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Aquatic beetle fauna of Dadra & Nagar Haveli, Daman & Diu, India with a taxonomic notes on *Eretes griseus* (Fabricius 1781) of national collections in zoological survey of India

Sujit KR Ghosh, Udipta Chakraborti and Bulganin Mitra

Abstract
Present communication reports 33 species under 18 genera belonging to 4 families of aquatic beetles for the first time from Dadra & Nagar Haveli (DNH) and Daman & Diu, Union territories of India. The distributional pattern of these reported species within and outside India are also discussed here. Present survey also discuss that very less number of habitats are remained in these UTs for these biodiversity indicator taxa. In addition to this, a taxonomical short note is also given on the misidentification of the species *Eretes griseus* (Fabricius, 1781) present in National Zoological collection of Zoological survey of India, Kolkata.

Keywords: Aquatic beetles, diversity, conservation, national zoological collection

1. Introduction
The preparation of the water beetle inventories are very much essential for conservation and management of the wetland ecosystem. Similarly, conservation of the habitats of aquatic beetles are also very much necessary to minimize the loss of biodiversity and species extinction. Because, freshwater aquatic beetles are the important taxa for evaluating the health of the ecosystem, its biodiversity and habitat characteristics (Foster 1987; Eyre and Foster 1989; Foster *et al*. 1990 [4, 5, 6]; Ribera and Foster 1993; Sabnchez-Fernandez *et al*. 2004) [18, 19]. Therefore, proper identification of the taxa and conservation of their habitats are both essential to enrich the biodiversity of the aquatic beetle fauna in a particular ecosystem/ locality/ state/ biogeographic zone.

With this view, a survey was conducted to study aquatic beetle fauna of Dadra & Nagar Haveli (DNH) and Daman & Diu from 13th to 21st September, 2016. Since the establishment of the Zoological Survey of India (1916), this is the first entomological faunal survey and also the first scientific documentation of any faunal group from these Union territories.

Present communication reports 33 species under 18 genera of 4 families of the aquatic beetles for the first time from 2 localities of Diu, 5 localities of Daman and 6 localities DNH (Figure 1). Except 2 localities of Diu and 1 localities of Daman, all the localities are temporary water bodies, formed due to rain water during the survey. The reported species are almost common to all the biogeographic zones of India and mostly enriched with Oriental (13) and Palearctic (11) species.

During the preparation of the aquatic beetle fauna of these UTs, the first author was studied several identified materials of earlier collections of Zoological survey of India, Kolkata. Of them, a good number of examples of *Eretes sticticus* reported by earlier authors from different localities are found misidentified. Therefore, a small taxonomical short note is also provided here on the misidentification of the species *Eretes griseus* (Fabricius, 1781) present in National Zoological collection of Zoological Survey of India, Kolkata with the comments of Kelly B. Miller, Department of Entomology, Comstock Hall, Cornell University, Ithaca, NY 14853, USA. (Dated 15/02/13).

2. Materials & Methods
2.1 Study area
Daman, Diu, Dadra and Nagar Haveli are situated on the western edge of India adjacent to Gujarat and Maharashtra state (Figure 1 [A]).

Both the Daman and Diu districts are situated on western coast of India at a distance of about 700 kms. Diu District is an island on southern portion of Gujarat Peninsula and lying in between 20°44' N to 20°42' N and 71°-00' E to 70°-52' E with an area of 40 km². Daman is situated in the mainland and lying in between 20° 22′ to 20° 27′ N to 72° 49′ and 72° 54′ E with an area of 72 km². The other UT, DNH is close to the western coast of India between 20° 0′ to 20° 25′ N and 72° 50′ to 73° 15′E. It occupies an area of 491 square kilometres.

Fig 1: [A] Location of Daman & Diu, DNH in India; [B] Collection sites in Diu; [C] Collection sites in Daman; [D] Collection sites in DNH

2.2 Methodology of collection

The collections were mostly made from inland water bodies, swamp and marshy land, temporary stagnant rain water. The study was carried out in 13 localities of these two Union territories in the year 2016. Of them, two localities in Diu 05 localities in Daman and 06 localities in DNH were surveyed. The Aquatic beetles were collected with the help of suitable insects collecting net made of nylon cloth and in some cases using a net of mesh size 500 µm whereby the vegetation was disturbed and the net was dragged around the vegetation for a unit of time or light trap was used. The beetles were killed with 90% alcohol solution and next day transfer to 70% solution.

3. Results

During this present study, 33 species belonging to 18 genera of 4 families are reported. Among them, the family Dytiscidae is reported with 18 species under 10 genera, *Hydrophilidae* with 13 species under 6 genera, Noteridae and Gyrinidae with 1 species under 1 genera each. One species of the family Dytiscidae and 1 species of the family *Hydrophilidae* couldn't be identified up to species level due to lack of literature and poor number of materials (Table 1).

Table 1 showed that, the highest number of species was found from DNH (26), followed by Daman (14) and Diu (13). Of them, four species namely, *Copelatus* sp, *Hydroglyphus pendjabensis* (Guignot), *Helochares pallens* (Macleay) and *Enochrus esuriens* (Walker) are found common in all the Union territories during this survey.

Present communication includes *Eretes griseus* (Fabricius) was reported from Gujarat (misidentification by earlier workers) and also from Maharashtra (Sheth and Ghate 2014) [21]. Therefore, among the 33 species collected from DNH and Daman & Diu, 12 and 14 species were not reported (NR) from Gujarat and Maharashtra respectively. Only 2 species are identified up to generic level (Table 1).

Table 1: List of species, collection localities and distribution to the adjacent states of India

So No	Name of the species	Collection localities & date of collection			Reported from	
		Diu (13.ix.2016)	Daman (17.ix.2016)	DNH (18.ix.2016 to21.ix.2016)	Gujart	Maharahtra
			Family Gyrinidae			
1.	*Dineutus indicus* Aubé, 1838			N20°17.150', E073°03.800'	+	+
			Family Noteridae			
2.	*Canthydrus laetabilis*(Walker,1858)		N20°23.285', E072°51.667'		+	+
			Family Dytiscidae			
3.	*Copelatus* sp.	N 20°43.188', E 070°53.684'	N20°27.56', E072°50.27'	N 20°17.32', E 073°01.80'		
			N20°25.940', E072°50.758'			
			N20°27.68', E072°53.31'			
4.	*Sandracottus dejeanii*(Aubé, 1838)			N20°17.150', E073°03.800'	+	+
5.	*Cybister tripunctatus lateralis* (Fabricius, 1798)	N20°43.483', E070°53.771'		N20°17.150', E073°03.800'	+	+
6.	*Eretes griseus* (Fabricius, 1781)		N20°27.56', E072°50.27'	N20°07.125', E073°02.864'	+	+
				N20°17.150', E073°03.800'		
7.	*Hydaticus fabricii fabricii* (Macleay, 1825)			N20°07.125', E073°02.864'	+	+
				N20°18.846', E072°57.760'		
8.	*Hydaticus satoi* Wewalka, 1975			N20°07.125', E073°02.864'	NR	
9.	*Hydroglyphus flammulatus* (Sharp, 1882)		N20°25.940', E072°50.758'	N 20°17.32', E 073°01.80'	+	+
			N20°27.68', E072°53.31'	N20°11.525', E073°03.232'		
			N20°24.32', E072°50.40'	N20°16.94', E072°55.72'		
				N20°17.150', E073°03.800'		
				N20°18.846', E072°57.760'		
10.	*Hydroglyphus geminus* (Fabricius, 1792)	N 20°43.188', E070°53.684'	N20°27.56', E072°50.27'		NR	
		N20°43.483', E070°53.771'	N20°27.68', E072°53.31'			
11.	*Hydroglyphus inconstans* (Regimbart, 1892)			N20°07.125', E073°02.864'	+	+
				N 20°17.32', E 073°01.80'		

12.	*Hydroglyphus pendjabensis*(Guignot, 1954)	N 20°43.188', E070°53.684'	N20°27.56', E072°50.27'	N20°18.846', E072°57.760'	+	+
		N20°43.483', E070°53.771'		N20°16.94', E072°55.72'		
13.	*Peschetius quadricostatus* (Aubé, 1838)			N20°11.525', E073°03.232'	+	+
14.	*Hydrovatus fractus* Sharp, 1882	N 20°43.188', E070°53.684'	N20°27.68', E072°53.31'		NR	
15.	*Hyphydrus renardi* Severin, 1890			N 20°17.32', E 073°01.80'	+	+
				N20°17.150', E073°03.800'		
16.	*Laccophilus flexuosus* Aubé, 1838			N20°11.525', E073°03.232'	+	+
17.	*Laccophilus indicus* Gschw., 1936			N20°11.525', E073°03.232'	NR	
18.	*Laccophilus inefficiens* (Walker, 1859)		N20°23.285', E072°51.667'	N20°07.125', E073°02.864'	+	+
				N 20°17.32', E 073°01.80'		
				N20°11.525', E073°03.232'		
				N20°17.150', E073°03.800'		
19.	*Laccophilus* parvulus Aubé, 1838		N20°27.68', E072°53.31'	N 20°17.32', E 073°01.80'	+	+
			N20°25.940', E072°50.758'	N20°11.525', E073°03.232'		
			N20°24.32', E072°50.40'	N20°17.150', E073°03.800'		
			N20°23.285', E072°51.667'			
20.	*Laccophilus sharpi* Regimbart, 1889	N 20°43.188', E070°53.684'			+	+
Family Hydrophilidae						
21.	*Paramus* evanescens (Sharp, 1890)		N20°27.56', E072°50.27'	N 20°17.32', E 073°01.80'	NR	
			N20°27.68', E072°53.31'	N20°16.94', E072°55.72'		
			N20°25.940', E072°50.758'			
			N20°24.32', E072°50.40'			
22.	*Helochares anchoralis* Sharp, 1890		N20°24.32', E072°50.40'		NR	+
23.	*Helochares* crenatus (Regimbart, 1903)			N 20°17.32', E 073°01.80'	NR	
				N20°16.94', E072°55.72'		
				N20°18.846', E072°57.760'		
				N20°16.94', E072°55.72'		
				N20°18.846', E072°57.760'		
24.	*Helochares dsensus* Sharp,1890	N 20°43.188', E070°53.684'			NR	
25.	*Helochares lentus* Sharp, 1890			N20°07.125', E073°02.864'	NR	
26.	*Helochares pallens*(Macleay, 1825)	N 20°43.188', E070°53.684'	N20°25.940', E072°50.758'	N20°18.846', E072°57.760'	NR	
			N20°24.32', E072°50.40'	N 20°17.32', E 073°01.80'		
27.	*Enochrus esurients* (Walker, 1858)	N 20°43.188', E070°53.684'	N20°27.56', E072°50.27'	N20°07.125', E073°02.864'	NR	
		N20°43.483', E070°53.771'	N20°27.68', E072°53.31'	N20°18.846', E072°57.760'		
			N20°25.940', E072°50.758'	N 20°17.32', E 073°01.80'		
			N20°24.32', E072°50.40'	N20°16.94', E072°55.72'		
				N20°17.150', E073°03.800'		
				N20°11.525', E073°03.232'		
28.	*Enochrus* sp.	N 20°43.188', E070°53.684'				
29.	*Sternolophus rufipes* (Fabricius,1792)	N 20°43.188', E070°53.684'		N20°07.125', E073°02.864'	+	+
		N20°43.483', E070°53.771'		N 20°17.32', E 073°01.80'		
				N20°11.525', E073°03.232'		
30.	*Sternolophus inconspicuous* (Nietner, 1856)			N 20°17.32', E 073°01.80'	NR	
31.	*Berosus indicus* Motschulsky, 1861	N 20°43.188', E070°53.684'		N20°07.125', E073°02.864'	NR	+
				N 20°17.32', E 073°01.80'		
				N20°11.525', E073°03.232'		
				N20°17.150', E073°03.800'		
32.	*Berosus pulchellus* Macleay, 1825		N20°27.56', E072°50.27'	N20°07.125', E073°02.864'	NR	
			N20°27.68', E072°53.31'	N20°18.846', E072°57.760'		
			N20°25.940', E072°50.758'	N 20°17.32', E 073°01.80'		
			N20°24.32', E072°50.40'	N20°16.94', E072°55.72'		
				N20°17.150', E073°03.800'		
33.	*Regimbartia attenuata* (Fabricius, 1801)	N 20°43.188', E070°53.684'		N20°07.125', E073°02.864'	+	+

				N 20°17.32', E 073°01.80'		
				N20°17.150', E073°03.800'		
				N20°11.525', E073°03.232'		

In addition to this, 13 species are restricted their distribution within Oriental region. Eleven species extend their distribution up to Palearctic region and 7 species beyond the Oriental and Palearctic regions.

3.1 Taxonomic notes on misidentification Eretes griseus of NZC (National Zoological Collection)

According to Ghosh & Nilsson (2012) [8], the Genus *Eretes* Laporte, 1833 is having only two species reported from India, namely, *Eretes griseus* (Himachal Pradesh, Jammu & Kashmir, Uttar Pradesh) and *Eretes sticticus* (Andaman & Nicobar Islands, Andhra Pradesh, Assam, Bihar, Delhi, Goa, Gujarat, Himachal Pradesh, Karnataka, Jammu & Kashmir, Jharkhand, Lakshadweep Islands, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal).

After publication of the world revisionary work of genus *Eretes* Castelnau by Miller [8], the authors were restudied the materials of NZC collection of *Eretes sticticus* collected by earlier workers from different localities of India (Table 2).

Table 2: Newly identified materials of *Eretes griseus* (Misidentified as *Eretes sticticus*) present in National Zoological Collection (NZC) and their distribution in India

Reported from	Reported by
Andaman Islands	(Vazirani 1970c; Vazirani 1972b; Ghosh 2012) [23, 24, 26].
Andhra Pradesh	(Mukhopadhyay, 2007)
Delhi	(Biswas *et al*, 1997) [3].
Goa	(Vazirani 1971) [25].
Gujarat	(Vazirani 1973b; Vazirani 1977c) [27, 31].
Himachal Pradesh	(Vazirani 1980) [32].
Lakshadweep Islands	(Biswas 1991) [1].
Maharashtra	(Vazirani 1977b) [31].
Meghalaya	(Mukhopadhya 2000) [14].
Rajasthan	(Vazirani 1970c) [23, 24].
Sikkim	(Mukhopadyay 2003a) [15].
Tamil Nadu	(Vizarani 1975b) [28].
Uttarakhand	(Mukhopadhyay and Ghosh 2010 [17].
Uttar Pradesh	(Vazirani 1976b) [29].
West Bengal	(Biswas 1995) [2].

According to Miller (2002) [12], genitalia of the old specimens were studied and found that *Eretes sticticus* of the NZC are misidentified by the earlier workers. Moreover, to confirm our observation, first author send the photographs of genitalia of old identified materials as *Eretes sticticus* to K. Miller. In his e-mail (dated 15/02/13) Miller wrote to first author that, *"Yes, this is definitely Eretes griseus and it should be common throughout much of India"*. Therefore, all the old materials of *Eretes sticticus* present in NZC (Table 2) have now onwards renamed as *Eretes griseus*. Apart from this, after the world revisionary work of genus *Eretes* Castelnau (Miller 2002) [12], several workers (Ghosh and Mitra, 2014; Ghosh *et al*. 2014; Jaiswal *et al*. 2014) [9, 11] were reported *Eretes griseus* from Chhatishgarh, Sundarban of West Bengal and Madhya Pradesh. Recently, this species was also reported from Maharashtra by Sheth and Ghate (2014) [21].

4. Discussion

Altogether, 33 species belonging to 18 genera of 4 families are distributed in DNH, Daman & DIU. Result shows that large number of species are not common among these Union territories (UT's). This may be due to limited number of samplings were made within a shorter period of time. Therefore, it can be assumed that, more number of surveys will definitely ascertain their commonness in all these UT's. Majority of this species are very common and found most of the UT's and States of India. But from the Table 1, it has been found that, several aquatic beetle species of these UT's are not so far reported from the adjacent states, Gujarat and Maharashtra (Sheth and Ghate 2014; Ghosh and Nilsson 2012; Vazirani 1973b; Vazirani, 1977b; Sharma and Bano 2012; Thakkar and Parikh 2015) [7, 8, 20, 21, 27, 30]. This may be due to lack of fanatic surveys in these areas.

It is true that the aquatic beetle fauna of DNH and Daman & Diu are very common and found most of the states and UT's of India. But the present survey reveals that very less number of habitats are remained in these UTs for these ecosystem service provider species (Figure 1[B to D]). In Diu, only two large habitats are there where from aquatic beetle fauna have been collected (Figure 2-3). According to Merritt, Cummins and Berg (Merritt 2008) [13], "*Aquatic insects are used for monitoring the health of aquatic environments because of their differential responses to stimuli in their aquatic habitat and determining the quality of that environment*". Therefore, it is also suggested that routine bio monitoring of these existing water bodies will facilitate better conservation and management of these aquatic insect indicator fauna.

These aquatic coleopteran species may be common to other Indian states, but there presence or absence may affect the local ecosystem, where they belong. Therefore, the aquatic beetle fauna of these territories should be conserved along with their habitats and this communication will definitely serve as baseline data for future conservational programme.

Fig 2: Vao Village

Fig 3: Pawati village

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