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Ecological Preferences of Two Diving Beetles (Coleoptera: Dytiscidae) From Olakkayam Waterfalls, Kerala, India With a New Record of *Hydaticusfabricii* Macleay, 1825.

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ABSTRACT:

Members of the family Dytiscidae (Coleoptera) occupy almost all kinds of freshwater and semi- saline habitats. They are present even in most unexpectedenvironments like tree holes, bromeliads andhygropetric habitats.In the present study adults of two species of diving beetles (Dytiscidae) such as *Hydaticusvittatus* and *Hydaticusfabricii*were collected from a pothole on the rock bed of Olakkayam waterfalls with *Hydaticusfabricii* being reported for the first time from Kerala.They are identified and characteristic features of their habitat are mentioned. Adult beetles were collected using plastic kitchen sieve and preserved in 75% ethyl alcohol. Including both species a total of 11 specimens were collected. Beetles were identified using available literature. Diagnostic characters of *Hydaticusfabricii*are also provided. Potholes are eccentric and are recently attaining recognition as model systems in the field of ecology.This study alsoforms a depiction of how such unique but usually unacknowledged habitats provide home for these fascinating beetles.

KEYWORDS: Dytiscidae, Waterfalls, Hydaticus, Pothole, Ecology

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INTRODUCTION:

Dytiscidae is one of the most speciose families of order coleoptera. They are also known as diving beetles or predaceous aquatic beetles. From the very unique habitats like bromeliads, wet surfaces of rocks etc., to the vast lakes they are present everywhere. Family Dytiscidae encompass 4440 species all around the world.[1] Compared to large permanent water bodies, small and temporary habitats have more numbers of species of aquatic beetles.[2] But small and temporary water bodies have been the subject of rather little ecological research.[3,4] In the present study dytiscids were collected from a leaf choked pothole on the bed rock of the waterfalls.

Potholes on rocks are the depressions or cavities formed by the process of weathering of rock due to the water current. These will be exposed during summer season and form independent habitats. They are very unique habitats and houses specialized communities adapted to the often unpredictable patterns of drying and flooding.[5]Dytiscids are known to occur very commonly in such sort of temporary habitats. *Hydaticus* is one of the widely distributed dytiscid genera throughout the world. Dytiscid fauna of India got a great appreciation mainly by the works of Vazirani.[6, 7, 8, 9]He has published taxonomic accounts on dytiscids of India. He has made several collections on aquatic beetles and described several species of dytiscids from different parts of India including Southern region. In his review of subfamilies Noterinae, Laccophilinae, Dytiscinae and Hydroporinae of India, he has described 10 species of dytiscids under the genus *Hydaticus*, including *Hydaticusvittatus* and *Hydaticusfabricii*. But data on their habitat is not provided. Later on in a collection of diving beetles from Maharashtra, Himachal Pradesh and Madhyapradesh he identified three species under the genus *Hydaticus* along with *H. vittatus*.

Afterwards many reports and new records of species under genus *Hydaticus* were started to come up from different parts of India. Mukherjee &Sengupta studied Dytiscidae of silent valley and reported five species including three species under genus *Hydaticus*,[10]Ghosh&Hegde made a collection on aquatic beetles of Renuka wildlife sanctuary, Himachal Pradesh and reported *Hydaticus (Prodaticus) ricinus*,[11] this species is also reported by Ghosh et.al., in a collection of aquatic beetles from Chhattisgarh,[12]Ghosh&Hegde studied diving beetles of Karnala Bird Sanctuary, Maharashtra and documented *H. luczonicus*and *H. satoisatoi* under genus Hydaticus,[13]*Hydaticusluczonicus* is reported by Ghosh in his study on the diving beetles of GovindSagar Wildlife Sanctuary, Himachal Pradesh,[14]Ghosh contributed to the diving beetle fauna of Maharashtra and reported three species of Hydaticans such as *H. luczonicus, H. ricinus, H. satoi satoi*,[15] Recently Dash & Roy documented dytiscidae of south coastal odisha (*Hydaticus (guignotites) fabricii, Hydaticusvittatus*)[16] and Deb recorded *Hydaticusbipunctatusbipunctatus* for the first time from Meghalaya.[17]

Even though the studies on the biology, morphology and systematic of dytiscids have progressed far beyond the expectations, almost all of their ecology is often ignored. Knowledge on the ecology of every single species is valuable in many ways like their possible use in bio- control programs, bio- monitoring of freshwater ecosystem health as well as for developing strategies for their own conservation. But researchers usually ignore or show less interest to recognize the habitat characteristics of species since they are focused on more advanced aspects like molecular taxonomy and systematics. The purpose of the present study is to identify and present the diving beetles found out from a pothole associated with Olakkayam waterfalls and also to shed light on their ecology.

MATERIALS & METHODS:

Study site

Study was conducted at Olakkayam waterfalls. It is situated at Marottichal in PuthurPanchayath, Thrissur, Kerala. The forests of Marottichal constitute the Western Ghats at the eastern part of Thrissur district. Marottichal is located 20 km away from Thrissurcity. Olakkayam is a horizontal waterfall with a rocky bed. Collection was done from the potholes on the exposed bedrock. During the monsoon season, waterfall receives copious water and gets recharged by the streams flowing out of the forest. During the cool dry season from December- February the waterfalls starts to loss its beauty and finally in the hot dry season they become completely dry. The duration of December- February is the suitable time to conduct aquatic insect collections since there will not be surplus water and more lentic microhabitats will be available for many of the aquatic insects to complete their life cycle. Lotic habitats are poor in aquatic insect diversity when compared to that of lentic habitats. Twelve rock pools were randomly selected for the study. All of them were open and exposed to direct sunlight except one, which was situated nearly six meters away from the rest and received moderate shade.

Collection of specimens

Collection has been done on 27th January 2018. A total of 12 pools were sampled. In case of a leaf choked pothole, primarily all the fallen leaves and twigs were removed carefully into a white plastic pan by handpicking and carefully examined for beetles. The pothole was then agitated using a stick to dislodge beetle. Then the entire content of the pothole was sieved using a plastic kitchen strainer with its mouth measuring a diameter of 17 cm. Water parameters were measured using a portable multi-parameter water quality tester (Model: EutechPCSTestr 35) at the site itself. After sieving, the residue and leaves were restored within the same pothole.

Identification

Specimens were observed and photographed using Leica stereozoom research microscope (Model: LEICA S8APO) with an attached digital microscope camera (LEICA MC170 HD). Identification was done following Vazirani, 1968. Systematic account on the species follows Deb R. (2017).

Figure 1: Leaf choked pothole

Figure 2: Exposed rock bed of olakkayam waterfall with potholes (View from the bottom)

RESULTS

Total of 12 potholes were examined. All of the sampled potholes were open to direct sunlight except the one which was found to be occupied by dytiscids. When compare to others this particular pothole received moderate amount of shade. A total of 11 specimens were collected (Ten *Hydaticus fabricii* and one *Hydaticus vittatus*). The pothole has 15 cm of water depth and measured 50 cm along its long axis and 30 cm length along its short axis. Substratum of the pothole was little muddy and mixed with leaf litter. This pothole had a few numbers of frogs as coexistent. Other 11 potholes were occupied with fishes, frogs, tadpoles, and nymphs of dragonflies etc. Chemical and physical parameters of water were measured and listed below in table 1.

Table No. 1: Water and atmospheric parameters of the leaf choked pothole

Atmospheric parameters		**Water Parameters**				
Atmospheric Temperature	Humidity	Water Temperature	pH	Conductivity (µS)	TDS (ppm)	Salt (ppm)
36.5 °C	39%	28.8 °C	6.18	59.2	42.2	39.4

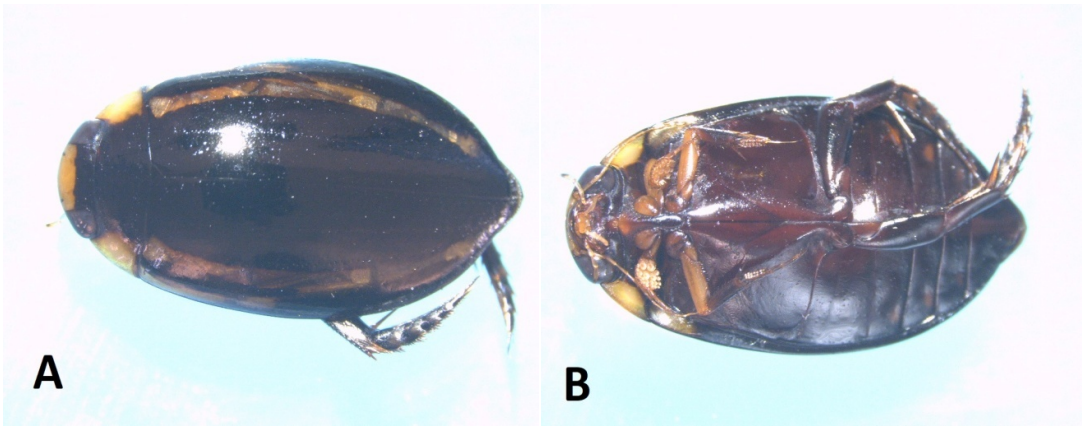

Figure 3: A. *Hydaticus vittatus*Fabricius (Dorsal view) B. *Hydaticus vittatus*Fabricius (Ventral view)

Systematic accounts

Order	COLEOPTERA
Suborder	ADEPHAGA
Family	DYTISCIDAE
Subfamily	DYTISCINAE
Tribe	HYDATISCINI
Genus	HYDATICUS

Hydaticus fabricii Macleay, 1825

Material examined: 10 specimens (3 male and 7 female)collected from a leaf choked pothole on exposed rock bed of Olakkayam waterfall, Kerala.

Diagnosis: Body length: male: 10 mm, female:10.4 mm, Form: oval and feebly convex, Head: reddish- yellow with posterior margin of the vertex black, Pronotum: reddish- yellow with posterior margin black in the middle, Elytra: reddish- yellow, densely speckled with black irrotations condensed near the suture giving appearance of black patches (**Fig. 4, A**), Ventral side:brownish-black, more or less concolorous (**Fig. 4, B**). In male three basal segments of protarsi largely dilated and provided with "sucker pallettes" and mesotarsi with two rows of "sessile pallettes" (**Fig. 4, C**).

*Distribution:*Andhrapradesh, Arunachlpradesh, Assam, Bihar, Delhi, Goa, Gujrat, Himachal Pradesh, Panjab, Manipur, Maharashtra, Madhyapradesh, Orissa, Rajasthan,Tamil Nadu, Sikkim, Uttaraghand, Uttar Pradesh, West Bengal. Elsewhere: Afghanistan, Pakisthan, Nepal, Myanmar, Sri Lanka

Remarks: First record from Kerala

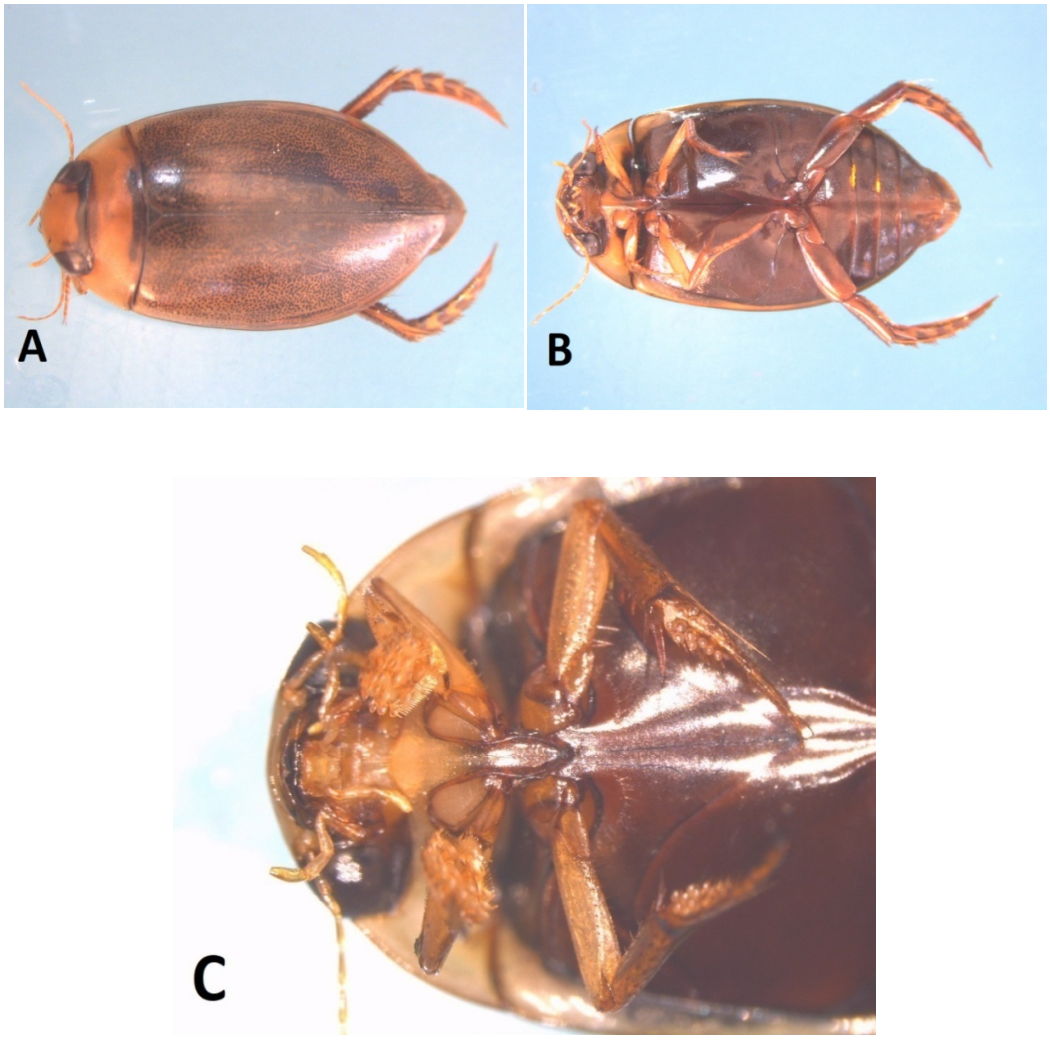

Figure 4: A. *Hydaticus fabricii*MacleayFemale(Dorsal view), B. *Hydaticus fabricii* Macleay Female (Ventral view), C. *Hydaticus fabricii* Male pro-tarsi enlarged and provided with Sucker palettes and meso-tarsi with sessile palettes.

DISCUSSION:

In India earlier works of late Mr.Vazirani laid a strong base for the further studies on dytiscidae. While considering the past ten years, there are plenty of works on the Indian fauna of dytiscids. Most of these works are descriptive in nature and contributed largely into the Indian diving beetle fauna. There are a few works from Kerala on the diving beetle fauna of Kerala. Except these efforts, it seems that the diving beetle fauna of Kerala is largely neglected. The genus *Hydaticus* itself encompasses 146 species all over the world.[1] So far 15 Hydatican species from India and Four species from Kerala has been reported (*H. b. bipunctatus*, *H. satoisatoi*, *H. histrio*, *Hydaticus vittatus*).[18] Literatures shows that *Hydaticus vittatus* is more commonly reported species when compared to *Hydaticus fabricii*, even though they share similar habitats. The current study presents *Hydaticus vittatus* is (1 specimen) & *Hydaticus fabricii* (10specimens) occupying together in a pothole on the rock bed of the waterfalls.

Potholeecosystems are exceptionaland are getting acceptance as model systems in various fields like ecology, evolutionary biology and conservation biology.These peculiar habitats sometimes smaller in size, occupy varieties of aquatic insect fauna. Freshwater rock pools houses a high diversity of specialist and endemic species and therefore contribute substantially to regional diversity.[19, 20] Soinsight of their ecologywill be helpfulto know the habitat preferences of every single species and also to take action for their conservation if necessary. Ren et al., suggests that pothole area, water depth and water temperature are important factors determining the benthic invertebrate community composition and the species richness.[21]Lindberg indicate that physico-chemical properties of rock pools have a great impact on the faunal diversity.[22] His concern was mainly on the effects of the salinity of rock pool water on water beetle distribution. He found a negative correlation between salinity and number of water beetle species in rock pools and a positive correlation between pool area, volume depth and species number.Additionally, inter- specific competition occurring in potholes may influence the richness and abundance of benthic invertebrates.[23]

Since the present studydid not consider variables like physical and chemical properties of other potholesof the same rock bed, the present study is not enough to authenticate the relation between water parameters and number of water beetles. In the current study the leaf chokedpothole had comparatively low predatory pressure as well as inter- specific competition. It was an isolated one situated around 6 meters away from the other 11 potholes. It was also sufficient in fallen leaves and decaying leaf matter which may act as a refuge for the beetles in order to get rid of their predators. On the other hand rests of the 11 potholes werevery close to each other. They were open to the sunlight and also had varieties of occupants like fishes, frogs, prawns, nymphs of dragon fly etc. This might be increased predatory pressure thereby made beetles to avoid these potholes. Absence of

any substrates in the potholereduces the possibility of beetles to hide from their predators. Directexposure to sun contributes to the rise of water temperature in these small shallow aquatic habitats. This may make them not to prefer those potholes. But more works should be done to substantiate these assumptions.

Literally there are only few works on various aspects of pothole ecosystem like ecology, diversity, predator- prey interactions, dispersal etc. Studies of the insects and other aquatic invertebrates that colonize ephemeral pools are in their infancy, with most investigations having been directed towards lotic systems.[24, 25]Insuch astate this work can be considered as a contribution towards the dytiscid fauna, specifically the Hydatican fauna of Kerala. Reduce pace between words.

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