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COMMUNICATION

Rapid multi-taxa assessment around Dhamapur Lake (Sindhudurg, Maharashtra, India) using citizen science reveals significant odonate records

Neha Mujumdar [1], Dattaprasad Sawant [2], Amila Sumanapala [3], Parag Rangnekar [4] & Pankaj Koparde [5]

[1] Bombay Natural History Society, Hornbill House, Opp. Lion Gate, Shaheed Bhagat Singh Road, Colaba, Mumbai, Maharashtra 400001, India.
[2] Department of Community Medicine, Seth G S Medical College and K E M Hospital, Parel, Mumbai, Maharashtra 400012, India.
[3] Department of Zoology and Environment Sciences, University of Colombo, Colombo 00700, Sri Lanka.
[4] Foundation for Environment Research and Conservation, #407, 3-A, Susheela Seawinds, Alto-Vaddem, Vasco-da-Gama, Goa 403802, India.
[5] School of Ecology & Environmental Management, Faculty of Sustainability Studies, MIT World Peace University, Kothrud, Pune, Maharashtra 411038, India.
[1] n.mujumdar@bnhs.org (corresponding author), [2] dattaprasad.101@gmail.com, [3] apsumanapala@gmail.com, [4] rangnekarparag@gmail.com, [5] pankajkoparde@gmail.com

Abstract: In the present work, we discuss the results of a four-day long rapid survey around Dhamapur Lake and surrounding freshwater habitats in the Sindhudurg District of Maharashtra through public participation. In total, 61 odonates, 51 butterflies, 17 species of amphibians and reptiles, 90 birds, and four mammals are documented. Our observations taken over a brief time reflect the importance of citizen science in documenting local biodiversity. We report involvement of citizen scientists in recovering significant odonate records for the state.

Keywords: Biodiversity, conservation, freshwater ecosystem, northern Western Ghats, Odonata, wetland.

Abbreviations: IUCN – International Union for Conservation of Nature, WPA – Wild Life (Protection) Act, 1972.

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INTRODUCTION

The indeterminate exploitation of the natural resources by humans has caused considerable alterations in the ecosystem functioning and biodiversity loss through urbanization, habitat destruction, habitat modification, and degradation of vital freshwater resources (Gleick et al. 2001; McKinney 2002; Diaz et al. 2006; Dudgeon et al. 2006). Despite the current body of knowledge of environmental degradation, several regions remain less explored in terms of data on biodiversity. The lack of knowledge on biodiversity hampers the decision making at policy level and hence considered as one of the global priorities when forming conservation frameworks (Meyer et al. 2015; Sorte & Somveille 2020). In recent years, citizen science has proved to be a beneficial tool in collecting biodiversity data through people's participation (Theobald et al. 2015; Chandler et al. 2017; Mckinley et al. 2017). It is used for research, to understand distribution and possible threats to multiple taxa like insects, amphibians, birds, and mammals (Kolby 2015; Forrester et al. 2017; Zapponi et al. 2017; Sorte & Somveille 2020). In India, the practice of citizen science has proved as a useful tool for biodiversity documentation at finer spatial scale (Badrinath 2015; Seshadri & Gururaja 2015; SoIB 2020).

DragonflySouthAsia (DSA), a part of DiversityIndia (http://diversityindia.org/), is a citizen science network of Odonata (dragonflies and damselflies) watchers and researchers from the Indian subcontinent (https://dragonflyindmeet.wordpress.com/). DSA has been actively involved in conservation outreach and research, popularizing odonatology and freshwater conservation through meets and workshops every year since 2014 (Andrew et al. 2015; Dawn & Roy 2017; Koparde et al. 2018, 2020), and facilitating collaborative research (Mujumdar et al. 2018). In the current survey, we used a combination of rapid multi-taxa assessment and citizen science to document biodiversity in Dhamapur Lake area taking odonates as target taxa. Here, we demonstrate that peoples' participation in science can provide reliable biodiversity data in a very short period of time and help highlight the potential of the lake to support the urgency to protect it.

METHODS

Study area

Sindhudurg District, situated at the southernmost tip of Maharashtra, is one of the biodiversity rich areas of the state and includes parts of northern Western Ghats, locally known as Sahyadri Hill ranges. Dhamapur Lake (16.033°N & 73.593°E; 22m) is located in the Malvan Tehsil of Sindhudurg District (Figure 1, Image 1). The climate of Malvan Tehsil remains hot and humid throughout the year having an annual average temperature 27.1°C and average annual precipitation of 2,865mm (Malvan summary 2020).

The lake is a 400 years old human-made lake with an area of 22 hectares. It provides water to Malvan City (TERI 2013). The surrounding villages Dhamapur and Walvali depend on its water for domestic use and irrigation purposes. The forest around the lake is moist deciduous and categorised as reserve forest. Streams having varying canopy cover, flow along one side of the lake (Image 3), while the other side is surrounded by marshes and paddy fields (Image 2).

Survey sites

We surveyed various freshwater habitats like lakes, ponds, wells, and streams around Dhamapur Village as our focal taxon was odonates. We also surveyed the natural vegetation, paddy-fields and forest patches around these habitats. Details of the study sites are given in Table 1 (Images 2–6).

Data collection

The 6th DragonflySouthAsia meet was conducted during 10–13 October 2019 wherein a total of 25 people participated from India and Sri Lanka. A few members of Syamantak, a local community working towards conservation of wetlands in the Sindhudurg area (http://syamantak.cfsites.org/), also took part.

On all the four days, we opportunistically surveyed the sites for rapid assessment of selective invertebrates and vertebrates. Rapid multi-taxa assessments are used to yield quick yet reliable results. These are cost-effective, useful to make inventories of the local biodiversity, and the information obtained in terms of species richness can be used potentially to represent the community structure (Oliver & Beattie 1993, 1996). We used citizen science model for data collection and to document the maximum number of species (Chandler et al. 2017). The process involves participation in the survey by volunteers with little or no expertise on the taxa whose observations were verified by the experts later on.

The participants were split into four different groups, each containing six to seven members, to cover different habitats surrounding the lake (Image 2 & 3). They were trained in using iNaturalist app (https://www.

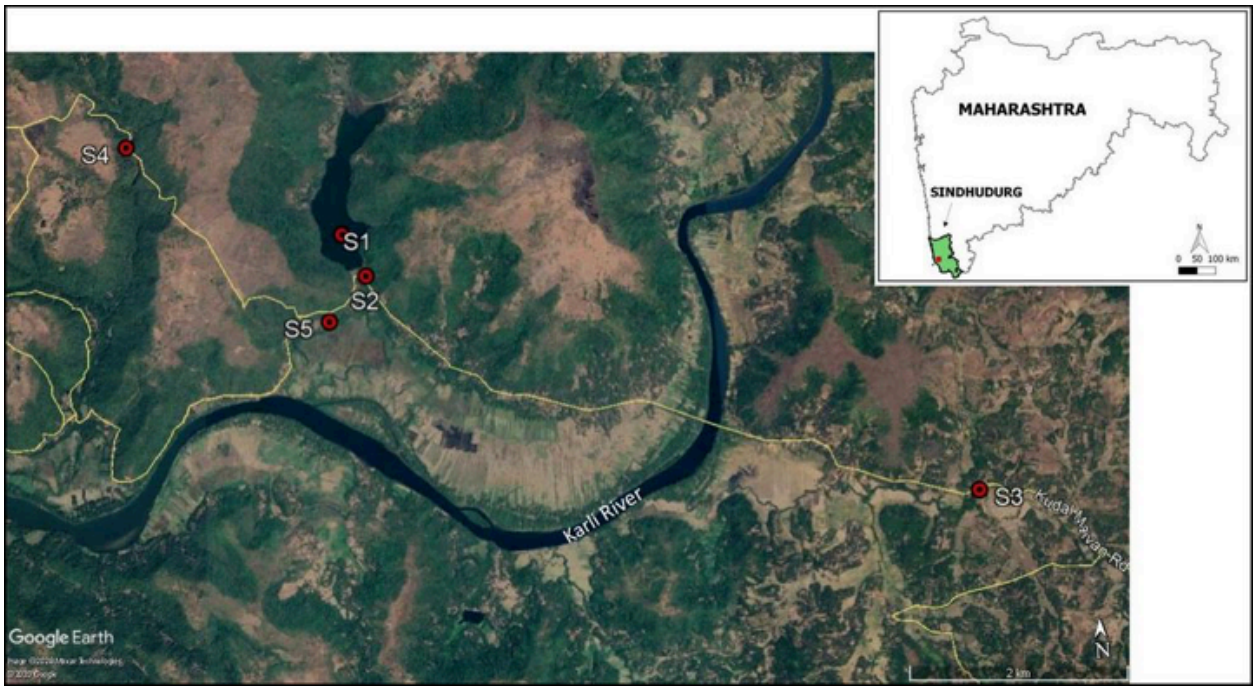

Figure 1. Location of the study area and survey sites.

Image 1. Dhamapur Lake

Image 2. Marshy habitat at Dhamapur Lake

Table 1. Study sites of Dhamapur lake area.

Survey sites	Survey locality	GPS coordinates and elevation	Habitat
S1	Dhamapur Lake (Image 1 & 2)	16.0335°N & 73.5939°E, 22m	Surrounded by moist deciduous forest and streams on one side and marshlands, paddy fields on other
S2	Stream along Dhamapur Lake (Image 3)	16.0325°N & 73.5952°E, 18m	Stream of varied canopy cover, fed by the lake flowing alongside through moist-deciduous and semi-evergreen vegetation; intermittent rocky areas forming temporary puddles; presence of algae on the rock surface
S3	Thakurwadi Lake (Image 4)	16.0112°N & 73.6474°E, 14m	Marshland with aquatic vegetation
S4	Kasartaka Stream (Image 5 & 6)	16.0448°N & 73.5746°E, 65m	A stream with varying water depth from open shallow areas to areas with 0.6–0.9 m water depth and closed canopy; intermittent grass patches and herbs along the banks
S5	Ponds and wells	16.0288°N & 73.5918°E, 17m	Temporary and permanent water sources in nearby residential areas

Image 3. Stream along Dhamapur Lake

Image 4. Thakurwadi Lake

Image 5. Kasartaka Stream

Image 6. Shady habitat at Kasartaka Stream

Image 7. Survey at marshy habitat of Dhamapur Lake

Image 8. Survey at Thakurwadi Lake

Image 9. Survey at Kasartaka stream.

inaturalist.org/). Taxa like odonates, butterflies, birds, and mammals were surveyed in the morning hours, i.e., from 08.00h to 12.30h. Bird activity was also recorded during afternoon hours 14.00–16.00 h. Amphibians, reptiles, nocturnal birds, and mammals were recorded during 20.30–23.00 h. Various habitats such as the moist deciduous forests, marshlands, open grasslands, paddy fields, and streams fed by Dhamapur Lake were surveyed by participants (Images 7–9).

Identification of odonates was based on field guides (Subramanian 2009) and taxonomy monographs (Fraser 1933, 1934, 1936). For identification, we referred to Bhakare & Ogale (2018) for butterflies, Grimmett et al. (2011) for birds, and Menon (2014) for mammals. Amphibians and reptiles were identified with multiple references like Daniel (2002), Whitaker & Captain (2004), Gururaja (2012), Padhye et al. (2015), and Pal et al. (2018). We documented most of the species in the field using point-and-shoot digital as well as SLR cameras. In case of ambiguity, we took photographs of the specimens on the field and later identified them to the species level with the help of field guides and taxa experts, especially in the case of amphibians and reptiles. All observations were compiled in the form of checklists adding categories according to the International Union for Conservation of Nature Red List of Threatened Species (hereafter, IUCN) at the end of the meet (IUCN 2020). Species of odonates, butterflies, and birds were arranged according to the family level and those of amphibians, reptiles and mammals according to the order level using standard references like Varshney & Smetacek (2015), Kamalakannan & Venkatraman (2017), Subramanian & Babu (2017), Aengals et al. (2018), Bhakare & Ogale (2018), Dinesh et al. (2019), Praveen et al. (2019), and Uetz et al. (2019).

RESULTS

In total, we documented 61 odonates (Table 2), 51 butterflies (Table 3), 17 species of amphibians and reptiles (Table 4 & 5), 90 birds (Table 6), and four mammals (Table 7) during the tenure. We encountered the newly described *Ceriagrion chromothorax* Joshi & Sawant, 2019 in both Dhamapur and Thakurwadi lakes (Image 17). As per the status provided by Wild Life (Protection) Act, 1972 (hereafter, WPA), *Doleschallia bisaltide* (Cramer, [1777]) and *Hypolimnas misippus* (Linnaeus, 1764) are included in schedule I, while *Cynitia lepidea* (Butler, 1868) and *Parthenos sylvia* (Cramer, 1775) are under schedule II among butterflies. In the case of birds, the majority of the species, i.e., 80 out of 90 species belong to schedule IV. Three species are categorised as Near Threatened, namely, *Anhinga melanogaster* Pennant, 1769, *Anthracoceros coronatus* (Boddaert, 1783), and *Brachypodius priocephalus* (Jerdon, 1839), while *Buceros bicornis* Linnaeus, 1758 is Vulnerable. *A. coronatus* and *B. bicornis* are included under schedule I whereas *A. melanogaster* and *B. priocephalus* are under schedule IV of WPA.

The anurans, *Euphlyctis cynophlyctis* (Schneider, 1799), *E. hexadactylus* (Lesson, 1834), *Hoplobatrachus tigerinus* (Daudin, 1802), and *Polypedates maculatus* (Gray, 1830) are Least Concern according to IUCN and first three are included under schedule IV of WPA. In order Serpentes among reptiles, *Fowlea piscator* (Schneider, 1799) and *Ptyas mucosa* (Linnaeus, 1758) belong to schedule II, *Oligodon taeniolatus* (Jerdon, 1853) and *Amphiesma stolatum* (Linnaeus, 1758) belong to schedule IV of WPA and remain Not Evaluated by IUCN. No species in Order Sauria is included under WPA but categorised as Least Concern according to IUCN with exception of *Calotes versicolor* (Daudin, 1802) which is Not Evaluated. The mammalian species *Herpestes edwardsii* (É. Geoffroy Saint-Hilaire, 1818), *Macaca radiata* (E. Geoffroy, 1812), and *Funambulus palmarum* (Linnaeus, 1766) are Least Concern while *Semnopithecus hypoleucos* Blyth, 1841 is Vulnerable as per IUCN. The first two are part of schedule II of WPA while the latter are not included under any schedule.

Comments on significant records of odonates

Following odonates observed at Thakurwadi Lake on 12 October 2019 are significant records considering their current known geographical distributions. The lake is filled with emergent and submergent aquatic vegetation including members of family Nymphaeaceae (Image 4).

Table 2. Checklist of Odonata (dragonflies and damselflies) species.

	Scientific Name	Common Name	IUCN status	Locality of observation
	Suborder Zygoptera			
	Family Lestidae			
1	*Lestes praemorsus decipiens* Kirby, 1893	Sapphire-eyed Spreadwing	LC	TL
2	*Platylestes* cf. *platystylus*	-	-	TL
	Family Platystictidae			
3	*Protosticta gravelyi* Laidlaw, 1915	Pied Reedtail	LC	KS
	Family Calopterygidae			
4	*Vestalis gracilis* (Rambur, 1842)	Clear-winged Forest Glory	LC	S
	Family Chlorocyphidae			
5	*Heliocypha bisignata* (Hagen in Selys, 1853)	Stream Ruby	LC	S
6	*Libellago indica* (Fraser, 1928)	Southern Heliodor	LC	S
	Family Euphaeidae			
7	*Euphaea fraseri* (Laidlaw, 1920)	Malabar Torrent Dart	LC	S; KS
	Family Platycnemididae			
8	*Copera marginipes* (Rambur, 1842)	Yellow Bush Dart	LC	DL
9	*Copera vittata* Selys, 1863	Blue Bush Dart	LC	DL
10	*Disparoneura quadrimaculata* (Rambur, 1842)	Black-winged Bamboo Tail	LC	KS
11	*Prodasineura verticalis* (Selys, 1860)	Black Bambootail	LC	S
	Family Coenagrionidae			
12	*Aciagrion occidentale* Laidlaw, 1919	Green-striped Slender Dartlet	LC	TL
13	*Agriocnemis pieris* Laidlaw, 1919	White Dartlet	LC	S; TL
14	*Agriocnemis pygmaea* (Rambur, 1842)	Pygmy Dartlet	LC	M; KS
15	*Agriocnemis splendidissima* Laidlaw, 1919	Splendid Dartlet	NE	M; KS
16	*Ceriagrion cerinorubellum* (Brauer, 1865)	Orange-tailed Marsh Dart	LC	DL
17	*Ceriagrion chromothorax* Joshi and Sawant, 2019	Sindhudurg Marsh Dart	NE	TL; DL
18	*Ceriagrion coromandelianum* (Fabricius, 1798)	Coromandel Marsh Dart	LC	DL
19	*Ceriagrion rubiae* Laidlaw, 1916	Orange Marsh Dart	NE	TL
20	*Ischnura rubilio* Selys, 1876	Western Golden Dartlet	LC	M
21	*Ischnura senegalensis* (Rambur, 1842)	Senegal Golden Dartlet	LC	TL; DL
22	*Mortonagrion varralli* Fraser, 1920	Brown Dartlet	DD	DL; S
23	*Pseudagrion decorum* (Rambur, 1842)	Three-striped Blue Dart	LC	DL
24	*Pseudagrion indicum* Fraser, 1924	Yellow-striped Blue Dart	DD	KS; S
25	*Pseudagrion malabaricum* Fraser, 1924	Malabar Sprite	LC	M; TL
26	*Pseudagrion microcephalum* (Rambur, 1842)	Blue Grass Dartlet	LC	M; DL
	Suborder Anisoptera			
	Family Aeshnidae			
27	*Anax guttatus* (Burmeister, 1839)	Blue-Tailed Green Darner	LC	DL
28	*Anax immaculifrons* Rambur, 1842	Blue Darner	LC	KS
29	*Anax indicus* Lieftinck, 1942	Lesser Green Emperor	LC	DL
30	*Gynacantha dravida* Lieftinck, 1960	Brown Darner	LC	KS
31	*Gynacantha* cf. *khasiaca*	-	-	TL
	Family Gomphidae			
32	*Ictinogomphus rapax* (Rambur, 1842)	Common Clubtail	LC	DL
33	*Paragomphus lineatus* (Selys, 1850)	Common Hooktail	LC	KS

	Scientific Name	Common Name	IUCN status	Locality of observation
	Family Macromiidae			
34	*Epophthalmia vittata* Burmeister, 1839	Common Torrent Hawk	LC	DL
	Family Libellulidae			
35	*Acisoma panorpoides* Rambur, 1842	Trumpet Tail	LC	DL
36	*Brachydiplax sobrina* (Rambur, 1842)	Little Blue Marsh Hawk	LC	DL
37	*Bradinopyga geminata* (Rambur, 1842)	Granite Ghost	LC	W
38	*Crocothemis servilia* (Drury, 1770)	Ruddy Marsh Skimmer	LC	DL
39	*Diplacodes nebulosa* (Fabricius, 1793)	Black-tipped Ground Skimmer	LC	DL
40	*Diplacodes trivialis* (Rambur, 1842)	Ground Skimmer	LC	DL
41	*Hydrobasileus croceus* (Brauer, 1867)	Amber-winged Marsh Glider	LC	P
42	*Indothemis limbata sita* Campion, 1923	Restless Demon	LC	TL
43	*Neurothemis fulvia* (Drury, 1773)	Fulvous Forest Skimmer	LC	TL
44	*Neurothemis tullia* (Drury, 1773)	Pied Paddy Skimmer	LC	M
45	*Orthetrum chrysis* (Selys, 1891)	Brown-backed Red Marsh Hawk	LC	DL
46	*Orthetrum glaucum* (Brauer, 1865)	Blue Marsh Hawk	LC	DL
47	*Orthetrum luzonicum* (Brauer, 1868)	Tricolored Marsh Hawk	LC	DL
48	*Orthetrum pruinosum* (Burmeister, 1839)	Crimson-tailed Marsh Hawk	LC	DL
49	*Orthetrum sabina* (Drury, 1770)	Green Marsh Hawk	LC	DL
50	*Pantala flavescens* (Fabricius, 1798)	Wandering Glider	LC	DL
51	*Potamarcha congener* (Rambur, 1842)	Yellow-tailed Ashy Skimmer	LC	DL
52	*Rhodothemis rufa* (Rambur, 1842)	Rufous Marsh Glider	LC	DL
53	*Rhyothemis variegata* (Linnaeus, 1763)	Common Picturewing	LC	DL
54	*Tetrathemis platyptera* Selys, 1878	Pygmy Skimmer	LC	KS
55	*Tholymis tillarga* (Fabricius, 1798)	Coral-tailed Cloud Wing	LC	DL
56	*Tramea basilaris* (Palisot de Beauvois, 1805)	Red Marsh Trotter	LC	DL
57	*Tramea limbata* (Desjardins, 1832)	Black Marsh Trotter	LC	KS
58	*Trithemis aurora* (Burmeister, 1839)	Crimson Marsh Glider	LC	DL
59	*Trithemis festiva* (Rambur, 1842)	Black Stream Glider	LC	KS
60	*Zygonix iris* Selys, 1869	Iridescent Stream Glider	LC	KS
61	*Zyxomma petiolatum* Rambur, 1842	Brown Dusk Hawk	LC	W

NE—Not Evaluated | DD—Data Deficient | LC—Least Concern | DL—Dhamapur Lake | KS—Kasartaka Stream | TL—Thakurwadi Lake | S—stream along Dhamapur Lake | M—marshes | W—well | P—pond.

***1. Lestes praemorsus decipiens* Kirby, 1894**

A pair was observed in the marshy area of the lake. The male was identified as *Lestes praemorsus* on the basis of characters like thorax with greenish antehumeral stirpes, crenulate on the outer sides; segment nine with dorso-lateral blue marking; blunt and curved cerci with whitish hairs and paraprocts blackish, short with white hairs at the tip (Image 10). The female looked similar to the male with profound thoracic antehumeral stripes. Anal appendages were whitish, short, and pointed (Image 11). The species is distributed from western India to Assam (Fraser 1933), Andaman Islands and across the northern parts of the country and consist of two subspecies *L. praemorsus sikkima* Fraser, 1929 and *L. praemorsus decipiens* Kirby, 1893 (Prasad & Varshney 1995; Dow & Sharma 2020). *L.p. sikkima* is confined to Sikkim in northeastern India and is distinguished by having a metallic posthumeral stripe (Fraser 1933). The male specimen observed at the lake lacks any metallic posthumeral markings (Image 12), thus it is concluded to be representing the widespread subspecies *L.p. dicipiens*. It should, however, also be noted that the taxonomic status of the subspecies of *L. praemorsus* is insufficiently resolved (Kosterin 2019). DS found the

species in September 2017 at a natural pond with aquatic weeds in Vimleshwar Village of the district. Considering the distribution in the mentioned references and citizen science portals (Anonymous 2020a), we note that these are the first confirmed records of the subspecies from Maharashtra.

2. *Platylestes* cf. *platystylus*

A single female individual sighted at the lake seems to be closer to *Platylestes platystylus* (Rambur, 1842) based on the pterostigma (quadrate as opposite to elongate in *Lestes* spp.) and thoracic markings (presence of black spots on each side) (Image 13). We did not collect the specimen hence species level identification was not confirmed. We treat our record as *Platylestes* cf. *platystylus*. The species *P. platystylus* has distribution in West Bengal in India (Fraser 1933; Prasad & Varshney 1995; Sharma 2010). It is also reported from Tripura and Kerala on citizen science portals (Anonymous 2020b; https://www.inaturalist.org/observations?place_id=6681&taxon_id=109709). Rison & Chandran (2020) recorded the species from few localities in Kerala recently. During present study, the female was seen curling abdomen on an emergent aquatic plant, indicating probable attempt at egg-laying.

3. *Pseudagrion malabaricum* Fraser, 1924

Pseudagrion malabaricum was first reported from Maharashtra State by Tiple et al. (2013) in the Vidarbha region. Subsequently, this species has also been reported from Devgad Taluka and Chaukul Village in Sindhudurg District (Anonymous 2020c). During the present survey, several adults were observed among the reeds and grassy aquatic vegetation near the lake edge (Image 14). The species was identified based on the cerci being shorter than abdomen segment 10 and not bifid at apex (Image 15). The only other *Pseudagrion* species recorded in the habitat, *P. microcephalum*, has bifid cerci clearly longer than the segment 10 while the morphologically similar species *P. australasiae* has cerci bifid at apex as seen in profile (Fraser 1933).

4. *Gynacantha* cf. *khasiaca*

A single male individual was observed in the vegetation surrounding the lake. The specimen was recognised separate from the other *Gynacantha* spp. recorded during the study and showed similar characters to those of *Gynacantha khasiaca* MacLachlan, 1896 i.e. paraproct longer than half of the length of cerci (Image 18) and two lateral brownish stripes on the greenish thorax (Image 19). *G. khasiaca* is distributed in West Bengal, Assam and Khasi hills in Meghalaya in India (Fraser 1936). Few studies further add the southernmost distribution of the species to West Bengal (Mitra 2002; Payra et al. 2017). We confirm the observed specimen as *Gynacantha* cf. *khasiaca* owing to confirmation of the mentioned limited characters as we did not collect the specimen. It is an interesting opportunistic record from the western India considering its affinity to *G. khasiaca* with the known distribution range in northeastern parts of the country (Mitra et al. 2010). It requires detailed study of the specimen further to confirm its identity.

5. *Indothemis limbata sita* Campion, 1923

Indothemis limbata was described as *Trithemis limbata* Selys, 1891 based on specimens from Myanmar and Malay Peninsula. A different form of the species was described as *I. limbata sita* from Sri Lanka, based on the wing venation and markings (Campion 1923). Later studies considered *I. limbata limbata* to be restricted to Myanmar and southeastern Asia and *I. limbata sita* to be restricted to the western India and Sri Lanka barring one record from Odisha (Fraser 1936; Prasad & Varshney 1995). Babu et al. (2009) reported *I. limbata limbata* as a new record for the state mentioning the distribution as Odisha, West Bengal, parts of northeastern India, and Karnataka. State checklists of odonates mention the species with the same reference (Director 2012; Tiple & Koparde 2015). The authors considered *I. limbata sita* in the checklist of India (Subramanian & Babu 2017), but there is no mention of the species in the Western Ghats atlas (Subramanian et al. 2018). Opportunistic observations indicate the presence of the species from Assam (Anonymous 2020d) and Uttara Kannada, Karnataka (https://www.facebook.com/photo/?fbid=707419235973335&set=gm.740960425953503). These studies show that there has been a discrepancy on the identity and distribution of both the subspecies. The new record of *I. limbata limbata* from Maharashtra needs to be confirmed by re-examining the specimens and comparing with the holotypes since all the other records of the subspecies are from Odisha and northeastern parts India and the paper didn't include any illustration or image of the specimens studied.

Present records from the lake show the presence of at least one adult (Image 20) and one sub-adult male (abdomen with yellowish markings) (Image 21). We confirm the record as *Indothemis limbata sita* based on characters of the adult male such as hyaline wing apices and 10-1/2 antenodal nervures in the forewing (apices bordered as blackish-brown and 11-1/2 - 12-1/2 antenodal nervures in *I. limbata limbata*). At species level *I. limbata* is distinguished from the congeneric species *I. carnatica* (Fabricius, 1798) by black body with black anal appendages and base of hindwing with extensive brown marking as opposite to violaceous body

Table 3. Checklist of butterflies.

	Scientific name	Common name	IUCN status	WPA schedule
	Family Papilionidae			
1	*Graphium agamemnon* (Linnaeus, 1758)	Tailed Jay	NE	-
2	*Graphium teredon* (C. & R. Felder, 1865)	Southern Bluebottle	NE	-
3	*Papilio demoleus* Linnaeus, 1758	Lime Butterfly	NE	-
4	*Papilio polymnestor* Cramer, [1775]	Blue Mormon	NE	-
5	*Papilio polytes* Linnaeus, 1758	Common Mormon	NE	-
	Family Hesperiidae			
6	*Aeromachus pygmaeus* (Fabricius, 1775)	Pygmy Scrub Hopper	NE	-
7	*Ampittia dioscorides* (Fabricius,1793)	Bush Hopper	NE	-
8	*Iambrix salsala* (Moore, [1866])	Chestnut Bob	NE	-
9	*Oriens goloides* (Moore, [1881])	Ceylon Dartlet	NE	-
10	*Parnara guttatus* (Bremer & Grey, [1852])	Straight Swift	NE	-
11	*Pelopidas* sp. Walker, 1870	-	NE	-
12	*Spialia galba* (Fabricius, 1793)	Indian Skipper	NE	-
13	*Tagiades litigiosa* Moeschler, 1878	Water Snow Flat	NE	-
14	*Taractrocera ceramas* (Hewitson, 1868)	Tamil Grass Dart	NE	-
15	*Udaspes folus* (Cramer, [1775]	Grass Demon	NE	-
	Family Pieridae			
16	*Catopsilia pomona* (Fabricius, 1775)	Common Emigrant	NE	-
17	*Delias eucharis* (Drury, 1773)	Common Jezebel	NE	-
18	*Eurema hecabe* (Linnaeus, 1758)	Common Grass Yellow	NE	-
19	*Leptosia nina* (Fabricius, 1793)	Psyche	NE	-
20	*Pareronia ceylanica* (C. & R. Felder, 1865)	Dark Wanderer	NE	-
21	*Pareronia valeria* (Cramer, [1776])	Common Wanderer	NE	-
	Family Riodinidae			
22	*Abisara bifasciata* Moore, 1877	Two-spot Plum Judy	NE	-
	Family Lycaenidae			
23	*Acytolepis puspa* (Horsfield, [1828])	Common Hedge Blue	NE	-
24	*Caleta decidia* (Hewitson, 1876)	Angled Pierrot	NE	-
25	*Chilades pandava* (Horsfield, [1829])	Plains Cupid	NE	-
26	*Jamides celeno* (Cramer, [1775]	Common Cerulean	NE	-
27	*Loxura atymnus* (Stoll, 1780)	Yamfly	NE	-
28	*Rathinda amor* (Fabricius, 1775)	Monkey Puzzle	NE	-
	Family Nymphalidae			
29	*Cirrochroa thais* (Fabricius, 1787)	Tamil Yeoman	NE	-
30	*Cupha erymanthis* (Drury, [1773])	Rustic	NE	-
31	*Cynitia lepidea* (Butler, 1868)	Grey Count	NE	II
32	*Danaus chrysippus* (Linnaeus, 1758)	Plain Tiger	LC	-
33	*Danaus genutia* (Cramer, [1779])	Common Tiger	NE	-
34	*Doleschallia bisaltide* (Cramer, [1777])	Autumn Leaf	NE	I
35	*Elymnias hypermnestra* (Linnaeus, 1763)	Common Palmfly	NE	-
36	*Euploea core* (Cramer, [1780])	Common Crow	LC	-
37	*Euthalia aconthea* (Cramer, [1777])	Common Baron	NE	-
38	*Hypolimnas bolina* (Linnaeus, 1758)	Great Eggfly	NE	-
39	*Hypolimnas misippus* (Linnaeus, 1764)	Danaid Eggfly	NE	I
40	*Junonia almana* (Linnaeus, 1758)	Peacock Pansy	LC	-
41	*Junonia atlites* (Linnaeus, 1763)	Grey Pansy	NE	-
42	*Junonia iphita* (Cramer, [1779])	Chocolate Pansy	NE	-
43	*Junonia lemonias* (Linnaeus, 1758)	Lemon Pansy	NE	-

	Scientific name	Common name	IUCN status	WPA schedule
44	*Melanitis leda* (Linnaeus, 1758)	Common Evening Brown	NE	-
45	*Mycalesis perseus* (Fabricius, 1775)	Common Bushbrown	NE	-
46	*Neptis hylas* (Linnaeus, 1758)	Common Sailer	NE	-
47	*Orsotriaena medus* (Fabricius, 1775)	Nigger	NE	-
48	*Parantica aglea* (Stoll, [1782])	Glassy Tiger	NE	-
49	*Parthenos sylvia* (Cramer, 1775)	Clipper	NE	II
50	*Tirumala limniace* (Cramer, [1775])	Blue Tiger	NE	-
51	*Ypthima huebneri* Kirby, 1871	Common Fourring	NE	-

NE—Not Evaluated | LC—Least Concern.

Table 4 Checklist of amphibians.

	Scientific name	Common name	IUCN Status	WPA Schedule
	Order Anura			
	Family Dicroglossidae			
1	*Euphlyctis cyanophlyctis* (Schneider, 1799)	Skittering Frog	LC	IV
2	*Euphlyctis hexadactylus* (Lesson, 1834)	Indian Green Frog	LC	IV
3	*Hoplobatrachus tigerinus* (Daudin, 1802)	Indian Bull Frog	LC	IV
4	*Sphaerotheca* sp. Günther, 1859	Burrowing Frog	-	-
	Family Ranidae			
5	*Hydrophylax bahuvistara* Padhye, Jadhav, Modak, Nameer & Dahanukar, 2015	Fungoid Frog	NE	-
	Family Ranixalidae			
6	*Indirana* sp.	-	-	-
	Family Rhacophoridae			
7	*Polypedates maculatus* (Gray, 1830)	Common Indian Tree Frog	LC	-

NE—Not Evaluated | LC—Least Concern

Table 5. Checklist of reptiles.

	Scientific name	Common name	IUCN Status	WPA Schedule
	Order Sauria			
	Family Agamidae			
1	*Calotes versicolor* (Daudin, 1802)	Garden Calotes	NE	-
2	*Monilesaurus rouxii* Duméril & Bibron, 1837	Forest Calotes	LC	-
	Family Gekkonidae			
3	*Hemidactylus* sp.	-	LC	-
4	*Hemidactylus frenatus* Duméril & Bibron, 1836	Asian House Gecko	LC	-
5	*Hemidactylus prashadi* Smith, 1935	Bombay Leaf-toed Gecko	LC	-
	Family Scincidae			
6	*Eutropis allapallensis* (Schmidt, 1926)	Allapalli Grass Skink	LC	-
	Order Serpentes			
	Family Colubridae			
7	*Fowlea piscator* (Schneider, 1799)	Checkered Keelback	NE	II
8	*Oligodon taeniolatus* (Jerdon, 1853)	Indian Streaked Kukri Snake	NE	IV
9	*Ptyas mucosa* (Linnaeus, 1758)	Indian Rat Snake	NE	II
	Family Natracidae			
10	*Amphiesma stolatum* (Linnaeus, 1758)	Buff-striped Keelback	NE	IV

NE—Not Evaluated | LC—Least Concern

Table 6. Checklist of birds.

	Scientific Name	Common Name	IUCN Status	WPA Schedule
	Family Accipitridae			
1	*Haliastur indus* (Boddaert, 1783)	Brahminy Kite	LC	I
2	*Hieraaetus pennatus* (J.F. Gmelin, 1788)	Booted Eagle	LC	I
3	*Nisaetus cirrhatus* (J.F. Gmelin, 1788)	Changeable Hawk Eagle	LC	I
4	*Pernis ptilorhynchus* (Temminck, 1821)	Oriental Honey Buzzard	LC	I
5	*Spilornis cheela* (Latham, 1790)	Crested Serpent Eagle	LC	I
	Family Aegithinidae			
6	*Aegithina tiphia* (Linnaeus, 1758)	Common Iora	LC	IV
	Family Alcedinidae			
7	*Alcedo atthis* (Linnaeus, 1758)	Common Kingfisher	LC	IV
8	*Ceryle rudis* (Linnaeus, 1758)	Pied Kingfisher	LC	IV
9	*Ceyx erithaca* (Linnaeus, 1758)	Oriental Dwarf-kingfisher	LC	IV
10	*Halcyon smyrnensis* (Linnaeus, 1758)	White-breasted Kingfisher	LC	IV
11	*Pelargopsis capensis* (Linnaeus, 1766)	Stork-billed Kingfisher	LC	IV
	Family Anatidae			
12	*Dendrocygna javanica* (Horsfield, 1821)	Lesser Whistling-duck	LC	IV
	Family Anhingidae			
13	*Anhinga melanogaster* Pennant, 1769	Oriental Darter	NT	IV
	Family Ardeidae			
14	*Ardea alba* Linnaeus, 1758	Great Egret	LC	IV
15	*Ardea cinerea* Linnaeus, 1758	Grey Heron	LC	IV
16	*Ardea intermedia* Wagler, 1829	Intermediate Egret	LC	IV
17	*Ardeola grayii* (Sykes, 1832)	Indian Pond-heron	LC	IV
18	*Bubulcus ibis* (Linnaeus, 1758)	Cattle Egret	LC	IV
	Family Bucerotidae			
19	*Anthracoceros coronatus* (Boddaert, 1783)	Malabar Pied Hornbill	NT	I
20	*Buceros bicornis* Linnaeus, 1758	Great Hornbill	VU	I
21	*Ocyceros griseus* (Latham, 1790)	Malabar Grey Hornbill	LC	-
	Family Campephagidae			
22	*Pericrocotus cinnamomeus* (Linnaeus, 1766)	Small Minivet	LC	IV
23	*Pericrocotus flammeus* (J.R. Forster, 1781)	Scarlet Minivet	LC	IV
	Family Caprimulgidae			
24	*Caprimulgus atripennis* Jerdon, 1845	Jerdon's Nightjar	LC	IV
	Family Charadriidae			
25	*Vanellus indicus* (Boddaert, 1783)	Red-wattled Lapwing	LC	IV
	Family Chloropseidae			
26	*Chloropsis aurifrons* (Temminck, 1829)	Golden-fronted Leafbird	LC	IV
	Family Cisticolidae			
27	*Orthotomus sutorius* (Pennant, 1769)	Common Tailorbird	LC	IV
28	*Prinia hodgsonii* Blyth, 1844	Grey-breasted Prinia	LC	IV
29	*Prinia inornata* Sykes, 1832	Plain Prinia	LC	IV
30	*Prinia socialis* Sykes, 1832	Ashy Prinia	LC	IV
	Family Columbidae			
31	*Chalcophaps indica* (Linnaeus, 1758)	Asian Emerald Dove	LC	IV

32	*Columba livia* J.F. Gmelin, 1789	Rock Pigeon	LC	IV
33	*Spilopelia chinensis* (Scopoli, 1786)	Spotted Dove	LC	IV
34	*Treron affinis* (Jerdon, 1840)	Grey-fronted Green-pigeon	LC	IV
	Family Corvidae			
35	*Corvus macrorhynchos* Wagler, 1827	Large-billed Crow	LC	IV
36	*Corvus splendens* Vieillot, 1817	House Crow	LC	IV
	Family Cuculidae			
37	*Cacomantis passerinus* (Vahl, 1797)	Grey-bellied Cuckoo	LC	IV
38	*Centropus sinensis* (Stephens, 1815)	Greater Coucal	LC	IV
39	*Eudynamys scolopaceus* (Linnaeus, 1758)	Asian Koel	LC	IV
	Family Dicaeidae			
40	*Dicaeum erythrorhynchos* (Latham, 1790)	Pale-billed Flowerpecker	LC	IV
	Family Dicruridae			
41	*Dicrurus aeneus* Vieillot, 1817	Bronzed Drongo	LC	IV
42	*Dicrurus leucophaeus* Vieillot, 1817	Ashy Drongo	LC	IV
	Family Estrildidae			
43	*Lonchura malacca* (Linnaeus, 1766)	Tricolored Munia	LC	IV
44	*Lonchura punctulata* (Linnaeus, 1758)	Scaly-breasted Munia	LC	IV
45	*Lonchura striata* (Linnaeus, 1766)	White-rumped Munia	LC	IV
	Family Hirundinidae			
46	*Cecropis daurica* (Laxmann, 1769)	Red-rumped Swallow	LC	IV
47	*Hirundo smithii* Leach, 1818	Wire-tailed Swallow	LC	IV
48	*Ptyonoprogne concolor* (Sykes, 1832)	Dusky Crag Martin	LC	IV
	Family Jacanidae			
49	*Metopidius indicus* (Latham, 1790)	Bronze-winged Jacana	LC	IV
	Family Leiotrichidae			
50	*Alcippe poioicephala* (Jerdon, 1841)	Brown Cheeked Fulvetta	LC	IV
	Family Megalaimidae			
51	*Psilopogon haemacephalus* (Statius Muller, 1776)	Coppersmith Barbet	LC	IV
52	*Psilopogon viridis* (Boddaert, 1783)	White-cheeked Barbet	LC	IV
53	*Psilopogon zeylanicus* (J.F. Gmelin, 1788)	Brown-headed Barbet	LC	IV
	Family Meropidae			
54	*Merops leschenaulti* Vieillot, 1817	Chestnut-headed Bee-eater	LC	IV
55	*Merops orientalis* Latham, 1801	Green Bee-eater	LC	IV
56	*Merops philippinus* Linnaeus, 1767	Blue-tailed Bee-eater	LC	IV
	Family Monarchidae			
57	*Hypothymis azurea* (Boddaert, 1783)	Black-naped Monarch	LC	IV
	Family Motacillidae			
58	*Motacilla cinerea* Tunstall, 1771	Grey Wagtail	LC	IV
59	*Motacilla maderaspatensis* J.F. Gmelin, 1789	White-browed Wagtail	LC	IV
	Family Muscicapidae			
60	*Copsychus saularis* (Linnaeus, 1758)	Oriental Magpie-robin	LC	IV
61	*Cyornis tickelliae* Blyth, 1843	Tickell's Blue-flycatcher	LC	IV
62	*Eumyias thalassinus* (Swainson, 1838)	Verditer Flycatcher	LC	IV
63	*Kittacincla malabarica* (Scopoli, 1786)	White-rumped Shama	LC	IV
64	*Saxicola torquatus* (Linnaeus, 1766)	Common Stonechat	LC	IV

	Family Nectariniidae			
65	*Aethopyga vigorsii* (Sykes, 1832)	Vigor's Sunbird	LC	IV
66	*Cinnyris lotenius* (Linnaeus, 1766)	Loten's Sunbird	LC	IV
67	*Leptocoma minima* (Sykes, 1832)	Crimson-backed Sunbird	LC	IV
68	*Leptocoma zeylonica* (Linnaeus, 1766)	Purple-rumped Sunbird	LC	IV
	Family Oriolidae			
69	*Oriolus xanthornus* (Linnaeus, 1758)	Black-hooded Oriole	LC	IV
	Family Paridae			
70	*Machlolophus xanthogenys* (Vigors, 1831)	Black-lored Tit	LC	IV
	Family Passeridae			
71	*Gymnoris xanthocollis* (E. Burton, 1838)	Chestnut-shouldered Bush-sparrow	LC	IV
	Family Pellorneidae			
72	*Pellorneum ruficeps* Swainson, 1832	Puff-throated Babbler	LC	IV
	Family Phalacrocoracidae			
73	*Microcarbo niger* (Vieillot, 1817)	Little Cormorant	LC	IV
	Family Phasianidae			
74	*Pavo cristatus* Linnaeus, 1758	Indian Peafowl	LC	I
	Family Phylloscopidae			
75	*Phylloscopus trochiloides* (Sundevall, 1837)	Greenish Warbler	LC	-
	Family Picidae			
76	*Dinopium benghalense* (Linnaeus, 1758)	Lesser Golden-backed woodpecker	LC	IV
77	*Micropternus brachyurus* (Vieillot, 1818)	Rufous Woodpecker	LC	IV
	Family Ploceidae			
78	*Ploceus philippinus* (Linnaeus, 1766)	Baya Weaver	LC	IV
	Family Psittacidae			
79	*Loriculus vernalis* (Sparrman, 1787)	Vernal Hanging Parrot	LC	IV
80	*Psittacula cyanocephala* (Linnaeus, 1766)	Plum-headed Parakeet	LC	IV
	Family Pycnonotidae			
81	*Brachypodius priocephalus* (Jerdon, 1839)	Grey-headed Bulbul	NT	IV
82	*Pycnonotus cafer* (Linnaeus, 1766)	Red-vented Bulbul	LC	IV
83	*Pycnonotus jocosus* (Linnaeus, 1758)	Red-whiskered Bulbul	LC	IV
	Family Rallidae			
84	*Amaurornis phoenicurus* (Pennant, 1769)	White-breasted Waterhen	LC	IV
	Family Scolopacidae			
85	*Actitis hypoleucos* (Linnaeus, 1758)	Common Sandpiper	LC	IV
	Family Strigidae			
86	*Otus* sp.	Scops Owl	-	IV
87	*Strix leptogrammica* Temminck, 1832	Brown Wood-owl	LC	IV
	Family Sturnidae			
88	*Acridotheres fuscus* (Wagler, 1827)	Jungle Myna	LC	IV
	Family Timaliidae			
89	*Dumetia hyperythra* (Franklin, 1831)	Tawny-bellied Babbler	LC	IV
90	*Pomatorhinus horsfieldii* Sykes, 1832	Indian Scimitar-babbler	LC	IV

LC—Least Concern | NT—Near Threatened | VU—Vulnerable

Table 7. Checklist of mammals.

	Scientific name	Common name	IUCN Status	WPA Schedule
	Order Carnivora: Family Herpestidae			
1	*Herpestes edwardsii* (É. Geoffroy Saint-Hilaire, 1818)	Indian Grey Mongoose	LC	II
	Order Primates: Family Cercopithecidae			
2	*Macaca radiata* (E. Geoffroy, 1812)	Bonnet Macaque	LC	II
3	*Semnopithecus hypoleucos* Blyth, 1841	Black-footed Gray Langur	VU	-
	Order Rodentia: Family Sciuridae			
4	*Funambulus palmarum* (Linnaeus, 1766)	Three-striped Palm Squirrel	LC	-

Abbreviations: LC—Least Concern | VU—Vulnerable

with white anal appendages and small amber yellow colour at hindwing base in the latter. *I. carnatica* was not recorded during the present study but is reported from peninsular India (Dow 2019). DS has observed it in Sindhudurg District (Anonymous 2020e). Image 20 has been used for comparison in the novel description of *Bradinopyga konkanensis* from western coastal parts of the state (Joshi & Sawant 2020). We highlight this as the first confirmed record of the subspecies from the western Maharashtra.

DISCUSSION

Inventorying and monitoring biodiversity at a regional scale is essential as it provides vital information on the occurrence and distribution of local diversity, and their associations with local habitat. A study by Kunte et al. (1999) recommended biodiversity surveys at a local level encompassing taxa from diverse groups and not just flagship vertebrate species like birds and mammals. It further states that building a network of long-term biodiversity monitoring projects with an understanding of landscape elements (e.g., vegetation types, microhabitats requirements of particular taxa) in ecologically sensitive areas such as the Western Ghats is important.

The current study dwells on two important aspects discussed as following -

a) Role of citizen science in biodiversity documentation

The very key aspect of citizen science is public engagement in data collection through which they can connect with nature and make a positive contribution towards the environment. It acts as a bridge between researchers and the local community, including the stakeholders. The participants actively participated in the current survey and documented different taxa of the study area with increased interest towards local biodiversity. Their effort resulted in the multi-taxa checklist of Dhamapur Lake and surroundings and also added two subspecies to the state Odonata checklist. They also uploaded their observations on the online database of iNaturalist that served the purpose of data sharing on a broader platform.

b) Conservation implications of Dhamapur Lake and surroundings

Among the odonates, presence of the species *Platylestes* cf. *platystylus* and *Gynacantha* cf. *khasiaca*, possible new records to the state (Tiple & Koparde 2015; Koparde et al. 2020), highlights the potential of the lakes for more systematic Odonata surveys in the future. Habitats around Dhamapur Lake support a rich and diverse fauna. The scheduled butterflies like *D. bisaltide*, *P. sylvia*, and *C. lepidea* and the key-stone bird species such as *A. coronatus* and *B. bicornis* are indicator species inhabiting dense moist forests. We observed a colour aberrant individual of *Psilopogon viridis* (Boddaert, 1783) during the survey (Image 46). We based the species identification, in the absence of prominent cheek and head coloration, on size and iris skin colour (black as in *P. viridis*). We speculate that the bird was either a leucistic or ino individual given features such as normal eye pigmentation, iris skin and beak colour (Grouw 2006; Koparde et al. 2014). Habitats around Dhamapur Lake are also known to harbour a large variety of animals including *Lutrogale perspicillata* (I. Geoffroy Saint-Hilaire, 1826) - Smooth Coated Otter, a Vulnerable species according to IUCN. The biodiversity action plan prepared for Sindhudurg and Malvan districts mentions the lake as a large wetland and as a unique feature of Malvan Tehsil, further mentioning that the lake has the potential to be developed as a Ramsar site, however,

biodiversity has to be studied (TERI 2013).

Biodiversity studies have been focused at certain locations in Sindhudurg District. Places like Amboli, a hill station in Sawantwadi Tehsil, attracts many nature enthusiasts and tourists every year. Explorations by the researchers have resulted in a number of scientific publications (Bhakare & Ogale 2018; Satose et al. 2018; Rao et al. 2019) and new species (Vogel & Rooijen 2011; Sayyed et al. 2018; Chaitanya et al. 2019) from this area. There are hardly any long-term monitoring studies in this area facing high tourism pressure.

Current work done over a period of just four days revealed some interesting faunal records, especially for odonates, birds, and mammals that tried to fill the knowledge gap on the biodiversity information of the district. The findings, though primary, form the base for future monitoring and conservation of the Dhamapur Lake area. We recommend systematic biodiversity surveys in this underexplored but potentially biodiversity rich area for conservation of local freshwater ecosystems such as the streams originating from the lake, and important rivers such as Karli River. Data collected on the local biodiversity can be used to target local students for awareness programmes and to promote sustainable tourism activities without disturbing the integrity of the lake and nearby forest, in order to avail the resources in the long run.

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Author details: Neha Mujumdar - working as scientist at Bombay Natural History Society, Mumbai. She has documented diversity and ecological aspects of butterflies and odonates in the Western Ghats. She is one of the admins of DrgaonflySouthAsia. Website: https://dragonflysouthasia.wordpress.com/. Dattaprasad Sawant - a doctor by profession and graduated from GMC JJ Hospital, Mumbai. He is pursuing MD in Preventive and Social Medicine in Seth GSMC and KEM Hospital, Mumbai. He is documenting Lepidoptera and Odonata diversity of Konkan region. He has described two new Odonata species from Maharashtra with Shantanu Joshi. Amila Prasanna Sumanapala - a Sri Lankan field researcher primarily studying Odonata diversity, ecology, biogeography and conservation. Also interested in arthropods and birds. Currently pursuing M.Phil on Odonata at University of Colombo, Sri Lanka. Parag Rangnekar - researcher and ecologist based in Goa with interest in avian, butterfly and odonate diversity and ecology. He has described two new species of dragonflies from the State. He operates various community-based ecotourism initiatives. Dr. Pankaj Koparde is an evolutionary ecologist, working as an assistant professor at MIT World Peace University. He is interested in science-driven conservation research and outreach. He is one of the admins of DrgaonflySouthAsia. website: https://www.chaturullu.in/

Author contribution: NM collected data in the field on butterflies, odonates and herps, contributed images, prepared checklists and wrote the manuscript. DS collected data on butterflies and odonates in the field, helped in their identification and manuscript editing, and contributed images. AS collected data in the field on butterflies, odonates, herps and birds, contributed images, helped in manuscript editing. PR collected data in the field on butterflies, odonates and birds, prepared checklists, helped in manuscript editing. PK conceptualized the idea and organized the field data collection drive, collected data in the field on odonates and birds, and reviewed manuscript draft.

Image 10. *Lestes praemorsus decipiens* (male)

Image 11. *Lestes praemorsus decipiens* (female)

Image 12. Lateral view of male *Lestes praemorsus decipiens*

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Image 21. Subadult male of *Indothemis limbata sita*

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