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 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 & Dewanj 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.,...
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-Bienkowska 2001; Sinev et al. 2005); Copepoda (Reddy 1994; Dussart & Defaye 2001; Holynska et al. 2003); Ostracoda (Víctor & 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).

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), Candoniidae (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.
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#### Table 2. Taxonomic checklist of all observed species.

| Class       | Order            | Family                | Genus            | Species       |
|-------------|------------------|-----------------------|------------------|---------------|
| **Rotifera**|                  |                       |                  |               |
|             |                  | Phylum                | Phylactolaemata |               |
|             |                  |                       | Lophopodidae    |               |
|             |                  |                       | BRYOZOA          |               |
|             |                  |                       | Spongillina     |               |
|             |                  |                       | PORIFERA        |               |
|             |                  |                       | Gastropoda      |               |
|             |                  |                       | Lepadellidae    |               |
|             |                  |                       | Colurellia      |               |
|             |                  |                       | Lepadella       |               |
|             |                  |                       | Manomattida     |               |
|             |                  |                       | Synchaetidae    |               |
|             |                  |                       | Candonidae      |               |
|             |                  |                       | Mytilinidae     |               |
|             |                  |                       | Mytilinidae     |               |
|             |                  |                       | Cephalothrix    |               |
|             |                  |                       | Chydoridae      |               |
|             |                  |                       | Ascothoracida   |               |
|             |                  |                       | Ostracoda       |               |
|             |                  |                       | Cyprididae      |               |
|             |                  |                       | Cyprididae      |               |
|             |                  |                       | Ctenophora      |               |
|             |                  |                       | Tetractinidae   |               |
|             |                  |                       | Epichiroptera   |               |
|             |                  |                       | Aschelminthes   |               |
|             |                  |                       | Insecta         |               |
|             |                  |                       | Araneae         |               |
|             |                  |                       | Lepidoptera     |               |
|             |                  |                       | Hymenoptera     |               |
|             |                  |                       | Diptera         |               |
|             |                  |                       | Odonata         |               |
|             |                  |                       | Anura           |               |
|             |                  |                       | Aves            |               |
|             |                  |                       | Mammalia        |               |

**Note:** The table lists the taxonomic checklist of all observed species, including various taxa from different taxonomic groups. Each entry includes the class, order, family, genus, and species names. The text is a detailed taxonomic list for a study conducted in a small temporary pond in Pune, India, detailing the species observed and their classification.
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 unguulata; 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.
The calanoid, *Heliothopous 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 Maharasthra (Padhye et al. 2015). All the Cladocera found in the study were circumtropical in distribution. *Laronaposis australis* Sars, 1888 sensu lato and *Latonopsis australis* 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).

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

**Table 3. Faunistic overview.**

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

**Image 5.** Representatives of Ostracoda from the pond. A - *Cypris* sp.; B - *Pseudostrandesia calapanensis*; C - *Ilyocypris dentifera*; D - *Hemicyprips pyxidata*; E - *Stenocypris major*; F - *Chriussa formosa*; G - *Cypretta fontinalis*; H - *Plesiocypridopsis dispar*.

Scales = A,B,C,D,G,H = 100µm; E,F = 200µm

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**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,
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.
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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, nympha 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.
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, *Cyclasa 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
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 physicochemical 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 & Dewanjii 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 maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained. In fact, in the formative years of the Department of Zoology of this University, this pond was maintained.

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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-Bienkowski 2001; Sinev et al. 2005; Smirnov 1971, 1992, 1996 |
| Copepoda       | Dussart & Defaye 2001; Ranga Reddy 1994; Holytska et al. 2003                                   |
| Ostracoda      | Savatenalinton & Martens 2009; Savatenalinton & Martens 2010; Victor & Fernando 1979a            |
| Mollusca       | Subba Rao 1989                                                                                  |
| Coleoptera     | Biström 1982; Brancucci 1983; Pederson 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; Thirimula 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; Tkader 1980; Tkader 1982; Yoshida 2009 |
| Amphibia       | Daniels 1997-I-II; Gururaja 2012                                                                |
| Reptilia       | Smith 1943                                                                                      |
| Aves           | Grimett et al. 1999                                                                             |

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