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Documenting the fauna of a small temporary pond from Pune, Maharashtra, India

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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.

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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 25m^2-2ha. 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^{0}33'18"N & 73^{0}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; Savatenalinton & 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 Grimett 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* (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).

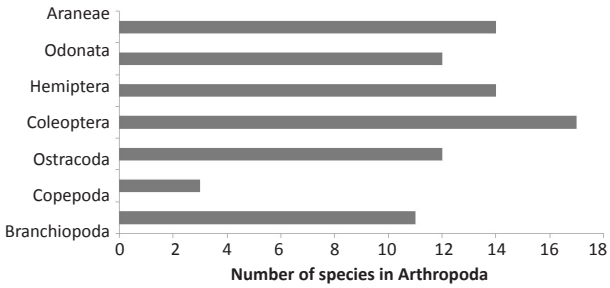

Figure 1. Representation of the Arthropoda

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

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 Cyprididae (10 species), Candonidae (one species) and Ilyocyprididae (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
Spongillina: Spongillidae
Dosilia plumosa (Carter, 1849)
Eunapius carteri (Bowerbank, 1863)
Radiospongilla cerebellata (Bowerbank, 1863)
BRYOZOA
Phylactolaemata: Lophopodidae
Asajirella gelatinosa (Oka, 1891)
ROTIFERA
Asplanchnidae
Asplanchna brightwellii Gosse, 1850
Asplanchnopus hyalinus Harring, 1913
Brachionidae
Anuraeopsis fissa Gosse, 1851
Brachionus calyciflorus Pallas, 1766
Brachionus caudatus Barrois & Daday, 1894
Brachionus quadridentatus Hermann, 1783
Keratella tropica (Apstein, 1907)
Plationus patulus patulus (Müller, 1786)
Platyias quadricornis quadricornis (Ehrenberg, 1832)
Epiphanidae
Cyrtonia tuba (Ehrenberg, 1834)
Epiphanes brachionus spinosa (Rousselet, 1901)
Euchlanidae
Beauchampiella eudactylota (Gosse, 1886)
Euchlanis dilatata dilatata Ehrenberg, 1832
Tripleuchlanis plicata (Levander, 1894)
Gastropodidae
Ascomorpha sp.
Lecanidae
Lecane arcula Harring, 1914
Lecane bulla bulla (Gosse, 1851)
Lecane closterocerca (Schmarda, 1859)
Lecane curvicornis (Murray, 1913)
Lecane hamata (Stokes, 1896)
Lecane hornemanni (Ehrenberg, 1834)
Lecane leontina (Turner, 1892)
Lecane ludwigii (Eckstein, 1883)
Lecane luna (Müller, 1776)
Lecane lunaris (Ehrenberg, 1832)
Lecane ohioensis (Herrick, 1885)
Lecane quadridentata (Ehrenberg, 1830)
Lecane ungulata (Gosse, 1887)
Lecane unguitata (Fadeev, 1925)
Lepadellidae
Colurella sp.
Lepadella (Lepadella) ovalis (Müller, 1786)
Lepadella (Heterolepadella) ehrenbergii (Perty, 1850)
Squatinella lamellaris (Müller, 1786)
Mytilinidae
Mytilina trigona (Gosse, 1851)
Mytilina ventralis ventralis (Ehrenberg, 1830)
Notommatidae
Monomatta sp.
Synchaetidae
Polyarthra vulgaris Carlin, 1943
Trichocercidae
Trichocerca similis similis (Wierzejski, 1893)
Trichocerca rattus (Müller, 1776)
Trichotriidae
Macrochaetus sericus (Thorpe, 1893)
Trichotria tetractis (Ehrenberg, 1830)
Flosculariidae
Ptygura tacita Edmondson, 1940
Ptygura pedunculata (Edmondson, 1939)
Hexarthridae
Hexarthra mira (Hudson, 1871)
Testudinellidae
Testudinella patina (Hermann, 1783)
GASTROTRICHA
Chaetonotus cf. *similis* Zelinka, 1889
ARTHROPODA: Crustacea: Branchiopoda
Leptestheriidae
Leptestheria nobilis (Sars, 1900)
Sididae
Diaphanosoma sarsi Richard, 1895
Latonopsis australis s. lat. Sars, 1888
Daphniidae
Ceriodaphnia quadrangula s. lat. (O.F. Müller, 1785)
Simocephalus mixtus Sars, 1903
Macrothricidae
Macrothrix spinosa King, 1853
Moinidae
Moina micrura s. lat. Kurz, 1874
Chydoridae
Chydorus parvus Daday, 1898
Dunhevedia crassa King, 1853
Karualona cf. *karua* (King, 1853)
Leberis punctatus (Daday, 1898)
Copepoda
Calanoida: Diaptomidae
Heliodiaptomus cinctus (Gurney 1907)
Cyclopoida: Cyclopidae
Thermocyclops sp.
Mesocyclops sp.
Ostracoda
Cyprididae
Bradleycypris vittata (Sars, 1903)
Chrissia formosa (Klie, 1938)
Cypretta fontinalis Hartmann, 1964
Cypris sp.
Hemicypris pyxidata (Moniez, 1892)
Plesiocypridopsis dispar (Hartmann, 1964)
Pseudocypretta maculata Klie, 1932
Pseudostrandesia calapanensis (Tressler, 1937)
Stenocypris derupta Vavra, 1906
Stenocypris major (Baird, 1859)
Candonidae
Physocypria furfuracea (Brady, 1886)
Ilyocyprididae
Ilyocypris dentifera Sars, 1903
Insecta: Coleoptera
Dytiscidae
Copelatus mysorensis Vazirani, 1970
Herophydrus musicus (Klug, 1834)
Hyphydrus intermixtus (Walker, 1858)
Laccophilus flexuosus Aubè, 1838
Laccophilus inefficiens (Walker, 1859)
Laccophilus parvulus parvulus Aubè, 1838
Hydaticus fabricii fabricii (W.S. Macleay, 1825)
Hydrovatus sp.
Gyrinidae
Dineutus indicus Aubé, 1838
Haliplidae
Haliplus arrowi Guignot, 1936
Hydrophilidae
Amphiops sp.
Berosus indicus (Motschulsky, 1861)
Berosus pulchellus MacLeay, 1825
Hydrobiomorpha spinicollis andromorpha Mouchamps, 1959
Sternolophus sp.
Noteridae
Canthydrus laetabilis (Walker, 1858)
Canthydrus luctuosus (Aube, 1838)
Hemiptera: Heteroptera
Belostomatidae
Diplonychus rusticus (Fabricius, 1781)
Corixidae
Agrataptacorixa hyalinipennis (Fabricius, 1803)
Micronectidae
Micronecta scutellaris (Stal 1858)
Nepidae
Laccotrephes griseus (Guerin-Meneville, 1835)
Ranatra filiformis Fabricius, 1790
Notonectidae
Anisops barbatus Brooks, 1951
Anisops cavifrons Brooks, 1951
Anisops sardeus Herrich – Shaffer, 1850
Enithares ciliata (Fabricius, 1798)
Pleidae
Paraplea frontalis (Fieber, 1844)
Gerridae
Tenagogonus fluviorum (Fabricius, 1798)
Hydrometridae
Hydrometra greeni Kirkaldy, 1898
Veliidae
Microvelia douglasi Scott, 1874
Odonata
Aeshanidae
Anax guttatus Burmeister, 1839
Coenagrionidae
Agriocnemis pygmea (Rambur, 1842)
Ischnura senegalensis (Rambur, 1842)
Gomphidae
Ictinogomphus rapax (Rambur, 1842)
Libellulidae
Acisoma panorpoides Rambur, 1842
Brachythemis contaminata (Fabricius, 1793)
Bradinopyga geminata (Rambur, 1842)
Crocothemis servilia (Drury, 1770)
Diplacodes trivialis (Rambur, 1842)
Orthetrum Sabina (Drury, 1770)
Trametea limbata Rambur, 1842
Trithemis festiva (Rambur, 1842)
Arachnida: Araneae
Araneidae
Araneus mitificus (Simon, 1886)
Cyclosa hexatuberculata Tikader, 1982
Eriovixia sp.
Neoscona mukerjei Tikader, 1980
Neoscona nautica (Koch, 1875)
Neoscona theisi (Walckenaer, 1841)
Lycosidae
Hippasa sp.
Oxyopidae
Oxyopes bharatae Gajbe, 1999
Pisauridae
Nilus albocinctus (Doleschall, 1859)
Salticidae
Plexippus sp.
Tetragnathidae
Leucauge decorata (Blackwall, 1864)
Tetragnatha sp.
Thomisidae
Runcinia roonwali Tikader, 1965
Uloboridae
Zosis geniculata (Olivier, 1789)
Gastropoda
Indoplanorbis sp.
Lymnaea luteola Lamarck, 1822
CHORDATA: Amphibia: Anura
Bufonidae
Duttaphrynus melanostictus (Schneider, 1799)
Dicroglossidae
Euphlyctis cyanophlyctis (Schneider, 1799)
Hoplobatrachus tigerinus (Daudin, 1802)
Zakerana sp.
Microhylidae
Microhyla ornata (Dumeril & Bibron, 1841)
Reptilia: Squamata
Xenochrophis piscator (Schneider, 1799)
Aves
Alcedinidae
Alcedo atthis (Linnaeus, 1758)
Ceryle rudis (Linnaeus, 1758)
Halcyon smyrnensis (Linnaeus, 1758)
Anatidae
Anas poecilorhyncha Forster, 1781
Ardeidae
Ardeola grayii (Sykes, 1832)
Egretta garzetta (Linnaeus, 1766)
Charadriidae
Vanellus indicus (Boddaert, 1783)
Motacillidae
Motacilla cinerea Tunstall, 1771
Phalacrocoracidae
Phalacrocorax niger (Vieillot, 1817)
Podicipedidae
Tachybaptus ruficollis (Pallas, 1764)
Rallidae
Amaurornis phoenicurus (Pennant, 1766)

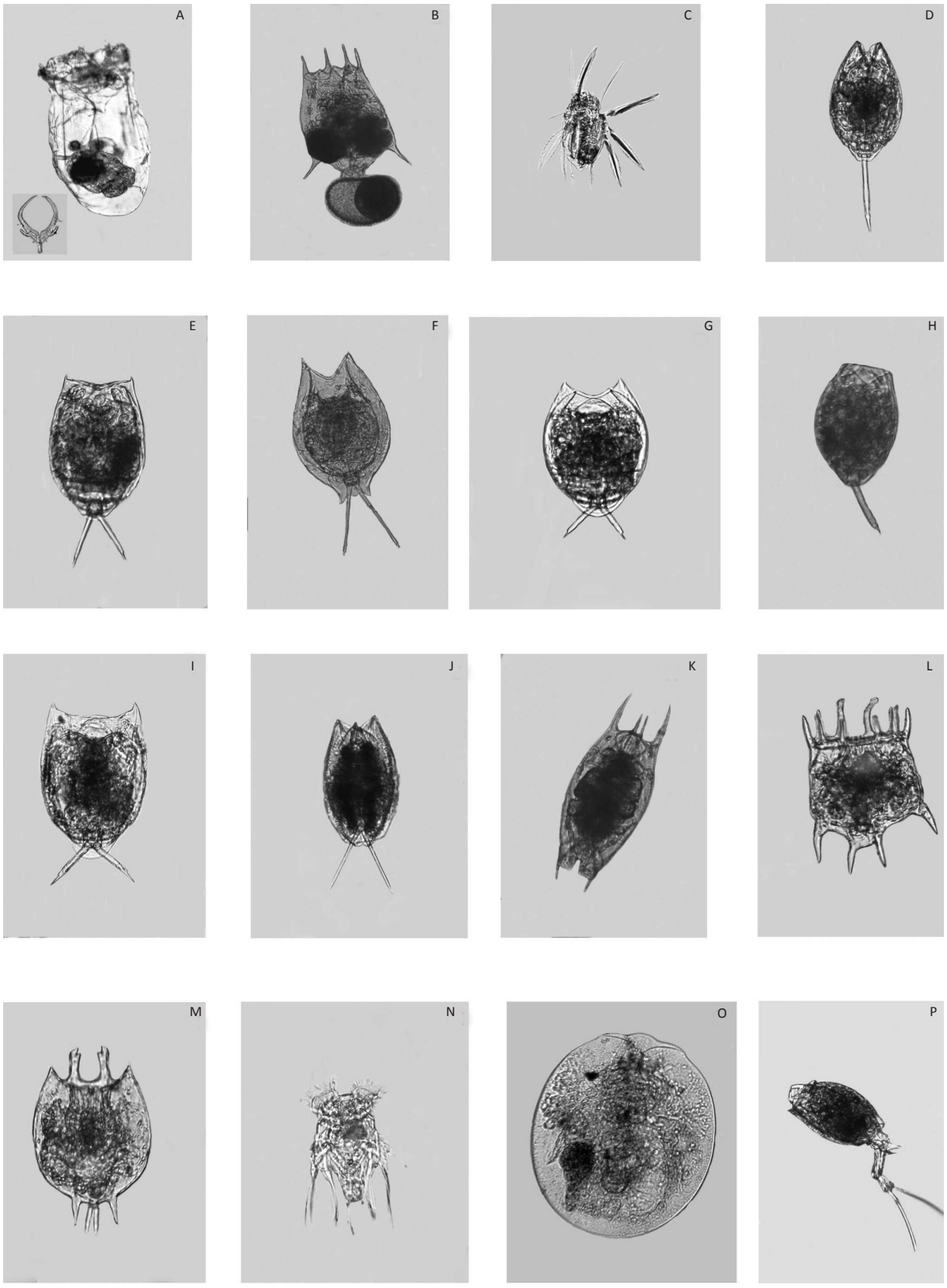

Image 3. Representatives of rotifers from the habitat. A - *Asplanchna brightwelli;* B - *Brachionus calyciflorus;* C - *Polyarthra* sp.; D - *Lecane bulla bulla;* E - *Lecane curvicornis;* F - *Lecane leontina;* G - *Lecane luna;* H: *Lecane lunaris;* I - *Lecane ungulata;* J - *Mytilina trigona;* K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

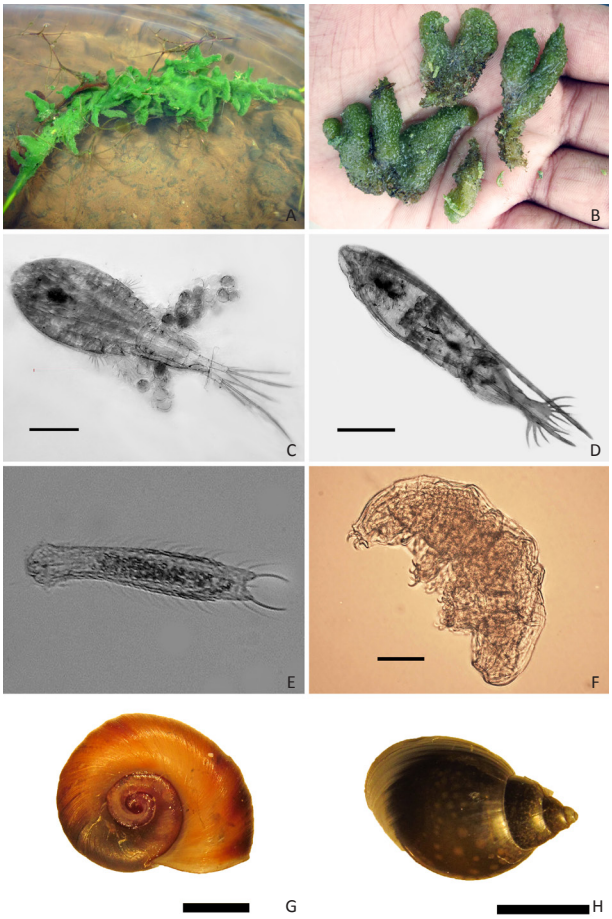

Image 4. A–B - Freshwater sponges, *Radiospongilla cerebellata* and *Dosilia plumosa*, respectively; C-D - Freshwater copepods, Cyclopoid (*Mesocyclops* sp., female) and Calanoid (*Heliodiaptomus cinctus*, female); E - Gastrotricha (*Chaetonotus* cf. *similis*); F - Tardigrade; G - *Indoplanorbis* sp.; 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, *Heliodiaptomus 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; Petrusek 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

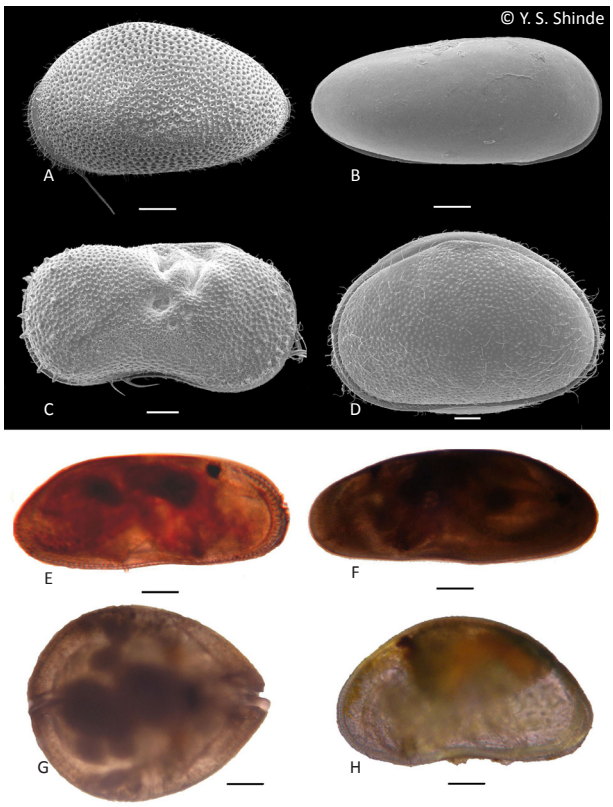

Image 5. Representatives of Ostracoda from the pond. A - *Cypris* sp.; B - *Pseudostrandesia calapanensis;* C - *Ilyocypris dentifera;* D - *Hemicypris pyxidata;* E - *Stenocypris major;* F - *Chrissia formosa;* G - *Cypretta fontinalis;* H - *Plesiocypridopsis dispar.* Scales = A,B,C,D,G,H = 100µm;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

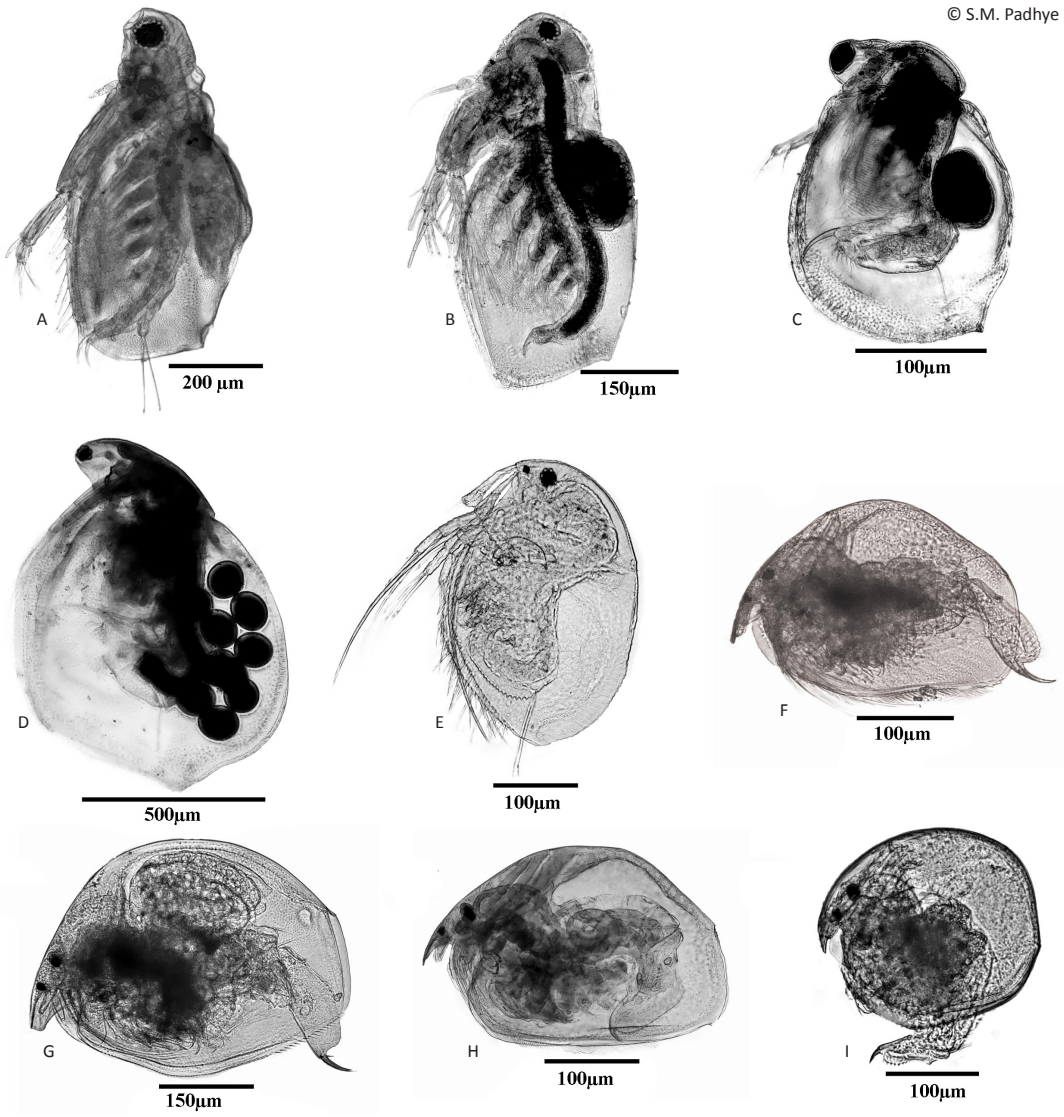

Image 6. Representatives of Cladocera from the pond. A - *Diaphanosoma sarsi*; B - *Latonopsis australis* s. lat.; C - *Ceriodaphnia quadrangula* s. lat.; D - *Simocephalus mixtus*; E - *Macrothrix spinosa*; F - *Karualona* cf. *karua*; G - *Leberis punctatus*; H - *Dunhevedia crassa*; I - *Chydorus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

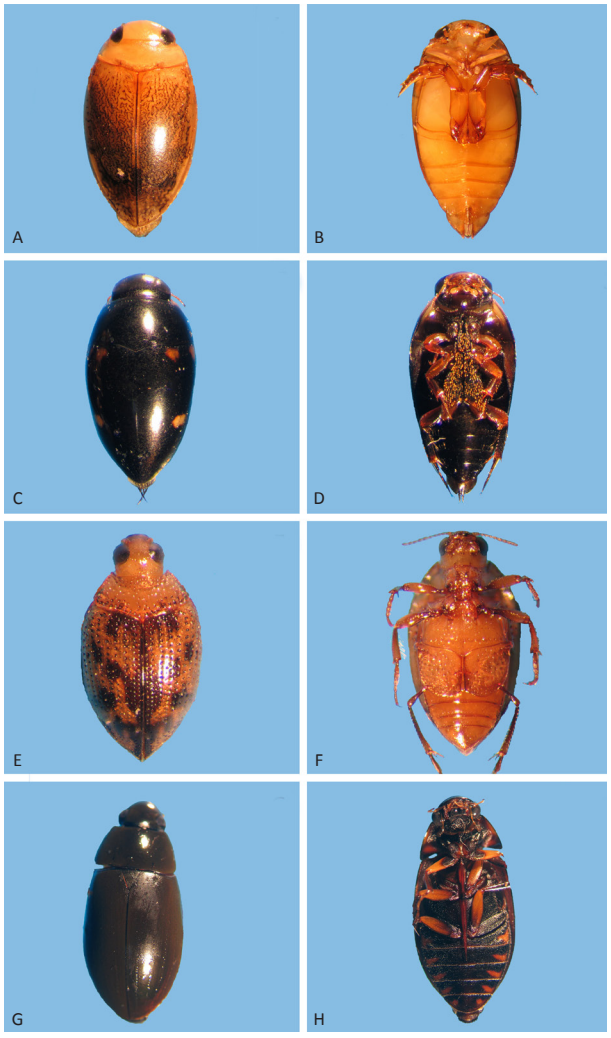

Image 8. Representatives of aquatic Coleoptera from the pond.
A,B - *Laccophilus flexosus*, DV & VV.; C,D - *Canthydrus luctuosus*, DV & VV.; E,F - *Haliplus arrowi*, DV & VV.; G,H - *Sternolophus* sp. DV & VV. © H.V. Ghate and S.D. Sheth.

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 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 - *Tenagogonus fluviorum*. © H.V. Ghate and S.V. Paripatyadar

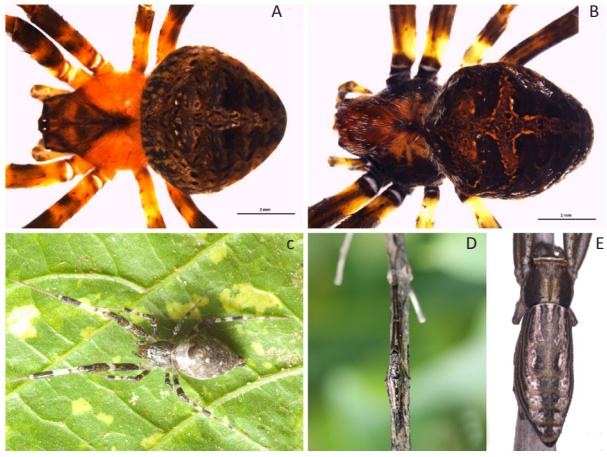

Image 10. Representatives of spiders from the pond.
A - *Neoscona mukerjei;* B - *Neoscona nautica*; C - *Zosis geniculata;*
D - *Tetragnatha* sp.; E - *Runcinia roonwali.* © S.S. Kulkarni

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

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 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.

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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 Holynska et al. 2003
Ostracoda	Savatenalinton & Martens 2009 Savatenalinton & Martens 2010 Victor & Fernando 1979a
Mollusca	Subba Rao 1989
Coleoptera	Biström 1982 Brancucci 1983 Komarek 2003 Pederzani1995 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

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