International Journal of Zoological Research

ISSN 1811-9778

Academic Journals Inc.

www.academicjournals.com

OPEN ACCESS International Journal of Zoological Research

ISSN 1811-9778
DOI: 10.3923/ijzr.2017.83.92

Research Article
Aquatic Coleopteran (Family: Dytiscidae) Diversity of South Coastal Odisha, India

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Abstract

Background and Objective: The aquatic insects belong to family Dytiscidae, often inhabiting the shores of salt or brackish water. The present study is focused on the members of family Dytiscidae beetles from water bodies of coastal area of Ganjam, connected directly to the Bay of Bengal via different rivers, rivulets and other water bodies adjacent to the estuaries present in the district. The purpose of the study was to invent and identify the specific species of estuarine coleopteran according to seasonal variation in estuaries of South coastal Odisha. **Materials and Methods:** Ganjam is a South coastal district of Odisha state, India located near the border of Andhra Pradesh. Four water-bodies were selected for the study. Pi-diagram was used to compare the percentage of aquatic insects collected from different sites. The aquatic coleopteran specimen comprises of 12 species, belonging to 07 genera of 04 subfamilies. **Results:** The 6 months study revealed the percentage of occurrence of Dytiscidae beetles with respect to other aquatic coleopteran families. Among the family Dytiscidae, *Laccophilus parvulus* (*L. parvulus*) and *Hydaticus vittatus* (*H. vittatus*) dominated all of the four water bodies. Only few Dytiscidae of subfamily Dytscinae and Colymbetinae were found in saline water of Rushikulya. **Conclusion:** Four subfamilies namely Laccophilinae, Dytiscinae, Colymbetinae and Hydroporinae are chiefly represented in the present report. The study opened the opportunities for future taxonomic and diversity studies on the aquatic Coleoptera of Odisha state.

Key words : Estuarine coleopteran, Dytiscidae, *Laccophilus*, *Hydaticus*, *Hydroglyphus*, *Hydrovatus*

Citation: Swetapadma Dash and Sanmitra Roy, 2017. Aquatic coleopteran (Family: Dytiscidae) diversity of South coastal Odisha, India. Int. J. Zool. Res., 13: 83-92.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Aquatic insects are broadly diverse group playing an important role in ecosystem functioning, in virtue of their numerical abundance, taxonomic diversity[1]. Water beetles are very integral parts of the biotic component of any water bodies or wetlands. They are indicator of ecological diversity and habitat characteristics[2,3]. The beetles are especially useful in certain habitats as peat bogs, coastal and saline lagoons, wood and wetland ponds, etc.[4]. Aquatic beetles are found in nearly any aquatic habitat including potholes but beetles reach their greatest diversity in lentic habitats such as wetlands and pond margins.

Among 14 families of aquatic Coleoptera, 5 families under suborder Adephaga and 9 families under suborder Polyphaga are fully or partly aquatic. More than 8000 species of aquatic beetles are found in world. Of these about 588 species are represented in India[5].

Study of Indian aquatic Coleoptera has received considerable interest since Vajirani[6] gave a detail taxonomic account of different families of aquatic beetles. Afterwards a detailed study on the family Dytiscidae, Gyrinidae, Hydrophilidae, of West Bengal was done[7]. Aquatic Coleoptera belong to the family Gyrinidae, Dytiscidae and Hydrophilidae had been described from Tripura[8]. Mukhopadhyay and Ghosh[9] reported aquatic Coleptera from Andhra Pradesh pertaining to the family Gyrinidae and Dytiscidae. In recent year Ghosh and Nilsson[10] made a catalogue of the diving Beetles (family Dytiscidae) of India and adjacent countries.The present study was based on distribution and seasonal variation of Dytiscidae beetles from various places of coastal region of Ganjam district, Odisha which includes the report of 12 species under 07 genera of 04 subfamilies. Diagnostic characters and distribution of the each species been provided. The purpose of the study was to invent and identify the specific species of estuarine Coleopteran according to seasonal variation in estuaries of South coastal Odisha.

MATERIALS AND METHOD

Study area: Ganjam is a South coastal district of Odisha, India located near the border of Andhra Pradesh (19.38°N, 85.07°E) with an area of 8,070 km^2. The study was focused on the members of family Dytiscidae present on water bodies of coastal Ganjam, that are connected directly to Bay of Bengal through different rivers, rivulets and lagoons and separate fresh water ponds that are adjacent to the estuaries present in the district. Four such water-bodied were selected for the study. Study sites with geographical coordinates are given in Fig. 1(a-e).

Station 1: Subhadra Estuary near Haripur Back water, Gopalpur, Ganjam district:

- Fishing ponds at Narayanpur, 2 km from Estuary mouth
  - Latitude: 19°16' 24.12" N
  - Longitude: 84°53' 59.88" E
  - Elevation: 5.8 m
- Water-bodies by the side of Keya plantation near Subhadra Estuary
  - Latitude: 19°16' 26.32" N
  - Longitude: 84°52' 20.20" E
  - Elevation: 5.5 m

Station 2: Water-bodies present near Indian Rare Earth (IRE) campus:

- Latitude: 19°18' 37.12" N
- Longitude: 84°57' 14.31" E
- Elevation: 14.6 m

Station 3: Tampara Lake of Chattrapur, Ganjam district:

- Latitude: 19°21' 42.97" N
- Longitude: 85°00' 43.06" E
- Elevation: 8.8 m

Station 4: Water-bodies near Rushikulya river, 1.5 km from Estuary mouth, Ganjam district:

- Latitude: 19°22' 43.15" N
- Longitude: 85°04' 23.96" E
- Elevation: 7.01 m

Methodology: Four surveys were conducted during the 6 months of study period from December, 2013 to July, 2014. The study is still relevant as this was a preliminary study of estuarine faunas. There were altogether 500 examples of aquatic insects collected, which include 80 examples of aquatic coleopteran pertaining to family Dytiscidae. For each of the four study sites, qualitative and quantitative samplings of aquatic insects were made with the help of different insect collecting nets. Surface floating and free swimming insects were collected with small circular nets made of either coarsely

Fig. 1(a-e): (a) GPS locations of four study sites, (b) GPS location of point 1 at Narayanpur, Ganjam, (c) GPS location of point 2 at Indian Rare Earth Ltd, Ganjam, (d) GPS location of point 3 at Tampara lake, Ganjam and (e) GPS location of point 4 at mouth area of Rushikulya river, Ganjam

meshed cotton cloths or finely meshed aluminium wire. Insects from deep water were collected through the 'D' shaped insect net of 50 cm long, made up of with polyester mosquito curtain cloth. The design and operation of the net was roughly based on those described by Junk[11]. Temperature, salinity and pH of water were taken into account from each of study sites. After collection insects were preserved in 70% alcohol. Only aquatic Coleopterans were identified in 10X stereo zoom binocular microscope. Other aquatic insects were preserved for future concern. Dissections of specimens were made as per necessity. The dissected genital organs were also preserved in 70% alcohol. Aquatic Coleoptera were identified by literature of Vazirani[12,13] and of Biswas *et al.*[7].

RESULTS

The collection from the survey comprises of 80 examples of aquatic coleopteran of family Dytiscidae including 12 species of 7 genera accommodated under 4 subfamilies. The diagnostic characters and distribution of the species have been given below:

- Family: Dytiscidae
- Subfamily: Laccophilinae

The members of the subfamily, Laccophilinae have front and middle tarsi clearly composed of 5 segments. The 4th segment is at most slightly shorter than the third. Body length of adults varies between 3.0-4.5 mm:

***Laccophilus anticatus* (Sharp, 1890):** Sharp, D. 1890. On aquatic Carnivorous coleopteran or Dytiscidae. Trans. Ent. Soc., London: 341.

Diagnostic characters

Length: 3.0-3.2 mm, body oval, suppressed, head testaceous, pronotum concolorous to the head, elytra ferruginous to black with yellow markings (fascia) as on (i) Lateral boarders, (ii) Small, median, sub-lateral spot, (iii) A post-basal transverse, irregular and dentate band, largely confluent with the border (Fig. 2) (iv) Small, post-median, transverse spot, not touching the suture, (v) Anti apical spot, ventral side testaceous, male basal three segments of the fore and mid tarsi little broadened and with sucker like palettes underneath, penis two branched, anterior long branch bend anteriorly, posterior short branch with rounded apex.

Distributions: Odisha: Ganjam Dist, Bihar, West Bengal, Manipur, Pondicherry, Tamil Nadu, Andhra Pradesh, Assam, Kerala, Karnataka, Maharashtra, Uttar Pradesh and Tripura.

Fig. 2: *Laccophilus anticatus* with lateral view of penis

Fig. 3: *Laccophilus parvulus* with lateral view of penis and right elytra

***Laccophilus parvulus* (Aube, 1838):** Aube, C. 1838. in Dejean's, Species Coleopteres, 6: 429.

Diagnostic characters

Length: 2.9-3.5 mm, body oval, elongate, head testaceous to red, pronotum concolorous to the head with narrow black lines in the middle along the anterior and posterior margins, elytra testaceous to ferruginous, covered with undulating fine black double lines, sometimes reduced to 5-6 lines in the middle, generally with a basal and apical yellow fascia, ventral side ferruginous to black, male fore-tarsi with three basal segments provided with small sucker palettes underneath, penis moderately strongly curved in the middle and almost uniformly wide and notched at the apex (Fig. 3).

Distribution: India: Odisha: Ganjam Dist, Andhra Pradesh, Bihar, Kerala, Madras, Madhya Pradesh and Rajasthan.

Fig. 4: *Laccophilus flexuosus* with right elytra and lateral view of penis

Fig. 5: *Laccophilus ellipticus* with right elytra and lateral view of penis

***Laccophilus flexuosus* (Aube, 1838):** Aube, C. 1838. in Dejean's, Species Coleopteres, 6: 430.

Diagnostic characters

Length: 4.25 mm, body oval, moderately elongate, head pale reddish, pronotum concolorous to the head with extremely narrow black lines along the anterior and posterior boarder, elytra same colour of pronotum, with numerous narrow double lines, broadly irregular, without leaving any fasciae (Fig. 4). Ventral side ferruginous, penis in male uniformly wide longer than *L. parvulus*, slightly twisted and moderately curved. This species is quite close to *L. parvulus* and *L. sharpi* but easily distinguished by the structure of penis.

Distribution: Odisha: Ganjam, Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Mysore, Rajasthan, Uttar Pradesh and West Bengal.

***Laccophilus ellipticus* (Regimbart, 1889):** Regimbart, M. 1889. Revesion des Dytiscidae de la Region Indo-sino-Malaise. Ann. Soc. Ent. France (6)9: 152.

Diagnostic characters

Length: 3.9 mm, body elongate, moderately oval elliptical, head reddish testaceous, pronotum concolorous with the head, elytra rust red or testaceous without any distinct marking on it (Fig. 5). Reticulation double and ventral side ferruginous, male penis curved twisted at the base and forming deep depression at the base.

Distribution: Odisha: Ganjam, Andhra Pradesh, Bihar, Madhya Pradesh, Madras, Maharashtra, Mysore, Rajasthan, Uttar Pradesh and West Bengal.

- Subfamily: Dytiscinae

Members of subfamily Dytiscinae are with regularly round eye margins behind the insertion of the antennae with at most a very slight suggestion of a notch. The first three segments of the front tarsus in males are extended with rounded or transversely oval suction pads. Body length of adults are generally >10 mm.

***Eretes sticticus* (Linnaeus, 1767):** Linnaeus, C. 1767. Systema Naturae, Holmiae, ed. 12, 1 (2): 666.

Diagnostic characters

Length: 14 mm, body oval. Head testaceous in colour, with two transverse black bands (i) On the frons and (ii) On the vertex, anterior boarder of eyes not excised. Pronotum pale testaceous with one transverse black band posterior angle of pronotum is rounded, sides of pronotum re-bordered, elytra testaceous in colour, entirely black irrotions, elytral lateral boarder smooth in the basal half but serrated from middle to the apex (Fig. 6). Three basal segments of the pro tarsi enlarged into oval pallet, hind margin of fore, meso and metatarsal segments on both anterior and posterior faces fringed with golden yellow ciliae, over-lapping the next segment, ventral side testaceous.

Distribution: Odisha: Ganjam, Andhra Pradesh, Assam, Bihar, Kashmir, Madras, Maharashtra, Manipur, Mysore, Rajasthan, West Bengal, Uttar Pradesh and Punjab.

***Hydaticus (guignotites) fabricii* (Macleay, 1833):** Macleay. 1833. Annulossa javanica: 134.

Diagnostic characters

Length: 11.5 mm, head dark reddish brown with a transverse black band on the posterior boarder of the vertex, pronotum slight light reddish brown in colour with a transverse black band along the posterior corner, three basal segments of the

Fig. 6: *Eretes sticticus*

Fig. 7: *Hydaticus* (*guignotites*) *fabricii*

pro-tarsi enlarged into oval pallet, hind margin of fore, meso and metatarsal segments on both anterior and posterior faces fringed with golden yellow ciliae, over-lapping the next segment, apical spur s of the hind tibiae simple pointed, ventral side blackish brown (Fig. 7).

Distribution: Odisha: Ganjam, Assam, Andhra Pradesh, Himachal Pradesh, Madras, Maharashtra, Punjab, Rajasthan, West Bengal, Eastern Himalaya, Manipur and Sikkim.

Remarks: This species is recorded for the first time from Ganjam district.

***Hydaticus vittatus* (Fabricius, 1775):** Fabricius, J.C. 1775. Syst. ent. App.,: 825.

Diagnostic characters

Length: 18.5 mm, head dark yellowish brown with a transverse black band on the posterior boarder of the vertex. Pronotum colour is yellow with a lateral black colouration at

Fig. 8: *Hydaticus vittatus*

the middle (Fig. 8). Humeral and sub marginal yellow stripes, narrow and joined together posteriorly after the middle of elytra. Rudimentary claws in the hind tarsi of female. Hind tarsi are with white bands.

Distribution: Odisha: Ganjam, Assam, Andhra Pradesh, Punjab, Rajasthan, West Bengal, Elsewhere: Myanmar, Pakistan, Sri Lanka, Nepal, China, Farmosa, Japan, Indonesia, Java and Sumatra.

Remarks: This species is recorded for the first time from Ganjam district:

- Subfamily: Colymbetinae

Members of this subfamily have pronotum with or without a border at the sides. Front margin of the metasternum maybe with or without a clear deep depression. Elytra finely transversely fissured. Length 16-17 mm.

***Rhantus sexualis* (Zimmermann, 1919):** Zimmermann. 1919. Arch. Naturgesch., 83A (12): 219.

Diagnostic characters

Length: 13.1-13.5 mm, body oval, suppressed, head testaceous with one median black marking and one black margin along the posterior boarder, pronotum testaceous with a transverse black spot, reticulation strong on head and pronotum, elytra testaceous to light brown with black punctures on it (Fig. 9). Three basal segments of fore tarsi never form any pallet, anterior boarder of eyes excised, mid and hind legs strong and with swimming hairs.

Fig. 9: *Rhantus sexualis*

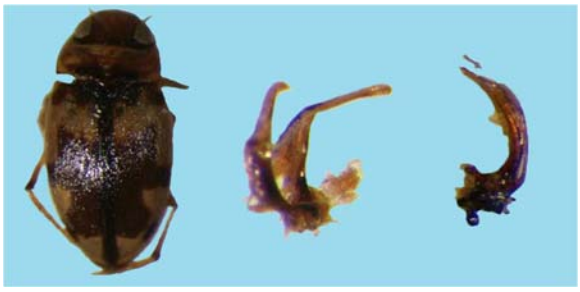

Fig. 10: *Hydroglyphus flammulatus* with lateral view of parameres and penis

Distribution: Odisha: Ganjam, Himachal Pradesh, Sikkim and Uttarakhand.

Remarks: This species is recorded for the first time from Odisha.

- Subfamily: Hydroporinae

Members of subfamily Hydroporinae have front and middle tarsi consisting of 4 segments or apparently so due to the 4th segment being very small and hidden between the lobes of the third segment. Claws of hind legs are very unequal in length, the outer one greatly shortened and difficult to find. Body oval, distinctly rounded at the sides and domed in section. Small species have body length, 1-5 mm.

***Hydroglyphus flammulatus* (Sharp, 1882):** Sharp, D. 1880-1882. On aquatic Carnivorous coleopteran or Dytiscidae. Sci. Trans. R. Dublin. Soc. 2: 359.

Diagnostic characters

Length: 2.3-2.5 mm, body oblong oval, head testaceous with narrow black marking on posterior margin, punctation fine, pronotum testaceous, narrowly black along posterior boarder,

Fig. 11: Left elytra and lateral view of parameres and penis of *H. inconstans*

latero-basal plica short, not continued on the elytra, elytra testaceous with black marking as (i) Basal transverse dented irregular band not touching the suture, (ii) Large broad marking along the suture indented and extremely irregular on the external side, punctuation strong and dense, ventral side blackish, penis moderately curved and narrowed at the apex, parameres broad basally and strongly narrowed at apex with hairs (Fig. 10).

Distributions: Odisha: Ganjam, Bihar, Andhra Pradesh, Uttar Pradesh, Madras, Maharashtra, Punjab, Rajasthan, West Bengal, Manipur, Sikkim and Tripura.

***Hydroglyphus inconstans* (Regimbart, 1892):** Regimbart, M. 1892. Insecte du Bengale Occidental. 16e Memoire Hydrocanthares. Ann. Soc. Ent. Belg. 36: 119.

Diagnostic characters

Length: 1.8-2.0 mm, body oblong oval, little short than *H. flammulatus,* head and pronotum testaceous, latero basal plica distinct in pronotum and of half length of the pronotum, punctation fine and irregular, elytra testaceous-grey with yellow spots, darker along the suture (Fig. 11) hind tarsal claws unequal, penis strongly and regularly curved, narrowed and pointed at apex.

Distribution: Odisha: Ganjam, Bihar, Andhra Pradesh, Uttar Pradesh, Madras, Maharashtra, Madhya Pradesh, Rajasthan, West Bengal, Manipur, Sikkim, Tripura, Goa, Karnataka and Tamil Nadu.

***Hydrovatus confertus* (Sharp, 1882):** Sharp, D. 1880-1882. On aquatic Carnivorous coleopteran or Dytiscidae. Sci. Trans. R. Dublin. Soc. 2: 329.

Fig. 12: *Hydrovatus confertus*

Fig. 13: *Yola consanguinea*

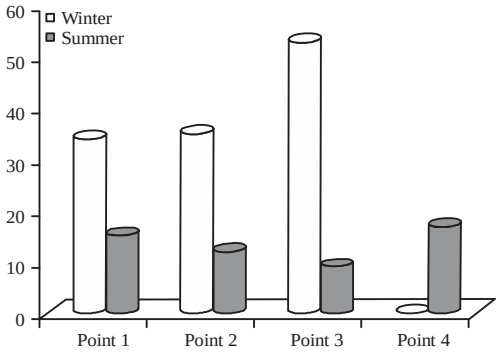

Fig. 14: Seasonal variation in beetle population
X-axis: Collection sites, Y-axis: Number of specimen of Coleoptera collected from various sites

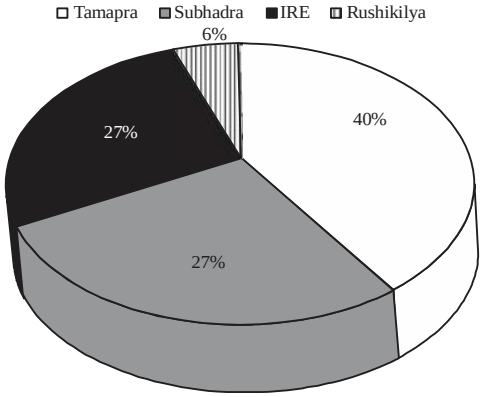

Fig. 15: Comparison of No. of insects belonging to order Coleoptera from different study sites

Diagnostic characters

Length: 2.3-2.5 mm, body oblong oval. Elytra aretestaceous or ferruginous. Elytra are more densely punctate than the pronotum, punctures almost coalescent (Fig. 12). Clypeus very narrowly rebordered, form more oval, side of pronotum arched, pronoto-elytral angle not distinct. Elytra are concolorous with head and pronotum.

Distribution: Odisha: Ganjam, Bihar, Kerala, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. It is also known from China, Indonesia, Myanmar, Sri Lanka, Thailand and Vietnam.

***Yola consanguinea* (Regimbart, 1892):** Regimbart, M. 1892. Insecte du Bengale Occidental. 16e Memoire Hydrocanthares. Ann. Soc. Ent. Belg. 36: 118.

Diagnostic characters

Length: 1.8 mm, body oval, small, head brownish to black, clypleus not rebordered, punctuation moderate, more on vertex, pronotum testaceous with black marking along anterior and posterior boarder, elytra testaceous with broad transverse black basal, median and sub apical facia, punctuation large, very close, forming two longitudinal carinae, one sub-basal and other little outer to the median line, both extending from the base to the three fourth of the length of elytra, ventral side ferruginous (Fig. 13).

Distribution: Odisha: Ganjam, Bihar, Gujarat, Maharashtra and Andhra Pradesh.

Remarks: This species is recorded for the first time from Ganjam District.

The highest species composition in aquatic Coleoptera observed belongs to Dytiscidae (48%) followed by Hydrophilidae (30%) and Gyrinidae (22%). Among Dytiscidae, *Laccophilus parvulus* and *Hydaticus vittatus* dominated all of the 4 water bodies and among Hydrophilidae, *Berosus pulchellus* and *Berosus indicus* were dominant (Fig.14, 15).

DISCUSSION

The highest species composition in aquatic Coleoptera observed belongs to Dytiscidae (48%) followed by Hydrophilidae (30%) and Gyrinidae (22%). Among Dytiscidae, *Laccophilus parvulus* and *Hydaticus vittatus* dominated all of the 4 water bodies and among Hydrophilidae, *Berosus pulchellus* and *Berosus indicus* were dominant species. This was the first study on aquatic coleopteran from the Southern coastal part of Odisha state. Aquatic Coleoptera constitute an important part of the macrobenthos of fresh water habitats. Small and temporary water bodies have more species than large and permanent ones[14]. This was the first study work done on members of this family from the above mentioned regions and several first time records were observed from Ganjam district, Odisha. Study revealed temporary fishing ponds at Subhadra and water body at Indian Rare Earth campus have more diverse population of Coleoptera than the permanent water body of Tampara Lake. Due to high salinity, water body near Rushikulya showed the lowest diversity. Only few Dytiscidae of subfamilies Dytscinae and Colymbetinae were found in saline water of Rushikulya estuary. Four subfamilies namely Laccophilinae, Dytiscinae, Colymbetinae and Hydroporinae are chiefly represented in the present report. This show that diversity of insect fauna in different wetland types varies widely which will depend on availability of macrophytes and general physico chemical conditions of water, hence more number of surveys has to be carried out indifferent freshwater ecosystems to assess the beetle diversity. The Dytiscidae family occurs all over the world but is more of the Palaearctic region. It contains nearly 4,000 species worldwide with 223 species reported from the Indian subcontinent. From the Odisha state 42 species of aquatic beetle have been reported from Chilika Lake and its adjoining areas by Ghosh et al. [15] which accounts to the occurrence of aquatic beetles and their colonization in the brackish water. Subramanian and Sivaramakrishnan[16,17] gives an account of the aquatic insect communities of the microhabitat of freshwater streams of Western Ghat. The study presented new records of 4 species from Ganjam under the 2 subfamilies. In a study on the diversity pattern of beetles in and around Joysagar Tank of Assam, India, 10 species of beetles belonging to 8 different families viz., Dytiscidae, Gyrinidae, Carabidae, Hydrophilidae, Chrysomelidae, Coccinellidae, Cerambycidae and Tenebrionidae were collected and identified. Dytiscidae was the predominant family with respect to number and abundance[18].Further studies aiming to improve our knowledge on water insects should focus on collecting in little known areas, revision of the still unstudied material from additional families and filling the large gaps in our knowledge regarding the diversity of water beetles in some specific habitats[19]. Ghosh and Hegde[20] reported 6 species of aquatic coleopteran belonging to family Dytiscidae from Renuka Wildlife Sanctuary, Himachal Pradesh, India. The study on availability of specific species of estuarine coleopteran according to seasonal variation will also provide the feeding choice of various estuarine fishes.

CONCLUSION

The study is significant to the researchers and scientists working on taxonomic and diversity studies on the aquatic Coleoptera of Odisha state. Four subfamilies namely Laccophilinae, Dytiscinae, Colymbetinae and Hydroporinae are chiefly represented in the present report. The collection from the survey comprises of 80 examples of aquatic coleopteran of family Dytiscidae including 12 species of 07 genera accommodated under 04 subfamilies. *Hydaticus vittatus* is recorded for the first time from Ganjam district. *Rhantus sexualis* is recorded for the first time from Odisha. *Yola consanguinea* is recorded for the first time from Ganjam District. Further study is needed for exploration of other groups of estuarine coleoptera.

SIGNIFICANCE STATEMENT

The study opened the opportunities for future taxonomic and diversity studies on the aquatic Coleoptera of Odisha state that can be beneficial for the researchers to study the scantily studied insect fauna of estuaries.

ACKNOWLEDGMENT

The authors are thankful to the Director, Zoological Survey of India (ZSI), Kolkata for providing facilities and support to carry out this work.

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