Short Communication

Journal of Threatened Taxa | www.threatenedtaxa.org | July 2013 | 5(11): 4556–4561

A report on Lecanidae (Rotifera: Monogononta) from Andhra Pradesh, India, including six new distribution records with notes on their contemporary taxonomic nomenclature

ISSN
Online 0974-7907
Print 0974-7893

OPEN ACCESS

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Abstract: The *Lecane*-species complex taxonomy the world over, witnessed a state of flux, causing confusion and controversies, among world's taxonomists over the treatment of various subgenera, taxa and sub and or infraspecific categories of the species rich genus *Lecane* Nitzsch 1827, on the basis of structure/shape of key, morphological features like foot/toes, lorica, etc. The taxonomic scenario in India, relying heavily on the classical, divergent taxonomic approaches presented a picture of more chaos/confusion, following poor accessibility to contemporary revisionary studies until the recent past. Despite revisionary studies across the world, a few notable Indian studies continued to be burdened with old nomenclature. This short communication reports for the first time ever, 33 valid species of lecanid rotifers (Lecanidae), including six new distributional records from Greater Hyderabad region and the entire state of Andhra Pradesh too with comments on their current nomenclature. Further, limnobiological correlation between five physicochemical parameters and rotifer associations revealed, *L. bulla*, *L. closterocerca, L. hamata, L. ludwigi, L. luna and L. papuana* as *euryokous* species, showing tolerance to a wide range of abiotic factors and habitats too.

Keywords: *Euryokous*, morphological variant, Lecanid taxonomy, limnological indicator and taxa.

Taxonomy of rotifers, the world over, in particular lecanid rotifers too, continued to remain in a state of flux in view of high species diversity, plasticity, regional and /or seasonal variability and geographic endemicity. warranting global revisionary studies on many groups/ families. In fact the taxonomy of ubiquitous, bio-geographically significant *Lecane* species-complex was in a state of flux for decades, and indeed a major irritant to taxonomists world wide, following differences, until the mid nineties; Segers (1995) finally setting to rest all prevailing confusions/ controversies, assigning all species under a single genus *Lecane* Nitzsch, 1827. The Indian scenario on lecanid taxonomy was no different and the confusion continued to prevail until the beginning of the century, ironically enough for lack of accessibility to standard world revisionary studies/literature and serious comprehensive Indian studies on the groups, despite its abundance and distinct tropical characteristics (Sharma 1996).

Notable pioneering taxonomic studies on lecanid rotifer from Andhra Pradesh were initiated by Dhanapathi (1976a) recording two new species, *Lecane bidentata* and *L. donnerianus,* including five first distribution reports. Incidentally, soon he also reported an other new taxon, *Lecane easwari,* from West Godavari and Krishna districts, Andhra Pradesh Dhanapathi (1976b). About the same time, Rao & Mohan (1977) reported *Monostyla obtusa* Murray, 1913, from Municipal tank, Mudasarlova, Visakhapatanam, and later seven new

DOI: http://dx.doi.org/10.11609/JoTT.o3095.4556-61 | **ZooBank:** urn:lsid:zoobank.org:pub:5888AD85-A94A-46F8-B578-CB9CF3C89BB0

Editor: Kalpana Pai, University of Pune, Pune, India **Date of publication:** 26 July 2013 (online & print)

Manuscript details: Ms # o3095 | Received 11 February 2012| Final received 28 June 2013 | Finally accepted 02 July 2013

Citation: Siddiqi, S.Z. & M. Karuthapandi (2013). A report on Lecanidae (Rotifera: Monogononta) from Andhra Pradesh, India, including six new distribution records with notes on their contemporary taxonomic nomenclature. *Journal of Threatened Taxa* 5(11): 4556–4561; http://dx.doi.org/10.11609/JoTT.o3095.4556-61

Funding: The junior author (MK) is supported by Research Fellowship (SRF) through ZSI by MoEF, New Delhi.

Competing Interest: None.

Acknowledgements: The authors are grateful to Dr. K. Venkatraman, Scientist G and Director, Zoological Survey of India, Kolkata for encouragement, infrastructural facilities, fellowship (KP) and to fellow scientists/staffs for cooperation.

distribution records (Rao & Mohan 1982). Arshaduddin & Khan (1991) reported 40 species of rotifers, including 10 species under the genus *Lecane* Nitzsch, 1827 from organically polluted temporary seasonal ponds from Osmania University, Jamia Osmania campus, Hyderabad, assigning them saprobic values following Sladecek (1983). Surprisingly enough, there are no comprehensive taxonomic studies on the family Lecanidae from the state, indeed Indian region too, save one by Sharma (1996) reporting 74 species of the genus *Lecane* from India. The actual number, including infraspecific varieties, may be marginally higher, going by recently published reports (Sharma 2007; Sharma & Sharma 2010, 2011). This short communication reports 20 species from Greater Hyderabad region, and the state, upgrading the tally to 33 species of lecanid rotifers, including six new distribution records from the state of Andhra Pradesh.

Material and Methods

A brief description of the three study sites follows. Site 1, a masonry pond (hereafter designated as MP), 17^{0}21'28"N & 78^{0}23'32"E, area 200m^2, rain fed, walled on three sides, a natural depression in undulating terrain, located at Attapur, Rajendranagar, Hyderabad, was chosen for its proximity, size and considerable (rainwater) retention period, and habitat variability. Site 2 Landscape Garden Pond, Osmania University, Hyderabad, abbreviated as LGP, 17^{0}25'02"N and 78^{0}31'52"E, rain fed, roughly square-shaped, natural depression, in undulating terrain, has an area (0.44km^2), remains dry for over 8–9 months, save during the south-west monsoons (July–September 2011) and a month or two beyond. The site was chosen as previous studies recorded rich rotifer diversity and therefore served as a comparable study. Site 3 Bandakum cheruvu, Bandakum Village, Pattancheruvu, Medak, shortened as BP, 17^{0}30'44"N & 78^{0}19'11"E, located in mildly undulating terrain, is a shallow habitat, depth (1.5–2 m), area 1.58km^2, receives inflows from precipitation and a mild stream located upwards. Of the three pond habitats, the masonry pond has a higher level of water retention period, following rock-cemented boundaries and no free out flows, high macrophyte infestations albeit low water levels until January 2012. There are no significant geomorphic differences in the three ponds but were chosen for proximity, accessibility and academic necessity (species richness, vis-à-vis short life cycle) and potential for aquatic ecological research.

The physical factors like temperature, pH, electrical conductivity and total dissolved solids were estimated in situ with the help of electronic dip testers (Hanna make pH ep, dip C, dip D, etc.) while samples for dissolved oxygen (200ml BOD, glass bottles) were Winklerized in the field. Surface water samples were collected in wide mouth PVC containers (Tarsons bottles with plugs and screw cap) for estimations of various physicochemical parameters. The dissolved oxygen was analyzed titrimetrically, while total alkalinity (OR-AIK-01), hardness (OR-TH-01), chloride (OR-Cl-01), calcium (OR-Ca-01), magnesium and inorganic plant nutrients - orthophosphate (P-PO_4, OR-P-01) nitrogen-nitrate (N-NO_2, OR-NO_2-01), nitrogen - nitrite (N-NO_3, OR-NO_3-01) and ammonical nitrogen (N-NH_3, OR-NH_3-01) analyzed using Orlab Instruments Pvt. Ltd. field kits, following standard limnological works/texts (Lind 1979; Wetzel & Likens 2000). Plankton samples from surface waters (littoral region) were collected by towing long handled plankton net (No 25. 64µm mesh size) and wading through waist deep shallow water, where feasible. 100ml plankton sample in PVC containers, preserved in 4% neutralized formalin, (Registration numbers FBRC/ZSI/UN: 6079-6714), stained in eosin ink, manually sorted and observed under a Nikon 80i light microscope and digitally photographed. Standard regional taxonomic works (Patil & Gouder 1989; Battish 1992; Dhanapathi 2000) and others were used for confirming taxonomic identity and contemporary status (Segers 1995 & 2007).

Results and Discussions

The present study revealed high species richness in the genus *Lecane*, 20 species to be precise, including six new distributional records from the region. *Lecane* species like *L. aculeata* (Jakubski, 1912), *L. haliclysta* Harring & Myers, 1926, *L. furcata* (Murray, 1913), *L. pawlowskii* Wulfert, 1966, *L. pyriformis* (Daday, 1905), and *L. ruttneri* (Hauer, 1938) form new distribution records from the region (Images 1–6). It further documents the range of values of physicochemical parameters and ecological conditions of the ponds, reiterating the ecological importance of the littoral regions and its continued under estimation in Indian studies, despite its faunistic richness and biogeographic significance (Segers et al. 1994). An exhaustive updated list of valid species of highly plastic, species-rich genus *Lecane* recorded from Andhra Pradesh, including new taxa and infraspecific varieties recorded to date, and their present taxonomic status is appended, for the benefit of Indian researchers (after Segers 1995, 2007).

The two new taxa reported by Dhanapathi (1976a) viz. *Lecane bidentata* and *Lecane donnerianus* are now indeed junior synonyms of *L. batillifer* (Murray, 1913) and *L. donneri* Chengalath & Mulamoottil, 1974; Segers

(2007) adding *L. bidentata* as species enquirendae. Further, of the five new distribution records reported then (Dhanapathy 1976), *Monostyla styrax* Harring & Myers, 1926 is subsumed as *L. styrax* (Harring & Myers, 1926) and *M. tethis* is a synonym of *L. furcata* (Murray, 1913). While *Monostyla obtusa* Murray, 1913, reported by Rao & Mohan (1977) is *Lecane obtusa* (Murray, 1913), the current taxonomic replacements of some of the other seven (Rao & Mohan 1982) are as under: *Lecane acanthinula* (Hauer, 1938) (=*L. acronycha* Harring & Myers, 1926), *L. curvicornis* (Murray, 1913) (= *L. curvicornis* var. *padespares* (Arora, 1963), *L. bulla* (Gosse, 1851) [=*Monostyla bulla* (Gosse, 1851)], *L. closterocerca* (Schmarda, 1859) [=*Monostyla closterocerca* Schmarda, 1859], *L. lunaris* Ehrenberg, 1832 [= *Monostyla lunaris* Ehrenberg, 1832] and *L. unguitata* (Fadeev, 1925) [=*Monostyla unguitata* ((Fadeev, 1925)] *Lecane ploensis* (Voigt, 1902) is now a junior synonym of *L. pideis* (Harring & Myers, 1926) and *L. ohioensis* Herrick, 1885 has been subsumed by *L. obtusa* (Murray, 1913). (Table 1).

The short duration seasonal studies revealed 16 (MP), 09 (LGP), and 15 spp. (BGP) respectively, of genus *Lecane* with masonry pond collections exhibiting relatively high species richness (18 spp.), perhaps more, following relatively higher habitat heterogeneity, nutrient loading, from surface runoffs, and a higher undisturbed retention period. The LGP, Osmania University, is an open system, having a slopy terrain all around that facilitates substantial outflows, and consequently relatively shorter retention period and habitat homogeneity. Further, while the BG pond retains water for the most part, it too has habitat homogeneity. The MP, Attapur, littered with boulders, higher depth (1–1.5 m) and littoral macrophytes, has higher aquatic productivity, witnessed through production of fish nekton [*Channa punctatus* (Perciformis: Channidae) - Snake heads], appear around the third month October], and offers more ecological niches. *Lecane bulla* (O.F. Muller, 1776), one of the highly

Image 1. *Lecane aculeata* (Jakubski, 1912)

Image 2. *Lecane pyriformis* (Daday, 1905)

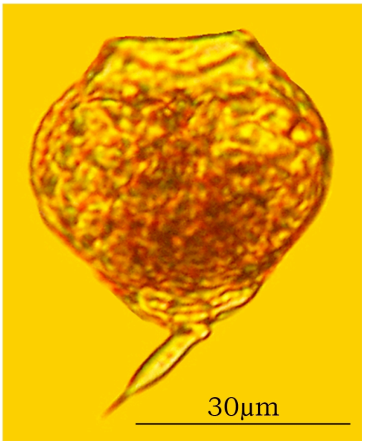

Image 3. *Lecane pawlowskii* Wulfert, 1966

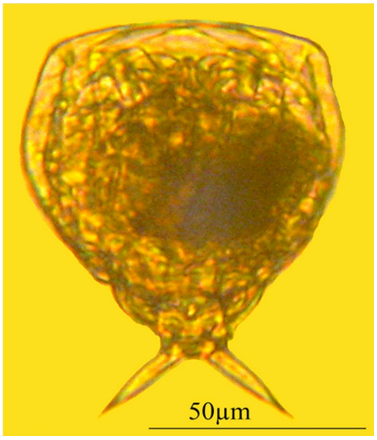

Image 4. *Lecane ruttneri* (Hauer, 1938)

Image 5. *Lecane furcata* (Murray, 1913)

Image 6. *Lecane haliclysta* Harring & Myers, 1926

morphologically variable taxon, was observed to be numerically abundant, inhabiting all ponds, all through the study, while *L. pyriformis* and *L. quadridentata* were common in LGP, Osmania University, Hyderabad. Further, of the 22 spp. recorded, eight species—*L. bulla*, *L. closterocerca, L. hamata, L. ludwigi, L. luna, L. lunaris* and *L. papuana*—occurred commonly in all three ponds. Sorensen's index/similarity coefficients (1948) were used to evaluate percent similarity between the three pond ecosystems. The quotient of similarity (QS) worked out to 32, 31 and 32%, respectively. Further the similarity/ dissimilarity index between the three worked out to 36 and 64%, respectively.

Table 2 highlights the range of values of various physicochemical parameters in littoral waters, besides range of values for inorganic plant nutrient-various forms of phosphorous ($P\text{-}PO_4$ mg/L) and Nitrogen ($N\text{-}NO_2$, $N\text{-}NO_3$ and $N\text{-}NH_3$ mg/L). Despite ecological potential of rotifers as possible limnological indicator, no categorical correlation can be drawn between rotifer fauna and the wide range of physicochemical indicators especially temperature, hydrogen ion concentration (pH), alkalinity, chlorides and or conductivity, in view of wide environmental tolerance range of the various species complexes, following difference in not just morphology but, genetics too (Kuczynski 1987). Present study also at best are indicative of range of tolerance of various *Lecane* species to wide pH (7.1–8.0), high chloride (61–506 mg/l), high alkalinity (128–331 mg/l) and lower medium conductivity (0.8–1.89 mS). Co-incidentally enough, six of the species namely *L. bulla*, *L. closterocerca, L. hamata, L. ludwigi, L. luna* and *L. papuana* are common to all studies from the region. Going by limnological indicators and rotifer associations (Kuczynski 1987), they may be categorized as euryokous.

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Table. 1 List of *Lecane* species reported from Hyderabad, Andhra Pradesh, India. (Dhanapathi 1976 onwards). Asterisk (*) as superscripts against the taxon name indicates first geographic records, while + (plus) sign indicates occurrence and – (Minus) as nonoccurrence.

	Rotifera **Lecanidae Remane, 1933** ***Lecane* Nitzsch, 1827**	**Temporary freshwater habitats**			**Previous studies**
		Masonry pond, Attapur, Hyderabad	Landscape Garden pond, Osmania Univ. Hyderabad	Bandakum cheruvu, Medak District	
1	*Lecane acanthinula* (Hauer, 1938) [=*Lecane acronycha* Harring & Myers, 1926]	+	-	-	Rao & Mohan 1982
2	*L. aculeate* (Jakubski, 1912)*	+	-	-	Present study
3	*L. batillifer* (Murray, 1913) = *L. bidentata* Dhanapathi, 1976 sp. *enqr.*	-	-	-	Dhanapathi 1976
4	*L. bulla* (Gosse, 1851)	+	+	+	Dhanapathi 1976, Rao & Mohan 1982, Arshaduddin & Khan 1991
5	*L. closterocerca* (Schmarda, 1859)	+	+	+	Dhanapathi 1991, Rao & Mohan 1982
6	*L. crepida* Harring, 1914 [=*L.crepida* var *bengalensis* Sharma 1978. Syn. *Lecane vasisthi* Sharma, 1980. Sym.]				Rao & Mohan 1982
7	*L. curvicornis* (Murray 1913) [=*L. curvicornis* var. *padespares* Arora, 1965. Syn.]	+	-	+	Dhanapathi 1976, Rao & Mohan 1982
8	*L. donneri* Chengalath & Mulamoottil, 1974 = *L. donnerianus* Dhanapathi, 1976	-	-	-	Dhanapathi 1976
9	*L. eswari,* Dhanapathi, 1976	-	-	-	Dhanapathi 1976
10	*L. furcata* (Murray, 1913)*	+	-	-	Present study
11	*L. haliclysta* Harring and Myers, 1926*	+	-	-	Present study
12	*L. hamata* (Stokes, 1896)	+	+	+	Dhanapathi 1976
13	*L. hastata* (Murray, 1913)	-	-	-	Arshaduddin & Khan 1991
14	*L. hornemanni* (Ehrenberg, 1881)	-	-	-	Dhanapathi 1976
15	*L. inopinata* Harring and Myers, 1926	-	-	-	Dhanapathi 1976
16	*L. lauterborni* (Hauer, 1924)	-	-	-	Dhanapathi 1976
17	*L. leontina* (Turner, 1892)	+	+	+	Dhanapathi 1976
18	*L. ludwigii* (Eckstein, 1883)	+	+	+	Dhanapathi 1976, Rao & Mohan 1982, Arshaduddin & Khan 1991
19	*L. luna* (O. F Muller, 1776)	+	+	+	Dhanapathi 1976 & Arshaduddin & Khan 1991
20	*L. lunaris* (Ehrenberg, 1832) *[=Monostyla lunaris* Ehrenberg, 1832]	+	+	+	Dhanapathi 1991, Rao & Mohan 1982
21	*L. obtusa* (Murray, 1913) [=*Monostyla obtusa* (Murray, 1913) =*L. ohioensis* (Herrick,1885)]	-	-	-	Rao & Mohan 1982, Arshaduddin & Khan 1991
22	*L. pawlowskii* Walfert, 1966*	+			Present study
23	*L. papuana* (Murray, 1913)	+	+	+	Dhanapathi 1976, Rao & Mohan 1982, Arshaduddin & Khan 1991
24	*L. pideis* (Harring & Mayers, 1926) = *L. ploensis* (Voigt, 1902)	-	-	-	Arshaduddin & Khan 1991
25	*L. pyriformis* (Daday, 1905)*	-	-	+	Present study
26	*L. quadridentata* (Ehrenberg, 1832)	-	+	+	Dhanapathi 1976
27	*L. ruttneri* (Hauer, 1938)*	+	-	+	Present study
28	*L. stenroosi* (Meissner, 1908)	-	-	+	Dhanapathi 1976
29	*L. stichoclysta* Segers, 1993 [= *L. styrax* Harring & Mayers, 1926]	-	-	-	Dhanapathi 1976
30	*Lecane tenuiseta* Harring, 1914 [=*L. tesselata* Arora, 1965 =*L. tethis* Harring & Mayers, 1926]	-	-	-	Dhanapathi 1976, Rao & Mohan 1982
31	*L. tryphema* Harring and Myers, 1926				Rao & Mohan 1982
32	*L. ungulata* (Gosse, 1887)	+	-	+	Dhanapathi 1976
33	*L. unguitata* (Fadeev, 1925) *[=Monostyla unguitata* Fadeev, 1925]	-	-	+	Rao & Mohan 1982
	Total Number of Species	**16**	**9**	**15**	

Table 2. Range of values different physicochemical parameters, in littoral surface, in three different temporary water habitats including various forms of orthophosphates and ions.

Parameters	Bandakum cheruvu, Bandakum Village, Patancheruvu, Medak	Masonry pond, Attapur, Rajedranagar, Hyderabad	Landscape Garden pond, Osmania University, Hyderabad
Ambient atmospheric temperature ^{0}C	25–33	25–29	27–28
Sub Surface water temperature ^{0}C	19–29	23–26	27
Light(Lux)	240–450	240–360	420
$_P$H	7.5–8.9	7.1–7.7	8.3–8.4
Electrical conductivity (mS)	0.97–1.89	0.8–2.2	0.55–0.60
Total Dissolved Solids (ppm)	690–1400	880–1155	440–450
Dissolved Oxygen (mg/L)	4.6–9.7	4.1–10.3	8.0–8.4
Total Hardness, $CaCO_3$ (mg/L)	189–284	242–406	141–166
Total Alkalinity, $CaCO_3$ (mg/L)	204–331	164–208	128–153
Chlorides, Cl- (mg/L)	182–506	152–248	61–82
Calcium, Ca^{++} (mg/L)	28–47	52–142	28–38
Magnesium, Mg^{++} (mg/L)	35–60	31–66	36–41
Nutrients Total Phosphates, P-PO_4 (mg/L)	0.08–0.4	0.4–0.7	0.09–0.12
Nitrates, N-NO_2 (mg/L)	1–40	1–37	1–1.5
Nitrites, N- $NO_{3 (}$mg/L)	0–0.17	0.01–0.4	0.031–0.035
Ammonia, N-NH_3 (mg/L)	0.12–3.66	0.01–0.6	- (not determined)