These habitats support a wide range of flora, which in turn sustains diverse insect populations.

Materials and Methods

Field surveys were conducted over multiple seasons to capture seasonal variation in insect diversity. Sampling was carried out during morning and evening hours when insect activity is typically high. Various methods were employed for insect collection and observation: Sweep netting for flying and vegetation-dwelling insects. Hand picking for slow-moving species Light trapping for nocturnal insects. Visual observation and photographic documentation Collected specimens were preserved and identified using standard taxonomic keys and reference literature. Identification was carried out up to the family or species level wherever possible.

Results and Observations

The study recorded a rich diversity of insect fauna belonging to several orders. The major groups observed are described below.

Order Lepidoptera (Butterflies and Moths)

Butterflies were among the most visually prominent insects observed in the study area. Species such as Plain Tiger, Common Crow, Lime Butterfly, and Common Grass Yellow were frequently recorded. These insects were primarily associated with flowering plants and played a crucial role in pollination. Moths were also abundant, especially during nighttime, and were attracted to light sources. They contribute significantly to pollination and serve as prey for nocturnal predators.

Order Coleoptera (Beetles)

Beetles exhibited considerable diversity, including ladybird beetles, dung beetles, and leaf beetles. Ladybird beetles were commonly found in agricultural fields where they act as natural predators of aphids and other pests. Dung beetles contributed to nutrient recycling and soil aeration.

Order Hymenoptera (Bees, Wasps, and Ants)

This group was well represented in the study area. Honeybees and solitary bees were observed visiting flowers, indicating their role as primary pollinators. Ants were abundant and found in almost all habitats, contributing to soil turnover and organic matter decomposition. Wasps, both parasitic and predatory, were also recorded.



Manduca quinquemaculata



Plecia nearctica



Aedes albapictus



Crocothemis servilia



halyomorpha halys



Reipta taurus

Order Diptera (Flies)

Flies were commonly observed in moist and decaying environments. Houseflies, fruit flies, and hoverflies were among the frequently encountered species. While some flies are considered pests, others, like hoverflies, are beneficial pollinators.

Order Orthoptera (Grasshoppers and Crickets)

Grasshoppers and crickets were abundant in grasslands and agricultural fields. These insects are herbivorous and can sometimes act as crop pests, but they also form an essential part of the food chain.

Order Odonata (Dragonflies and Damselflies)

Dragonflies and damselflies were commonly found near water bodies. They are important biological control agents as both larvae and adults feed on mosquitoes and other small insects.

Discussion

The diversity of insect species observed in Kuldharan reflects the ecological richness of the region. The presence of multiple insect orders indicates a balanced ecosystem with well-established food chains and ecological interactions.

Agricultural fields supported a high number of beneficial insects such as pollinators and predators. However, the use of chemical pesticides poses a significant threat to these beneficial species. Water bodies served as breeding grounds for aquatic insects, particularly odonates, which are indicators of environmental health.

Seasonal variation was evident, with higher diversity recorded during the monsoon and post-monsoon periods. This can be attributed to increased vegetation and favorable climatic conditions.

Human activities such as urbanization, pesticide use, and habitat destruction can negatively impact insect diversity. Therefore, sustainable agricultural practices and habitat conservation are essential for maintaining ecological balance.

Ecological Importance of Insects

Insects play vital roles in maintaining ecosystem health. Pollinators such as bees and butterflies are essential for the reproduction of flowering plants and agricultural crops. Decomposers like beetles and flies help in nutrient cycling by breaking down organic matter. Predatory insects control pest populations, reducing the need for chemical pesticides. Insects also serve as a food source for birds, amphibians, and other wildlife, thus supporting biodiversity at higher trophic levels.

Conservation Implications

The findings of this study highlight the need for conservation of insect biodiversity in rural landscapes. Protecting natural habitats, reducing pesticide

use, and promoting organic farming can help sustain insect populations. Awareness programs should be conducted to educate farmers and local communities about the ecological importance of insects. Conservation efforts should focus on preserving both terrestrial and aquatic habitats.

Conclusion

The present study provides valuable insights into the diversity and distribution of insect species in Kuldharan village of Karjat tehsil. The region supports a rich assemblage of insect fauna across multiple orders, reflecting a healthy and functional ecosystem. However, increasing anthropogenic pressures pose a threat to this diversity. Immediate measures are required to promote sustainable practices and conserve insect biodiversity. The data generated from this study can serve as a baseline for future research and biodiversity monitoring programs.

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Diversity of Beetles (Coleopteran) within the Three Different Localities of the Ahmednagar District, Maharashtra

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Abstract

Insects are the largest group of animals present in the world. Only 20% of the total species has been discovered till today and around 80% of the species still waiting to be discovered. Insects are dominating group of animals that they make up about 80% of all animal species. All the beetles belong to the coleopteran family. Among the all orders of insects Coleoptera is the dominating. There are approximately 40,000 described species in coleopteran. Most of the beetles are herbivores which consume plant parts like leaves, roots, stems, wood and fruits. Some acts as a decomposers and feed on the fungi, dung, and decaying organic matter helps to keep environment clean. The present study gives the information about the diversity of the beetles among the Ahmednagar region. Environment of Ahmednagar district is favourable for the insects. In the present study collection of beetles, photography, and identification has done.

Keywords: Beetles, Coleopteran, Ahmednagar, Environment, Agriculture.

Introduction

The class Insecta is the largest class of organisms on the Earth. Among the insects, Coleoptera is the largest group of organisms at the order level. Coleoptera includes beetles. In the Coleoptera order, the family Scarabaeidae is the largest one which includes around 27,800 species worldwide and these are further divided into 16 subfamilies (Fincher,1981). Beetles have useful as well as harmful impacts on the environment. In the terrestrial ecosystem, beetles play an important role. Beetles are economically important groups of insects. The coprophagous beetles improve the soil quality; while phytophagous beetles are harmful as they feed on agricultural crops and act as serious agricultural pests.

Beetles are by far the largest order of insects with roughly 400,000 species making up about 40% of all insect species so far described, and about 25% of all animals (Bouchard et al, 2011; Gilliott, 1995; Rosenzweig, 1995; Hammond, 1992). Among these 17431 species are identified from the Indian region (Mittal and Jain, 2015; Zothansanga, 2021). Beetles are economically important groups of insects. Some beetle species act as serious agricultural pests. Beetles are cosmopolitan in habitat and they also show wide adaptations to the environmental conditions. Elytra is the adaptation of the forewings of Coleoptera into the defensive covers. Beetles are usually recognized by their size and shape of antenna, mouthparts, and elytra. Elytra differentiate the Coleoptera from the other insects. There are a number of taxonomic studies on beetle fauna of Maharashtra (Dabhade et al., 2012; Hegde and Vasanthkumar, 2018; Kalawate, 2018, 2019; Kalawate and Patole, 2018; Aland, et al. 2012; Bhawane, 2013, Pawara et al. 2014; Tambe et al. 2014; Hon, 2018 and Kalawate, 2018; Pande et al., 2020). However, a perusal of literature shows that there is no published record on the scarabaeid beetle fauna of Ahmednagar city and adjoining areas. Keeping in view the scarcity of available taxonomic record of beetle diversity in Ahmednagar, the present research work was undertaken. This research work is an attempt to generate a baseline information on the abundance and diversity of insects in the study area.

Material and Methods

Study area: Survey sites were chosen based on accessibility and location within an ecoregion. Three different types of habitats were selected on the basis of ecological factors, flora, surrounding environment, and anthropogenic activities, to get an insight into the best possible insect diversity. The study was conducted during the period from March 2022- to May 2022. Collection sites include (1) Agricultural fields from Shirsgaon village, (2) Koregaon village, and (3) Ahmednagar College Campus (Botanical Garden, Playground, and Girls Hostel).

Ahmednagar Location in Maharashtra State

Collection and Preservation

Beetles were collected during the period of three months (March/April/May 2022). Each study area was visited frequently in the morning time. Beetles were hand-collected from 6:00 am to 8:00 am in the early morning. Upon having been brought to the laboratory, the collected specimens were narcotized, killed, spread, and then dry-preserved by keeping specimens in the oven at about 50°C for 24 hrs. Entomological pins were used for pinning. The equipment used for the

collection are gloves, Brush, Oven, Pins, Storing cans, a Pinning board, and chloroform used to kill the insect specimens. Specimens were collected by hand picking method. Scientific procedures were followed to prevent any damage to the specimen. This helped to secure the collection of morphologically intact specimens for proper study and inventory for the future. Collected specimens were preserved by killing using chloroform, drying, and pinning. The collected specimens were sent to the ZSI Pune for the further identification.

Identification






The beetle specimens were identified by the Dr. Vasantkumar D (Assistant Zoologist) ZSI Akurdi, Pune. And also, by using identification keys in the standard references key Introduction to the Identification of Beetles (Coleoptera) (P.M. Choate, 1999; Zidek and Pokorny, 2008) and standard taxonomic literature such as “The insect life (A guide to the collecting, mounting, and studying Them) by W.P. Flint.


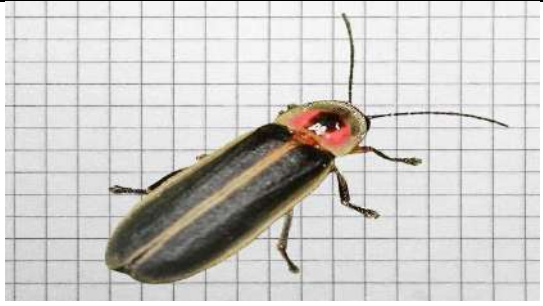
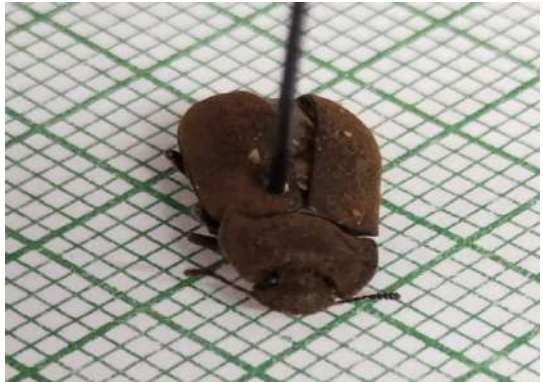
Result

A total 33 beetle specimens were collected during the study period from March 2022 to May 2022 in different localities of Ahmednagar district. The collected specimens belonged to 8 different families within the order coleoptera. Among the recorded families, the family Scarabaeidae showed the highest abundance followed by Cerambycidae, Tenebrionidae, Cerabidae, Coccinellidae, Dermestidae, Lampyridae, Silvanidae. Beetles were commonly observed in agricultural fields, vegetation, and under stones or leaf litter.

Sr.No.	Family	No. of ind	Common Name
1	Scarabaeidae	17	Rhinoceros beetle
2	Cerambycidae	5	Longhorn beetle
3	Tenebrionidae	3	Darkling beetle
4	Cerebidae	2	Ground beetle
5	Coccinellidae	2	Ladybird beetle
6	Dermestidae	2	Carpet beetle
7	Lampyridae	1	Fireflies
8	Silvanidae	1	Grain beetles

Diversity of Beetles (Coleoptera) within the Three Different Localities of the Ahmednagar

Sr. No	Common Name	Family	No. of specimens	Photograph
1	Rhinoceros beetle	Scarabaeidae	17	
2	Longhorn beetle	Cerambycidae	5	
3	Darkling beetle	Tenebrionidae	3	
4	Ground beetle	Cerebidae	2	
5	Ladybird beetle	Coccinellidae	2	

6	Carpet beetle	Dermestidae	2	
7	Fireflies	Lampyridae	1	
8	Grain beetles	Silvanidae	1	<p>A</p> 

Discussion

The study documents diverse beetle species (order Coleoptera) from rural habitats of Ahmednagar District, found across agricultural fields, vegetation, and soil surfaces. Their abundance is linked to food availability and favorable environmental conditions. Beetles play key ecological roles as predators, scavengers, and decomposers, making their documentation vital for understanding biodiversity and ecosystem functioning.

The results obtained confirm more or less with those obtained through studies by Gaikwad and Bhawane (2013), Pawaraet al. (2014), Tambe et al. (2014), Hon (2018), and Kalawate (2018). The result obtained is indicative of the species

richness of the study area and provides a clue about the need to conduct further in-depth studies on this group of fauna. The result obtained will serve as a preliminary source of information on the diversity and occurrence of hemipteran and coleopteran in the study area. We recommend a more detailed insect survey so as to explore the diversity of insects from the study area.

Conclusion

The study highlights the rich beetle diversity in Ahmednagar and nearby areas, where specimens were collected from households, crop fields, gardens, and the Ahmednagar College Campus. A total of 33 taxa belonging to 8 families were recorded, with Scarabaeidae being the most dominant. The findings reflect variation in beetle diversity across habitats and will contribute to updating faunal records of Maharashtra and the country, supporting studies in conservation, taxonomy, and evolutionary biology.

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Synoptic Study on Zooplankton Diversity in Bhima River, Maharashtra, India

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Introduction

Limnology is the study of fresh water bodies like river, ponds and lakes. Phytoplankton, zooplankton, small fish & large fish is main component of fresh water ecosystem. This all factor are part of food web. Zooplankton are microscopic aquatic organisms that drift in water bodies and form an essential component of freshwater ecosystems. They act as a crucial link between primary producers (phytoplankton) and higher trophic levels such as fish. Their diversity, abundance, and seasonal variation are widely used as indicators of water quality and ecological health.

The Bhima River, a major tributary of the Krishna River, flows through Maharashtra and supports agriculture, drinking water supply, and fisheries. However, increasing anthropogenic activities have influenced its ecological balance, making zooplankton studies important for environmental monitoring.

Study Area: Bhima River

Bhima river originates near Bhima shanker temple in the Bhima shanker hills in khed taluka on the western side of western Ghats, known as Sahyadri, in Pune district, Maharashtra state. It flows through Bhimashanker wildlife sanctuary where it enters khed taluka and is soon joined by its tributaries. the Bhima River originates in the Western Ghats and flows through districts such as Pune, Ahmednagar, and Solapur. Various stretches of the river (e.g., Karjat, Khed, siddhatek, dudhodi, jalalpur) from Ahmednagar district have been studied for zooplankton diversity.

Different sampling stations along the river exhibit variations due to:

- Sewage discharge
- Agricultural runoff Industrial effluents
- Seasonal hydrological changes

Composition of Zooplankton

Studies on the Bhima River reveal that zooplankton belong mainly to four major groups:

- Rotifera
- Cladocera Copepoda
- Ostracoda / Protozoa

In some studies, up to 90 species of zooplankton have been recorded across these groups while localized studies reported 13–33 genera or 18–20 species depending on site and duration

Dominant Zooplankton Groups

Across multiple studies of the Bhima River:

- Rotifera is consistently the dominant group in terms of diversity and abundance
- Followed by Copepoda and Cladocera
- Ostracods are least abundant or sometimes absent

Rotifers dominate due to:

- High reproductive rate
- Adaptability to varying environmental conditions
- Tolerance to organic pollution

Seasonal Variation

Zooplankton diversity in the Bhima River shows clear seasonal patterns:

- **Winter:** Highest species diversity and abundance due to stable water conditions
- **Summer:** Moderate to high abundance due to increased temperature
- **Monsoon:** Lowest diversity due to dilution, turbulence, and flushing effect

Some studies also indicate peak abundance in summer followed by winter, depending on local conditions.

Physico-Chemical Influences

Zooplankton diversity is strongly influenced by water quality parameters such as:

- Temperature
- pH (generally alkaline in Bhima River) Dissolved Oxygen (DO)
- Alkalinity
- Nutrient levels
- The river water is generally alkaline and suitable for aquatic life, though local variations occur due to pollution.
- Environmental factors like temperature, DO, and alkalinity play a significant role in regulating zooplankton distribution.

Impact of Anthropogenic Activities

Human activities significantly affect zooplankton diversity:

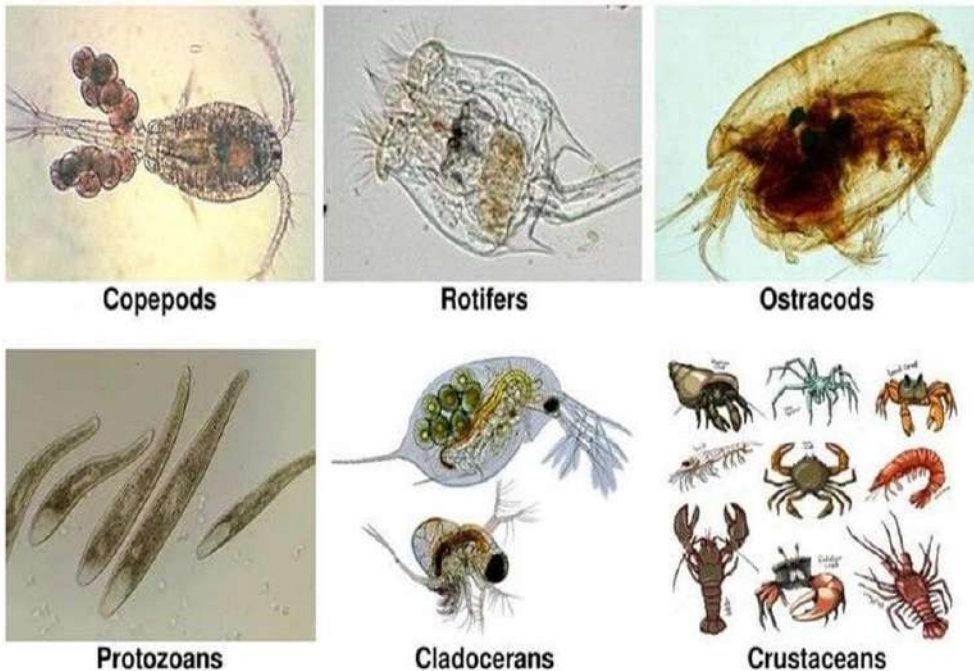
- Domestic sewage input
- Agricultural runoff (fertilizers, pesticides)
- Industrial discharge These factors lead to:
- Eutrophication
- Changes in species composition
- Increase in pollution-tolerant species (especially rotifers)

Ecological Significance

Zooplankton in the Bhima River serve important ecological roles:

- Indicator of water quality
- Food source for fish and aquatic organisms
- Regulators of phytoplankton population Contributors to nutrient cycling
- Their diversity reflects the ecological condition of the river ecosystem.

Major groups of freshwater zooplankton



Conclusion

The synoptic study of zooplankton diversity in the Bhima River reveals that:

- The river supports moderate to high zooplankton diversity
- Rotifers dominate across most regions and seasons
- Seasonal variation significantly influences distribution patterns
- Water quality and human activities strongly affect community structure

Overall, zooplankton diversity indicates that while the Bhima River remains biologically productive, certain stretches are under ecological stress due to anthropogenic pressures. Continuous monitoring and sustainable management are necessary for conservation.

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Diversity of Helminths in the Gut of Fishes of the Pravara River, Ahilyanagar District, Maharashtra

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Abstract

This study investigates the diversity, prevalence, host associations of helminth parasites in the gastrointestinal tract of freshwater fishes of Pravara River. The research was conducted over one year across multiple sites along the river to capture spatial and seasonal variations in parasitic infection. A total of 420 fish specimens representing 12 species were examined. Helminths belonging to trematodes, cestodes, and nematodes were recorded, with notable findings in carnivorous hosts (e.g., *Clarias batrachus*). Results demonstrate distinct helminth assemblages influenced by fish feeding behavior, habitat, and water quality.

Keywords: Pravara river; Helminth diversity; Freshwater fishes; Seasonal prevalence; *Clarias batrachus*.

Introduction

Freshwater fishes host a diverse range of parasitic helminths such as trematodes, cestodes, and nematodes, which can significantly affect their physiology, growth, reproduction, and overall fisheries productivity. These helminths are also important components of aquatic biodiversity and play a role in shaping trophic interactions within ecosystems. The Pravara River, a tributary of the Godavari in the semi-arid region of Ahilyanagar District, Maharashtra, supports a moderate diversity of fish species (about 15–18 species), yet detailed studies on their parasitic fauna are limited. Investigating helminth diversity in these fishes is essential for understanding ecological relationships, assessing fish health, and identifying potential zoonotic risks.

Materials and Methods

Helminths were identified using standard morphological keys and taxonomic

descriptions. Trematodes were identified following diagnostic criteria provided in Keys to the Trematoda (Gibson, Jones, & Bray, 2002; Bray, Gibson, & Jones, 2008). Nematodes were identified based on morphological characters described by Moravec (1998, 2004).

Study Area

Sampling was carried out along the Pravara River in Ahilyanagar District (Maharashtra, India), spanning upstream, midstream, and downstream sites that reflect variable flow regimes, water quality, and anthropogenic influences.

Fish Collection

Fish specimens were collected monthly over 12 months (January–December) using conventional methods such as cast nets and gill nets. A total of 420 fish specimens representing 12 species (including *Clarias batrachus*, *Channa punctatus*, *Labeorohita*, and *Mystus* spp.) were obtained.

Parasitological Examination

Each fish was humanely euthanized, measured (length and weight), and dissected in the laboratory. The entire gastrointestinal tract was removed, opened, and washed with physiological saline. Contents were examined under a stereomicroscope, and helminths were isolated, counted, and preserved in 70% ethanol.

Helminth Identification

Helminths were cleared in glycerine or lactophenol and identified using standard parasitological keys. Trematodes were identified to species where possible; cestodes and nematodes were identified to genus or morphospecies.

Data Analysis

- **Prevalence (%)** = (number of infected fish / total fish examined) × 100
- **Mean Intensity** = total helminths recovered / number of infected fish
- **Abundance** = total helminths recovered / total fish examined

Statistical analyses (e.g., ANOVA) were used to compare infection parameters among species and seasons.

Results

Helminth Diversity

A total of 18 helminth taxa were recorded from examined fishes. Trematodes were dominant, followed by nematodes and cestodes, consistent with patterns reported from other freshwater ecosystems (Kennedy, 2006; Rohde, 2005).

Higher parasite richness was observed in carnivorous fishes such as *Clarias batrachus* (Linnaeus, 1758) and *Channa punctatus* (Bloch, 1793), likely due to trophic transmission via infected invertebrates (Poulin, 2007). Herbivorous

species such as *Labeorohita* (Hamilton, 1822) harboured comparatively fewer helminths.

A total of 18 helminth taxa were recorded from the gut of examined fishes, distributed among:

- **Trematodes (Flukes):** 9 taxa (e.g., *Clinostomum*spp., *Allocreadium* spp.)
- **Cestodes (Tapeworms):** 5 taxa (including species recorded in *Clarias batrachus*, based on earlier observations in the river)
- **Nematodes (Roundworms):** 4 taxa (e.g., *Capillaria* spp., *Rhabdochona* spp.)

Carnivorous and omnivorous hosts exhibited higher parasite richness than herbivorous species.

Host–Parasite Associations

Infection was prominent in predatory fishes such as *Clarias batrachus* and *Channa punctatus*, likely due to trophic transmission via intermediate hosts (invertebrates). Herbivorous species such as *Labeorohita* harboured fewer helminths.

Infection Parameters

Parasite Group	Prevalence (%)	Mean Intensity	Abundance
Trematodes	32.5	10.8	3.51
Cestodes	16.7	6.3	1.05
Nematodes	25.7	8.4	2.16

Seasonal Variation

Seasonal Dynamics of Helminth Infection (2023–2024)

During the investigation period of January 2023 to December 2024, helminth infections in fishes of the Pravara River demonstrated clear seasonal fluctuations. The highest prevalence and mean intensity of infection were observed during the monsoon months (June–September 2023 and 2024) and the subsequent post-monsoon period (October–November).

The elevated infection rates during these months can be attributed to:

Increased river discharge and water spread

- Enhanced connectivity between main channel and marginal habitats
- Proliferation of intermediate hosts such as aquatic gastropods, insect larvae, and small crustaceans
- Favorable temperature and dissolved oxygen levels supporting larval development

Helminth Diversity in Fishes of the Pravara River

Table 1: List of Helminths Recovered from Examined Fish Hosts

Sr. No.	Parasite Species	Group	Host Species	Site of Infection	Prevalence (%)	Mean Intensity
1	<i>Clinostomum complanatum</i>	Trematoda	<i>Channa punctatus</i>	Intestine	18.4	6.2
2	<i>Allocreadium</i> sp.	Trematoda	<i>Labeorohita</i>	Intestine	12.3	4.1
3	<i>Proteocephalus</i> sp.	Cestoda	<i>Clarias batrachus</i>	Intestine	15.6	5.3
4	<i>Bothriocephalus acheilognathi</i>	Cestoda	<i>Labeorohita</i>	Intestine	9.7	3.8
5	<i>Capillaria</i> sp.	Nematoda	<i>Mystus</i> sp.	Intestine	14.2	4.9
6	<i>Rhabdochona</i> sp.	Nematoda	<i>Clarias batrachus</i>	Stomach	10.8	3.6

Figure 1: Percentage Composition of Helminth Groups

- Trematodes – 45%
- Cestodes – 28%
- Nematodes – 27%

Figure 2: Seasonal Variation in Prevalence

Season	Prevalence (%)
Pre-monsoon	21
Monsoon	39
Post-monsoon	32
Winter	18

Figure 3: Host-wise Parasite Richness

- *Clarias batrachus* – 6 species
- *Channa punctatus* – 5 species
- *Labeorohita* – 4 species

Detailed Taxonomic Descriptions

A. Trematoda

1. *Clinostomum complanatum* (Rudolphi, 1814)

Phylum: Platyhelminthes

Class: Trematoda

Order: Digenea

Family: Clinostomidae

Morphology: Body elongated and dorsoventrally flattened, with a subterminal oral sucker and a larger ventral sucker. It possesses two tandem testes and a coiled uterus

Site in Host: Intestine

Remarks: Common digenean parasite transmitted via snails and fish-eating birds. High prevalence during monsoon due to intermediate host abundance.

2. *Allocreadium sp.* Looss, 1900

Family: Allocreadiidae

- Body oval
- Acetabulum prominent
- Vitellaria lateral
- Eggs operculated
- Often found in omnivorous fishes.

B. Cestoda Weinland, 1858

3. *Proteocephalus sp.*

Phylum: Platyhelminthes

Class: Cestoda

Order: Proteocephalidea

Family: Proteocephalidae

Morphology:

- Scolex with four suckers
- Proglottids wider than long
- Uterus branched
- Common in carnivorous fishes like *Clarias batrachus*.

4. *Bothriocephalusacheilognathi*, Yamaguti, 1934

Order: Bothriocephalidea

- Scolex spatulate with two bothria
- Segmented body
- Known as Asian fish tapeworm
- Important pathogenic parasite affecting growth of host fish.

C. Nematoda

5. *Capillaria sp.*, Zeder, 1800

Phylum: Nematoda

Order: Trichurida

- Thread-like body
- Anterior thin, posterior thick
- Eggs barrel-shaped with polar plugs

- Infects intestinal lining.

6. *Rhabdochona* sp., Railliet, 1916

Order: Spirurida

- Mouth with prostom
- Thick cuticle
- Indirect life cycle via aquatic insects
- Common in riverine systems.

Morphometric Measurement

Table 2: Morphometric Observations (in mm)

Parasite	Body Length	Body Width	Oral Sucker	Ventral Sucker	Egg Size
<i>Clinostomum complanatum</i>	8.2–10.5	2.1–3.4	0.45	0.72	0.09
<i>Proteocephalus</i> sp.	15–25	1.5–2.2	NA	NA	0.06

Host–Parasite Matrix

Host Species	Trematodes	Cestodes	Nematodes	Total Species
<i>Clarias batrachus</i>	2	2	2	6
<i>Channa punctatus</i>	3	1	1	5
<i>Labeorohita</i>	2	1	1	4

Discussion

The predominance of trematodes in the present study corresponds with ecological observations that digenean parasites thrive in freshwater systems where molluscan intermediate hosts are abundant (Kennedy, 2006; Poulin, 2007).

Higher infection rates in carnivorous fishes such as *Clarias batrachus* and *Channa punctatus* support trophic transmission theory, wherein predators accumulate parasites through consumption of infected prey (Rohde, 2005).

Seasonal peaks during monsoon months align with enhanced intermediate host proliferation and favorable environmental conditions for larval development (Kennedy, 2006).

Conclusion

This baseline study provides the first systematic account of helminth diversity in the gastrointestinal tracts of fishes from the Pravara River in Ahilyanagar district, Maharashtra. Key findings include:

- A diverse helminth assemblage dominated by trematodes.
- Higher infection rates in carnivorous and omnivorous hosts.
- Seasonal peaks associated with monsoon and post-monsoon conditions.

Given the ecological and economic importance of the Pravara River, continued parasitological monitoring is essential for sustainable fisheries management and for understanding host–parasite interactions in this semi-arid riverine system.

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An Insight into the Diversity of Odonata: A Case Study of Karjat Tehsil, Ahmednagar District, Maharashtra, India

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Introduction

Odonata, comprising dragonflies and damselflies, represent one of the most ancient and ecologically significant groups of insects inhabiting freshwater ecosystems. Their evolutionary history dates back to the Carboniferous period, making them key organisms for understanding insect evolution as well as present-day ecological dynamics. The diversity of odonates is closely linked to the availability and quality of freshwater habitats, as their life cycle is intimately associated with aquatic environments. This chapter presents a comprehensive account of odonate diversity with special reference to Karjat tehsil in Ahmednagar district of Maharashtra, India, highlighting species richness, habitat associations, ecological roles, and conservation concerns.

Karjat tehsil lies in the semi-arid zone of Maharashtra and forms part of the Deccan plateau. The region is characterized by a mosaic of agricultural landscapes, seasonal streams, ponds, irrigation canals, and patches of scrub vegetation. Although not as lush as the Western Ghats, Karjat provides a range of microhabitats that support diverse insect fauna, including odonates. The presence of temporary and permanent water bodies plays a crucial role in sustaining odonate populations, as these insects depend on aquatic environments for breeding and larval development.

Odonates are broadly divided into two suborders: Anisoptera (dragonflies) and Zygoptera (damselflies). Dragonflies are generally robust, strong fliers with widely spread wings at rest, whereas damselflies are slender with delicate bodies and wings held together over the abdomen. Both groups exhibit remarkable diversity in coloration, behavior, and habitat preference. Their distribution is influenced by factors such as water quality, vegetation, temperature, and availability of prey.

Studies conducted across Maharashtra indicate that the state harbors a rich diversity of odonates, with over 130 species recorded across different habitats including forests, wetlands, and agricultural landscapes. The family Libellulidae,

commonly known as skimmer dragonflies, is the most dominant group, followed by families such as Gomphidae, Coenagrionidae, and Aeshnidae. This broader diversity pattern is reflected, to a considerable extent, in the Karjat region as well. Field observations in Karjat tehsil reveal that odonate diversity is closely associated with habitat heterogeneity. Seasonal ponds formed during the monsoon act as breeding grounds for several species. Common dragonflies such as *Pantala flavescens*, often referred to as the globe skimmer, are frequently observed in large numbers during the monsoon and post-monsoon seasons. This species is known for its migratory behavior and ability to colonize temporary water bodies quickly. Similarly, species belonging to the genera *Orthetrum* and *Diplacodes* are commonly encountered around stagnant water bodies and agricultural fields.

Damselflies, on the other hand, are more sensitive to habitat conditions and are typically found in areas with relatively undisturbed vegetation near water bodies. Members of the family Coenagrionidae are frequently observed resting on grasses and aquatic plants along the margins of ponds and streams. Their presence often indicates relatively good water quality and stable microhabitats.

The diversity of odonates in Karjat is also influenced by seasonal variations. The monsoon season marks the peak of odonate activity, as the availability of water bodies increases significantly. Breeding activities intensify during this period, leading to a surge in population density. Post-monsoon months continue to support high diversity due to the persistence of water bodies and abundant prey availability. In contrast, the summer season, characterized by high temperatures and drying of water sources, results in a decline in odonate populations. Some species survive by exploiting perennial water sources, while others may undergo diapause or migrate to more favorable habitats.

Habitat characteristics play a critical role in determining species composition and abundance. Studies from similar regions have shown that odonates exhibit strong habitat preferences, with certain species being restricted to specific ecological conditions. In Karjat, water bodies with emergent vegetation, such as reeds and grasses, support higher diversity of damselflies, whereas खुले and sunlit water bodies are preferred by many dragonfly species. Agricultural fields with irrigation facilities also provide suitable habitats, particularly for generalist species that can tolerate moderate levels of disturbance.

Odonates are widely recognized as bioindicators of environmental health. Their sensitivity to changes in water quality, habitat structure, and climate makes them valuable tools for ecological monitoring. The presence or absence of certain species can provide insights into the condition of freshwater ecosystems. For instance, the dominance of pollution-tolerant species may indicate degraded habitats, whereas the presence of sensitive species suggests relatively pristine

conditions. In Karjat tehsil, the occurrence of both generalist and habitat-specific species reflects a mix of disturbed and relatively undisturbed habitats.

The ecological role of odonates extends beyond their value as indicators. Both larvae and adults are important predators, feeding on a variety of insects including mosquitoes, flies, and agricultural pests. This predatory behavior contributes to the regulation of insect populations and has implications for human health and agriculture. In rural areas like Karjat, where agriculture forms the backbone of the economy, odonates play an indirect but significant role in pest control.

Despite their ecological importance, odonate diversity is increasingly threatened by anthropogenic activities. Habitat destruction, pollution of water bodies, excessive use of pesticides, and urbanization pose significant challenges to their survival. In Karjat tehsil, agricultural intensification and changing land-use patterns have led to the degradation of natural habitats. The use of chemical fertilizers and pesticides not only affects water quality but also reduces the availability of prey for odonates. Additionally, the conversion of wetlands into agricultural or residential land results in the loss of critical breeding sites.

Comparative studies from other regions of Maharashtra highlight similar trends. For example, surveys conducted in different districts have reported variations in species richness depending on habitat quality and degree of human disturbance. Urban areas with fragmented habitats tend to support fewer species, whereas protected areas and regions with diverse water bodies exhibit higher diversity. These findings underscore the importance of habitat conservation for maintaining odonate diversity.

Conservation of odonates in Karjat tehsil requires a multifaceted approach that integrates habitat protection, sustainable land-use practices, and community awareness of natural water bodies, restoration of degraded habitats, and reduction in pesticide use are essential steps in this direction. Promoting agroecological practices that minimize chemical inputs can help create a more favorable environment for odonates and other beneficial insects.

Public awareness and citizen science initiatives can also play a vital role in documenting and conserving odonate diversity. Encouraging local communities, students, and nature enthusiasts to participate in biodiversity surveys can generate valuable data and foster a sense of stewardship towards the environment. The use of digital platforms and mobile applications for recording species observations has further enhanced the scope of such initiatives.

We conclude that the diversity of odonates in Karjat tehsil reflects the complex interplay between environmental factors, habitat availability, and human activities. Although the region does not possess the high biodiversity of more humid zones like the Western Ghats, it nonetheless supports a significant assemblage of dragonflies and damselflies adapted to semi-arid conditions. The

study of odonate diversity in this region not only contributes to our understanding of insect ecology but also highlights the need for sustainable management of freshwater ecosystems. संरक्षण efforts aimed at preserving habitat diversity and improving environmental quality are crucial for ensuring the continued survival of these fascinating insects.

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Observations on the Life cycle, Mating, Oviposition and Cannibalism of genus *Hierodula* Burmeister, 1838

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Abstract

The genus *Hierodula* Burmeister, 1838, represents a diverse group of predatory mantids within the family Mantidae, widely distributed across tropical and subtropical regions. This communication provides a deep observation of the life history, reproductive strategies, and behavioral ecology of *Hierodula* species, specifically *H. ventralis*, *H. patellifera*, and *H. membranacea*. Through laboratory and field observations, this study highlights a hemimetabolous development cycle consisting of seven nymphal instars over approximately 53 days. We examine the complex mating rituals, including pheromone-driven attraction and the resilience of headless males during copulation. Furthermore, we analyze oviposition site selection as an anti-predator strategy and investigate the dual nature of cannibalism, both sexual and density-dependent and its impact on population dynamics and female fecundity.

Keywords: *Hierodula*, life cycle, mating, oviposition, cannibalism.

Introduction

Praying mantids are charismatic, exclusively carnivorous insects characterized by their highly specialized raptorial forelegs and remarkable camouflage. Among the diverse genera within the family Mantidae, the genus *Hierodula* is of particular interest due to its ecological role as an apex invertebrate predator. These insects serve as significant natural biocontrol agents, effectively regulating populations of agricultural and forest pests.

Despite their prominence, detailed literature on the specific life stages and behavioral adaptations of many *Hierodula* species is limited. Understanding the biological parameters, such as the duration of nymphal instars, the precise timing of oviposition, and the frequency of cannibalism, is essential for assessing their

potential in integrated pest management systems. This communication integrates findings from multiple studies to present a holistic view of the *Hierodula* life cycle and the evolutionary trade-offs involved in their reproductive and predatory behaviors.

Methodology and Observations

The data presented in this communication derived from both controlled laboratory environments and natural field observations. Laboratory studies, such as those conducted on *H. ventralis*, typically utilize insect cages (e.g., 20 x 15 cm) covered with muslin cloth to maintain aeration while providing a controlled space for monitoring moulting and mating (Raut et al., 2014). Field studies were taken from Balakrishnan, 2012, particularly those focusing on *H. membranacea* in tropical wet evergreen forests like the Western Ghats, involve systematic sampling of vegetation to identify ambush and oviposition sites.

The Life Cycle

From Ootheca to Adult: The development of *Hierodula* is hemimetabolous, involving three distinct life stages: the ootheca (egg case), the nymph, and the adult (Raut et al., 2014).

- **Incubation and Hatching:** The life of a *Hierodula* mantis begins within the protective confines of the ootheca. In species like *H. ventralis*, the incubation period lasts an average of 24.8 days, with observations ranging between 24 and 26 days (Raut et al., 2014). Hatching usually occurs simultaneously, with nymphs emerging from the ootheca in a synchronized burst. In *H. patellifera*, the interval between the deposition of the ootheca and the subsequent hatching can range from 36 to 43 days depending on environmental conditions (Leong, 2009).
- **1.2. Nymphal Instars and Moulting:** Nymphs are essentially miniature. The total nymphal duration for *H. ventralis* is approximately 53.2 days (Raut et al., 2014). During this period, the insect undergoes seven moults, with each "instar" increasing in size and complexity:
- **1st Instar:** Lasts about 6.8 days; nymphs are highly active and begin hunting small prey immediately (Raut et al., 2014).
- **Intermediate Instars (2nd–6th):** These stages range from 6 to 9 days each. During these phases, the nymphs are highly susceptible to environmental stressors and cannibalism (Raut et al., 2014).
- **7th Instar:** The final nymphal stage is the longest, lasting an average of 13.2 days (Raut et al., 2014). This period is critical as the insect undergoes significant physiological changes to develop wings and reproductive organs.

Adult Longevity and Sexual Dimorphism

Upon the final moult, the mantis reaches adulthood. Significant sexual

dimorphism is observed in the lifespan of *Hierodula*. Research indicates that females live substantially longer than males. For *H. ventralis*, the average male lifespan is 50 days, while the female lifespan extends to 71.5 days (Raut et al., 2014). This extended female longevity is likely an evolutionary adaptation to ensure sufficient time for multiple oviposition events.

Reproductive Biology and Mating Rituals

The reproductive behavior of *Hierodula* is a complex sequence of signaling, cautious approach, and prolonged copulation.

- **Mate Attraction and Pheromonal Signaling:** In *H. patellifera*, the initiation of mating is primarily governed by the female. Virgin females adopt a specific "calling" posture, characterized by the ventral flexion of the abdomen and rhythmic pulsations (Leong, 2009). This behavior releases volatile pheromones that attract males from the surrounding environment. Interestingly, this calling behavior is not observed in females that have already successfully mated (Leong, 2009).
- **The Mating Process:** Mating typically occurs during two distinct time windows: mid-afternoon (03:00 PM to 06:00 PM) and late evening (08:00 PM to 11:00 PM) (Raut et al., 2014). The male approaches the female with extreme caution to avoid being mistaken for prey. A remarkable biological observation in *H. ventralis* is the resilience of the male reproductive drive. If a female becomes aggressive and decapitates the male during their second mating encounter, the headless male is still capable of completing the mating process. This suggests that the copulatory movements are governed by the abdominal ganglia, independent of the higher brain centers (Raut et al., 2014).

Oviposition Strategies

Oviposition is the process of depositing eggs within a protective structure called an ootheca. This process is both a physiological feat and a strategic choice.

- **The Process of Ootheca Construction:** Females typically choose the early morning hours (between 4:00 AM and 6:00 AM) to lay their eggs (Raut et al., 2014). The female produces a frothy, foamy secretion from her accessory glands, which she whips into a structured mass using her ovipositor. The construction of a single ootheca takes approximately 2 hours and 30 minutes. Initially, the ootheca is light green and soft, but it hardens into a tough, parchment-like material within 24 hours, turning golden or dark brown (Leong, 2009; Raut et al., 2014).
- **Site Selection and Anti-Predator Tactics:** Studies on *H. membranacea* in tropical forests reveal that site selection is far from random. Females prefer to

oviposit on the tips of delicate branches with a mean diameter of only 0.58 cm (Balakrishnan, 2012) (Balakrishnan, 2012) These sites are typically located at an average height of 2.19 meters above the ground (Balakrishnan,2012). By choosing the terminal ends of thin twigs, the mantis ensures that heavier arboreal predators, such as large lizards or birds, cannot easily reach the ootheca without the branch bending or breaking (Balakrishnan, 2012). This strategic placement significantly increases the survival rate of the offspring.

- **Reproductive Output:** A single mating event can provide the female with enough sperm to fertilize multiple egg cases. In *H. patellifera*, a single female has been observed to produce up to three oothecae over her lifetime (Leong, 2009). The number of nymphs emerging from these cases can vary widely, often exceeding 100 individuals per ootheca.

Cannibalism

Ecological and Nutritional Drivers Cannibalism is a defining characteristic of the genus *Hierodula*, occurring in two primary forms: sexual cannibalism and nymphal cannibalism.

- **Sexual Cannibalism** Sexual cannibalism, where the female consumes the male during or after mating, occurs in approximately 31% of encounters in species like *H. membranacea* (Fisher et al., 2018). While this behavior appears detrimental to the male, it offers significant "fecundity benefits" to the female (Kamila & Sureshan, 2025). Consumption of the male provides a high-protein meal that improves the female's body condition and increases the mass of the first ootheca produced (Fisher et al., 2018). From an evolutionary standpoint, the male's sacrifice may enhance the survival chances of his own offspring by providing the female with the necessary nutrients for egg production.
- **Nymphal and Density:** Dependent Cannibalism Cannibalism among siblings is a major factor in nymphal mortality. In *H. ventralis*, cannibalistic behavior is rarely seen during the first three instar. however, it becomes highly prevalent from the 4th instar onwards (Raut et al., 2014). This shift is primarily driven by:
 - **Overcrowding:** High population density in a limited area increases encounter rates. Food Scarcity: When natural prey is insufficient, nymphs turn to their siblings as a primary food source. Security: Reducing the number of competitors for a specific hunting territory (Raut et al., 2014).

Ecological Significance and Biocontrol Potential

The life history of *Hierodula* reflects a highly optimized predatory lifestyle. Their long lifespan, particularly in females, allows them to act as a consistent predatory

force in their habitat for several months (Raut et al., 2014). Their ability to produce multiple oothecae and the synchronized hatching of nymphs ensure that they can quickly populate an area when pest numbers rise. Furthermore, the strategic selection of oviposition sites on thin branches demonstrates an advanced evolutionary response to vertebrate predation (Balakrishnan, 2012). The combination of high reproductive output and aggressive predatory behavior makes the genus *Hierodula* an excellent candidate for biological control in sustainable agriculture (Kamila & Sureshan, 2025). By maintaining a balance of these predators, farmers can reduce reliance on chemical pesticides.

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Study of Agricultural Crop Pest in and Around Alsunde Village, Karjat

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Abstract

The pest specimens were collected from in and around Alsunde village of Karjat Tahsil.

In total, 14 insect pest species are recorded representing 10 genera of 4 orders of class insecta from different localities within the study area. The 07 species are from order Lepidoptera, 4 species from Coleoptera, 2 species from Hemiptera and 1 species from Dermaptera. By studying the various plant pests, their morphology, their damage to host plant, their diversity we were able to understand various type of plant pest. With the help of this information, we can control the pest population of the particular crops and this will help for increasing the productivity of crops.

Introduction

India is the world's largest popular agriculture countries In the Globe and the largest producer of crop wheat, Rice, Sugarcane vegetables, Ground nut, Fruits And cotton food Plants of the world are damaged by More than 10,000 species of insects. 100,000 diseases, 30,000 species of weeds and 1000 species of nematodes (Hall, 1995; Dhaliwal et al, 2007). Insect cause damaged to plants Either directly or indirectly in their Attempts to Source Food and almost All the portion viz. Roots, Bark, Shoots, Stem, leaves, buds, Flowers and fruits of plant Are attacked Injured by Insects (Atwal and Dhaliwal,2015).

Many of the insects Pest such as aphids, caterpillar, grasshopper, locusts, whiteflies, leafhopper, mole cricket, Thrips and some bugs etc. are Damage the crop Are many different Insects pest Included assessed from time to time (singh et al, 2014; Dhaliwal and Arora, 2015). Extensive survays carried out during

early 1960s Revealed that Fruit, Cotton, Rice and sugarcane suffered 25,18,10 and 10% yield losses, Perspectively (pradhan 1964). The Number of insect pest damage the crop and loss of the yield.

Insect pest has a directly influence on agricultural food production by Sucking out Plant Juices, Chewing The leaves of crop plants, Stems or leaves and spreading plant pathogens boring

Within the roots. They feed on natural Fibers, destroy wooden Building materials, ruin stored Grain and accelerate the process of decay. (Yang et al. 2014)

Pests are among the most prevalent to visit crop Fields acting as pests Pollinators and other ecologically important organisms to a particular Plant (Mitra et al. 2018). The global diversity of tropical insect fauna significantly exceeds Predictions As insect's Key components of animal diversity in terms of the number of species in most habitats and ecosystems (stork 1988).

The current study investigates the relationships between pest abundance and species variety in the agricultural lands surrounding Nashik, Maharashtra. The study will record the variety of insects and the distribution of pest species among their host plants. The most diverse group of organisms on the planet, insects are essential to both the health of ecosystems.

Material and Methods

Study Area

Alsunde village is located in Karjat Tahsil, Ahilyanagar at 18.46312° N, 75.028132° E. It has an average elevation of 527 meters. The climate of Alsunde is quiet hot place as it receives scanty rainfall an inland climate of Maharashtra. The observation of agricultural insect pest was carried out in twice a day (morning and evening) from two places of sampling site of Karjat. The study period is 15 Dec 2024 to 30 March 2025.

Sampling Site

Throughout the Alsunde village, extensive survey was carried out to cover maximum study area in and around the village, actual collection sites shown along with their GPS location and elevation.

Photo Collection of the Insect

The regular collection of agricultural insects made during period of 15 Dec. 2024 to 30 March 2025 using hand picking and insect net. The photography of the specimen was carried out by using DSLR camera Canon 760 D with 18-55 lenses / Mobile Camera. The insects were anesthetized using jar containing cotton wad dipped chloroform. The insects then sun- dry & preserved and entomological pins were used for spread of the insect on entomological board.

Taxonomic Identification: Agricultural insect pest identification was done by using the available literature, Research article and identification keys.

Result and Discussion

There are number of plant pests which feed on agricultural plants. We studied few plant pests with their host plant and their control measures are given in the table:

Sr. No.	Name of species	Scientific name	Order	Origin of host plant
01	Corn beetle	<i>Cheilomenes sexmaculata</i>	Coleoptera	Maize
02	Cryptolaemus larvae	<i>Cryptolaemus</i>		French bean
03	Yellow lady bugs	<i>Coccinella</i>		Ridged luffa
04	Lady bug	<i>Cheilomenes</i>		Beans
05	Safflower aphids	<i>Uroleucon compositae</i>	Hemiptera	Sanflower
06	Citrus blackfly	<i>Aleurocanthus</i>		Mango leaf
07	Earwings	-	Dermaptera	Maize
08	pea moth larvae	<i>Cydia nigricana</i>	Lepidoptera	Pea tree
09	Lime butterfly	<i>Papilio Demoleus</i>		Citrus lemon, curry tree
10	Corn earworm	<i>Helicoverpa zea</i>		Tobacco, barley, wheat , pea, corn
11	Cotton bollworm	<i>Helicoverpa armigera</i>		Cotton capsicum
12	Black Army worm	<i>Spodoptera exempta</i>		Maize, rice
13	Fall webworm	<i>Hyphantria</i>		Pea plant
14	Gram pod Borer	<i>Helicoverpa</i>		

Conclusion

The pest specimens were collected from in and around Alsunde village of Karjat Tahsil. In total, 14 insect pest species are recorded representing 10 genera of 4 orders of class insecta from different localities within the study area. The 07 species are from order Lepidoptera, 4 species from Coleoptera, 2 species from Hemiptera and 1 species from Dermaptera. By studying the various plant pests, their morphology, their damage to host plant, their diversity we were able to understand various type of plant pest. With the help of this information, we can control the pest population of the particular crops and this will help for increasing the productivity of crops.

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Feathered Farmers: Avian Contributions to Sustainable Agricultural Landscapes

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Abstract

Agriculture now occupies a major share of the terrestrial surface, and for many bird species, croplands, orchards, and agroforestry systems have become primary habitats rather than marginal ones. Within these landscapes, birds interact with crops and associated biota as predators, seed consumers, seed dispersers, pollinators, scavengers, and ecosystem engineers. The same species can support farmers by suppressing pests and dispersing useful plants, yet at other times inflict losses by feeding on grains or fruits, leading to a dynamic balance of services and disservices.

Functional Groups of Farmland Birds

Bird communities in agricultural landscapes can be organized into broad foraging guilds such as insectivores, granivores, frugivores, nectarivores, scavengers, carnivores, and omnivores, each with distinct ecological functions. Surveys from Indian and global agroecosystems show that omnivorous and insectivorous species often dominate, followed by carnivores and smaller proportions of pure granivores, frugivores, and nectarivores. This functional composition is critical because it determines whether bird assemblages primarily deliver pest regulation, weed seed removal, seed dispersal, or direct crop consumption.

Intensive monocultures with simplified vegetation structure usually support fewer species and narrower functional diversity than mosaics that retain hedgerows, wetlands, or agroforestry elements. As a result, highly intensified systems may lose key functional groups—such as specialist insectivores or frugivores—even when some generalists remain abundant, potentially eroding important ecosystem services.

Birds as Natural Enemies of Crop Pests

Insectivorous birds consume lepidopteran larvae, beetles, orthopterans, and sap sucking insects that are responsible for defoliation, stem boring, or fruit damage in many crops. By removing large numbers of herbivores, especially during the breeding season when energetic demands are high, they can substantially lower pest pressure at critical crop growth stages. In addition to direct mortality, the presence of avian predators can alter pest behavior, causing them to spend more time hiding and less time feeding, which further reduces plant damage.

Granivory, Weed Seed Predation, and Crop Loss

Seed eating birds illustrate the “dual role” theme particularly clearly. Flocks of sparrows, pigeons, and other granivores can remove substantial quantities of sown seed and ripening grains, occasionally causing economically important losses in cereals and pulses, especially where planting is unprotected and birds concentrate along field edges. At the same time, these same species may consume large numbers of weed seeds in stubble fields, fallows, and margins during non-crop periods, thereby helping to regulate weed populations.

The net impact of granivores therefore depends on timing (sowing vs. post-harvest), alternative food availability, and field management. Management strategies such as adjusting sowing dates, using seed treatments or physical coverings, and providing nearby alternative foraging habitats can sometimes shift the balance towards weed seed removal while reducing direct damage to crops.

Seed Dispersal and Vegetation Dynamics

Frugivorous and omnivorous birds that consume fleshy fruits play a central role in seed dispersal within and around agricultural fields. By moving seeds away from parent plants and depositing them at new sites, birds influence the regeneration of hedgerows, woodlots, riparian strips, and shade trees that form the backbone of semi natural habitat in farmed landscapes.

In agroforestry and mixed farming systems, avian dispersal promotes the spread of economically valuable tree and shrub species that provide shade, fuelwood, fodder, timber, or non-timber forest products. These woody elements stabilize soils, buffer microclimates, support pollinators and natural enemies, and thus indirectly sustain agricultural productivity and resilience. However, birds may also spread seeds of invasive or noxious weeds; therefore, the identity of dispersed plant species must be considered when evaluating this service.

Avian Pollination of Crops and Associated Flora

Although insects are the main pollinators for most crops, birds also play an important role in pollinating certain plant species, especially in tropical and subtropical regions. Nectar-feeding birds such as hummingbirds, sunbirds, and honeyeaters transfer pollen while feeding on brightly colored, tubular flowers

adapted to bird visitation. In agricultural landscapes, they support fruit and seed set in some crops, ornamentals, and surrounding wild plants, helping maintain plant diversity. This role becomes particularly important when insect pollinators decline or are less active. Practices like maintaining flowering hedgerows, mixed cropping, and natural vegetation patches can support bird-mediated pollination.

Scavenging, Waste Removal, and Nutrient Cycling

Scavenging birds such as vultures, kites, corvids, and some storks play an important role in agricultural landscapes by removing carcasses and organic waste, thereby reducing disease risk, controlling populations of pests like feral dogs and rats, and lowering waste management costs. Birds also aid in nutrient cycling through the deposition of guano and movement of nutrients across habitats. Species such as waterbirds and large roosting flocks enrich soils with nitrogen- and phosphorus-rich excreta, while regular movements of farmland birds help redistribute nutrients across fields, enhancing soil fertility and overall productivity.

Birds as Indicators and Cultural Assets in Farming Landscapes

Birds are sensitive to changes in land use, pesticide exposure, and habitat simplification, making them valuable bioindicators of agricultural ecosystem health. Declines in farmland bird populations often reflect intensification and loss of biodiversity, helping guide management practices such as habitat restoration, reduced chemical use, and crop diversification. In addition to ecological roles, birds also provide cultural benefits by enriching landscapes, supporting ecotourism, and featuring in local traditions, thereby encouraging public support for conservation-friendly farming practices

Disservices, Conflicts, and Coexistence Strategies

Although birds provide many benefits, they can also create conflicts by damaging high-value crops, especially when present in large flocks. Studies show that birds often increase yields in woody crops through pest control but may reduce production in herbaceous crops when crop consumption exceeds these benefits. Farmers in low-income regions, facing higher risks and fewer mitigation options, tend to view birds more negatively. However, non-lethal methods such as scaring devices, netting, and changes in sowing practices can effectively reduce damage. Modern approaches promote coexistence by combining these techniques with habitat management to support beneficial species while limiting harmful ones, recognizing that the role of birds varies with species, season, and farming practices.

Management for Bird Friendly and Productive Farms

Habitat and Landscape Design

Farms located in heterogeneous landscapes with features like hedgerows, woodlots, riparian vegetation, ponds, and fallows support more diverse and functional bird communities than monocultures. These habitats provide nesting, shelter, and varied food resources, enabling birds to contribute to pest control, seed dispersal, and pollination. Similarly, agroforestry, shade-grown systems, and mixed cropping enhance habitat complexity, increasing bird diversity and improving crop protection and yield stability. Supporting such practices through policies and incentives can benefit both biodiversity conservation and agricultural productivity.

Ecological Intensification and IPM

Ecological intensification aims to increase or sustain yields by amplifying ecological processes rather than by simply adding external inputs. Promoting birds as allies in pest control—for example by installing nest boxes for insectivorous species in orchards and vineyards, conserving insect rich field margins, and reducing lethal control—fits squarely within this paradigm.

Integrated pest management frameworks increasingly recognize birds as part of the natural enemy complex, though formal inclusion in IPM decision making tools is still limited. Future IPM strategies can incorporate simple indicators of bird activity, species specific risk assessments, and guidelines on when to encourage or deter birds, supported by extension services that communicate both services and disservices to farmers.

Conclusion

Birds are integral to agroecosystems, contributing to pest control, seed dispersal, pollination, scavenging, nutrient cycling, and cultural value, while sometimes causing crop damage. The key challenge is to enhance their beneficial roles and reduce conflicts through habitat diversification, non-lethal methods, and integration into IPM and sustainable farming practices. As agriculture intensifies, conserving bird communities becomes essential for maintaining ecosystem services, supporting long-term food security, and promoting environmental sustainability.

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Ecology and Distributional Dynamics of Butterflies in Satara District (MS)

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Abstract

Butterflies are important ecological bioindicators, they play a crucial role in ecosystem functioning through pollination and trophic interactions. This study deals with the distribution of butterflies in Satara district and presents a combination of available literature along with field observations that documents butterfly distribution patterns across varied habitats. The chapter integrates published studies, regional records, and habitat-based surveys to understand the trends in species richness and composition. The analysis shows distributional variations shaped by the ecology of varied habitats.

Keywords: Butterfly Distribution, Satara District, Habitat Heterogeneity.

Introduction

Butterflies (Order: Lepidoptera; Class: Insecta) are most studied insect taxa (Bonebrake et al., 2010) are important components of terrestrial biodiversity. Ecologically, they perform important role in pollination, trophic regulation, and bioindication. Butterflies are considered as sensitive bioindicators of changes in environmental conditions as their abundance, phenology, and distribution responds to climatic changes, habitat, and vegetation (Murphy et al., 1990). As they are host plant specific their sensitivity to ecological disturbances such as deforestation, urbanization, intensified agriculture and pesticide use, increases (Kremen et al., 1993; Mahata et al., 2018). They contribute significantly to

energy transfer within food webs (Hammond & Miller, 1998), these characters make butterflies valuable model organisms for biodiversity monitoring (Kremen et al., 1993). Satara district (MS) is situated between the Western Ghats and the Deccan Plateau producing steep western incline and a gradual slope in the east that creates altitudinal and climatic gradients, forming an ecologically and geologically important transition zone. Orographic interception of southwest monsoon winds along with the Ghats results in high rainfall in western tehsils supporting evergreen, semi-evergreen, and moist deciduous forests, whereas rain-shadow region in the east transitions into dry deciduous forests and thorn-scrub vegetation (Gadgil & Meher-Homji, 1986). The rainfall gradient and habitat variability create diverse ecological niches that influences butterfly diversity and distribution patterns. Three distinct ecological zones are created in the district due to orographic influence of Western Ghats. This difference in altitude and rainfall generates habitat heterogeneity (Champion & Seth, 1968) that shapes the diversity and distribution patterns in butterflies.

Study Area

Satara district is located in western part of Maharashtra between 17°05'–18°11' N and 73°33'–74°54' E, covers area about 10,480 km² (District Census Handbook, 2011; District Gazetteer). The district altitudinal gradient from west to east. Current study is carried out in the three distinct zones of Satara district.

- Zone I (1300–1400 m) including tehsils Mahabaleshwar, Jaoli, Patan, Satara (West, North), Karad (West).
- Zone II (600–700 m) the central region, including tehsils Wai, Satara (East), Karad (North, East).
- Zone III (500–600 m) comprises the eastern plains, including Khatav, Koregaon, Man, Phaltan, and Khandala.

Material and Methods

Butterflies and plants were identified in the field using field guides, keys, and literatures [Evans (1932), Wynter-Blyth (1957), and Varshney and Smetacek (2015), (N.P. Singh 2001)]. Scientific names follow Varshney & Smetacek (2015), Bhakare & Ogale (2018), common English names follow Wynter-Blyth (1957). Survey was conducted using the Pollard Walk method (Pollard, 1977).

Result

Historical Documentation and Baseline Records

A comprehensive study of butterfly diversity across the district is yet to be conducted. Previous studies have documented butterfly diversity in (1) Satara Tehsil 52 species from Nymphalidae, being dominant family highlighting its ecological position in moist and forested habitats (Pawar & Deshpande, 2016);

(2) 153 species of butterflies were recorded from Satara district (Amit Sayyed, 2016); (3) A paddy field (Pesticide free) in Mahadare forest that sustains 13 species of butterflies (Pawar et al., 2024); (4) Mahadare Conservation Reserve documented 184 butterfly species (Sutar et al., 2025), this reserve shows habitat heterogeneity due to transitional forest landscape; (5) 91 Butterfly species were recorded from Koyna Wildlife Sanctuary Maharashtra (ZSI, 2022); (6) 113 species of butterflies have been observed in Khatav tehsil (P.Obs.)

Butterfly populations increase during post-monsoon period (October-January) The seasonal patterns are due to ecological factors (Champion & Seth, 1968).

Distribution of Butterflies

- **Zone I:** This zone contains species such as Bamboo Treebrown, Commander, Club Beak, Dark Evening Brown, Chocolate Albatross, Tree-spot Grass Yellow, Southern Birdwing, Common Mime, Lime, Spot Swordtail, Brown King crow, Double Branded Crow, Common Lascar, Extra Lascar, Colour Sargeant, Grey Count, Black Prince, Southern Blue Oakleaf, Orange Awlet, Orange-tail Awl. And indicator species such as Malabar Banded Peacock, Common Tinsel, Yamfly, Large Oakblue, Lesser Gull, Common Bluebottle.
- **Zone II:** Being transitional zone this area habitats butterflies from both regions. However, Strict indicator species of both zones are restricted to their respective area. This zone contains species such as Malabar Banded Peacock, Spot Swordtail, Red Helen, Southern Birdwing, Malayan, Common Quaker, Orchid Tit, Monkey Puzzle, Common Apefly, Southern Blue Oakleaf, Common Map, Tawny Coster, Commander, Common Sailor, Bamboo Treebrown, Baronet, Rustic, Common Evening Brown, Dark Evening Brown, Common Nawab, Anomalous Nawab, Black Rajah, Blue Tiger, Glassy Tiger, Grass Demon, Banana Skipper, Water Snow Flat, Tri Colour Pied Flat, Brown Awl, Orange Awlet, Orange-tail Awl, Golden Angle, Black Angle, Fulvous Pied Flat, Rice Swift, Bevans Swift, Great Orange Tip, Spotless Grass yellow, due to the presence of the larval food plants in the region.
- **Zone III:** This zone supports the species such as Small Salmon Arab, African Marbled Skipper, Joker, Baronet, which are Indicator species of the dry region. Common Castor, and Angled Castor are abundant in this area. Butterflies such as the Crimson Tip, White Orange Tip, Common Gull, Pioneer, Wanderer, Great Orange Tip, Psyche, Common Grass Yellow, Small Grass Yellow. Common Emigrant and Mottled Emigrant. These species are observed due to presence of plants from family Capparaceae, Poaceae, Fabaceae and Genera Senna, Cassia, Momosa, Albezia,

The Occurrence of These Butterfly Species Across Three Zones

- **Pieridae:** Common Emigrant, Mottled Emigrant, Small grass yellow, Common Grass Yellow, Spotless grass yellow, Psyche, Indian Jezebel, White Orange Tip, Crimson Tip, Pioneer, Common Gull, Common Wanderer, Great Orange Tip, Stripped Albatross, Common Albatross
- **Hesperiidae:** Vindyan Bob, Brown Awl, Common Banded Awl, Common Small Flat, Indian Skipper, Grass demon, Indian Palm Bob, Banana Skipper.
- **Papilionidae:** Common Rose, Crimson Rose, Blue Mormon, Common Mormon, Tailed Jay Common Jay.
- **Nymphalidae:** Plain Tiger, Common Tiger, Glassy Tiger, Blue Tiger, Common Crow, Common Nawab, Black Rajah, Common Bushbrown, Common Evening Brown, Common Treebrown, Common Fourring, Common Threering, Common Fivering, Common Sailor, Common Baron, Gaudy Baron, Angled Castor, Common Castor, Painted Lady, Peacock Pansy, Grey Pansy, Yellow Pansy, Chocolate Pansy, Lemon Pansy, Blue Pansy, Great Eggfly, Danaid Eggfly, Southern Blue Oakleaf, Common Leopard, Tawny Coster.
- **Lycaenidae:** Indian Sunbeam, Common Apefly, Common Acacia Blue, Peacock Royal, Cornelian, Common Guava Blue, Common Red Flash, Slate Flash, Transparent Sixlineblue, Tailless Lineblue, Common Lineblue, Dark Cerulean, Common Cerulean, Peablu, Zebra Blue, Black-spotted Pierrot, Striped Pierrot, Dark Grass Blue, Pale Grass Blue, Tiny Grass Blue, Red Pierrot, Gram Blue.

Conclusion

Butterfly distribution in Satara district is characterized by the biotic and abiotic factors such as Altitude, Rainfall, Host plant availability etc., While, larval host plant specificity remains a primary determinant of species presence, the combined conditions such as presence of nectar plants, microclimatic stability, habitat structure, and landscape connectivity influence species abundance and community composition. Butterfly distribution patterns in Satara district reflect strong ecological pattern between climatic gradients, complex topography, vegetational zonation, and resource specialization.

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An Insight into the Life Cycle of Butterflies: A Case Study of Karjat Tehsil, Ahmednagar District, (MS), India

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Introduction

Butterflies are among the most captivating and ecologically significant insects, representing both beauty and biological precision in nature. Their life cycle, characterized by complete metamorphosis, offers a remarkable example of transformation and adaptation. The present chapter provides a detailed account of the life cycle of butterflies, contextualized through a case study conducted in Karjat tehsil of Ahmednagar district in Maharashtra, India. This semi-arid region, with its mosaic of agricultural lands, scrub forests, grasslands, and seasonal water bodies, provides a unique habitat that supports a diverse assemblage of butterfly species.

Karjat tehsil lies in the rain-shadow zone of the Western Ghats and experiences a tropical semi-arid climate. The region is characterized by moderate rainfall, hot summers, and mild winters. Vegetation primarily consists of dry deciduous elements, interspersed with cultivated crops such as sugarcane, millet, and pulses. This heterogeneity in habitat structure plays a crucial role in supporting butterfly diversity, as different species rely on specific host plants and microhabitats for survival and reproduction.

The butterfly life cycle consists of four distinct stages: egg, larva (caterpillar), pupa (chrysalis), and adult. Each stage is morphologically and functionally distinct, allowing butterflies to exploit different ecological niches during their development.

The life cycle begins with the egg stage. Female butterflies exhibit remarkable selectivity in choosing oviposition sites. In Karjat tehsil, species such as the Common Mormon, Plain Tiger, and Lemon Butterfly are commonly observed laying eggs on host plants like curry leaves, Calotropis, and citrus plants, respectively. Eggs are usually laid on the underside of leaves to protect them from predators and environmental stress. They vary in shape, size, and texture depending on the species, ranging from spherical to elongated forms with intricate surface sculpturing. The incubation period typically lasts from three to

seven days, influenced by temperature and humidity. In the relatively warm climate of Karjat, embryonic development tends to be rapid, ensuring timely progression to the larval stage.

Upon hatching, the larval stage begins, marking a phase of intense feeding and growth. Caterpillars are voracious feeders and primarily consume the leaves of their host plants. This stage is critical for energy accumulation required for metamorphosis. In agricultural landscapes of Karjat, caterpillars often feed on crop plants, sometimes being considered pests. However, their ecological role extends beyond herbivory, as they contribute to nutrient cycling and serve as prey for birds, reptiles, and other insects.



Caterpillars undergo multiple molts, known as instars, during which they shed their exoskeleton to accommodate growth. Morphological adaptations such as cryptic coloration, spines, or chemical defenses are commonly observed. For instance, caterpillars of the Plain Tiger butterfly sequester toxic compounds from their host plant, making them unpalatable to predators. Field observations in Karjat indicate that larval survival is influenced by predation pressure, availability of host plants, and climatic conditions. Heavy rainfall during the monsoon can dislodge larvae, while extreme heat during summer may lead to desiccation.

Following the larval stage, the butterfly enters the pupal stage, also known as the chrysalis. This is a transitional phase during which the caterpillar undergoes

profound physiological and morphological changes. The pupa is typically immobile and often camouflaged to blend with the surroundings, reducing the risk of predation. In Karjat tehsil, pupae are commonly found attached to plant stems, leaves, or even man-made structures such as walls and fences.

Inside the chrysalis, a process known as histolysis and histogenesis takes place. Larval tissues break down and reorganize to form adult structures such as wings, antennae, and reproductive organs. This stage may last from one to two weeks, depending on environmental conditions. In cooler months, pupal duration may be slightly extended. The transformation occurring within the chrysalis is one of the most fascinating phenomena in biology, symbolizing renewal and adaptation.

The final stage of the life cycle is the adult butterfly. Upon emergence, the butterfly expands and dries its wings before taking its first flight. Adult butterflies are primarily involved in reproduction and dispersal. They feed on nectar, which provides the energy required for flight and mating activities. In the Karjat region, flowering plants such as lantana, cosmos, and sunflower serve as important nectar sources.

Adult butterflies exhibit a range of behaviors including territoriality, courtship, and migration. Males often establish territories and engage in aerial displays to attract females. Courtship involves visual and chemical cues, culminating in mating. After fertilization, females seek suitable host plants to lay eggs, thus completing the life cycle.

Seasonal variations significantly influence butterfly populations in Karjat tehsil. The monsoon season, with its abundance of vegetation, supports high larval and adult populations. Post-monsoon months are particularly rich in butterfly diversity due to the availability of nectar sources and favorable climatic conditions. Conversely, the harsh summer months may lead to reduced activity and population decline. Some species adopt survival strategies such as diapause or migration to cope with adverse conditions.

Human activities also play a crucial role in shaping butterfly habitats. Agricultural practices, use of pesticides, urbanization, and deforestation can negatively impact butterfly populations by reducing host plant availability and increasing mortality rates. However, the presence of home gardens, roadside vegetation, and conservation efforts can provide refuge and support biodiversity. In Karjat, traditional farming practices and the cultivation of diverse crops contribute to maintaining ecological balance and supporting butterfly life cycles. The study of butterfly life cycles in Karjat tehsil highlights the intricate relationship between organisms and their environment. Butterflies serve as important bioindicators, reflecting the health of ecosystems. Their sensitivity to environmental changes makes them valuable in monitoring biodiversity and assessing the impact of anthropogenic activities.

Conclusion

In conclusion, the life cycle of butterflies is a complex and finely tuned process that exemplifies the adaptability and resilience of living organisms. The case study of Karjat tehsil underscores the importance of habitat diversity, climatic factors, and ecological interactions in shaping butterfly populations. Conservation of natural habitats, promotion of sustainable agricultural practices, and awareness about the ecological significance of butterflies are essential for ensuring their continued survival. Through understanding and appreciating their life cycle, we gain deeper insight into the delicate balance of nature and the need to preserve it for future generations.

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Smart Apiary: Leveraging Effective Technology for Beekeeping

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Introduction

Beekeeping, or apiculture, has been practiced for centuries as an essential part of agriculture and environmental sustainability. Honeybees play a vital role not only in honey production but also in pollination, which directly supports food security and biodiversity. Traditionally, beekeeping depended on the beekeeper's experience, observation, and seasonal knowledge. However, with the advancement of science and technology, modern beekeeping has evolved into a more precise and efficient system known as the smart apiary.

A smart apiary represents the integration of advanced technologies such as sensors, automation, and data analysis into conventional beekeeping practices. It allows beekeepers to monitor and manage their hives with greater accuracy and less physical effort. Instead of frequent manual inspections, which can disturb the bees and consume time, smart systems provide real-time information about hive conditions. This transformation has introduced the concept of precision beekeeping, where decisions are guided by data rather than assumptions.

At the core of a smart apiary are sensor-equipped beehives that continuously collect information about internal and external conditions. These sensors measure parameters such as temperature, humidity, hive weight, and bee activity. Temperature and humidity are critical for brood development, while hive weight gives an estimate of honey production and nectar flow. In addition, some systems include microphones that analyze sound patterns inside the hive, which can indicate the health and behavior of the colony. All this data is transmitted through communication devices to a centralized system, where it is stored and analyzed.

One of the most significant technological contributions to smart apiaries is the Internet of Things (IoT). IoT enables different devices within the hive to communicate with each other and with external platforms. Through wireless connectivity, the collected data is sent to cloud-based systems, allowing beekeepers to access information remotely using smartphones or computers. This

remote monitoring capability is particularly useful for large-scale or migratory beekeeping, where managing multiple apiaries manually can be challenging.

Another important component is artificial intelligence and machine learning, which enhance the value of collected data. These technologies analyze patterns and detect abnormalities that may not be visible through simple observation. For example, changes in temperature or unusual sound patterns can indicate disease, pest infestation, or queen loss. Early detection allows timely intervention, preventing colony collapse and improving survival rates. Predictive analysis can also help in forecasting honey production and identifying optimal harvesting times.

Cloud computing plays a crucial role in managing the vast amount of data generated by smart apiaries. It provides a platform for storing, processing, and visualizing information in an organized manner. Beekeepers can view dashboards that present real-time updates and historical trends, helping them make informed decisions. The ability to monitor multiple hives from a single interface significantly improves efficiency and reduces the need for physical inspections.

In addition to monitoring, smart apiaries often incorporate GPS and geolocation technologies. These features are particularly beneficial in migratory beekeeping, where hives are moved to different locations for better pollination opportunities. GPS tracking ensures the safety of hives and helps in studying environmental factors affecting bee activity. Furthermore, many smart systems are powered by renewable energy sources such as solar panels, making them suitable for remote areas with limited access to electricity.

The functionality of a smart apiary extends beyond simple monitoring. It enables real-time tracking of hive conditions, allowing immediate response to any changes. Disease detection is one of the most valuable aspects, as early identification can save entire colonies. Activity monitoring helps assess the strength and productivity of the colony, while weight measurements guide honey harvesting decisions. Remote management allows beekeepers to focus only on hives that require attention, saving both time and labor.

The adoption of smart apiary systems offers several advantages. It improves bee health by maintaining optimal conditions and enabling early intervention in case of disease or stress. Productivity increases as beekeepers can optimize honey production and pollination efficiency. Labor costs are reduced due to fewer manual inspections, and time is saved by prioritizing necessary actions. Additionally, smart beekeeping promotes sustainability by minimizing unnecessary disturbances and reducing the use of chemicals.

Despite these benefits, there are certain challenges associated with the implementation of smart apiaries. The initial cost of installing sensors and communication systems can be high, which may discourage small-scale beekeepers. Technical complexity is another barrier, as

users need basic knowledge of digital tools and data interpretation. Connectivity issues in remote areas can affect real-time data transmission, limiting the effectiveness of these systems. Moreover, the reliability of smart apiaries depends on the quality of equipment and proper maintenance.

Smart apiaries have found applications in various fields, including commercial honey production, research, and environmental monitoring. Researchers use these systems to study bee behavior, colony dynamics, and the impact of environmental changes. Farmers benefit from improved pollination services, which enhance crop yields. On a larger scale, smart beekeeping contributes to addressing global concerns such as declining bee populations and ecosystem imbalance.

Looking ahead, the future of smart apiaries is promising. Emerging technologies such as drones and advanced analytics are expected to further enhance monitoring and management capabilities. Drones can be used to survey apiary locations and assess environmental conditions, while improved artificial intelligence models will provide more accurate predictions. Efforts are also being made to develop low-cost solutions, making smart beekeeping accessible to a wider range of users. The integration of big data from multiple apiaries will offer deeper insights into global bee health and environmental trends.

Conclusion

In conclusion, the smart apiary represents a significant advancement in the field of beekeeping. By combining traditional knowledge with modern technology, it offers a more efficient, sustainable, and precise approach to managing bee colonies. Although challenges remain, continuous innovation is making these systems more practical and affordable. The adoption of smart apiary technology not only benefits beekeepers but also supports environmental conservation and global food security. As technology continues to evolve, smart beekeeping will play an increasingly important role in ensuring the health and productivity of honeybee populations.

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Biology, Phylogeny and Morphology of Odonata

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Introduction

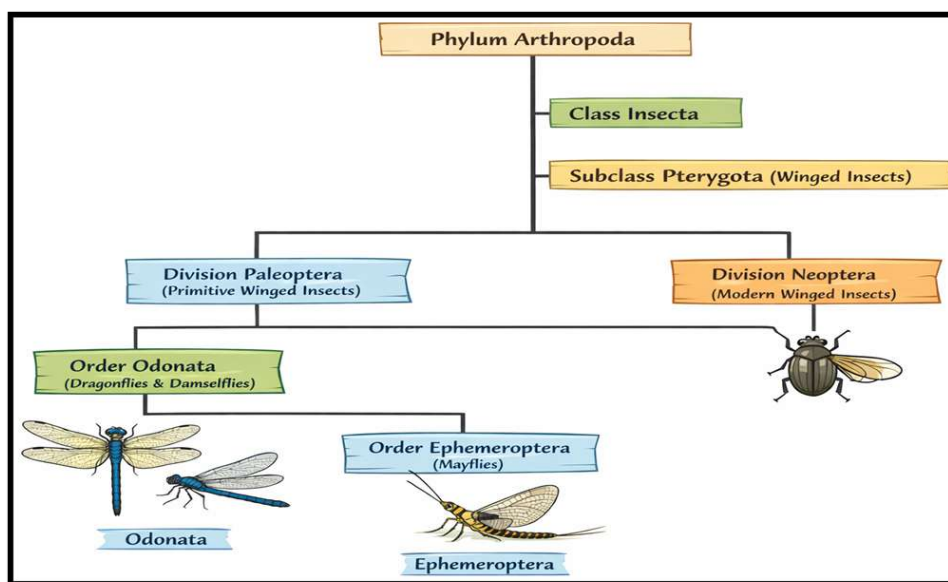
The order Odonata represents one of the most ancient, evolutionarily significant, and ecologically important groups of insects, comprising dragonflies and damselflies. These insects are widely recognized for their remarkable aerial agility, efficient predatory behavior, and close association with freshwater ecosystems. Odonates have existed for more than 300 million years, making them invaluable for understanding the origin and evolution of winged insects. The term “Odonata” is derived from the Greek word *odous*, meaning “tooth,” which refers to their strong mandibles adapted for biting and chewing. Members of this order are predominantly found near freshwater habitats such as ponds, lakes, rivers, and wetlands, as their life cycle is closely linked with aquatic environments. The dual existence of aquatic larvae and terrestrial adults reflects a unique evolutionary strategy that has contributed significantly to their long-term survival.

Phylogeny and Evolutionary History

Odonata belongs to the phylum Arthropoda and class Insecta, and within insects, it is placed under the subclass Pterygota, which includes winged insects. It is grouped in the division Paleoptera along with Ephemeroptera (mayflies), forming one of the most primitive lineages of winged insects. Paleopteran insects are characterized by their inability to fold their wings over the abdomen, a feature that distinguishes them from the more advanced Neopteran insects. This primitive condition provides important insights into early stages of insect flight evolution.

The evolutionary history of Odonata dates back to the late Carboniferous period, approximately 300 million years ago. Fossil evidence suggests that early odonate-like insects were among the first to develop powered flight. These ancestral forms belonged to an extinct group known as Protodonata or Meganisoptera. One of the most remarkable representatives of this group is

Meganeura, a giant dragonfly-like insect with a wingspan reaching up to 70 centimeters. The existence of such enormous insects is attributed to the high atmospheric oxygen levels during the Carboniferous period, which allowed efficient respiration through the tracheal system and supported larger body sizes. These ancient forms were dominant aerial predators and possessed advanced wing venation and flight capabilities, indicating that insect flight had already reached a high level of efficiency.



Over millions of years, Odonata underwent significant diversification, leading to the emergence of modern dragonflies and damselflies. Evolutionary success in this group can be attributed to several factors, including efficient flight mechanisms, highly developed visual systems, and specialized adaptations in the aquatic larval stage. Modern phylogenetic studies, including both morphological and molecular analyses, support the idea that Odonata is a monophyletic group, meaning all its members share a common ancestor. However, some studies suggest that the suborder Zygoptera may be paraphyletic, indicating the complexity of evolutionary relationships within the group.

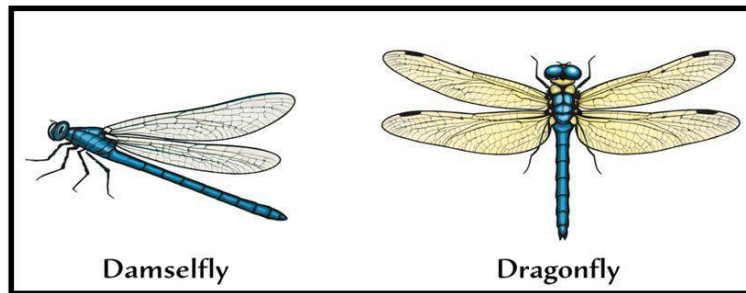
General Biology and Classification

Odonates are characterized by a body divided into three main regions: head, thorax, and abdomen. They possess two pairs of membranous wings supported by a network of veins, which provide strength and flexibility during flight. The head is dominated by large compound eyes that occupy most of its surface, providing nearly 360-degree vision. Their antennae are short and inconspicuous, while their mouthparts are of the chewing type, adapted for predation. Both larval and adult stages are carnivorous, feeding on a variety of small insects and other

invertebrates.

The order Odonata is primarily divided into two major suborders, Zygoptera and Anisoptera, with a third intermediate group sometimes recognized as Anisozygoptera. Zygoptera, commonly known as damselflies, are characterized by their slender bodies, delicate appearance, and relatively weak flight. Their wings are similar in size and shape and are held vertically above the abdomen when at rest. In contrast, Anisoptera, or dragonflies, are robust insects with strong and rapid flight capabilities. Their hindwings are broader than the forewings, and they typically hold their wings horizontally when at rest. Their large compound eyes often meet at the top of the head, enhancing their visual capabilities. The intermediate group, represented by genera such as *Epiophlebia*, exhibits characteristics of both suborders and is considered a living relic of evolutionary transition.

Morphology and Anatomy



Odonate morphology reflects strong adaptation to an active predatory lifestyle. The head is highly mobile with large compound eyes that provide excellent vision for detecting prey. The thorax is specialized for flight, with enlarged and tilted mesothorax and metathorax that enable powerful and efficient wing movement. Their transparent wings are supported by a network of veins and include a distinctive pterostigma that helps stabilize flight, while the long, slender abdomen (with ten segments) supports functions like reproduction and respiration. Internally, odonates have a well-developed digestive system suited for carnivory, and their respiratory system varies by life stage—adults use a tracheal system, while larvae possess gills (external in damselflies and rectal in dragonflies, aiding both respiration and movement). A well-developed nervous system ensures quick coordination and response.

Life Cycle and Development

Odonates exhibit hemimetabolous development, meaning they undergo incomplete metamorphosis. Their life cycle consists of three stages: egg, nymph (naiad), and adult. Eggs are typically laid in or near water, ensuring that the emerging larvae have immediate access to an aquatic environment. The nymphal

stage is entirely aquatic and highly predatory. A unique feature of the nymph is the presence of a specialized prehensile labium, which acts like an extendable arm to capture prey with remarkable speed and precision.

The duration of the nymphal stage varies widely, ranging from a few months to several years depending on species and environmental conditions. After completing development, the nymph emerges from the water and undergoes metamorphosis into the adult form. The transition from aquatic larva to aerial adult represents a significant ecological shift and is one of the key factors contributing to the success of odonates.

Behavior, Ecology and Adaptations

Odonates are highly active predators throughout their life cycle. Adult dragonflies are capable of powerful flight, including hovering, gliding, and long-distance migration, while damselflies exhibit more delicate and fluttering flight. Their predatory efficiency is enhanced by their exceptional vision, strong mandibles, and agile flight.

Reproduction in odonates involves a unique mating behavior known as the “wheel position,” in which the male and female form a circular structure during copulation. This behavior is distinctive and plays an important role in successful fertilization.

Adaptations in odonates are diverse and highly specialized. Their wings and flight muscles allow precise aerial maneuvering, while their large compound eyes provide excellent vision. Larval adaptations, including gills and the prehensile labium, enable efficient predation in aquatic environments. Camouflage and body coloration help them avoid predators and blend into their surroundings.

Ecological and Economic Importance

Odonates play a crucial role in maintaining ecological balance. As predators, they help control populations of mosquitoes and other insects, making them beneficial to humans. They are also important components of food chains, serving as prey for birds, fish, and other animals. Odonates are generally harmless to humans and do not pose any significant threat.

One of the most significant roles of odonates is their function as bioindicators. Because their life cycle depends on clean freshwater habitats, their presence indicates good environmental quality. Conversely, a decline in odonate populations often signals pollution, habitat degradation, or ecological imbalance.

Evolutionary Trends and Significance

The evolutionary trends observed in Odonata include the development of strong, membranous wings with complex venation, the evolution of direct flight muscles, and the enlargement of compound eyes for enhanced vision. Odonata holds a special place in evolutionary biology as it represents an early stage in the

evolution of insect flight. It also demonstrates the transition from primitive to more advanced structural and functional adaptations. As such, odonates serve as a model group for studying flight mechanics, predator-prey interactions, and life cycle adaptations across different environments.

Conclusion

In conclusion, the order Odonata represents a remarkable group of insects with ancient origins and highly specialized adaptations. From prehistoric ancestors to modern dragonflies and damselflies, they have adapted successfully to environmental changes over time. Their unique life cycle, efficient predatory nature, and ecological importance make them vital to freshwater ecosystems. Additionally, their role as bioindicators underscores the need to conserve aquatic habitats, highlighting both their evolutionary significance and importance in environmental conservation.

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Effect of Polluted Water on Molluscan Diversity in Ahilyanagar District, (MS), India

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Introduction

Water is the foundation of life, shaping ecosystems and sustaining biodiversity across the globe. In the semi-arid landscapes of Ahilyanagar District, water bodies such as rivers, ponds, percolation tanks, and reservoirs form ecological lifelines. These freshwater habitats harbor a diverse array of organisms, among which molluscs occupy a unique and indispensable position.

Molluscs, including freshwater snails and bivalves, are often overlooked due to their small size and slow movement. Yet, they silently perform essential ecological roles—filtering water, recycling nutrients, and maintaining the balance of aquatic ecosystems. Their presence indicates ecological health, while their decline signals environmental distress. In recent decades, increasing water pollution in Ahilyanagar district has begun to alter these delicate ecosystems, leaving a visible imprint on molluscan diversity.

This chapter presents a descriptive account of how polluted water influences molluscan communities, drawing connections between environmental degradation and biological response.

Freshwater Molluscs: Silent Engineers of Aquatic Ecosystems

In the still waters of village ponds or the gentle flow of seasonal streams, molluscs thrive as integral components of aquatic life. Gastropods such as *Pila globosa* and *Lymnaea luteola* glide slowly over submerged surfaces, grazing on algae and organic debris. Bivalves, buried within sediments, filter large volumes of water, removing suspended particles and improving clarity. These organisms act as natural purifiers. A single bivalve can filter liters of water daily, trapping microorganisms and organic matter. Over time, this filtering activity contributes to the self-cleaning capacity of freshwater systems. Molluscs also serve as food for fish, birds, and amphibians, forming an important link in the aquatic food web. However, their dependence on clean, oxygen-rich water makes them highly

vulnerable to pollution. Even subtle changes in water chemistry can influence their survival, growth, and reproduction.

Changing Landscape of Water Bodies in Ahilyanagar

Traditionally, water bodies in Ahilyanagar district were sustained by monsoon rains and supported by local conservation practices. However, rapid agricultural expansion, population growth, and industrial development have altered this balance. In rural areas, agricultural runoff carries fertilizers and pesticides into nearby ponds and streams. During the rainy season, these chemicals wash into water bodies, increasing nutrient levels and introducing toxic substances. In semi-urban zones, untreated sewage and domestic waste enter aquatic systems, raising organic load and microbial contamination. In regions such as Karjat, groundwater often exhibits high Total Dissolved Solids (TDS), making the water chemically stressful for aquatic organisms. Over time, these factors collectively degrade water quality, transforming once-healthy ecosystems into polluted habitats.

Pollution and Its Direct Impact on Molluscs

The effect of polluted water on molluscs is both immediate and cumulative. When pollutants enter aquatic systems, molluscs are among the first organisms to be affected. Heavy metals such as lead, mercury, and cadmium can accumulate in molluscan tissues. These toxic substances interfere with physiological processes, damaging organs and impairing metabolic functions. In severe cases, they lead to mortality. Even when not immediately lethal, prolonged exposure weakens the organisms, reducing their ability to survive environmental stress. Pesticides and chemical residues further exacerbate the problem. These compounds disrupt enzyme activity and interfere with reproduction. Eggs may fail to develop properly, and larval stages become highly vulnerable. Over time, this results in declining populations.

Another emerging concern is microplastic pollution. Tiny plastic particles, often invisible to the naked eye, are ingested by filter-feeding bivalves. These particles accumulate within tissues, causing physical and chemical stress. Molluscs thus become carriers of pollutants, transferring them up the food chain. Polluted water severely affects the biological systems of molluscs, disrupting their survival and ecological functions. One of the primary impacts is on the respiratory system, where reduced dissolved oxygen and suspended particles clog gills, leading to suffocation. The digestive system is also affected, as molluscs ingest pollutants such as heavy metals, pesticides, and microplastics, which damage digestive glands and reduce nutrient absorption.

Toxic substances enter the circulatory system, spreading through the body and causing systemic damage. The nervous system is impaired by chemical pollutants, resulting in altered behavior, slow movement, and reduced response to

stimuli. Pollution also disrupts the reproductive system, leading to decreased fertility, abnormal larval development, and population decline. Shell formation is particularly sensitive; acidic water and heavy metals weaken calcium deposition, producing thin or deformed shells. The excretory system becomes inefficient as toxins accumulate faster than they can be removed, leading to internal poisoning. At the cellular level, pollutants cause oxidative stress, enzyme inhibition, and DNA damage. Altogether, these effects reduce growth, survival, and biodiversity, making molluscs highly vulnerable indicators of aquatic pollution.

Alteration of Habitat and Living Conditions

Pollution not only introduces toxic substances but also transforms the physical and chemical environment of water bodies. One of the most critical changes is the reduction of dissolved oxygen. Organic waste from sewage increases microbial activity, which consumes oxygen during decomposition. As oxygen levels decline, molluscs struggle to respire. Species that require well-oxygenated water disappear, leaving behind only a few tolerant forms. Sedimentation is another major consequence. Soil erosion and runoff deposit fine particles into water bodies, covering the natural substrate. For bivalves that live buried in sediments, this can be disastrous. Excessive silt clogs their feeding structures and restricts movement, leading to suffocation. Changes in pH and temperature further stress molluscan communities. Acidic or highly alkaline conditions affect shell formation, as calcium carbonate deposition becomes difficult. Temperature fluctuations alter metabolic rates, influencing growth and reproduction cycles.

Decline in Molluscan Diversity

As pollution intensifies, a noticeable shift occurs in species composition. Sensitive species gradually disappear, unable to tolerate degraded conditions. In their place, a few hardy species dominate, often those capable of surviving in low oxygen and high pollution levels. This reduction in diversity is not merely a loss of species—it represents a breakdown of ecological balance. Each molluscan species occupies a specific niche, contributing uniquely to ecosystem functioning.

Molluscs as Indicators of Environmental Health

One of the most significant aspects of molluscs is their role as bioindicators. Because they are sensitive to environmental changes and accumulate pollutants, their presence or absence provides valuable information about water quality. In Ahilyanagar district, declining molluscan populations can serve as an early warning signal. A reduction in species diversity, abnormal shell growth, or changes in population density may indicate rising pollution levels. Monitoring these organisms can therefore help in assessing ecological health and guiding

conservation efforts.

Ecological Consequences of Declining Molluscan Populations

The loss of molluscan diversity has far-reaching consequences. As natural filter feeders decline, water quality deteriorates further. Suspended particles and organic matter accumulate, reducing clarity and promoting algal blooms. The disruption of food chains is another critical outcome. Fish and birds that depend on molluscs as a food source face nutritional stress. This can lead to cascading effects across the ecosystem, affecting multiple trophic levels. Furthermore, reduced nutrient recycling slows down ecological processes. Organic matter accumulates, and the natural balance of the ecosystem is disturbed. Over time, the water body may shift from a balanced system to a degraded, less productive one.

Conclusion

The freshwater ecosystems of Ahilyanagar district are undergoing significant transformation under the pressure of pollution. Molluscs, as sensitive and ecologically important organisms, reflect these changes vividly. Their declining diversity is a clear indication of environmental degradation. Protecting molluscan diversity is not just about conserving a group of organisms—it is about preserving the health and sustainability of entire aquatic ecosystems. Through effective management, community participation, and scientific intervention, it is possible to restore balance and ensure that these silent engineers continue to thrive in the waters of Ahilyanagar.

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Evaluation of Pesticide Induced Stress Responses in Economically Important Fish, *Oreochromis niloticus*

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Introduction

Aquatic ecosystems across the globe are increasingly subjected to contamination from anthropogenic activities, among which pesticide pollution has emerged as one of the most pervasive and hazardous threats. Pesticides, widely applied in agriculture to control pests and enhance crop productivity, often find their way into nearby water bodies through runoff, leaching, spray drift, and improper disposal practices. Once introduced into aquatic environments, these chemicals can persist for prolonged periods, exerting toxic effects on non-target organisms, particularly fish.

Fish occupy a crucial position in aquatic food chains and serve as reliable bioindicators of environmental health due to their sensitivity to chemical stressors. Among the various fish species used in ecotoxicological research, *Oreochromis niloticus*, commonly known as Nile tilapia, holds significant importance. This species is widely distributed, economically valuable, and highly adaptable to diverse environmental conditions. Its physiological and biochemical responses to toxicants make it an ideal model organism for studying the effects of pesticide-induced stress.

Pesticide Contamination in Aquatic Systems

The extensive use of pesticides in modern agriculture has led to their ubiquitous presence in aquatic ecosystems. These compounds include organophosphates, carbamates, organochlorines, pyrethroids, and neonicotinoids, each differing in chemical structure, persistence, and toxicity. Organophosphates such as chlorpyrifos are known for their neurotoxic effects, while organochlorines are persistent in the environment and tend to bioaccumulate in aquatic organisms.

When pesticides enter aquatic systems, they undergo processes such as adsorption, degradation, and bioaccumulation. However, many pesticides resist rapid degradation and accumulate in sediments and biological tissues. Fish

absorb these toxicants through their gills, skin, and digestive tract, leading to internal exposure even at low environmental concentrations. Chronic exposure to sublethal levels of pesticides often results in significant physiological disturbances, which may not be immediately visible but can impair survival, growth, and reproduction.

Biological and Economic Significance of *Oreochromis niloticus*

Oreochromis niloticus is one of the most extensively cultured freshwater fish species worldwide. Its popularity in aquaculture stems from its rapid growth rate, efficient feed utilization, resistance to diseases, and ability to tolerate a wide range of environmental conditions, including variations in temperature, salinity, and dissolved oxygen levels. In many developing countries, including India, Nile tilapia plays a vital role in ensuring food security and providing livelihood opportunities.

From a scientific perspective, *O. niloticus* is frequently employed in toxicological studies due to its well-characterized physiology and sensitivity to environmental pollutants. Its responses to toxic stressors can be easily monitored through changes in behavior, blood parameters, enzyme activities, and tissue structure. Consequently, it serves as an excellent model for assessing the impact of pesticide contamination on aquatic organisms.

Mechanisms of Pesticide-Induced Toxicity

Pesticides exert their toxic effects through multiple mechanisms, often acting simultaneously to disrupt normal physiological processes in fish. One of the primary mechanisms involves the induction of oxidative stress, which arises from an imbalance between the production of reactive oxygen species (ROS) and the organism's ability to neutralize them. Excessive ROS generation leads to damage of cellular components, including lipids, proteins, and DNA.

Another important mechanism is neurotoxicity, particularly associated with organophosphate and carbamate pesticides. These compounds inhibit the activity of acetylcholinesterase, an enzyme essential for nerve impulse transmission. As a result, fish exhibit abnormal behavioral patterns such as erratic swimming, hyperactivity, and loss of equilibrium.

Pesticides also act as endocrine disruptors by interfering with hormonal signaling pathways. This disruption can adversely affect growth, reproduction, and metabolic processes. Additionally, immunotoxic effects have been observed, where pesticide exposure weakens the immune system, making fish more susceptible to infections and diseases.

Stress Responses in *Oreochromis niloticus*

Exposure to pesticides triggers a cascade of stress responses in *O. niloticus*, which can be broadly categorized into behavioral, physiological, hematological,

and biochemical changes. Behavioral responses are often the earliest indicators of toxic stress. Fish exposed to pesticides may exhibit erratic swimming patterns, reduced feeding activity, increased surfacing behavior, and loss of balance. These changes reflect disturbances in the nervous system and energy metabolism.

Physiological responses include alterations in respiration rate, oxygen consumption, and metabolic activity. Under pesticide stress, fish often experience increased energy demand to maintain homeostasis, leading to elevated respiration and metabolic rates. One of the most common physiological responses is hyperglycemia, which results from the mobilization of energy reserves to cope with stress.

Hematological changes are also prominent and serve as important indicators of internal physiological disturbances. Alterations in red blood cell count, hemoglobin concentration, and white blood cell count are frequently observed. An increase in white blood cells may indicate an immune response, while changes in red blood cells and hemoglobin levels can affect oxygen transport.

Biochemical responses involve changes in enzyme activities, protein metabolism, and lipid profiles. Elevated levels of stress hormones such as cortisol and increased blood glucose concentrations are commonly reported in pesticide-exposed fish. Liver enzymes, which play a crucial role in detoxification, often show altered activity, reflecting hepatic stress and damage.

Oxidative Stress and Antioxidant Defense

Oxidative stress plays a central role in pesticide-induced toxicity in *O. niloticus*. The excessive production of reactive oxygen species overwhelms the antioxidant defense system, leading to cellular damage. Lipid peroxidation is one of the most significant consequences of oxidative stress, resulting in the degradation of cell membranes and the formation of malondialdehyde (MDA), a widely used biomarker of oxidative damage.

To counteract oxidative stress, fish possess a complex antioxidant defense system comprising enzymatic and non-enzymatic components. Enzymatic antioxidants include superoxide dismutase, catalase, and glutathione peroxidase, which work in coordination to neutralize reactive oxygen species. Non-enzymatic antioxidants such as reduced glutathione, vitamin C, and vitamin E also play a vital role in maintaining cellular redox balance.

However, pesticide exposure often impairs these mechanisms by reducing enzyme activity and depleting antioxidant molecules. This imbalance results in increased oxidative damage to cellular components, ultimately affecting tissue function and organismal health.

Histopathological Alterations

Histopathological examination provides valuable insights into the structural damage caused by pesticide exposure. In *O. niloticus*, significant alterations have been observed in vital organs such as the gills, liver, and kidneys.

The gills, being the primary site of respiration and direct contact with waterborne pollutants, are particularly vulnerable. Pesticide exposure can cause lamellar fusion, epithelial lifting, and necrosis, which impair gas exchange and lead to respiratory distress.

The liver, as the main organ involved in detoxification, shows pronounced pathological changes, including hepatocellular degeneration, vacuolization, and necrosis. These alterations reflect impaired metabolic and detoxification functions.

The kidneys, responsible for excretion and osmoregulation, also exhibit structural damage such as tubular degeneration and glomerular shrinkage. Such changes can disrupt ionic balance and waste elimination.

Molecular and Cellular Responses

At the molecular level, pesticide exposure induces significant changes in gene expression and cellular processes. One of the major effects is DNA damage, which may manifest as strand breaks, chromosomal aberrations, and mutations. Such damage can have long-term consequences, including impaired cell function and increased risk of carcinogenesis.

Pesticides also influence the expression of stress-related genes, including those encoding heat shock proteins and antioxidant enzymes. These proteins play a crucial role in protecting cells against stress-induced damage. Additionally, oxidative stress can trigger apoptosis, or programmed cell death, which contributes to tissue degeneration.

Biomarkers of Pesticide Stress

Biomarkers are essential tools for assessing the impact of pesticide exposure on fish. In *O. niloticus*, a wide range of biomarkers has been identified, including biochemical indicators such as glucose and cortisol levels, oxidative stress markers such as MDA and antioxidant enzyme activities, and histological changes in tissues.

The use of multiple biomarkers provides a comprehensive understanding of the physiological status of fish and enables early detection of environmental stress. Biomarker-based monitoring is particularly useful in aquaculture and environmental management.

Mitigation Strategies

Addressing pesticide pollution requires a multifaceted approach. Sustainable agricultural practices, such as integrated pest management, can reduce reliance on

chemical pesticides. Regular monitoring of water quality using biomarkers can help detect contamination at an early stage.

The use of dietary supplements, particularly antioxidants like vitamin C, has shown promise in mitigating oxidative stress in fish. Additionally, strict regulations and policies are needed to control pesticide usage and prevent environmental contamination.

Conclusion

Pesticide-induced stress responses in *Oreochromis niloticus* represent a complex interplay of physiological, biochemical, and molecular processes. Among these, oxidative stress emerges as a central mechanism driving toxicity. The evaluation of various biomarkers provides valuable insights into the health status of fish and the extent of environmental pollution.

Understanding these responses is essential for developing effective strategies to mitigate the adverse effects of pesticides and ensure the sustainability of aquatic ecosystems and aquaculture practices. Continued research in this field will enhance our ability to protect economically important fish species and maintain ecological balance.

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Physiological and Ecological Impacts of Microplastics on Animalia

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Introduction

The Entry Points of Plastic into Biological Systems

The presence of microplastics (MPs) in animal tissues is a global biological reality. Animals encounter these synthetic particles through three primary pathways: ingestion, inhalation, and skin absorption. Ingestion is the most significant route, occurring either directly—when an animal mistakes plastic for prey—or indirectly through "trophic transfer," where a predator consumes prey that has already accumulated plastic. For many species, the sensory cues that once guided successful foraging are now being subverted. For example, some seabirds are attracted to the scent of dimethyl sulfide (DMS) produced by algae growing on floating plastic, leading them to consume toxic debris under the biological "illusion" of a high-quality meal.

Gastric Obstruction and Nutritive Dilution

Once ingested, the physical presence of microplastics creates immediate mechanical challenges within the animal's digestive system. In smaller animals, such as soil-dwelling earthworms (*Lumbricus terrestris*) or marine copepods, microfibers can cause physical blockages in the gut, leading to inflammation and reduced nutrient absorption. In larger vertebrates, such as sea turtles and cetaceans, the accumulation of micro- and macro-plastics leads to "nutritive dilution." This occurs when the stomach remains distended with non-digestible material, suppressing the animal's hunger drive. Consequently, the animal may die of starvation despite having a full stomach. This chronic lack of energy intake translates to reduced metabolic rates, affecting the animal's ability to migrate, escape predators, or maintain body temperature.

Cellular Translocation and Systemic Spread

One of the most concerning aspects of microplastic pollution in zoology is the ability of "nanoplastics" (particles smaller than 1 micrometer) to translocate across epithelial barriers. Research has shown that these ultra-fine particles can pass through the gut wall and enter the circulatory or lymphatic systems. Once in the bloodstream, they can be deposited in vital organs, including the liver, kidneys, and even the brain. In certain fish species, the presence of plastic particles in brain tissue has been linked to behavioral changes, such as altered activity levels and impaired social cohesion. The ability of synthetic polymers to breach the blood-brain barrier represents a profound shift in how we understand the "internalized" environment of modern wildlife.

The Chemical Burden: Additives and Adsorbed Toxins

Microplastics act as a "chemical cocktail" for the animals that harbor them. During the manufacturing process, various chemicals are added to plastics to provide specific properties; these include:

- **Phthalates:** Used as plasticizers, which act as endocrine disruptors.
- **Bisphenol A (BPA):** Known to interfere with hormonal signaling and reproductive health.
- **Heavy Metals:** Often used as pigments or stabilizers (e.g., lead, cadmium).

Furthermore, the hydrophobic surface of microplastics acts as a magnet for persistent organic pollutants (POPs) present in the environment. When an animal ingests these particles, the change in pH and temperature within the digestive tract can cause these chemicals to "leach" out and bioaccumulate in the animal's fatty tissues, leading to long-term reproductive failure and immune suppression.

Reproductive and Developmental Impairment

The sub-lethal effects of microplastics are perhaps most evident in the reproductive success of animal populations. Studies on oysters and other bivalves have demonstrated that exposure to polystyrene micropheres results in significantly lower sperm motility and a decrease in oocyte (egg) size. In terrestrial environments, soil contaminated with microplastics has been shown to reduce the growth rate and reproductive output of various insect species. Because these impacts often occur at the larval or embryonic stages, they can lead to "silent" population declines—where the number of adult individuals remains stable for a time, but the lack of viable offspring eventually leads to a sudden demographic collapse.

Trophic Magnification and the Human Connection

The movement of microplastics through the food web follows a pattern of "biomagnification," particularly regarding the associated chemical toxins. As small invertebrates are eaten by small fish, which are in turn eaten by larger

predators, the concentration of plastic-associated pollutants increases. This has significant implications for apex predators, including sharks, seals, and eagles, who sit at the top of these contaminated chains. For humans, the consumption of seafood, particularly whole organisms like shellfish or small dried fish, represents a direct pathway for microplastic ingestion.

Bacteria that Break Down Microplastics

While microplastics pose a massive environmental challenge, nature is beginning to fight back through the process of microbial evolution. Several species of bacteria have developed the unique ability to metabolize synthetic polymers, effectively using plastic as a primary carbon source for their energy and growth. A landmark discovery in this field is *Ideonella sakaiensis*, a bacterium found near a recycling facility in Japan that produces specialized enzymes known as PETase and MHETase. These enzymes work in tandem to break down Polyethylene Terephthalate (PET)—the plastic commonly used in water bottles—into its basic environmental building blocks.

Beyond this specific species, certain strains of *Pseudomonas* and *Rhodococcus* have also shown significant promise in degrading other stubborn plastics like polyethylene and polystyrene. These microbes attach to the plastic's hydrophobic surface and secrete extracellular enzymes that "cut" long polymer chains into smaller monomers, which are then absorbed and processed through the bacterial cell's Citric Acid Cycle. Although these natural biological processes are currently too slow for industrial-scale waste management, scientists are using protein engineering to "supercharge" these enzymes, aiming to create a sustainable, bio-based solution for the global plastic crisis. This research represents a critical bridge between synthetic waste and natural recycling systems.

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Effect of Secondary Metabolites on Animals

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Introduction

Living organisms produce a wide variety of chemical compounds that are broadly classified into primary and secondary metabolites. Primary metabolites such as carbohydrates, proteins, and lipids are directly involved in growth, development, and reproduction. In contrast, secondary metabolites are organic compounds that are not directly essential for basic life processes but play crucial roles in ecological interactions. These compounds are widely produced by plants, microorganisms, and some algae, and they significantly influence the physiology and behavior of animals.

Secondary metabolites include diverse groups such as alkaloids, terpenoids, phenolics, flavonoids, and glycosides. These compounds often serve as defense mechanisms for plants against herbivores, pathogens, and environmental stress. When animals consume plants or come into contact with these compounds, secondary metabolites can produce a range of effects, from beneficial to harmful, depending on their concentration, chemical nature, and the physiology of the animal.

Secondary metabolites are typically low molecular weight compounds that are synthesized through specialized metabolic pathways. Unlike primary metabolites, they are often produced in specific tissues, developmental stages, or in response to environmental stimuli such as stress, herbivory, or pathogen attack.

One of the defining characteristics of secondary metabolites is their restricted distribution. While primary metabolites are universally present in all living cells, secondary metabolites are often species-specific or found only in certain taxonomic groups. Additionally, their production is influenced by both genetic and environmental factors, including light, temperature, nutrient availability, and biotic interactions.

One of the most prominent effects of secondary metabolites on animals is toxicity. Many plant-derived compounds act as natural poisons to deter herbivory. Alkaloids such as nicotine, morphine, and strychnine can affect the

nervous system of animals, leading to paralysis or even death at high doses. Similarly, cyanogenic glycosides release hydrogen cyanide when metabolized, which interferes with cellular respiration. These toxic effects serve as protective strategies for plants but can have serious consequences for animals that consume them.

In addition to toxicity, secondary metabolites can influence animal behavior. Certain compounds act as feeding deterrents by producing bitter tastes or unpleasant odors. For example, tannins reduce the palatability of plant tissues, discouraging herbivores from feeding. Some metabolites also affect digestion by binding to proteins and reducing nutrient availability. This leads to decreased growth and reproduction in animals that rely heavily on such food sources.

Despite their potential harmful effects, secondary metabolites can also provide significant benefits to animals. Many animals have evolved mechanisms to tolerate or even utilize these compounds. For instance, some herbivores can detoxify plant toxins through specialized enzymes, allowing them to feed on plants that are toxic to other species. In certain cases, animals sequester these compounds in their bodies and use them as a defense against predators. This phenomenon is commonly observed in insects such as butterflies and beetles, which accumulate toxic compounds from host plants and become unpalatable to predators.

Secondary metabolites also play an important role in medicinal and pharmacological effects in animals, including humans. Many drugs used in modern medicine are derived from plant secondary metabolites. Compounds such as quinine, used for treating malaria, and morphine, used as a pain reliever, demonstrate the therapeutic potential of these substances. Flavonoids and phenolic compounds exhibit antioxidant properties, helping to protect animal cells from oxidative stress and reducing the risk of chronic diseases.

Another important effect of secondary metabolites is their influence on the immune system. Certain compounds can enhance immune responses by stimulating the production of antibodies and activating immune cells. For example, some plant-derived polysaccharides and phenolics have immunomodulatory properties that improve resistance to infections. On the other hand, some metabolites may suppress immune function, making animals more susceptible to diseases.

Secondary metabolites also impact reproductive processes in animals. Some compounds act as endocrine disruptors, interfering with hormone regulation. Phytoestrogens, which are plant-derived compounds structurally similar to estrogen, can mimic or block hormonal activity. This can lead to altered reproductive behavior, reduced fertility, or developmental abnormalities in animals exposed to high levels of these compounds.

The ecological significance of secondary metabolites extends to interactions between plants and animals. These compounds influence feeding patterns, habitat selection, and co-evolutionary relationships. Herbivores and plants often engage in an evolutionary arms race, where plants develop new chemical defenses and animals evolve strategies to overcome them. This dynamic interaction contributes to biodiversity and ecosystem stability. In agricultural systems, secondary metabolites have both positive and negative implications. On one hand, they can act as natural pesticides, reducing the need for synthetic chemicals. On the other hand, certain compounds in fodder plants can be toxic to livestock, leading to economic losses. Understanding the effects of these metabolites is essential for selecting safe and nutritious feed for animals.

Environmental factors such as climate, soil conditions, and stress can influence the production of secondary metabolites in plants. Changes in these factors may alter the concentration and composition of these compounds, thereby affecting their impact on animals. For example, drought stress can increase the production of certain toxic metabolites, making plants more harmful to grazing animals.

In recent years, there has been growing interest in using secondary metabolites as alternatives to synthetic drugs and chemicals. Plant-based compounds are being explored for their antimicrobial, anti-inflammatory, and anticancer properties. In animal husbandry, these compounds are being used as feed additives to improve health and productivity while reducing the use of antibiotics.

- **Nicotine (Alkaloid):** Produced by tobacco plants, nicotine affects the nervous system. It causes paralysis and death in insects, while in mammals it leads to increased heart rate and toxicity at high doses.
- **Tannins (Phenolics):** Found in plants like acacia, tannins bind proteins and reduce digestion in ruminants, leading to poor growth. In small amounts, they may help control parasites.
- **Cyanogenic Glycosides:** Present in cassava and sorghum, they release hydrogen cyanide. In animals, this blocks respiration and can cause rapid death.
- **Phytoestrogens:** Found in clover, these mimic estrogen and cause reproductive problems like infertility in sheep (“clover disease”).
- **Cardiac Glycosides:** Milkweed produces these toxins. Monarch butterflies store them, making themselves poisonous to predators.
- **Alkaloids (Lupine):** Cause nervous disorders and birth defects (crooked calf disease) in grazing animals.
- **Saponins:** Disrupt cell membranes in fish, causing gill damage and hemolysis. Sometimes used traditionally for fishing.
- **Mycotoxins (Aflatoxins):** Produced by fungi, they contaminate feed and

cause liver damage, reduced immunity, and cancer in animals.

- **Caffeine:** Acts as a stimulant in animals, causing hyperactivity and nervous effects; toxic at high doses.
- **Rotenone:** A plant compound that blocks cellular respiration in fish, leading to death; used as a natural pesticide.

Conclusion

In conclusion, secondary metabolites play a complex and multifaceted role in influencing animal life. While they primarily function as defense mechanisms in plants, their effects on animals range from toxic and inhibitory to beneficial and therapeutic. The interaction between secondary metabolites and animals is a key aspect of ecological balance and evolutionary processes. A deeper understanding of these compounds can help in harnessing their benefits while minimizing their harmful effects, contributing to advancements in agriculture, medicine, and environmental conservation.

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A Tale of Alien Species Tilapia (*Oreochromis* Spp.) As A Major Threat to Indian River Ecosystems

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Introduction

Freshwater ecosystems are among the most biologically diverse yet threatened habitats on Earth. In India, rivers, lakes, and reservoirs sustain a wide range of aquatic organisms and provide essential ecosystem services, including fisheries, irrigation, and drinking water. However, these ecosystems are increasingly under pressure due to pollution, habitat destruction, climate change, and the introduction of non-native species. Among the invasive aquatic organisms, tilapia—particularly species belonging to the genus *Oreochromis*—has emerged as a significant ecological concern.

Tilapia are native to Africa and parts of the Middle East but have been widely introduced across the globe for aquaculture due to their fast growth, adaptability, and economic value. In India, their introduction was initially considered beneficial for enhancing fish production.

History of Introduction and Spread in India

The introduction of tilapia into India dates back to the mid-20th century, when species such as *Oreochromis mossambicus* were brought in to improve inland fisheries. Later, *Oreochromis niloticus* was introduced due to its superior growth performance and higher market demand. These species were initially cultured in controlled environments such as ponds and reservoirs.

However, due to inadequate management practices, tilapia escaped into natural water systems through flooding, overflow from aquaculture ponds, and deliberate release by fish farmers and local communities. Over time, they established self-sustaining populations in major river systems including the Ganga, Yamuna, Godavari, Krishna, and Cauvery.

Today, tilapia are widely distributed across diverse freshwater habitats in India, from slow-moving rivers to polluted urban water bodies. Their remarkable adaptability has enabled them to colonize ecosystems that are unsuitable for

many native species.

Biological and Ecological Traits Contributing to Invasiveness

The success of tilapia as an invasive species is largely attributed to its unique biological and ecological characteristics. These include rapid growth, early maturity, high fecundity, and parental care through mouth brooding. Female tilapia incubate eggs in their mouths, providing protection from predators and increasing survival rates of offspring.

Tilapia are also highly tolerant of environmental stress. They can survive in low dissolved oxygen levels, high salinity, and polluted conditions, giving them a competitive advantage over sensitive native species. Their omnivorous feeding behavior allows them to exploit a wide range of food resources, including phytoplankton, zooplankton, detritus, and small invertebrates.

Distribution in Indian River Systems

Tilapia have now become a common component of fish communities in many Indian rivers. Their presence is particularly notable in regions with intense aquaculture activity and disturbed ecosystems. In Maharashtra, for instance, tilapia populations have been recorded in rivers and reservoirs across districts such as Ahmednagar, Pune, and Nashik.

In semi-arid regions like Karjat tehsil of Ahmednagar district, water bodies are already under environmental stress due to irregular rainfall, agricultural runoff, and anthropogenic disturbances. The introduction of tilapia in such ecosystems exacerbates existing pressures, leading to further ecological degradation.

Field observations and fisheries data suggest that tilapia often dominate catch composition in these areas, indicating their successful establishment and proliferation.

Impact on Native Fish Diversity

One of the most significant impacts of tilapia invasion is the decline in native fish diversity. Indian rivers are home to a rich assemblage of indigenous fish species, many of which are endemic and ecologically specialized. The introduction of tilapia disrupts these communities through competition, predation, and habitat alteration. Tilapia compete with native fishes for food and breeding sites. Due to their generalized feeding habits and aggressive behavior, they often outcompete indigenous species that rely on specific ecological niches. This competition leads to reduced growth, reproduction, and survival of native fish populations.

In addition, tilapia may prey on the eggs and larvae of other fishes, further affecting recruitment and population stability. Over time, this results in a decline in native species richness and even local extinctions in heavily invaded areas.

Alteration of Aquatic Food Webs

Tilapia play a significant role in altering the structure and functioning of aquatic food webs. As omnivores, they occupy multiple trophic levels and influence both primary producers and higher-level consumers. By feeding on phytoplankton and aquatic vegetation, tilapia can reduce primary productivity in water bodies. At the same time, their consumption of zooplankton and benthic organisms disrupts the balance between different trophic groups. This leads to cascading effects throughout the ecosystem, affecting species composition and energy flow.

Furthermore, the high population density of tilapia can result in overgrazing of available resources, leading to resource depletion and increased competition among aquatic organisms.

Habitat Modification and Environmental Changes

Tilapia are known to modify their habitats through their feeding and breeding activities. They often disturb sediments while foraging, increasing water turbidity. This reduces light penetration, which in turn affects photosynthesis in aquatic plants and algae. Their nesting behavior also contributes to habitat alteration. Male tilapia construct shallow nests in the substrate, disturbing the riverbed and affecting spawning grounds of native species. Increased turbidity and sedimentation can negatively impact species that rely on clear water for feeding and reproduction. Additionally, tilapia can influence nutrient cycling in aquatic ecosystems.

Socio-Economic Implications

Despite their ecological drawbacks, tilapia have considerable economic importance in India. They are widely cultivated due to their fast growth, low production cost, and high market demand. For many small-scale fish farmers, tilapia provides a reliable source of income and food security. However, the dominance of tilapia in natural water bodies can have negative socio-economic consequences. Traditional fisheries that depend on native species may suffer due to reduced availability of indigenous fishes, many of which have higher commercial and cultural value. Moreover, the overpopulation of tilapia can lead to stunted growth, resulting in smaller fish that fetch lower market prices. This can affect the profitability of fisheries and reduce economic returns for local communities. Thus, while tilapia contributes to aquaculture production, its impact on natural ecosystems and traditional livelihoods must be carefully managed.

Case Study Perspective: Maharashtra Rivers

In Maharashtra, the spread of tilapia has been particularly evident in reservoirs and river systems associated with irrigation and aquaculture. Studies conducted in districts such as Ahmednagar indicate a noticeable shift in fish community structure following the introduction of tilapia.

In Karjat tehsil, for example, local fishermen have reported a decline in native carp species and an increase in tilapia catch over the past decade. Changes in water quality, vegetation, and sediment composition have also been observed, suggesting broader ecological impacts. These findings highlight the need for region-specific studies to assess the extent of tilapia invasion and its effects on local biodiversity and ecosystem health.

Conclusion

Tilapia, particularly species of the genus *Oreochromis*, represents a classic example of an introduced species that has become invasive due to its biological advantages and human-mediated spread. While it offers economic benefits through aquaculture, its impact on natural ecosystems is profound and often detrimental. In Indian rivers, the proliferation of tilapia has led to reduced biodiversity, altered food webs, habitat degradation, and socio-economic challenges for traditional fisheries. Addressing this issue requires a balanced approach that integrates scientific research, policy intervention, and community participation. Sustainable management of freshwater ecosystems must prioritize the conservation of native biodiversity while ensuring the responsible use of aquatic resources. Only through such integrated efforts can the ecological integrity of Indian rivers be preserved for future generations.

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Toxicological Effects of Heavy Metals and Curative Role of Ascorbic Acid in Freshwater Bivalve *Lamellidenscorrianus*

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Introduction

Aquatic ecosystems are increasingly threatened by pollution, particularly due to the accumulation of heavy metals. Industrialization, agricultural runoff, and domestic waste introduce toxic metals such as copper and nickel into water bodies. These metals, though essential in trace amounts, become highly toxic when their concentration exceeds permissible limits. They adversely affect aquatic organisms by altering physiological and biochemical processes.

Freshwater bivalves like *Lamellidenscorrianus* serve as excellent bioindicators of aquatic pollution due to their sedentary lifestyle and filter-feeding habits. They accumulate pollutants in their tissues, making them ideal organisms for toxicological studies. Proteins are vital biomolecules responsible for structural and functional roles in living organisms. Any alteration in protein metabolism reflects physiological stress. Heavy metals are known to disrupt protein synthesis and degradation, leading to reduced protein content in tissues.

In recent years, attention has been given to natural antioxidants such as ascorbic acid (Vitamin C) for their protective role against toxicity. Ascorbic acid is known for its ability to neutralize free radicals and reduce oxidative stress, thereby helping organisms recover from toxic damage.

Objectives of the Study

The present study was conducted with the following objectives:

- To investigate the effect of heavy metals (copper and nickel) on protein content in different tissues. To evaluate the toxic impact on gills, gonads, and digestive glands.
- To study the protective role of ascorbic acid during metal exposure. To analyze the recovery pattern in treated and untreated organisms.

Materials and Methods

- **Test Organism-**The freshwater bivalve *Lamellidenscorrianus* was selected for the study. Specimens were collected from a clean freshwater source and acclimatized under laboratory conditions before experimentation.

Experimental Design

The organisms were divided into different groups:

- **Control Group:** Maintained in clean water
- **Toxicity Group:** Exposed to heavy metals (copper sulphate and nickel chloride)
- **Treatment Group:** Exposed to heavy metals along with ascorbic acid
- **Recovery Group:** Transferred to clean water after exposure
- **Recovery + Ascorbic Acid Group:** Provided with ascorbic acid during recovery

Duration of Exposure

- **Toxic Exposure:** 15 and 30 days, Recovery period: 5 and 10 days
- **Biochemical Analysis:** Protein content was estimated using Lowry's Method, a widely used biochemical technique for determining total protein concentration.

Results

The results of the study clearly indicated that exposure to heavy metals caused significant alterations in protein content across different tissues.

- **Effect on Gills:** Gills showed a marked decrease in protein levels after exposure to copper and nickel. Since gills are directly in contact with the aquatic environment, they are highly susceptible to pollutants.
- **Effect on Gonads:** Protein content in gonads was significantly reduced, indicating possible effects on reproductive functions and fertility.
- **Effect on Digestive Glands:** The digestive glands also exhibited a decline in protein levels, suggesting impaired metabolic activity.
- **Role of Ascorbic Acid:** The groups treated with ascorbic acid showed comparatively lesser reduction in protein levels. This indicates its protective effect against heavy metal toxicity.
- **Recovery Pattern:** Recovery in normal water was slow and incomplete. Recovery with ascorbic acid was faster and more effective. Protein levels gradually returned towards normal in treated groups.

Discussion

Heavy metals such as copper and nickel interfere with normal cellular functions. They bind to proteins and enzymes, disrupting their structure and function. This leads to increased protein degradation and decreased synthesis.

The reduction in protein content observed in this study may be due to Enhanced proteolysis (breakdown of proteins) Inhibition of protein synthesis. Increased energy demand under stress conditions

Among the tissues studied, gills showed maximum alteration because they are the primary site of metal entry. Gonads are also sensitive, and their impairment may affect reproduction. Digestive glands, being metabolically active, are prone to biochemical disturbances. Ascorbic acid plays a crucial role in mitigating these toxic effects. It acts as a powerful antioxidant by scavenging free radicals generated due to metal toxicity. It also helps in maintaining cellular integrity and supports enzyme function. The improved recovery in ascorbic acid-treated organisms highlights its importance as a protective and curative agent. It enhances detoxification and accelerates tissue repair mechanisms.

Conclusion

The present study demonstrates that heavy metals like copper and nickel have a significant toxic effect on protein metabolism in freshwater bivalves. The decrease in protein content in gills, gonads, and digestive glands indicates severe physiological stress.

However, ascorbic acid was found to be effective in reducing the toxic impact and promoting recovery. It acts as both a protective and curative agent by minimizing oxidative stress and aiding in biochemical restoration. Thus, ascorbic acid can be considered a useful supplement in reducing heavy metal toxicity in aquatic organisms.

Significance of the Study

Highlights the impact of environmental pollution on aquatic life Emphasizes the importance of biochemical indicators in toxicity studies .Suggests the use of natural antioxidants for detoxification .Provides insight into eco-friendly approaches for pollution management Heavy metals cause protein depletion in aquatic organisms Gills are the most affected tissue .Ascorbic acid acts as an antioxidant Recovery is faster with treatment than without treatment and *Lamellidenscorrianus* is an important bioindicator species

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Hydrochemical Stress and Renal Health: A Study of High TDS Water in Karjat, Ahilyanagar

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Abstract

Water quality plays a crucial role in maintaining human health, particularly in rural and semi-arid regions where groundwater serves as the primary source of drinking water. Karjat tehsil in Ahilyanagar district of Maharashtra is characterized by dry climatic conditions and increasing dependence on groundwater resources with elevated Total Dissolved Solids (TDS). The present chapter explores the relationship between hydrochemical stress caused by high TDS levels and the growing incidence of kidney-related health issues in the region. It highlights the environmental, geological, and anthropogenic factors contributing to poor water quality and discusses their potential impact on renal health. The chapter also emphasizes the need for sustainable water management and public health interventions.

Introduction

Water is fundamental to life, yet its quality often determines whether it sustains or harms human health. In many parts of rural India, including Karjat in Ahilyanagar district, groundwater is the principal source of drinking water. However, this reliance has led to increasing exposure to dissolved minerals and salts, reflected in high Total Dissolved Solids (TDS) levels. The issue is particularly significant in semi-arid regions, where limited rainfall, high evaporation, and geological characteristics contribute to water quality deterioration.

Karjat region exhibits a dry to semi-arid climate with irregular rainfall patterns and prolonged dry seasons. Such environmental conditions not only reduce groundwater recharge but also concentrate dissolved substances in water sources. Over time, the consumption of such water may pose serious health risks, particularly to kidney function, as the kidneys are directly involved in filtering impurities and maintaining electrolyte balance in the body.

Geographical and Environmental Setting of Karjat

Karjat lies in a drought-prone belt of Ahilyanagar district, where water scarcity is a recurring concern. The region is dominated by basaltic rock formations typical of the Deccan Plateau. These geological formations influence groundwater chemistry, often leading to increased levels of dissolved minerals such as calcium, magnesium, sodium, and bicarbonates. The climatic conditions further exacerbate the situation. Low rainfall combined with high temperatures accelerates evaporation, leaving behind concentrated salts in the remaining water. Additionally, over-extraction of groundwater for agriculture and domestic use leads to deeper aquifer exploitation, where water tends to have higher mineral content. Human activities also play a role in altering water quality. The use of fertilizers, pesticides, and improper waste disposal practices contributes to groundwater contamination, further increasing the TDS levels. As a result, the local population is exposed to water that may not meet recommended drinking standards.

Understanding Total Dissolved Solids (TDS)

Total Dissolved Solids refer to the combined content of all inorganic and organic substances dissolved in water. These include minerals, salts, metals, and ions that are present in molecular or ionized form. TDS is an important parameter used to assess water quality. Water with low TDS is generally considered safe and palatable, while high TDS levels can affect taste, hardness, and overall suitability for drinking. According to international guidelines, TDS levels above 500 mg/L may be undesirable, and levels exceeding 1000 mg/L can pose health concerns if consumed over long periods. In Karjat, several studies and field observations indicate that groundwater TDS levels frequently exceed acceptable limits. This is primarily due to natural geological processes combined with environmental stressors. Continuous consumption of such water can have cumulative effects on human health.

Hydrochemical Stress in the Region

Hydrochemical stress refers to the condition where water chemistry deviates significantly from natural or acceptable standards, thereby exerting stress on biological systems. In Karjat, hydrochemical stress is largely driven by elevated TDS levels and associated ionic imbalances.

The major ions contributing to high TDS include sodium, calcium, magnesium, chloride, and sulfate. Excessive intake of these ions through drinking water can disrupt physiological processes. For example, high sodium levels may contribute to hypertension, while excessive calcium and magnesium can lead to hardness-related health issues. The interaction between geological formations and water leads to continuous dissolution of minerals, especially in deeper aquifers. As

water remains in contact with rocks for longer durations, the concentration of dissolved solids increases. This process, combined with limited dilution due to low rainfall, intensifies hydrochemical stress in the region.

Renal Health and Water Quality

The kidneys play a vital role in filtering blood, removing waste products, and maintaining fluid and electrolyte balance. When individuals consume water with high levels of dissolved solids over extended periods, the kidneys are subjected to increased workload. One of the major concerns associated with high TDS water is the formation of kidney stones. Minerals such as calcium and oxalates can accumulate and crystallize in the urinary tract, leading to stone formation. In regions like Karjat, where water hardness is high, cases of nephrolithiasis (kidney stones) are often reported. In addition to kidney stones, prolonged exposure to poor-quality water may contribute to chronic kidney disease (CKD). Although multiple factors influence CKD, including lifestyle and genetic predisposition, environmental factors such as water quality are increasingly being recognized as significant contributors.

The cumulative impact of hydrochemical stress on renal health is particularly concerning in rural populations, where access to healthcare facilities is limited. Early detection and management of kidney disorders are often lacking, leading to severe health outcomes.

Socio-Economic and Public Health Implications

The impact of high TDS water extends beyond individual health, affecting the socio-economic fabric of the region. Medical treatment for kidney-related diseases can be expensive and burdensome for rural households. Loss of productivity due to illness further compounds the problem. Lack of awareness about water quality and its health implications is another challenge. Many residents continue to consume groundwater without proper treatment or testing. The absence of regular monitoring systems and limited infrastructure for water purification exacerbate the issue. Public health interventions are essential to address these challenges. Community-level awareness programs, regular water quality assessments, and the provision of safe drinking water can significantly reduce health risks. Government initiatives aimed at improving rural water supply systems must prioritize quality alongside quantity.

Mitigation Strategies and Recommendations

Addressing hydrochemical stress and its impact on renal health requires a multi-faceted approach. Sustainable water management practices should be implemented to prevent over-extraction of groundwater. Rainwater harvesting and artificial recharge techniques can help improve water availability and dilute dissolved solids.

Water treatment technologies such as reverse osmosis (RO) can effectively reduce TDS levels. However, affordability and maintenance remain challenges in rural areas. Community-based water purification systems may offer a more practical solution. Regular monitoring of water quality is essential to identify problem areas and implement timely interventions. Collaboration between government agencies, researchers, and local communities can facilitate effective management strategies. Health screening programs focusing on kidney function should be conducted periodically in high-risk regions. Early diagnosis and preventive measures can reduce the burden of kidney diseases.

Conclusion

The relationship between hydrochemical stress and renal health in Karjat highlights the critical importance of water quality in determining public health outcomes. High TDS levels in groundwater, driven by environmental and anthropogenic factors, pose a significant risk to kidney health. The situation is further aggravated by the arid climate, limited water resources, and lack of awareness. Addressing this issue requires an integrated approach that combines scientific research, policy intervention, and community participation. Ensuring access to safe drinking water is not only a basic necessity but also a fundamental step toward improving health and quality of life in the region.

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Relationship between Fingerprints and Blood Groups among Females

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Abstract

The present study aims to investigate the relationship between fingerprint patterns and blood groups in 248 female students (mean age = 19 years). Results revealed a higher incidence of loop fingerprints (47.17%), followed by whorl (37.50%) and arch (15.32%) patterns. The distribution of blood groups was as follows: A (23.79%), B (38.30%), O (27.01%), and AB (10.88%). Rh-positive individuals constituted 91.12%, and Rh-negative individuals 8.87%. Students with blood groups A, B, and AB exhibited a higher incidence of loop fingerprints, whereas those with blood group O showed more whorl patterns. Both Rh-positive and Rh-negative participants showed a predominance of loop patterns. Chi-square analysis indicated no statistically significant relationship between fingerprint patterns and human blood groups.

Keywords: Blood groups, dermatoglyphics, fingerprint patterns, relationship

Introduction

Fingerprints and blood groups are unique biological characteristics widely used in forensic science and anthropology (Rao, 2010). The study of fingerprint patterns is called as dermatoglyphics. Fingerprints, with their distinctive ridge patterns, provide a permanent and unalterable means of personal identification. Similarly, blood groups, classified under the ABO and Rh systems, are genetically determined traits that can be used to differentiate individuals. Fingerprints are formed during fetal development between 11th and 24th weeks of gestation due to differential epithelial elevation caused by pressure and friction (Hamilton et al., 1972). Each fingerprint is unique; even identical twins have distinct patterns (Rao, 2010). The three main fingerprint types are loops, whorls, and arches—accounting for approximately 65%, 35%, and 7% of the general population, respectively. Human blood groups are categorized into A, B, AB, and O types,

based on specific antigens present on erythrocytes (Landsteiner, 1900). The Rh factor further classifies individuals as Rh-positive or Rh-negative. Several studies have explored possible correlations between fingerprint patterns and blood groups (Deopa et al., 2014; Ekanem et al., 2014; Umraniya et al., 2013), though their findings have been inconsistent. Some reported distinct relationships (Bhavana et al., 2013; Sharma et al., 2008), while others found no significant association (Varlekar et al., 2024; Vankara et al., 2021). The significance of the present study lies in enhancing understanding of potential relationship between fingerprint patterns and human blood groups, with implications for forensic identification, anthropology, and genetics.

Materials and Methods

The study was conducted at a women's college at Ahilyanagar (formerly Ahmednagar) between November 2022 and February 2023. A total of 248 female students (mean age = 19 years) residing in the college hostel were randomly selected.

- **Fingerprint Collection:** Fingerprint impressions were obtained using a stamp pad on white paper and examined with a magnifying glass to identify the pattern type. Participants with hypersensitivity to ink were excluded. To ensure accuracy, fingerprints were collected after washing hands thoroughly.
- **Blood Group Determination:** Blood group information was obtained from college identity cards and verified by the participants.
- **Statistical Analysis:** Data was analysed using the Chi-square test to assess the relationship between fingerprint patterns and blood groups. A p-value < 0.05 was considered statistically significant.

Results

Distribution of fingerprint patterns

Among 248 participants, 47.17% (n = 117) exhibited loop patterns, 37.50% (n = 93) had whorl patterns, and 15.32% (n = 38) showed arch patterns.

Table 1 Showing the distribution of fingerprint pattern among the females

SR. No	Fingerprint patterns	Number	Percentage (%)
1	Loop	117	47.17
2	Whorl	93	37.5
3	Arch	38	15.32
4	Total	248	100

Distribution of Blood Groups

Table 2 Showing distribution of blood groups among the females

SR. No	Blood group	Number	Percentage
1	A	59	23.79
2	B	95	38.30
3	AB	27	10.88
4	O	67	27.01
5	Total	248	100

Distribution of Blood Groups and Fingerprint Pattern

Table 3 Showing relationships of blood groups and fingerprint pattern among the females

Blood group	No. of loop and their percentage		No. of whorl and their percentage		No. of Arch and their percentage		P value
	Number	Percentage	Number	Percentage	Number	Percentage	
A	31	12.5	23	9.27	5	2.01	0.147
B	45	18.14	35	14.11	15	6.04	
AB	14	5.64	7	2.82	6	2.41	
O	27	10.88	28	11.29	12	4.83	
Rh Positive	107	43.14	84	33.87	35	14.11	0.863
Rh Negative	10	4.03	9	3.62	3	1.20	

Discussion

Fingerprint patterns serve as a reliable biometric feature for identification. In this study, loop patterns were the most frequent, consistent with previous research (Kshirsagar et al., 2003; Deopa et al., 2014). In this study the blood group B was the most prevalent, followed by O and A, while AB was least common.

While the earlier studies (Rastogi et al., 2023; Narayana et al., 2016) suggested possible relationship between fingerprint and blood group, the present study results align with Vankara et al. (2021) and Varlekar et al. (2024), who found no statistically significant relationship.

The dominance of loop patterns among all the blood groups and Rh factors implies that the genetic and environmental factors influencing dermatoglyphic

development operate independently of the ABO and Rh systems. However, further studies with larger, gender-balanced, and ethnically diverse populations are necessary to confirm these findings.

Conclusion

This study aims to explore the relationship between fingerprint patterns and blood groups among female's students. The findings showing that the most common fingerprint type was loop, and the least common was arch. Blood group B was predominant, while AB was the rarest. Statistical analysis indicated no significant relationship between fingerprint pattern distribution and blood group or Rh factor ($p > 0.05$). Despite the absence of correlation, such research contributes valuable baseline data for dermatoglyphic and forensic investigations.

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Haemoglobin Status and Awareness for Anaemia Prevention: A Community Survey in Karmala

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Abstract

Haemoglobin deficiency is a common public health problem that can lead to anaemia and affect overall health and productivity. Early detection and awareness are important for the prevention of anaemia in the community. This study was conducted in Karmala area to assess haemoglobin status among the population. Data was collected through a structured questionnaire and health survey. The result showed that several participants had haemoglobin level below the normal range, indicating the presence of anaemia. The study concludes that regular screening and improved nutritional awareness are necessary to prevent anaemia.

Keywords: Haemoglobin, survey, anaemia, prevention

Introduction

Haemoglobin, a protein molecule found in human red blood cells, has long been known as a key in the process of oxygen transport in the body. The percentage of Hb varies depending upon the age, sex, ethnic background, body fluid and social, nutritional and environmental factors. Abnormal level of haemoglobin causes disorders (Yandamuri Ayyanna et.al 2013). Focus on the role of haemoglobin in maintaining health. The population studied includes humans of various age groups and health conditions. Factors such as nutrition, environment and health conditions affect a person's haemoglobin levels (Nireza Agasti et.al 2024).

The World Health Organization [WHO] estimates that in 2019, approximately 1.62 billion people were affected by anaemia with iron deficiency being the most common cause. The impact of Iron Deficiency Anaemia (IDA) is particularly evident in regions like India, where the Indian Council of Medical Research [ICMR] highlights concerning trends and the need for targeted interventions to address iron deficiency, particularly among women and children (Abhinav Manish et.al 2024).

Therefore, creating awareness about haemoglobin, its normal range and the importance of iron-rich foods is essential for preventing anaemia. This study was conducted to assess the level of awareness about haemoglobin and anaemia prevention among Karmala city people and to promote knowledge about maintaining healthy haemoglobin levels through proper diet and lifestyle.

Literature Review

Researchers highlight that haemoglobin is essential for oxygen transport and overall health, with iron playing a key role in its function. Factors like nutrition and health conditions influence haemoglobin levels, and imbalances can lead to disorders such as anaemia. Iron deficiency causes fatigue, weakness, and reduced cognitive ability, while low haemoglobin—especially in women and pregnant individuals—can result in serious health issues like low birth weight and premature delivery.

Methodology

Study Design

The present study was conducted as a descriptive survey-based study to assess awareness about haemoglobin and anaemia prevention among students and members of the general public. The study also aimed to educate participants about the importance of maintaining normal haemoglobin levels and anaemia control through proper nutrition and lifestyle practices.

Study Area

The study was carried out in Karmala, Maharashtra, India. Data collection was conducted over a specific period during the awareness campaign. The study included participants from educational institutions and local community members who voluntarily participated in the survey.

Study Population

The study population consisted of students and members of the general public. Individuals from different age groups were included in order to understand the general level of community awareness on haemoglobin and anaemia control.

Sample Size and Sampling Method

A total of 80-90 participants were included in the study. Participants were selected using a random sampling method to ensure that different individuals from the community could participate in the survey.

Data Collection Tools

Data were collected using a structured questionnaire prepared in simple language to ensure easy understanding by the participants. The questionnaire consisted of both closed-ended and multiple-choice questions related to awareness and

prevention of iron deficiency anaemia.

The questionnaire included questions such as:

- Do you know about haemoglobin?
- Do you know the normal haemoglobin range?
- Has a doctor ever told you that your haemoglobin level is low?
- Do you know about iron-rich foods?
- Do you know the symptoms of anaemia?

Awareness Activity

After the survey, participants were given basic information about assessment of awareness about haemoglobin levels and anaemia prevention. They were informed about the importance of a balanced diet and iron-rich foods such as spinach, jaggery, dates and non-veg.

Awareness and Educational Activity

After collecting the responses, an awareness session was conducted to educate participants about haemoglobin and anaemia prevention. Participants were informed about the importance of maintaining normal haemoglobin levels and the role of proper nutrition. Information about iron-rich foods such as green leafy vegetables, jaggery, dates, pulses and other nutrients foods was shared. The aim of this activity was to 'improve participant's knowledge and encourage healthy dietary habits.

Data Collection Procedure

Data was collected through two methods

- **Online Survey:** A Goggle form was created and shared through social media platforms.
- **Offline Survey:** Printed questionnaire was distributed among local peoples. Before collecting responses, participants were informed about purpose of the study.

Data Analysis

The collected data were organized and analyzed using simple statical methods. The responses calculated in the form of percentages and presented using pie charts and graphs to clearly show the level of evaluation of knowledge regarding haemoglobin and anaemia among participants.

Observation

The survey, based on 80–87 participants aged 18–60 years, revealed that most people have basic awareness of haemoglobin and its importance for health. However, detailed knowledge—such as the need for regular haemoglobin check-ups—is limited, and not all participants undergo routine testing. Some individuals reported low haemoglobin levels in the past, indicating the presence of

deficiency. While there is some awareness of anaemia symptoms like weakness and fatigue, understanding of proper dietary practices and normal haemoglobin levels remains inadequate, highlighting the need for improved health awareness.

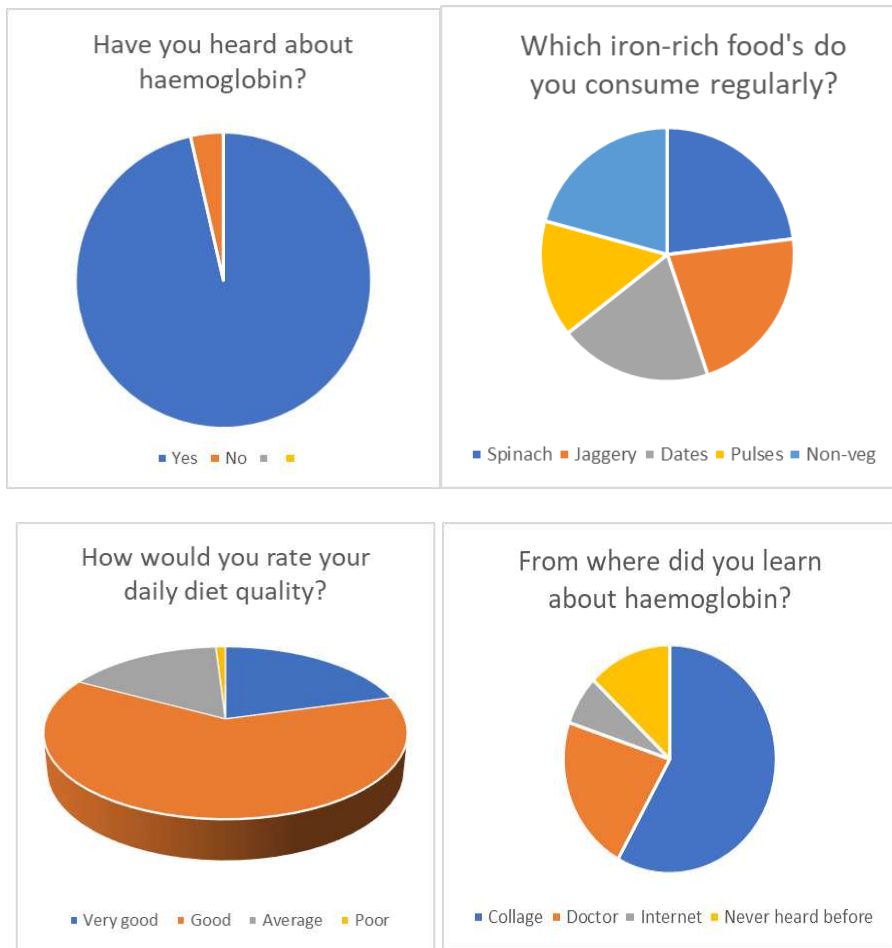
Results and Discussion

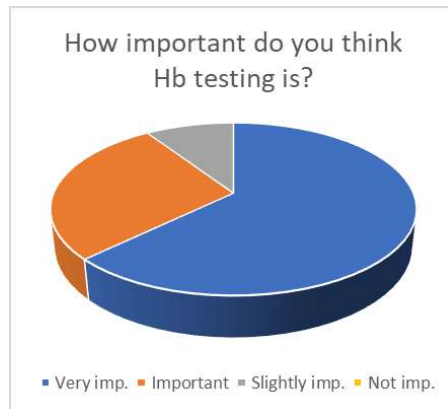
This study involved 80–87 participants aged 18–60 years, and their responses were analyzed to assess knowledge about haemoglobin levels and anaemia prevention. The results showed that while some participants were aware of haemoglobin and anaemia, many lacked knowledge about normal haemoglobin levels and the importance of regular testing. The data were organized into tables and presented using pie charts to clearly illustrate the proportion of participants who were aware or unaware of haemoglobin levels, anaemia, and its prevention.

Sr. No.	Question	Option	Number of Responses	Percentage
1	What is your gender?	Female Male	60 27	69% 31%
2	Have you heard about haemoglobin (Hb)?	Yes No	75 12	86.2% 13.8%
3	Have you ever checked your haemoglobin level?	Yes No	69 17	80.2% 19.8%
4	What type diet you follow?	Vegetarian Non-vegetarian Mixed	43 8 36	49.4% 9.2% 41.4%
5	Do you include iron-rich foods in your daily diet?	Yes No	67 20	78.8% 21.2%
6	Which iron-rich foods do you consume regularly?	Spinach Jaggery Dates Pulses Non-veg	20 19 17 13 18	23% 21.8% 19.5% 14.9% 20.7%
7	How would you rate your daily diet quality?	Very good Good Average Poor	54 18 14 1	20.7% 62.1% 16.1% 1.1%
8	From where did you learn about haemoglobin?	School Doctor Internet	50 19 6	58.1% 22.1% 7%

		Never heard before	11	12.8%
9	Have you ever told by a doctor that your Hb is low?	Yes No	37 50	
10	How important do you think Hb testing is?	Very important Important Slightly important Not important	54 24 9 0	62.8% 27.9% 9.3% 0%

Graphical Representation of Results





Conclusion

This study showed that many people have heard about haemoglobin and anaemia, but their complete knowledge is limited. Some participants did not know the normal haemoglobin range, symptoms of anaemia, and the importance of iron-rich foods. The awareness activity helped participants understand the importance of maintaining healthy haemoglobin levels. They also learned that eating iron-rich foods such as green leafy vegetables, jaggery and pulses can help control anaemia. Therefore, it can be concluded that awareness programs are very important to improve people's knowledge about haemoglobin and anaemia prevention. Proper nutrition, regular health check-ups, and awareness can help in reducing the risk of anaemia and improving overall health.

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Healthy Lifestyle & Nutritional Awareness Survey Among Karjat Community

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Abstract

This study examines an assessment of knowledge, awareness and action toward healthy food intake among community members. This cross-sectional study was conducted to spread awareness and various practices related to healthy lifestyle and nutrition among community members. Total 300 Participants responded to online as well as offline questionnaires, through Google form. The majority respondents were young adults aged 18-25 years. The result showed that 88% of participants rated their nutrition knowledge as very poor. Daily consumption of fruits & vegetables was low while more than half respondents reported irregular physical activity. Although 46.2% obtained 7-8 hours of sleep, awareness of healthy lifestyle practices was low in 36% of respondents which is especially in the 60-80 age groups. Many participants agreed that maintaining a healthy lifestyle improves academic performance & overall well-being. The findings indicate a need for targeted nutrition education & health promotion programs.

Keywords: Healthy, lifestyle, nutritional

Introduction

A healthy lifestyle leaves everyone fit, energetic, and also reduced risk of disease and it is depends of healthy lifestyle habits such as good nutrition, daily exercise and proper sleep (Nasir Muwfaq Younis 2024). The world health organization (WHO) stated that, 60% of individual's health depend on quality of his/her lifestyle practices (Ziglio et.al. 2004). Also many publications viz. Othlings et.al, 2010, Reddy et.al 2011 have shown that, healthy lifestyle practices minimize diseases occurrence and mortality rates.

Nutrition knowledge refers to practices and concepts related to nutrition & awareness of health Such as adequate Food intake diet related disease (Adam Zarnowski, 2022). The term 'lifestyle' is often used to denote “The way people live”. It is the way of living of individuals which manifest in coping with their

physical, psychological, social and economic environment on a daily basis. A balance healthy lifestyle incorporates being physically active, eating healthy nutritious food, managing stress and getting a proper sleep [Anjali et.al 2024]. Knowledge of food, nutrition and healthy lifestyle has been found to be important factor in healthier food consumption and lower rate of metabolic illness [Shihkuan Hsu et.al 2025].

The present study was conducted to assess the level of awareness, attitudes and practices related to healthy lifestyle and nutrition among the Karjat city population. The questionnaire includes of junk food consumption, intake of fruits and vegetable, exercise pattern, sleep duration and awareness about nutrition labels and balanced diet. It also aimed to identify gaps between knowledge and actual lifestyle practices.

Material and Methods

Research Design

The present study was conducted using descriptive survey research design to assess awareness and practices related to healthy lifestyle and nutrition among selected population. The survey method was adopted to collect primary data directly from respondents in a structured format.

Study Area

This study was conducted in Karjat Tehsil, Maharashtra, among college student and local people. The area was selected based on convenience and accessibility for data collection.

Target population

The target population includes

- College students
- Young adults
- General public

Participant from different age group and educational background were included.

Sample Size and Sampling Technique

A total 300 respondents participated in the study. A simple random method sampling technique was used to select participant in the age group from 11 to 85 years.

Data Collection Tool

Data was collected using structured questionnaire the questionnaire consisted of:

- Demographic level (age, occupation etc.)
- Questions related to dietary habits
- Physical activity patterns

- Awareness about balance diet

This questionnaire includes multiple-choice questions for easy analysis.

Data Collection Procedure

Data was collected through two methods

- **Online Survey:**A Goggle form was created and shared through social media platforms.
- **Offline Survey:**Printed questionnaire was distributed among local peoples. Before collecting responses, participants were informed about purpose of the study.

Data Analysis

Data was collected from both online and offline and analyzed using simple statical method.

Observation

The study of 300 participants (aged 18–85 years) showed that most had average to poor knowledge of healthy lifestyle and nutrition. Intake of fruits and vegetables was low, and checking food labels was uncommon. Although many followed regular meal patterns, fast food and sugary drink consumption was frequent, and physical activity levels were generally inadequate. Awareness was lower in older adults (60–80 years) and higher among younger groups (20–40 years). While sleep duration was mostly adequate (7–8 hours), there was a clear gap between awareness and actual healthy lifestyle practices.

Result and Discussion

The present study was conducted to assess knowledge, awareness and practices related to healthy lifestyle and nutrition among 300 respondents. The findings reveal important trends regarding habits, physical activity, and overall health awareness.

Data Analysis Sample Size

Total number of respondents ranged between 287-292 across different age groups.

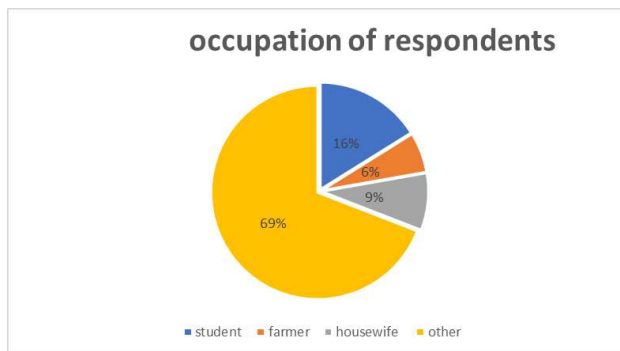
- **Age Distribution**
 - Age ranges: 18-85 years
 - Majority of respondents fall in 18-25year category.
 - The data shows positively distribution, as higher frequency is concentrated in young adult age group.

Observation Table by Questionnaires

Questions	Category	Percentage
occupation	Student	28%
	Farmer	10.6%
	Housewife	15%
	Other	35.8%
Knowledge of healthy nutrition	very good	28%%
	Good	21.3%
	Average	22%
	Poor	29.9%
	Very poor	9.4%
3 Consumption of fruits and vegetables	Daily	6-9%
	4-6 times / week	9%
	1-3 times / week	35.9%
	Rarely	30.2%
	Never	7.3%
Checking nutrition labels	Always	0 %
	Often	6.5%
	Sometimes	14.3%
	Rarely	23.7%
	Never	36.3%
No. of meals per day	1-2 times per day	23%
	2-3 times per day	60.8%
	4-5 times per day	<1%
	More than 5 times / day	0%
Consumption of fast food and sugary drinks	Frequently	6
	Daily	2%
	Several times in week	8.2%
	Once a week	18.4%
	Rarely	33.1
	Never	26%
Physical activity	Daily	10.2%
	3-5 times in week	7.8%
	1-2 times in week	16.8%
	Rarely	23.4%
	Never	31.1%
Awareness of healthy lifestyle	Very high	3%
	High	14.3%
	Moderate	26.2%

	Low	34.4%
	Very low	10.7%
Sleep duration	<5 hours	2%
	5-6 hours	39.3%
	7-8 hours	47%
	>8 hours	1%
	Belief in healthy lifestyle improving performance	Strongly agree
Agree		32.2%
Neutral		42.3%
Disagree		>2%
Strongly disagree		0%

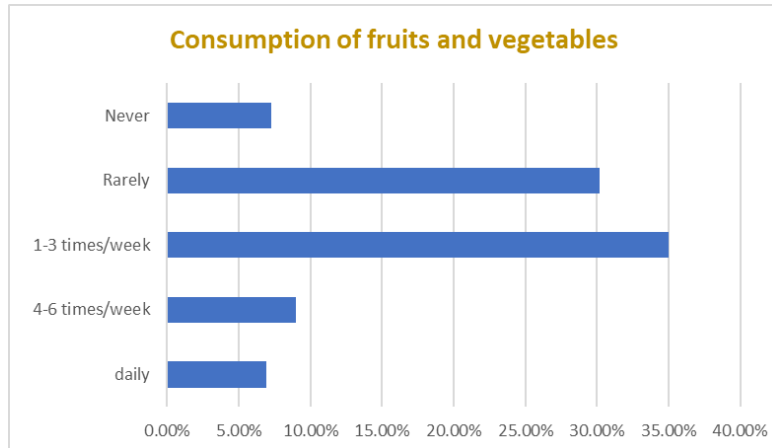
Graphical Representation of Results



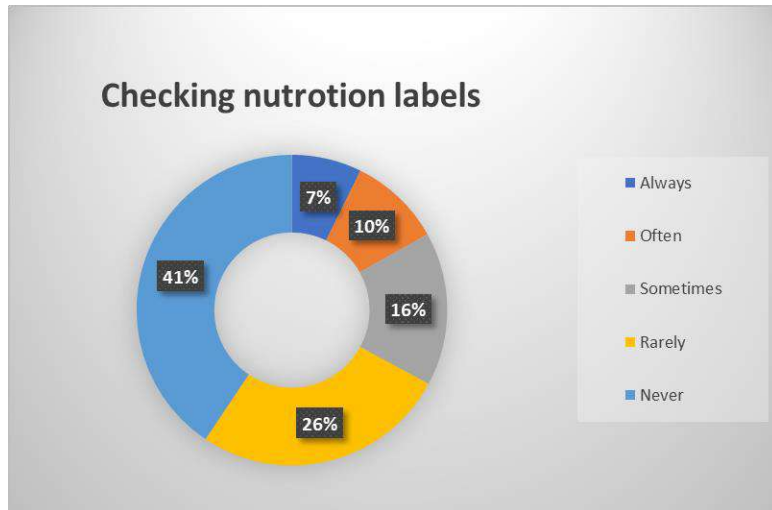
The study includes diverse occupational background, but other participants is dominant



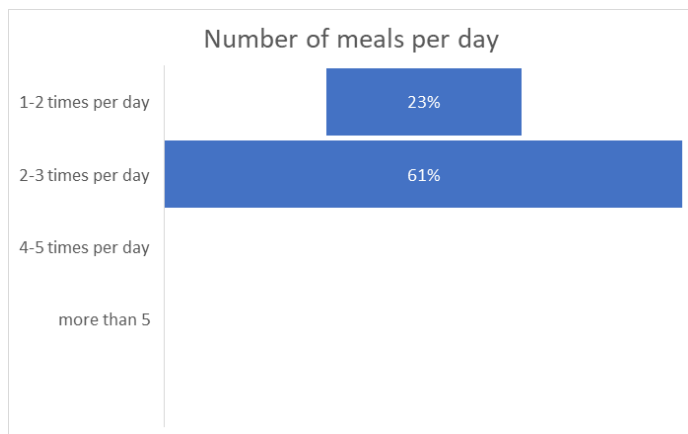
Majority fall under average to poor, overall nutrition knowledge is moderate to low among respondents



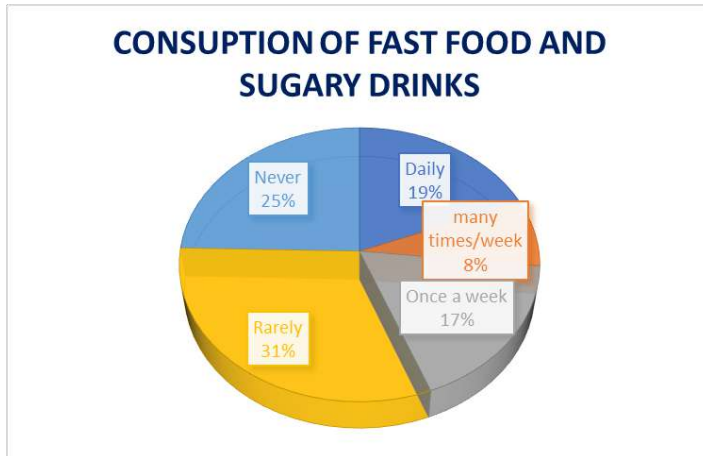
Only about 9% consume fruits daily, showing insufficient regular intake.



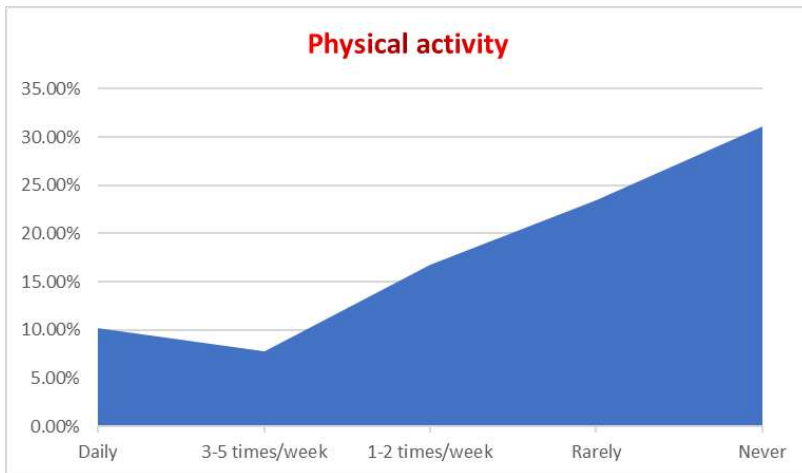
Nearly 67% (Rarely + Never) do not actively check nutrition labels, indicating low practical awareness.



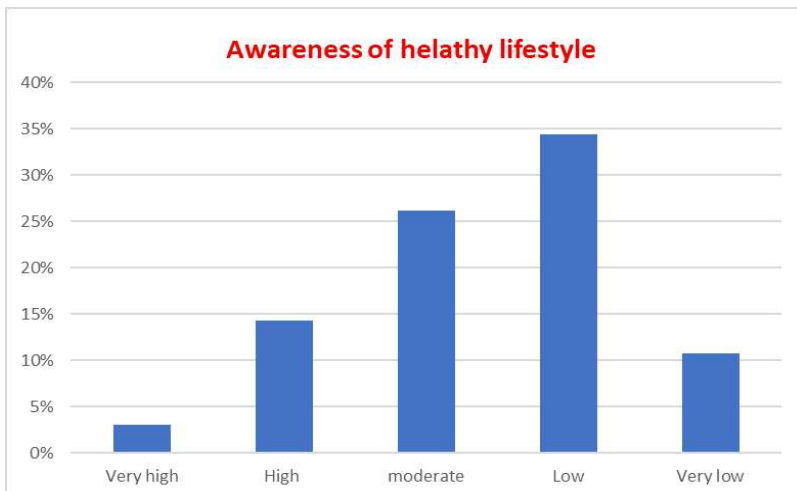
Most respondents maintain a standard 2-3 times per day meal pattern.



Though daily consumption is low, about 38% consume fast food and sugary drinks weekly or more this is notable.



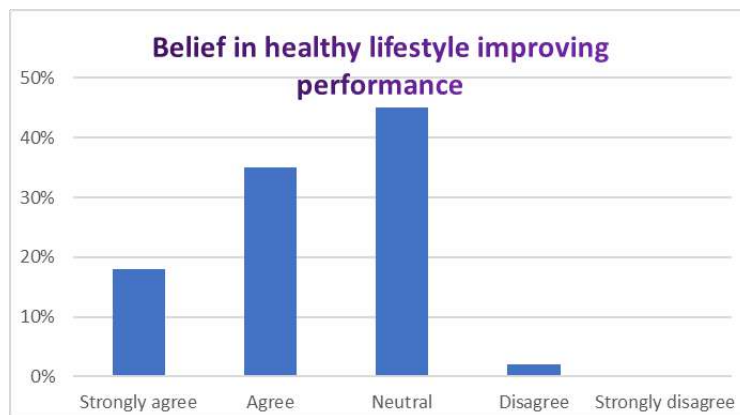
Approximately 57% do not exercise regularly indicating sedentary lifestyle trends.



Majority fall in low to moderate awareness categories



Most respondents meet recommended sleep duration



While many agree, high neutral response suggests uncertainty about direct academic impact.

The findings of this survey reveal noticeable gap between awareness and actual practice of healthy lifestyle behaviors. Overall result emphasizes the importance of targeted nutrition education programs, promotion of physical activity and community-level interventions to bridge the gap between awareness and practice.

Conclusion

The present survey on healthy lifestyle and nutrition awareness indicates that most respondents have a basic understanding of important maintaining a healthy lifestyle. The results suggest that a considerable proportion of participants are aware about balanced diet, regular physical activity, however results also highlight certain gaps between awareness and actual practice, as not all respondents consistently follow healthy habits. Factors such as busy schedule, lack of proper guidance, and lifestyle changes may emphasize the need for increased

health education and awareness programs to encourage individuals to maintain healthier lifestyle practices.

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A Case Study of Screen Time and Its Effects on Lifestyle of People from Dada Patil Mahavidyalaya Karjat Campus and Tehsil Karjat, Dist. Ahilyanagar

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Abstract

Digital detox is the concepts that have emerged in recent times, due to the excessive use of gadgets, such as mobiles phones, computers and iPad, people are becoming disconnection from the world around them. Digital detox means stepping out of this virtual word and understanding the importance of the real world-building meaningful and relative and nurturing emotional bonds while uploading social responsibility in real life interaction. Digital detox refers to a conscious effort to reduce or completely avoid the use of digital devise for a certain provide to the time this paper explores the concepts of digital detox its importance additionally practically strategies for implementing digital detox in daily life are discussed. The study of digital detox usage in Dada Patil Mahavidyalaya to the highlights the extensive screen time among group with students, recording the total usage followed by teacher man and women are present digital engagement across participants, while education and productivity app were manually excessive screen time can adversely affect mantal health, sleep pattern for promoting mental, physical and social wall- being and fostering a healthier more approach to technology use in today's digital age.

Keywords: screen, time, effect, lifestyle.

Introduction

In today's world, technology has become an essential part of our daily lives, from studying to entertainment we depend heavily on digital devices however excessive use of Smartphones and social media is affecting our mental health Physical health and academic performance this is where the concept of digital becomes importance.

In this presentation I will explain how digital Detox is, why it is necessary it's benefits and how we can practice it in our daily lives. This is where the concept of digital Detox becomes important digital means talking conscious break from digital devices for a certain period to focus on real life activity selfcare and personal growth digital Detox its causes and effects the importance of limiting screen time and simple practical ways we can reduce our digital dependency to lead healthier and more balanced lifeIn today's modern world, digital technology has become an important part of everyday life. People widely use smartphones, computers, tablets, and social media for communication, education, entertainment, and work. Although these technologies provide many benefits, excessive use of digital devices can lead to problems such as eye strain, poor sleep, reduced concentration, stress, and decreased social interaction.

Digital detox refers to a period of time during which a person reduces or completely avoids the use of digital devices such as mobile phones, computers, and social media. The main aim of digital detox is to reduce screen time, improve mental and physical health, and encourage people to focus on real-life activities and relationships.

In recent years, the concept of digital detox has gained attention as people have become more aware of the negative effects of excessive screen time. Therefore, it is important to understand the level of awareness, knowledge, and practices related to digital detox among individuals. This study aims to assess digital device usage and the awareness of digital detox and its impact on health and lifestyle.

Literature Review

Digital detox, defined as the intentional reduction or abstinence from digital device use, has gained attention as a potential strategy to address the negative effects of excessive smartphone and social media engagement. Radtke et al. reviewed 21 intervention studies involving 3,625 participants to assess the effectiveness of digital detox programmes on wellbeing, health, social relationships, discipline, and productivity. Their findings revealed mixed outcomes, with some studies reporting positive effects and others showing minimal or even adverse impacts.

Coyne and Woodruff examined a 14-day social media restriction among young individuals and observed improvements in sleep quality, life satisfaction, stress levels, perceived health, and social support, although increased dependence on smartphones was also reported. Díaz-Meneses and Estupinan-Ojeda highlighted psychological and well-being factors influencing digital disengagement, particularly during vacations. Media reports further emphasize the risks of prolonged screen use and advocate structured digital breaks. Overall, while digital detox shows promise, inconsistent results indicate the need for further

systematic research.

Material and Methods

In the present study a house to house and class to class survey conducted in Karjat village to essays smartphone screen time usage a 315 participant wear selected and categories in to four groups - 90 man, 75 student, 75 women, 75 teachers smartphones screen time data for each participant all application where classified into different categories and the duration of usage for each application of analyzed to determine patterns of smartphone use among the participants. Participants were selected using a random sampling method. The questionnaire was distributed online through social media platforms and messaging applications. Participation in the study was voluntary, and responses were collected anonymously.

The collected data were organized and analyzed using basic statistical methods such as percentages, frequency distribution, and graphical representation (charts and graphs). The results were then interpreted to understand the patterns of digital device usage and awareness about digital detox among the respondents.

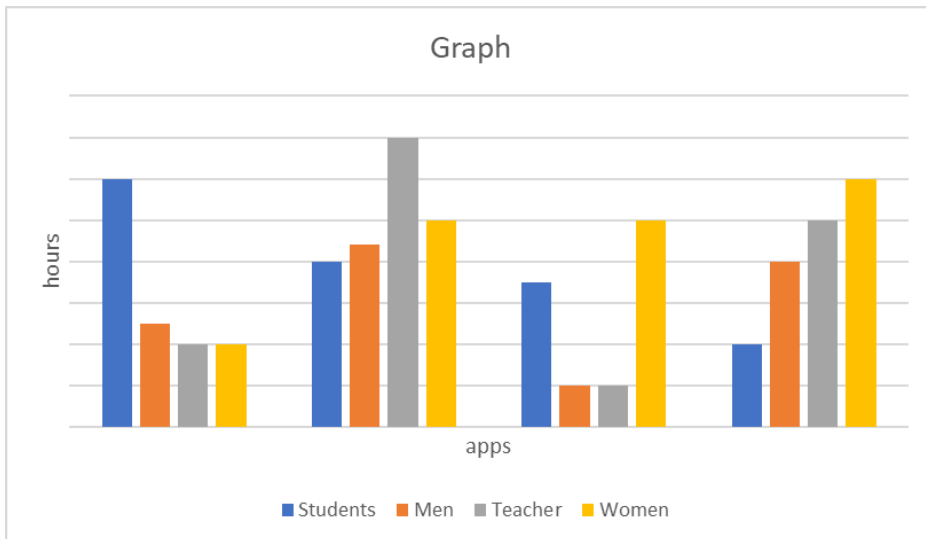
Observation

In today's Era digital detox is no longer just an option it has become a necessity for maintaining mental physical and social well-being constant Exposure to screen notifications and social media engagement negatively affect attention inner calm and personal relationship practicing digital detox a lose allows individuals to connect with themselves restore balance in their lifestyle and experience a lace trace full more mindful way to living there for taking periodic digital brakes while using Technology responsibility is considered a wise and beneficial practices.

Result and Discussion

- Students use YouTube the most.
- According to graph teachers are using WhatsApp the most.
- Women and Men use the YouTube most of the time.

The present study examined the awareness, knowledge, and practices related to digital detox among respondents. The findings indicate that excessive use of digital devices such as smartphones, laptops, and social media platforms has become common in daily life. Many respondents reported spending several hours per day on digital devices, which may affect their physical health, mental well-being, and social interactions. However, the results also show that a significant number of participants are aware of the concept of digital detox and believe that reducing screen time can improve concentration, sleep quality, and overall lifestyle.



The data further suggest that individuals who practice digital detox activities, such as limiting screen time, spending time outdoors, and engaging in offline hobbies, experience better focus and reduced stress levels. Despite this awareness, some respondents still find it difficult to reduce their digital usage due to academic, professional, or social media demands. Therefore, promoting awareness programs, encouraging balanced digital habits, and educating people about the benefits of digital detox can help improve overall health and well-being.

Conclusion

The study of smartphone usage in Dada Patil Mahavidyalaya campus to the highlights the extensive screen time among age groups with students recording the highest total usage, followed by teachers, men and women application such as Instagram, WhatsApp and YouTube dominated digital engagement across participants. file education and productivity where used Minimally excessive screen time can adversely affects mental health sleep pattern and social relationships indicate growing need for Digital Detox practices. The present study highlights the growing importance of digital detox in maintaining a healthy lifestyle. The findings show that many people spend a significant amount of time using digital devices such as smartphones, computers, and social media platforms. Excessive screen time can negatively affect physical health, mental well-being, sleep patterns, and social relationships. However, the study also reveals that most respondents are aware of the concept of digital detox and believe that reducing screen time can improve concentration, productivity, and overall health.

Alternative Activities for Digital Detox Reading books –Engage in reading to relax and stimulate the mind. Going for walks – Spend time outdoors for physical

and mental well-being. Practicing yoga – Improve flexibility, focus, and reduce stress. Exercising – Maintain physical fitness and overall health. Conducting research or learning – Engage in intellectual activities to enhance knowledge. Writing poetry – Express creativity and emotions through writing. Singing songs – Enjoy music to uplift mood and relieve stress. Having discussions with others – Strengthen social connections and communication skills. Optional note: Incorporating these activities in daily life can help reduce screen time, improve mental and physical health, and foster better social interactions.

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Unlocking the Biochemical Potential of Locally Available Crab Species: A Study on Estimation of Protein, Carbohydrates and Ascorbic Acid

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Abstract

The study evaluated two freshwater crab species, *Barytelphusa cunicularis* and *Barytelphusa guerini*, across muscle and hepatopancreas tissues in both genders. Results showed that female crabs had higher biochemical contents than males. Muscle tissue, especially in female *B. cunicularis*, had the highest protein levels, while the hepatopancreas of female *B. guerini* was rich in glycogen and ascorbic acid. Overall, muscle is a major protein source, whereas the hepatopancreas is important for energy and antioxidants. These findings suggest *B. cunicularis* as a good protein source and *B. guerini* as beneficial for energy and antioxidant-rich diets.

Introduction

Crabs are recognized as rich sources of protein and bioactive nutrients, with their muscle and hepatopancreas tissues containing important biochemical components. Studies on species such as *Portunus pelagicus*, *Scylla serrata*, and *Eriocheir sinensis* show that muscle tissue is generally rich in protein, while the hepatopancreas serves as a major site for glycogen, lipid, and vitamin storage. Research also indicates variations between genders, with females often showing higher protein and nutrient content in some species, while males may have higher mineral levels. The hepatopancreas additionally functions in metabolism, energy storage, detoxification, and immune responses. Overall, these studies highlight the nutritional value of crabs and their potential importance for human diet and aquaculture.

Material and Method

- **Duration of Study**

01 January 2025 to 30 March 2025 Animal Collection

Live freshwater crabs were collected from the local crab market in Karjat, located in the district of Ahilya Nagar, Maharashtra. Immediately after collection, the animals were brought to the laboratory in aerated containers to minimize stress during transportation and to preserve physiological integrity.

- **Identification of Crabs**

Identification was performed using standard taxonomic keys specific to freshwater crabs of India. Two species were confirmed: *Barytelphusacunicularis* and *Barytelphusaguerini*. Gender differentiation was carried out by observing the abdominal flap structure: male crabs possess a narrow and pointed flap, whereas females exhibit a broad and rounded one.

- **Collection of Tissues**

The crabs were anesthetized by placing them in a refrigerator at approximately 4°C for 15 – 20 minutes. Following anesthesia, two key tissues were dissected for analysis: Muscle tissue from the chelipeds (claws) and hepatopancreas (digestive gland located beneath the carapace) and washed with chilled physiological saline (0.9% NaCl) and processed fresh for biochemical estimation.

- **Estimation of Biochemical Constituents**

Standardized and widely accepted spectrophotometry methods were used to estimate each component as described below:

- **Protein Estimation:** Lowry's Method
- **Glycogen Estimation:** Anthrone Method (Dezwaan / Zander)
- **Ascorbic Acid Estimation:** Roe's Method

Result and Discussion

Absorbance Readings and Calculated Biochemical Concentrations

The following table includes the species-wise, gender-wise and tissue-wise absorbance readings and the estimated concentrations of protein, glycogen and ascorbic acid.

Species	Gender	Tissue	O.D. of Protein 530 nm	O.D. of Glycogen (620 nm)	O.D. of Ascorbic (530 nm)	Conc. Of Protein (mg/mL)	Conc. Of Glycogen (mg/L)	Conc. Of Ascorbic Acid (mg/L)
<i>Barytelphusa guerini</i>	Male	Muscle	0.0453	0.256	0.031	0.1776	0.2586	0.0886
	Male	Hepatopancreas	0.0654	0.2886	0.218	0.2565	0.2915	0.6229
	Female	Muscle	0.274	0.498	0.092	1.0745	0.503	0.2629
	Female	Hepatopancreas	0.321	0.564	0.255	1.2588	0.5697	0.7286
<i>Barytelphusa unicularis</i>	Male	Muscle	0.088	0.436	0.057	9.7778	0.3328	0.5429
	Male	Hepatopancreas	0.08	0.326	0.042	8.8889	0.2489	0.4
	Female	Muscle	0.099	0.462	0.076	11.0	0.3527	0.7238
	Female	Hepatopancreas	0.088	0.422	0.063	9.7778	0.3221	0.6

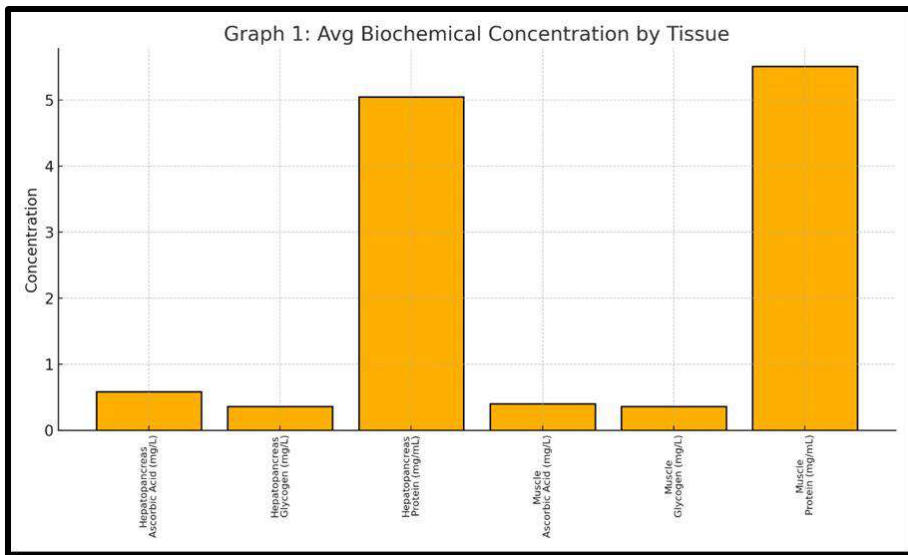
Formula Used for Estimation and Its Significance

The concentration of each biochemical component was calculated using the proportional relationship derived from the Beer-Lambert Law:

$$\text{Concentration} = \frac{(\text{Sample Absorbance} \times \text{Standard Concentration})}{\text{Standard Absorbance}}$$

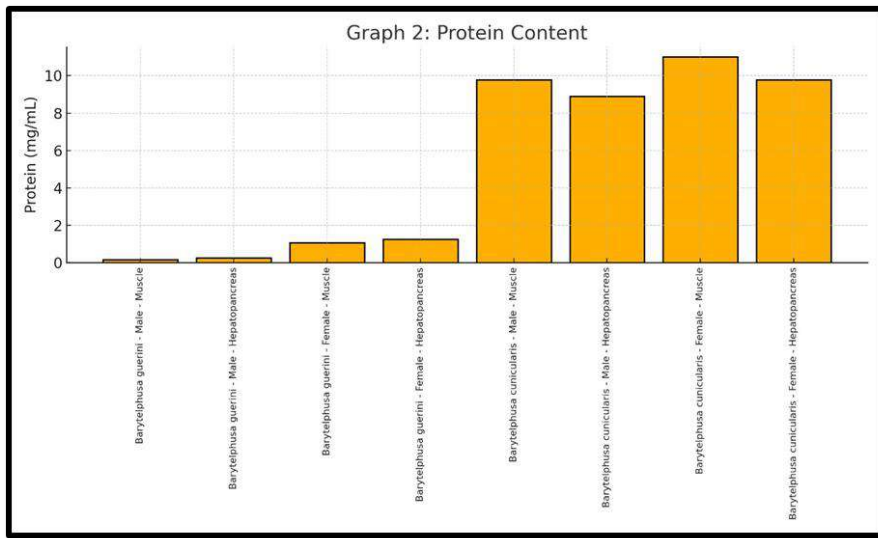
Graphical Representation and Interpretations

Graph 1: Average biochemical concentration across tissues (muscle vs hepatopancreas) from both species.



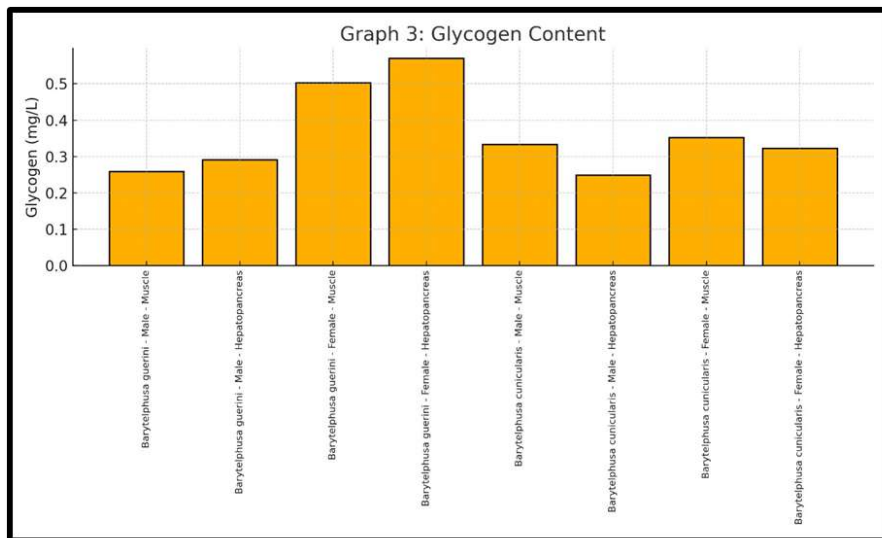
This graph presents the mean concentrations of protein, glycogen, and ascorbic acid based on tissue type. Hepatopancreas tissues exhibited significantly higher glycogen and ascorbic acid levels, which is consistent with their role in nutrient storage and metabolic regulation. Muscle tissue was predominantly protein-rich, especially in *B. cunicularis* females.

Graph 2: Protein concentration in each group (Species-Gender-Tissue).



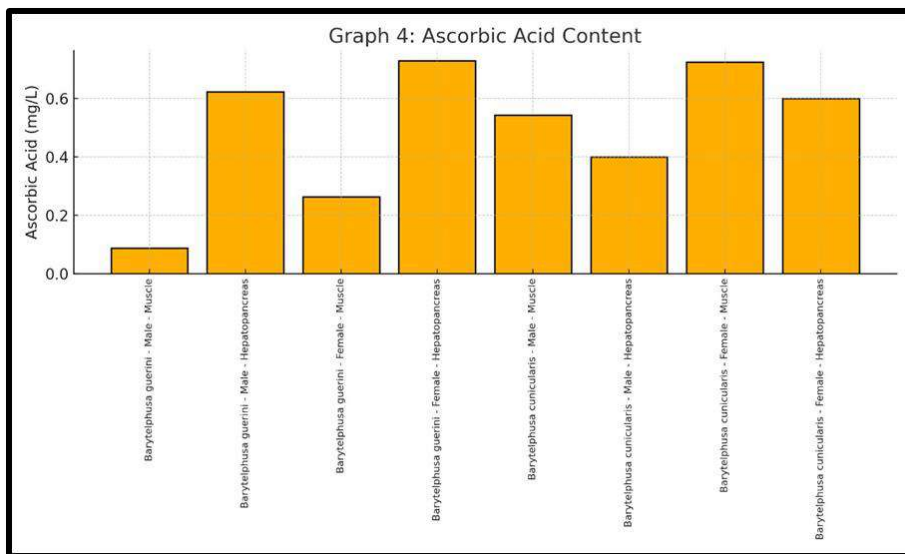
Graph 2 emphasizes the dominance of protein in the muscle tissue of *Barytelphusa acunicularis*, particularly in females. This tissue serves as a primary site of structural and contractile protein accumulation, supporting mobility and physiological strength. Male and hepatopancreas tissues showed notably lower levels.

Graph 3: Glycogen concentration in each group (Species-Gender-Tissue).



The hepatopancreas of female *Barytelphusa guerini* demonstrated the highest glycogen values. This result indicates that females possibly maintain higher energy reserves due to reproductive or metabolic demands.

Graph 4: Ascorbic acid concentration across all study groups.



The pattern in ascorbic acid closely mirrors glycogen levels, with female hepatopancreas of *B. guerini* showing peak values. Ascorbic acid is crucial for oxidative stress management and tissue repair, and its abundance in hepatopancreas underlines its detoxifying function.

Conclusion

The study highlights that both crab species offer distinct nutritional benefits: *Barytelphusa cunicularis* is rich in protein, especially in the muscle of females, while *Barytelphusa guerini* provides higher glycogen and ascorbic acid, particularly in the hepatopancreas of females. Nutrient content varies with tissue and gender, with the hepatopancreas acting as a major storage site and females generally showing higher biochemical levels. Using standard methods (Lowry, Anthrone, and Roe), the study confirms that specific crab tissues can be targeted for particular nutritional needs, supporting their use in aquaculture, diet planning, and commercial applications.

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A Review on Economic Importance of Whey

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Abstract

Whey is a liquid by-product obtained during the manufacture of milk products. Once considered a waste product due to its high BOD and COD, whey is now recognized as a valuable industrial resource. It contains lactose, high-biological-value proteins, minerals and vitamins, making it nutritionally and commercially significant. Advances in membrane processing and biotechnology have enabled the production of whey protein concentrate, whey protein isolate, lactose powder and permeate for use in food, pharmaceutical and nutraceutical industries. Whey proteins possess essential amino acids and bioactive peptides with health-promoting properties. Additionally, whey lactose serves as an economical substrate for microbial fermentation, supporting the production of bioethanol, lactic acid, bioplastics and single-cell protein. Sustainable whey utilization reduces environmental pollution, enhances dairy industry profitability, and supports renewable energy generation. Thus, whey valorization plays a vital role in promoting environmental sustainability and strengthening the circular bioeconomy.

Keywords: Whey, Dairy by-product, Bioethanol, Biotechnology, Renewable energy.

Introduction

The liquid by-product that is produced during the production of casein, paneer, cheese, and chhana is called whey (Fox & McSweeney, 2017). Every kilogram of cheese produced yields about 8 to 9 liters of whey (Chanakira, 2011). Whey was disposed of on land or water bodies for many years since it was considered a low-value waste product. Nonetheless, unprocessed whey poses significant environmental problems because of its high chemical and biological oxygen

demands (COD and BOD), which normally range from 30,000 to 50,000 mg/L (Guimarães et al., 2010).

Chemically, whey contains 4.5–5% lactose, 0.6–0.8% high-quality proteins, minerals (calcium, phosphorus, and magnesium), small amounts of lipids, and water-soluble vitamins (Fox & McSweeney, 2017). Advances in dairy chemistry, membrane technology, and biotechnology have transformed whey from an environmental liability into a high-value industrial raw material (Smithers, 2008). Today, whey plays a significant role in global food, pharmaceutical, nutraceutical, feed, and bioenergy industries.

Global Production and Market Growth

Each year, more than 22 million tonnes of cheese are produced worldwide, producing more than 180 million tons of whey (Chandan & Kilara, 2011). According to FAO reports, growing populations and increased demand for protein are driving up dairy production (FAO, 2022). Whey production is therefore growing internationally as well.

Whey can be fractionated into value-added products such as whey protein concentrate (WPC), whey protein isolate (WPI), lactose powder, permeate powder, and demineralized whey using modern processing techniques like ultrafiltration, nanofiltration, reverse osmosis, electrodialysis, and spray drying (Singh & Boland, 2011). Sports nutrition, clinical nutrition, and infant formula have all contributed to the consistent expansion of the worldwide whey protein market (Smithers, 2008).

Significant whey generation has resulted from rising paneer and cheese manufacturing in developing nations like India. Organized dairy sectors are now investing in whey processing plants, recognizing its commercial potential (Aneja et al., 2002).

Nutritional Importance of Whey Proteins

Because they include every essential amino acid, whey proteins are categorized as high biological value proteins (Walzem et al., 2002). β -lactoglobulin, α -lactalbumin, immunoglobulins, lactoferrin, and bovine serum albumin are major portions (Fox & McSweeney, 2017). Branching-chain amino acids (BCAAs), especially leucine, which promotes muscle protein synthesis and recovery, are abundant in these proteins (Walzem et al., 2002).

Excellent functional qualities such solubility, emulsification, foaming, and gelation are displayed by whey proteins (Smithers, 2008). Because of these qualities, they are useful components of dairy sweets, beverages, baked goods, and baby food. The desire for foods with more protein has raised the whey components' commercial value considerably.

Pharmaceutical and Nutraceutical Applications

Antihypertensive, antibacterial, antioxidant, and immunomodulatory qualities are displayed by whey-derived bioactive peptides (Korhonen&Pihlanto, 2006). An iron-binding glycoprotein with antibacterial and anti-inflammatory properties, lactoferrin is frequently utilized in baby formula and therapeutic nutrition (Madureira et al., 2010).

According to Fox and McSweeney (2017), lactose produced from whey is widely utilized as a pharmaceutical excipient due to its stability, compressibility, and compatibility with active medicinal components. For refined lactose products, the pharmaceutical industry is a reliable and valuable market.

Biotechnological Applications

According to Guimarães et al. (2010), whey lactose is a cost-effective carbon source for microbial fermentation operations. Whey sugars can be effectively converted into bioethanol by lactose-fermenting yeasts like *Kluyveromyces marxianus* (Ozmihci&Kargi, 2007). Whey-based bioethanol helps reduce greenhouse gas emissions and produce renewable energy (Demirbas, 2021).

The synthesis of bioethanol from whey offers two advantages to nations with high dairy output, such as India: the creation of renewable fuel and the management of dairy waste. Additionally, lactic acid, single-cell protein, enzymes, bioplastics (polyhydroxyalkanoates), and biogas can be produced by integrated fermentation systems (Koller et al., 2010; Panesari et al., 2007). Because whey valorization converts agro-industrial waste into clean energy and industrial bioproducts, it so firmly complies with the principles of the circular bioeconomy.

Environmental and Socioeconomic Importance

Due to the high organic load, improper whey disposal pollutes water (Guimarães et al., 2010). If whey effluents are not valorized, treatment expenses are high. While producing financial gains, turning whey into value-added goods lessens the environmental impact (Prazeres et al., 2012).

Dairy biorefineries maximize profitability and minimize waste by encouraging full usage of milk components (Smithers, 2008). Climate change mitigation plans and national environmental policies are supported by sustainable whey management.

Future Prospects

Future developments focus on integrated dairy biorefineries producing food, feed, pharmaceuticals, and renewable energy simultaneously (Demirbas, 2021). Innovations include enzyme engineering for improved lactose conversion and biodegradable plastics production from whey.

Conclusion

Whey has evolved from a problematic dairy waste into a valuable industrial resource. Its applications in food, pharmaceuticals, biotechnology, animal feed, and renewable energy highlight its economic significance. Efficient whey utilization supports environmental sustainability, rural development, and circular bioeconomy growth.

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A Case Study of Blood Pressure Awareness

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Abstract

Blood pressure is an important indicator of cardiovascular health and a major factor in the preventing of heart diseases & stroke. This study aims to assess the awareness and prevalence of blood pressure condition among residents of Patharwadi, Koregoan, Morwad villages using a digital survey method through Google forms. The research focuses on collecting data regarding age, lifestyle habits, family history and blood pressure status of participants. Data collected from 200 respondents from Patharwadi, Koregoan & morwad village peoples of age group between 18–60 years. The study concludes that increasing awareness, early detection & preventive measures are essential for improving cardiovascular health among villagers. The research provides useful insights for healthcare workers & policymakers to design targeted health awareness and screening programs in rural areas.

Keywords: Case, study, blood, pressure, awareness.

Introduction

Blood pressure is the force exerted by circulating blood against the walls of the arteries as the heart pumps blood throughout the body. It is an important indicator of a person's cardiovascular health. Blood pressure is measured in millimetres of mercury (mmHg) & is expressed with two values: systolic pressure & diastolic pressure. Systolic pressure represents the force when the heart contracts and pumps blood. While diastolic pressure represents the pressure when the heart relaxes between beats.

Normal blood pressure is essential for proper circulation of oxygen & nutrients to body tissue. Abnormal blood pressure levels, such as high blood pressure (hypertension) or low blood pressure (hypotension) can lead to various health problems. factors such as age, lifestyle, diet, stress & physical activity can influence blood pressure level regular monitoring of blood pressure helps early detection & prevention of cardiovascular disease.

High blood pressure is a major risk factors for stroke, heart beat attack & kidney damage. It is often called the “silent killer” because it rarely causes symptoms until significant damage has occurred, making regular monitoring.

Review of Literature

Marco De Giusti, Eleonora Dito states that Hypertension represents a major cardiovascular risk factor with relevant consequences on morbidity and mortality in the general population. An optimal control of blood pressure (BP) is far from being achieved.

Chythra R. Rao, Veena G. Kamath, Avinash Shetty & Asha Kamath was represented that Hypertension is an enormous health problem & is one of the biggest health challenges in the 21st century. Although the condition is common, readily detectable & easily treatable, it is usually asymptomatic and often leads to lethal complication if left untreated.

Tanuja R. Brahmana, Priya M. Prabhu states Hypertension the “silent killer” is a modern day’s epidemic & is becoming a public health emergency worldwide, especially in the developing countries. Sedentary life-style & stress are important risk factors for hypertension. The job of bank employees is both sedentary in nature about and accompanies high levels of mental stress thereby at a higher risk of developing hypertension. Hence the present study was concluded to study the prevalence & risk factors of hypertension among the bank employees in western Maharashtra.

M. Dolores Marrodán states that the objectives is to analyse the association between the degree of compliance with mediterranean Diet and blood pressure in 1078 Spanish schoolchildren (514 boys, 564 girls) aged 9 - 16 years. We measured weight (kg), height (cm), waist circumference (cm), skinfold thicknesses (bicipital, tricipital, subscapular & suprailia) & blood pressure. The waist-to-Height Ratio (WtHR), Body Mass index (BMI) & the percent body fat (% BF) were calculated. Subjects were classified as “underweight”, “normal weight”, “overweight” or “obese” according to the International obesity Task force (IOTF). Diet quality was assessed by the KIDMED Index & the hypertensive status according to National High Blood pressure Education program working Group.

Material and Method

Study Area

Study was conducted in the villages of Patharwadi, Koregoan and Morwad villages in Karjat Tehsil, Ahilyanagar, Maharashtra, India.

Study Design

The study was community -based cross -sectional survey conducted to assess

blood pressure level and awareness among people in the selected villages.

Study Population

Participants included adult residents of the selected village. Individual above 18 years of age who were willing to participate were included in the study.

Material Used

Mobile phone, internet connection, Google form questionnaire, consent from participants

Data Collection Method

Data were collected using a structured questionnaire created through the Google form platform. The form included questions on:

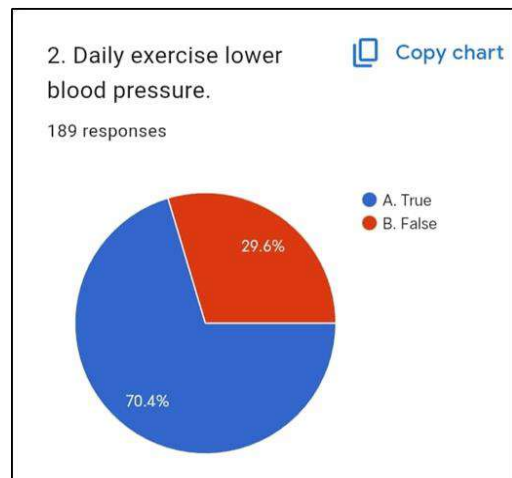
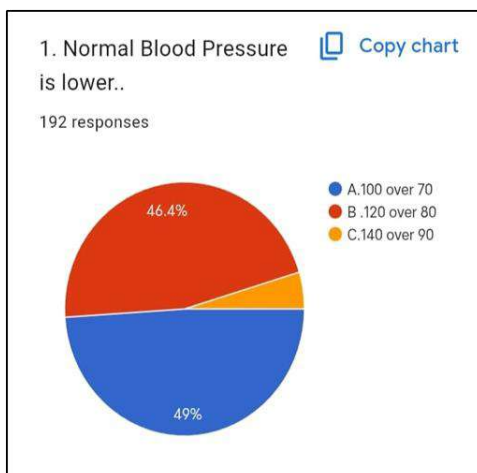
- Age and Gender
- Lifestyle Habits
- Medical History

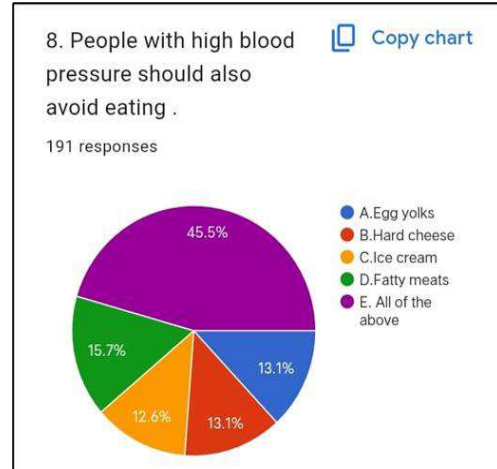
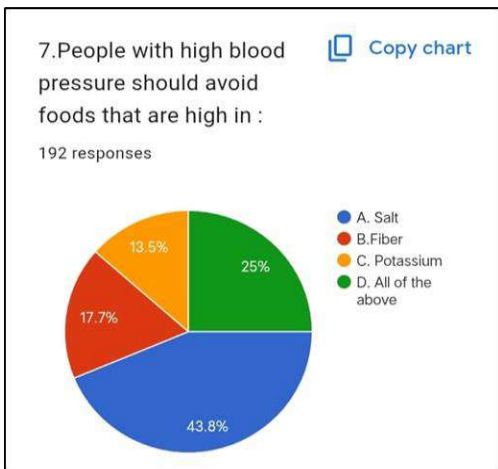
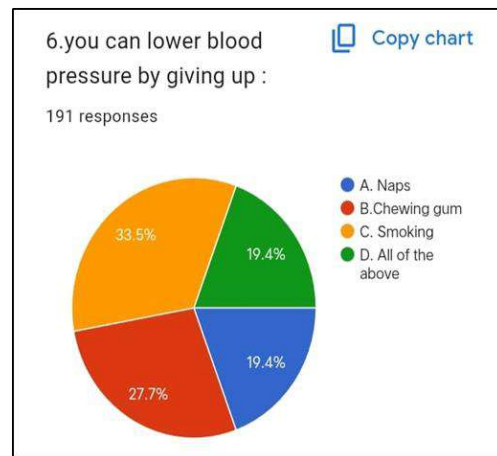
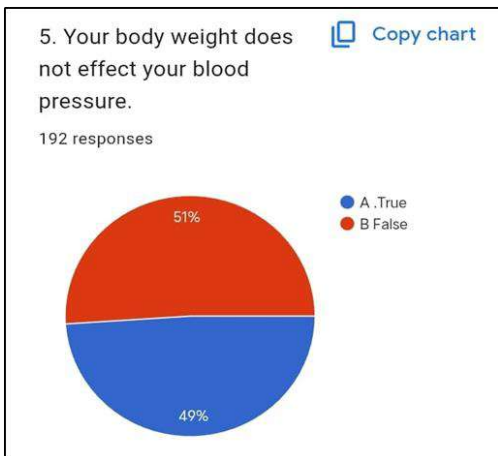
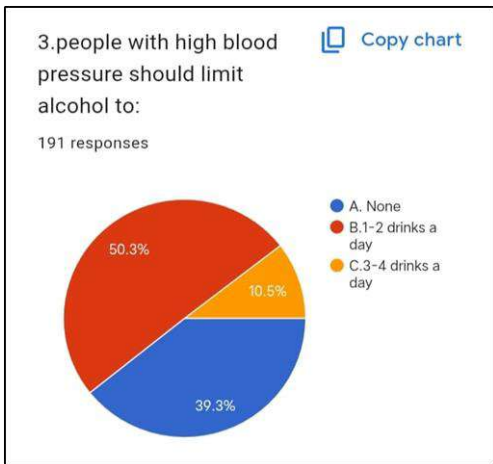
Sampling Method

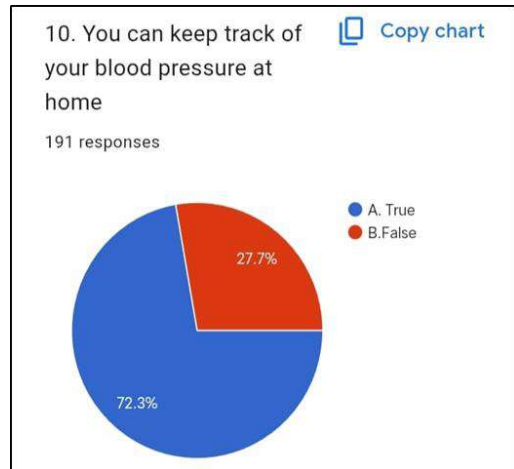
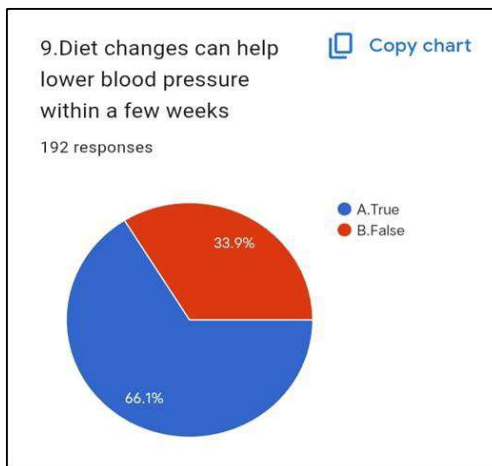
A simple random convenient sampling Methods was used to collect responses from participants available during the survey periods.

Data Analysis

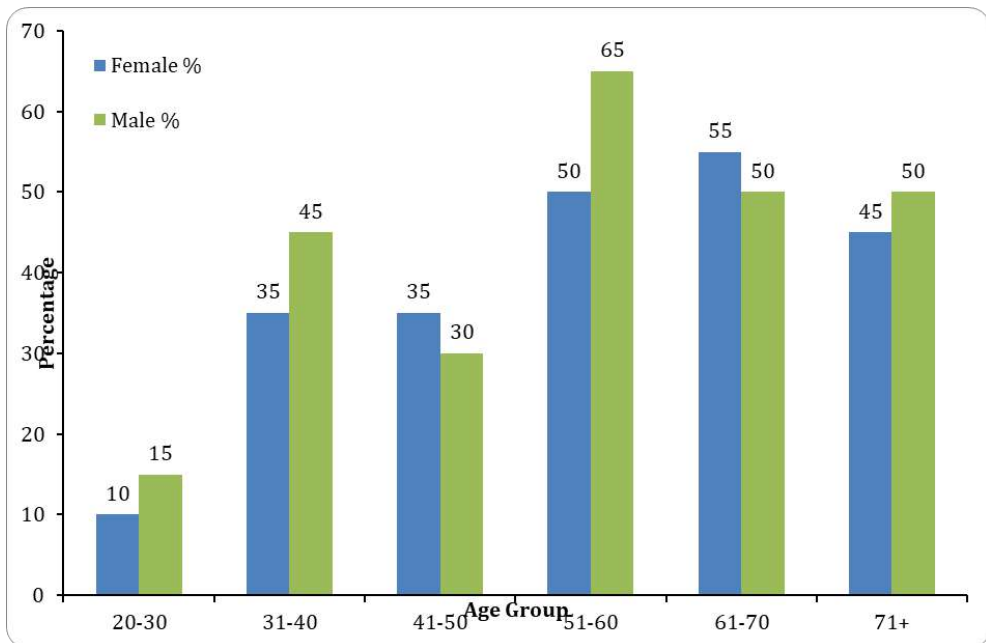
The connected responses from Google form were compiled and analysed using basic methods such as percentage and average. The result is presented in graph and table.







Observation and Result



- Most participants were aware of blood pressure and its health effect.
- Many people do not regularly monitor their blood pressure.
- 35% peoples are conscious for blood pressure check-up.
- 65% peoples are not conscious for blood pressure check-up.

Conclusion

The survey of blood pressure conducted in Patharwadi, Koregoan and Morwad villages using 200 respondents through a Google form. The results show that most participants were aware of blood pressure and its effects on health but not

everyone regularly monitors their blood pressure. A few respondents reported having high blood pressure, which may be linked to factors such as stress unhealthy diet lack of exercise and irregular lifestyle habits. The study highlights the importance of regular health checkup and maintaining a Healthy lifestyle to control blood pressure. Increasing awareness about balanced diet, physical activity, and stress management can help reduce the risk of hypertension and related diseases. Overall, the survey helps in understanding community awareness and the need for preventive health measure.

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Resting Pulse Rate and Anxiety: A Community-Based Study in Karjat Region, Maharashtra

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Abstract

The present study explores the relationship between resting pulse rate and anxiety among individuals from Dada Patil College and surrounding villages in the Karjat region of Maharashtra. Conducted over a four-month period from December 2025 to March 2026, this survey investigates the interdependence of physiological and psychological parameters and their influence on health and sports performance. Resting pulse rate and anxiety are closely linked psycho-physiological variables that significantly affect athletic efficiency and overall well-being.

The study also examines attitudes toward physical exercise and its correlation with cardiovascular fitness. Findings indicate that individuals engaging in regular physical activity (at least 20 minutes, three times per week) exhibit an average resting heart rate approximately 7 beats per minute lower than sedentary individuals. This reduction reflects improved cardiovascular efficiency and reduced stress levels.

A total of 200 individuals were surveyed, of which 150 participants were included in the final analysis. The results highlight variations in pulse rate across age groups and emphasize the role of anxiety in altering cardiovascular responses. Elevated anxiety levels were associated with increased heart rate, blood pressure, and oxygen consumption, ultimately affecting physical performance.

This study underscores the importance of promoting physical activity and stress management strategies to maintain optimal heart health and improve quality of life. It also suggests the need for further research on community health interventions targeting cardiovascular and psychological well-being.

Introduction

In recent decades, increasing emphasis has been placed on maintaining cardiovascular health, with regular exercise being widely advocated as a

preventive measure against heart diseases. Health education programs consistently highlight the importance of physical activity in reducing the risk of lifestyle-related disorders. However, merely providing information is often insufficient to bring about behavioral change, as observed in the limited success of anti-smoking campaigns.

Resting pulse rate, defined as the number of heart beats per minute during a state of complete rest, serves as a vital indicator of cardiovascular efficiency. It reflects the heart's ability to pump blood effectively and is influenced by factors such as age, fitness level, emotional state, and overall health. Studies have shown that resting heart rate can predict the development of ischemic heart disease, making it an essential parameter in preventive healthcare.

Anxiety, on the other hand, is a psychological condition that can significantly impact physiological responses. When an individual experiences anxiety, the body undergoes several changes, including increased heart rate, elevated blood pressure, rapid breathing, and higher oxygen consumption. While mild anxiety may act as a motivating factor, excessive anxiety can impair performance, particularly in athletes.

The relationship between resting pulse rate and anxiety is particularly relevant in sports science. Athletes with high anxiety levels often exhibit increased resting heart rates, which may negatively affect endurance and performance. Therefore, understanding this relationship is crucial for developing strategies to enhance athletic performance and mental well-being. This study aims to examine the correlation between resting pulse rate and anxiety among individuals involved in different physical activities, particularly ball games. Additionally, it evaluates community attitudes toward exercise and its role in maintaining cardiovascular health.

Normative Ranges of Pulse Rate

Understanding normal pulse rate ranges is essential for interpreting physiological data. The following table summarizes the standard resting pulse rates across different age groups:

Age Group	Pulse Rate (Beats per Minute)
Newborn	100–180 bpm
Infant	80–150 bpm
Children (2–6 years)	75–120 bpm
Children (6–12 years)	70–110 bpm
Adolescents & Adults	60–90 bpm

These values serve as a reference for identifying deviations that may indicate underlying health issues or stress-related conditions.

Review of Literature

Several studies have examined the relationship between resting pulse rate, anxiety, and physical activity: Suman Ghosh and Kuntal Thakur (2014) conducted a comparative study highlighting that anxiety and resting heart rate are interrelated psycho-physiological variables that adversely affect sports performance.

A community survey by Laird and Campbell (1988) investigated exercise levels and resting pulse rate, revealing that regular physical activity is associated with lower resting heart rates and improved cardiovascular health. The study also noted that most participants were capable of accurately measuring their resting heart rate. Campbell (1985) explored the prediction of running speed based on questionnaire data and emphasized the role of cardiovascular fitness in athletic performance. Kannel, Wilson, and Blair (1985) conducted an epidemiological assessment demonstrating that physical activity plays a significant role in preventing cardiovascular diseases and improving overall fitness levels. These studies collectively support the hypothesis that regular exercise reduces resting pulse rate and that anxiety can negatively influence cardiovascular responses.

Materials and Methods

Study Area

The study was conducted in the Karjat region of Maharashtra, specifically at three locations: Yashin Nagar, Patewadi, and Nimgaon Daku. Data collection took place during morning hours to ensure consistency in measurements. Participants included college students, school children, and village residents.

Study Design

A pilot study was conducted to assess the reliability and validity of resting pulse rate measurements. Twelve participants had their pulse rates recorded on three separate days at the same time to ensure consistency.

Methods of Pulse Measurement

Manual Method Radial Pulse: Measured at the wrist using index and middle fingers.

Carotid Pulse: Measured at the neck beside the trachea.

- Digital Method Pulse oximeter (finger probe) Automated BP monitor
- Apical Pulse Measured using a stethoscope in clinical settings.

- Data Recording Data included date, time, pulse rate (bpm), and rhythm. Participants were required to rest for 5–10 minutes before measurement to ensure accuracy.
- **Additional Tools:** Photographic documentation was carried out using mobile cameras with GPS tagging to record survey locations and group data collection activities.

Observations

The study recorded data from various demographic groups across the selected regions. GPS-based documentation confirmed the geographic accuracy of the sampling locations. Observations indicated variability in resting pulse rates influenced by age, lifestyle, and physical activity levels. Participants who engaged in regular exercise demonstrated lower resting pulse rates compared to those with sedentary lifestyles. Additionally, individuals reporting higher levels of anxiety exhibited elevated pulse rates and signs of physiological stress.

Results

Out of 200 surveyed individuals, 150 participants were included in the final analysis. The findings revealed: Individuals with regular exercise habits had significantly lower resting pulse rates. Awareness of normal pulse rate ranges was moderate among participants. A majority (65.5%) correctly identified the normal adult resting pulse rate as 60–100 bpm. Among children aged 6–15 years, 64.8% identified the correct range (70–100 bpm).

The Study Also Examined Clinical Correlations

Mortality rate among participants with normal blood pressure and heart rate was 20%. Mortality increased to 36% in individuals with abnormal cardiovascular parameters. Highest mortality was observed in hypotension-bradycardia cases (80%), followed by hypertension-bradycardia (58%) and tachycardia-hypotension (48%). Elderly individuals showed higher mortality (35%) compared to adults (23%). These findings emphasize the importance of maintaining normal cardiovascular parameters for overall health and survival.

Discussion

The results of this study reinforce the strong relationship between resting pulse rate, anxiety, and physical activity. Regular exercise was found to significantly reduce resting heart rate, indicating improved cardiovascular efficiency. This aligns with previous research suggesting that physically active individuals have stronger heart muscles and better circulation. Anxiety emerged as a critical factor influencing heart rate. Individuals with higher anxiety levels showed increased pulse rates, which can lead to long-term cardiovascular complications if not managed properly. In sports contexts, excessive anxiety can impair performance

by increasing fatigue and reducing endurance. The study also highlights the need for increased awareness about normal pulse rate ranges and the importance of regular monitoring. Community-based health education programs can play a vital role in promoting healthy lifestyles and preventing cardiovascular diseases.

Conclusion

This study concludes that resting pulse rate and anxiety are closely interconnected variables that significantly impact physical and mental health. Regular physical activity is an effective strategy for reducing resting heart rate and managing anxiety, thereby improving overall well-being. The findings emphasize the importance of early detection and monitoring of abnormal cardiovascular parameters. Individuals with irregular pulse rates should seek medical attention to prevent complications.

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