

UPDATED STATUS OF ANOSTRACA IN PAKISTAN

Quddusi B. Kazmi^{1*} and Razia Sultana²

¹Marine Reference Collection and Resource Center; University of Karachi, Karachi-75270, Pakistan

²Food & Marine Resources Research Center, PCSIR Laboratories Complex Karachi; Karachi-75270, Pakistan

*Corresponding author e-mail: qbkazmi@yahoo.com

ABSTRACT

Previously, nine species of the order Anostraca have been reported from Pakistan viz, *Branchinella hardingi* (Qadri and Baqai, 1956), *B. spinosa* (H. Milne Edwards, 1840) (now *Phallocryptus spinosa*), *Streptocephalus simplex*, 1906, *S. dichotomus* Baird, 1860, *S. maliricus* Qadri and Baqai, 1956, *S. lahorensis* Ghauri and Mahoon, 1980, *Branchipus schaefferi* Fischer, 1834, *Chirocephalus priscus* Daday, 1910 and *Artemia* sp. In the present report these Pakistani species are reviewed. *Streptocephalus dichotomus* collected from Pasni (Mekran), housed in the Smithsonian National Museum of Natural History, USA (cat no. 213712) is inserted herein and another specimen of *Streptocephalus* sp., from a new locality, collected from Kalat not yet reported, is illustrated and described in this report, thus extending genus range further Northward. The need for further surveys directed towards getting the knowledge necessary in order to correctly understand and manage temporary pools- the elective habitat of large branchiopods is stressed.

KEYWORDS: Anostraca, Branchiopoda, Pakistan, Present status

INTRODUCTION

Anostraca is one of the four orders of Crustacea in the Class Branchiopoda. It is the most diverse of the four orders of Branchiopoda and comprises around 300 species, grouped into 26 genera in eight families (Brendonck *et al.*, 2008).

Class Branchiopoda

Subclass Sarcostraca

Order Anostraca

Family Artemiidae – 1 genus, *Artemia*

Branchinectidae – 1 genus, *Branchinecta*

Branchipodidae – 8 genera

Chirocephalidae – 10 genera

Polyartemiidae – 2 genera, *Polyartemia*, *Polyartemiella*

Parartemiidae – 1 genus

Streptocephalidae – 1 genus, *Streptocephalus*

Thamnocephalidae – 6 genera

Anostracans are small shrimp like organisms and commonly called as brine and fairy shrimps. Fairy shrimps are usually found in fresh water pools whereas, brine shrimps are found in saline lakes and coastal salt works. They swim on their dorsal part with ventral part up, bearing the swimming appendages. They are usually 6–25 mm long (exceptionally up to 170 mm). They live in vernal pools and hyper saline lakes across the world, including pools in deserts, subterranean rivers (Qadri and Baqai, 1956), in rice field, in ice-covered mountain lakes and in Antarctica, even in volcano craters.

The shrimps provide a number of ecological, commercial, and nutritional values. Ecologically, they provide food for humans, fish and birds. Fairy shrimps can be used as a potential, cost-effective, nutritionally adequate, yet economically feasible source of live feed of practical utility in aquaculture both at hatchery level as well as maturation (Munuswamy, 2005). The aquarium keepers promote fairy shrimp species as fancy organisms due to their inversely swimming nature with attractive and lustrous coloured cercopods.

Commercially, the brine shrimp *Artemia* genus is of particular importance, with the cysts collected, processed, and sold as fish food, both for aquaria and for industrial aquaculture to feed fish larvae. This interesting group are called 'living fossils' in literature, due to their Cambrian origin (Briggs, 1976).

From Oriental region 56 species in 10 genera are shown (map, Brendonck *et al.*, 2008). There are more than 17 species of Anostraca belonging to 7 genera on the Indian subcontinent (Belk and Esparza, 1995; Raina and Vass, 2006). These are: *Artemia* sp.; *Branchinecta orientalis* Sars, 1901; *B. schantzi*, Mackin, 1952; *Branchinella hardingi* (Qadri and Baqai, 1956); *B. ornata* Daday, 1910; *B. maduraiensis* Raj, 1951; *Branchipodopsis acanthopenes* (Malhotra and Duda, 1970); *B. affinis* Sars, 1901; *Branchipus schaefferi* Fischer, 1834; *Chirocephalus priscus* (Daday, 1910); *Ch. soulukliensis* Rogers and Soufi, 2013; *Streptocephalus dichotomus* Baird, 1860; *S. echinus* Bond, 1934; *S. longimanus* Bond, 1934; *S. simplex* Gurney, 1906; *S. spinifer* Gurney, 1906 and *S. sahyadriensis* Rogers and Padhye, 2014.

Review of literature: The first report of Anostraca in Pakistan was by Qadri and Baqai (1956) from subterranean rivers in Sindh. Then Mahoon (1960) worked on their anatomy; Tirmizi (1969) described the morphology of one species; Ghauri and Mahoon (1980) established a new species; Campbell (1991) and Sultana *et al.* (1991, 2000) reported on wild brine shrimp. Lately Siddiqui *et al.* (2004a & b) investigated the development stages and genitalia of one species and Kazmi (2004) listed several species with other crustacean species in a checklist. Classification of Rogers (2013) is followed.

From Pakistan nine species have been reported: *Branchinella hardingi* (Qadri and Baqai, 1956); *B. spinosa* (H. Milne Edwards, 1840); *Streptocephalus dichotomus* Baird, 1860; *S. simplex* 1906; *S. lahorensis* Ghauri and Mahoon, 1980; *S. maliricus* Qadri and Baqai, 1956; *Branchipus schaefferi* Fischer, 1834; *Chirocephalus priscus* Daday, 1910 and *Artemia* sp. Three species-*Branchinecta paludosa* (Müller, 1788), *Eubranchipus ornatus* Holmes, 1910 and *Eubranchipus gelidus* (Hay and Hay, 1889) were given in a check list by Kazmi (2004), presently they are not included, while reviewing their inclusion it seemed Kazmi (2004) erroneously included them. An unspecified specimen of *Streptocephalus* is being described and *S. simplex* is re-illustrated in this paper; taxonomy of Pakistani species is reviewed.

Taxonomy

Artemiidae

Artemia sp. (Fig. 1)

There is confusion in names in the genus *Artemia*. Artom (1922) in his publications on *Artemia*, used a number of names to differentiate various populations and subpopulations. Campbell (1991), Shah and Qadri (1992) and Sultana *et al.* (1991, 2000) reported a parthenogenetic form of undetermined species from Pakistan given under the binomen *A. parthenogenetica* which is no more accepted.



Fig. 1. *Artemia* sp.

Thamnocephalidae

***Branchinella (Branchinellites) hardingi* (Qadri & Baqai, 1956) (sensu Rogers, 2006)**

=*Streptocephalus hardingi* Qadri & Baqai, 1956

=*Branchinellites hardingi* (Qadri & Baqai, 1956)

=*Branchinellites (Branchinellopsis) hardingi* (Qadri & Baqai, 1956) in Brtek, 1997

=*Branchinella? hardingi* (Qadri & Baqai, 1956) in Tiwari, 1971

Qadri and Baqai, (1956) described the species as *Streptocephalus hardingi*; the species was first collected in Karachi, Sindh. According to Tiwari (1965, 1971) it was incorrectly assigned by these authors to the genus and corrected the generic assignment and re-described the species. Treated by Brtek and Mura (2000) as belonging in their revived genus *Branchinellites* but we are following Belk and Brtek (1997) on the conservative approach of retaining it in *Branchinella*.

Distribution: Karachi, Malir, also in Chhatarpur District, Madhya Pradesh, India

***Branchinella (Branchinellites) maduraiensis* (Raj, 1951)**

=*Branchinellites kugenumaensis* var. *madurai* Raj, 1951

=*Branchinellites madurai* (Raj, 1951)

=*Streptocephalus karachiensis* Qadri & Baqai, 1956

=*Branchinella karachiensis* (Qadri & Baqai, 1956)

=*Branchinella maduraiensis* (Raj, 1951)

Qadri and Baqai (1956) created a new synonym for *B. kugenumaensis* when they proposed a new name for specimen of this species from Pakistan. Their drawing of *Streptocephalus karachiensis* shows their taxon to be *B. kugenumaensis* which is also synonymized by some workers as *B. madurai* Raj, 1951. Brendonck and Belk (1997), however, considered *Branchinella madurai* Raj, 1951 a valid species. Referring to Martin and Boyce (2004) who have suggested that *B. kugenumaensis* is actually a Japanese species, that the Indian species is *B. madurai* (see also Brendonck and Belk 1997, where the species name is unfortunately misspelled as *maduraiensis*) is valid species. The specimens from the type locality (Karachi) were gifted to Walter Moore, Loyola University, Chicago by I. U. Baqai of University of Karachi.

Distribution: Disjunctly distributed species occurring from Japan, China through eastern Asia to southern India and Karachi, reported by Battish (1983) in Indian Punjab.

***Phallocryptus spinosa* (H.Milne Edwards, 1840) (sensu Rogers, 2003)**

=*Branchipus spinosa* Milne-Edwards, 1840

=*Branchinecta spinosa* (Milne-Edwards, 1840)

=*Branchinella spinosa* (Milne-Edwards, 1840) (fide Rogers, 2003) =*Branchinema aculeata* Wolf, undescribed, deposited types; Seidgar *et al.*, 2009

Phallocryptus spinosa Vakili and Sari, 2012

Milne-Edwards (1840) described *Phallocryptus spinosa* as *Branchipus spinosus*, then Simon (1886) changed the name into *Branchinecta spinosa* but Daday (1910) transferred it to *Branchinella spinosa* and several authors have used recent name. Rogers (2003 and 2006) revised the genus *Phallocryptus* of the Thamnocephalidae and categorized the case in this genus.

Distribution: *Phallocryptus spinosa* lives in shallow, salty and temporary pool with a muddy bed and clear water in the vicinity of a solar salt work inhabits continental salt works where large production of fairy shrimps, support a great numbers of wintering and breeding water birds ranging Mediterranean basin, Pakistan, Iran (Seidgar *et al.*, 2009, Vakili and Sari, 2012), Arabian Peninsula (Theiry and Puff, 1998). It lives in saline lakes of America, Africa, and occidental Asia. There are very few data on its biology and ecology.

Branchipodidae

***Branchipus schaefferi* Fischer, 1834**

It is eurythermic species and considered a rather tolerant species.

Distribution: Sindh, Pakistan. (Gurney, 1906), Bahrain (Al-Sayed and Zainal, 2005), representing again an eastern disjunction for this North African and European anostracan, frequently and in high abundance in the rice fields of eastern Macedonia, Europe, North Africa (Bond, 1934).

Chirocephalidae

***Chirocephalus priscus* (Daday, 1910)**

=*Pristicephalus priscus* Daday, 1910

Distribution: found in Punjab, Sargodha District, Pakistan as well as Punjab and Himachal Pradesh, India (Daday, 1910; Bond, 1934; Belk and Brtek, 1995; Rogers, 2013)

Streptocephalidae

***Streptocephalus (Streptocephalus) dichotomus* Baird, 1860 (sensu Velu and Munuswamy, 2005)**

=*Branchipus bengalensis* Alcock, 1896

=*Streptocephalus dichotomius* Roger *et al.*, 2013

Unreported specimen(?) of *Streptocephalus dichotomus* collected from Pasni, Mekran, are deposited in the Smithsonian National Museum of Natural History, USA (cat no. 213712). The precise locality of "Baird's type specimen is not known (Kemp, 1911). The species has been reported under the synonym of *Streptocephalus bengalensis* Alcock by Qadri and Baqai (1956). The combined records from collections and literature reports included *S. dichotomus* make it the most common anostracan of the subcontinent.

Distribution: South India, Myanmar and the western most record near Karachi, Pakistan.

***Streptocephalus (Streptocephalus) simplex* Gurney, 1906 (Not Bond, 1934 (in Velu and Munuswamy)) (sensu Velu and Munuswamy, 2005) (Fig. 2).**

=*Streptocephalus dichotomus* var. *simplex* Gurney, 1906

=*Chirocephalus stoliczkae* Wood-Mason (nomen nudum in Gurney, 1906)

=*Streptocephalus simplex arabicus* Bond, 1934

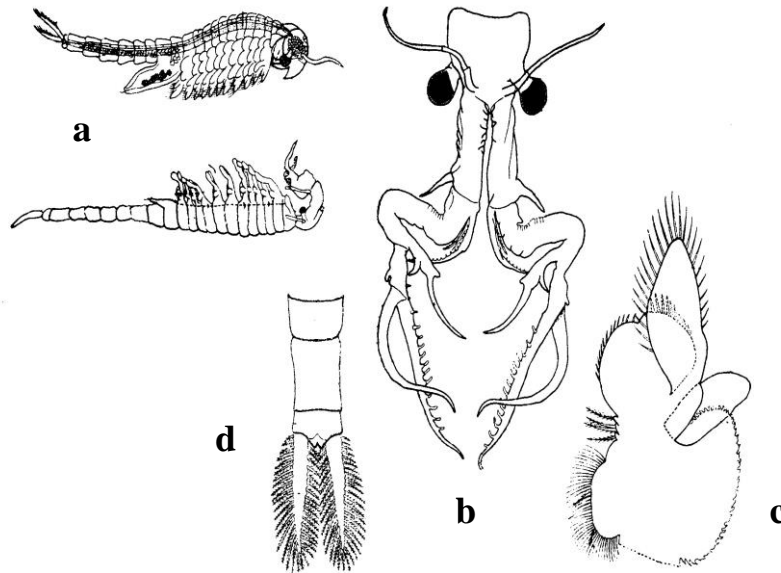


Fig. 2. *Streptocephalus simplex* a. Animal; b. Front; c. Thoracic appendage; d. Posterior abdominal somite and telsonic plate.

Remarks: Gurney (1906) reported it from Kutch (Sindh) as variety “*simplex*” of *S. dichotomus*. It is a problematic species (Munoswamy, 1982) like the previous species making a pair (*S. dichotomus* - *S. simplex*), it is probably a conserved member of the *S. dichotomus*-group (Sanoamuang, 2002). Radhakrishna and Prasad (1976) suggested Bonds’ (1934) morph *S. simplex* with other morphs to represent *Streptocephalus dichotomus*. The taxonomic status of the Indian *S. dichotomus* and *S. simplex* is re-evaluated and updated by Velu and Munuswamy (2005) with additional information on various features such as penis, cercopods and cysts.

Distribution: Europe and Northern Asia (excluding China); Southern Asia; considerable disjunction separates the next records from Aden, Yemen on the southwestern edge of the Arabian Peninsula.

***Streptocephalus* sp.** (Fig. 3 and plate 1a-f)

One female measuring 33 mm (including cercopods) was made available to the authors for determination collected in Pakistan from Hamun-i-Mashkhel, a large dry lake on Kalat Plateau, Kalat, and Balochistan. The specimen being a female was only tentatively given the name of *Streptocephalus* sp. The females of the Anostraca generally present a difficulty, sometimes, if they occur without males, it is not even possible to say with certainty to what family they belong. However, the amplexial groove, dorsal ornamentation, and the form of the brood pouch were used in Californian female fairy shrimps identification by Rogers (2002). Our drawings were sent by the first author (QBK) to several experts abroad. Frank Ferrari was especially approached to match the figures with the Pakistani specimens of *Streptocephalus dichotomus* collected in 1965 from almost the same region and housed in the Smithsonian Institution. He kindly compared our illustrations with them. Frank Ferrari informed (pers. comm.) that the morphology of the limb (cercopod) on the telson of our specimen is not like that of either female or male of *S. dichotomus*. Thus a specific name is not given to Kalati specimen. However a short description is given below:

Front bilobed (Fig. 3a). Antennules 2- segmented. Antennae more muscular, tapering abruptly to a pointed end (Fig. 3b). Mandibles asymmetrical, strong, left bearing 9 large conical teeth, right with only 4 such teeth, bear no palp (Fig. 3c). Thorax bears 11 pairs of leaf like legs, their endopods and exopods equal in length, former broad, provided with sensory setae on inner margin, surface setose, latter triangular, setose, epipod short, three lobes on the outer side, inner side with six lobes, 4th to 6th lobes each provided with a single sensory seta, (Fig. 3d); telson plate notched between cercopods, latter long, broad, narrow, distally pointed, armed all around with moderately long, plumose setae (Fig. 3e). Ovisac short and broad.

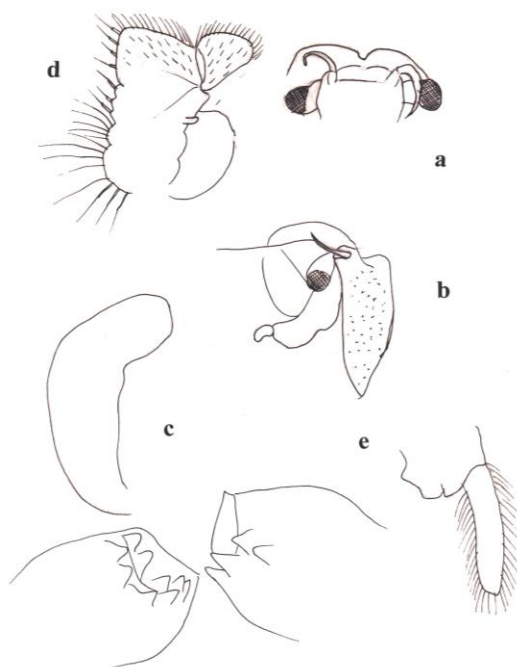


Fig. 3. *Streptocephalus* sp. a-Front, ventral view; b-Same, lateral view; c-Mandible and molar surfaces; d-Sixth left thoracic leg; e-Telsonic plate and right cercopod.

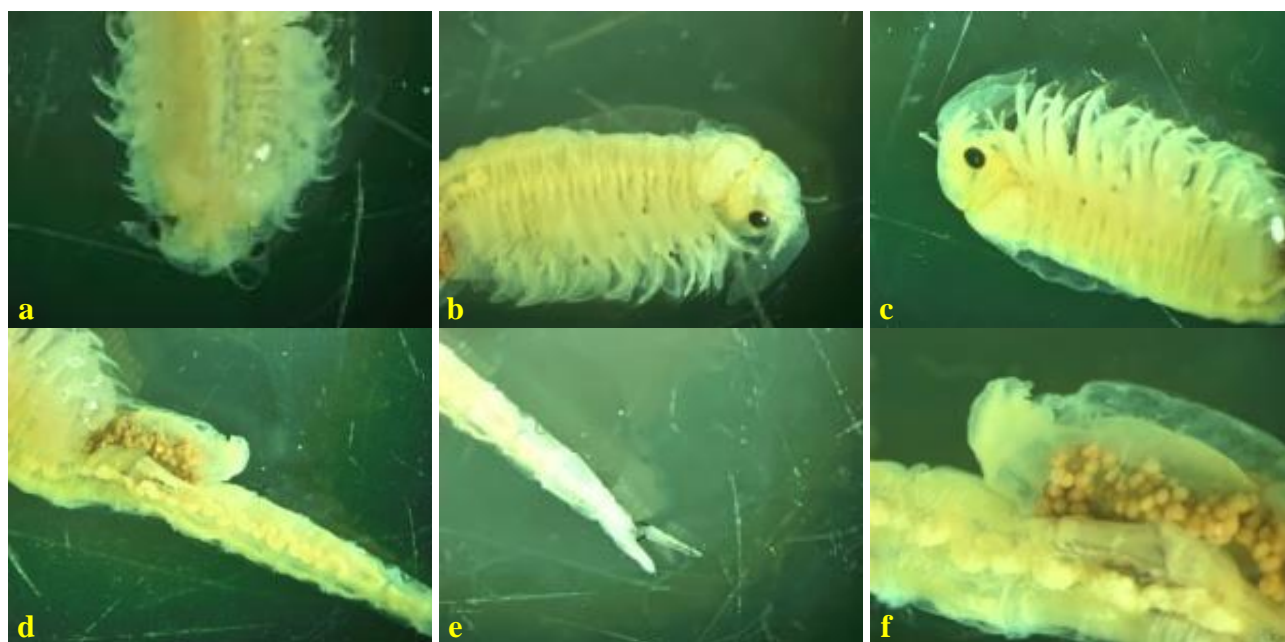


Plate 1. *Streptocephalus* sp. a, b, c. Anterior part, dorsal and lateral views; d. posterior part; e. tail; f. brood pouch.

***Streptocephalus (Streptocephalus) lahorensis* Ghauri and Mahoon, 1980**

Rogers (2013) has a printing error of authorship of the species (pages 526, 540)

***Streptocephalus maliricus* Qadri and Baqai, 1956**

The fate of *Streptocephalus maliricus* Qadri and Baqai (1956) is not known.

We are confident that further exploration will yield more new species and more new species records across Pakistan.

Note on conservation: The need for more study of anostracan zoogeography is demonstrated by the fact that none of the species in this checklist is recently described, some are known only from their type localities. Until we have more complete information on the distributions of the species, it will not be possible to make an accurate evaluation of the status of anostracan biodiversity in Pakistan.

Comparing numbers of species for Pakistan, India has reasonably well studied areas, because of its larger land mass and large number of water bodies and more interest of its scientists in the group, in spite of that it is still considered receiving "sporadic attention" in India (Velu and Munuswamy, 2005). As we see that in Pakistan very few reports are published so before the group is threatened by habitat destruction, and might become extinct a thorough exploratory survey is suggested. Like other developing countries, no data on deterioration of temporary pools are available, but are likely to be as dramatic, due to uncontrolled spraying with insecticides, mining, and agricultural activities (Brendonck and Williams, 2000).

The 2001 IUCN Red List includes 28 anostracan species. Conservation status of the New World *Streptocephalus* following the IUCN red list criteria has been prepared by Maeda-Martínez (2005) but no such studies have been taken up for our region.

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