RESEARCH ARTICLE

Similarity Analysis in Species Composition of the Aquatic Beetle Fauna among Some Indian Protected Areas in Respect to Satkosia and Baisipalli Wildlife Sanctuary, Odisha

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Study Area:

Introduction:

Generally, protected areas (PAs) are formed or declared through legal or other effective means to minimize the human activities and to achieve the long-term conservation of nature with associated ecosystem services and cultural values. The other approach of the establishment of protected area systems is to prevent the loss of biodiversity and to support the conservation policies. Unfortunately, insects (Terrestrial as well as aquatic) are always overlooked when bio-inventorisation of protected areas are concerned. Therefore, little is known about how protected areas represent the insect biodiversity with special reference to the aquatic beetle.

The group of water beetles is a potentially ideal indicator of the aquatic ecosystem and meets most of the criteria generally accepted in the selection of indicator taxa (Noss, 1990; Pearson, 1994). Their taxonomy is well known and well-studied in India, especially the family Dytiscidae (Ghosh & Nilsson, 2012). Beetles occupy the

Abstract

Till date, aquatic beetle fauna among the thirteen Indian protected areas reported 86 species under 33 genera of 05 families of aquatic beetle species. Among the 05 families, Dytiscidae was included with the highest number of species whereas Haliplidae included the lowest. The highest numbers of species were found in Satkosia Gorge Wildlife Sanctuary (WLS) (19% of total species) and minimum in Buxa Tiger Reserve, Bhibhutibhusan WLS and Binsar WLS (2% of total species). In respect of species composition, the maximum similarity was found in between Satkosia Gorge WLS and Baisipalli WLS ($S\&D=0.64$), and Binsar was having no similarity in view of species composition with the rest of the protected areas. Within the state, other than Odisha, the maximum similarity in species composition were found in between Buxa TR and Bhibhutibhusan WLS ($S\&D=0.14$) in West Bengal. In Uttar Pradesh, Sandy Bird Sanctuary and Suraha Tal WLS are more similar in species composition ($S\&D=0.47$) than others. Similarly, in Himachal Pradesh, Govind Sagar WLS and Renuka WLS are more similar in species composition ($S\&D=0.15$). Whereas, no similarity were found in between Binsar Wildlife Sanctuary and Asan Wetland Conservation Reserve of Uttarakhand.

complete range of aquatic habitats, inhabiting virtually every kind of fresh and brackish water body (Ghosh *et al.*, 2016). Furthermore, they show individual species specialization within habitats. They are present all the year round, sometimes in large numbers. Most species have ecological demands that are sufficiently limited to allow useful predictions to be made about changes in quality and land-use history or simply for characterizing the community and the habitat (Foster, 1987; 1996; Ribera & Foster, 1992). They have already been used in some areas as biodiversity indicators for identifying priority areas of that region (Sánchez-Fernández *et al.*, 2004).

Present work is an attempt to explore the aquatic beetle faunal diversity and to analyze the similarity in species composition of 11 protected areas from 05 states of India in respect to presently surveyed Satkosia Gorge WLS and Baisipalli WLS of Odisha. Apart from this, present communication also highlights the similarity in species composition of the protected areas within the states.

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Methodology:

Study area: Among the 13 protected areas, 03 from West Bengal: Sundarban Biosphere Reserve (SBR), Buxa Tiger Reserve (BTR) and Bhimbhutibhushan Wildlife Sanctuary (BBWLS); 03 from Uttar Pradesh: Suraha Tal Wildlife Sanctuary (STWLS), Dudhwa Tiger Reserve (DTR) and Sandi Bird sanctuary(SBS); 02 each from Uttarkhand: Binsar Wildlife Sanctuary (BIWLS) and Asan Wetland Conservation Reserve (AWCR); Himachal Pradesh: Govind Sagar Wildlife Sanctuary (GSWLS) and Renuka Wildlife Sanctuary (RWLS) and Odisha: Satkosia Gorge Wildlife Sanctuary (SGWLS) and Baisipalli Wildlife Sanctuary (BWLS); 01 from Maharashtra: Karnala Bird Sanctuary (KBS) were studied (Table-1).

Among these 13 protected areas, 05 are Wildlife Sanctuaries, 02 bird sanctuaries, 02 Tiger Reserves, 01 Wetland conservation area and 01 Biosphere Reserve. The selection of all these protected areas were made on the basis of surveyed and studied by the authors of the present communication. The details of the protected areas are given in Table-1. All the species of true aquatic beetles present in the studied area and earlier reports were included in this communication except unidentified species. Data on species were obtained from the published literature and from fieldwork.

Table-1: Details of the protected areas (Pas)

Name, Year Established	State	Area (Km ²)	Longitude/Latitude
SGWLS, 1976	Odisha	745.52	84° 51'E; 20° 34'N Sp. No.: 39 Ref.: New Record
BWLS, 1981	Odisha	168.35	84° 45'E; 20° 29'N Sp. No.: 34 Ref.: New Record
SBR, 1989	West Bengal	4263	88° 53' E; 21° 56'N Sp. No.: 35 Ref.: Mitra, 2017
BTR, 1983	West Bengal	757.9	89° 34'E; 26° 39'N Sp. No.: 4 Ref.: Nandi <i>et al.</i> , 2004
BBWLS, 1985	West Bengal	0.64	88° 46'E; 23° 3'N Sp. No.: 4 Ref.: Ghosh, <i>et al.</i> , 2011
STWLS, 1991	Uttar Pradesh	3432	84° 10' E; 25° 50'N Sp. No.: 13 Ref.: Ghosh, <i>et al.</i> , 2010
DTR, 1987	Uttar Pradesh	644	80° 39'E; 28° 31'N Sp. No.: 11 Ref.: Ghosh & Hedge, 2013
SBS, 1990	Uttar Pradesh	3.085	79° 58'E; 27° 18'N Sp. No.: 18 Ref.: Ghosh, 2011
BIWLS, 1988	Uttarakhand	47.07	79° 58'E; 27° 18'N Sp. No.: 4 Ref.: Ghosh <i>et al.</i> , 2011
AWCR, 2005	Uttarakhand	4.444	77° 39'E; 30° 26'N Sp. No.: 9 Ref.: Mukhopadhyay & Ghosh, 2003
GSWLS, 1962	Himachal Pradesh	170	76° 30' E; 31° 25'N Sp. No.: 9 Ref.: Ghosh, 2015
RWLS, 2013	Himachal Pradesh	4.00	77° 27'E; 30° 36'N Sp. No.: 21 Ref.: Ghosh & Hedge, 2013
KBS, 1968	Maharashtra	4.48	73° 7'E; 18° 53' N Sp. No.: 9 Ref.: Ghosh & Hedge, 2015

Source: ENVIS Centre on Wildlife & Protected Areas Hosted by Wildlife Institute of India, Dehradun (Updated- July 5, 2017)

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Abbreviation: Sundarban Biosphere Reserve (SBR), Buxa Tiger Reserve (BTR), Bhimbhutibhushan Wildlife Sanctuary (BBWLS), Suraha Tal Wildlife Sanctuary (STWLS), Dudhwa Tiger Reserve (DTR), Sandi Bird sanctuary(SBS), Binsar Wildlife Sanctuary (BIWLS), Asan Wetland Conservation Reserve (AWCR), Govind Sagar Wildlife Sanctuary (GSWLS), Renuka Wildlife Sanctuary (RWLS), Satkosia Gorge Wildlife Sanctuary (SGWLS), Baisipalli Wildlife Sanctuary (BWLS), Karnala Bird Sanctuary (KBS).

Collection and Preservation: specimens were collected with the help of aquatic insect net from the bank of water bodies which were randomly selected in different studied areas. A line of approximately 10 meters was selected on each side of the selected water bodies and each side sampled for 3 times randomly. The collected species were preserved into 90% alcohol and taken to the laboratory of Zoological Survey of India, Kolkata for identification.

Ecological and statistical analysis: biodiversity Pro (version-2) software was used to analyze the rank of different protected areas regarding their similarity of species composition with Satkosia and Baisipalli respectively. Cluster analysis was done with the help of PAST software (Version-3.19) (Accessed on 1st April 2018), using a paired group algorithm (UPGMA) and Jaccard similarity measure. Jaccard Similarity measure was also used to determine the similarity and distance indices (S&D index). The value of similarity and distance indices nearer to 1 indicates higher similarity whereas 0 indicates nosimilarity.

Results :

A total of 86 species under 33 genera of 05 families of aquatic beetles are reported from 13 selected protected areas. Of them, 39 species and 23 genera are reporting for the first time from Satkosia and 34 species and 20 genera from Baisipalli, (Table-2). The family Dytiscidae shared highest number of species (48 species under 16 genera), followed by Hydrophilidae (21 species under 12 genera), Gyrinidae (09 species under 02 genera), Noteridae (06 species under 02 genera) and Haliplidae (02 species under 01 genus) (Table-2).

Among the 86 species reported here, *Regimbaertia attenuata* of the family Hydrophilidae was found very common and distributed in 09 protected areas. Beside this, 02 species were reported from 08 PAs, 04 species from 07 PAs, 01 species from 06 PAs, 05 species from 05 PAs, 04 species from 04 PAs, 12 species from 03 PAs and 17 species from 02 PAs. But a majority of the species (40) were found only from a single protected area (Table-2).

Among the 13 studied protected areas, the highest number of species were found in SGWLS (19%) and lowest from BIWLS (2%) (Fig.-1).

Table.2. List of Aquatic beetles recorded from the protected areas

Sl. No	Species	Family	Protected Areas												
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	<i>Dineutus indicus</i> Aube, 1938	Gyrinidae	-	-	-	-	-	-	-	-	+	-	-	+	-
2	<i>Dineutus spinosus</i> (Fabricius, 1781)	Gyrinidae	-	-	-	-	-	-	+	-	-	-	-	+	-
3	<i>Orectochilus haemorrhous</i> Regimbart, 1891	Gyrinidae	+	-	-	-	-	-	-	-	-	-	-	-	-
4	<i>Orectochilus indicus</i> Regimbart, 1883	Gyrinidae	-	-	-	-	-	-	-	-	-	-	-	+	-
5	<i>Orectochilus limbatus</i> Regimbart, 1883	Gyrinidae	-	-	-	-	-	-	-	-	-	-	-	+	+
6	<i>Orectochilus murinus</i> Regimbart, 1891	Gyrinidae	-	-	-	-	-	-	-	-	+	-	-	-	-
7	<i>Orectochilus neglectus</i> Ochs, 1925	Gyrinidae	-	-	-	-	-	-	-	-	+	-	-	-	-
8	<i>Orectochilus ribeiroi</i> Vazirani, 1958	Gyrinidae	+	-	-	-	-	-	-	-	-	-	-	-	-
9	<i>Orectochilus similis</i> Ochs, 1929	Gyrinidae	+	-	-	-	-	-	-	-	-	-	-	-	-
10	<i>Halipilus indicus</i> Regimbart, 1899	Haliplidae	-	-	-	-	-	-	-	-	-	-	-	+	-
11	<i>Halipilus pruthii</i> Vizarani, 1966	Haliplidae	+	-	-	-	-	-	-	-	-	-	-	-	-
12	<i>Canthydrus angularis</i> Sharp, 1882	Noteridae	+	-	-	-	-	+	-	-	-	-	-	-	-
13	<i>Canthydrus flavus</i> Motschulsky, 1855	Noteridae	+	-	-	-	-	-	-	-	-	-	-	-	-
14	<i>Canthydrus laetabilis</i> (Walker, 1858)	Noteridae	+	+	+	+	+	-	-	-	-	-	-	+	+
15	<i>Canthydrus lactuosus</i> Aube, 1838	Noteridae	-	-	-	-	-	-	-	-	-	-	-	+	+
16	<i>Neohydrocoptus subvittulus</i> Motschulsky, 1859	Noteridae	+	-	-	-	-	-	-	-	-	-	-	+	+
17	<i>Neohydrocoptus bivittis</i> Motschulsky, 1859	Noteridae	-	-	-	+	-	-	-	-	-	-	-	-	-
18	<i>Agabus amoenus sinuaticollis</i> Regimbart, 1899	Dytiscidae	-	-	-	-	-	-	-	+	-	-	-	-	-
19	<i>Agabus biguttatus</i> (Olivier, 1795)	Dytiscidae	-	-	-	-	-	-	-	+	-	-	-	-	-
20	<i>Clypeodytes bufo</i> (Sharp, 1890)	Dytiscidae	-	-	-	-	-	-	-	-	-	-	+	-	+
21	<i>Cybister confusus</i> Sharp, 1882	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	+	+
22	<i>Cybister convexus</i> Sharp, 1882	Dytiscidae	-	-	-	-	-	-	+	-	-	-	-	-	-
23	<i>Cybister guerini</i> Aube, 1838	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	-	-
24	<i>Cybister limbatus</i> (Fabricius, 1775)	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	-	-
25	<i>Cybister ventralis</i> Sharp, 1882	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	-	-
26	<i>Cybister sugillatus</i> Erichson, 1834	Dytiscidae	-	-	-	-	-	-	+	-	-	+	-	-	-
27	<i>Cybister tripunctatus lateralis</i> (Fabricius, 1798)	Dytiscidae	-	-	-	-	-	+	+	-	-	+	-	+	+
28	<i>Eretes griseus</i> (Fabricius, 1781)	Dytiscidae	+	-	-	-	-	-	-	-	-	+	-	-	-
29	<i>Hydaticus discindens</i> Walker, 1858	Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	+	+
30	<i>Hydaticus fabricii fabricii</i> Macleay, 1881	Dytiscidae	-	-	-	+	+	-	+	-	-	-	-	-	-
31	<i>Hydaticus luczonicus</i> Aube, 1838	Dytiscidae	+	-	-	-	-	-	-	-	-	+	+	+	+
32	<i>Hydaticus ricinus</i> Wewalka, 1979	Dytiscidae	-	-	-	-	-	-	-	-	+	-	-	+	+
33	<i>Hydaticus satoi satoi</i> Wewalka, 1975	Dytiscidae	-	-	-	-	-	-	-	-	-	-	+	+	+
34	<i>Hydaticus vittatus vittatus</i> (Fabricius, 1775)	Dytiscidae	-	-	-	-	-	-	+	-	-	-	-	+	+
35	<i>Hydroglyphus flammulatus</i> (Sharp, 1882)	Dytiscidae	+	-	-	-	+	+	-	-	+	+	-	+	+
36	<i>Hydroglyphus pendjabensis</i> (Guignot, 1954)	Dytiscidae	+	-	-	-	-	+	-	-	-	-	-	-	-
37	<i>Hydroglyphus pradhani</i> (Vazirani, 1969)	Dytiscidae	-	-	-	-	-	-	-	-	+	-	-	-	-
38	<i>Hydroglyphus regimbarti</i> (Gschw. 1936)	Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	+	+
39	<i>Hydrovatus acuminatus</i> Motschulsky, 1859	Dytiscidae	-	-	-	+	-	-	-	-	-	-	-	-	-
40	<i>Hydrovatus bonvouloiri</i> Sharp, 1882	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	-	-
41	<i>Hydrovatus fractus</i> Sharp, 1882	Dytiscidae	-	-	-	+	-	-	-	-	-	-	-	-	-
42	<i>Hydrovatus rufescens</i> Motschulsky, 1859	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	-	-
43	<i>Hydrovatus seminaries</i> Motschulsky, 1859	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	-	-
44	<i>Hyphoporus aper</i> Sharp, 1882	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	-	-
45	<i>Hyphoporus bengalensis</i> Severin, 1890	Dytiscidae	-	-	-	-	-	+	-	-	-	-	-	-	-
46	<i>Hyphoporus elevates</i> Sharp, 1882	Dytiscidae	-	-	-	-	-	-	-	-	+	-	-	-	-
47	<i>Hyphoporus geetae</i> (Vazirani, 1969)	Dytiscidae	-	-	-	-	+	-	-	-	-	-	-	-	-
48	<i>Hyphydrus renardi</i> Severin, 1890	Dytiscidae	-	-	-	-	-	-	-	-	-	+	+	+	+
49	<i>Laccophilus antitatus anticatus</i> Sharp, 1890	Dytiscidae	+	-	+	-	-	-	-	-	-	-	-	-	-
50	<i>Laccophilus chinensis</i> Boheman, 1858	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	-	-
51	<i>Laccophilus flexuosus</i> Aube, 1838	Dytiscidae	-	-	+	+	+	+	-	-	+	+	-	+	+
52	<i>Laccophilus inefficiens</i> (Walker, 1859)	Dytiscidae	+	-	-	-	-	-	-	-	+	+	+	+	+
53	<i>Laccophilus parvulus parvulus</i> Aube, 1838	Dytiscidae	+	-	-	-	+	-	-	-	+	-	-	+	+
54	<i>Laccophilus sharpi</i> Regimbart, 1889	Dytiscidae	+	-	-	+	+	+	-	-	+	-	+	+	-
55	<i>Laccophilus uniformis</i> Motschulsky, 1859	Dytiscidae	-	-	-	-	-	+	-	-	-	-	-	-	-
56	<i>Peschetius quadricostatus</i> (Aube, 1838)	Dytiscidae	+	-	-	-	-	-	-	-	-	-	-	+	+

Sl. No	Species	Family	Protected Areas												
			1	2	3	4	5	6	7	8	9	10	11	12	13
57	<i>Peschetius toxophorus</i> Guignot, 1942	Dytiscidae	-	-	-	-	-	-	-	-	-	-	+	+	+
58	<i>Platynectes kashmiranus kashmiranus</i> J. Balfour-Browne, 1944	Dytiscidae	-	-	-	-	-	-	-	+	-	-	-	-	-
59	<i>Nebrioporus balli</i> (Vazirani, 1970)	Dytiscidae	-	-	-	-	-	-	-	+	-	-	-	-	-
60	<i>Rhantaticus congestus</i> (Klug, 1833)	Dytiscidae	-	-	-	-	-	-	-	-	+	-	-	+	-
61	<i>Sandracottus dejeani</i> (Aube, 1838)	Dytiscidae	-	-	-	-	-	-	-	-	+	+	+	-	-
62	<i>Sandracottus festivus</i> (Illiger, 1801)	Dytiscidae	-	-	-	-	-	-	-	-	+	-	+	-	-
63	<i>Sandracottus mixtus</i> (Blanchard, 1843)	Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	+	-
64	<i>Uvarus livens</i> (Regimbart, 1892)	Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	-	+
65	<i>Yola consanguinea</i> (Regimbart, 1892)	Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	+	-
66	<i>Amphiops pedestris</i> Sharp, 1890	Hydrophilidae	+	-	+	-	-	-	-	-	+	-	-	-	-
67	<i>Amphiops simplex</i> Sharp, 1890	Hydrophilidae	-	-	-	-	+	-	-	-	-	-	-	-	-
68	<i>Berosus indicus</i> Motschulsky, 1861	Hydrophilidae	+	+	-	-	-	-	-	-	+	-	-	+	+
69	<i>Berosus pulchellus</i> Mcleay, 1828	Hydrophilidae	+	-	-	+	+	+	-	-	+	-	-	+	+
70	<i>Enochrus esuriens</i> (Walker, 1858)	Hydrophilidae	+	-	-	+	+	-	-	-	-	-	-	+	+
71	<i>Enochrus rubrocinctus</i> Regimbart, 1903	Hydrophilidae	-	-	-	-	+	-	-	-	-	-	-	-	-
72	<i>Globaria leachi</i> Hope, 1838	Hydrophilidae	-	-	-	-	+	-	-	-	-	-	-	+	+
73	<i>Helochares anchoralis</i> Sharp, 1890	Hydrophilidae	-	-	-	+	+	-	-	-	+	-	-	+	-
74	<i>Helochares lentus</i> Sharp, 1890	Hydrophilidae	+	-	-	-	+	-	-	-	-	-	-	+	+
75	<i>Helochares densus</i> Sharp, 1890	Hydrophilidae	-	-	-	-	-	-	-	-	-	-	-	+	+
76	<i>Helochares pallens</i> (Macleay, 1825)	Hydrophilidae	+	-	-	-	-	-	-	-	-	-	-	+	+
77	<i>Helochares crenatus</i> Regimbart, 1903	Hydrophilidae	-	-	-	-	-	-	-	-	+	-	-	-	-
78	<i>Hydrophilus olivaceus</i> Fabricius, 1781	Hydrophilidae	-	-	-	-	-	-	+	-	-	-	-	+	+
79	<i>Laccobius rotundatus</i> Regimbart, 1903	Hydrophilidae	-	-	-	-	+	-	-	-	-	-	-	-	+
80	<i>Paracymus evanescens</i> Sharp, 1890	Hydrophilidae	-	-	-	+	+	-	-	-	-	-	-	+	+
81	<i>Regimbaertia attenuata</i> Fabricius, 1801	Hydrophilidae	+	+	-	+	+	+	+	-	+	-	-	+	+
82	<i>Sphaeridium cameronid</i> d'Orchymont, 1936	Hydrophilidae	+	-	-	-	-	-	-	-	-	-	-	-	-
83	<i>Sternolophus acutipenis</i> Nasserzadeh & Komarek, 2017	Hydrophilidae	-	-	-	-	-	-	-	-	-	-	-	-	+
84	<i>Sternolophus rufipes</i> (Fabricius, 1792)	Hydrophilidae	+	+	-	+	+	+	+	-	+	-	-	-	+
85	<i>Sternolophus solieri</i> Castelnau, 1840	Hydrophilidae	-	-	-	-	-	-	-	-	-	-	-	+	-
86	<i>Coelostoma subditum</i> d'Orchymont, 1936	Hydrophilidae	-	-	-	-	-	-	-	-	-	-	-	+	-

1: SBR, 2: BTR, 3: BBWLS, 4: STWLS, 5: SBS, 6: DTR, 7: AWC, 8: BIWLS, 9: RWLS, 10: GSWLS, 11: KBS, 12: SGWLS, 13: BWLS

Figure-1: Species distribution in various protected areas (%-wise)

A similarity of species composition of different protected areas in respect to Satkosia WLS and Baisapalli WLS: it demonstrates the maximum and minimum similarity among these thirteen protected areas. As Binsar has no similarity in species composition with any protected areas, therefore Binsar is excluded from the analysis.

The cluster analysis among the 13 protected areas show that the maximum similarity in species composition

of SGWLS is with BWLS and vice versa (S&D index = 0.64). The minimum similarity in species composition of SGWLS and BWLS are with BBWLS (S&D = 0.04) and (S&D index = 0.05) respectively (Fig.-2).

Figure-2: Similarity in species composition of Baisapalli and Satkosia with other protected areas

Similarity in species composition in different protected areas: SBR shown maximum similarity with BWLS (S&D index = 0.27) and minimum with AWC (S&D index = 0.04). BTR showed more similarity with STWLS

Figure-3: Cluster analysis of species composition among different PAs.

(S&D index=0.21) minimum with KBS and GSWLS (S&D index=0). BBWLS has shown maximum similarity (S&D index=0.14) with BTR and minimum with AWCRC and KBS (S&D index=0). STWLS maximum with SBS (S&D index=0.47) and minimum with GSWLS (S&D index=0.04); SBS maximum with STWLS (S&D index=0.47) and minimum with KBS (S&D index=0.03); DTR maximum with STWLS (S&D index=0.26) and minimum with KBS (S&D index=0.05); AWCRC maximum with BTR (S&D index=0.18) and minimum with BBWLS and KBS (S&D index=0); RWLS maximum with SBS (S&D index=0.25) and minimum with AWCRC (S&D index=0.07); GSWLS maximum with KBS (S&D index=0.28) and minimum with BTR (S&D index=0); KBS maximum with GSWLS (S&D index=0.28) and minimum with BTR, BBWLS and AWCRC (S&D index=0) (Fig.-3).

Present paper also studied the similarity in species composition of the protected areas within the State. Among the six states, Maharashtra is excluded here for survey due to having only one PAs. Among the three PAs of West Bengal, the maximum similarity in species composition was observed in between BTR & BBWLS (S&D index =0.14). Similarly, SBS & STWLS are more similar in species composition (S&D index =0.47) in Uttar Pradesh. In between GSWLS & RWLS of Himachal Pradesh, the similarity in species composition was (S&D index= 0.15). Whereas, no similarity has been found in between BIWLS & AWCRC of Uttarakhand. It is already stated that SGWLS & BWLS of Odisha state is having the maximum similarity in species composition (S&D index=0.64) (Table-3).

Table-3: State wise Similarity in species composition of each PA

State	Protected Areas	S & D index
Odisha	SGWLS & BWLS	0.644
Himachal Pradesh	GSWLS & RWLS	0.153
Uttarakhand	BIWLS & AWCRC	No similarity
Uttar Pradesh	SBS & DTR	0.260
	SBS & STWLS	0.47
	DTR & STWLS	0.263
West Bengal	SBR & BTR	0.114
	BTR & BBWLS	0.142
	BBWLS & SBR	0.083

Discussion:

This work also highlights the commonness of the species among the 13 protected areas. Among the 86 species found in the referred PAs, 40 species were found to distribute only in a single protected area. *Regimbaertia attenuata* of the family Hydrophilidae is found in maximum number of PAs (09 protected areas). The maximum numbers of species (15 species) were reported only from Sundarban Biosphere Reserve. Therefore, it is high time to provide a conservation priority to SBR for its unique species assemblage.

Hydroglyphus flammulatus, *Hydroglyphus regimbarti*, *Laccophilus parvulus parvulus*, *Laccophilus sharpi*, *Canthydrus laetabilis*, *Canthydrus luctuosus*, *Neohydrocoptus subvittulus*, *Amphiops pedestris*, *Berosus indicus*, *Berosus pulchellus*, *Enochrus esuriens*, *Helochaeres anchoralis*, *Helochaeres pallens*, *Regimbaertia attenuata*, *Sphaeridium cameroni*, *Sternolophus rufipes* of this study were reported earlier by Ghosh et al. (2016) from the brackish water of Chilika. Presence of these beetles from high altitude [Renuka (RWLS) and Govind sagar (GSWLS)] to low altitude (Sundarban Biosphere Reserve) are proving their ability to adapt in different climatic zones and in various salinity range.

This study also reveals that it is not obvious, the species composition would be similar in between adjacent protected areas or dissimilar in between distant protected areas. In this study, it has been found that SBR is having maximum similarity with BWLS of Odisha (S&D index=0.27) than closer one (BBWLS & BTR in West Bengal).

This study can be treated as a pilot project to understand the similarity in species composition among the protected areas of different climatic zones in India. We hope, this baseline information will help to monitor the aquatic beetle diversity for conservation aspects and certainly prevent the loss of biodiversity.

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