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Cover: Mixed media with fine liners, colour pencils, and watercolour background of an Indian funnel web spider. © Elakshi Mahika Molur.

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COMMUNICATION

Diving into diversity: aquatic beetles of Sukhna Wildlife Sanctuary, Chandigarh, India

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Abstract: The Sukhna Wildlife Sanctuary, located in the Shivalik Hills of Chandigarh, India, encompasses several freshwater ecosystems, including ponds, streams, and marshes. The objective of this study is to fill the current information void regarding the populations of aquatic beetles in the sanctuary. During the period from June to September 2023, a comprehensive study was conducted in the Sukhna Wildlife Sanctuary, resulting in the identification and documentation of 164 specimens of aquatic Coleoptera. These specimens belonged to six species, five genera, and two families in which the Dytiscidae family was found to be the most prevalent. The study findings offer significant insights into the population magnitude and geographical dispersion of aquatic beetles within the investigated settings and show the need for comprehensive surveys to understand the intricate interplay of factors governing beetle distribution.

Keywords: Biodiversity, Coleoptera, Dytiscidae, ecological indicators, freshwater ecosystems, Hydrophilidae, *Hydroglyphus*, *Laccophilus*, Shivalik hills, species richness.

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INTRODUCTION

Aquatic beetles belonging to the Coleoptera order and its Adephaga and Polyphaga suborders are a remarkably diverse and ecologically significant group of insects that exert a substantial impact on freshwater ecosystems worldwide. With over 13,000 species worldwide, these insects inhabit a variety of aquatic habitats, including rivers, lakes, ponds, and marshes (Short 2017). In India, a nation renowned for its abundance of species, aquatic beetles are no exception to the abundance of species. India is a hotspot of aquatic beetle diversity, with approximately 776 species distributed across 137 genera and 17 families (Chandra et al. 2017). Aquatic beetles play crucial roles in freshwater ecosystems by engaging in nutrient cycling and serving as integral components of aquatic food webs. Furthermore, their sensitivity to environmental changes provides valuable insights into ecosystem health (Ribera et al. 2003).

The Sukhna wildlife sanctuary in the Shivalik Hills of Chandigarh, India (Figure 1) contains a variety of freshwater habitats, such as ponds, streams, and wetlands, and is of great ecological significance. Its strategic location, which acts as a link between the Himalaya and the northern plains, increases its ecological significance. Despite the environmental significance of the sanctuary and the crucial role aquatic beetles play in shaping freshwater ecosystems, there has been a dearth of research on the composition and distribution of aquatic beetle communities within the sanctuary. Understanding the intricate structure of these communities is crucial for conserving the sanctuary's aquatic ecosystems. Several environmental factors, including microhabitat characteristics, habitat size, vegetation structure, and ecological habitat types, are known to influence these communities (Lundkvist et al. 2003; Akunal & Aslan 2017). Prior research on Indian aquatic beetles has focused primarily on taxonomic aspects, providing limited insight into their habitats and ecology (Sheth et al. 2018). Given the unique biodiversity of the Shivalik region, the significance of this knowledge gap increases.

This study represents the first investigation into the aquatic beetle population within the Sukhna Wildlife Sanctuary, aiming to bridge the existing knowledge gap in this particular field. The survey findings indicate that a total of 164 specimens were observed, encompassing seven distinct species belonging to two separate families and five genera. This investigation aims to contribute to the expanding body of knowledge on aquatic beetles in India and compile a comprehensive baseline dataset on aquatic Coleoptera for the union territory of Chandigarh. This research on the aquatic beetle fauna of Sukhna Wildlife Sanctuary hopes to shed light on their ecological significance, contribute to the sanctuary's conservation efforts, and increase our knowledge of the region's freshwater ecosystems.

METHODS & MATERIALS

Study Area

The Sukhna Wildlife Sanctuary is located within the geographical coordinates of $30^0171'–30^0110'$ N and $76^0162'–76^0291'$ E. It is situated in the Shivalik Hills of Chandigarh, India, and is renowned for its untouched ecological environment. On 16 March 1998, the region was officially established as a wildlife refuge, covering a vast land area of around 25.98 km^2 (equal to 6,420.99 ac), with the primary purpose of protecting a wide range of plant and animal species. Located in close proximity to the renowned Sukhna Lake, this sanctuary serves as a crucial contributor to the region's endeavours in conserving biodiversity. The Sukhna Wildlife Sanctuary encompasses forests, shrub fields, and sections of the Nepli Forest, resulting in a distinctive and vital ecological environment for various wildlife species. The ecological value of the area is enhanced by its position inside the outermost Shivalik Range, which is distinguished by geological formations and an altitude range spanning from 346 m to 620 m .

Sampling

The survey was conducted in the Nepli Range of Sukhna Wildlife Sanctuary from June to September 2023. The data collection efforts were primarily directed towards four prominent water bodies which act as siltation dams in the sanctuary, as shown in Figure 1. A 20-cm-diameter, pond net with mesh size of 500 µm and an extendible telescopic handle was used for the aquatic beetle collection (Dudgeon 1999; Merrit & Cummins 1978). At each body of water, samples were collected by meticulously sweeping the net six times in opposite directions across a 1-m distance (Subramanian & Sivaramakrishnan 2007). This strategy guaranteed the capture of aquatic beetles from a variety of microhabitats along the water bodies coastlines. After collecting the contents of the sweep net, they were gently poured into a spill tray. The aquatic beetles were then counted visually, and one representative specimen of each species was collected and preserved in an ethanol solution containing 90% ethanol. To minimise

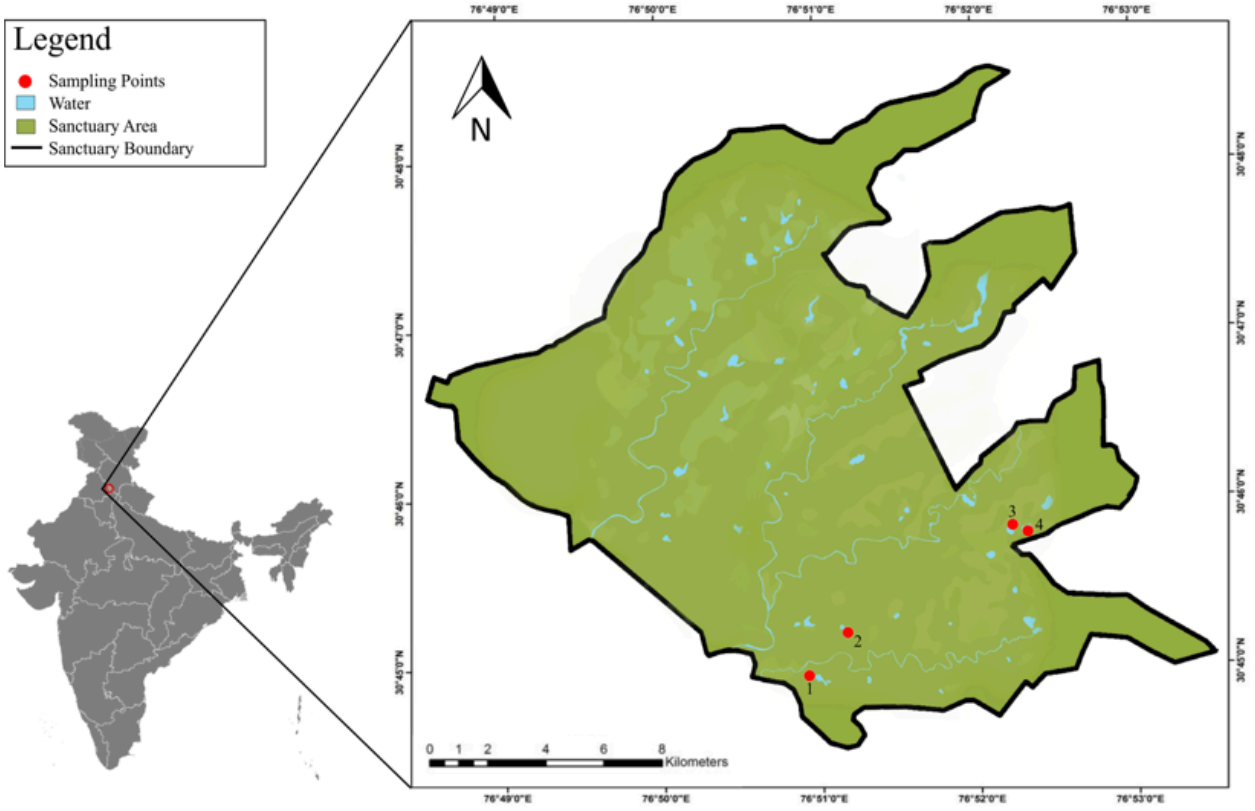

Figure 1. Sampling locations within Sukhna Wildlife Sanctuary.

Table 1. Sampling locations of aquatic beetles within Sukhna Wildlife Sanctuary.

Sampling point	Name of water body	Description of water body	Latitude (N)	Longitude (E)	Elevation (in m)	Area (in m2)
Point 1	Majla Wala Dam No.3	Check the dam with little vegetation on the shoreline and high depth.	30.752	76.853	366	7648
Point 2	Julahe Wala Dam No.4	Check the dam with decent vegetation and rocky substrate.	30.755	76.857	390	9174
Point 3	Kandalewla Dam No.2	Check dam with low vegetation, high turbidity and deep water.	30.765	76.875	426	5848
Point 4	Kandalewla Dam No.1	Check dam with high vegetation, low turbidity and shallow water.	30.764	76.876	450	4217

disturbance, the remaining contents of the spill tray were returned to their natural habitat.

Taxonomic Identification

Each specimen was photographed using a Wadec Digital Microscope. Subsequently, the samples were forwarded to the Zoological Survey of India (ZSI) in order to undergo taxonomic identification. The process of identification was accomplished by means of dissecting the collected specimens and conducting a comparison of male genitalia along with the use of reliable identification keys and original descriptions (Vazirani 1968, 1984; Ghosh & Nilsson 2012).

RESULTS

In the present investigation, a total of 164 aquatic Coleoptera specimens belonging to six species, five genera, and two families were identified and documented at Sukhna Wildlife Sanctuary (Image 1, Table 2). All species were recorded for the first time from the union territory of Chandigarh.

The most numerous family was discovered to be Dytiscidae, followed by Hydrophilidae. As seen in the figure below, the species *Laccophilus parvulus* demonstrated the greatest overall abundance, with a significant presence specifically at point 4, where

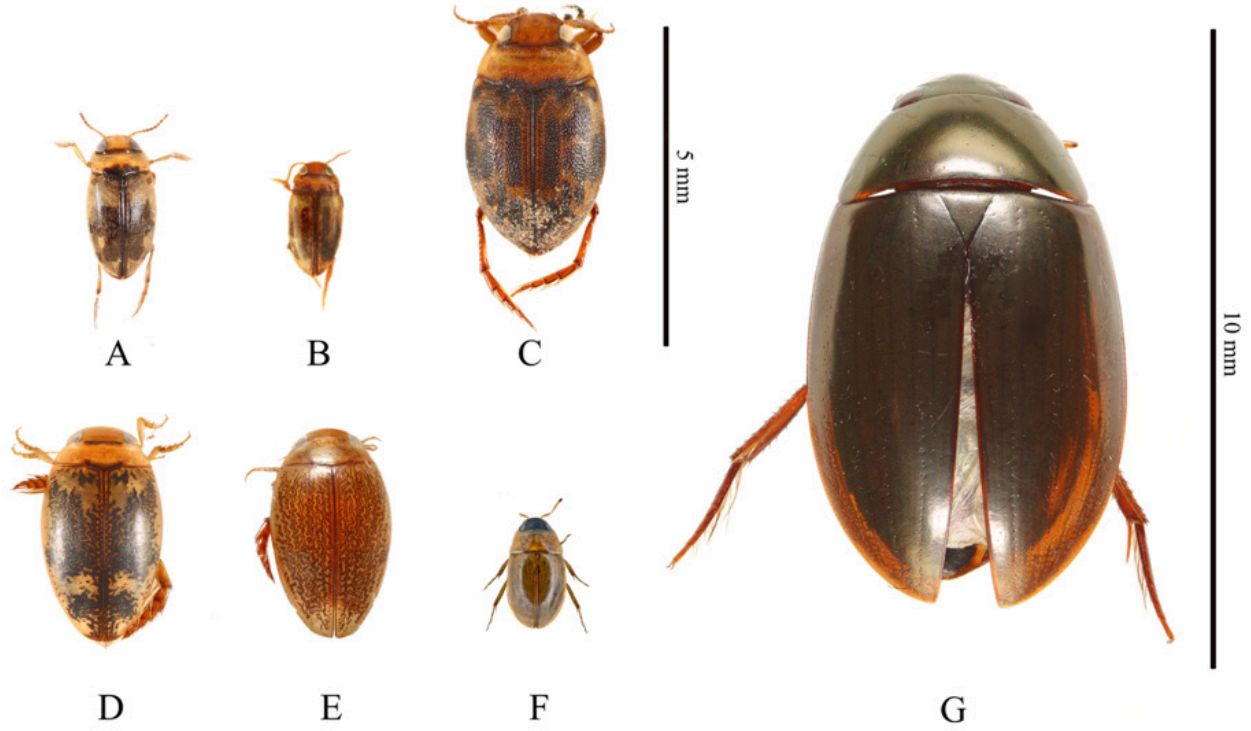

Image 1. A—*Hydroglyphus flammulatus* (Sharp, 1882) | B—*Hydroglyphus pendjabensis* (Guignot, 1954) | C—*Hyphoporus* sp. | D—*Laccophilus sharpi* (Régimbart, 1889) | E—*Laccophilus parvulus* (Aubé, 1838) | F—*Enochrus* (*Methydrus*) *esuriens* (Walker, 1858) | G—*Sternolophus inconspicuus* (Nietner, 1856). © Karmannye Om Chaudhary.

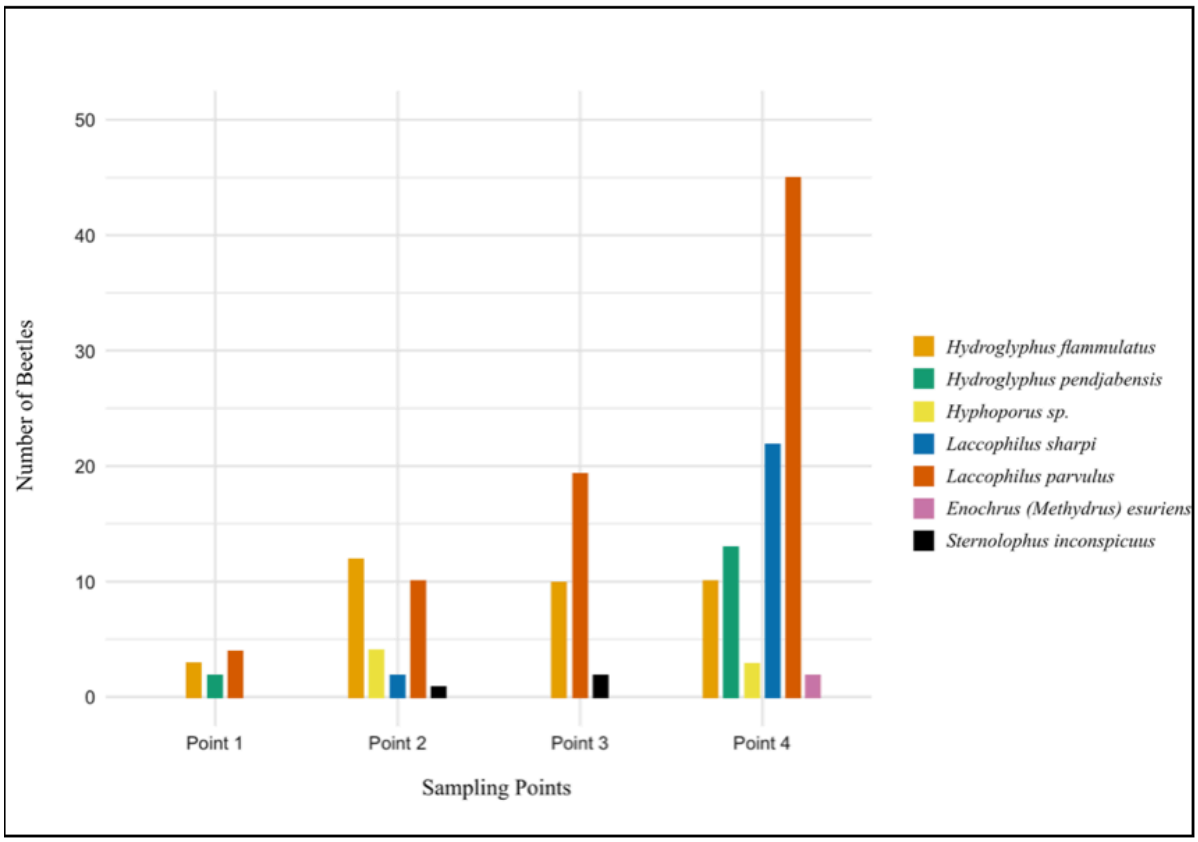

Figure 2. Distribution of aquatic beetles through the various sampling points.

Table 2. A systematic inventory of water beetles found in Sukhna Wildlife Sanctuary, Chandigarh, India and their distribution through India and the world (Ghosh & Nilsson 2012; Chandra et al. 2017; Gupta et al. 2022; Sonali et al. 2022).

Family	Scientific name	Distribution through India	Distribution through the world
Dytiscidae	*Hydroglyphus flammulatus (Sharp, 1882)*	Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Himachal Pradesh, Jharkhand, Kerala, Maharashtra, Manipur, Meghalaya, Madhya Pradesh, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, West Bengal.	Bangladesh, China, Indonesia, Iran, Japan, Sri Lanka, Cambodia, Malaysia, Nepal, Pakistan, Thailand, Taiwan, Vietnam.
	Hydroglyphus pendjabensis (Guignot, 1954)	Andhra Pradesh, Bihar, Delhi, Goa, Gujarat, Jharkhand, Maharashtra, Madhya Pradesh, Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal.	Bangladesh, Myanmar, Nepal, Pakistan
	Hyphoporus sp.	-	Palearctic and Oriental, from Iran to India and southeastern Asia;
	Laccophilus sharpi (Régimbart, 1889)	Andaman & Nicobar Islands, Assam, Bihar, Delhi, Gujarat, Himachal Pradesh, Haryana, Jharkhand, Kerala, Maharashtra, Meghalaya, Manipur, Madhya Pradesh, Odisha, Puducherry, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, West Bengal.	Sri Lanka, Myanmar, Nepal, Pakistan.
	Laccophilus parvulus (Aubé, 1838)	Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Goa, Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Maharashtra, Manipur, Odisha, Puducherry, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, West Bengal.	Bangladesh, Bhutan, China, Indonesia, Sri Lanka, Myanmar, Malaysia, Nepal, Philippines, Pakistan, Singapore, Thailand, Vietnam.
Hydrophilidae	*Enochrus (Methydrus) esuriens (Walker, 1858)*	Andaman & Nicobar Islands, Andhra Pradesh, Dadra and Nagar Haveli, Jammu & Kashmir, Jharkhand, Maharashtra, Manipur, Madhya Pradesh, Odisha, Punjab, Sikkim, Telangana, Uttarakhand, Uttar Pradesh, West Bengal.	Australia, Bangladesh, China, Fiji, Indonesia, Japan, South Korea, Sri Lanka, Malaysia, Philippines, Papua New Guinea, Saudi Arabia, Vietnam
	Sternolophus inconspicuus (Nietner, 1856)	Madhya Pradesh, Maharashtra, Meghalaya, Tamil Nadu, Uttar Pradesh.	Cambodia, China, Hong Kong, Indonesia, Japan, Laos, Myanmar, Nepal, Philippines, South Korea, Sri Lanka, Taiwan, Thailand, Vietnam.

a total of 45 individuals were recorded. The species *Hydroglyphus pendjabensis* exhibited a higher concentration at point 3, where a total of 13 individuals were seen. In contrast, the species *Hyphoporus* sp. demonstrated a more uniform distribution, with four individuals observed at point 1 and six individuals observed at point 3. The species *Laccophilus sharpi* had a notable presence at point 2, with a total of 22 individuals being seen. *Enochrus* (*Methydrus*) *esuriens* had a predominant distribution at point 1, where a total of four individuals were seen. The species *Sternolophus inconspicuus*, which was quite uncommon, was observed as a single specimen at point 1 and as two specimens at point 2. *Hydroglyphus flammulatus* exhibited a very homogeneous spatial distribution over the entirety of the four designated sample locations, with a range of abundances spanning 2–12 individuals.

As seen in Figure 2, sampling point 1 had the lowest number of aquatic beetle individuals and similar species richness to point 3. Sampling point 2 had a higher species richness than point 2 and point 3 had a lower number of individuals as compared to point 3. Point 4 had the highest number as well highest species richness of aquatic beetles.

DISCUSSION

The results obtained from this research provide valuable information regarding the population size and spatial distribution of aquatic Coleoptera species in the Sukhna Wildlife Sanctuary. The majority of species that were recorded are widely distributed and often found throughout various regions of India. According to the data presented in Table 2, it has been observed that four out of the seven aquatic beetle species found in Chandigarh have not yet been reported in the neighbouring states of Punjab and Haryana (Ghosh & Nilsson 2012).

The results show that the Dytiscidae family is dominant in aquatic habitats, which is consistent with global trends in aquatic ecosystems. Predatory diving beetles, scientifically known as Dytiscidae, are amazing adapters to a wide range of aquatic settings and frequently hold the top predatory positions within them (Miller & Bergsten 2016). The abundance of these species in the Sukhna Wildlife Sanctuary emphasises their biological relevance in the aquatic food chain, as they act as important predators and nutrient recyclers. The comparatively uniform distribution of *Laccophilus parvulus* and *Hydroglyphus flammulatus* throughout the sampling sites is a noteworthy observation, which implies that these species have less specialized habitat

preferences and are capable of adjusting to a diverse array of environmental conditions because specific environmental conditions, including vegetation type, water profundity, and temperature, are preferred by particular species (Lundkvist et al. 2003). Different species of aquatic beetles were found in different numbers and areas at each of the four sampling sites, which shows that the aquatic habitats in the sanctuary are not all the same. The observed discrepancies may be ascribed to distinct microhabitat attributes, habitat dimensions, vegetation configuration, and additional ecological variables that are recognized to impact communities of aquatic beetles (Ribera et al. 2003; Akunal & Aslan 2017; Sharma et al. 2019).

Figure 2 shows a steady increase in the population size of aquatic beetles from point 1 to point 4 of the Sukhna Wildlife Sanctuary, which corresponded to a significant elevation gradient, where point 1 was positioned at the lowest altitude and point 4 was at the highest. This corresponds to the fact that altitude may have a significant impact on the composition of aquatic insects by influencing the distribution of species (Taher & Heydarnejad 2020). The results also exhibit that points 2 & 4 had greater species richness than points 1 & 3. The differences seen may be due to the different biological features of the places where samples were taken. With higher vegetation, detritus, and shallower water, points 2 & 4 were suitable water bodies to harbour a variety of beetle species (Molnar et al. 2009), while points 1 & 3 exhibited low vegetation cover, high turbidity, and stagnant water, which may have led to a lack of species diversity (Gomezlutz et al. 2017). A detailed and extensive examination of the temporal variations and habitat preferences of aquatic beetles might aid in statistically validating the findings. This is required since the current study has a small sample size and was completed over a short period of time. Completing such an investigation would present substantial challenges since it would require removing a large population of aquatic beetles from their environment, which might alter the balance of the aquatic ecosystems. Furthermore, precisely identifying beetle species requires microscopic inspection of their genitalia, which would require their euthanasia. The fact that only seven species from two families were observed during this time period calls for further surveying and building upon the data that this paper offers. Aquatic beetles from the families Gyrinidae, Noteridae, and Elmidae remain absent from this habitat.

CONCLUSION

In conclusion, this study lays down the baseline data for the aquatic Coleoptera found in Chandigarh and provides insights into the functioning of aquatic beetle communities in Sukhna Wildlife Sanctuary. A considerable abundance of the family Dytiscidae was revealed by the systematic identification and categorization of 164 specimens representing seven species, revealing insight into its critical role as the principal predator and contributor to nitrogen cycling within aquatic environments. A pattern in the diversity and number of beetles at different altitudes influenced by different factors, such as habitat quality, was also observed; it is critical to undertake more extensive surveys and long-term surveillance of aquatic Coleoptera populations in order to acquire an understanding of their responses to environmental changes and the complex interrelationships between biotic and abiotic factors. The findings not only add to our understanding of the richness present in the Sukhna Wildlife Sanctuary but also highlight the need for coordinated conservation efforts to maintain these essential freshwater habitats because, as indicators of habitat features and ecological variety, water beetles are vital members of the biotic community in all wetland environments (Eyre & Foster 1989; Fairchild et al. 2000).

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