



ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

DOCUMENTING THE FAUNA OF A SMALL TEMPORARY POND FROM PUNE, MAHARASHTRA, INDIA

Mihir R. Kulkarni¹, Sameer Padhye², Avinash Isaac Vanjare³, Shriraj S. Jakhalekar⁴,
Yugandhar S. Shinde⁵, Shruti V. Paripatyadar⁶, Sayali D. Sheth⁷, Siddharth Kulkarni⁸,
Samadhan K. Phuge⁹, Kalyani Bhakare¹⁰, Aboli S. Kulkarni¹¹, Kalpana Pai¹² &
Hemant V. Ghate¹³

OPEN ACCESS

^{1,2,5,9,10,12} Department of Zoology, Savitribai Phule Pune University, Pune, Maharashtra 411007, India

² Wildlife Information Liaison Development Society, 96 Kumudham Nagar, Vilankuruchi Road, Coimbatore, Tamil Nadu 641035, India

³ Department of Zoology, Ahmednagar College, Ahmednagar, Maharashtra 414001, India

^{4,5,13} Department of Zoology, Modern College, Shivajinagar, Pune, Maharashtra 411005, India

^{6,7,11} Department of Biodiversity, M.E.S's Abasaheb Garware College, Pune, Maharashtra 411004, India

⁸ Biome Conservation Foundation, Pune, 18, Silver Moon Apts., 1/2A/2, Bavdhan Kh., Pune, Maharashtra 411021, India

¹ mihircoolkarni@gmail.com, ² sameer.m.padhye@gmail.com, ³ avinashisaac7@gmail.com, ⁴ shriraj.jak@gmail.com,

⁵ yugandharshinde@gmail.com, ⁶ shruti.paripatyadar@gmail.com, ⁷ saylisheth@gmail.com, ⁸ sskspider@gmail.com,

⁹ samadhanmphuge@gmail.com, ¹⁰ kalyani2488@gmail.com, ¹¹ aboli.kulkarni5@gmail.com,

¹² kalpanapai@unipune.ac.in, ¹³ hemantghate@gmail.com (corresponding author)

Abstract: Most of the limnological studies in India have focussed on a few taxa of large, permanent water bodies, and pond ecosystems, and related temporary water bodies are neglected. We present here a faunal inventory, with representative photographs, for a single, small temporary pond, reporting over 125 species of strictly aquatic fauna and 25 species of associated fauna, even though we did not identify some groups such as Protozoa, Diptera and nymphs of Odonata, etc. The identified species belong to seven taxa of vertebrates and invertebrates together. Arthropoda and Rotifera were the most species rich groups, observed with 83 and 45 representatives, respectively. Coleoptera were the most numerous in terms of species number. Such a small water body holds some endemics as well as otherwise very rare animals and so deserves better attention. We also highlight the potential and importance of such habitats for research and conservation.

Keywords: Fauna, habitat conservation, pond ecosystem, temporary water body.



DOI: <http://dx.doi.org/10.11609/JoTT.o4190.7196-210> | ZooBank: urn:lsid:zoobank.org:pub:3364BB83-0F9C-4CD3-9C78-CF733B26E207

Editor: B.A. Daniel, Zoo Outreach Organisation, Coimbatore, India.

Date of publication: 26 May 2015 (online & print)

Manuscript details: Ms # o4190 | Received 26 November 2014 | Final received 17 February 2015 | Finally accepted 10 April 2015

Citation: Kulkarni, M.R., S. Padhye, A.I. Vanjare, S.S. Jakhalekar, Y.S. Shinde, S.V. Paripatyadar, S.D. Sheth, S. Kulkarni, S.K. Phuge, K. Bhakare, A.S. Kulkarni, K. Pai & H.V. Ghate (2015). Documenting the fauna of a small temporary pond from Pune, Maharashtra, India. *Journal of Threatened Taxa* 7(6): 7196–7210; <http://dx.doi.org/10.11609/JoTT.o4190.7196-210>

Copyright: © Kulkarni et al. 2015. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use of this article in any medium, reproduction and distribution by providing adequate credit to the authors and the source of publication.

Funding: MRK is supported by a CSIR-JRF; SP was supported by CSIR-SRF; AIV is funded by ATREE Small grants (2010-11) & BCUD-UoP (Proposal No 13SCI00001-2013-15); YSS was supported by UGC-CAS Dept. of Zoology, Savitribai Phule Pune University; SVP and SDS are supported by UGC-JRF; KB is supported by UoP-UPE (Life Sciences) grant; KP was funded by ISRO-UoP, UGC-CAS, BCUD-UoP and is currently funded by UoP-UPE (Life Sciences) grant.

Competing interests: The authors declare no competing interests.

Author Contribution: All authors contributed equally.

Author Details: See end of this article.

Acknowledgements: The authors acknowledge the Head, Dept. of Zoology, Savitribai Phule Pune University; The authorities of Ahmednagar College, Ahmednagar; Modern College, Shivajinagar, Pune; Abasaheb Garware College, Pune for facilities and encouragement. We also thank Anand Padhye (Garware College) for all the help and encouragement. We also acknowledge Reginald Victor, Sultan Qaboos University, Oman (Ostracoda); K. Subramanian, Scientist D, Zoological Survey of India, Kolkata (Odonata); Y. Ranga Reddy, Acharya Nagarjuna University, Guntur and Maria Holyńska, Museum and Institute of Zoology, Poland (Copepoda); A. Komarek, Austria and Andrew Short, U.S.A. (Hydrophilidae); and Mandar Datar, Agharkar Research Institute, Pune (aquatic macrophytes) for their help. We thank Christopher Thorpe-Dixon, Plymouth University, UK and Nikhil Modak, Abasaheb Garware College, Pune, for literature; Sanjay Molur, Wildlife Information Liaison Development Society, Coimbatore and Neelesh Dahanukar, IISER, Pune for their support. We especially thank Reginald Victor for his critical comments on an earlier version of the manuscript.

INTRODUCTION

Ponds, as defined by Williams et al. (2004), are lentic water bodies (temporary or permanent, including both natural and man-made water bodies) with an area typically ranging from 25m²-2ha. Temporary ponds are characterised by a recurrent dry phase and these occur everywhere, with hydroperiod varying from about a month to the better part of the year (Williams 2006). Despite their small size and unpredictable nature, these temporary water bodies are known to harbour novel, endemic, rare and/or threatened fauna (Blaustein & Schwartz 2001; Williams 2006; Oertli et al. 2007) and their resting stages, thus acting as “local nature reserves” or “hotspots” (Cereghino et al. 2008). The high beta diversity of these ponds is related to the high diversity in habitat characteristics, such as hydroperiod, trophic structure and macrophyte diversity (de Meester et al. 2005). The physico-chemical properties of temporary ponds show large seasonal fluctuations (Williams 2006). The biota of these habitats is adapted to such highly fluctuating conditions, by means of rapid life-cycles, production of resting eggs and diapause (Wiggins et al. 1980; Wyngaard et al. 1991). However, there has been a tendency to ignore and undervalue the biota of such water bodies (Boix et al. 2001).

As is evident from the available published literature from India (Mukhopadhyay & Dewanji 2005; Kiran et al. 2007; Muthukumar et al. 2007; Garg et al. 2009; Santhala et al. 2009), recent studies on different groups of aquatic biota are scarce, especially multi-taxa inventories on fauna of ephemeral and seasonal water bodies are very rare, as compared to those on permanent water bodies. Even here, studies on permanent water bodies have focussed on inventories restricted to particular groups.

Here, we present a multi-taxa biodiversity inventory of a temporary pond situated within the campus of the Savitribai Phule Pune University, Pune, focussing mainly on the aquatic and associated invertebrate taxa, although regularly visiting birds are also documented.

MATERIALS AND METHODS

Study site

The study was carried out in a small seasonal pond (Image 1 A,B) in the Savitribai Phule Pune University campus, Pune (18°33'18"N & 73°49'27"E) mainly from 2009 to 2014; however one of us (H.V. Ghate) has been studying the fauna of the same water body since ca. 1975 intermittently. This pond is actually an abandoned stone

quarry, which supplied the stone for the construction of the residence of the Governor (now the Main building of the Savitribai Phule Pune University). This quarry was excavated around 1864, during the time when the construction of the Governor's residence started. Rainwater accumulated in the quarry in addition to the natural groundwater streams, which was subsequently converted to a swimming pool by the British. One can still see the remains of the diving board at the site, and also the changing room which was constructed later. (News article in newspaper DNA, November 2010). The pond is still relatively undisturbed in terms of human activity which is evident in other similar quarries around Pune, except a few instances of waste dumping.

This quarry is located at a mean elevation of 576m and has a maximum depth of about 5m, the average depth being about 1m with an area of 0.457ha.

Inundation starts with the monsoon (late June – early July) and remains till late March, during which most of the area dries up, except the deepest parts, which dry up by the end of April.

Vegetation

Submerged (*Hydrilla* sp., *Ceratophyllum* sp.), emergent (*Typha* sp.), floating (*Azolla* sp., *Lemna* sp.), and semiaquatic (*Ipomoea aquatica* Forskal) vegetation is observed, in addition to algae (*Spirogyra* sp., *Chara* sp.,



Image 1. A–B - The study site in dry and wet seasons; C–E - Threats to the habitat.

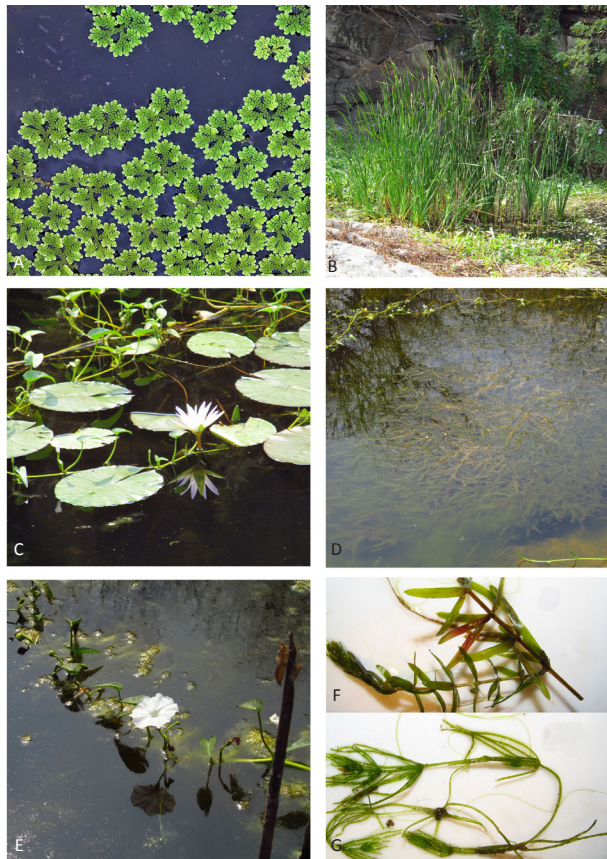


Image 2. Vegetation. A - *Azolla* sp.; B - *Typha* sp.; C - Water lily; D - *Hydrilla* sp. bed in habitat; E - *Ipomoea aquatica*; F - *Hydrilla* sp.; G - *Chara* sp. © A - S.M. Padhye; B-G - M.R. Kulkarni.

and infrequent *Hydrodictyon* sp., etc.) (Image 2 A–G).

The surrounding area is dominated by *Dalbergia* sp., an introduced deciduous plant spread all over the University campus. Additionally other species like *Gliricidia* sp., *Jatropha* sp., *Lantana camara* are also observed on the periphery.

Sampling and identification methods

Samples were collected from the 2009 to 2014 and identified using updated keys/descriptions for each group (see Appendix 1 for references). Whenever necessary, international experts were contacted for verifying the identities of the species. Collection methods for individual taxa are as follows:

Porifera and Bryozoa

Porifera and Bryozoa were visually located and collected from peripheral shallow margins of the pond. Aquatic vegetation and submerged rocks were screened for their occurrence and surveys in the dry season were also carried out for a thorough search of sponges.

Observed sponges were photographed in the field and then small pieces with gemmules were scraped off from the substrata with a scalpel and were preserved dry. Spicules were isolated and permanent slides were prepared as per Annandale (1911) and Jakhalekar & Ghate (2013). Porifera species were identified following Annandale (1911), and Penney & Racek (1968).

Bryozoan colonies were fixed and preserved in 4% formaldehyde. For identification of bryozoans, colony and polypide characters were studied and permanent preparations of statoblasts were also made to confirm the species. Identification was based on Annandale (1911) and revised nomenclature was verified with the experts.

Rotifera, Cladocera, Copepoda and Ostracoda

Horizontal sampling was done for Rotifera using a 53µm mesh size Nytex nylon Plankton Tow Net (Wildco, USA). Sampling for Cladocera, Copepoda and Ostracoda was done using Nylon Net (150µm). For benthic forms the littoral sediment was scraped using a hand net. Samples were immediately preserved in 4–5% formalin. Specimens were identified in the laboratory, following standard procedures and updated taxonomic keys for each taxa, as given here: Rotifera (Koste 1978; Segers 2002, 2007); Cladocera (Goulden 1968; Smirnov 1971, 1992, 1996; Berner 1985; Michael & Sharma 1988; Korovchinsky 1992; Dumont & Silva-Briano 2000; Orlova-Bienkowskaja 2001; Sinev et al. 2005); Copepoda (Reddy 1994; Dussart & Defaye 2001; Holynska et al. 2003); Ostracoda (Victor & Fernando 1979; Savatentalinton & Martens 2009, 2010).

Heteroptera, Coleoptera and Odonata

Aquatic Heteroptera and Coleoptera were collected using different hand held nets (25x25 cm, mesh size—1mm and 500µm, respectively) by sweeping the net through submerged and emergent aquatic vegetation as well as by disturbing the substratum. The specimens were preserved in absolute ethanol.

Coleoptera were identified following keys given in recent as well as older references (Vazirani 1968, 1970a,b, 1984; Biström 1982; Brancucci 1983; Schödl, 1992; Pederzani 1995; Vondel 1998, 2011; Komarek 2003).

Heteroptera identification was based on many available papers (Anderson et al. 2005; Brooks 1951; Chen 1960; Lansbury 1968; Cheng & Fernando 1969; Thirumalai 1994; Cheng et al. 2001; Nieser 2002, 2004; Yang & Zettel 2005; Nieser et al. 2009; Polhemus & Polhemus 2013).

Odonata were sampled randomly with a nylon net (ring diameter 30cm and rod length 100cm). Common species of odonates were identified on the field and unidentified species were collected and brought to the laboratory for identification. Odonata were identified following Fraser (1933, 1934, 1936) and Subramanian (2009).

Araneae

Spiders in the vicinity of the pond were collected by visually searching for them in the aquatic vegetation and the area around the pond. Spiders were identified using the following literature (Tikader 1980, 1982; Tanikawa 1999; Jose et al. 2003; Gajbe 2008; Yoshida 2009; Alvarez-Padilla & Hormiga 2011).

Mollusca

Snails were handpicked from the aquatic vegetation and the margins of the pond and identified following Rao (1989).

Amphibia

Anurans were collected by searching for them on the margins of the pond and also located by their calls, identified and released immediately. As these are fairly common species and well known, none were preserved.

Identification was done following Daniels (1997 I–III parts), Gururaja (2012).

Aves

Birds were observed with binoculars (Olympus 10X50) and identified following Grimmett et al. (1999).

A handheld probe (Eutech, Singapore) was used for measuring pH, Temperature and Salinity of the water. Dissolved Oxygen (DO) was estimated using Winkler titration (Anonymous 1992). Other factors like vegetation, depth, etc. were also noted on the field (see Table 1).

RESULTS

One hundred and fifty two species from seven invertebrate and vertebrate taxa were observed at the study site and their full scientific names were tabulated (see Tables 2,3; Fig. 1).

Notes on some taxa

Porifera: Occurrence of three species of sponges from this small pond was noted. Of these, *Eunapius carteri*

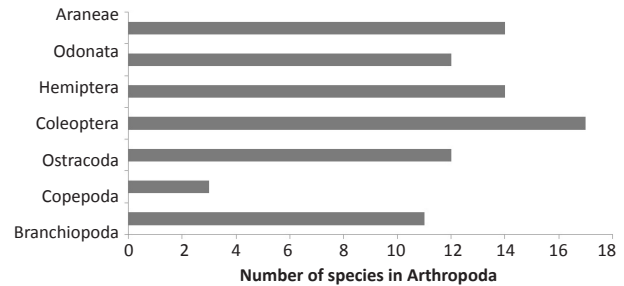


Figure 1. Representation of the Arthropoda

Table 1. Ranges for some physico-chemical parameters.

Parameter	pH	Water Temperature (°C)	Salinity (ppm)	Dissolved Oxygen (mg/L)
Range	7.1–9.7	19–31.6	91–426	0.3–7

(Bowerbank, 1863) and *Radiospongilla cerebellata* (Bowerbank, 1863) are common in occurrence, while *Dosilia plumosa* (Carter, 1849) is relatively rare (Jakhalekar & Ghate 2013) (Images 4 A,B).

Bryozoa: *Asajirella gelatinosa* (Oka, 1891) was previously reported from this site as *Pectinatella burmanica* Annandale, 1908 (Tonapi & Vargese 1983). We have also observed this species sporadically in the same pond. Recently, Jakhalekar (2012) had also noted it in Pashan Tank, Pune, at a place about 5km away from this pond.

Rotifera: Vanjare & Pai (2010) reported 13 rotifer species, including the biogeographically interesting sessile rotifer, *Ptygura pedunculata* Edmondson, 1939. So far 45 species of rotifers belonging to two orders, 15 families and 26 genera have been identified from this pond (for details, see Vanjare & Pai 2010; 2013) (Images 3 A–P).

Annelida: Hirudinea: A single specimen of a leech (of the family Glossiphonidae) was also found but could not be identified. It was found attached to a tadpole.

Arthropoda

Crustacea

Ostracoda: Twelve species belonging to the families Cypridae (10 species), Candonidae (one species) and Ilyocypridae (one species) were observed. Of these eight are Oriental in distribution. *Bradleycypris vittata* (Sars, 1903), an Oriental endemic, which was the first record for India, was also collected from this pond (Shinde 2012) (Images 5 A–H).

Copepoda: One species of calanoid copepod and two species of cyclopoid copepods were recorded.

Table 2. Taxonomic checklist of all observed species.

PORIFERA	Daphniidae	Hydrometridae
Spongillina: Spongillidae	<i>Ceriodaphnia quadrangula</i> s. lat. (O.F. Müller, 1785)	<i>Hydrometra greeni</i> Kirkaldy, 1898
<i>Dosilia plumosa</i> (Carter, 1849)	<i>Simocephalus mixtus</i> Sars, 1903	Veliidae
<i>Eunapius carteri</i> (Bowerbank, 1863)	Macrothricidae	<i>Microvelia douglasi</i> Scott, 1874
<i>Radiospongilla cerebellata</i> (Bowerbank, 1863)	<i>Macrothrix spinosa</i> King, 1853	Odonata
BRYOZOA	Moinidae	Aeshanidae
Phylactolaemata: Lophopodidae	<i>Moina micrura</i> s. lat. Kurz, 1874	<i>Anax guttatus</i> Burmeister, 1839
<i>Asajirella gelatinosa</i> (Oka, 1891)	Chydoridae	Coenagrionidae
ROTIFERA	<i>Chydorus parvus</i> Daday, 1898	<i>Agriacnemis pygmaea</i> (Rambur, 1842)
Asplanchnidae	<i>Dunhevedia crassa</i> King, 1853	<i>Ischnura senegalensis</i> (Rambur, 1842)
<i>Asplanchna brightwellii</i> Gosse, 1850	<i>Karualona</i> cf. <i>karua</i> (King, 1853)	Gomphidae
<i>Asplanchnopus hyalinus</i> Hanning, 1913	<i>Leberis punctatus</i> (Daday, 1898)	<i>Ictinogomphus rapax</i> (Rambur, 1842)
Brachionidae	Copepoda	Libellulidae
<i>Anuraeopsis fissa</i> Gosse, 1851	Calanoidea: Diaptomidae	<i>Acisoma panorpoides</i> Rambur, 1842
<i>Brachionus calyciflorus</i> Pallas, 1766	<i>Heliodiaptomus cinctus</i> (Gurney 1907)	<i>Brachythemis contaminata</i> (Fabricius, 1793)
<i>Brachionus caudatus</i> Barrois & Daday, 1894	Cyclopoida: Cyclopidae	<i>Bradinopyga geminata</i> (Rambur, 1842)
<i>Brachionus quadridentatus</i> Hermann, 1783	<i>Thermocyclops</i> sp.	<i>Crocothemis servilia</i> (Drury, 1770)
<i>Keratella tropica</i> (Apstein, 1907)	<i>Mesocyclops</i> sp.	<i>Diplacodes trivialis</i> (Rambur, 1842)
<i>Platyonus patulus patulus</i> (Müller, 1786)	Ostracoda	<i>Orthetrum Sabina</i> (Drury, 1770)
<i>Platylas quadricornis quadricornis</i> (Ehrenberg, 1832)	Cyprididae	<i>Tramea limbata</i> Rambur, 1842
Epiphanidae	<i>Bradleycypris vittata</i> (Sars, 1903)	<i>Trithemis festiva</i> (Rambur, 1842)
<i>Cyrtonia tuba</i> (Ehrenberg, 1834)	<i>Chrissia formosa</i> (Klie, 1938)	Arachnida: Araneae
<i>Epiphanes brachionus spinosa</i> (Rousselet, 1901)	<i>Cypretta fontinalis</i> Hartmann, 1964	Araneidae
Euchlanidae	<i>Cypris</i> sp.	<i>Araneus mitificus</i> (Simon, 1886)
<i>Beauchampiana eudactyloa</i> (Gosse, 1886)	<i>Hemicypris pyxidata</i> (Moniez, 1892)	<i>Cyclosa hexatuberculata</i> Tikader, 1982
<i>Euchlanis dilatata dilatata</i> Ehrenberg, 1832	<i>Plesiocypridopsis dispar</i> (Hartmann, 1964)	<i>Eriovixia</i> sp.
<i>Tripleuchlanis plicata</i> (Levander, 1894)	<i>Pseudocyprretta maculata</i> Klie, 1932	<i>Neoscona mokerjei</i> Tikader, 1980
Gastropodidae	<i>Pseudostrandesia calapanensis</i> (Tressler, 1937)	<i>Neoscona nautica</i> (Koch, 1875)
<i>Ascomorpha</i> sp.	<i>Stenocypris derupta</i> Vavra, 1906	<i>Neoscona theisi</i> (Walckenaer, 1841)
Lecanidae	<i>Stenocypris major</i> (Baird, 1859)	Lycosidae
<i>Lecane arcuata</i> Hanning, 1914	Candonidae	<i>Hippasa</i> sp.
<i>Lecane bulla bulla</i> (Gosse, 1851)	<i>Physocypris furfuracea</i> (Brady, 1886)	Oxyopidae
<i>Lecane closteroerca</i> (Schmarda, 1859)	Ilyocyprididae	<i>Oxyopes bhataratae</i> Gajbe, 1999
<i>Lecane curvicornis</i> (Murray, 1913)	<i>Ilyocypris dentifera</i> Sars, 1903	Pisauridae
<i>Lecane hamata</i> (Stokes, 1896)	Insecta: Coleoptera	<i>Nilus albocinctus</i> (Doleschall, 1859)
<i>Lecane hornemanni</i> (Ehrenberg, 1834)	Dytiscidae	Salticidae
<i>Lecane leontina</i> (Turner, 1892)	<i>Copelatus mysorensis</i> Vazirani, 1970	<i>Plexippus</i> sp.
<i>Lecane ludwigii</i> (Eckstein, 1883)	<i>Herophydrus musicus</i> (Klug, 1834)	Tetragrathidae
<i>Lecane luna</i> (Müller, 1776)	<i>Hyphydrus intermixtus</i> (Walker, 1858)	<i>Leucauge decorata</i> (Blackwall, 1864)
<i>Lecane lunaris</i> (Ehrenberg, 1832)	<i>Laccophilus flexuosus</i> Aubé, 1838	<i>Tetragrathina</i> sp.
<i>Lecane ohioensis</i> (Herrick, 1885)	<i>Laccophilus inefficiens</i> (Walker, 1859)	Thomisidae
<i>Lecane quadridentata</i> (Ehrenberg, 1830)	<i>Laccophilus parvulus parvulus</i> Aubé, 1838	<i>Runcinia roonwali</i> Tikader, 1965
<i>Lecane unguolata</i> (Gosse, 1887)	<i>Hydaticus fabricii fabricii</i> (W.S. Macleay, 1825)	Uloboridae
<i>Lecane unguitata</i> (Fadeev, 1925)	<i>Hydrovatus</i> sp.	<i>Zosis geniculata</i> (Olivier, 1789)
Lepadellidae	Gyrinidae	Gastropoda
<i>Colurella</i> sp.	<i>Dineutus indicus</i> Aubé, 1838	<i>Indoplanoorbis</i> sp.
<i>Lepadella</i> (<i>Lepadella</i>) <i>ovalis</i> (Müller, 1786)	Halipilidae	<i>Lymnaea luteola</i> Lamarck, 1822
<i>Lepadella</i> (<i>Heterolepadella</i>) <i>ehrenbergii</i> (Perty, 1850)	<i>Haliplus arrowi</i> Guignot, 1936	CHORDATA: Amphibia: Anura
<i>Squatinella lamellaris</i> (Müller, 1786)	Hydrophilidae	Bufonidae
Mytilinidae	<i>Amphiops</i> sp.	<i>Duttaphrynus melanostictus</i> (Schneider, 1799)
<i>Mytilina trigona</i> (Gosse, 1851)	<i>Berosus indicus</i> (Motschulsky, 1861)	Dicroglossidae
<i>Mytilina ventralis ventralis</i> (Ehrenberg, 1830)	<i>Berosus pulchellus</i> Macleay, 1825	<i>Euphylyctis cyanophlyctis</i> (Schneider, 1799)
Notommatidae	<i>Hydrobiomorpha spinicollis andromorpha</i>	<i>Hoplobatrachus tigerinus</i> (Daudin, 1802)
<i>Monomatta</i> sp.	Mouchamps, 1959	<i>Zakerana</i> sp.
Synchaetidae	<i>Sternolophus</i> sp.	Microhylidae
<i>Polyarthra vulgaris</i> Carlin, 1943	Noteridae	<i>Microhyla ornata</i> (Dumeril & Bibron, 1841)
Trichocercidae	<i>Canthydrus laetabilis</i> (Walker, 1858)	Reptilia: Squamata
<i>Trichocerca similis similis</i> (Wierzejski, 1893)	<i>Canthydrus luctuosus</i> (Aube, 1838)	<i>Xenochrophis piscator</i> (Schneider, 1799)
<i>Trichocerca rattus</i> (Müller, 1776)	Hemiptera: Heteroptera	Aves
Trichotriidae	Belostomatidae	Alcedinidae
<i>Macrochaetus sericus</i> (Thorpe, 1893)	<i>Diplonychus rusticus</i> (Fabricius, 1781)	<i>Alcedo atthis</i> (Linnaeus, 1758)
<i>Trichotria tetractis</i> (Ehrenberg, 1830)	Corixidae	<i>Ceryle rudis</i> (Linnaeus, 1758)
Flosculariidae	<i>Agrataptacorixa hyalinipennis</i> (Fabricius, 1803)	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)
<i>Ptygura tacita</i> Edmondson, 1940	Micronectidae	Anatidae
<i>Ptygura pedunculata</i> (Edmondson, 1939)	<i>Micronecta scutellaris</i> (Stal 1858)	<i>Anas poecilorhyncha</i> Forster, 1781
Hexarthridae	Nepidae	Ardeidae
<i>Hexarthra mira</i> (Hudson, 1871)	<i>Laccotrephes griseus</i> (Guerin-Meneville, 1835)	<i>Ardeola grayii</i> (Sykes, 1832)
Testudinellidae	<i>Ranatra filiformis</i> Fabricius, 1790	<i>Egretta garzetta</i> (Linnaeus, 1766)
<i>Testudinella patina</i> (Hermann, 1783)	Notonectidae	Charadriidae
GASTROTRICHA	<i>Anisops barbatus</i> Brooks, 1951	<i>Vanellus indicus</i> (Boddaert, 1783)
<i>Chaetonotus</i> cf. <i>similis</i> Zelinka, 1889	<i>Anisops cavifrons</i> Brooks, 1951	Motacillidae
ARTHROPODA: Crustacea: Branchiopoda	<i>Anisops sardus</i> Herrich – Shaffer, 1850	<i>Motacilla cinerea</i> Tunstall, 1771
Leptestheriidae	<i>Enithares ciliata</i> (Fabricius, 1798)	Phalacrocoracidae
<i>Leptestheria nobilis</i> (Sars, 1900)	Pleidae	<i>Phalacrocorax niger</i> (Vieillot, 1817)
Sididae	<i>Paraplea frontalis</i> (Fieber, 1844)	Podicipedidae
<i>Diaphanosoma sarsi</i> Richard, 1895	Gerridae	<i>Tachybaptus ruficollis</i> (Pallas, 1764)
<i>Latonopsis australis</i> s. lat. Sars, 1888	<i>Tenagogonus fluviorum</i> (Fabricius, 1798)	Rallidae
		<i>Amaurornis phoenicurus</i> (Pennant, 1766)

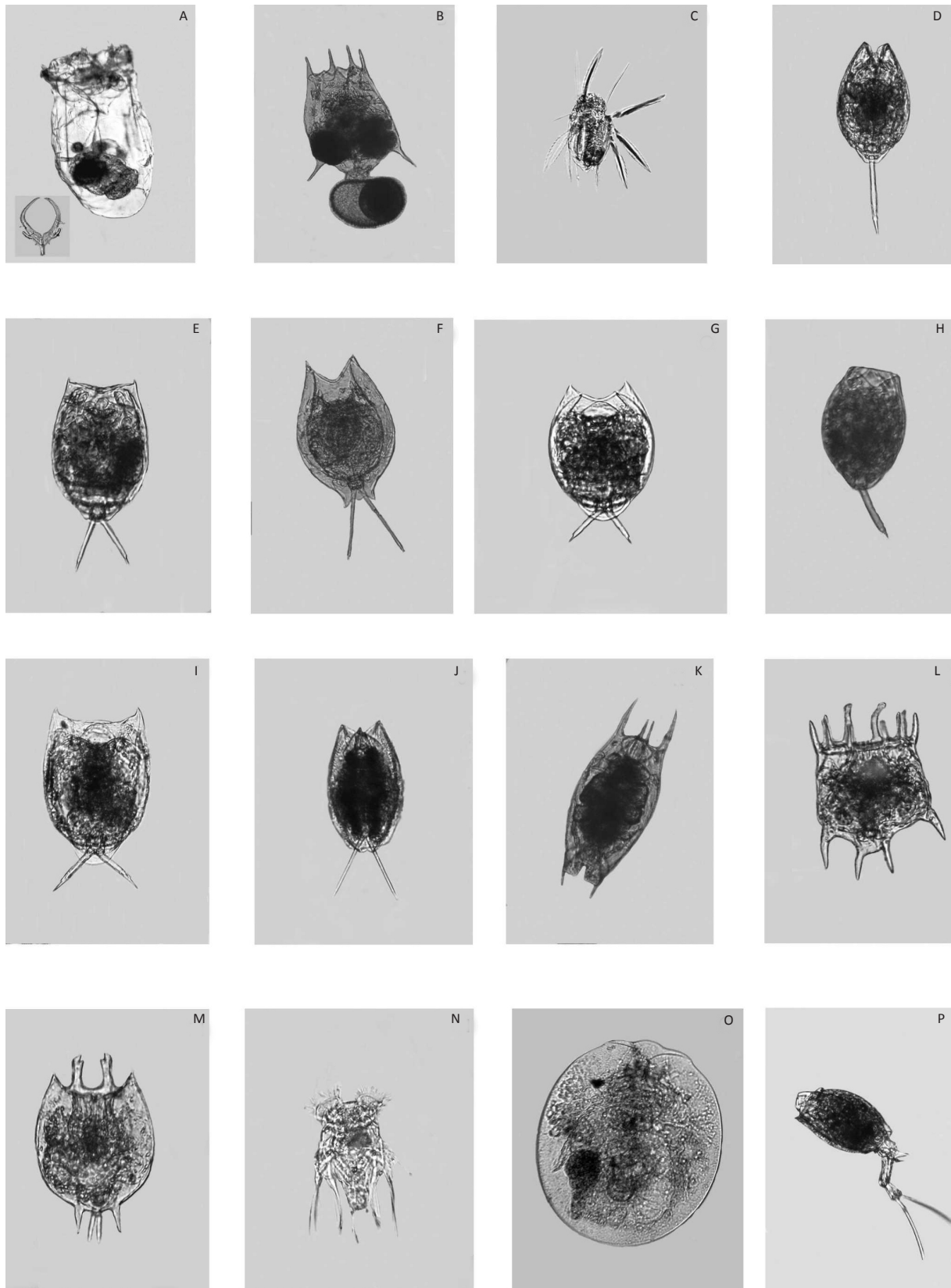


Image 3. Representatives of rotifers from the habitat. A - *Asplanchna brightwellii*; B - *Brachionus calyciflorus*; C - *Polyarthra* sp.; D - *Lecane bulla bulla*; E - *Lecane curvicornis*; F - *Lecane leontina*; G - *Lecane luna*; H - *Lecane lunaris*; I - *Lecane unguolata*; J - *Mytilina trigona*; K - *Mytilina ventralis ventralis*; L - *Plationus patulus patulus*; M - *Platygaster quadricornis quadricornis*; N - *Hexarthra* sp.; O - *Testudinella patina*; P - *Trichotria tetractis*. © A.I. Vanjare.

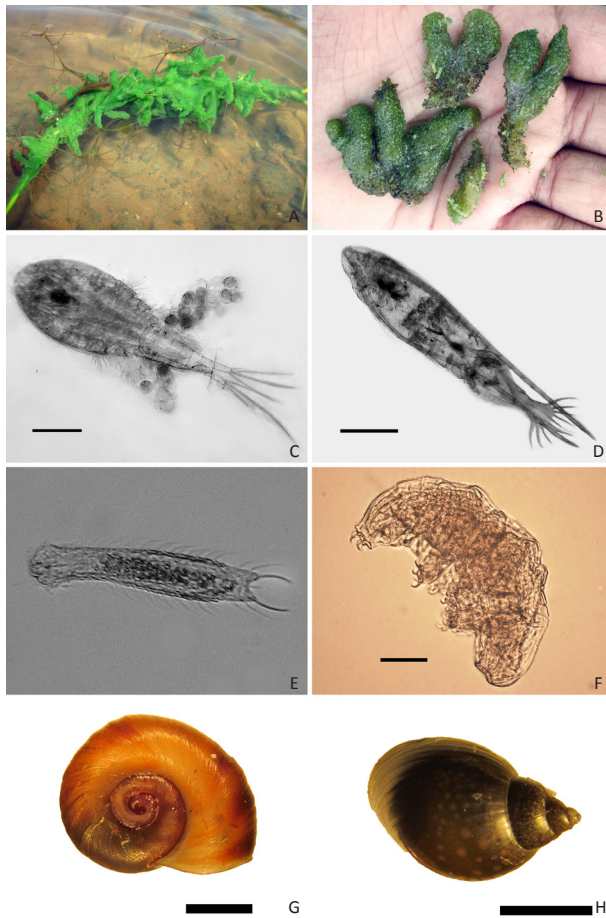


Image 4. A–B - Freshwater sponges, *Radiospongilla cerebellata* and *Dosilia plumosa*, respectively; C–D - Freshwater copepods, Cyclopoid (*Mesocyclops* sp., female) and Calanoid (*Heliodyptomus cinctus*, female); E - Gastrotricha (*Chaetonotus* cf. *similis*); F - Tardigrade; G - *Indoplanorbis* sp.; H - *Lymnaea luteola*. Scales = C & D = 200µm; F = 50µm; G & H = 5mm. © A–B - S.S. Jakhalekar; C,D,F–H - M.R. Kulkarni; E - Y.S. Shinde.

The calanoid, *Heliodyptomus cinctus* (Gurney, 1907) occurs commonly in the region (Reddy 1994; M. Kulkarni unpublished data), however, *Thermocyclops* sp. has been observed for the first time in Pune (Images 4 C–D).

Branchiopoda: *Leptestheria nobilis* (Sars, 1900) (Branchiopoda: Spinicaudata) was seen during the monsoon season. This species is an Indian endemic commonly known from Western Maharashtra (Padhye et al. 2015). All the Cladocera found in the study were circumtropical in distribution. *Latonopsis australis* Sars, 1888 sensu lato and *Moina micrura* Kurz, 1874 sensu lato represent species groups with a number of cryptic species (Chatterjee et al. 2013; Petrussek et al. 2004). *Karualona* cf. *karua* (King, 1853) may also represent a separate species but further detailed taxonomic study is needed (Images 6 A–I).

Table 3. Faunistic overview.

Taxon	Species
Porifera	3
Bryozoa	1
Rotifera	45
Gastrotricha	1
Arthropoda	83
Mollusca	2
Chordata (Vertebrata)	17
Total	152

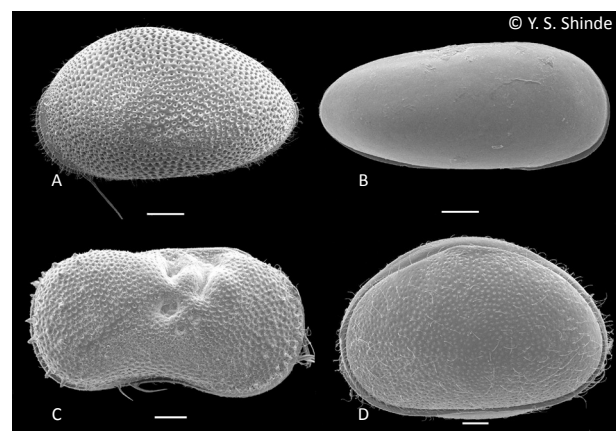


Image 5. Representatives of Ostracoda from the pond. A - *Cypris* sp.; B - *Pseudostrandesia calapanensis*; C - *Ilyocypris dentifera*; D - *Hemicypris pyxidata*; E - *Stenocypris major*; F - *Chrissia formosa*; G - *Cypretta fontinalis*; H - *Plesiocypridopsis dispar*. Scales = A,B,C,D,G,H = 100µm; E,F = 200µm

Insecta

Hemiptera: Heteroptera: The observed species were of oriental distribution, belonging to two infra-orders Nepomorpha and Gerromorpha and nine families namely Belostomatidae, Nepidae, Corixidae, Micronectidae, Pleidae, Notonectidae, Gerridae, Hydrometridae and Veliidae. The occurrence of so many families in a single,

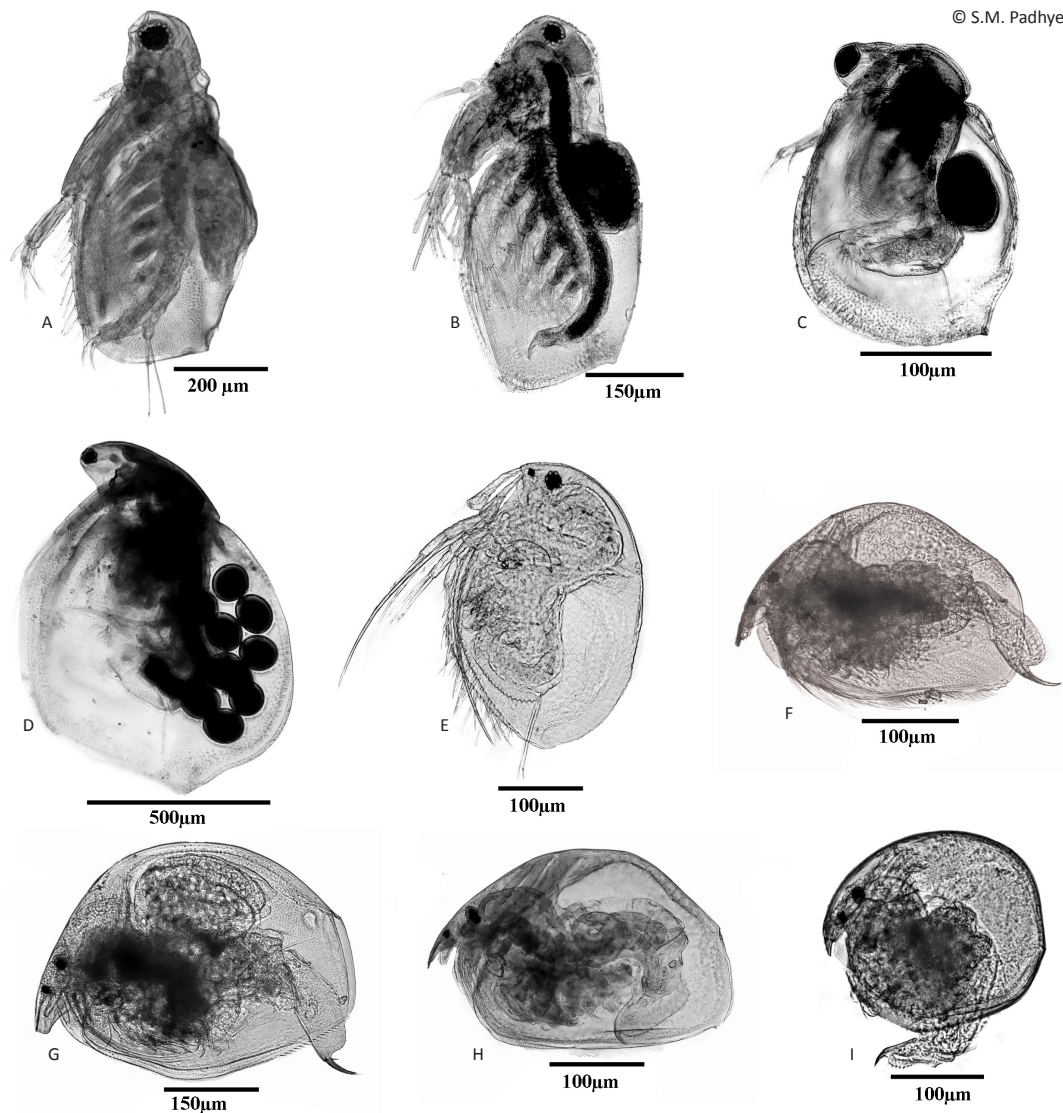


Image 6. Representatives of Cladocera from the pond. A - *Diaphanosoma sarsi*; B - *Latonopsis australis* s. lat.; C - *Ceriodaphnia quadrangula* s. lat.; D - *Simocephalus mixtus*; E - *Macrothrix spinosa*; F - *Karualona* cf. *karua*; G - *Leberis punctatus*; H - *Dunhevedia crassa*; I - *Chydorus parvus*.

relatively small pond habitat, is remarkable (Images 9 A–F).

Coleoptera: Members of the families Dytiscidae, Hydrophilidae, Gyrinidae, Haliplidae and Noteridae, all known from India, were recorded in this habitat (Image 8 A–H). *Canthydrus* sp. (Noteridae) or the burrowing water beetles and *Laccophilus* sp. (Dytiscidae) were particularly abundant. Again, the presence of five different families in such a small pond is remarkable.

Mollusca

Gastropoda: Two species, namely *Indoplanorbis* sp. and *Lymnaea luteola* Lamarck, 1822, were common all over and were breeding profusely. Both species occur commonly in and around Pune area (Image 4 G–H).

Chordata: Vertebrata

Amphibia: Anura: Six common species of anurans were observed (both adults and tadpoles) (Image 11 A–E). All species are widely distributed in India. These are listed in Table 2. Members of the families Bufonidae, Ranidae and Microhylidae were recorded. The *Microhyla ornata* (Dumeril & Bibron, 1841) population was once severely damaged by invasive fish *Gambusia*, released for mosquito control (see discussion), but it was possible to see this frog again as the fishes have all gone during the dry phase.

Reptilia: Serpentes: A single species, Checkered Keelback *Xenocrophis piscator* (Schneider, 1799) was noted occasionally.



Image 7. Odonates from the pond.
 A - *Acisoma panorpoides*; B - *Brachythemis contaminata*;
 C - *Bradinopyga geminata*; D - *Ictinogomphus rapax*; E -
Crocothemis servilia. © A.S. Kulkarni.

Chelonia: Soft-shelled Turtles were observed basking in the middle of the pond but were never caught and identified.

Aves

Locally migrating birds like Spot-billed Duck *Anas poecilorhyncha* Forster, 1781, Dabbling Duck *Tachybaptus ruficollis* (Pallas, 1764) and Little Cormorant *Phalacrocorax niger* (Vieillot, 1817) were observed. The nesting of dabbling ducks, Indian Moorhen *Amaurornis phoenicurus* (Pennant, 1766) was also observed (Images 12 A–I).

DISCUSSION

Importance of study

This study is one of the few multi-taxa surveys of temporary pond fauna in India. In fact, such water bodies are neglected, in recent years, by biologists and abused by the public at large. There are scattered reports of aquatic fauna in recent years, but these have mostly focussed on permanent water bodies (e.g. Deepa & Rao

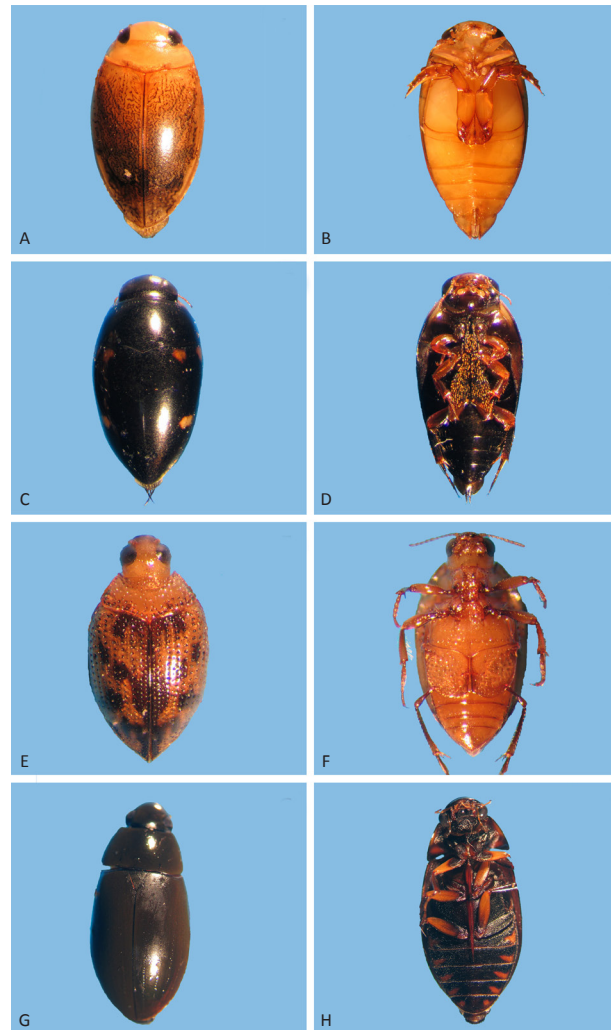


Image 8. Representatives of aquatic Coleoptera from the pond.
 A,B - *Laccophilus flexosus*, DV & VV.; C,D - *Canthyrus luctuosus*, DV & VV.; E,F - *Haliphus arrowi*, DV & VV.; G,H - *Sternolophus* sp. DV & VV. © H.V. Ghate and S.D. Sheth.

2007; Thakare & Zade 2011; Takhelmayum & Gupta 2011; Sehgal et al. 2013). Thus, although ubiquitous and found in large numbers in suitable places, 'the pond' is overlooked and understudied. We have attempted to fill this lacuna about pond fauna, and have sampled less studied taxa. In spite of excluding some other species rich taxa (like Protozoa - in classical sense and larval Diptera, nymphal Odonata, etc.), we have documented over 150 species from this small water body, which is a considerably large number.

This inventory also includes many taxa that have been neglected for decades in our area. For example freshwater sponges, in spite of a small number of species found in India, have not been studied in detail



Image 9. Representatives of aquatic Heteroptera from the pond.
 A - *Diplonychus rusticus*; B - *Agraptacorixa hyalinipennis*;
 C - *Anisops barbatus*; D - *Enithares ciliata*; E - *Ranatra filiformis*;
 F - *Tenagogenus fluviorum*. © H.V. Ghate and S.V. Paripatyadar

and the biology of these organisms is poorly known; even morphological data using scanning electron microscopy, at least for some species, became available only recently (Jakhalekar & Ghate 2013). Freshwater Bryozoa are being intensively investigated elsewhere but we found hardly any detailed studies from India in recent years, other than the classic work of Annandale (1911). Aquatic beetles are quite diverse (and this small pond has representative of all the known families found in India!) and form an important group as scavengers and predators in the aquatic ecosystem; but no serious taxonomical or biological work has been done in Maharashtra since the pioneering work by Vazirani (1968, 1970a,b, 1984) and Tonapi & Ozarkar (1969a,b). The same is true of aquatic Heteroptera or true bugs. Two spider species, *Cyclosa hexatuberculata* and *Runcinia roonwali* were described from Pune (the latter from a locality very close to University campus) (Tikader 1980, 1982), however, both species have remained

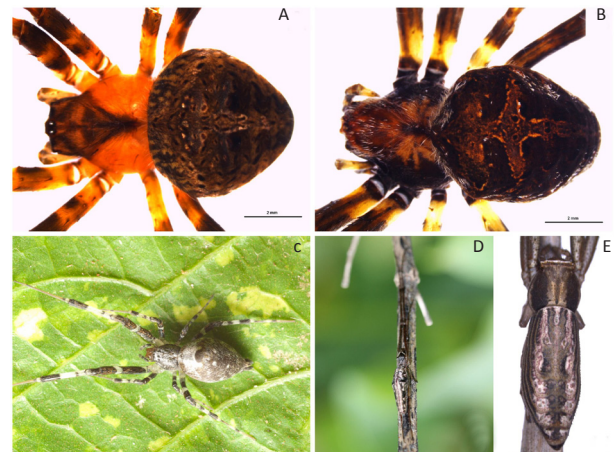


Image 10. Representatives of spiders from the pond.
 A - *Neoscona mokerjei*; B - *Neoscona nautica*; C - *Zosis geniculata*;
 D - *Tetragnatha* sp.; E - *Runcinia roonwali*. © S.S. Kulkarni



Image 11. Amphibians from the habitat.
 A - *Duttaphrynus melanostictus* mating pair in amplexus; B - *Euphlyctis cyanophlyctis*; C - *Zakerana* sp.; D - *Microhyla ornata*; E - *Hoplobatrachus tigerinus*. © A, C-E - S.S. Jakhalekar; B - K. Bhakare

unstudied for a long period.

Crustacea, especially Branchiopoda, found in such temporary water bodies are equally neglected. One of the authors (SP) has completed a survey of many such water bodies in and around Pune (Padhye 2013). Further work in this regard led to the discovery of two



Image 12. Birds from the pond.

A - *Egretta garzetta*; B - *Vanellus indicus*; C - *Halcyon smyrnensis*; D - *Anas poecilorhyncha*; E - *Tachybaptus ruficollis*; F - *Motacilla cinerea*; G - *Ardeola grayii*; H - *Alcedo atthis*; I - *Ceryle rudis*. © S.S. Jakhalekar.

new species: (1) *Streptocephalus sahyadriensis* Rogers & Padhye, 2014; (2) *Moina hemanti* Padhye & Dumont, 2014, of which the latter's type locality is situated on the university campus itself (Rogers & Padhye 2014; Padhye & Dumont 2014). This shows that an extensive survey of entire Maharashtra and other regions of Western Ghats may reveal as yet unknown species and also highlights the fact that the crustacean fauna is not properly known (for example, see Padhye & Dumont 2015; Padhye et al. 2015 - Branchiopods).

Rotifer and ostracod fauna of Pune and its environs has also been investigated by some of us in detail, with many surprising finds as well (Vanjare & Pai 2013; Shinde 2012).

This pond, as the results show, harbours species with

varying ecological roles ranging from primary producers (diatoms, algae not identified here) and various consumers (insects, tadpoles and birds). This diversity indicates a fully functional and healthy aquatic ecosystem. The animal taxa observed occupy various feeding niches and modes. There are also some noteworthy endemics and some are being reported for the first time from Maharashtra. It is evident that the habitat has a chemical composition suitable for establishment and growth of taxa like sponges, ostracods and molluscs, which require proper pH as well as certain minerals like silica and calcium in good proportion. There is a trend observed in zooplankton appearance. The conditions are hypoxic soon after inundation (with rainwater), and animals like chironomid larvae, mosquito larvae, *Moina*

micrura, *Thermocyclops* sp. are observed as 'blooms'. These disappear in a few days following which there is a growth of aquatic vegetation and subsequent increase in the dissolved oxygen content. The other physico-chemical parameters also change during this phase.

The presence of large numbers of chironomid larvae and blooms of rotifers initially indicate the presence of substantial biodegradable matter in the early phase.

The lack of such multi-taxa studies from other parts of Maharashtra limits comparative analysis. Some studies have been carried out in India, but they are mostly focussed on a single group of organisms, like macrophytes (Mukhopadhyay & Dewanji 2005), phytoplankton (Muthukumar et al. 2007; Santhala et al. 2009), zooplankton (Kiran et al. 2007) and molluscs (Garg et al. 2009). A multi-taxa study is really important, as it better reflects the status of the ecosystem.

Studies on pond ecosystems have been used elsewhere (United Kingdom) to identify "indicator taxa" (Briers & Biggs 2003) that can help rapid assessment of the health of ponds. There is a need to perform similar analyses for this pond in future.

Anthropogenic threats to aquatic habitats occur in various forms such as destruction of habitat due to industrialization and concomitant urbanization, pollution, destruction of biota via proliferation of introduced exotics, etc. (Brendonck et al. 2008; Molur et al. 2011). Exotic fishes like *Gambusia* pose a serious threat to the aquatic fauna as these were earlier found to predate on *Microhyla* tadpoles in the same habitat (Ghate & Padhye 1988).

Conservation suggestions

This is an important pond ecosystem and it can be used in teaching the basic principles of ecology and biodiversity and hence must be protected and maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was used as a temporary laboratory for demonstration of various aquatic organisms. We wish this practice becomes more regular so that the habitat will be well looked after.

The ecological and biological importance of such water bodies is now being revealed and de Meester et al. (2005) have listed the importance of ponds as model systems for studies on various aspects of ecology, evolutionary biology and conservation biology, which can be taken up for research purposes.

We did these surveys for fauna because proper documentation of faunal resources from temporary water bodies may help in developing strategies for

conservation of these important habitats. Similar surveys have been carried out in the United Kingdom on a large scale (National Ponds Survey 1989) (cited in Biggs et al. 2005) and we need to take a leaf out of their books.

REFERENCES

- Alvarez-Padilla, F. & G. Hormiga (2011). Morphological and phylogenetic atlas of the orb-weaving spider family Tetragnathidae (Araneae: Araneoidea). *Zoological Journal of Linnean Society* 162: 713–879.
- Anderson, N.M., C.M. Yang & H. Zettel (2005). Guide to the aquatic Heteroptera of Singapore and Peninsular Malaysia. 2. Veliidae. *The Raffles Bulletin of Zoology* 50(1): 231–249.
- Annandale, N. (1911). *The Fauna of British India, including Ceylon and Burma. Freshwater Sponges, Hydroids and Polyzoa*. Taylor and Francis, London, 251pp.
- Anonymous (1992). *Standard Methods for the Examination of Water and Wastewater*, APHA-AWWA-WEF, 18th Edition (1992), Method 4500-O.
- Berner, D. (1985). Morphological differentiation among species in the *Ceriodaphnia cornuta* complex (Crustacea, Cladocera). *Verhandlungen der Internationalen Vereinigung fuer Theoretische und Angewandte Limnologie* 22: 3099–3103.
- Biggs, J., P. Williams, M. Whitfield, P. Nicolet & A. Weatherby (2005). Fifteen years of pond assessment in Britain: results and lessons learned from the work of pond conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems* 15: 693–714.
- Biström, O. (1982). A revision of the genus *Hyphydrus* Illiger (Coleoptera, Dytiscidae). *Acta Zoologica Fennica* 165: 1–121.
- Blaustein, L. & S.S. Schwartz (2001). Why study ecology in temporary pools? *Israel Journal of Zoology* 47(4): 303–312.
- Boix, D., J. Sala & R. Moreno-Amich (2001). The Faunal Composition of Espolla Pond (Ne Iberian Peninsula): The Neglected Biodiversity of Temporary Waters. *Wetlands* 21(4): 577–592.
- Brancucci, M.P. (1983). Révision des espèces es t-paléar étiques, orientales et australiennes du genre *Laccophilus* (Coleoptera: Dytiscidae). *Entomologische Arbeiten aus dem Museum G. Frey* 31/32: 241–426.
- Brendonck, L., D.C. Rogers, J. Olesen, S. Weeks & W.R. Hoeh (2008). Global diversity of large branchiopods (Crustacea: Branchiopoda) in freshwater. *Hydrobiologia* 595: 167–176.
- Briers, R.A. & J. Biggs (2003). Indicator taxa for the conservation of pond invertebrate diversity. *Aquatic Conservation: Marine and Freshwater Ecosystems*.13: 323–330.
- Brooks, G.T. (1951). A revision of Genus *Anisops* (Notonectidae, Hemiptera). *University of Kansas Science Bulletin* 34(1): 301–519.
- Cereghino, R., J. Biggs, S. Declerck & B. Oertli (2008). The ecology of European ponds: defining the characteristics of a neglected freshwater habitat. *Hydrobiologia* 597: 1–6.
- Chatterjee, T., A. Kotov, K. van Damme, S.V.A. Chandrasekhar & S. Padhye (2013). An annotated checklist of the Cladocera (Crustacea: Branchiopoda) from India. *Zootaxa* 3667: 89.
- Chen, L.C. (1960). A Study of the Genus *Micronecta* of India, Japan, Taiwan and Adjacent Regions (Heteroptera: Corixidae). *Journal of the Kansas Entomological Society* 33(3): 99–118.
- Cheng, L., M.Y. Chang & J.T. Polhemus (2001). Guide to the aquatic Heteroptera of Singapore and Peninsular Malaysia Introduction and key to families. *The Raffles Bulletin of Zoology* 49: 121–127.
- Cheng, L. & C.H. Fernando (1969). Taxonomic study of the Malayan Gerridae (Hemiptera: Heteroptera) with notes on their biology and distribution. *Oriental Insects* 3(2): 97–160.
- Daniels, R.J.R. (1997a). A field guide to the frogs and toads of the Western Ghats of India. Part I. *Cobra* 27: 1–25.
- Daniels, R.J.R. (1997b). A field guide to the frogs and toads of the

- Western Ghats of India. Part II. *Cobra* 28: 1–24.
- Daniels, R.J.R. (1997c)**. A field guide to the frogs and toads of the Western Ghats of India. Part III. *Cobra* 29: 1–13.
- de Meester, L., S. Declerck, R. Stoks, G. Louette, F. van de Meutter, T. de Bie, E. Michels & L. Brendonck (2005)**. Ponds and pools as model systems in conservation biology, ecology and evolutionary biology. *Aquatic Conservation: Marine and Freshwater Ecosystems* 15: 715–725.
- Deepa, J. & C. A. N. Rao (2007)**. Aquatic Hemiptera of Pocharam lake, Andhra Pradesh. *Zoos' Print Journal* 22(12): 2937–2939; <http://dx.doi.org/10.11609/JoTT.ZPJ.1599.2937-9>
- Dumont, H.J. & M. Silva-Briano (2000)**. *Karuolona* n. gen. (Anomopoda: Chydoridae), with a description of two new species, and a key to all known species. *Hydrobiologia* 435: 61–82.
- Dussart, B. & D. Defaye (2001)**. Introduction to the Copepoda, In: Dumont, H.J. (ed.). *Guides to the Identification of Microinvertebrates of the Continental Waters of the World - 2nd Edition*. Backhuys Publications, Lieden, 200+pp.
- Fraser, F.C. (1933)**. *The Fauna of British India including Ceylon and Burma. Odonata Vol. I*. Taylor and Francis Ltd., London, 423pp.
- Fraser, F.C. (1934)**. *The Fauna of British India including Ceylon and Burma. Odonata Vol. II*. Taylor and Francis Ltd., London, 398pp.
- Fraser, F.C. (1936)**. *The Fauna of British India including Ceylon and Burma. Odonata Vol. III*. Taylor and Francis Ltd., London, 461pp.
- Gajbe, U.A. (2008)**. *Fauna of India and the Adjacent Countries: Spiders (Arachnida: Araneae: Oxyopidae)*. Zoological Survey of India, Kolkata, 117pp.
- Garg, R.K., R.J. Rao & D.N. Saksena (2009)**. Correlation of molluscan diversity with physicochemical characteristics of water of Ramsagar reservoir, India. *International Journal of Biodiversity and Conservation* 1(6): 202–207.
- Ghate, H.V. & A.D. Padhye (1988)**. Predation of *Microhyla* tadpoles by *Gambusia*. *Journal of the Bombay Natural History Society* 85: 200–201.
- Goulden, C.E. (1968)**. The systematics and evolution of the Moinidae. *Transactions of the American Philosophical Society* 58: 101.
- Grimmett, R., C. Inskipp & T. Inskipp (1999)**. *Pocket Guide to the Birds of the Indian Subcontinent*. Oxford University Press, 480pp.
- Gururaja, K.V. (2012)**. *Pictorial Guide to Frogs and Toads of the Western Ghats*. Gubbi Labs Publication, xviii+154pp.
- Holynska, M., I. Mirabdullayev, J. W. Reid & H. Ueda (2003)**. Copepoda: Cyclopoida. Genera Mesocyclops and Thermocyclops. In: Ueda, H. & J.W. Reid (eds.). *Guides to the Identification of Microinvertebrates of the Continental Waters of the World*. Backhuys Publications, Lieden, 317pp.
- Jakhalekar, S. (2012)**. Report of a Freshwater Bryozoa *Asajirella gelatinosa* from Pune. *Ela Journal* 1(3): 11.
- Jakhalekar, S.S. & H.V. Ghate (2013)**. A note on five freshwater sponges (Porifera: Spongillina: Spongillidae) from Pune, Maharashtra, India. *Journal of Threatened Taxa* 5(9): 4392–4403; <http://dx.doi.org/10.11609/JoTT.o3356.4392-403>
- Jose, K.S., P.A. Sebastian, S. Davis & A.P. Varghese (2003)**. First record of *Thalassius albocinctus* (Doleschall) (Araneae: Pisauridae) from India. *Entomon* 28: 309–314.
- Kiran, B.R., E.T. Puttaiah & D. Kamath (2007)**. Diversity and fluctuation of zooplankton in fish pond of Bhadra fish pond, Karnataka. *Zoos' Print Journal* 22(12): 2935–2936; <http://dx.doi.org/10.11609/JoTT.ZPJ.1464.2935-6>
- Komarek, A. (2003)**. Hydrophilidae: I. Check list and key to Palearctic and Oriental genera of aquatic Hydrophilidae (Coleoptera), pp. 383–395. In: Jäch, M.A. & L. Ji (eds.). *Water Beetles of China, Vol. III*. Wien: Zoologisch-Botanische Gesellschaft in Österreich and Wiener Coleopterologenverein.
- Korovchinsky, N.M. (1992)**. Sididae & Holopediidae, pp. 1–82. In: Dumont H. J. (ed.). *Guides to the identification of the Microinvertebrates of the Continental Waters of the World* 3, SPB Academic Publishing, The Hague.
- Koste, W. (1978)**. *Rotatoria*. Die Rädertiere Mitteleuropas, begründet von Max Voigt. Überordnung Monogononta. Gebrüder Borntraeger, Berlin, Stuttgart. I. Text U. II. Tafelbd. (T. 234), 673pp.
- Lansbury, I. (1968)**. The Enithares (Hemiptera-Heteroptera-Notonectidae) of the Oriental Region. *Pacific Insects* 10(2): 353–442.
- Michael, R.G. & B.K. Sharma (1988)**. *Fauna of India and adjacent countries. Indian Cladocera (Crustacea: Branchiopoda: Cladocera)*. Zoological Survey of India, Kolkata, 262pp.
- Molur, S., K.G. Smith, B.A. Daniel & W.R.T. Darwall (Compilers) (2011)**. *The Status and Distribution of Freshwater Biodiversity in the Western Ghats, India*. Cambridge, UK and Gland, Switzerland: IUCN, and Coimbatore, India: Zoo Outreach Organisation, 116pp.
- Mukhopadhyay, G. & A. Dewanji (2005)**. Presence of tropical hydrophytes in relation to limnological parameters - a study of two freshwater ponds in Kolkata, India. *Annales de Limnologie* 41(4): 281–289.
- Muthukumar, C., G. Muralitharan, R. Vijayakumar, A.P. Selvam & N. Thajuddin (2007)**. Cyanobacterial biodiversity from different freshwater ponds of Thanjavur, Tamilnadu (India). *Acta Botanica Malacitana* 32: 17–25.
- Nieser, N. (2002)**. Guide to the aquatic Heteroptera of Singapore and Peninsular Malaysia. IV. Corixidae. *The Raffles Bulletin of Zoology* 50(1): 263–274.
- Nieser, N. (2004)**. Guide to the aquatic Heteroptera of Singapore and Peninsular Malaysia. III. Pleidae and Notonectidae. *The Raffles Bulletin of Zoology* 52(1): 79–96.
- Nieser, N., H. Zettel & P.P. Chen (2009)**. Notes on *Laccotrephes* Stål, 1866 with the description of a new species of the *L. griseus* group (Insecta: Heteroptera: Nepidae). *Annalen des Naturhistorischen Museums in Wien, B* (110): 11–20.
- Orlova-Bienkowskaja, M.Y. (2001)**. Daphniidae: Genus *Simocephalus*. In: Dumont H.J. (ed.). *Guides to the Identification of the Microinvertebrates of the Continental Waters of the World* 17. Backhuys Publishers, Lieden, 130pp.
- Padhye, S.M. (2013)**. Ecology and biodiversity of branchiopods with special reference to cladocerans from Pune region. PhD Thesis, Savitribai Phule Pune University, Pune, 344 pp.
- Padhye, S., N. Rabet & H.V. Ghate (2015)**. First faunal inventory of large branchiopods (Crustacea: Branchiopoda) of Western Maharashtra, India with taxonomical and distributional comments. *Zootaxa* 3904(2): 208–222.
- Padhye, S.M. & H.J. Dumont (2014)**. *Moina hemanti* n. sp., a new species of the genus *Moina* s.l. (Branchiopoda: Anomopoda) from Pune, India. *Zootaxa* 3860 (6): 561–570.
- Padhye, S.M. & H.J. Dumont (2015)**. Species richness of Cladocera (Crustacea: Branchiopoda) in the Western Ghats of Maharashtra and Goa (India), with biogeographical comments. *Journal of Limnology* 74(1): 182–191.
- Pederzani, F. (1995)**. Keys to the identification of the genera and subgenera of adult Dytiscidae (*sensu lato*) of the world (Coleoptera: Dytiscidae) *Atti Accademia roveretana Agiati*, a 244 (1994), ser VII, vol. IV, B:5–83.
- Penney, J.T. & A.A. Racek (1968)**. Comprehensive revision of a worldwide collection of freshwater sponges (Porifera: Spongillidae). Bulletin of U.S. National Museum, No. 272, 184pp.
- Petrusek, A., M. Černý & E. Audenaert (2004)**. Large intercontinental differentiation of *Moina micrura* (Crustacea: Anomopoda): one less cosmopolitan cladoceran. *Hydrobiologia* 526: 3–81.
- Polhemus, D.A. & J.T. Polhemus (2013)**. Guide to the aquatic Heteroptera of Singapore and Peninsular Malaysia. X. Infraorder Nepomorpha - Families Belostomatidae and Nepidae. *The Raffles Bulletin of Zoology* 61(1): 25–45 .
- Rao, N.V.S. (1989)**. *Handbook of Freshwater Molluscs of India*. Zoological Survey of India, Kolkata, 289pp.
- Reddy, Y.R. (1994)**. *Copepods: Calanoida: Diaptomidae*. SPB Academic Publishing, The Hague, Netherlands. 227pp.
- Rogers, D.C. & S.M. Padhye (2014)**. A new species of *Streptocephalus* (Crustacea: Anostraca: Streptocephalidae) from the Western Ghats, India, with a key to the Asian species. *Zootaxa* 3802: 75–84.
- Santhala, M., S.P. Hosmani & B.B. Hosetti (2009)**. Diversity of phytoplankton in a waste stabilization pond at Shimoga Town,

- Karnataka State, India. *Environmental Monitoring and Assessment* 151:437–443; <http://dx.doi.org/10.1007/s10661-008-0287-5>
- Savatenalinton, S. & K. Martens (2009).** Generic revision of Cypricerinae McKenzie, 1971 (Crustacea, Ostracoda), with the description of three new genera and one new species and a phylogenetic analysis of the subfamily. *Hydrobiologia* 638: 1–48.
- Savatenalinton, S. & K. Martens (2010).** On the subfamily Cypricerinae McKenzie, 1971 (Crustacea, Ostracoda) from Thailand, with description of six new species. *Zootaxa* 2379: 1–77.
- Schödl, S. (1992).** In Revision Gattung der *Berosus* Leach 2. Teil: Die orientalischen Arten der untergattung *Enoplurus* (Coleoptera:Hydrophilidae). *Koleopterologische Rundschau-Wien* 64: 137–164.
- Segers, H. (2002).** The nomenclature of the Rotifera: annotated checklist of valid family and genus-group names. *Journal of Natural History* 36: 631–640.
- Segers, H. (2007).** Annotated checklist of the rotifers (Phylum Rotifera), with notes on nomenclature, taxonomy and distribution. *Zootaxa*: 1564.
- Sehgal, K., G.G. Phadke, S.K. Chakraborty & S.V.K. Reddy (2013).** Studies on Zooplakton diversity of Dimbhe reservoir, Maharashtra, India. *Advances in Applied Science Research* 4(1): 417–420.
- Shinde, Y.S.(2012).** Studies on freshwater Ostracoda (Crustacea) of Pune district, Maharashtra. PhD Thesis, Department of Zoology, University of Pune, 304pp.
- Sinev, A.Y., K. van Damme & A.A. Kotov (2005).** Re-description of tropical-temperate cladocerans *Alona diaphana* King, 1853 and *Alona davidi* Richard, 1895 and their translocation to *Leberis* (Branchiopoda: Anomopoda: Chydoridae). *Arthropoda Selecta* 14(3): 183–205.
- Smirnov, N.N. (1971).** *Chydoridae fauny mira. Fauna USSR.* Rakoobraznie, 1, Leningrad, 531pp.
- Smirnov, N.N. (1992).** The Macrothricidae of the World. In: Dumont, H.J. (ed.). *Guides to the Identification of the Microinvertebrates of the Continental Waters of the World.* SPB Academic Publishers, The Hague, 143pp.
- Smirnov, N.N. (1996).** Cladocera: the Chydorinae and Sayciinae (Chydoridae) of the world, In: Dumont, H.J. (ed.). *Guides to the Identification of the Microinvertebrates of the Continental Waters of the World*, 11. SPB Academic Publishers, The Hague, 197pp.
- Smith, M.A. (1943).** *Fauna of British India including Ceylon and Burma. Reptila and Amphibia, Vol. III Serpentes.* Today and Tomorrow's Printers & Publishers, New Delhi, Indian Reprint (1981), 583pp.
- Subramanian, K.A. (2009).** *Damselflies and Dragonflies of Peninsular India - A Field Guide.* Vigyan Prasara, Department of Science and Technology, India, 118pp.
- Takhelmayum, K. & S. Gupta (2011).** Distribution of aquatic insects in phumdis of Loktak lake, Manipur, North-eastern India. *Journal of Threatened Taxa* 3(6): 1856–1861.
- Tanikawa, A. (1999).** Japanese spiders of the genus *Eriovixia* (Araneae: Araneidae). *Acta Arachnologica, Tokyo* 48: 41–48.
- Thakare V.G. & V.S. Zade (2011).** Diversity, Abundance and Species Composition of Water Beetles (Coleoptera: Dytiscidae, Hydrophilidae and Gyrinidae) in Kolkas Region of Melghat Tiger Reserve, Central India. *Academic Journal of Entomology* 4 (2): 64–71.
- Thirumalai, G. (1994).** Aquatic and Semi-aquatic Hemiptera (Insecta) of Tamilnadu - I Dharmapuri and Pudukkottai Districts. *Records of the Zoological Survey of India*, Occasional Paper No. 165, 45pp.
- Tikader, B.K. (1980).** Thomisidae (Crab-spiders). *Fauna of India (Araneae)*, Zoological Survey of India 1: 1–247.
- Tikader, B.K. (1982).** Family Araneidae (=Argiopidae), typical orbweavers. *Fauna of India (Araneae)*. *Zoological Survey of India* 2: 1–293.
- Tonapi, G.T. & G. Varghese (1983).** Preliminary observations on the bioecology of the Ectoproct - *Pectinatella burmanica* Annandale. *Current Science* 52(13): 646–647.
- Tonapi, G.T. & V.A. Ozarkar (1969a).** A Study on the Aquatic Coleoptera of Poona (Maharashtra). *Journal of Bombay Natural History Society* 66(2): 310–316.
- Tonapi, G.T. & V.A. Ozarkar (1969b).** A study on the Aquatic Coleoptera of Poona (Maharashtra). *Journal of the Bombay Natural History Society* 66(3): 533–538.
- Vanjare, A.I. (2011).** Biodiversity studies of freshwater Rotifera in lentic and lotic water bodies from Pune, Maharashtra. PhD Thesis, Department of Zoology, University of Pune, 145pp.
- Vanjare, A. & K. Pai (2010).** Rotifers from University of Pune (India), with record of *Ptygura pedunculata* (Edmondson, 1939) (Rotifera: Monogononta) from Oriental region. *Turkish Journal of Zoology* 34: 417–419.
- Vanjare, A. & K. Pai (2013).** Ecology of freshwater Rotifera in a seasonal pond in the University of Pune (Maharashtra, India). *Applied Ecology and Environmental Research* 11(4): 525–539.
- Vazirani, T.G. (1968).** Aquatic insects, In: Contribution to the study of aquatic beetles (Coleoptera) 2. A Review of the Subfamilies Noterinae, Laccophilinae, Dytiscinae and Hydroporinae (in part) from India. *Oriental Insects* 2(3–4): 221–341.
- Vazirani, T.G. (1970a).** Aquatic insects, In: Contribution to the study of aquatic beetles (Coleoptera) V. A review of Hydroporinae: Dytiscidae (in part), from India. *Oriental Insects* 4(1): 93–129.
- Vazirani, T.G. (1970b).** Contributions to the study of aquatic beetles (Coleoptera) VII. A revision of Indian Colymbetinae (Dytiscidae). *Oriental Insects* 4: 303–362.
- Vazirani, T.G. (1984).** *The fauna of India: Coleoptera. Family Gyrinidae and Family Haliplidae.* Zoological Survey of India, Kolkata, 140pp.
- Victor, R. & C.H. Fernando (1979).** Freshwater ostracods (Ostracoda: Crustacea) of India. *Records of Zoological Survey of India* 74: 147–242.
- Vondel, B.J. van (1998).** Additional notes on the Haliplidae of China and neighbouring countries (Coleoptera), pp. 131–136. In: Jäch, M.A. & L. Ji (eds.). *Water Beetles of China Vol. II. - Wien: Zoologisch-Botanische Gesellschaft in Österreich and Wiener Coleopterologenverein.*
- Vondel, B.J. van (2011).** Annotated catalogue of the Haliplidae of China with the description of a new species and new records from China (Coleoptera, Adephaga). *ZooKeys* 133: 1–17.
- Wiggins, G.B., R.J. Mackay & I.M. Smith (1980).** Evolutionary and ecological strategies of animals in annual temporary pools. *Archiv fuer Hydrobiologie Supplement* 58: 97–206.
- Williams, D.D. (2006).** *The Biology of Temporary Waters.* Oxford University Press, New York, 337pp.
- Williams, P., M. Whitfield, J. Biggs, S. Bray, G. Fox, P. Nicolet & D.A. Sear (2004).** Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England. *Biological Conservation* 115: 329–341.
- Wyngaard, G.A., B.E. Taylor & D.L. Mahoney (1991).** Emergence and dynamics of cyclopoid copepods in an un-predictable environment. *Freshwater Biology* 25: 219–232.
- Yang, C.M. & H. Zettel (2005).** Guide to the aquatic Heteroptera of Singapore and Peninsular Malaysia. V. Hydrometridae. *The Raffles Bulletin of Zoology* 53(1): 79–97.
- Yoshida, H. (2009).** Uloboridae, Theridiidae, Ctenidae, pp. 142–147, 356–393, 467–468, In: Ono, H. (ed.). *The Spiders of Japan with Keys to the Families and Genera and Illustrations of the Species.* Tokai University Press, Kanagawa.

Appendix 1. Taxon-wise list of references used for identification.

Taxon	References
Porifera & Bryozoa	Annandale 1911
Rotifera	Koste 1978 Segers 2002 Segers 2007
Cladocera	Berner 1985 Dumont & Silva-Briano 2000 Goulden 1968 Korovchinsky 1992 Michael & Sharma 1988 Orlova-Bienkowskaja 2001 Sinev et al. 2005 Smirnov 1971, 1992, 1996
Copepoda	Dussart & Defaye 2001 Ranga Reddy 1994 Holyńska et al. 2003
Ostracoda	Savatenalinton & Martens 2009 Savatenalinton & Martens 2010 Victor & Fernando 1979a
Mollusca	Subba Rao 1989
Coleoptera	Biström 1982 Brancucci 1983 Komarek 2003 Pederzani 1995 Schödl 1992 Vazirani 1968 Vazirani 1970a,b Vazirani 1984 Vondel 1998 2011
Hemiptera	Anderson et al. 2005 Brooks 1951 Chen 1960 Cheng & Fernando 1969 Cheng et al. 2001 Lansbury 1968 Nieser 2002, 2004 Nieser et al. 2009 Polhemus & Polhemus 2013 Thirumalai 1994 Yang & Zettel 2005
Odonata	Fraser 1933 Fraser 1934 Fraser 1936 Subramanian 2009
Arachnida	Alvarez-Padilla & Hormiga 2011 Gajbe 2008 Jose et al. 2003 Tanikawa 1999a Tikader 1980 Tikader 1982 Yoshida 2009
Amphibia	Daniels 1997 I-III Gururaja 2012
Reptilia	Smith 1943
Aves	Grimett et al. 1999



Author Details: MIHIR R. KULKARNI is a PhD student at the Department of Zoology, Savitribai Phule Pune University, Pune. He studies diversity and ecology of freshwater Diptomidae (Copepoda) from the Western Ghats. SAMEER PADHYE is a Research Associate, Wildlife Information Liaison Development Society, Coimbatore. He studies the taxonomy and ecology of branchiopod crustaceans from the Western Ghats. AVINASH ISAAC VANJARE is an Assistant Professor, Department of Zoology, Ahmednagar College. He studies the taxonomy and diversity of Monogonont Rotifera from the Western Ghats. SHRIRAJ S. JAKHALEKAR worked as a Research Student at the Department of Zoology, Modern College, Pune and is now pursuing PhD at the CSIR - National Institute of Oceanography, Dona Paula, Goa. He is interested in studies on sponges. YUGANDHAR SATISH SHINDE is an Assistant Professor, Department of Zoology, Modern College, Pune. He is interested in the taxonomy and diversity of freshwater Ostracoda from the Western Ghats. SHRUTI V. PARIPATYADAR is a PhD student at the Department of Biodiversity, Abasaheb Garware College, Pune. She studies aquatic bugs from the Western Ghats, and has a keen interest in Heteroptera in general. SAYALI D. SHETH is a PhD student at the Department of Biodiversity, Abasaheb Garware College, Pune. She studies the taxonomy and ecology of aquatic beetles from Western Maharashtra. SIDDHARTH KULKARNI is working on taxonomy of Araenomorph spiders. He is a country coordinator for the World Spider Catalog. SAMADHAN K. PHUGE is a Technical Assistant at the Department of Zoology, Savitribai Phule Pune University, Pune. He is keen in studying sexual development and behavioural ecology of frogs and their tadpoles. KALYANI BHAKARE is an MPhil Student at the Department of Zoology, Savitribai Phule Pune University, Pune. She studies diversity of wetland birds and rotifers. ABOLI S. KULKARNI is a PhD student at the Indian Institute of Science, Education and Research, Pune. She is interested in working on taxonomy of Odonata. KALPANA PAI is a Professor at the Department of Zoology, Savitribai Phule Pune University, Pune. She is an immunologist, and is also interested in biodiversity of various aquatic taxa. HEMANT V. GHATE retired as an Associate Professor and Head, Department of Zoology, Modern College, Pune. He is interested in the taxonomy of insects, particularly aquatic beetles and bugs, Cerambycidae as well as pentatomid bugs and mantids. He has also worked on fishes and amphibians from the Western Ghats of India.