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ON A FEW INDO-PACIFIC SPECIES OF PINNO-  
THERES, WITH SPECIAL REFERENCE TO  
ASYMMETRY OF THE WALKING LEGS.

BY

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On a few Indo-Pacific species of *Pinnotheres*, with special reference to  
asymmetry of the walking legs. By ISABELLA GORDON, D.Sc., Ph.D., F.L.S.

(With 7 text-figures)

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A SMALL collection of *Pinnotheres*, mostly females, were recently submitted to me for determination by Mr. R. Winckworth, who found them in certain Indo-Pacific bivalve molluscs. In addition to describing these species I have thought it advisable to add notes on two forms already included in the very small Pinnotherid collection in the British Museum. I wish to express my thanks to Mr. Winckworth for kindly presenting his material to the Museum.

The genus *Pinnotheres*, comprising a very large number of species, is urgently in need of thorough revision. While Bürger (1895, key, pp. 362–364) may be said to have laid the foundations of our knowledge of the Indo-Pacific forms, it is unfortunate that his descriptions and figures of some twenty-six new species are, for the most part, inadequate. Tesch (1918, p. 251) drew up a key to the determination of fifty-eight Indo-Pacific species, but does not seem to indicate how many of these he had actually examined. It is unlikely, however, that he had first-hand knowledge of Bürger's types. When specimens have been provisionally determined by means of Tesch's key, it is often quite impossible to say, with any degree of certainty, that they actually are referable to the species in question. For example, two of the species dealt with in this paper run down to division 42 of Tesch's key (i.e. to *P. alcocki* or to *P. similis*). They differ markedly, especially as regards the walking legs, and Bürger's description of *P. similis* gives little information about the legs, the relative lengths of the dactyli excepted.

De Man (1929, p. 16) has expressed the opinion that the proportion of carapace breadth to length should not be used (as it has been by Tesch, 1918, p. 254—e.g. in division 30 of his key) for distinguishing sections of the genus *Pinnotheres*. I am in agreement with de Man on this point, since, in addition to exhibiting a good deal of variation in ovigerous (mature) females, the relative breadth of the carapace tends to be less in young specimens (see p. 176, and de Man, 1929, p. 15, Table of measurements). It is probable that other

characters used by Tesch to distinguish the species may prove to be less helpful than he had supposed. For example, he distinguishes between forms in which the dactylus of the third maxillipede reaches, or falls short of, the apex of the propodus (e.g. divisions 31 and 38 of his key); it is possible that this difference may sometimes depend on the size of the individuals (see p. 170).

*Asymmetry.*—Another curious feature, not known, apparently, to Tesch, would have to be studied in considerable detail by anyone revising the genus, and that is the often marked asymmetry of the longest pair (or pairs) of legs in at least some species. All the fourteen females that I have dealt with in this paper, belonging to species with the third pair of legs longest and the dactyli of the two posterior pairs longer than those of the two anterior pairs, show this asymmetry, which is most marked in the larger specimens. In ten females the left, in the remaining four the right, third leg is the shorter. The difference is most marked in the dactylus, which in some specimens is more like that of the second leg in shape as well as in size; the propodus, and sometimes also the carpus, is rather shorter. I had at first supposed that this difference in the third pair of legs was due to regeneration of the shorter limb. But, finding it, to a greater or lesser degree, in every female, I now think that it may prove to be a normal characteristic of at least some species. De Man (1921) found this asymmetry in two specimens and described it as an anomaly. He regarded the left leg as abnormal in both, although in one specimen (referred to *P. arcophilus*) it was the longer, in the other specimen (referred to *P. palaensis*) it was the shorter. If the shorter limb be regarded as abnormal, de Man pointed out that, as far as the walking legs are concerned, both specimens should be referred to *P. palaensis*. Later he (de Man, 1929, p. 14) found the same asymmetry in eleven females and two males of *P. palaensis*; from his table of measurements the difference between the dactyli is slight in the males and very marked in some of the larger females. De Man suggested that this asymmetry might prove "to be a constant character not only of this (*P. palaensis*), but also of other species of *Pinnotheres*". In the only male, a very small specimen referred to *P. spinidactylus*, there is no apparent asymmetry (see Table I).

Because of the interest of this phenomenon, I have examined specimens belonging to some other species, and the results suggest that it occurs quite commonly in the genus. In three females of *P. pisum* from Jersey, taken at random, the *second* pair of legs were asymmetrical; in this species the second legs are the longest and all the dactyli are subequal. The asymmetry is far less obvious than in those species in which the longest pair of legs have long dactyli; the difference is also more marked in the propodus than in the dactylus in two of the three specimens measured. In the holotype (male) of *P. margaritifera* Laurie \*, the second pair of legs shows only a very slight

\* 1906, Rep. Pearl Oyster Fish., London, v, p. 424.

difference. A female specimen from Hauraki Gulf, New Zealand, belonging most probably to an undescribed species, shows marked asymmetry in the *three anterior pairs* of legs (see measurements). The second pair of legs are longest in this form and have the longest dactyli. This asymmetry can be seen with the unaided eye, as the specimen is of large size, and the fine setae on the propodi and dactyli of the three anterior left legs are longer and more numerous than those on the right legs. The following are the measurements of the distal segments of the legs in mm. (*l* of carapace 12.3 mm.) :—

	<i>l</i> 1.	<i>r</i> 1.	<i>l</i> 2.	<i>r</i> 2.	<i>l</i> 3.	<i>r</i> 3.	<i>l</i> 4.	<i>r</i> 4.
Carpus . . . . .	3.20	2.88	3.20	3.20	3.20	3.00	2.40	2.48
Propodus ..	4.12	3.60	5.60	4.64	4.80	4.24	2.88	2.90
Dactylus ..	3.12	2.64	4.04	3.28	3.44	2.80	2.24	2.24
Total . . . . .	10.44	9.12	12.84	11.12	11.44	10.04	7.52	7.62

A cursory examination of *P. villosulus* Guérin and *P. pilumnoides* Nobili (Laurie det.) revealed no very apparent difference in the legs, which, in the former species especially, are short and robust, and have subequal dactyli.

Assuming that this asymmetry is a normal condition, it adds to the difficulty of identifying the forms that exhibit it. Bürger and Tesch have both used the relative lengths of the dactyli of the walking legs to distinguish between groups of species. Moreover, as Bürger invariably figured the legs of the right side, he may in some instances have utilized the longer, in others the shorter, leg of a pair for systematic purposes. I have made use of the longer third leg in attempting to run down the specimens in Tesch's key, and have described and figured it throughout. One reason for doing so is that the longer seemed to be much less variable than the shorter one\*.

It is seldom that large numbers of specimens of a species of *Pinnotheres* are available for study. It is most desirable, however, that this question of asymmetry should be adequately investigated in at least one species. Large numbers of both sexes and of varying size would be required. Until such an examination can be undertaken, and more is known of the habits of Pinnotherids, it does not seem possible to offer any satisfactory explanation of this asymmetry. De Man at first thought that it might be the result of cross-breeding between two species inhabiting the same molluscan host; later he seems to have considered this explanation improbable (1929, p. 16). The

\* According to Shen's measurements (1932, p. 134), the third left leg of *P. sinensis* is actually rather shorter than the second; in fig. 78 *b*, p. 132, however, the artist has drawn the legs symmetrical and the third pair is the longest.

few males that I have examined show little, if any, trace of asymmetry, but this does not necessarily imply that asymmetry is restricted to the females—at any rate, in all species. Should it prove, on further investigation, to be characteristic of the female sex, it might be that, owing to the position taken up within the host, the growth of the longer leg (or legs) on one side of the body is rather hampered—e.g. by the pressure exerted by the shell of the host. In that case, one would not expect to find asymmetry in species that live in soft-bodied Holothurians.

It would be interesting to know (1) how many species of the large genus *Pinnotheres* are markedly asymmetrical; (2) whether it is characteristic of both sexes, or only of the female; (3) whether or not the position of the female within the mollusc shell (should the asymmetry prove to be restricted to females of species inhabiting Mollusca) is constant and such that growth of the legs on one side might be rather hampered, and (4) at what stage in the development of Pinnotherids the asymmetry first becomes apparent.

*P. edwardsi* excepted, the species described below have the following characters in common:—(1) The carapace is smooth, naked, and parchment-like. (2) The dactyli of the last two pairs of walking legs are longer than those of the first two pairs, which are subequal. (3) The external maxillipedes are quite similar, with the styliform dactylus inserted on the inner margin, and never exceeding the apex, of the propodus. They differ most as regards the walking legs, quite apart from the asymmetry already discussed—to a lesser extent also in general shape of carapace and chela.

Unwilling though I am to add to the already long list of *Pinnotheres* species, it seems preferable to describe three of the following forms as new rather than to refer them doubtfully to imperfectly known species; two forms have been referred, with much hesitation, to species established by Bürger. The main purpose of this short paper, however, is to emphasize the need for a thorough revision of the genus and to illustrate unexpected differences in the walking legs of a few forms. I believe that a careful examination of the legs will prove most useful to any subsequent worker who may find the time and the opportunity to study the genus adequately.

#### I. DACTYLI OF ALL FOUR WALKING LEGS SUBEQUAL.

##### PINNOTHERES EDWARDSI de Man.

de Man, 1888, p. 103, pl. vi, figs. 6-9.

Tesch, 1918, pp. 248 & 258.

*Material*.—1 large ovigerous ♀.

*Host*.—*Pinna* sp.

*Locality*.—Siglap (Singapore).

*Remarks*.—The walking legs are unfortunately incomplete; in two specimens from Abrolhos the legs show no very apparent asymmetry.

II. DACTYLI OF THE TWO POSTERIOR, LONGER THAN THOSE OF THE TWO ANTERIOR, LEGS.

These species may be distinguished from each other as follows :—

- I. Fourth dactylus longer than third \*.
  - A. Numerous short setae on dorsal, as well as ventral, margin of third and fourth dactyli; fourth dactylus longer than propodus, and armed with a series of spines or spinules on ventral margin, near claw; ratio of second propodus to dactylus not exceeding 1.66 : 1.
    - 1. Front advanced beyond, and distinct from, anterior margin of carapace; ratio of second to fourth dactylus 1 : 1.40-1.65; 5-6 long spines near claw of fourth dactylus ..... *P. spinidactylus*, sp. n.
    - 2. Front advanced slightly beyond, and not distinctly separated from, anterior margin of carapace; ratio of second to fourth dactylus <sup>trans</sup> 2 : 1; 8 short spinules near claw of fourth dactylus ..... *P. similis* Bürger.
  - B. Long setae restricted to ventral margin of third and fourth dactyli; fourth dactylus subequal to, or shorter than, propodus, with spines on ventral margin, near claw, absent or vestigial; ratio of second propodus to dactylus 1.82-2.35 : 1.
    - 1. Ratio of fourth to third dactylus at most 4 : 3; dactylus of chela scarcely two-thirds of dorsal border of palm; propodus of third maxillipede not contracted distally... *P. tiwelae*, sp. n.
    - 2. Ratio of fourth to third dactylus at least 5 : 3; dactylus of chela four-fifths of dorsal border of palm; propodus of third maxillipede contracted distally ..... *P. alcocki* Rathbun.
- II. Third dactylus longer than fourth; [front advanced beyond and distinct from, anterior margin of carapace].
  - A. Numerous short setae on dorsal, as well as ventral, margin of third and fourth dactyli; third propodus a trifle shorter than dactylus; chela with border of palm convex proximal to base of immovable finger ..... *P. latissimus* Bürger.
  - B. Long setae on ventral margin of third and fourth dactyli; third propodus at least about half as long again as dactylus; chela with border of palm straight, or slightly concave, proximal to base of immovable finger ..... *P. winckworthi*, sp. n.

In Table I (p. 168) the relative lengths of the dactyli of the second, third, and fourth legs are given, followed by the measurements of the dactylus and propodus of the third leg (in mm.). In Table II length of propodus ÷ length

\* For the sake of brevity the words "dactylus" and "propodus", unless otherwise stated, refer to the walking legs, e.g. "fourth dactylus" is an abbreviation for "the dactylus of the fourth leg"; also "ratio of . . ." refers to the length of the parts mentioned. The longer third leg is implied throughout (see p. 165).

of dactylus is given for the second, third, and fourth legs. The first specimen in each of the new species is the holotype. An asterisk indicates the shorter third leg, which varies considerably.

TABLE I.

Species.	Sex.	Left.			Right.			Left.		Right.	
		2.	3.	4.	2.	3.	4.	da 3.	pr 3.	da 3.	pr 3.
<i>P. spinidactylus</i> .	♀	1	1.20*	1.65	1	1.33	1.63	1.14	1.36	1.28	1.44
	♀	1	1.09*	1.52	1	1.30	1.57	1.00	1.24	1.20	1.40
	♀	1	1.07*	1.51	1	1.30	1.50	0.84	1.16	1.00	1.32
	♀	1	1.04*	1.57	1	1.30	1.61	0.88	1.28	1.00	1.40
	♀	1	1.10*	1.47	1	1.25	1.40	0.88	1.16	1.00	1.28
	♂	.....	.....	.....	.....	.....	.....	0.68	1.00	0.69	1.00
<i>P. similis</i> .....	♀	1	1.59	2.00	1	1.35+*	2.00	1.04	1.40	0.80	1.28
<i>P. tivelae</i> .....	♀	1	2.10	2.40	1	1.10*	2.45	3.36	4.96	1.76	4.00
	♀	1	2.00	2.65	1	1.00*	2.60	3.36	4.88	2.00	4.30
	♀	1	1.08*	1.88	1	1.60	1.96	1.20	2.32	1.68	2.64
<i>P. alcocki</i> .....	♀	1	1.14*	2.50	1	1.41	2.40	0.88	1.60	0.96	1.72
<i>P. latissimus</i> ...	♀	1	1.43*	2.14	1	2.14	2.07	1.60	2.44	2.60	2.56
	♀	1	1.73*	2.45	1	2.67	2.33	1.52	2.24	2.56	2.48
<i>P. winckworthi</i> ..	♀	1	2.50	2.36	1	1.21*	2.32	2.80	4.16	1.44	2.88
	♀	1	1.07*	1.71	1	2.00	1.79	1.20	2.56	2.24	3.68

TABLE II.

Species.	Length of carapace.	Left.			Right.		
		2.	3.	4.	2.	3.	4.
<i>P. spinidactylus</i> .	5.76 (ovig. ♀)	1.39	1.21*	0.82	1.38	1.12	0.83
	5.20 (ovig. ♀)	1.43	1.24*	0.83	1.39	1.17	0.81
	4.80 (ovig. ♀)	1.45	1.38*	0.86	1.40	1.32	0.84
	5.12 ♀	1.48	1.46*	0.89	1.48	1.26	0.86
	4.72 ♀	1.66	1.32*	0.83	1.50	1.28	0.88
<i>P. similis</i> .....	4.24 (ovig. ♀)	1.65	1.35	0.82	1.65	1.60—*	0.79
<i>P. tivelae</i> .....	11.50 ♀	2.25	1.48	1.19	2.15	2.27*	1.12
	?	2.35	1.45	1.10	2.25	2.16*	1.11
	8.30 ♀	1.92	1.93*	1.27	2.00	1.57	1.22
<i>P. alcocki</i> .....	approx. 7.00 (ovig. ♀)	1.82	1.96*	1.02	1.96	1.70	1.05
<i>P. latissimus</i> ...	9.60 (ovig. ♀)	2.14	1.53*	0.90	2.14	0.98	0.99
	8.16 ♀	2.27	1.47*	0.85	2.08	0.97	0.82
<i>P. winckworthi</i> ..	8.00 (ovig. ♀)	1.93	1.49	1.06	1.95	2.00*	1.09
	7.36 (ovig. ♀)	1.91	2.13*	1.24	1.93	1.64	1.20

## PINNOTHERES SPINIDACTYLUS, sp. n.

*Material*.—5 ♀♀ (including holotype, 3 with ova) and 1 ♂.

*Host*.—*Modiolus philippinarum* (Hanley).

*Locality*.—Siglap (Singapore).

*Description of female*.—The holotype has the *carapace* 1.25 times as long as broad ( $l.=5.76$ ,  $b.=7.2$  mm.). It is moderately convex, sloping rather steeply downwards near the anterior and postero-lateral margins. Fig. 1 *a*

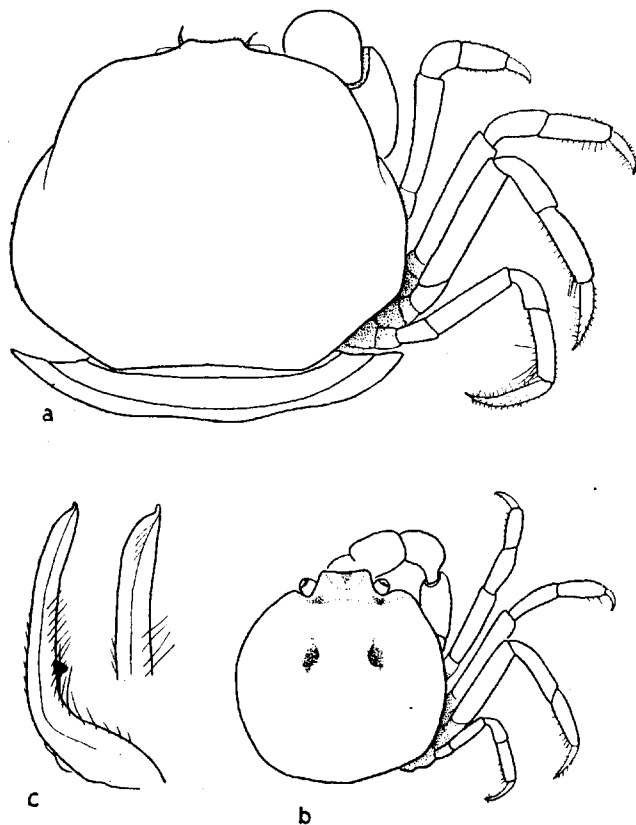


Fig. 1.—*Pinnotheres spinidactylus*, sp. n.

*a*. Holotype, in dorsal aspect.  $\times$  approx. 7.5.

*b*. Male in dorsal aspect.  $\times$  9.

*c*. First pleopod of male.  $\times$  27 & 35.

shows the general outline of the carapace; the front is considerably advanced beyond the anterior border and the shoulders (or antero-lateral angles) are very rounded. The posterior border is slightly concave. The eyes are visible in dorsal aspect; in frontal view they are subcircular, with a small subterminal triangular pigmented area. The antennae are not excluded from the orbits.



The *external maxillipede* is represented in fig. 2 *a*; the dactylus may extend to, or, as in the smallest specimen, fall rather short of, the very blunt apex of the propodus.

The *cheliped* is about as long as the third walking leg and considerably more massive. The merus, measured along the outer margin, is approximately twice as long as wide; the carpus is abruptly bent inwards, almost at a right angle, near the proximal articulation, and is rather wider than the proximal end of the palm. The chela is represented in fig. 2 *b*; the dactylus is a trifle longer than the maximum width of the palm, and bears the usual blunt triangular tooth on the inner margin.

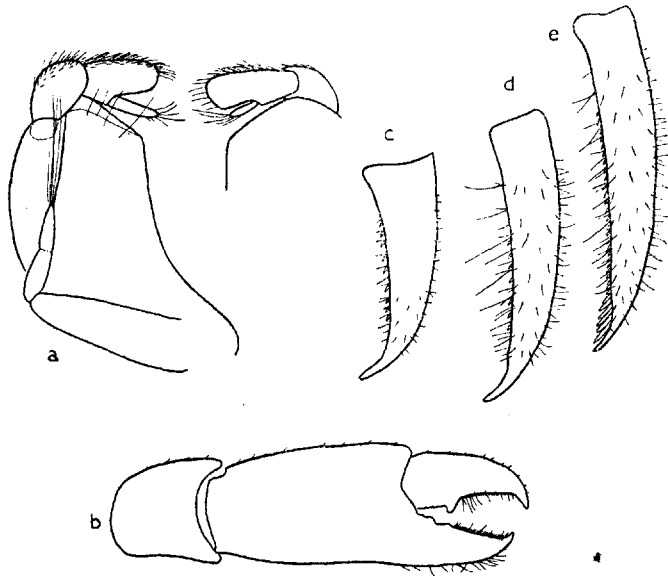


Fig. 2.—*Pinnotheres spinidactylus*, sp. n.

- a.* Third maxillipede of female, from inner side, most of the setae omitted.  $\times 27$ .  
*b.* Chela of female paratype.  $\times 12$ .  
*c-e.* Dactylus of second, third, and fourth right legs respectively of female paratype.  $\times 35$ .

*The walking legs.*—The first and second legs are subequal and rather shorter than the fourth. In the holotype the relative lengths of the legs on the right side are as 1 : 1.07 : 1.29 : 1.11, the third left leg is rather shorter—1.20. In all the females the third left leg is shorter than that on the right side (Tables I and II); this difference is most marked in the dactylus, which tends to resemble that of the second leg; the propodus and carpus may also be rather shorter (see also p. 164). As shown in Table I the third right dactylus is approximately  $\frac{1}{3}$  longer than the second in the larger females,  $\frac{1}{4}$  longer

in the smallest specimen. The fourth or longest dactylus exceeds the propodus in length (Tables I and II). In fig. 2 *c-e* the dactyli of (right) legs 2, 3, and 4 are represented greatly enlarged; in some females the spinules on the inner margin of the third dactylus are apparently absent, and there appear to be fewer spinules on the fourth dactylus proximal to the subterminal series of long claw-like spines. The third and fourth dactyli bear numerous fine setae on all sides, those on the inner margin being rather longer than the rest.

*Male*.—Of the three male specimens that accompany the females, only the smallest appears to belong to the same species. The general outline of the carapace, which is 3.48 mm. long and 3.52 mm. broad, is represented in fig. 1 *b*. The ratios of dactyli 2, 3, and 4 are 1 : 1.40 : 1.33, the length of propodus ÷ length of dactylus is 2.08, 1.55 and 1.06 respectively. There is no apparent asymmetry in this small specimen; the measurements of the left and right third dactyli and propodi are inserted in Table I.

The chela is wider than in the female and the dactylus is thus rather shorter than the greatest width of the palm. The abdomen is rather similar to that of *P. sinensis* Shen (1932, p. 133, fig. 79 *e*), but segments 4, 5, and 7 are equal in length and one-fifth longer than segment 6; segment 4 is three times as long as wide (proximal margin) and segment 7 is four-fifths as long as wide. The first pleopod is represented in fig. 1 *c*.

[The two other male specimens, measuring about 4.4 and 5.4 mm. in length respectively, have the second and third legs fringed with setae on the propodus and carpus much as in *P. tsingtaoensis* Shen (1932, p. 149). The abdomen, however, and the dactylus of the external maxillipede are more like those of *P. gordonii* Shen (p. 152), but the first pleopod is heavily setose on both sides and is straight, not curved, at the apex. The distance between the fourth pair of legs is equal to the fronto-orbital width, and the carapace length, including the much advanced front, is equal to the width. These males, which I have not attempted to identify, belong to a species with all the dactyli of the walking legs subequal. They show no apparent asymmetry of the walking legs.]

*Remarks*.—These specimens are most closely related to *P. parvulus* Stimpson according to Tesch's key (1918, p. 254), since the carapace is not wide enough for *P. latus* Bürger, especially as described by Tesch (1918, p. 259)\*. They certainly do not agree with the description of *P. parvulus* (cf. fig. 1 *a* with Rathbun, 1910, p. 333, fig. 13) as that species has (1) a series of long setae on the inner margin of the dactylus of each leg, those on the third being particularly long; (2) the fourth dactylus rather shorter than the propodus; and (3) the propodi of the second and third legs longer in proportion to the dactyli.

\* The *P. latus* of Tesch may not be identical with Bürger's species. According to Tesch's measurements dactyli 2, 3, and 4 are as 1 : 2 : 2.9; from Bürger's measurements the fourth dactylus is 1.7 times, and in his figure about twice, as long as the second.

## PINNOTHERES SIMILIS Bürger.

Bürger, 1895, p. 373, pl. ix, fig. 14.

*Material*.—1 ovigerous ♀ (*l.* = 4.24, *b.* = 5.28 mm.).

*Host*.—*Placenta placenta* (Linné).

*Locality*.—Siglap (Singapore).

*Description*.—The dorsal surface of the smooth naked *carapace* is nearly flat posteriorly, sloping rather steeply down towards the slightly setose front and, to a lesser extent, in the postero-lateral region. The anterior border is convex in the middle, although the front is not clearly separated as in the preceding species (fig. 3 *a*). The eyes are not visible in a strictly dorsal view; the pigmented area is larger than in the preceding form. The antero-lateral angles, though rounded, are more pronounced than in *P. spinidactylus*. The posterior margin is almost straight.

The *external maxillipede* has the antero-internal angle of the ischio-merus rather sharply defined and the dactylus does not extend to the rather narrowed apex of the propodus (fig. 3 *b*).

The *chelipeds* are equal and more robust than the walking legs. The dactylus is almost three-fourths of the upper border, and considerably more than the greatest width, of the palm. The dactylus has a blunt triangular tooth on the inner margin as in *P. spinidactylus*.

The two posterior pairs of *walking legs* are rather more slender than the two anterior pairs. The third is longest; the second and fourth subequal and rather longer than the first. The relative lengths of the legs are almost as in the preceding species on the left side; the third dactylus on the right side is not quite complete, but must have been rather shorter. The third and fourth dactyli are longer relatively to the second than in *P. spinidactylus* (see Table I and figs. 2 *c-e* and 3 *c-e*); the fourth is the longest and exceeds the propodus (Table II), but it is a trifle foreshortened in fig. 3 *a*. It is, moreover, not much compressed, with fine setae on all sides and a series of 8-9 spinules near the terminal claw (fig. 3 *e*). The third dactylus is more compressed and the setae on the ventral are longer than those on the dorsal margin (fig. 3 *d*).

*Remarks*.—According to Tesch's key this specimen is referable to division 42—*P. similis* and *P. alcocki*. I have compared it with a female of the latter species from Mergui, determined by de Man (1888, p. 105, as *P. parvulus*) and it certainly does not belong to that form (cf. figs. 3 & 5). The dactylus of the fourth leg in *P. alcocki* is more compressed, has a series of long setae on the ventral margin, is longer relatively to the second dactylus, and is subequal to the propodus (Tables I & II). There are also very long setae on the ventral margins of the propodus and dactylus of the third leg.

Bürger's (1895, p. 373) description of *P. similis* is very brief, and there is probably an error in his measurements of the carapace length and breadth, which are given as 6 and 9 mm. respectively. In his description he says "Rückenschild um  $\frac{1}{2}$  breiter als lang", and his figure is more in keeping with

this than with his measurements. His figure (pl. ix, fig. 14) is so small that the dactyli of the walking legs cannot be measured accurately. The proportions of the second, third, and fourth are approximately 1 : 1.70 : 2.33, and the fourth is distinctly longer than the propodus. Without a re-examination of the type, it is impossible to know whether the setae on the dactyli of the two posterior legs occur on all sides, or are more or less restricted to the ventral margin. The third maxillipede is stated to be "ganz wie bei *P. latissimus*", and in the figure of the latter (pl. x, fig. 13) the antero-internal angle of the ischio-merus is more rounded than in the specimen from Siglap.

Nor can this specimen be referred to *P. nigrans* Rathbun (1910, p. 334, figs. 16 & 17) \*, a form in which the angle of the ischio-merus of the third

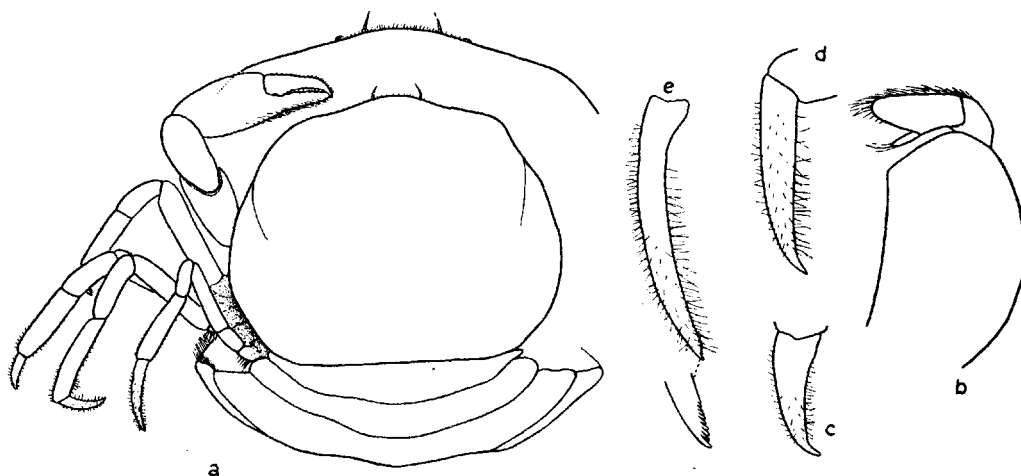


Fig. 3.—*Pinnotheres similis* Bürger.

- a. Female, in dorsal aspect,  $\times 9$ , with front of carapace more highly magnified.  
 b. External maxillipede, from outer side, with most of the setae omitted.  $\times 35$ .  
 c-e. Dactylus of second, third, and fourth left legs respectively.  $\times 28$ .

maxillipede is very well marked. In *P. nigrans* the "dactyli of the third and fourth pairs [of walking legs are] longest, equal and twice as long as those of the first and second pairs".

As I have only a rather small female, I think it advisable to refer it, for the present, though with some hesitation, to *P. similis* with which it agrees fairly well. Of course, when the type of *P. similis* is re-examined the walking legs might prove to differ considerably.

\* According to Miss Rathbun's measurements the ratio of carapace length to breadth is 1 : 1.22; in the photograph (fig. 16) the carapace appears to be broader than this and Tesch has placed the species in division 33 of his key—with those forms in which the carapace is "nearly  $1\frac{1}{2}$  times as broad as long".

## PINNOTHERES TIVELAE, sp. n.

*Material*.—1 ♀ (holotype,  $l.=11.5$ ,  $b.=13.6$  mm.), 1 ♀ with part of carapace missing, about same size as holotype, and 1 smaller ♀ ( $l.=7.76$ ,  $b.=9$  mm.).

*Host*.—*Tivela ponderosa* (Philippi).

*Locality*.—Muscat (Arabia).

*Description*.—The *carapace* is smooth, naked, soft, and parchment like, and the tissues underneath are withdrawn slightly here and there round the margins.

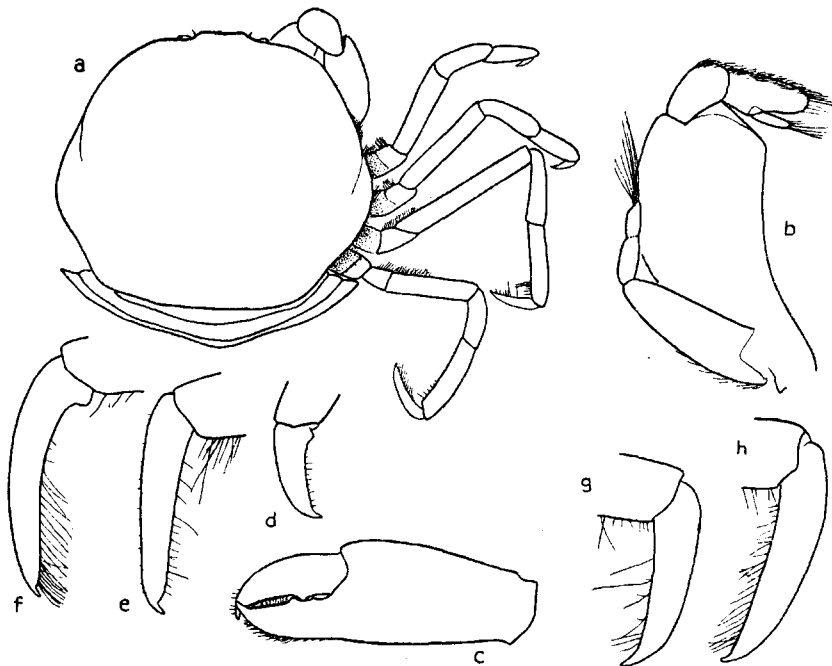


Fig. 4.—*Pinnotheres tivelae*, sp. n.

- a. Smaller paratype, in dorsal aspect.  $\times 4.5$ .  
 b. External maxillipede, from inner side, with most of the setae omitted.  $\times 20$ .  
 c. Chela of smaller paratype.  $\times 9$ .  
 d-f. Dactylus of second, third, and fourth left legs respectively of holotype.  $\times 9$ .  
 g, h. Dactylus of third and fourth right legs of smaller paratype.  $\times 20$ .

The general outline of the smallest specimen is represented in fig. 4 a; in the holotype the eyes are not visible in dorsal aspect and the posterior margin is slightly concave in the middle. The carapace is rather convex antero-posteriorly, almost flat transversely, except at the sides where it slopes obliquely downwards.

The *external maxillipede* is represented in fig. 4 b; the dactylus scarcely reaches to the blunt apex of the propodus,

The *cheliped* is very similar to that of the preceding species; the chela is represented in fig. 4 *c*, the dactylus is not quite two-thirds of the dorsal border, and exceeds the greatest width, of the palm.

The *walking legs* have the following relative lengths:—1 : 1.22 : 1.66 : 1.41. The dactylus of the first is four-fifths that of the second leg. In the two larger females, the third dactylus is twice as long as the second and rather shorter than the fourth (Table I and fig. 4 *d-f*). In the smallest specimen the third and fourth dactyli are relatively shorter and broader (Table I and fig. 4 *g, h*). In all three specimens the third leg is shorter, especially as regards the dactylus, on one side than on the other (Tables I and II). The fourth dactylus is rather shorter than the propodus and the second dactylus is shorter relatively to the propodus than in either of the preceding species (Table II). The third and

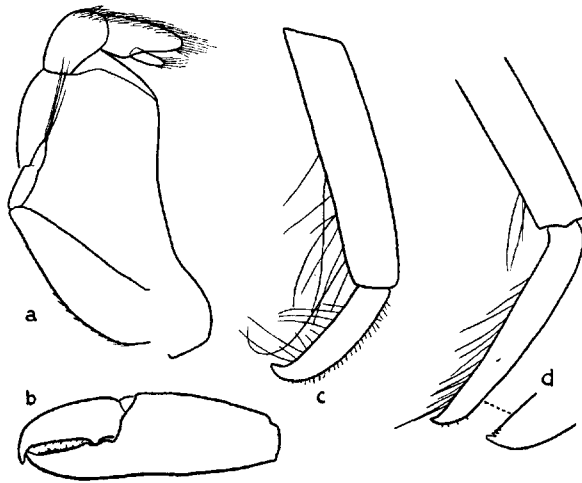


Fig. 5.—*Pinnotheres alcocki* Rathbun.

- a.* External maxillipede from inner side, with most of the setae omitted.  $\times 20$ .  
*b.* Chela.  $\times 9$ .  
*c, d.* Dactylus of third and fourth right legs respectively.  $\times 20$ .

fourth dactyli are rather compressed and bear longish setae on the inner margin; there are also a few setae near the distal end of the ventral margin of propodi 3 and 4 (fig. 4 *a, e-h*).

*Remarks.*—These specimens, according to Tesch's key, run down to *P. similis* and *P. alcocki*. The specimen from Siglap appears to be more nearly related to *P. similis* Bürger, especially as regards the general shape of the carapace, than these from Muscat (p. 172, cf. figs. 3 & 4, with Bürger, 1895, pl. ix, fig. 14). As already mentioned, the fourth dactylus of *P. similis* is longer than the propodus, not shorter, as in these specimens.

There is, in the British Museum Collection, one female of *P. alcocki* from Mergui (de Man, 1888, p. 105, as *P. parvulus*). Unfortunately, the carapace

is very crumpled and its true outline is thus destroyed. The third maxillipede is quite similar to that of the specimens from Muscat (figs. 5 *a* & 4 *b*), but the apex of the propodus, though rounded, is narrower. The chela has a relatively longer dactylus—at least three-fourths of the dorsal border of the palm (figs. 5 *b* & 4 *c*).

The dactylus of the third leg is shorter relatively to the fourth and second (see Table I, and figs. 5 *c* & 4 *e, g*; *P. alcocki* is nearer in size to the smallest specimen from Muscat. The fourth dactylus is also subequal to its propodus (Table II).

PINNOTHERES ALCOCKI Rathbun. (Fig. 5.)

*Pinnotheres parvulus* de Man, 1888, p. 105.

*Pinnotheres alcocki* Tesch, 1918, p. 248.

*Remarks.*—See under preceding species.

PINNOTHERES LATISSIMUS Bürger.

? *Pinnotheres obesus* Miers, 1880, p. 314, pl. xiv, fig. 4 (*l.*=9.6, *b.*=12.16 mm. in ovig. ♀).

*Remarks.*—The three female specimens (one in fragments), from Indo-Malayan Seas, referred doubtfully by Miers to *P. obesus* Dana, certainly do not belong to that species. Dana (1855, pl. xxiv, fig. 3) only figured the male in detail and the dactyli of the walking legs in that sex are subequal. Tesch (1918, p. 251), in his key to the Indo-Pacific species, includes *P. obesus* in the group with "dactyli of all the walking legs subequal in length".

The specimens examined by Miers have, on the other hand, very long dactyli on the two posterior pairs of legs (fig. 6 *a* and Table I). They seem to be most nearly related to *P. palaensis* and *P. latissimus* (Bürger, 1895, pp. 372–3). The shape of the carapace, in the larger specimen particularly, is nearer to that of the latter form except that the front is distinctly separated from the rest of the anterior border (fig. 6 *a-a'*) and the shoulders (antero-lateral angles) are more rounded. The ratio of carapace length to breadth is about 1 : 1.27 in the smaller, 1 : 1.30 in the larger specimen. In Bürger's figure of *P. latissimus* (1895, pl. ix, fig. 13) the distal segments of the second and fourth legs are missing, but in the text he says "die Gehbeine verhalten sich wesentlich wie bei *A. palaensis*"\* and, in the latter, the third and fourth dactyli are described as follows: "Sie sind annähernd gleich lang und etwa 3 mal so lang wie vom Beinpaar 2". Bürger figures the chela with the immovable finger much shorter than the dactylus; without reference to the type it is not possible to judge whether or not this is a normal condition. In the specimens under consideration only three detached chelipeds now remain. The chela is very characteristic and differs appreciably in shape from that of any of the other species (fig. 6 *b*,

\* Bürger does not state whether the legs on the other side of the figured specimen were complete.

cf. figs. 2 *b*, 4 *c*, 5 *b*, 7 *c*). The palm bulges somewhat near the base of the immovable finger and is much narrowed proximally. The smallest chela, belonging presumably to the small specimen figured, has the palm relatively shorter and less contracted proximally.

Although the third dactylus is not quite three times as long as the second in the small specimen (Table I) and is relatively shorter in the larger complete specimen, this form is certainly very nearly allied to, if not identical with, *P. latissimus*. Bürger's original description and figures are inadequate to permit of a detailed comparison.

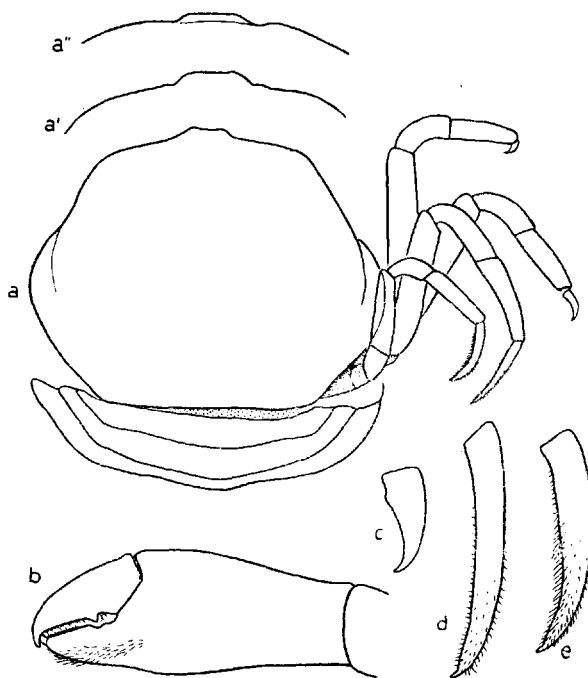


Fig. 6.—*Pinnotheres latissimus* Bürger.

- a*. Smaller female, in dorsal aspect.  $\times 4.5$ .  
*a'*. Anterior border of carapace smaller, *a''* of larger female.  $\times 6$ .  
*b*. Chela, from inner side.  $\times 9$ .  
*c-e*. Dactylus of second, third, and fourth right legs respectively.  $\times 20$ .

*PINNOTHERES WINCKWORTHI*, sp. n.

*Material*.—2 ovigerous ♀♀ (*l.* of holotype=8.16, *b.*=10.32 mm.).

*Host*.—*Paphia gallus* (Gmelin).

*Locality*.—Penang.

*Description of holotype*.—The *carapace*, which is approximately  $1\frac{1}{4}$  times as long as broad, seems to be almost flat on the dorsal surface, sloping downwards



anteriorly on either side and in front. On closer examination the mid-dorsal surface is seen to be raised somewhat (longitudinally) and there are two wide shallow depressions on either side of this low ridge. The general outline is represented in fig. 7 *a*; the front is rather advanced beyond the anterior margin and the eyes are not visible in a strictly dorsal view, although the pigment shows faintly through the thin carapace. The posterior margin is straight.

The *external maxillipede* has the antero-internal angle of the ischio-merus

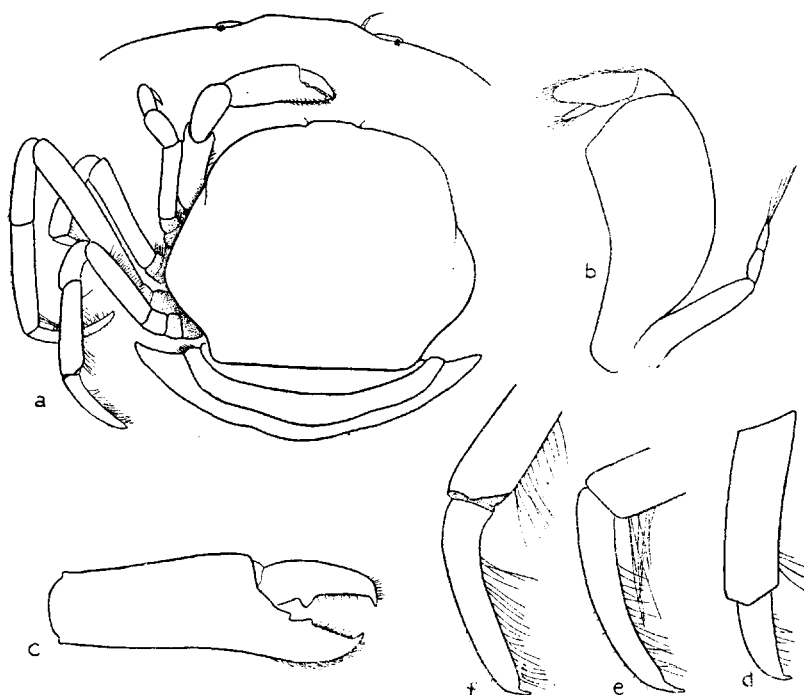


Fig. 7.—*Pinnotheres winckworthi*, sp. n.

- a.* Holotype, in dorsal aspect,  $\times 4$ , and anterior margin of carapace more highly magnified.  
*b.* External maxillipede, from outer side, with most of the setae omitted.  $\times 20$ .  
*c.* Chela.  $\times 12$ .  
*d-f.* Dactylus of second, third, and fourth left legs respectively of holotype.  $\times 20$ .

rather well defined and the dactylus reaches almost to the apex of the propodus (fig. 7 *b*).

The *cheliped* scarcely exceeds the carapace in length and is rather stouter than the walking legs; the chela is represented in fig. 7 *c*, the dactylus is about two-thirds of the dorsal border, and rather longer than the greatest width, of the palm.

*The walking legs.*—In the holotype the relative lengths of the legs are as 1 : 1.16 : 1.83 : 1.39 and, in the paratype, as 1 : 1.15 : 1.87 : 1.27. In both specimens the third leg on one side is shorter than that on the other, and the difference is most marked in the dactylus, which is somewhat similar in shape to that of the second leg (see Tables I and II, and p. 164). On the other side, the third leg is nearly twice as long as the first and, as illustrated in fig. 7 *a, d-f*, has the longest dactylus. The dactyli of the three posterior legs of the holotype are represented in fig. 7 *d-f*; in the paratype the fourth dactylus is somewhat shorter (Tables I & II). There is a series of long fine setae on the inner (ventral) margin of dactylus 3 and 4, of propodus 4, and a few longer setae at the distal extremity of propodus 3. There are, in addition, a few setae on the dorsal border of carpus 4 (fig. 7 *a*). The dactyli are all rather compressed laterally.

*Remarks.*—I have not been able to fit this species into Tesch's key. The carapace is 1.26 times as broad as long and should, therefore, be included in the first subdivision of section 30. It does not appear to be referable to any of the species with wider carapace in divisions 31–36 of the key, but to be related to *P. consors*, *P. parvulus*, and *P. lanensis*. It differs from *P. consors* Bürger (1895, p. 377, pl. ix, fig. 20, pl. x, fig. 18) in having the front less advanced beyond the anterior margin of the carapace, the two posterior pairs of legs stouter; the ischio-merus of the external maxillipede narrower in proportion to its length and the dactylus and propodus not extending beyond the antero-internal angle. In the female referred by Tesch (1918, p. 260, pl. xvii, fig. 4) to *P. consors* the front is also much advanced and the antero-lateral angles of the carapace are rather sharply defined, the distance between them being only about half of the greatest width (of the carapace). The two posterior pairs of legs are very slender and their dactyli are equal, the propodi are without setae.

In *P. parvulus* (Rathbun, 1910, p. 331, fig. 13) the fourth dactylus is "distinctly longest", the third is only half as long as the propodus and has a fringe of long setae on the inner border.

I think it unlikely that *P. lanensis* Rathbun (1910, p. 332, fig. 14) is a younger specimen of this form (*l.* of carapace 2.4 mm.), because, even if the shorter dactylus of the third maxillipede were due to the small size of the individual, the outer border of the ischio-merus is much more convex than in the specimens from Penang. In *P. lanensis* the third and fourth dactyli are equal.

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# THE LINNEAN SOCIETY OF LONDON

JOURNAL (ZOOLOGY) VOL. XL. (No. 269.)

## CONTENTS

	Page
I. Scientific results of the Cambridge Expedition to the East African Lakes, 1930-1.—No. 16. The smaller Crustacea. By A. G. LOWNDES, M.A., F.L.S. (With 5 Text-figures.) .....	1
II. Scientific results of the Cambridge Expedition to the East African Lakes, 1930-1.—No. 17. The vertical distribution and movements of the plankton in Lakes Rudolf, Naivasha, Edward, and Bunyoni. By Dr. E. B. WORTHINGTON, F.L.S., and C. K. RICARDO, F.L.S., Zoological Laboratory, Cambridge. (With 13 Text-figures.) .....	33
III. Contributions to the study of some African mammals.—I. The humerus and femur of certain East African antelopes. By A. TINDELL HOPWOOD, D.Sc., F.L.S., Department of Geology, British Museum (Natural History). (With 6 Text-figures.) .....	71
IV. Extinct Pleistocene mollusca from Lake Edward, Uganda, and their bearing on the Tanganyika problem. By V. E. FUCHS, M.A., Sedgwick Museum, Cambridge. (Communicated by Dr. E. B. WORTHINGTON, F.L.S.) (PLATES 1-3 and 4 Text-figures.) .....	93
V. Additions to the Trombidiid and Erythraeid Acarine Fauna of Australia and New Zealand. By H. WOMERSLEY, A.L.S., F.R.E.S. (With 12 Text-figures.) .....	107
VI. The seasons in a tropical rain-forest (New Hebrides).—Part 3. Fruit-bats (Pteropidae). By JOHN R. BAKER, M.A., D.Phil., and ZITA BAKER. (Communicated by Professor E. S. GOODRICH, F.R.S.) (From the Department of Zoology and Comparative Anatomy, Oxford.) (With a Text-figure.) .....	123
VII. The seasons in a tropical rain-forest (New Hebrides).—Part 4. Insectivorous bats (Vespertilionidae and Rhinolophidae). By JOHN R. BAKER, M.A., D.Phil., and T. F. BIRD. (From the Department of Zoology and Comparative Anatomy, Oxford.) (Communicated by Dr. JULIAN S. HUXLEY, F.L.S.) (PLATE 4 and a Text-figure.) .....	143
VIII. On a few Indo-Pacific species of <i>Pinnotheres</i> , with special reference to asymmetry of the walking legs. By ISABELLA GORDON, D.Sc., Ph.D., F.L.S. (With 7 text-figures.) .....	163