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RESEARCH ARTICLE

Bionomics of Four Species of Aquatic Bugs (*Hemiptera: Heteroptera: Nepomorpha*) of Sasthamkotta Lake, A Ramsar Site of Kerala, India

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ABSTRACT

Predatory aquatic bugs in the infraorder *Nepomorpha* play vital roles in freshwater ecosystems. The present inventory contributes to the bionomics of four species of aquatic bugs, *Diplonychus rusticus* (Fabricius, 1781), *Laccotrephes griseus* (Guerin-Meneville, 1844), *Cercotmetus pilipes* (Dallas, 1850) and *Enithares ciliata* (Fabricius, 1798) collected from Sasthamkotta lake, the largest freshwater lake of Kerala. Possibly, many species including new species and their associated bioecological information is yet to be discovered from the lake. In addition to the taxonomy and diversity of waterbugs, studies on the bioecology are highly crucial for employing better conservation measures. Hence, further studies on the bionomics aspect of water bugs from different wetlands of Kerala, along with its morphotaxonomic description are needed to fill the knowledge gap.

Keywords: Bioecology, Freshwater Lake, Morphotaxonomy, Systematics, Waterbugs.

INTRODUCTION

Aquatic Heteropterans are a group of bugs with distinctive morphological traits and adaptations. They are categorized into three infraorders based on their ecological interests and niches: *Gerromorpha* , *Nepomorpha* , and *Leptopodomorpha* . Approximately 4940 species of aquatic and semi-aquatic bugs are described globally [1]. With the available checklists, there are 318 species of water bugs under 82 genera and 18 families in India [2-4]. There are only

fewer studies on aquatic and semi aquatic *Heteroptera* of Kerala. Thirumalai [5] conducted studies on Gerridae and Notonectidae from Silent Valley region, Kerala. Thirumalai and Radhakrishnan [6] studied aquatic Hemiptera of Kasaragod district of Kerala. Nirmala Kumari and Balakrishnan Nair [7] conducted studies on the taxonomy, life history of *Ranatra filiformis* Fabricius and examined the morphotaxonomy of *Cercotmetus pilipes* (Dallas). Due to their abundance in many freshwater ecosystems; they are widely used as bioindicators of water quality [8]. *Nepomorpha* or true bugs is one of the most remarkable groups of Heteropterans, spending complete life cycle within the water. They can be found both in lotic and lentic environments. Most of the bugs are primarily predatory in nature and function as effective bio control agents of risky vectors like mosquito larvae [8]. Systematics and bioecological studies on true bugs in lentic ecosystems of Kerala are sparse. Due to their enormous significance, studies on the morpho taxonomy and bionomics of aquatic bugs are very much essential. The present study deals with the documentation and to build up baseline information on the taxonomy and bionomics of four species of predatory aquatic bugs of Sasthamkotta lake.

MATERIALS AND METHODS

Study area

The present study was conducted in Sasthamkotta lake, the largest fresh water lake of Kerala, in Kollam district. It lies between 9' 00'-9' 05' N and 76' 35'-76' 46' E. It is spreads out in the adjacent villages of Sasthamkotta, Mynagappally and West Kallada of Kunnathur Taluk. The lake covers an area of 3.75 sq. km with an average depth of 6.79 m. Sampling was conducted in four sites of the lake, S1; Vettolikadavu (9°1'56.93" N and 76°37'29.72" E), S2; (9°2'58.4" N and 76°38'24.79"E), S3; Adikkadu Kadavu (9°2'4.01" N and 76°36' 49.36" E) and S4; Punnakkadu Kadavu (9° 2' 41.27"N and 76° 37' 44.17" E) (Fig. 1).

Taxonomy and Bioecological study of Aquatic bugs

Aquatic bugs were collected from the lake, using a hand operated D-frame aquatic insect net with a mesh size of 500µm from July 2021 to June 2022. The collected specimens were preserved in 70% ethanol in the field and transported to the laboratory for detailed morpho-taxonomic analysis. Identification was done using published taxonomic literatures and monograph on aquatic bugs [9-12]. Photographs and measurements were taken using Olympus Tg 6 digital camera and Olympus SZ51 stereomicroscope. During the study period, aquatic bugs from various microhabitats of the lake were surveyed to determine the preferred zone and their presence or absence in the habitat was recorded to investigate their bioecology [13].

RESULTS

SYSTEMATIC ACCOUNT

Class : Insecta
Order : Hemiptera
Suborder : Heteroptera
Infra order : *Nepomorpha* Popov, 1968
Super family : Nepoidea Latreille, 1802
Family : Belostomatidae Leach, 1815
Sub family : Belostomatinae Leach, 1815
Genus : *Diplonychus* Laporte, 1833

***Diplonychus rusticus* (Fabricius, 1781)**

Family : Nepidae Latreille, 1802
Subfamily : Nepinae Latreille, 1802
Genus : *Laccotrephes* Stal, 1866

***Laccotrephes griseus* (Guerin-Meneville, 1844)**
Sub family : Ranatrinae Douglas and Scott, 1865
Genus : *Cercotmetus* Amyot and Serville, 1843

***Cercotmetus pilipes* (Dallas, 1850)**
Super family : Notonectoidea Latreille, 1802
Family : Notonectidae Latreille, 1802
Subfamily : Notonectinae Latrielle, 1802
Genus : *Enithares* Spinola, 1837

***Enithares ciliata* (Fabricius, 1798)**

***Diplonychus rusticus* (Fabricius, 1781) (Fig.2A)**
Materials examined
3 exs., Sasthamkotta Lake, Kollam district; S1; Vettolikadavu (9°1'56.93" N and 76°37'29.72" E), 5 exs., S3; Adikkadu Kadavu: 9°2' 4.01" N and 76°36' 49.36" E, 25.xii.2021, Coll. Jyothylakshmi K and S. Nandakumar.

Diagnostic characters
Body flattened and oval shaped. Adult has a size of 15.4-16.5 mm. Colour varies from yellowish brown to dark brown. Lateral margin of head, pronotum and the tip of scutellum are lighter in colour. Vertical border of the abdomen is transparent, broad with dark brownish bands. Ventrally light brown in colour. Legs are yellowish brown in colour with pale brown bands. Mid and hind legs are with dense, long swimming hairs. *Diplonychus rusticus* can be distinguished from other species of this genus by the following combination of characters: wings with spiny patch on corium, fore tarsae single segmented and with a small claw; respiratory straps with cluster of setae in males, Male paramere curved, narrowed at apex.

Bionomics
Diplonychus rusticus was found clinging to rhizomes and leaves of *Salvenia molesta*, a common invasive macrophyte in Sasthamkotta lake. Closer observations revealed that, they move swiftly even under mild disturbance. The species have morphological modifications such as flattened body, curved tarsal claws and respiratory straps for clinging to vegetation. They readily come to light trap. The females of the species forcefully put and attach the eggs on the elytra of males. Male *Diplonychus rusticus* shows parental care, carries the eggs on the dorsal side until it hatches. This amazing behaviour serves to protect the eggs. Wing polymorphism is commonly seen among some Heteropterans. All the collected specimens except the nymphs of the species were macropterous during this investigation. Apterous or brachypterous morphs were not found during this collection. *Salvenia molesta* is the major habitat upon which the bugs move, rest and find shelter in the lake. They extend their body obliquely downward to rest at the surface of aquatic macrophytes. It has been observed that they consume the larvae of chironomids and mosquitoes. The bugs were abundantly during the dry season (December-June) and were few during monsoon (July-November).

***Laccotrephes griseus* (Guerin-Meneville, 1844) (Fig. 2B)**
Materials examined
2 exs., S1; Vettolikadavu (9°1'56.93" N and 76°37'29.72" E), 2 exs., S2; Pulikuzhi (9°2'58.4" N and 76°38'24.79"E), 1ex., S3; Adikkadu Kadavu (9°2'4.01" N and 76°36' 49.36" E), 2 exs., S4; Punnakkadu Kadavu (9° 2' 41.27"N and 76° 37' 44.17" E), 18.xii.2022, Coll. Jyothylakshmi K and S. Nandakumar.

Diagnostic characters
Body colour is somewhat similar to dark soil. Length typically ranges from 15-20 mm. Respiratory siphon is 12.9–14.5 mm in length and always shorter than the body. Anterior region of the prosternum is armed with a highly acute tubercle. Abdomen with a faint bluish tint above and abdominal appendages are considerably shorter than the body.

Base of the front femora is equipped with an obtusely rounded tooth. It can be easily distinguished by the shape of the paramere since male paramere is moderately hook-shaped and symmetrical.

Bionomics

It is a sluggish species. Body colour is bit similar to dark soil. They are frequently found at the edges of the lake, among aquatic weeds or at the bottom of the water. Swimming requires the use of all legs. However they are not proficient swimmers. When they creep or move slowly, abdominal appendages protrude upward. They use front raptorial legs to catch different kinds of small aquatic organisms. It is a voracious feeder on mosquito larvae and hence it can be used as an effective biocontol agent of mosquito. When handled, they inflict painful bite.

***Cercotmetus pilipes* (Dallas, 1850) (Fig. 2C)**

Materials examined

4 exs., S1; Vettolikadavu (9°1'56.93" N and 76°37'29.72" E), 2 exs., S2; Pulikuzhi (9°2'58.4" N and 76°38'24.79"E), 2 exs., S4; Punnakkadu Kadavu (9° 2' 41.27"N and 76° 37' 44.17" E), 25.xii.2021, Coll. Jyothylakshmi K and S. Nandakumar.

Diagnostic characters

Elongated cylindrical body. Size ranges from 40– 41mm; respiratory siphon 10–11 mm in length. Body covered with fine setae. Colour dark brown or yellowish brown. Legs marked with a light brown band. Head is small, subconical and prognate. A sharp tubercle is present on the vertex between the eyes. They have small, three segmented and concealed antenna. Prothorax is narrower than head. Forelegs are highly prehensile without claws. Femur of the anterior leg is heavier, shorter than the pronotum. Mid and hind legs are longer and more specialized for walking. Mid, hind tibiae and tarsi with spinous process and long yellow hairs placed in two rows. Male parameres are bifurcated, symmetrical, stout, and anteriorly narrowed but medially bulged.

Bionomics

Cercotmetus pilipes has elongated and linear in shaped body having similarity to floating sticks and straws. The darker colour, greater size, shorter coxae, stout respiratory tube and shorter fore femora distinguish them from closely similar species *Ranatra filiformis*. They camouflage well with the background of fallen leaves and decaying plant materials. It is a sluggish species. They often attach to the substrate while maintaining close contact with the surface film. In the lake, individuals of this species are commonly found among the aquatic macrophytes near the edges of water. It has been observed that they deposit eggs on the stem of floating aquatic plants. Eggs are collected from inside the stems of floating vegetation. It has two long, thin filaments at its apex. All obtained specimens from the study area were macropterous. They are extremely voracious and found attacking small fishes, tadpoles and mosquito larvae. More individuals of *Cercotmetus pilipes* were obtained during the month of May.

***Enithares ciliata* (Fabricius, 1798) (Fig. 2D)**

Materials examined

1 ex., S2; Pulikuzhi (9°2'58.4" N and 76°38'24.79"E) 2 exs., S4; Punnakkadu Kadavu (9° 2' 41.27"N and 76° 37' 44.17" E), 21.x.2022, Coll. Jyothylakshmi K and S. Nandakumar.

Diagnostic characters

Average body length ranges from 8.5 to 9.6 mm. Males are little bit smaller than females. Dorsal side is usually blackish in colour. The vertex is yellow, the anterior half to two thirds of the pronotum is yellow with varying brown patterns and the remaining portion is translucent with blackish underlying sections. Basal portion of the hemielytra and the caudal lobe of the membrane are translucent. Lateral margins of the scutellum have a greenish fluorescent stripe that turns yellow in dead specimens. First mid tarsal segment is concealed, the second mid tarsal segment is broad and nearly triangular in lateral view. The mesotrochanter is rounded with a patch of black spicules along the ventral border. Male paramere is small and round.

Bionomics

This species comes under the category of "back swimmers" since it swims upside down position. They are often found near to the water surface. Their raptorial forelegs help them to have a grip on the prey. It has been observed that they feed on tadpole larvae, mosquito larvae and the nymphs of other aquatic insects. Only macropterous morphs of the species were obtained from the lake. It was observed that the males of *Enithares ciliata* are smaller than the females. It is very difficult to capture them because of their quick movement. *Enithares ciliata* were abundant in pooled microhabitats which lacked floating macrophytes. Macrophytic association could not be observed for this species.

DISCUSSION

Early studies have systematically classified *Nepomorpha* ns in some of the aquatic ecosystems of the state. However, information on the bioecology of these groups is yet to be documented in detail. Some scientists [7; 5; 6] have made substantial contribution towards the systematics of aquatic bugs in Kerala. The present study would facilitate the knowledge on the bionomics of some Heteropteran species from Kerala which have not yet been described. The present study contributes to the taxonomy and bionomics of four *Nepomorpha* species from the lake. Bionomics of water bugs would definitely help to explore their position and role in the ecosystem. At the same time a comprehensive assessment of the biological significance as well as the biological diversity of these insects are needed to be documented in detail. Systematics of water bugs of Kerala need to be described further to bridge the knowledge gap in the taxonomy of aquatic insects across different regions in India.

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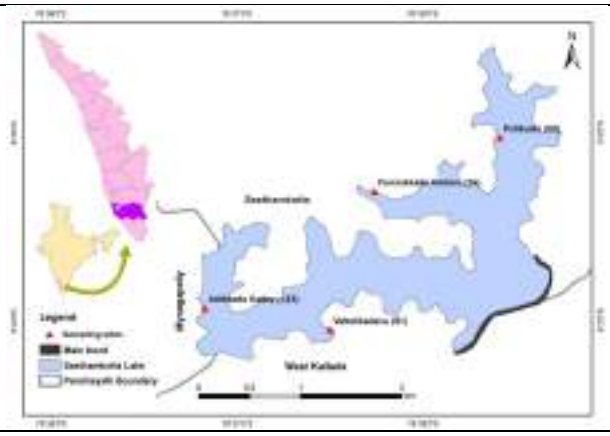

Fig. 1: Location map of the study area with sampling sites.

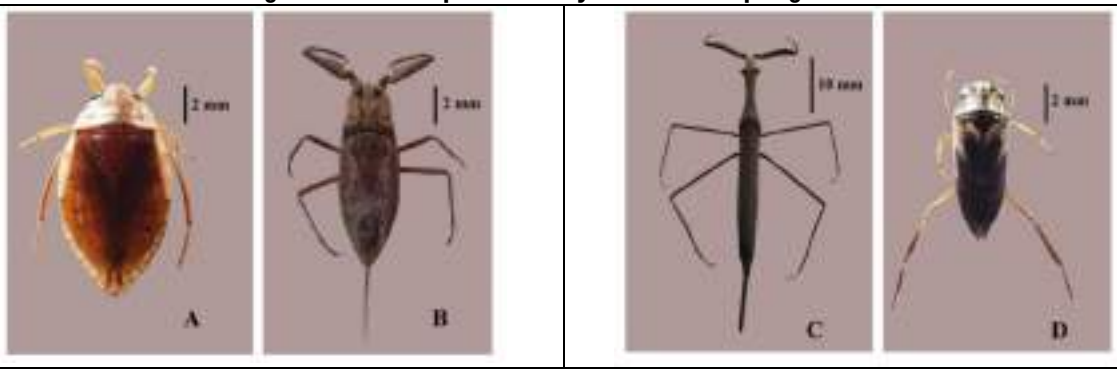

Fig.2: Dorsal habitus images: A- *Diplonychus rusticus* (Fabricius, 1781), B- *Laccotrephes griseus* (Guerin-Meneville, 1844), C- *Cercotmetus pilipes* (Dallas, 1850), D- *Enithares ciliata* (Fabricius, 1798).