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## Role of physico-chemical parameters in biodiversification of aquatic insects (Coleopteran and Hemipteran) in Konkan, Maharashtra, India

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### Abstract

The Konkan is a shred of land on the west Indian coast of India that stretches from Thane in the north, Karwar in the south, the Arabian Sea to the west, and the Western Ghats to the east. This region is gifted with an eclectic range of floral and faunal marine biodiversity with a whopping total of 367 species of marine flora and fauna are being so far discovered from this region. Its marine biodiversity includes marine algae (73 species), mangroves (18 species), corals (11 species), molluscs (73 species), polychaetes and arthropods (47 species), sea anemones (18 species), and fishes (74 species). Not many studies are so far conducted for aquatic insects in this region. So, the goal of the present study was to understand the role of physicochemical parameters in the diversification of Aquatic insects and the role of these insects in sustaining this ecologically important zone in Maharashtra. Our study clinched seven species from four Coleoptera families and ten species from seven Hemiptera families from 8 different sites in the Konkan region. Physico-chemical characteristics were also analyzed from these different sites and their average was taken as a parameter for aquatic insect species diversity. The level of dissolved oxygen was on the low side, indicating organic contamination in the area. This research also aims to validate the impact of physicochemical conditions in aquatic insect population biodiversification.

**Keywords:** aquatic insects, konkan, coleoptera, hemiptera, conservation

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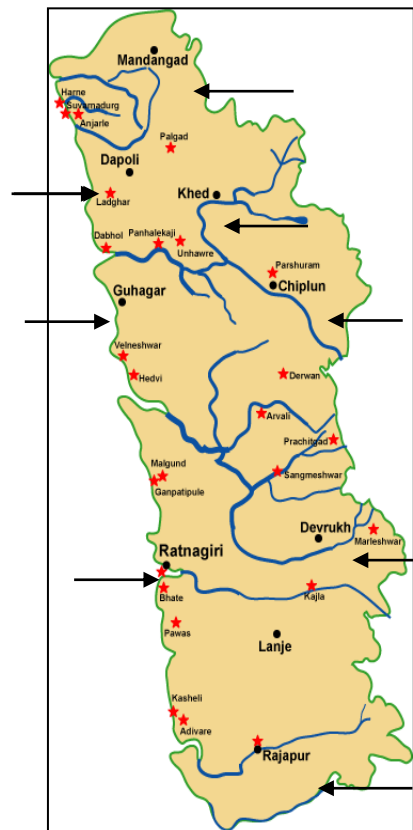
### Introduction

The literal meaning of Biodiversity is the diversity of life that includes everything from genes, microbes to top predators. The human being, the most efficacious animal also relies upon biodiversity for satisfying its all needs. On the other hand, Human activities are losing biodiversity 1000 times faster than natural rates. Biodiversity loss is already jeopardizing hard-won socio-economic benefits and obstructing future growth. Biodiversity loss is a worldwide concern. In the present time, the pace of animals species extinction is between 100 and 10,000 times that of the background extinction. According to Sanchez-Bayo & Wyckhus Kris (2019) <sup>[26]</sup>, insect species are declining at double the rate of vertebrates, and the rate of insect's species extinction is eight times faster. Anthropological activities cause around 1% of all insect species to be added to the extinction list each year, leading to biodiversity degradation and a 2.5 per cent yearly loss of biomass worldwide (Bayo & Wyckhus Kris, 2019) <sup>[26]</sup>.

Until recently, the scientific attention has been more focused on the extinction of vertebrates, especially mammals and birds (Ceballos and Ehrlich, 2002; Manne *et al.*, 1999) <sup>[7, 22]</sup> whereas insects have been routinely underrepresented in biodiversity and conservation studies despite their importance. Aquatic insects are known to play a significant role in nutrient digestion and cycling, as well as contributing to the freshwater environment's secondary production (Star and Wallace, 2021). At present, there are more than 88,500 species of aquatic insects are classified into 13 orders. Even though there is a strong link between taxonomy and fundamental biology and ecological investigations, groups of aquatic insects remain poorly studied. Our acquaintance of aquatic insect life cycles and their role in production and bioenergetics may be hindered by a lack of species-level data.

With around 3.65 lakh hectares of water area, Konkan is rich in aquatic resources, with its wetlands displaying great faunal variety, aided by a sub-tropical temperature, favourable ecological and topographical circumstances, and self-stocking capability (Barman and Baruah, 2015) <sup>[4]</sup>. However, the majority of the studies on the Konkan region ignores one of the most essential components: its aquatic insects. There are around 850 aquatic bug species classified into 13 groups (Hury, 2019; Dijkstra, 2015) <sup>[18]</sup> in this region.

Anthropological activities cause a wide range of environmental disturbances. The tolerance levels of aquatic insects are regarded as a very excellent indicator of water quality (Crowder and Cooper, 1998). This tolerance of insects is now utilized as a biological instrument and they are served as biological indicators to assess water quality (Barman and Gupta, 2015). Despite the significant importance of freshwater ecology, there is diminutive information available on the quantity and variety of aquatic insects in the Konkan (Choudhury and Gupta, 2015) region of Maharashtra. The purpose of this study was to fill a knowledge gap in the taxonomy and diversity of aquatic insects in this region and the role of physicochemical parameters in the diversity of aquatic insects in Konkan.



**Fig 1:** Sampling sites for physicochemical parameters and aquatic insects biodiversity.

### Study site

The Konkan has several river basins and riverine islands. For our research, we chose a total of eight locations (arrowed). The sampling sites for our studies are Mandangad, Dapoli, Khed, Guhagar Chiplun, Ratnagiri, Rajapur and Devrukh.

### Materials and Methodology

The study lasted from January through November of 2019. For our research, a total of eight locations were selected through the entire Konkan region. At all sites, sampling took place in the evening between 6 and 7 p.m. The sampling zones were stratified based on the prevalence of insects. Inside the sample locations, repeated sampling was randomly separated from one another by enough distance that they did not interact with one another. Aquatic insects were collected in three repetitions from eight sampling sites shown above (Dalal and Gupta, 2016) <sup>[10]</sup>.

Researchers utilized an "all-out search" method (Subramanian and Sivaramakrishnan, 2007) for sampling aquatic insects. For sampling, a nylon pond net (mesh size: 500 mm; diameter: 30 cm; depth: 15 cm) was used to sample aquatic insects on the water surface. The samples were collected by submerging the net and whipping it through the water column. The net was scraped against the bottom substrate once again to dislodge and collect the organisms from the soil. Insect population was harvested using a bottom mud scraper with a tow-line. To capture insects from the soil, a small sieve and a hand-operated 'D' framed sweep net (50 cm length, 25 cm width, and mesh size 200 m) was used as described by Junk 1977. The insects that were captured during the sampling process were washed and cleaned in the laboratory, the insects were sorted from the finer remaining detritus using elutriation and handpicking from a white enamel pan, then transferred to 70% alcohol. Insects were recognized using standard keys and a dissecting microscope with a stereo zoom lens (Bal and Basu, 1994a; Subramanian and Sivaramakrishnan, 2007) <sup>[3, 29]</sup>.

### Physico-Chemical parameters

Air temperature (AT) was measured using a mercury bulb thermometer (Dalal and Gupta, 2016) <sup>[10]</sup>. Dissolved oxygen (DO) was estimated using Winkler's method and other water parameters were analyzed following APHA (2005), Trivedi and Goel, (1984) <sup>[30]</sup>.

### Statistical analysis

Statistical analysis is done with the help of IBM-SPSS version 16.

### Results

#### Physico-chemical parameters

The Physico-chemical parameters during the four seasons of the year are depicted in Table 1.

**Table 1:** Physico-chemical parameters of Konkan (2019)

Parameters	Monsoon	Retreating Monsoon	Winter	Pre-Monsoon
Air Temp C°	28.52 ± 1.91	26.2 ± 1.55	19.6 ± 1.23	21.44 ± 1.22
Water Temp C°	26.21 ± 0.89	24.11 ± 0.57	18.7 ± 0.64	17.94 ± 1.22
pH	6.85 ± 0.17	6.55 ± 0.15	6.45 ± 0.17	6.81 ± 0.22
DO (mg/L)	5.11 ± 0.12	5.36 ± 0.17	5.77 ± 0.47	5.41 ± 0.41
FCO <sub>2</sub>	2.11 ± 0.11	1.96 ± 0.14	1.84 ± 0.17	1.17 ± 0.14
Water depth (m)	2.58 ± 0.86	3.14 ± 0.19	2.47 ± 0.14	1.37 ± 0.14

**Aquatic Insects (Coleoptera and Hemiptera)**

During the study, seven species from four Coleoptera families and ten species from eight Hemiptera families were discovered. The alpha diversity indices are presented in Table 3.

**Table 2:** Aquatic insects (Coleoptera and Hemiptera) found in Konkan (2019)

Order	Family	Scientific Name
Coleoptera	Hydrophilidae	<i>Berosus pulchellus</i> McLeay, 1825, <i>Helochaeres pallens</i> (Macleay, 1825), <i>Coelostoma stratum</i> Walk, 1858
	Crambidae	<i>Hymenopteryx dida</i> (pneumatophore moth)
	Dysticidae	<i>Laccophilus</i> sp. (Sharp, 1882) <i>Cybister ventralis</i> (Sharp, 1882)
	Gyrinidae	<i>Orectochilus (Patrus) productus</i> Regimbart, 1883
Hemiptera	Corixidae	<i>Micronecta siva</i> (Kirkaldy, 1897)
	Pyrrhocoridae	Red bug
	Pseudococcidae	Mealybug (Scale insect)
	Notonectidae	<i>Anisops bouvieri</i> (Kirkaldy, 1904)
	Hydrometridae	<i>Hydrometra greeni</i> Kirkaldy, 1898
	Nepidae	<i>Ranatra filiformis</i> (Fabricius, 1790), <i>Ranatra varipes</i> (Stål, 1861)
	Belostomatidae	<i>Lethocerus indicus</i> , <i>Diplonychus rustic</i> (Fabricius, 1781)
	Gerridae	<i>Norris parvula</i>

**Table 3:** Diversity Indices of the aquatic insects of Konkan

Parameter	Pre-Monsoon (March-May)	Monsoon (June-July)	Retreating Monsoon (August-October)	Winter (November-December)
Individuals	244	221	162	59
Shannon_H	2.147	2.314	2.246	2.314
Evenness_e^H/S	0.874	0.842	0.861	0.794

**Discussion**

The dynamics of its physicochemical and biotic environment limit the biodiversity of aquatic insects in freshwater (Wetzel, 2001) [36], hence studying seasonal fluctuations in physicochemical characteristics of freshwater becomes critical (Deka, 2015) [12]. During the research, Konkan was discovered to have a low average water temperature. Water temperature has a significant impact on all metabolic and physiological activities, including life functions such as eating, reproduction, migration, and dispersion of aquatic species (Sivakumar and Karuppasamy, 2008) [27]. Throughout the research period and across the whole range of seasons, the temperature variance measured was within the permissible limit (FEPA, 1991) [23].

The dissolved oxygen level (DO) in sample sites in Konkan was likewise kept below the threshold necessary for aquatic insects to live sustainably. These low DO levels imply poor water quality and, as a result, serve as a marker for organic contamination. Organic pollution may be responsible for the extinction of a small number of aquatic insect species.

The levels of free carbon dioxide (FCO<sub>2</sub>) in Konkan's freshwater were likewise found to be on the low side. Low amounts of FCO<sub>2</sub> can be ascribed to autotrophs like phytoplankton and macrophytes quickly consuming it (Adoni and Vaishya, 1985) [32]. Because of the inadequate diversity of aquatic vegetation in freshwater settings, which is indicated by low FCO<sub>2</sub> levels, low FCO<sub>2</sub> levels may be the cause of fewer insect species.

In freshwater areas in the Konkan, the pH value fluctuates between mild acidic and near neutral. High phytoplankton density, which uses CO<sub>2</sub> during photosynthetic activity, may be to blame for the increased pH of water observed during the summer and monsoon months (Wani and Subla, 1990) [35]. The reduction in pH in the autumn and winter might be attributed to lower photosynthetic activity and a faster rate of decomposition (Deka, 2015) [12]. Seven species from four Coleoptera families and 10 species from eight Hemiptera families were identified throughout the research. The overall number of people reported was largest in the pre-monsoon season

and lowest in the winter season, which is because water levels in the Konkan reach their lowest point during the winter season, with temperatures below zero in certain regions. Species diversity is high in Konkan during all seasons except winter, according to the  $H'$ -diversity indices. The Shannon  $H'$  diversity index ranges from 0 to 5, with good community composition ranging between 1.5 and 3.5. (Turkmen and Kazanci, 2010).

The index in this study ranged from 2.479 to 2.39 across the study period, indicating high species variety. As a result, the evenness exhibited a healthy range from 0.85 to 0.77 across the research period, indicating that the species were dispersed equally. As a result, the structure and composition of the examined aquatic insect populations are well mirrored in the variance in Konkan's physicochemical water characteristics. As a result, physicochemical conditions are important determinants of aquatic species diversity in every freshwater environment.

### Conclusion

Aquatic insect populations vary widely within and between habitats, as well as depending on how humans have affected nearby areas, and these groups play important roles in the freshwater ecosystems they occupy, whether through nutrient cycling or total contribution to secondary production. Aquatic insects contribute to ecosystem trophic structure by performing a variety of functions ranging from detritivores to predators, as well as providing food for vertebrate and invertebrate predators. Because many aquatic insects have both aquatic (larval and adult) and terrestrial (adult) life phases, their effect extends beyond the aquatic to the terrestrial riparian ecosystem. Members of the Dytiscidae family of the order Coleoptera, as well as aquatic hemipterans such as those belonging to the Belostomatidae and Nepidae families, play an essential role in mosquito control (Jaiswal, 2013). However, their importance in regulating the aquatic ecosystem is frequently overlooked. The reduced levels of DO in the Konkan are due to organic pollution, and any further changes in the physicochemical qualities of water might hurt the Konkan's aquatic insect population structure. As a result, Konkan's productivity will diminish, eventually leading to its degeneration. As a result, immediate action is needed to document the aquatic insect variety of the region's freshwater environment, as its existence or absence can indicate whether the system is healthy or not (Prakash and Verma, 2020), and then essential corrective actions should be taken.

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### Conflict of Interest

The authors declare that there is no conflict of interest.

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