

Pakistan Journal of Marine Sciences, Vol. 25(1&2), 131-143, 2016.

**REDESCRIPTION OF *ARCOOTHERES PLACUNAE* AND THREE
NEW RECORDS, *A. AFF. ALCOCKI*, *A. CASTA* AND
PINNOTHERES QUADRATUS FROM PAKISTAN WITH A NOTE
ON PREVIOUSLY RECORDED PAKISTANI PINNOTHERID
CRABS**

Quddusi B. Kazmi, Razia Sultana and Farhana S. Ghory

Marine Reference Collection and Resource Centre, University of Karachi (QBK, FSG);
Food and Marine Research Centre PCSIR Laboratories Complex Karachi (RS)
email: farhanaghory@yahoo.com

ABSTRACT: *Arcotheres placunae* a common commensal of bivalve *Placuna placenta* is redescribed; two species of the same genus: *A. aff. alcocki* and *A. casta* and one species of another genus *Pinnotheres P. quadratus* are reported as new records from Pakistan. Previously recorded Pakistani pinnotherid crabs are reviewed.

KEYWORDS: Crustacea, taxonomy, Pinnotheridae *Arcotheres placunae*, *Arcotheres aff. alcocki*, *Arcotheres casta*, *Pinnotheres quadratus*, Pakistani pinnotherid crabs.

INTRODUCTION

The crab family Pinnotheridae is known to be highly diverse family and are reported from different part of the world as commensals of bivalves, some of them are mariculture objects. Due to their cryptic way of life, the sexual dimorphism, and the different morphotypes of the female, the taxonomy of the Pinnotheridae is a serious challenge.

A small collection of pinnotherids, mostly females, were recently submitted to the first author for determination. It contained three new records, described below enriching the list of Pinnotheridae inhabiting the Pakistani waters. The new records belong to the genera *Arcotheres* and *Pinnotheres* respectively.

Diagnosis of *Arcotheres*: Carapace subhexagonal, anterolateral margin acute, posterior margin concave. Third maxilliped with ischium and merus indistinguishably fused; exopod with 3-segmented flagellum; palp 3-segmented; propodus longer than carpus; digitiform dactylus inserted medially on ventral margin of propodus, may extend or slightly overreach-ing apex of propodus. Walking third leg asymmetrical in length either left or right is longer. Dactyli of walking legs dissimilar, those of leg 3-4 longer than legs 1 and 2. Abdomen of six somites and telson well-separated in both sexes Adapted from (Campos and Manning, 2001)

Remarks: In *Arcotheres* Manning, 1993 one pair of walking legs or a single leg can be elongated (Campos, 1996), the third walking legs are asymmetrical in length, either left or right is longer (Campos, 2001). The elongated walking legs is supposed to pick up the mucus from the bivalve gills. The relative length of walking legs and their asymmetry is the important characters among pinnotherids (Gordon, 1936, Campos and Manning, 2001 Campos, 2002). The incidence of left- and right-handed crabs is correlated with their placement on the left or right valve of its bivalve host. However, from Chhappgars' (1957)

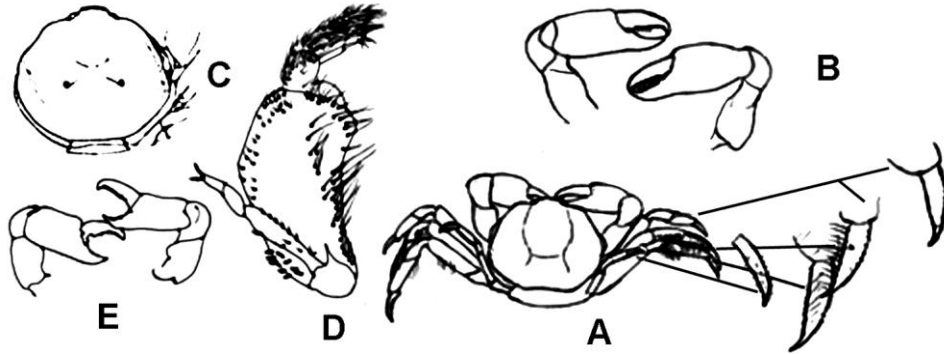


Fig. 1. *Arcotheres* aff. *alcocki*. Female, CL 5.5mm, CW 5.6mm: A, carapace; B, left cheliped (dorsal and ventral views) Male CL 6mm, CW 7mm; C, carapace; D, third maxilliped; E, left cheliped (dorsal and ventral views).

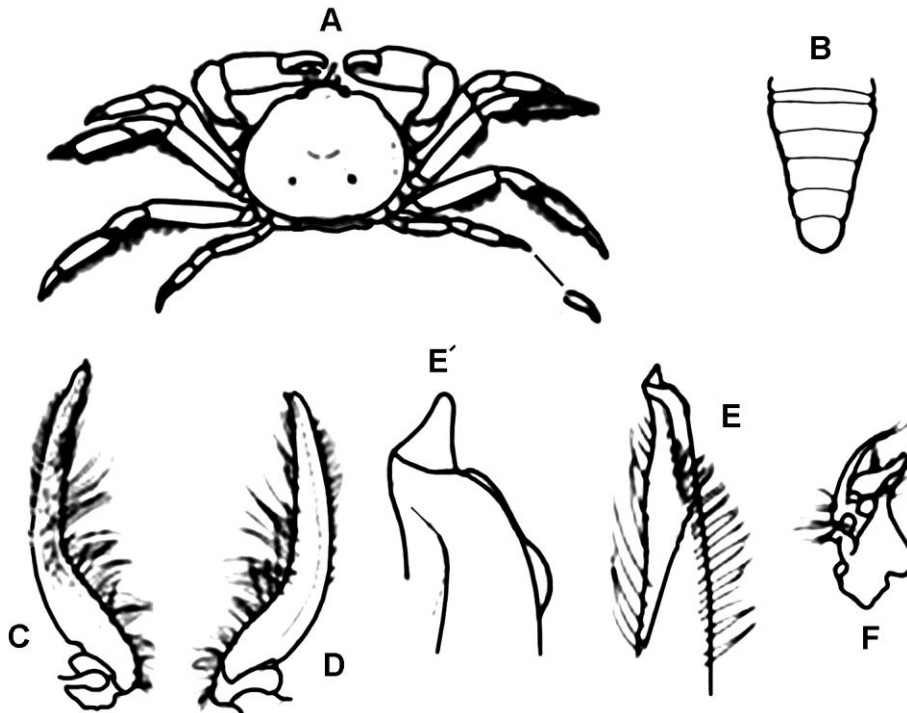


Fig. 2. *Arcotheres* aff. *alcocki*, male CL 13mm: A, dorsal view; B, abdomen; C & D, first gonopod; E & E', tip of same enlarged; F, second gonopod.

description of *P. placunae* it appears that the two sides of all the legs in both the sexes are not exactly of the same dimensions except the second pair of legs which is of the length but the dimensions of the joints are different on both sides.

***Arcotheres aff. alcocki* (Rathbun, 1909)** Figs. 1-2

Pinnotheres parvulus (not Stimpson, 1858) -Alcock, 1900: 339.

Pinnotheres alcocki Rathbun, 1909: 114. -- Tesch, 1918: 248, 254. --Gordon, 1936: 163, 167, 172, 175, fig. 5a-c. -- Silas and Alagarswami, 1967: 1195. -- Schmitt *et al.*, 1973: 38. -- Devi, 1981:215

Arcotheres alcocki (not Takeda and Konishi, 1988: 138, figs 1, 2f-h, 3)

Arcotheres alcocki -Ahyong and Ng, 2007:193 fig 1; Pati *et al.*,2015:1067

Material: two males CL 6-13mm; one female CL 5.5mm-8th May,2008

Host not noted.

Description: Carapace broader than long and frontal region protruded forward, having blunt, thick lateral margins along anterior half; gastro-cardiac separation indicated at each lateral end by shallow depression; whole dorsal surface devoid of setae but pitted. Front directed very weakly downward, provided with short setae along anterior margin. Second somite of abdomen broadest. Chelipeds with short setae dense and longer along cutting margins. First 3 pairs of legs gradually increase in length, similar in shape; in second and third pairs, each merus provided with long setae along posterior margin, each carpus with row of long setae on upper surface from basal part of posterior border to distal part of anterior border, each propodus fringed with row of long setae along anterior part as continuation of row of carpus; dactyli of first two pairs not much different from each other, being rather short and subequal to one another, that of third long, less curved, all setose. Last pair about 2/3 as long as preceding pairs, slenderer than preceding ones, setose, armed with distal claw, having arrow of 9-10 spinules; right fourth shorter than left in one male. Gonopod 1 is compressed, curving laterally, tapering distally with setae on margins; acute tip directed medially, gonopod 2 short.

Remarks: The present material seems to stand near to species described by Takeda and Konishi (1988) as *A. alcocki* in having very blunt, thick lateral margins along its anterior half; gastro-cardiac separation being indicated at each lateral end by a shallow depression, with sparse minute pits along entire length of both lateral margins; front dorsally covered with minute pits, and provided with short setae along anterior margin, in second and third pairs, each merus provided with long setae along posterior margin, each carpus with a row of long setae on its upper surface from basal part of posterior border to distal part of anterior border, and each propodus fringed with a row of long setae along anterior part as continuation of a row of carpus except that the carapace excluding frontal region is not exactly circular. Ahyong and Ng (2007) and Theil *et al.*, (2016) commented that *A. alcocki* of Takeda and Konishi (1988) could be synonym of *A. sinensis* which has been reported from Manakudy Estuary, Southwest Coast of India by Kannappan, *et al.*, (2012).

The males resemble male of *P. alcocki* described by Devi (1981) in structure of legs but differing in the abdomens' shape and gonopod tip. The males at hand also resemble *Pinnotheres vicaji* Chhapgar (1957) (this should be transferred to *Nepinnotheres* (Ng and Kumar, 2015) in having a straight front, the merus-ischium of third maxilliped, its pronounced antero-internal angle, propodus abruptly narrowing in the distal half, and hair

setal pattern of second and third pairs of legs. They resemble *A. guinoti* Campos in having setae on the ventral side of fourth leg longer than those of its dorsal margin.

This will be the third report of males; the first was described by Devi (1981) then Pati *et al.* (2015) reported one male. Ahyong and Ng (2007) mentioned of male never described, they were probably not aware of Devis' paper of 1981.

Sometimes the males were observed in literature outside the host, it might be the reason of host not known in the present case. Otherwise the known hosts are *Tegillarca granosa* (Linnaeus, 1758) (as *Andara*), *Cythera*, *Mytilus*, and *Meretrix casta*, all from Bay of Bengal.

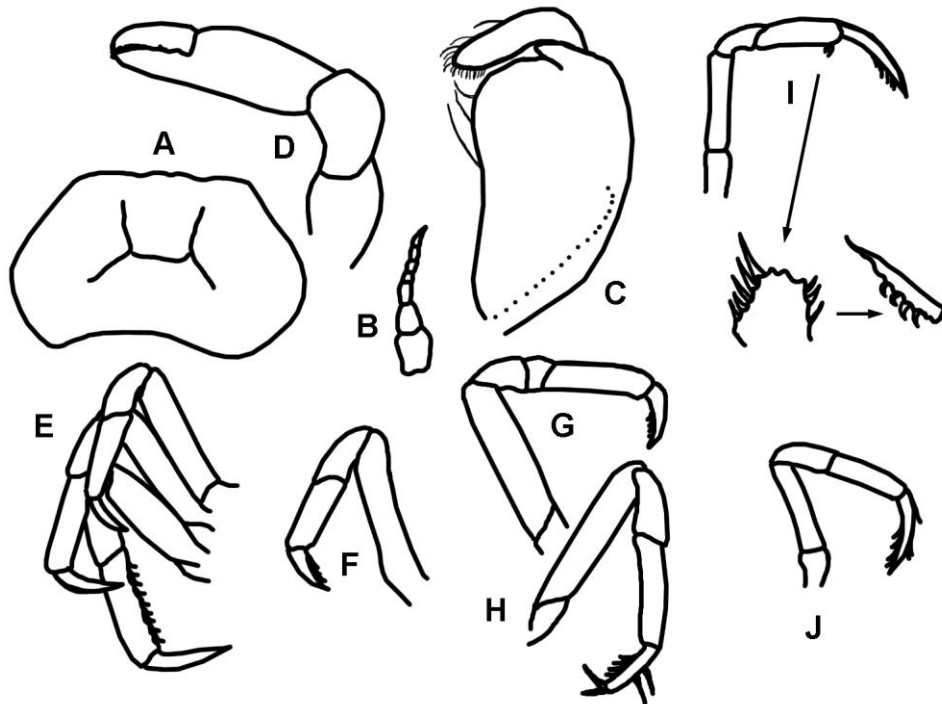


Fig. 3. *Arcotheres placunae*: A, carapace and frontal view; B, antennule; C, third maxilliped; D, right cheliped; E, left last three legs; F, first leg; G, second right leg; H, second left leg; I, third leg; J, fourth leg.

Distribution: Eastern Indian Ocean

Arcotheres placunae (Hornell and Southwell, 1909) Figs. 3-4.

Pinnotheres placunae Hornell and Southwell, 1909:99--Chaapgar, 1957:503- Hashmi, 1963:239-- Tirmizi and Ghani, 1996 :88--Devi and Rao, 1986:445(biology)- Jose and Deepthi, 2005:1090

Arcotheres placunae -Venkataraman *et al.*, 2004: 156,157,165 (list)--Beleem *et al.*,2014: 422--Trivedi *et al.*, 2015: 27

Material: Korangi Creek, 4-11-98, January 99, 17-4-99, 23-4-99, 25-10-99 (all the five samples were pooled together), 52 females cl 7-11mm, all egg-bearing

Host *Placuna placenta*.

Description: Carapace sub trapezoidal, wider posteriorly, dorsal surface of carapace naked, smooth, anterior margin straight, sloping in postero-lateral region. Anterior border well defined, front not projecting, convex medially, separated. Eyes visible only on pressing front, the latter slightly setose. Anterolateral angles rounded, pronounced. Posterior border concave.

Antennae composed of 6 articles, basal segment wide, distal segment setose. Third maxilliped antero-anteral angle of ischio-merus defined; dactylus short not extending to narrowed apex of propodus.

Chelipedes equal, and robust, dactylus less than half of upper border of palm, fixed finger with sinuous cutting margin and setose posterior margin, and dactylus with a tooth and long setae on occlusal margin.

Walking legs similar in shape, third being the longest, margins from merus to carpus without setae; propodi longer than carpi and scantily setose on ventral margins; third propodi sometimes asymmetrical. third and fourth dactyli longer than first and second, fine setae present on all sides, those on ventral edge longer than those on dorsal margin; terminal claw spooned, 12-14 spinules; fourth pair of walking legs more slender than others; fourth dactylus longest and longer to propodus, latter having a tuft of setae at distal end, dactylus provided with thick setae all over.

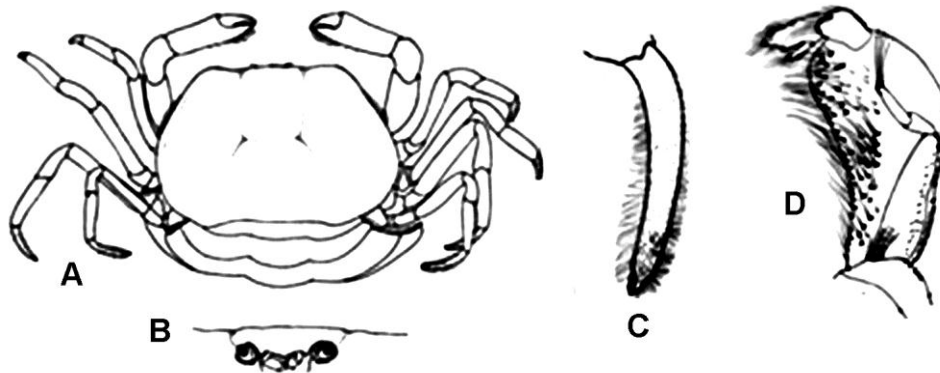


Fig. 4. *Arcotheres placunae* Female CL 9mm: A, entire; B, Front; C, dactylus of fourth leg; D, third maxilliped.

Incidence of occurrence: The frequency of occurrence of *Arcotheres placunae* was noted down. It occurred that almost 90% of *Placuna* population was infested. No relationship was observed between the season and size of the clam (length 100- 165mm, breadth 110-170 mm); however, the size of the crab was not noted. The number of crabs in each clam varied from one to seven when checked randomly. For Indian population of *Placuna* Hornell and Southwell (1909) remarked that immature shells of *Placuna placenta* less frequently revealed the presence of the pea-crab and in such instances the crabs were mostly immature. They opined that in this case the crabs grew towards maturity

concurrently with their hosts. *A. placunae* causes small lesions in the mantle and can cause partial sterility in *P. placenta* (Narisimham, 1984).

Remarks: We think it is advisable to refer the present females, for the present, though with some hesitation, to *A. placunae*. Nor can these specimens be referred to *A. similis* Burger, 1895 described by Gordon (1936) though they resemble *similis* in having the same host, a hairy front, a defined angle of merus of third maxilliped and in movable finger /palm ratio since *similis* is advised in a need of restudy (Ahyong and Ng, 2007). The movable fingers of chelipeds are smaller than the palm in the present material also resembling *P. placunae* of Chaapgar's material from Mumbai and Devis' material from Kakinada, India but differing from the holotypes' description where they are equal to the palm.

Jose and Deepthi (2005) found *Perna viridis*, as new host for *A. placunae* (as *Pinnotheres*) along the Malabar coast, Kerala (India), this material needs to be re-examined (Ng and Kumar, 2015)

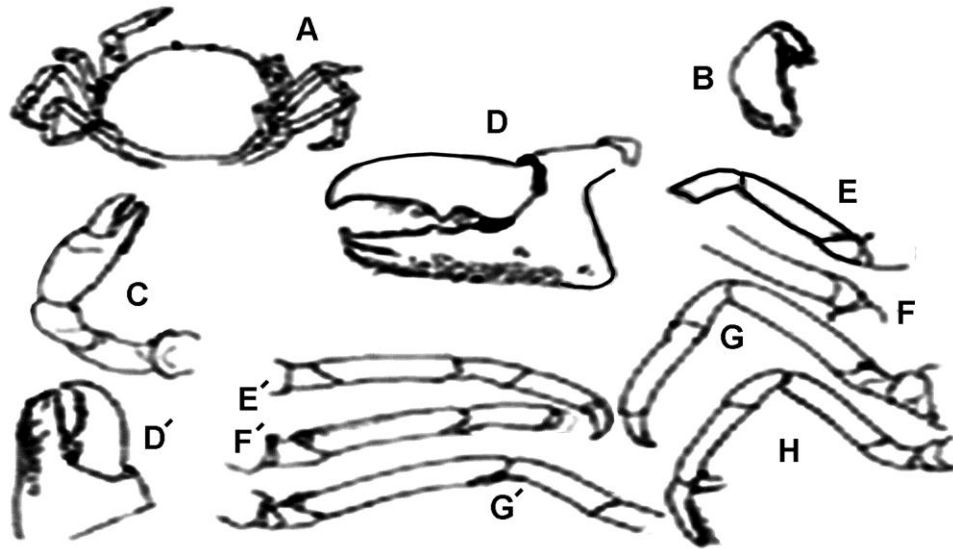


Fig- 5. *Arcotheres casta*, Female CL 6mm: A, dorsal view; B, third maxilliped; C, cheliped; D' & D'' chela; E&E', first right and left legs (right broken); F & F', second legs, broken; G & G', third right and left legs (left broken); H, fourth leg.

Distribution: India and Pakistan

Arcotheres casta (Antony and Kuttyama, 1971) Fig 5.

Pinnotheres sp. Silas and Alagarwami, 1965: 1164

Pinnotheres casta Antony and Kuttyama, 1971: 60- Lal Mohan *et al.*, 2002: 142-Roy, 2013: 156,158,163

Arcotheres casta -Ng and Kumar, 2015: 265

Material: Two females, one damaged spent female, CL 6mm, 19-01-1998 (Entire, maxilliped); one damaged spent female, 17-07- 2001.

Host: *Marcenaria*

Description: Carapace slightly broader than long and consequently appears sub quadrate in outline, curving downwards towards the lateral margins. surface of carapace smooth and naked; front inconspicuous, hardly projects beyond the straight anterior margin of the carapace; minute ovate orbits barely visible dorsally; merus-ischium of the third maxilliped large; the outer margin evenly curved, long setae implanted along inner border from base to distal end, carpus short, propodus relatively longer and more or less uniformly broad and bluntly rounded at the tip. Dactylus long, slender and uniformly broad and reaches to a level beyond the tip of the propodus. Distal margin of the carpus, the outer margin and tip of the propodus and the tip of the dactylus bear short to moderately long setae. A conspicuous tooth on the inner margin of the movable finger and a fringe of minute serrations or undulations on the fixed finger of the cheliped. Walking legs slender, moderately elongate and sub equal, the third pair being the longest, second pair longer than the first pair, but slightly shorter than the fourth pair; propodus longest in the third walking legs, on its inner side distally bears two or three long fine setae; dactyli of the walking legs show a progressive increase in size from the first leg to the fourth leg; those of the first three legs end as slightly recurved claws; barb-like short setae present along the inner margin of the dactyli of the first two walking legs and the dactyli of the third pair of walking legs have in addition a few long fine setae; dactylus of the fourth pair of legs conspicuously elongate, being almost as long as the propodus and having moderately elongate setae along the inner margin.

Distribution: West coast of India; Kayamkulam, Cochin backwaters, Kerala and Calicut

Remarks: In one of the present specimens the dactylus of left third is long and those of fourth pair are the longest. The present females resemble that described by Barnard (1950) as *Pinnotheres* sp. from Delagoa Bay in shell of *Modiola* in the shape of dactyli of third maxilliped and fourth and fifth legs. It is very close to that of Antony and Kuttyama (1971) but differs from both Silas and Alagarwami (1967) and Antony and Kuttyama (1971) in having teeth on the cutting edges of the fingers of chelipeds.

Both Silas and Alagarwami (1967) and; Antony and Kuttyama (1971) obtained material from the same host species, viz., *Meretrix casta* while Lal Mohan, et al. (2002) found it in *Perna viridis*. The host for present female of cl 6mm is *Mercenaria* sp. (mantle cavity).

Diagnosis of Pinnotheres: Carapace sub circular, with rounded angles. Dorsal surface with regions poorly defined. Front, orbits and eyes minute. Third maxillipeds elongate, with ischium and merus indistinguishably fused; propodus longer than carpus; dactylus sub terminal, inserted at or near the base of ventral margin of propodus, styliform, apex not extending to end of propodus. Ambulatory legs not fringed dorsally and ventrally with long setae; propodus not expanded distally in female; dactyli sub equal and similar, falcate. Male telson almost as long as broad. (After Guinot, 1998).

Remarks: *Pinnotheres* is a widespread genus. Many species formerly in *Pinnotheres* have been placed in new genera.

Pinnotheres quadratus Rathbun, 1909 Fig. 6.

Pinnotheres quadratus Rathbun, 1909, 1910: 333, fig. 15 (?). - Tesch, 1918: 250, 255, 261, pi. 17 (c?) fig. 2 — Suvatti, 1938, 1950, 160 (listed). - Chhapgar, 1955: 256, fig. 2 (a, b), 1957: 506 pi. 12 figs. 1-m. - Silas and Alagarwami, 1967: 1207, 1208, 1223, 1225.

Material: One young damaged female, 5mm; Korangi Creek.

Host *Placuna placenta*

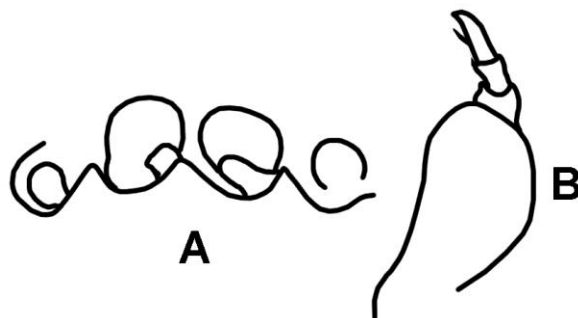


Fig. 6. *Pinnotheres quadratus*: A, front; B, third maxilliped.

Description: Carapace sub hexagonal. Regions defined. The frontal margin is trilobed. Third maxilliped with ischium and merus indistinguishably fused; exopod with flagellum; propodus much longer than carpus; dactylus minute, spatulate, inserted before midlength of ventral margin of propodus, not extending beyond end of propodus. Legs asymmetrical left 4 extending beyond merus of leg 3 by half dactylus, right 4 not reaching merus of leg 3. Dactylia of legs 1-3 similar, with slight increase in size from anterior to posterior, 2-3 with long setae on propodus and carpus. Dactylia of leg 4 slender, shorter than others, tip spined.

Distribution: India, Gulf of Thailand; east coast of Lombok (Indonesia); northwest coast of Waigeu Island (New Guinea) in *Arca*.

Remarks: It is a minute crab, male measuring 2.4 mm in length, 2.75 mm in width (Tesch, 1918); ovigerous females' length was 5.2 mm, width 5.3 mm (Rathbun, 1909). Tesch (1918) has provisionally placed a male and a female pea-crab from the Siboga Expedition collections from bivalve *Arca* under this species and at the same time drawn attention to the differences between his specimens and the description of the species given by Rathbun, 1909. The dark speckles on carapace shown by Chaapgar (1955) are not visible in Pakistani specimen. This specimen is provisionally placed here as *Pinnotheres quadratus* until further collection is seen.

Note on previously recorded Pakistani pinnotherids: Two free living species *Asthenognathus gallardoi* Serene and Soh, 1976 and *Xenophthalmus wolffi* and were described by Ghani and Tirmizi (1991) and Tirmizi and Ghani (1995), respectively in Pinnotheridae, the former is now in the Family Xenophthalmidae and the latter is now as *Gopkittisak gallardoi* in the family Varunidae (see Naruse and Clark, 2009). Another free-living species *Indopinnixa* aff. *sipunculana* Manning and Morton, 1987 was reported by Kazmi and Moazzam (2012) associated with sipunculids and capitellid polychaetes.

The commensal species *Arcotheres tivelae* (Gordon, 1936) was collected by Moazzam and Rizvi (1985) as *Pinnotheres tivelae* from our backwaters in *Tivela panderosa*. Then the first author collected the species (now housed in the Smithsonian Institution, Washington) from *Mercenaria cor* on 21st February 1993, from Cape Monze. Recently

A. tivelae was found at low tide, infesting the bivalve *Amiantis umbonella*, partially dug in the sediment in the Persian Gulf of Iran (Saeedi and Ardalan 2010).

As *Pinnotheres placunae* from *Placuna placenta* first Hashmi (1963, 1969) as larvae, then Khan and Ahmed, 1975 listed from Pakistan. Lastly Tirmizi and Ghani (1996) described it. The figure given by them (cf. fig 33) is, what so ever the sex is, (from figure it looks like a male but given as female; they described the female abdomen similar to male), more close to *Pinnotheres* sp. described by Barnard (1950). *Arcotheres placunae* was originally described by Hornell and Southwell (1909) from Kathiawar, the Gulf of Kutch along the west coast of India. Since we have presently only the figures of Hornell and Southwell (1909) and the description is missing we quote Naderloo and Türkay (2012). According to Naderloo and Türkay (2012) Hornell and Southwell (1909) description “is imprecise in many ways. The figures do not agree with the description given in the text, e.g. walking legs in the female. While the text describes the female dactylus of the third and fourth pair of walking legs being one and a half times longer than those of the first and second, this is not represented in the drawing. Furthermore, the sub hexagonal shape of the female carapace is strongly exaggerated”. Naderloo and Türkay (2012) have also examined the type material of *Arcotheres tivelae* (Gordon, 1936) from Muscat, Gulf of Oman and “revealed that this species is in all respect identical with *A. placunae*, the latter”. Naderloo and Türkay (2012) have not included Chhapgar (1957) report in their account who described *A. placunae* as *Pinnotheres placunae* from *Placuna placenta*, Okhamandal, Mumbai. He has given the dimensions in quite detail but his illustrations are not in details. We thought of following Naderloo and Türkay (2012) but according to Dr Peter Ng (pers. comm.QBK) Naderloo and Türkay (2012) were incorrect in assuming *A. placunae* and *A. tivelae* the same species.

The unspecified species of *Pinnotheres* from *Soletellina arata* given by Tirmizi and Ghani (1996 fig 34) has a carapace broader than long, and all its dactyli of legs illustrated by them are equal (cf. fig 34) whereas in the description (p.89) that of the third pair is given long. The dactylus of third maxilliped is longer than the propodus. This is close to *Afropinnotheres* Manning, 1993. Ng and Kumar (2015) included Tirmizi and Ghani (1996, fig 34) species with their new species *Afropinnotheres ratnakara* living in *Perna perna* and as such a new record of the genus from the Indian Ocean.

Planktonic larvae of an unspecified pinnotherid species have been described by Ghory and Kazmi (in press) from here.

The genus *Sindheres* was established by Kazmi and Manning, (2003) as *Sindheres karachiensis* Kazmi and Manning, (2003) living inside the mantle cavity of probably *Gastrochaena* sp.

Nepinnotheres villosulus was reported firstly by Siddiqui (2012) then by Jahangir et al (2015) from *Meretrix casta*, *Marcia recens*, *Callista umbonella*, *Gastrana multangula*, *Protapes cor* and *Psammotreta angulata* and *Anadara antiquata*; the genus/species has never been reported from the Indian Ocean.

ACKNOWLEDGMENTS

The first author is grateful to Drs. P.K.L. Ng and E. Campos, for helping during the writing of the manuscript.

REFERENCES

- Ahyong, S.T. and P.K.L. Ng. 2007. The pinnotherid type material of Semper (1880), Nauck (1880), and Bürger (1895) (Crustacea: Decapoda: Brachyura). *Raffles Bull. Zool. Suppl.* 16: 191–226.
- Alcock, A. 1900. Materials for a carcinological fauna of India No. 6. The Brachyura Catometopa, or Grapsoida. *J. Asiat. Soc. Bengal.* 64(3. Part 2): 279-456.
- Antony A. and V.J. Kuttamma. 1971. A new species of the pea crab *Pinnotheres* Latreille (Crustacea; Brachyura; Pinnotheridae from the clam *Meretix casta* (Chemnitz). *Bull. Dept. Mar. Biol. Oceanogr.* 5: 59-68.
- Barnard, K.H. 1950. Descriptive catalogue of South African Decapod Crustacea. *Ann. S. African Mus.* 38: 1-837.
- Beleem, I.B., J.S.Y. Kumar, Ch. Satyanarayana, K. Venkataraman and R.D. Kamboj. 2014. Distribution of Marine Crabs from the Marine National Park, Gulf of Kachchh. Scholars Academic Journal of Biosciences (SAJB) (Online) *Sch. Acad. J. Biosci.* 2(7): 419-427.
- BÜRGER O. 1895. Ein Beitrag zur Kenntniss der Pinnotherinen. *Zoologische Jahrbücher, Abtheilung für Systematik, Geographie und Biologie der Thiere* 8: 361-390, pls 9: 10.
- Campos, E. 1996. Partial revision of pinnotherid crab genera with a two-segmented palp on the third maxilliped (Decapoda: Brachyura). *J. Crust. Biol.* 16: 556–563.
- Campos, E. 2001. A new crab species of the genus *Arcotheres* Manning, 1993, from Thailand (Crustacea: Brachyura: Pinnotheridae). *Zoosystema* 23(3): 493-497.
- Campos, E. and R.B. Manning. 2001. Authorship and diagnosis of the genus *Arcotheres* Manning, 1993 (Crustacea: Brachyura: Pinnotheridae). *Raffles Bull. Zool.* 49(1): 167-170.
- Campos E. 2002. Two new genera of pinnotherid crabs from the Tropical Eastern Pacific (Decapoda: Brachyura: Pinnotheridae). *J. Crus. Biol.* 22: 328–336.
- Chhapgar, B.F. 1955. *On two new species and a new variety of crabs* (Decapoda, Brachyura) from Bombay State. *Rec. Indian Mus.* 53(1&2): 251-260.
- Chhapgar, B.F. 1957. *Marine Crabs of Bombay State*. Diocesan Press, 89 pages.
- Devi, L.S. 1981. *Occurrence of pea crabs Pinnotheres gracilis Burger and P. alcocki Rathbun at Kakinada*. *J. Mar. Biol. Assoc. India.* 23(1&2): 215-218.
- Devi, L.S. and K.H. RAO. 1986 Some Aspects of Biology of the Pea-Crab *Pinnotheres placunae* Hornell and South well. *Proc. Indian natn. Sci. Acad.* 1352(4): 455-459.
- Ghani, N. and N.M. Tirmizi. 1991. Rediscovery of *Asthenognathus gallardoi* Serène and Soh, 1976, from Pakistan (Northern Arabian Sea) with description of the male. *Crustaceana.* 61(1): 100–102.
- Ghory, F., and Q.B. Kazmi. In press. *Experimental studies on the larval development and identification of common marine crustacean larval stages in wild with emphasis on those of the Decapods* (LAP LAMBERT Academic Publishing, Germany).
- Gordon, I. 1936. On a few Indo-Pacific species of *Pinnotheres*, with special reference to asymmetry of the walking legs. *J. Linnaean Soc. London.* 40: 163-180.
- Guinot, D. 1998. Diagnoses de Crustacés Décapodes Brachyours. *The crabs of Japan*. ETI World Biodiversity Database, Linnaeus II, Amsterdam. 4th International Crustacean Congress, Amsterdam.

- Hashmi, S.S. 1963. Carcinological fauna of Karachi, Agriculture Pakistan. XIV(2): 237-243.
- Hashmi, S.S. 1969. The larvae of *Elamena* (Hymenosomidae) and *Pinnotheres* (Pinnotheridae) hatched in the laboratory (Decapod: Crustacea). *Pakistan J. Sci. Ind. Res.* 12: 279-285.
- Hornell, J. and T. Southwell. 1909. Description of a new species of Pinnotheres from *Placuna placenta*, with a note on the genus. Report on the Marine Zoology of Okhamandal in Kittiawar, I: 99-103, pl. 1.
- Jahangir, S., G. Siddiqui, Z. Ayub and C.B. Boyko. 2015. New record of the pea crab *Nepinnotheres villosulus* (Guérin-Meneville, 1831) (Brachyura: Pinnotheridae) from clams and cockles of Pakistan (northern Arabian Sea). *Marine Biodiversity Records*. Volume 8.
- Jose, B. and T.R. Deepthi. 2005. Green mussel *Perna viridis*, a new host for the pea crab *Pinnotheres placunae* along the Malabar Coast, *Kerala Current Science*. 89: 1090-1091.
- Kannappan, T., M. Shanmugavelu, C. Sudhamathi, V. Elumalai and M.M. Karthikeyan. 2012. New Record of Pea Crabs (*Pinnotheres sinensis* Shen, 1932) along the Manakudy Estuary, Southwest Coast of India. *Europ. J. Biol. Sci.* 4(2): 45-48.
- Kazmi Q.B. and R.B. Manning. 2003. A new genus and species of pinnotherid crab from Karachi, northern Arabian Sea (Crustacea, Decapoda, Brachyura). *J. Nat. Hist.* 37: 1085-1089.
- Kazmi, Q.B. and M. Moazzam. 2012. Four New Records of Brachyurans from Pakistan *Pak. J. Zool.* 44(6): 1499-1505.
- Khan, M.A. and M.F. Ahmad. 1975. A Checklist of Brachyura of Karachi Coasts, Pakistan. *Records of the Zoological Survey of Pakistan*. 7(1&2): 71-85.
- Lal Mohan R.S., G. Vearghes and E. Campos. 2002. On the damage caused to the green mussel *Perna viridis* by pinnotherid crab *Pinnotheres casta* Antony and Kuttyamma, 1971 along the Calicut coast. *J. Bombay Nat. Hist. Soc.* 99(1): 142-3.
- Linnaeus, C. 1758. *Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Editio decima, reformata. Laurentius Salvius: Holmiae.* ii. 824 pp.
- Manning, R.B. and Morton, B. 1987. Pinnotherids (Crustacea: Decapoda) and Leptonaceans (Mollusca: Bivalvia) associated with sipunculan worms in Hong Kong. *Proc. Biol. Soc. Washington*, 100: 534-551.
- Manning, R.B. 1993. Three genera removed from the synonymy of *Pinnotheres* Bosc, 1802 (Brachyura: Pinnotheridae). *Proceedings of the Biological Society of Washington*. 106(3): 523-531.
- Moazzam, M. and Rizvi, S. H. N. 1985. *Pinnotheres tivelae* Gordon 1936: a new addition to the crab fauna of Pakistan, *Pak. J. Zool.* 17(4): 441-442.
- Naderloo, R. and M. Türkay. 2012. Decapod crustaceans of the littoral and shallow sub littoral Iranian coast of the Persian Gulf: Faunistics, Biodiversity and Zoogeography. *Zootaxa* 3374: 1-67.
- Narisimham, K.A. 1984. Biology of windowpane *Oyster placenta placenta* (Linnaeus) In Kakinada Bay. *Indian J. Fish.* 31(2): 272-284.

- Naruse, T. and P.F. Clark. 2009. Establishment of a new genus for *Asthenognathus gallardoi* Serène and Soh, 1976 within Gaeticinae Davie and N.K. Ng, 2007 (Crustacea: Decapoda: Brachyura: Varunidae) *Zootaxa* 1987: 61-68.
- Ng, P.K.L. and A.B. Kumar. 2015. A new species of *Afropinnotheres* Manning, 1993 (Crustacea, Brachyura, Pinnotheridae) from southwestern India, the first record of the genus from the Indian Ocean, with a review of the Pinnotheridae of India and adjacent seas *Zootaxa* 3947(2): 264–274.
- Pati, P., B. Sahu and R.C. Panigrahi. 2015. Pea crab *Arcotheres alcocki* (Rathbun, 1909) as endoparasite of the backwater clam *Meretrix casta* (Chemnitz, 1782). *IJMS* 44(07): 1067-1070
- Rathbun, M.J. 1909. New crabs from the Gulf of Siam. *Proceedings of the Biological Society of Washington* 22: 107-114.
- Roy, M.K.D. 2013. Ecology and Conservation of Tropical Marine Faunal Communities Venkataraman, K., Sivaperuman, Cand. Raghunathan, C. (Eds). Springer Science and Business Media, - Science - 481 pages.
- Saeedi, H. and A.A. Ardalan. 2010. Incidence and biology of *Arcotheres tivelae* (Crustacea: Decapoda) in *Amiantis umbonella* (Bivalvia: Veneridae) on the northern coast of the Persian Gulf, Iran. *J. Mar. Biol. Assoc. United Kingdom*. 90(4): 655-661.
- Schmitt, W.L., J.C. McCain and E.S. Davidson. 1973. Decapoda I Brachyura I Fam. Pinnotheridae. In 'Crustaceorum Catalogus', Pars 3 (Eds: H.E. Gruner and H.L. Holthuis.) pp. 1-160. (W. Junk B.V.: Den Haag, The Netherlands).
- Serène, R. and C.L. Soh, 1976. Brachyura collected during the Thai-Danish expedition 1966. *Res. Bull. Phuket mar. biol. Center*, 12: 1-37, figs. 1-28, pls. 1-7.
- Siddique, G. 2012. Infestation of pea crab, *Nepinnotheres villosulus* and their associated bopyrids *Hypocepon enoencis* in clams and cockles from Sonmiani (Balochistan). 1st Congress of Applied Chemical Sciences (CApChem-2012).
- Silas, E.G. and K. Alagarwami. 1967. On an instance of parasitisation by the pea crab [*Pinnotheres* sp.] on the backwater clam [*Meretrix casta* (Chemnitz)] from India, with a review of the work on the systematics, ecology, biology and ethology of pea crabs of the genus *Pinnotheres* Latreille, *Proceed. Symp. Crust. Marine Biological Association of India*, 3: 1161-1227.
- Stimpson, W. 1858. Prodromus descriptionis animalium evertibratorum quoe in Expeditione ad Oceanum Pacificum eptentrionalem a Republica Federata Missa, Cadwaladaro Ringgold et Johann Rodgers Ducibus, observavit et descripsit – Part V, Crustacea Ocyphodoidea. *Proceedings of the Academy of Natural Science, Philadelphia*, 10: 93–110.
- Suvatti, C. 1938. A check-list of aquatic fauna in Siam (excluding fishes). *Bureau of Fisheries* (Bangkok), pp. 116.
- Takeda, M. and K. Konishi. 1988. Redescription of *Pinnotheres alcocki* Rathbun, 1909, a commensal pea crab new to Japan. *Bull. Nat. Sci. Mus. Series A (Zoology)*. 14(3): 137–144.
- Tesch, J.J. 1918. Decapoda Brachyura II. Goneplacidae and Pinnotheridae. *Siboga Expeditie Monographite*, 39c1: 149–295, pls. 7–18.

- Theil, E.P., J.A. Cuesta and D.A. Felder. 2016. Molecular evidence for non-monophyly of the pinnotheroid crabs (Crustacea: Brachyura: Pinnotheroidea), warranting taxonomic reappraisal Supplementary Material: Invertebrate Systematics 30: 1-27.
- Tirmizi, N.M. and N. Ghani. 1995. *Xenopthalmus wolffi* Takeda and Miyake. A genus and species of free living Pinnotherid crab new to Pakistani waters (Decapoda, Brachyura), *Crustaceana*. 68(5): 633-655.
- Tirmizi, N.M. and N. Ghani. 1996. Marine Fauna of Pakistan: 5, Crustacea: Brachyura, Brachyrhyncha, Part I (Xanthidae, Goneplacidae, Pinnotheridae, Ocypodidae, Grapsidae). Publication of the Centre of Excellence in Marine Biology, University of Karachi, 188 pp.
- Trivedi, D.J., J.N. Trivedi, G.M. Soni, B.D. Purohit and K.D. Vachhrajani. 2015. Crustacean Fauna of Gujarat State of India: A Review. *Electron. J. Environ. Sci.* 8: 23-31.
- Venkataraman, K., R. Jeyabaskaran, K.P. Raghuram and J.R.B. Alfred. 2004. Bibliography and Checklist of Coral and Associated Organisms of India. Zoological Survey of India. 226: 1-468.