



Aquatic beetles (Insecta, Coleoptera) of Koundinya wildlife sanctuary, Andhra Pradesh, India

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ABSTRACT. The present investigation was carried out to study the fauna of aquatic beetles of Koundinya wildlife sanctuary (India). A total of forty two species belonging to four families was recorded. The highest number of species was found in the family Dytiscidae followed by Hydrophilidae, Gyridae and Noteridae. All the species are recorded for the first time from the wildlife sanctuary and 9 species are new from the state of Andhra Pradesh.

Key words: Beetles, diversity, ecosystems, environment, Koundinya, wildlife

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INTRODUCTION

Aquatic beetles are considered significant bio-indicators that help to understand and manage aquatic ecosystems (Lundkvist et al., 2003). They inhabit ponds, reservoirs, lakes, pools, streams and rivers. Aquatic beetles with more than 13000 described species are one of the most globally abundant groups of aquatic insects (Short, 2017). More than 786 species belonging to 137 genera 17 families and three suborders are recorded from India (Chandra et al., 2017; Sayali et al., 2018; Sheth et al., 2020; Sheth et

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al., 2021; Deepa et al., 2022a). So far, 46 species have been reported from the state of Andhra Pradesh (Mukhopadhyay, 2007; Mukhopadhyay & Ghosh, 2007; Deepa et al., 2022a).

Koundinya Wildlife Sanctuary is located in Palamner – Kuppam forest ranges of Andhra Pradesh between 12°39'–13°10' N and 78°29'–78°52' E, in Chittoor District, Andhra Pradesh and a part of the Southeastern Ghats. Sanctuary also has numerous ponds and pools and the Palar river passing through it. The vegetation comprises Southern Tropical Dry Mixed Deciduous (Champion, & Seth, 1968) Sanctuary is the only residence for Asian elephants in the state of Andhra Pradesh and home for Leopard, Sloth Bear, Jungle Cat, Golden Jackal, Sambar, Cheetal, Slender Loris, Porcupine and Wild Boar. However, studies on aquatic beetle on Koundinya wildlife sanctuary are unexplored. Hence the present study aims to assess and document the aquatic beetle diversity from Koundinya wildlife sanctuary.

MATERIAL AND METHODS

Qualitative sampling method was used to collect the aquatic beetle from the wildlife sanctuary (Fig. 1, Table 1). D-Shaped insect net and strainer were used to collect the insects from littoral zone, collected specimens were preserved in 70% alcohol and some are preserved in 10% formalin for photographs. The specimens were studied with a Leica stereomicroscopes model EZ4. Photographs were taken using stereomicroscopes Leica M205A (Leica co. Germany). 10–15 photos were used in Combine ZP software to stock the photographs. Microsoft Excel were used to prepare pie chart to represent the family wise species composition (Fig. 2). Specimens were identified by the authors using the reliable identification keys and original descriptions (Vazirani, 1968; Ghosh & Nilsson, 2012; Sayali et al., 2018; Sheth et al., 2021; Deepa et al., 2021). The state distribution of each species compiled from Ghosh & Nilsson (2012); Sayali et al. (2018); and Deepa et al. (2022a, 2022b). General distributions followed the Zoogeographical zonation proposed by Holt et al. (2013). The following abbreviation are used for the name of the states: AN – Andaman & Nicobar Islands; AP – Andhra Pradesh; AR – Arunachal Pradesh; AS – Assam; BR Bihar; CG – Chhattisgarh; DL – Delhi; GA – Goa; GJ – Gujarat; HR – Haryana; HP – Himachal Pradesh; JK – Jammu & Kashmir; JH – Jharkhand; KA – Karnataka; KL – Kerala; MP – Madhya Pradesh; MH – Maharashtra; MN – Manipur; ML – Meghalaya; NL – Nagaland; OD – Odisha; PY – Puducherry; PB – Punjab; RJ – Rajasthan; SK – Sikkim; TN – Tamilnadu; TS – Telangana; TR – Tripura; UP – Uttar Pradesh; UK – Uttarakhand; WB – West Bengal. The identified specimens were registered and deposited in the National Zoological Collection of Zoological Survey of India, Freshwater Biological Regional Centre, Hyderabad, Telangana.

Table 1. Sampling locations of aquatic beetles from Koundinya wildlife sanctuary, AP., India.

Sl. No	Sampling station	District	Latitude	Longitude
1	Pedduru	Chittoor	12°49'03.36"N	78°33'48.60"E
2	Kamalapalli	Chittoor	12°48'50.40"N	78°31'54.48"E
3	Viranmala	Chittoor	12°47'47.04"N	78°31'19.56"E
4	Venkatesapuram	Chittoor	12°44'26.88"N	78°27'18.00"E
5	Narayanpuram	Chittoor	12°51'13.68"N	78°32'32.28"E
6	Galapalli	Chittoor	12°52'58.44"N	78°33'39.24"E
7	Naniyal	Chittoor	12°51'10.44"N	78°33'58.32"E
8	Kottur Thanda	Chittoor	12°53'45.96"N	78°35'04.92"E
9	Pathurnatham	Chittoor	13°03'33.84"N	78°34'26.76"E
10	Veerlabanda	Chittoor	13°03'24.48"N	78°38'40.92"E
11	Kalyani Revu Waterfall	Chittoor	13°02'49.02"N	78°42'20.16"E
12	Keeramanda	Chittoor	13°05'31.56"N	78°48'16.20"E

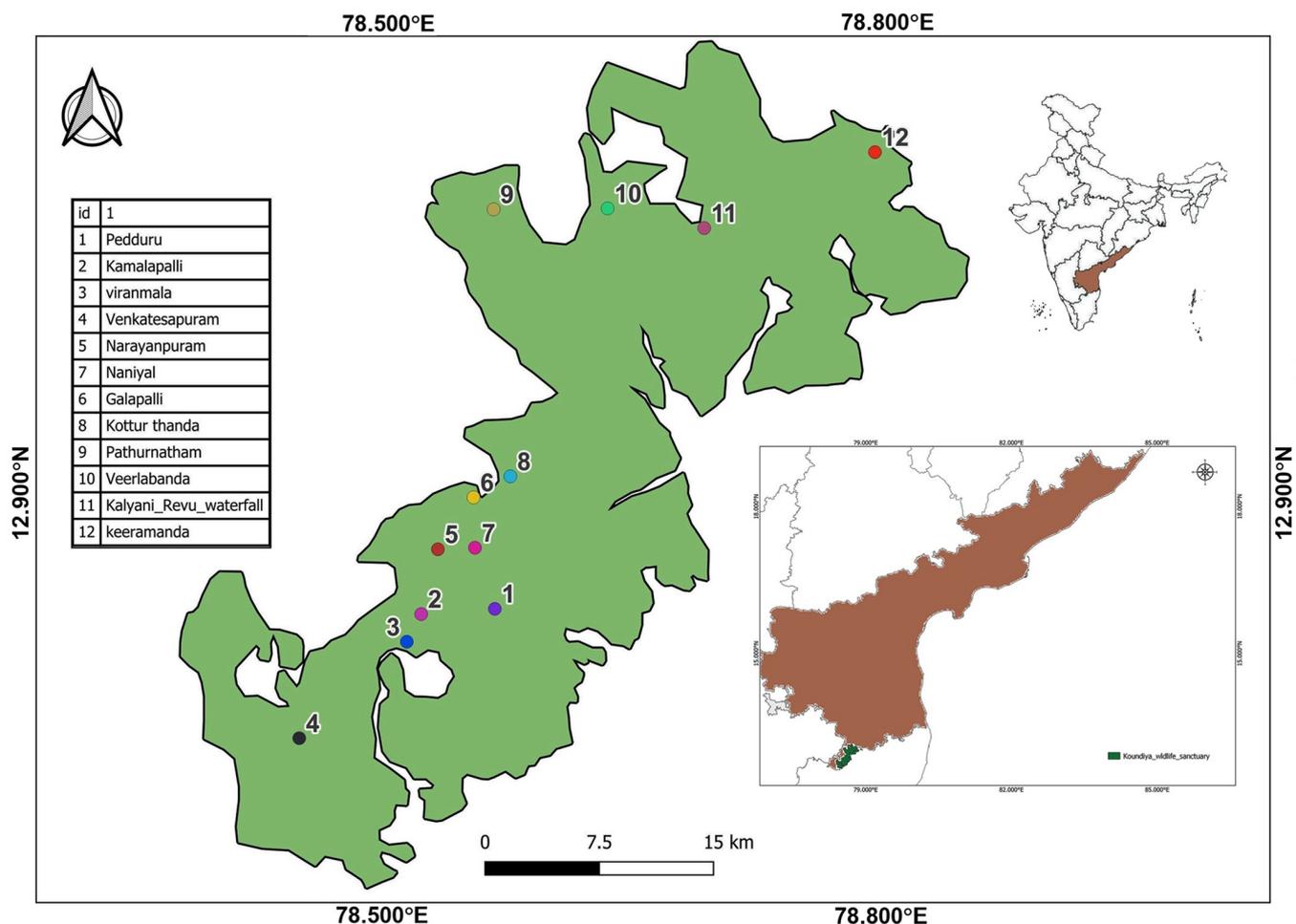


Figure 1. Study area of Koundinya wildlife sanctuary, Andhra Pradesh, India.

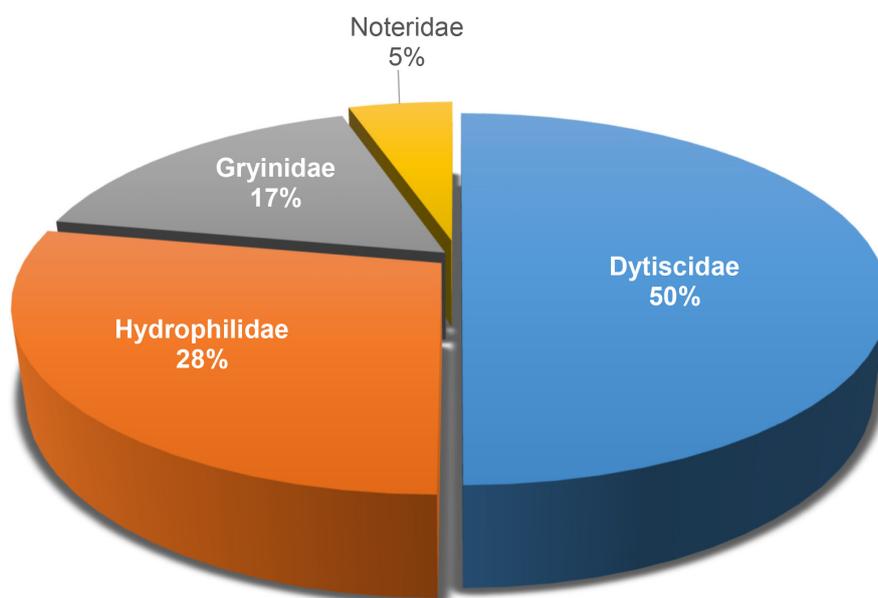


Figure 2. Family wise species composition of the aquatic beetles from Koundinya wildlife sanctuary India.

RESULTS

A total of forty two species belong to four families viz. Dytiscidae, Hydrophilidae, Gyrinidae and Noteridae were collected from Koundinya wildlife sanctuary. The family Dytiscidae is the most diverse group that includes 21 species followed by Hydrophilidae 11 species, Gyrinidae 7 species, Noteridae with 2 species.

Taxonomic hierarchy

Phylum Arthropoda von Siebold, 1848

Class Insecta Linnaeus, 1758

Order Coleoptera Linnaeus, 1758

Family Dytiscidae Leach, 1815

Subfamily Copelatinae Branden, 1885

Genus *Copelatus* Erichson, 1832

***Copelatus mysorensis* Vazirani, 1970 (Fig. 3)**

Material examined: 2♂♂, Narayanpuram (12°51'13.68"N, 78°32'32.28"E), 29.xi.2022, Reg. No. FBRC/ZSI/INS/3493; 1♀, Kottur Thanda (12°53'45.96"N, 78°35'4.92"E), 30.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3505.

Remarks. Recorded first time from the state of Andhra Pradesh.

Distribution: *Oriental* (India [AP, KA, MH, TN, TS], Sri Lanka, Thailand) (Ghosh & Nilsson, 2012; Sayali et al., 2018; Deepa et al., 2022a).

***Copelatus sociennus* Balfour-Browne, 1952 (Fig. 4)**

Material examined: 1♂, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), 3.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3530.

Distribution: *Oriental* (India [AP, TS, UK], Sri Lanka); *Palaeartic* (China) (Ghosh & Nilsson, 2012; Sayali et al., 2018; Deepa et al., 2022a).

Remarks. *Copelatus sociennus* was reported from Bangalore, Karnataka as *C. bangalorensis* (Vazirani, 1970), later synonymized with *C. sociennus* (Sayali et al., 2018) based on the type from China and India.

Subfamily Dytiscinae Leach, 1815

Genus *Cybister* Curtis, 1827

***Cybister rugulosus* (Redtenbacher, 1844) (Fig. 5)**

Material examined: 1♂, Keeramanda (13°5'31.56"N, 78°48'16.2"E), 5.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3522.

Distribution: *Oriental* (India [AP, JH, MP, MH, WB, JK]) (Ghosh & Nilsson, 2012).

Remarks. *Cybister rugulosus* was recorded from Andhra Pradesh by Sharma (2002) for the first time, and this is the re-discovery of this species after two decades.

***Cybister (Meganectes) tripunctatus asiaticus* Sharp, 1899 (Fig. 6)**

Material examined: 5♂♂, 9♀♀, Kamalapalli (12°48'50.4"N, 78°31'54.48"E), 28.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3484.

Distribution: *Oriental* (Bangladesh, Bhutan, India [AP, AS, BR, DL, GJ, HR, HP, JK, MP, MH, MN, OD, PB, RJ, SK, TN, TS, TR, UP, UK, WB], Myanmar, Nepal, Pakistan, and Sri Lanka); *Palaeartic* (Afghanistan, China, Iran, Iraq, Japan, Kyrgyzstan, Mongolia, Russia, Syria, Tajikistan, Turkey, Turkmenistan, Uzbekistan) (Ghosh & Nilsson, 2012; Deepa et al., 2022a).

Genus *Eretes* Castelnau, 1833

Eretes sticticus (Linnaeus, 1833) (Fig. 7)

Material examined: 3♂♂, 5♀♀, Pedduru (12°49'3.36"N, 78°33'48.6"E), 27.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3476.

Distribution: *Afrotropical* (Botswana, Kenya, Namibia, Sudan, South Africa, Zimbabwe); *Nearctic* (Mexico, USA); *Neotropical* (Ecuador, Peru, Puerto Rico, Venezuela); *Oriental* (Bangladesh, India [AP, AS, BR, GJ, GA, HP, JH, KA, MP, MH, MN, ML, OD, PB, RJ, SK, TN, TS, UP, UK, WB], Myanmar, Nepal, Thailand, Sri Lanka); *Palaeartic* (Afghanistan, Algeria, Canary Islands, Cyprus, Egypt, Iran, Kazakhstan, Qatar, Pakistan [Quetta], Tajikistan, Turkey, Turkmenistan, United Arab Emirate); *Madagascan* (Madagascar) *Saharo-Arabian* (Saudi Arabia, Yemen) (Jiří, 2006; Miller, 2002).

Genus *Hydaticus* Leach, 1817

Hydaticus discindens Walker, 1858 (Fig. 8)

Material examined: 3♂♂, 1♀, Kottur Thanda (12°53'45.96"N, 78°35'4.92"E), 30.xi.2022, Reg. No. FBRC/ZSI/INS/3508; 1♀, 4♂♂, Pathurnatham (13°3'33.84"N, 78°34'26.76"E), 1.xii.2022, Reg. No. FBRC/ZSI/INS/3511; 1♂, Veerlabanda (13°3'24.48"N, 78°38'40.92"E), 2.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3512.

Distribution: *Oriental* (Bhutan, India [AP, OD, TN, TS], Sri Lanka) (Ghosh & Nilsson, 2012).

Hydaticus ricinus Wewalka, 1979 (Fig. 9)

Material examined: 4♂♂, 3♀♀, Venkatesapuram (12°44'26.88"N, 78°27'18"E), 25.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3490.

Distribution: *Oriental* (Bhutan, India [AP, AS, MH, OD, TN, TS], Myanmar, Nepal, Laos, Vietnam Thailand, Sri Lanka); *Palaeartic* (Afghanistan, China, Pakistan [Khyber Pakhtunkhwa, Sindh]) (Ghosh & Nilsson, 2012; Mustafa & Zubair, 2015; Deepa et al., 2022a).

Hydaticus satoi satoi Wewalka, 1975 (Fig. 10)

Material examined: 3♂♂, 1♀, Naniyal (12°51'10.44"N, 78°33'58.32"E), 21.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3497.

Distribution: *Oriental* (Bhutan, India [AP, KL, MH, OD, SK, TN, TS, WB], Myanmar, Nepal, Indonesia, Thailand, Philippines, Sri Lanka); *Palaeartic* (China, Japan, Taiwan); *Saharo-Arabian* (Saudi Arabia) (Ghosh & Nilsson, 2012; Deepa et al., 2022a).

Subfamily Hydroporinae Aubé, 1836

Genus *Hydroglyphus* Houlbert, 1934

Hydroglyphus flammulatus Sharp, 1854 (Fig. 11)

Material examined: 1♀, Viranmala (12°47'47.04"N, 78°31'19.56"E), 26.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3485.

Distribution: *Oriental* (Bangladesh, Cambodia, India [AP, AS, BR, DL, GJ, HP, JK, KL, MP, MH, MN, OD, PB, RJ, SK, TN, TS, TR, UP, UK, WB], Myanmar, Nepal, Indonesia, Sri Lanka, Thailand, Vietnam); *Palaeartic* (China, Iran, Japan, Pakistan [Khyber Pakhtunkhwa, Sindh], Taiwan) (Ghosh & Nilsson, 2012; Mustafa & Zubair, 2015; Deepa et al., 2022a).

Genus *Hydrovatus* Motschulsky, 1855

Hydrovatus acuminatus Motschulsky, 1859 (Fig. 12)

Material examined: 1♂, Viranmala (12°47'47.04"N, 78°31'19.56"E), 26.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3486.

Distribution: *Oriental* (Cambodia, India [AP, AN, AS, DL, JH, KL, OD, TN, TS, UP, WB], Indonesia, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam); *Palaeartic* (China, Iran, Iraq, Japan, Pakistan [Baluchistan], Syria, Taiwan, Turkey); *Madagascan* (Madagascar); *Saharo-Arabian* (Oman, Saudi Arabia) (Jiří, 2006; Ghosh & Nilsson, 2012).

Genus *Hyphydrus* Illiger, 1802

Hyphydrus (signatus) renardi Severin, 1890 (Fig. 13)

Material examined: 1♀, Pedduru (12°49'3.36"N, 78°33'48.6"E), 27.xi.2022, Reg. No. FBRC/ZSI/INS/3479; 2♂♂, 2♀♀, Keeramanda (13°5'31.56"N, 78°48'16.2"E), 5.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3526.

Distribution: *Oriental* (Bangladesh, Bhutan, India [AP, AS, BR, GJ, HP, JK, JH, KL, MP, MH, OD, RJ, SK, TN, TS, UP, UK, WB], Myanmar, Nepal, Pakistan, Sri Lanka) (Ghosh & Nilsson, 2012; Deepa et al., 2022a).

Remarks. First record from the state of Andhra Pradesh.

Genus *Laccophilus* Leach, 1817

Laccophilus anticatus anticatus Sharp, 1890 (Fig. 14)

Material examined: 1♂, Naniyal (12°51'10.44"N, 78°33'58.32"E), 21.xi.2022, Reg. No. FBRC/ZSI/INS/3499; 1♀, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), 3.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3521.

Distribution: *Oriental* (Bangladesh, India [AP, AS, BR, DL, GJ, GA, KA, KL, MH, MN, OD, PY, TN, TR, UP, WB], Indonesia, Pakistan, Sri Lanka) (Ghosh & Nilsson, 2012).

Laccophilus inefficiens (Walker, 1859) (Fig. 15)

Material examined: 2♂♂, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), Reg. No. FBRC/ZSI/INS/3531; 1♀, Naniyal (12°51'10.44"N, 78°33'58.32"E), Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3537.

Distribution: *Oriental* (Bangladesh, Bhutan, India [AP, AS, BR, DL, GJ, GA, HP, JK, JH, KA, KL, MP, MH, MN, OD, RJ, SK, TN, TS, TR, UP, UK, WB], Indonesia, Malaysia, Myanmar, Nepal, Sri Lanka); *Palaeartic* (Iran, Pakistan [Quetta]) (Jiří, 2006; Ghosh & Nilsson, 2012).

Laccophilus parvulus Aubé, 1838 (Fig. 16)

Material examined: 1♂, Narayanpuram (12°51'13.68"N, 78°32'32.28"E), 29.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3495.

Distribution: *Oriental* (Bangladesh, Bhutan, India [AP, AR, AS, BR, DL, GJ, GA, HP, JH, KA, KL, MP, MH, MN, OD, PY, RJ, SK, TN, TR, TS, UP, UK, WB], Indonesia, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam); *Palaeartic* (China) (Ghosh & Nilsson, 2012).

Laccophilus sharpi Regimbart, 1889 (Fig. 17)

Material examined: 2♂♂, Kamalapalli (12°48'50.4"N, 78°31'54.48"E), 28.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3483.

Distribution: *Oriental* (Myanmar, India [AP, AS, BR, DL, GJ, HR, HP, JK, JH, KL, MP, MH, MN, ML, OD, PY, RJ, SK, TN, TS, TR, UP, UK, WB], Nepal, Philippines, Sri Lanka, Vietnam); *Palaeartic* (China, Hong Kong, Indonesia, Iran, Iraq, Japan, Pakistan [Baluchistan], Saudi Arabia, South Korea, Taiwan) (Jiří, 2006; Ghosh & Nilsson, 2012; Deepa et al., 2022a).

Genus *Peschetius* Guignot, 1935***Peschetius quadricostatus* (Aube, 1838) (Fig. 18)**

Material examined: 1♂, 1♀, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), 3.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3532.

Distribution: *Oriental* (India [AP, BR, GJ, GA, HP, JH, KL, MP, MH, OD, TN, TS, UP, WB], Nepal); *Palearctic* (Iran) (Ghosh & Nilsson, 2012; Deepa et al., 2021).

Remarks. First record from the state of Andhra Pradesh.

***Peschetius toxophorus* Guignot, 1942 (Fig. 19)**

Material examined: 2♀♀, Narayanpuram (12°51'13.68"N, 78°32'32.28"E), 29.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3492.

Distribution: *Oriental* (India [AP, BR, GJ, JH, KA, KL, MH, OD, TN, TS]) (Ghosh & Nilsson, 2012; Deepa et al., 2021).

Subfamily Colymbetinae Erichson, 1837**Genus *Rhantus* Dejean, 1833*****Rhantus taprobanicus* Sharp, 1890 (Fig. 20)**

Material examined: 3♂♂, 2♀♀, Pedduru (12°49'3.36"N, 78°33'48.6"E), 27.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3475.

Distribution: *Oriental* (India [AP, BR, DL, HP, JK, JH, KA, MH, MN, ML, PY, RJ, SK, TN, TS, UK, WB], Nepal, Pakistan, Sri Lanka) (Ghosh & Nilsson, 2012).

Subfamily Dytiscinae Leach, 1815**Genus *Sandracottus* Sharp, 1882*****Sandracottus dejeanii* (Aube, 1838) (Fig. 21)**

Material examined: 2♂♂, Narayanpuram (12°51'13.68"N, 78°32'32.28"E), 29.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3496.

Distribution: *Oriental* (India [AP, AR, GA, GJ, HP, JH, KL, MP, MH, OD, RJ, SK, TS, TN, UP, UK, WB], Pakistan); *Palearctic* (Iran) (Ghosh & Nilsson, 2012; Deepa et al., 2022a).

***Sandracottus mixtus* (Blanchard, 1843) (Fig. 22)**

Material examined: 1♀, Viranmala (12°47'47.04"N, 78°31'19.56"E), 26.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3487.

Distribution: *Oriental* (India [AP, HP, NL, SK, TN, TS, UP, UK, WB], Indonesia, Japan, Myanmar, Vietnam); *Palearctic* (China) (Ghosh & Nilsson, 2012; Deepa et al., 2021).

Subfamily Hydroporinae Aubé, 1836**Genus *Yola* Gozis, 1886*****Yola consanguinea* (Regimbert, 1892) (Fig. 23)**

Material examined: 1♂, Keeramanda (13°5'31.56"N, 78°48'16.2"E), 5.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3529.

Distribution: *Oriental* (India [AP, GJ, JH, MH, OD, TS], Nepal) (Ghosh & Nilsson, 2012).

Family: Gyrinidae Latreille, 1802**Subfamily Enhydrinae****Genus *Dineutus* Macleay, 1825****Subgenus *Dineutus* (*Cyclous*) Gustafson & Miller, 2017*****Dineutus* (*Cyclous*) *indicus* Aube, 1838 (Fig. 24)**

Material examined: 3♂♂, Kamalapalli (12°48'50.4"N, 78°31'54.48"E), 28.xi.2022, Reg. No. FBRC/ZSI/INS/3482; 1♂, 1♀, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), 3.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3520.

Distribution: *Oriental* (India [AP, BR, GJ, HP, JK, KA, KL, MP, MH, RJ, OD, PY, TN, TS, UP, WB]); *Palaearctic* (Pakistan) (Vazirani, 1984; Deepa et al., 2022a).

Subgenus *Dineutus* (*Cyclous*) Gustafson & Miller 2017***Dineutus* (*Cyclous*) *spinosus* Fabricius, 1781 (Fig. 25)**

Material examined: 1♂, Viranmala (12°47'47.04"N, 78°31'19.56"E), 26.xi.2022, Reg. No. FBRC/ZSI/INS/3488; 4♂♂, 1♀, Galapalli (12°52'58.44"N, 78°33'39.24"E), 19.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3500.

Distribution: *Oriental* (Bangladesh, India [AP, AS, BR, MN, ML, OD, TN, TS, UP, WB], Malaysia, Myanmar, Thailand, Vietnam); *Palaearctic* (Pakistan [Sindh]) (Vazirani, 1984; Mustafa & Zubair, 2015; Deepa et al., 2022a).

***Dineutus* (*Cyclous*) *unidentatus* Aubé, 1838 (Fig. 26)**

Material examined: 1♀, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), 3.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3519.

Distribution: *Oriental* (Burma, India [AP, BR, MP, KL, ML, OD, RJ, TN], Indonesia, Malaysia, Sri Lanka, Thailand) (Vazirani, 1984).

Genus *Gyrinus* Geoffroy, 1762**Subfamily Gyrininae Latreille, 1810*****Gyrinus* *convexusculus* Macleay, 1871 (Fig. 27)**

Material examined: 1♂, 4♀♀, Pedduru (12°49'3.36"N, 78°33'48.6"E), 27.xi.2022, Reg. No. FBRC/ZSI/INS/3478; 1♀, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), 3.xii.2022, Reg. No. FBRC/ZSI/INS/3516; 3♀♀, Keeramanda (13°5'31.56"N, 78°48'16.2"E), 5.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3528.

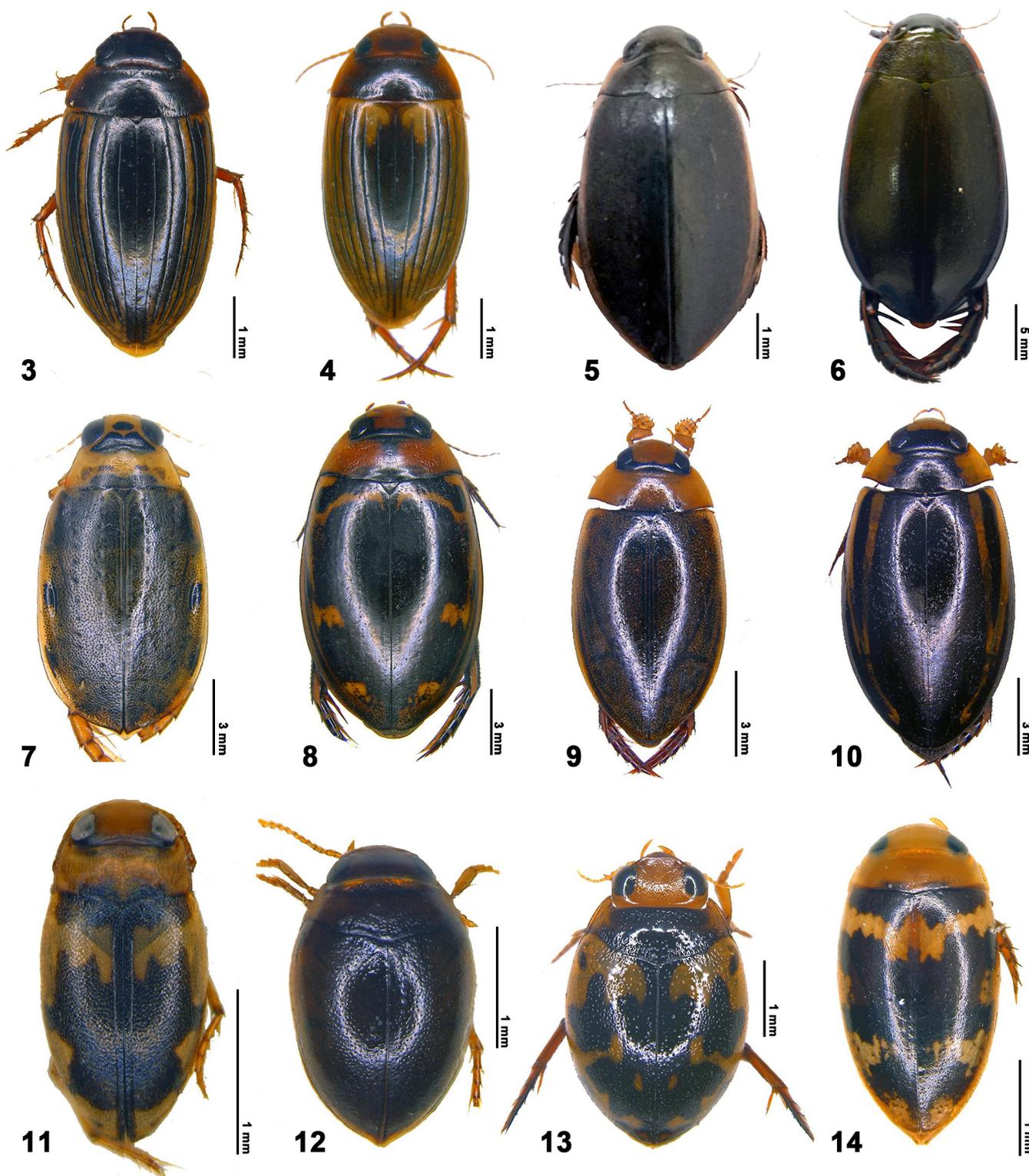
Distribution: *Oriental* (India [AP, AS, BR, KA, KL, MP, MH, MN, ML, OD, PY, NL, TS, WB]); *Australian* (Australia) (Vazirani, 1984; Deepa et al., 2022a).

Subfamily Orectochilinae Reegimbar, 1882**Genus *Orectochilus* Dejean, 1838*****Orectochilus* *indicus* Regimbart, 1883 (Fig. 28)**

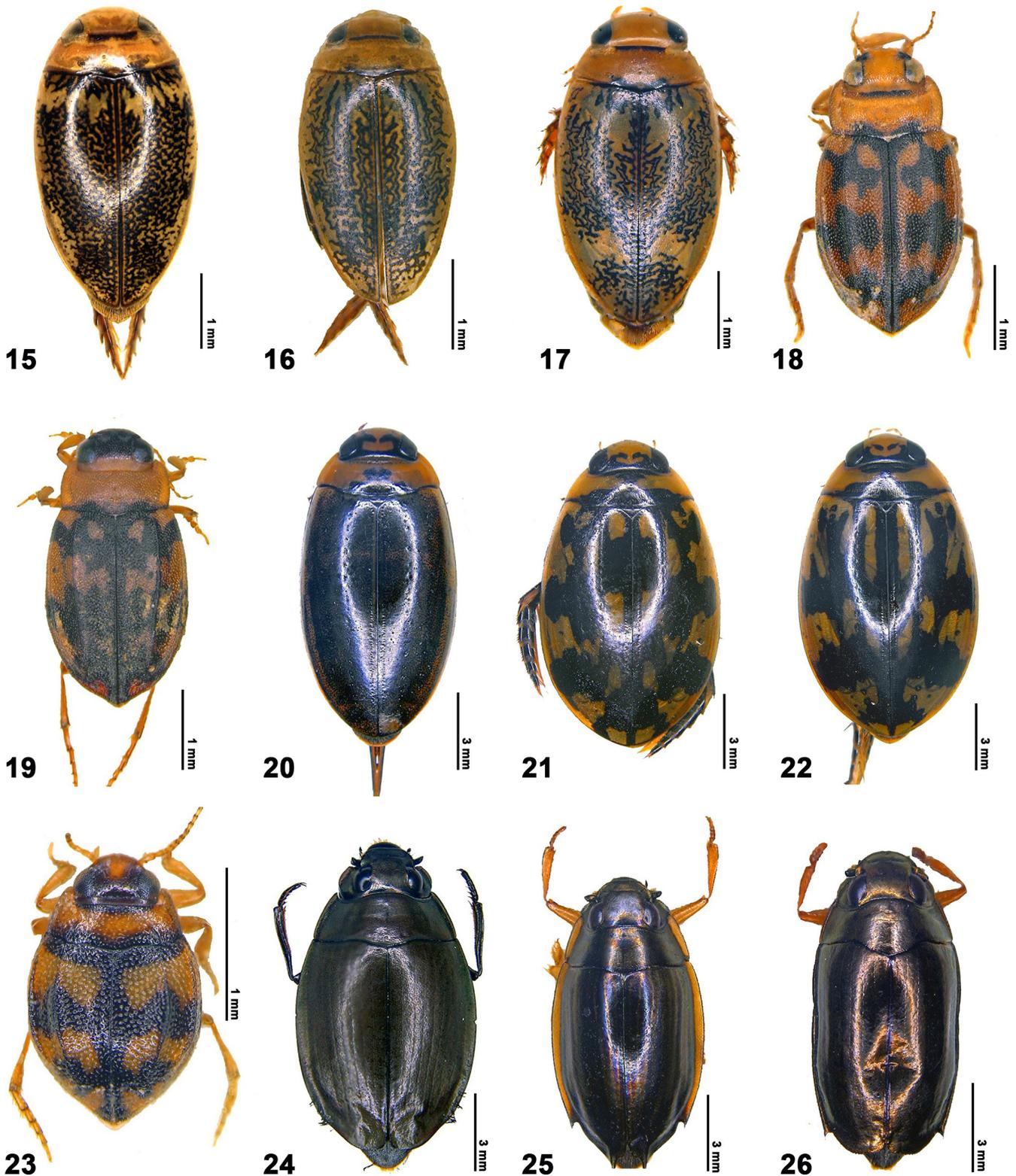
Material examined: 1♂, Pedduru (12°49'3.36"N, 78°33'48.6"E), 27.xi.2022, Reg. No. FBRC/ZSI/INS/3473; 3♂♂, 5♀♀, Keeramanda (13°5'31.56"N, 78°48'16.2"E), 5.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3525.

Distribution: *Oriental* (India [AP, KA, MP, OD, TN], Sri Lanka) (Vazirani, 1984).

Remarks. First record from the state of Andhra Pradesh.



Figures 3–14. Habitus of the species/aquatic beetles were collected from Koundinya wildlife sanctuary. **3.** *Copelatus mysorensis* Vazirani, 1970; **4.** *C. sociennus* Balfour-Browne, 1952; **5.** *Cybister rugulosus* (Redtenbacher, 1844); **6.** *C. tripunctatus lateralis* Sharp, 1899; **7.** *Eretes sticticus* (Linnaeus, 1833); **8.** *Hydaticus discindens* Walker, 1858; **9.** *H. ricinus* Wewalka, 1979; **10.** *H. satoi satoi* Wewalka, 1975; **11.** *Hydroglyphus flammulatus* Sharp, 1854; **12.** *Hydrovatus acuminatus* Motschulsky, 1859; **13.** *Hyphydrus (signatus) renardi* Severin, 1890; **14.** *Laccophilus acticatus acticatus* Sharp, 1890.



Figures 15–26. Habitus of the species/aquatic beetles were collected from Koundinya wildlife sanctuary. **15.** *L. inefficiens* (Walker, 1859); **16.** *L. parvulus* Aubé, 1838; **17.** *L. sharpi* Regimbart, 1889; **18.** *Pescheti* *quadricostatus* (Aube, 1838); **19.** *P. toxophorus* Guignot, 1942; **20.** *Rhantus taprobanicus* Sharp, 1890; **21.** *Sandracottus dejeanii* (Aube, 1838); **22.** *S. mixtus* (Blanchard, 1843); **23.** *Yola consanguinea* (Regimbert, 1892); **24.** *Dineutus* (*Cyclous*) *indicus* Hatch, 1927; **25.** *D.* (*Cyclous*) *spinosus* Fabricius, 1781; **26.** *D.* (*Cyclous*) *unidentatus* Aubé, 1838.

***Orectochilus limbatus* Regimbart, 1883 (Fig. 29)**

Material examined: 1♂, Kamalapalli (12°48'50.4"N, 78°31'54.48"E), 28.xi.2022, Reg. No. FBRC/ZSI/INS/3480; 1♂, 3♀♀, Galapalli (12°52'58.44"N, 78°33'39.24"E), 19.xi.2022, Reg. No. FBRC/ZSI/INS/3504; 1♀, Kottur Thanda (12°53'45.96"N, 78°35'4.92"E), 30.xi.2022, Reg. No. FBRC/ZSI/INS/3507; 6♂♂, 4♀♀, Keeramanda (13°5'31.56"N, 78°48'16.2"E), 5.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3523.

Remarks. Recorded first time from the state of Andhra Pradesh.

Distribution: *Oriental* (India [AP, BR, HP, MP, MH, OD, TN, TS, UP], Sri Lanka) (Vazirani, 1984; Deepa et al., 2022a).

***Orectochilus negletus* Ochs, 1925 (Fig. 30)**

Material examined: 1♂, Galapalli (12°52'58.44"N, 78°33'39.24"E), 19.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3501.

Distribution: *Oriental* (India [AP, HR, HP, JK, PB, UK, WB]) (Vazirani, 1984).

Remarks. First record from the state of Andhra Pradesh.

Family Hydrophilidae Latreille, 1802**Subfamily Sphaeridiinae Latreille, 1802****Genus *Amphiops* Erichson, 1843*****Amphiops mater* Sharp, 1873 (Fig. 31)**

Material examined: 1♂, Kamalapalli (12°48'50.4"N, 78°31'54.48"E), 28.xi.2022, Reg. No. FBRC/ZSI/INS/3481; 1♂, 3♀♀, Galapalli (12°52'58.44"N, 78°33'39.24"E), 19.xi.2022, Reg. No. FBRC/ZSI/INS/3502; 1♀, Kottur Thanda (12°53'45.96"N, 78°35'4.92"E), 30.xi.2022, Reg. No. FBRC/ZSI/INS/3506; 4♂♂, 5♀♀, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), 3.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3515.

Distribution: *Australian* (Australia); *Oriental* (Bangladesh, India [AP, DL, HP, JK, MN, SK, TS, WB], Malaysia, Nepal, Philippines, Sri Lanka, Vietnam); *Palaeartic* (China, Iran, Japan) (Mukhopadhyay, 2015).

Remarks. *Amphiops mater* and *A. simplex* are two water scavenger beetle species reported from India (Mukhopadhyay, 2015). *Amphiops mater* is a new distributional record to the state of Andhra Pradesh.

Subfamily Hydrophilinae Latreille, 1802**Genus *Berosus* Leach, 1817*****Berosus indicus* Motschulsky, 1861 (Fig. 32)**

Material examined: 1♂, Pathurnatham (13°3'33.84"N, 78°34'26.76"E), 1.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3510.

Distribution: *Oriental* (India [AP, BR, GA, HP, KL, JH, MP, MH, MN, OD, PB, RJ, SK, TN, TS, TR, UP, WB, JK]); *Palaeartic* (Pakistan [Khyber Pakhtunkhwa, Sanghar]) (Mukhopadhyay, 2015; Mustafa & Zubair, 2015; Deepa et al., 2022a).

***Berosus pulchellus* Macleay, 1825 (Fig. 33)**

Material examined: 1♂, 1♀, Narayanpuram (12°51'13.68"N, 78°32'32.28"E), 29.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3491.

Distribution: *Australian* (Australia); *Oriental* (Bangladesh, China, India [AP, AS, BR, DL, HR, JK, HP, KL, KA, MP, MH, MN, ML, NL, PB, OD, PY, RJ, SK, TN, TS, TR, UP, WB], Indonesia, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam); *Palaeartic* (Hong Kong, Iran, Japan, Taiwan) (Mukhopadhyay, 2015; Deepa et al., 2022a).

Subfamily Sphaeridiinae Latreille, 1802

Genus *Coelostoma* Brulle, 1835

Coelostoma bhutanicum Jayaswal, 1972 (Fig. 34)

Material examined: 2♂♂, Naniyal (12°51'10.44"N, 78°33'58.32"E), 21.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3541.

Distribution: *Oriental* (Bhutan, India [AP, KL, TS, ML, RJ], Japan, Nepal); *Palaeartic* (China, Taiwan) (Sayali et al., 2021; Deepa et al., 2022b).

Remarks. *Coelostoma bhutanicum* is only known from the states of KL, RJ, UK, TS, and ML (Sheth et al., 2020; Deepa et al., 2022a). The present study has confirms its distribution not only from the Koundinya wildlife sanctuary but also from State of Andhra Pradesh.

Coelostoma horni Regimbart, 1902 (Fig. 35)

Material examined: 3♂♂, 1♀, Pedduru (12°49'3.36"N, 78°33'48.6"E) 27.xi.2022, Reg. No. FBRC/ZSI/INS/3474; 2♂♂, 6♀♀, Kalyani Revu Waterfall (13°2'49.2"N, 78°42'20.16"E), 3.xii.2022, Reg. No. FBRC/ZSI/INS/3517; 1♀, Keeramanda (13°5'31.56"N, 78°48'16.2"E), 5.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3524.

Distribution: *Afrotropical* (South Africa, Yemen); *Oriental* (Bhutan, India [AN, AP, SK, TN and TS], Indonesia, Nepal, Sri Lanka, Thailand, Vietnam); *Palaeartic* (China); *Saharo-Arabian* (Oman, Saudi Arabia) (Deepa et al., 2022b).

Subfamily Hydrophilinae Latreille, 1802

Genus *Enochrus* Thomson, 1859

Enochrus esuriens (Walker, 1858) (Fig. 36)

Material examined: 2♂♂, 1♀, Keeramanda (13°5'31.56"N, 78°48'16.2"E), Reg. No. FBRC/ZSI/INS/3533; 2♂♂, Kottur Thanda (12°53'45.96"N, 78°35'4.92"E), Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3538.

Distribution: *Australian* (Australia); *Oriental* (India [AP, HP, JK, MN, SK, WB], Indonesia, Myanmar, Philippines, Sri Lanka, Vietnam); *Palaeartic* (China, Pakistan [Khyber Pakhtunkhwa, Sindh]) (Mukhopadhyay, 2015; Mustafa & Zubair, 2015).

Genus *Helocharus* Mulsant, 1844

Helochares anchoralis Sharp, 1890 (Fig. 37)

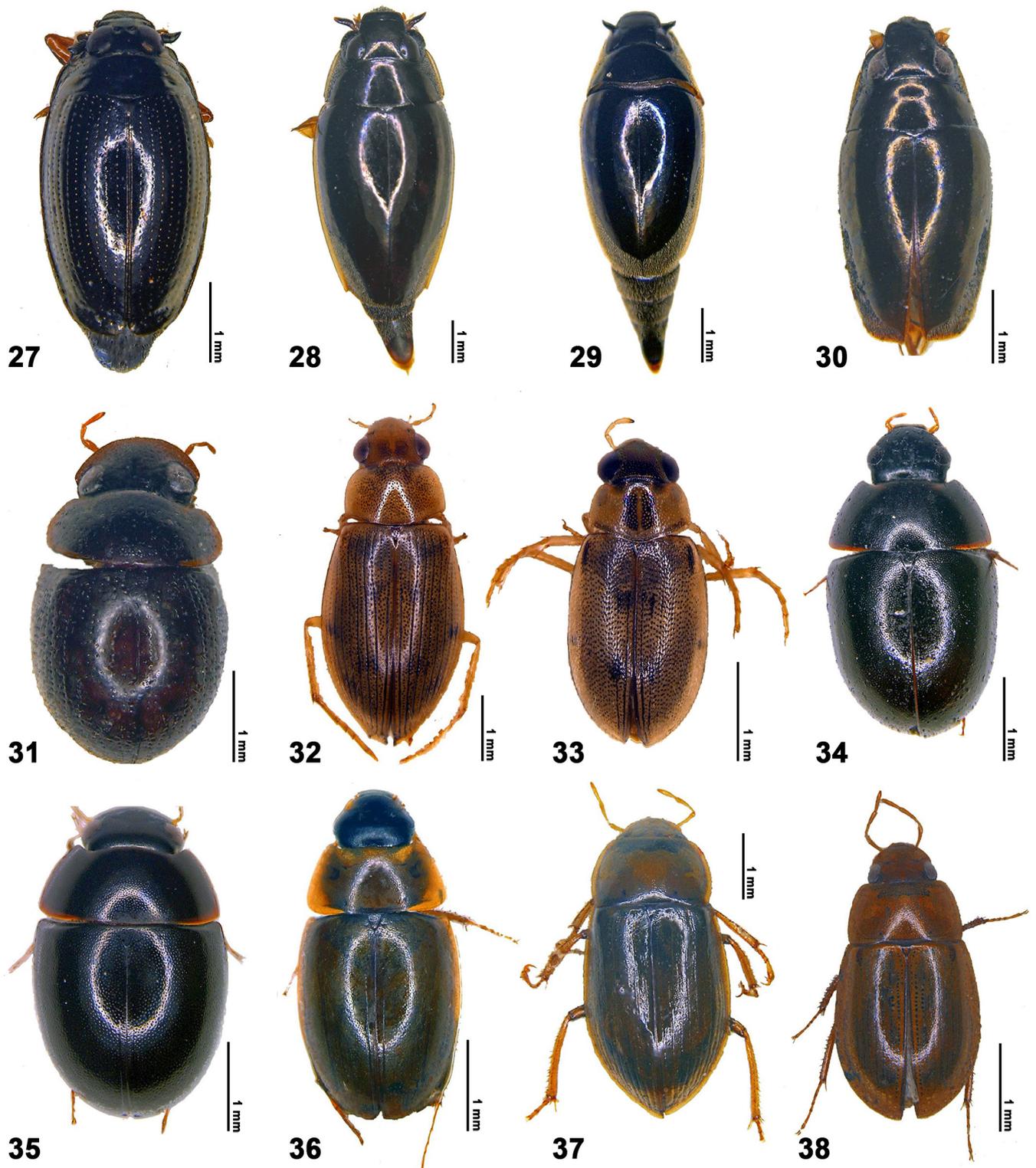
Material examined: 1♂, 3♀, Kottur Thanda, (12°53'45.96"N, 78°35'4.92"E), Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3535.

Distribution: *Oriental* (India [AP, AS, BR, TS, WB]); *Palaeartic* (Pakistan [Khyber Pakhtunkhwa, Sindh]) (Mukhopadhyay, 2015; Mustafa & Zubair, 2015).

Helochares pallens (MacLeay, 1825) (Fig. 38)

Material examined: 2♂♂, Keeramanda (13°5'31.56"N, 78°48'16.2"E), Reg. No. FBRC/ZSI/INS/3534; 1♀, Galapalli (12°52'58.44"N, 78°33'39.24"E), Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3539.

Distribution: *Afrotropical* (Egypt); *Oriental* (India [AP, AS, BR, TS, WB], Indonesia, Philippines, Vietnam); *Palaeartic* (China, Syria) (Mukhopadhyay, 2015).



Figures 27–38. Habitus of the species/aquatic beetles were collected from Koundinya wildlife sanctuary, **27.** *Gyrinus convexiusculus* Macleay, 1871; **28.** *Orectochilus indicus* Regimbart, 1883; **29.** *O. limbatus* Regimbart, 1883; **30.** *Orectochilus neglectus* Ochs, 1925; **31.** *Amphiops mater* Sharp, 1873; **32.** *Berosus indicus* Motschulsky; 1861, **33.** *B. pulchellus* Macleay, 1825; **34.** *Coelostoma bhutanicum* Jayaswal, 1972; **35.** *C. horni* Regimbart, 1902; **36.** *Enochrus esuriens* (Walker, 1858); **37.** *Helochares anchoralis* Sharp, 1890; **38.** *H. pallens* (MacLeay, 1825).

Genus *Hydrophilus* Geoffroy, 1762***Hydrophilus olivaceus* Fabricius, 1781 (Fig. 39)**

Material examined: 1♂, 1♀, Venkatesapuram (12°44'26.88"N, 78°27'18"E), 25.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3489.

Distribution: *Oriental* (India [AP, MH, TN, TS, WB]); *Palaeartic* (Tonkin) (Mukhopadhyay, 2015; Deepa et al., 2022a).

Genus *Regimbartia* Zaitzev, 1908***Regimbartia attenuata* (Fabricius, 1801) (Fig. 40)**

Material examined: 1♂, 4♀♀, Naniyal (12°51'10.44"N, 78°33'58.32"E), 21.xi.2022, Reg. No. FBRC/ZSI/INS/3498; 4♀ Galapalli (12°52'58.44"N, 78°33'39.24"E), 19.xi.2022, Reg. No. FBRC/ZSI/INS/3503; 1♂, Kottur Thanda (12°53'45.96"N, 78°35'4.92"E), 30.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3509.

Distribution: *Australian* (Australia); *Oriental* (India [AP, JK, MH, MN, ML, PB, SK, TN, TS, TR, UP, WB], Indonesia, Philippines, Sri Lanka); *Palaeartic* (China, Japan) (Mukhopadhyay, 2015).

Genus *Sternolophus* Solier, 1834***Sternolophus acutipenis* (Hiva & Albrecht, 2017) (Fig. 41)**

Material examined: 1♂, Veerlabanda (13°3'24.48"N, 78°38'40.92"E), 2.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3513.

Distribution: *Oriental* (India [AP, MP, TN], Indonesia, Myanmar, Thailand, Vietnam); *Palaeartic* (China) (Hiva & Albrecht, 2017).

Remarks. Recorded first time from the state of Andhra Pradesh.

***Sternolophus rufipes* (Fabricius, 1792) (Fig. 42)**

Material examined: 2♂♂, 7♀♀, Pedduru (12°49'3.36"N, 78°33'48.6"E), 27.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3477.

Distribution: *Oriental* (Bhutan, Cambodia, India [AP, BR, CG, GJ, HP, JK, MP, MH, MN, ML, OD, PB, SK, TN, TS, TR, UP, WB], Indonesia, Malaysia, Myanmar, Nepal, Philippines, Singapore, Sri Lanka, Vietnam); *Palaeartic* (China, Hong Kong, Japan, Pakistan [Khyber Pakhtunkhwa, Sindh], Taiwan, South Korea) (Mustafa & Zubair, 2015; Hiva & Albrecht, 2017; Deepa et al., 2022a).

Family Noteridae Thomson, 1860**Subfamily Noterinae Thomson, 1860****Genus *Canthydrus* Sharp, 1882*****Canthydrus laetabilis* Walker, 1858 (Fig. 43)**

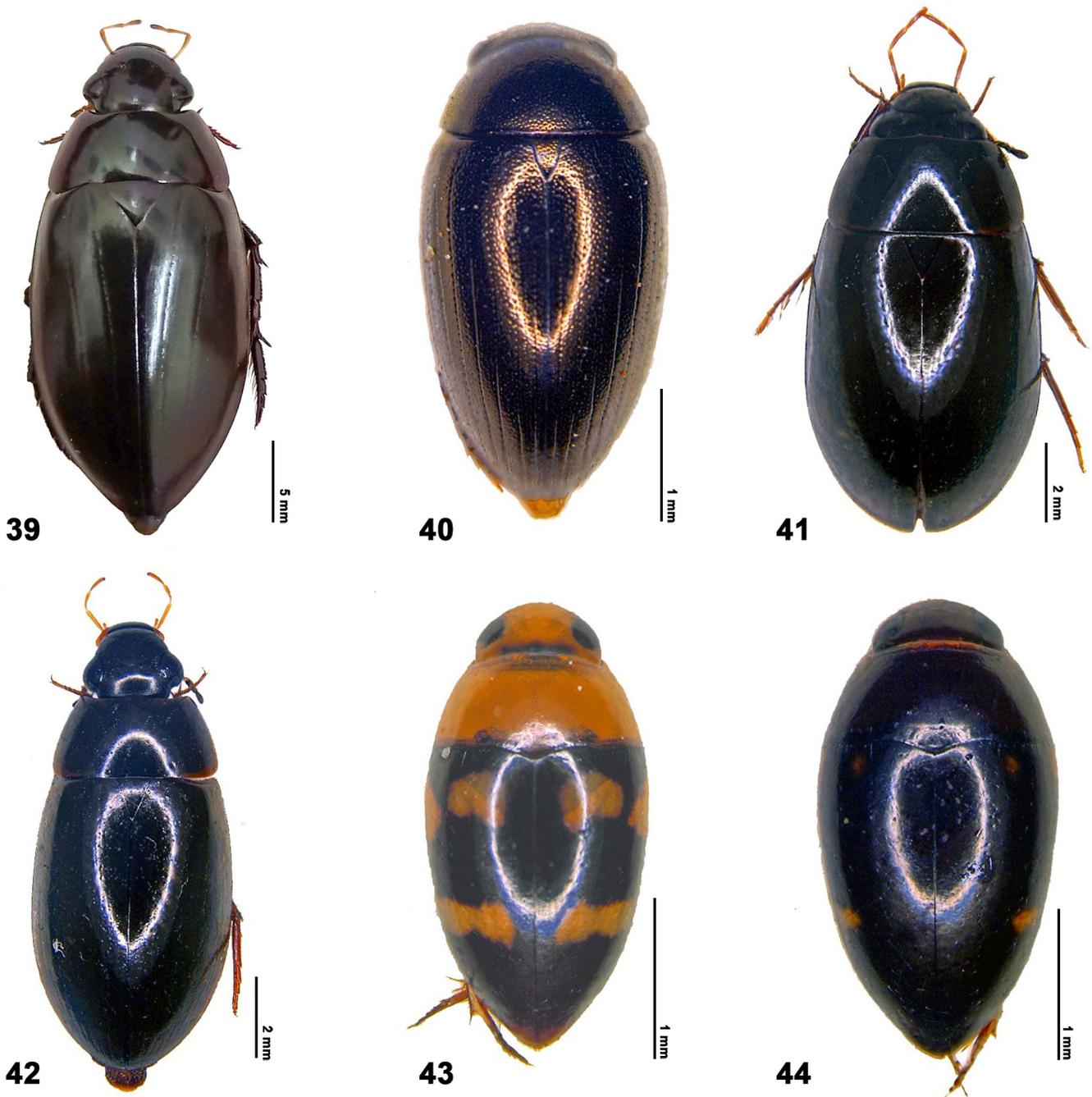
Material examined: 3♀♀, Galapalli (12°52'58.44"N, 78°33'39.24"E), 19.xi.2022, Reg. No. FBRC/ZSI/INS/3536; 3♂♂, 1♀, Naniyal (12°51'10.44"N, 78°33'58.32"E), 21.xi.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3540.

Distribution: *Oriental* (India [AP, BR, GJ, MH, ML, SK, TS, WB], Pakistan, Myanmar, Nepal, Sri Lanka) (Mukhopadhyay, 2015; Deepa et al., 2022a).

***Canthydrus luctuosus* (Aubé, 1838) (Fig. 44)**

Material examined: 1♂, 2♀♀, Veerlabanda (13°3'24.48"N, 78°38'40.92"E), 2.xii.2022, Reg. No. FBRC/ZSI/INS/3514; 1♀, Keeramanda (13°5'31.56"N, 78°48'16.2"E), 5.xii.2022, Leg.: J. Deepa & S. Shankar, Reg. No. FBRC/ZSI/INS/3527.

Distribution: *Oriental* (Cambodia, India [AP, BR, MH, OD], Indonesia, Sri Lanka, Vietnam); *Palaeartic* (Iran, Iraq, Saudi Arabia, Syria); *Saharo-Arabian* (Saudi Arabia) (Mukhopadhyay, 2015).



Figures 39–44. Habitus of the species/aquatic beetles were collected from Koundinya wildlife sanctuary. **39.** *Hydrophilus olivaceus* Fabricius, 1781; **40.** *Regimbartia attenuate* (Fabricius, 1801); **41.** *Sternolophus acutipenis* (Hiva & Albrecht, 2017); **42.** *Sternolophus rufipus* (Fabricius, 1792); **43.** *Canthydrus laetabilis* Walker, 1858; **44.** *Canthydrus luctuosus* (Aubé, 1838).

DISCUSSION

Fifty percent of the collected species in the Koundinya wildlife sanctuary are diving beetles. It followed by Hydrophilidae with 28%, Gyrinidae 17% and Noteridae 5% (Fig. 2). The species *Copelatus mysorensis*, *C. sociennus*, *Peschetius quadricostatus*, *Hyphydrus renardi* (Dytiscidae), *Sternolophus acutipenis*, *Amphiops mater* (Hydrophilidae), *Orectochilus indicus*, *O. limbatus*, and *O. negletus* (Gyrinidae) are new records for the state of Andhra Pradesh. *Hydaticus discindens*, *Gyrinus convexiusculus*, *Orectochilus limbatus*,

Canthydrus luctuosus, *Coelostoma horni*, and *Regimbartia attenuate* were more common, while *Dineutus unidentatus*, *Orectochilus negletus*, *Copelatus socinnus*, and *Yola consengunea* were rarely collected. The study observed the species of *Gyrinus convexiusculus* and *Orectochilus limbatus* as being more abundant in different sampling sites of wildlife sanctuary which indicates the good health of aquatic ecosystems and management (CPCB, 2017) *Orectochilus indicus* and *O. limbatus* are habituated to fast-flowing water, which indicates good water quality and has been well studied in Indian states (Vazirani, 1984). In addition to the forty-two species, the study also collected *Allocotocerus* sp., *Amphiops* sp., *Bidessus* sp., *Laccophilus* sp., *Hydroscapha* sp., and *Paracymus* sp., from wildlife sanctuary as well as from the state of Andhra Pradesh, which need more detailed taxonomic examination for further species-level identification. *Allocotocerus*, *Bidessus* sp., are collected for the time being from the state of Andhra Pradesh. The present study collected specimens of *Hydroscapha* for the first time not only from Andhra Pradesh but also from south India.

The current research added nine new distributional records to the Andhra Pradesh aquatic beetle fauna, bringing the total to 55 species. Previously, 46 species had been reported from the state (Mukhopadhyay, 2007; Mukhopadhyay & Ghosh, 2007; Deepa et al., 2022b). Andhra Pradesh's beetle fauna shares similarities with that of the neighboring Indian state of Telangana, which has 56 species (Chandra et al., 2021). There are few studies on the aquatic beetle fauna from India's protected regions. According to Deepa et al. (2022a), Kawal Tiger Reserve in Telangana has the highest diversity of aquatic beetles, with 41 species, followed by Satkosia Gorge Wildlife Sanctuary in Odisha, which has 39, Sundarban Biosphere Reserve in West Bengal, which has 35, Baisipalli Wildlife Sanctuary in Odisha, which has 34, Renuka Wildlife Sanctuary in Himachal Pradesh, which has 21, Sandi Bird Sanctuary in Uttar Pradesh, which has 18, Suraha Tal wildlife sanctuary which has 13, Dudhwa tiger reserve in Uttar Pradesh reported 11, Asan wetland conservation reserve in Uttarakhand, Govind Sagar wildlife sanctuary in Himachal Pradesh, Karnala bird sanctuary in Maharashtra with 9 species each, Buxa tiger reserve in West Bengal, Binsar wildlife sanctuary in West Bengal has reported 4 species respectively (Ghosh et al., 2018). There are only two species of aquatic beetles in Keibul Lamjao National Park in Manipur, which is the least diverse. (Takhelmayum & Gupta, 2015). With 42 species, the current investigation revealed the greatest diversity of aquatic beetles among all the Indian protected areas listed above. On the other hand, the current research on the aquatic beetles of the Koundinya wildlife sanctuary is a baseline study to comprehend the diversity of aquatic beetles, and it may be helpful in the future to understand the diversity of aquatic beetles in the wildlife sanctuary as well as to help with better management of the ecosystem.

AUTHOR'S CONTRIBUTION

The authors contribution in the present study as follows: S. Shankar, & J. Deepa: Identifying the specimens, preparing the photograph of the mounted specimen, writing the manuscript and correspondence; D. Kumar & M. Karuthapandi: field survey, collecting the specimens and preparing the photo plates; S. Jadhav & K.B. Kunte: preparation of the map and revising the manuscript. All authors read and approved the final version of the manuscript.

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AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited in the collection of Freshwater Biology Regional Centre, Zoological Survey of India, Hyderabad, Telangana, and are available from the curator, upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this paper.

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سخت‌بال پوشان آبزی (Insecta, Coleoptera) پناهگاه حیات وحش کاوندینیا، آندرا پرادش، هند

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چکیده: این تحقیق با هدف مطالعه فون سخت‌بال پوشان آبزی در پناهگاه حیات وحش کاوندینیا (هند) انجام شد. تعداد ۴۲ گونه متعلق به ۴ خانواده ثبت شدند. بیشترین تعداد گونه‌ها متعلق به خانواده Dytiscidae بودند و پس از آن خانواده‌های Hydrophilidae، Gryinidae و Noteridae قرار گرفتند. همه گونه‌ها برای اولین بار از این پناهگاه حیات وحش گزارش می‌شوند. تعداد ۹ گونه نیز برای ایالت آندرا پرادش جدید هستند.

واژگان کلیدی: سوسک‌ها، تنوع، اکوسیستم، محیط زیست، کاوندینیا، حیات وحش