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ON THE POST-NAUPLIAR DEVELOPMENT OF THE CALANOID COPEPOD *LABIDOCERA PECTINATA* THOMPSON AND SCOTT (1903)

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ABSTRACT

Six post-naupliar developmental stages (Stages C-I to C-VI) of *Labidocera pectinata* Thompson and Scott are described and illustrated. The segmentation and setation of the maxillipeds of copepodites offer important criteria for separating the different stages and as such special attention has been given to study their developmental sequence. The variations in meristic characters associated with growth have also been investigated. Attention has also been drawn to the variations in the genital segment and fifth legs of the females of this species from the Indian Seas.

INTRODUCTION

THIRTEEN species of *Labidocera* have been described or recorded from the Indian Seas (Silas and Pillai, 1971), but the developmental stages of only very few species of this genus have been investigated. Sewell (1912, 1932) described some of the copepodid stages of *L. pavo* (stages C-III, C-IV and C-V) and *L. acuta* (stages C-I to C-VI), and Krishnaswamy (1950) described the second naupliar stage of *Labidocera* sp. Only one Indian species of *Labidocera*, namely *L. bengalensis* Krishnaswamy has been successfully reared in the Laboratory (Ummerkutty, 1964). However, no attempt has hitherto been made to present a detailed account of the segmentation and setation of the appendages of the different copepodid stages of any of the species. The present account gives the results of a study of the copepodid stages of *L. pectinata* collected from the surface plankton of the backwaters around Cochin, from December 1968 to April 1969. It forms a part of a series dealing with the developmental stages of some calanoid copepods.

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DESCRIPTION

The salient features by which the different copepodites are distinguished are summarised in Table-1. The prosome of C-II possesses five segments and urosome one segment. Ummerkutty (1964) recorded four prosomal and two urosomal segments in C-II of *L. bengalensis*, a closely allied species. Oberg (1906) clearly showed that the small segment present anterior to the urosomal segment, in these stages gets separated from the preceeding thorasic segment at the moult from C-I to C-II and thus it belongs to the thorax. In the adult *L. pectinata*, the fifth prosomal segment is fused with the fourth, though in the copepodid stages five segments are normally observed.

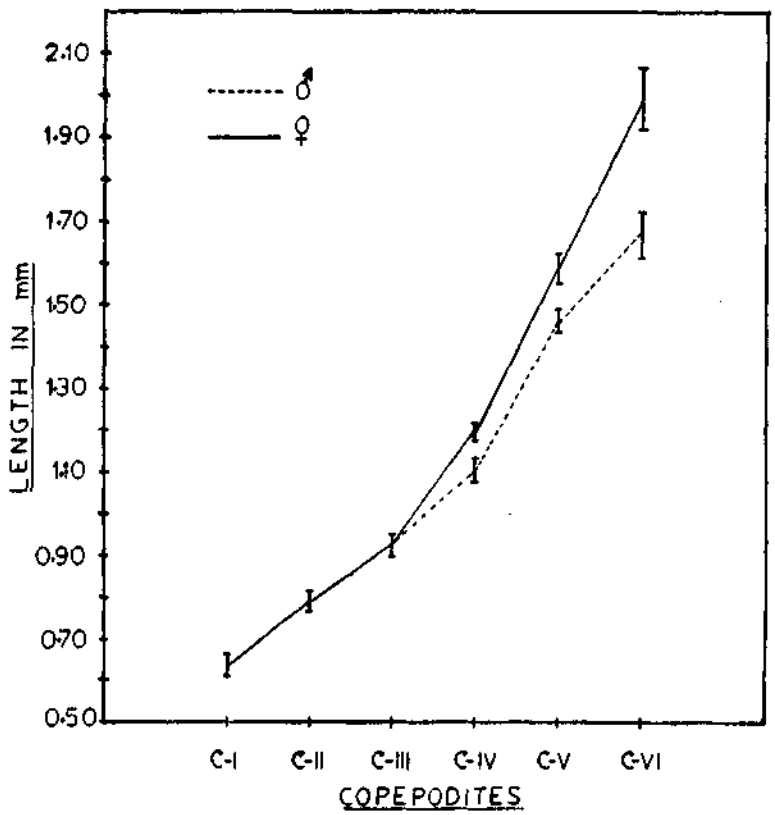
Sexes can be identified, even as early as stage C-IV (Fig. 1) as the exopodites of the male fifth legs show asymmetry ; the right leg being relatively larger. However,

by stage C-V this difference gets well established as the fifth legs in both the sexes develops other distinguishing features.

TABLE 1. *Identification table for the copepodid stages of* L. pectinata

Characters	stages C-I	C-II	C-III	C-IV	C-V	Adult
Number of specimens measured	11	18	16	29	31	55
Mean length (in mm.)	0.64	0.79	0.93	1.21(F) 1.13(M)	1.59(F) 1.46(M)	2.0(F) 1.7(M)
Number of prosomal segments	4	5	5	5(F, M)	5(F, M)	4(F, M)
Number of urosomal segments	1	1	2	3(F, M)	3(F) 4(M)	3(F) 5(M)
Number of swimming feet	2	3	4	5(F, M)	5(F, M)	5(F, M)
Cephalic hooks	Absent	Present	Present	Present	Present	Present

(F=females, M=males, C-I—C-V=Copepodid stages I—V)



TEXT-FIG. 1. Observed variations in the total lengths of copepodites of *Labidocera pectinata* associated with growth.

The number of endopodal segments and the arrangement of setae on endopods on either side and on the second basipod of maxillipeds are also useful in distinguishing the copepodid stages (Table 2).

Appendages of C-I to C-V and Adult

A-1 : (Fig. 2b and 5g-h)

Copepodid stages I-IV have 9, 12, 20 and 23 segments respectively ; arrangements of setae and aesthetes as in Table 2 ; a row of small setae present on ventral margin of anterior twelve segments in C-IV, C-V and adult; right A-1 of male in C-V with dorsal spines on segments 17 and 18 ; segments 17 and 22 in adult with spines on dorsal margin and toothed plates on segments 18 and fused segments 19-21 ; hinge present in adult male between segments 18 and 19-21, distal to which are present four segments, namely 19-21, 22, 23 and 24-25 (Table 2).

A-2 : (Fig. 2c and 5b)

C-I with same number of segments as in adult ; terminal segment of Ri showing increase in number of terminal and lateral setae from C-I to adult from 10 to 15 (Table 2) ; seventh segment of Re in C-I with three setae (two terminal and one lateral) but in subsequent stages one more seta is added to distal segment.

Mnd : (Fig. 2d and 5c)

Number of setae in B-2 and terminal segment (Ri) increases from 3 to 4 and 9 to 11 respectively with development (Table 2) ; mandibular blade with 4 teeth and one flagellum-like seta in C-I ; C-II to adult each with 5 teeth and one flagellum-like seta and with fine setose spines scattered in between teeth and seta.

Mx-1 : (Fig. 2e and 5d)

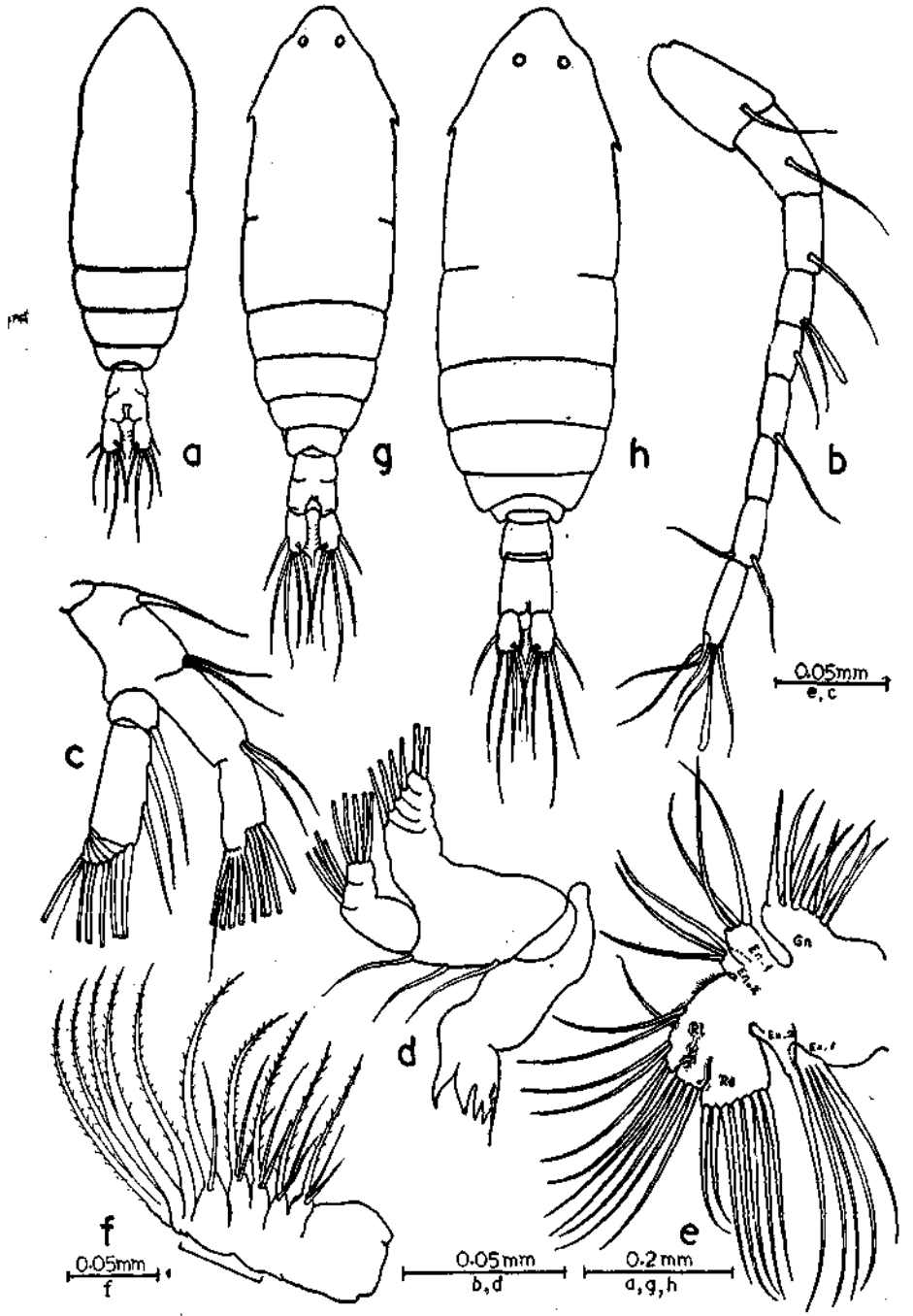
In C-I precoxa bears a gnathobase with 9 subequal bristles ; coxa with two lobes, internal lobe (endite-1) with three setae, and external lobe (exite-1) with four long and stout setae ; B-1 with two lobes, internal one (endite-2) with three setae and external lobe (exite-2) with one stout seta ; B-2 with three setae ; Ri with two indistinctly segmented lobes Ri-1 and Ri-2 ; Ri-1 with two lobes each carrying two setae (indicated in Table 2 as '2+2') ; Ri-2 with five seae ; Re with seven plumose setae. Gradual increase in number of setae from copepodid stages to adult is found in the gnathobase (9 to 11), exite-1 (4 to 9), endite-2 (3 to 4) and Re (7 to 9).

Mx-2 : (Fig. 2f and 5e)

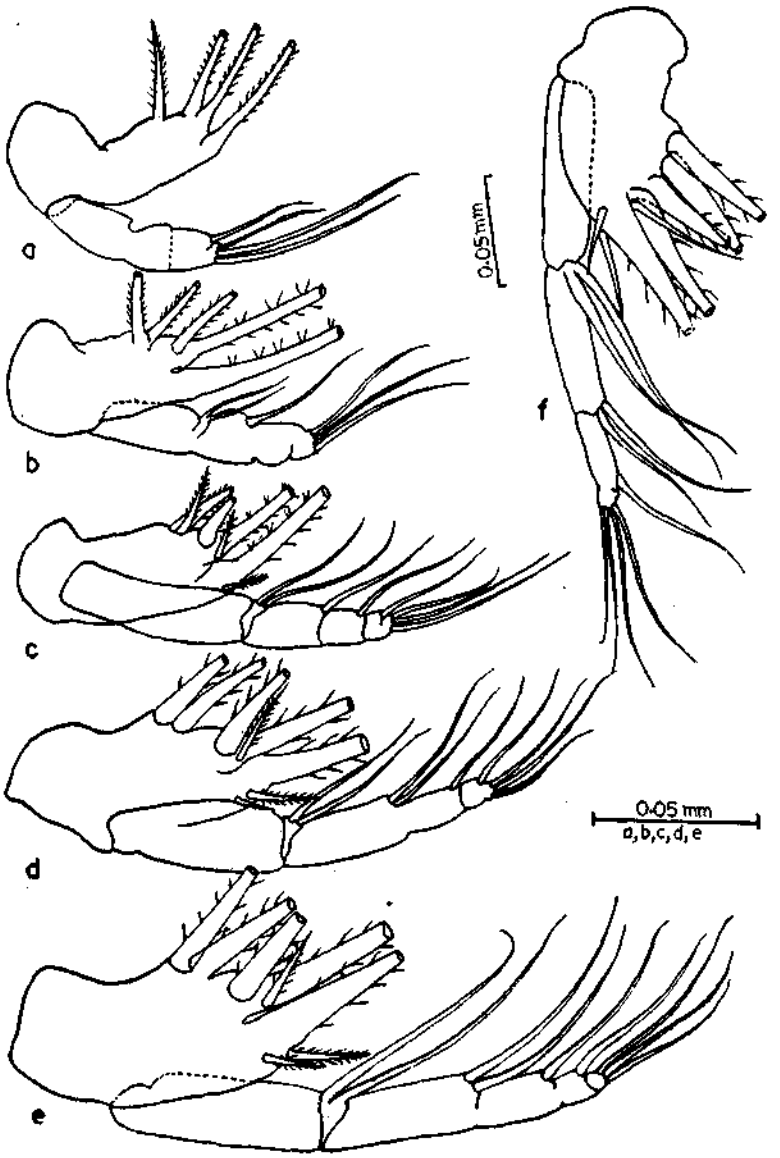
Uniramous ; In C-I, Ri with four indistinctly separable segments whreas in all other stages it is of five segments ; number of setae on first endite of coxa increases from 2 in C-I to 3 in C-II and later stages (Table 2).

Mxp : (Fig. 3 a-f)

Maxillepeds form a good criterion for distinguishing different stages of copepodites ; Ri of C-I with indistinct segmentation between Ri-1 and Ri-2, former with a terminal plumose seta and latter with terminal setae ; Ri of C-II and C-III with three and five segments respectively, the latter number being retained in subsequent stages and the adult ; number of setae on basipods also increases, from 4 in C-I to 8 in adult (Table 2).



TEXT-FIG. 2. *Labidocera pectinata* *a*. copeodid stage I dorsal view ; *b*. A-1 ; *c*. A-2 ; *d*. Mnd ; *e*. Mx-1 ; *f*. Mx-2 ; *g*. copepodid stage II dorsal view ; *h*. copepodid stage III dorsal view.



TEXT-FIG. 3. *Labidocera pectinata a-f.* Development of the maxillipeds in copepodid stages to VI.

P-1 :

Present in all stages ; basipodal seta appears in B-1 of C-II ; Ri one segmented in C-I to C-IV and two segmented in C-V and adult; number of setae increases from 10 in C-I to 16 in adult (Table 3).

P-2 :

Present in all stages ; seta in B-1 as in P-1, appearing first in C-II; Ri one segmented in C-II to C-IV and two segmented in C-V and adult ; Re one segmented in C-I, two segmented in C-II to C-IV and three segmented in C-V and adult ; number of setae increases from 9 in C-I to 19 in adult (Table 3).

P-3 :

Appears as rudimentary bud in C-I but shows progressive rapid development from C-II onwards (Table 3) ; basipodal seta present on B-1 from C-III onwards ; Ri one segmented in C-II to C-IV and two segmented in C-V and adult ; Re one segmented in C-II, two segmented in C-III and C-IV, and three segmented in C-V and adult ; number of setae increases from 10 in C-II to 19 in adult.

P-4 :

Present from C-III to adult (Table 3) ; single seta present on B-1 of C-IV ; Ri one segmented in C-III and C-IV, and two segmented in C-V and adult ; Re one segmented in C-III, two segmented in C-IV and three segmented in C-V and adult ; number of setae increases from 9 in C-III to 18 (or 19) in adult.

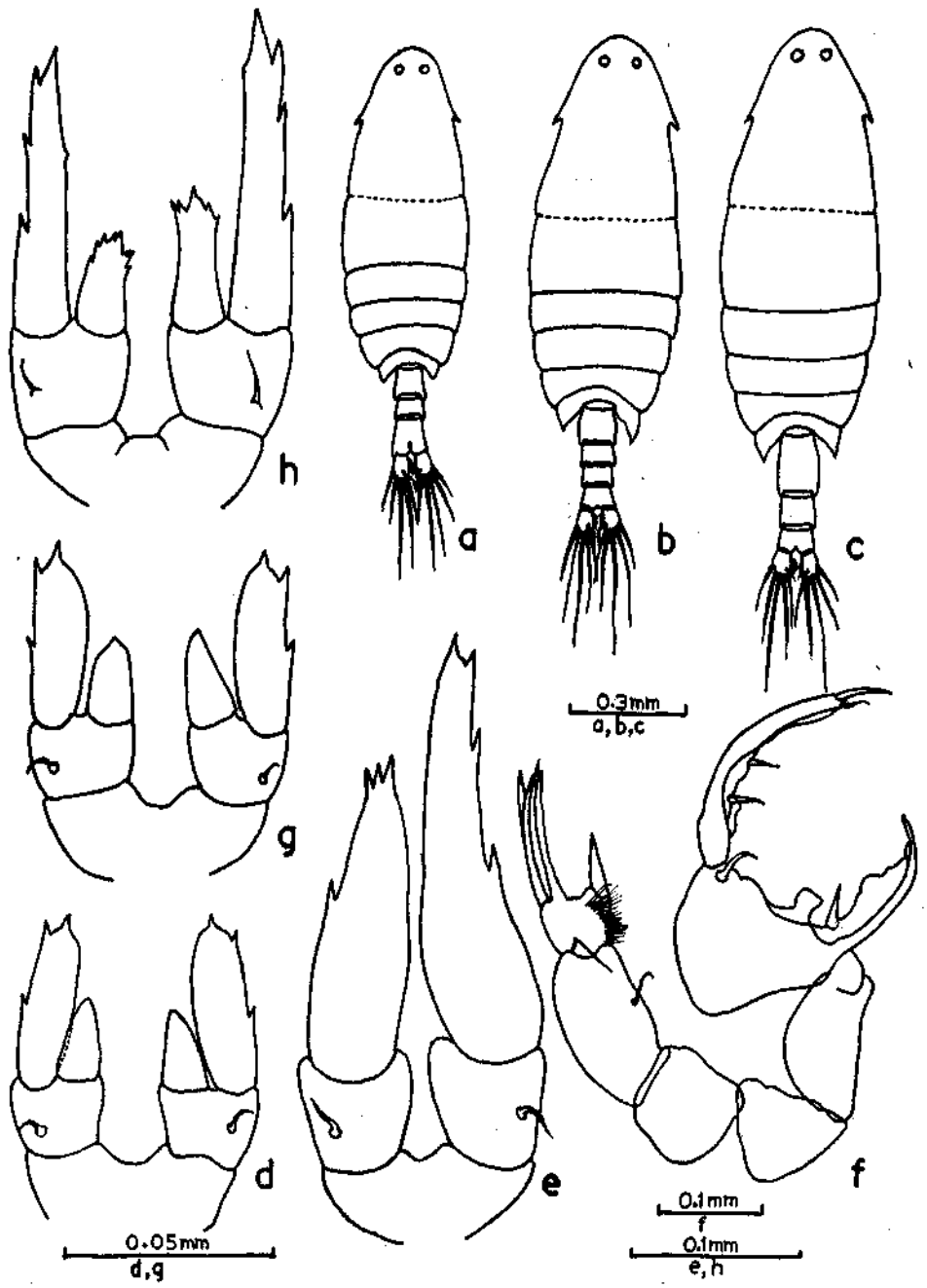
TABLE 2. *Segmentation and Setation of the Mouth parts of C-I to C-VI*
(setae in Arabic and spines in Roman numerals)

	Characters		Stages					
			C-I	C-II	C-III	C-IV	C-V	Adult
A-1 :								
	No. of segments	:	9	12	20	23	24(F) 23 (M)	24(F) 23 (M)
	No. of setae	:	14	20 (21)	30	43	47 (F)* 44 (M)*	49 (F)* 42 (M)*
	No. of aesthetes	:	2	4	6	12	14 (F)* 12 (M)*	17 (F)* 8 (M)*
	Total No. of spines	:	0	0	0	0	III (M)	VI (M)
A-2 :								
	B-1	:	1	1	1	1	1	1
	B-2	:	2	2	2	2	2	2
	Ri-1	:	2	2	2	2	2	2
	Ri-2 (lateral)	:	4	5	6	6	8	8
	Ri-2 (terminal)	:	6	6	7	7	7	7
	Re-1	:	1	1	1	1	1	1
	Re-2	:	3	3	3	3	3	3
	Re-3	:	1	1	1	1	1	1
	Re-4	:	1	1	1	1	1	1
	Re-5	:	1	1	1	1	1	1
	Re-6	:	1	1	1	1	1	1
	Re-7	:	3	3	3	4	4	4
	Total setae	:	26	27	29	30	32	32

*Variable. Liable to be lost on preservation.

TABLE 2 (*Contd.*)

Characters		Stages C-I	C-II	C-III	C-IV	C-V	Adult
Mnd :							
Coxa	:	4t+1	5t+1	5t+1	5t+1	5t+1	5t+1
B-1	:	0	0	0	0	0	0
B-2	:	3	4	4	4	4	4
Ri-1 (terminal)	:	4	4	4	4	4	4
Ri-1 (lateral)	:	5	6	6	7	7	7
Re-1	:	1	1	1	1	1	1
Re-2	:	1	1	1	1	1	1
Re-3	:	1	1	1	1	1	1
Re-4	:	1	1	1	1	1	1
Re-5	:	2	2	2	2	2	2
Total setae	:	18	20	20	21	21	21
Mx-1 :							
Gnathobase	:	9	10	10	11	11	11
Coxa-Endite-1	:	3	3	3	3	3	3
B-1-Endite-2	:	3	3	4	4	4	4
Coxa-Exite-1	:	4	6	8	8	9	9
B-1-Exite-2	:	1	1	1	1	1	1
B-2	:	3	3	3	3	3	3
Ri-1	:	2+2	2+2	2+2	2+2	2+2	2+2
Ri-2	:	5	5	5	5	5	5
Re-1	:	7	7	8	9	9	9
Total setae	:	39	42	46	48	49	49
Mx-2 :							
B-1 Endite-1	:	3	3	3	4	5	5
Endite-2	:	3	3	3	3	3	3
B-2 Endite-3	:	3	3	3	3	3	3
Endite-4	:	3	3	3	3	3	3
Ri-1	:	2	2	2	2	2	2
Ri-2	:	1	1	1	1	1	1
Ri-3	:	1	1	1	1	1	1
Ri-4	:	3	1	1	1	1	1
Ri-5	:	—	3	3	3	3	3
Total setae	:	19	20	20	21	22	22
Mxp :							
B : Lobes	:	3	3	3	3	3	3
setae	:	1 : 2 : 1 (=4)	2 : 2 : 1 (=5)	2 : 2 : 3 (=7)	2 : 3 : 3 (=8)	2 : 3 : 3 (=8)	2 : 3 : 3 (=8)
Ri : Segments	:	2	3	5	5	5	5
Setae	:	1 : 3	2 : 1 : 3	2:1:1:1:3	2:2:1:1:3	2:2:1:1:3	2:2:1:1:3



TEXT-FIG. 4. *Labidocera pectinata a.* copepodid stage IV dorsal view ; *b.* copepodid stage V, male, dorsal view ; *c.* copepodid stage V, female, dorsal view ; *d-f.* development of male fifth legs in copepodid stages IV to VI ; *g-h.* development of female fifth legs in copepodid stages IV and V.

P-5 :

Present in C-IV, C-V, and adult as follows :

(*a*) *C-IV :* *Female :* (Fig. 4g) Biramous, small and symmetrical ; B-2 with a short plumose seta on its posterior surface ; Ri present as a short smooth segment ; Re one segmented with one distal and two outer marginal spines ;

Male : (Fig. 4d) Biramous and asymmetrical ; B-2 and Ri as in C-IV female ; Re asymmetrical, that on right side slightly larger ; each Re with one terminal and two outer marginal spines.

(b) *C-V :* *Female :* (Fig. 4h) Biramous ; Ri and Re of different sizes ; Ri on left leg with 8 tooth-like spines and on the right with five spines ; right Re slightly longer and larger than left.

Male : (Fig. 4e) Uniramous ; Ri entirely lacking ; Re highly asymmetrical, right leg large, with one terminal and three outer marginal spine ; smaller left leg with one outer marginal and three terminal spines.

(c) *Adult :* *Female :* (Fig. 6 a-1 to f-1) Re asymmetrical, right leg being larger ; both legs basally stout and each terminating in two

TEXT-FIG. 5. *Labidocera pectinata* copepodid stage VI (adult) : *Female. a.* dorsal view ; *b.* A-2 ; *c.* Mnd ; *d.* Mx-1 ; *e.* Mx-2. *Male. f.* dorsal view ; *g-h.* development of the grasping portion of A-1 in male copepodid stages V and VI (adult).

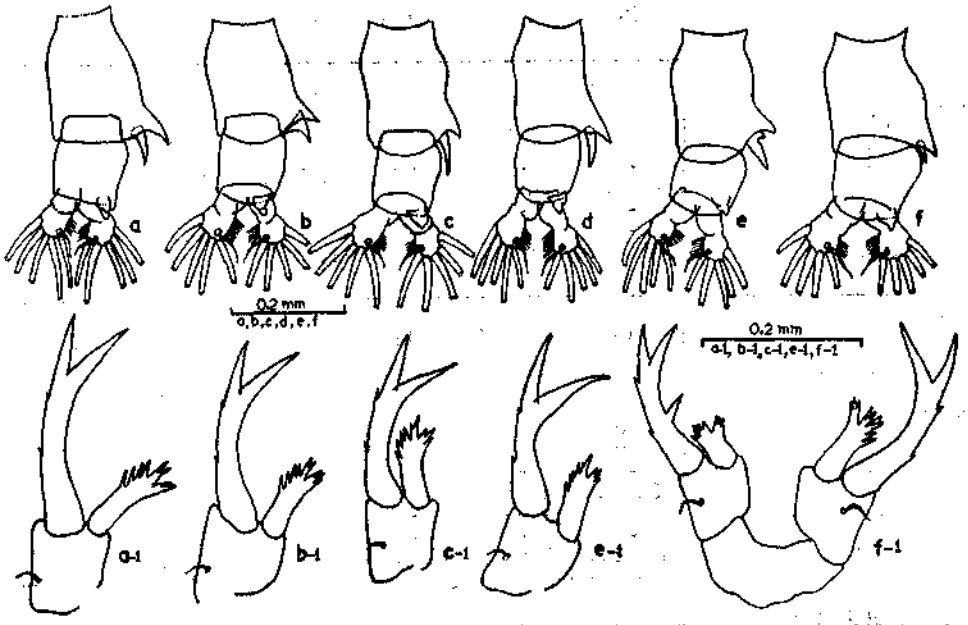
pointed spinuous prongs ; two small spines placed equidistant present along outer margin of Re ; a stout spine present on the mid-inner margin of left Re ; Ri asymmetrical, with a group of distal spinuous prongs of varying number.

Male : (Fig. 4 f) *Right leg :* with a chela, large and orbicular ; movable finger of chela slender and with two widely spaced setae along its inner margin and two terminally ; thumb slender, pointed and with a spine and a rectangular process towards the base. *Left leg :* B-2 with a short stout distal conical spine ; distal segment terminating in 4 finger-like spiniform processes ; a stout conical spine present towards its distal inner corner ; inner margin of terminal segment with a fringe of marginal hairs

Remarks

Labidocera pectinata was originally described by Thompson and Scott (1903) based on four females collected from the Palk Strait, Ceylon. Cleve (1903) described *L. similis* from the Karachi Coast of the Arabian Sea, but this species hardly differs from *L. pectinata*. Sewell (1932) described the male of *L. pectinata* based on the material collected from Cochin and from the Bay of Bengal. The taxonomic status of this species has been discussed elsewhere (Silas and Pillai, 1971). Its known distribution indicates that *L. pectinata* is restricted to the neritic waters of the Arabian Sea and the Bay of Bengal.

An examination of the specimens collected from the inshore regions of Bombay and Cochin on the west coast, and from the Gulf of Mannar and Palk Bay showed that some descrepancies exist in the previously published descriptions and figures. Some of the variations seen are :



Text-fig. 6. *Labidocera pectinata Female. a-f.* variations in genital segment and fifth legs in six adults (*a* and *b* from Gulf of Mannar, *c*, *d* and *e* from Cochin and *f* from Bombay).

The genital segments of the females (Fig. 6 *a-f*) are provided with two lateral spines which show different configurations in their length and width. In some specimens an additional small spinuous process is present in between the above mentioned two spines. Cleve's material of *L. similis* had only one spine on the right-lateral margin of the genital segment, which seems to be an error (Cleve, 1903, Fig. 16c).

In the fifth legs of the females (Fig. 6 a-1 to f-1) there is a clear variation in the number of distal spinuous prongs on the endopod. From the literature it is seen that the endopod of the females' fifth legs have five teeth on the right leg and nine teeth on the left leg (Cleve, 1903) ; eight teeth on both right and left legs (Thompson and Scott, 1903) or nine teeth on both the legs (Sewell, 1912). In the material examined by the present author the number of endopodal spines on the right endopod varies from eight to ten while the left endopod has regular nine teeth.

Material of the specimens available with the author does not seem enough to explain the significance of the variations seen in the genital segment and the number and arrangement of the spines in the segment and the variations in the fifth legs of females. It is interesting to note that the males do not have corresponding variations.

TABLE 3. *Segmentation and Setation of the Swimming Feet 1-4 of C-I to C-VI*

(setae in Arabic and spines in Roman numerals)

Characters		Stages					
		C-I	C-II	C-III	C-IV	C-V	Adult
P-1 :							
B-1	:	0	1	1	1	1	1
B-2	:	0	0	0	0	0	0
Ri-1	:	—	—	—	—	3 : 0	3 : 0
Ri-2	:	4 : 2 : 1	5 : 2 : 1	6 : 2 : 1	6 : 2 : 1	3 : 2 : 1	3 : 2 : 1
Re-1	:	—	—	—	—	I : 1	I : 1
Re-2		—	—	—	—	I : 1	I : 1
Re-3	:	IV : I : 3	III : I : 4	III : I : 4	III : I : 4	II : I : 4	II : I : 4
Total setae	:	10	13	14	14	16	16
P-2 :							
B-1	:	0	1	1	1	1	1
B-2	:	0	0	0	0	0	0
Ri-1	:	—	—	—	—	3 : 0	3 : 0
Ri-2	:	3 : 2 : 1	4 : 2 : 2	5 : 2 : 2	6 : 2 : 2	4 : 2 : 2	4 : 2 : 2
Re-1	:	—	—	—	—	I : 1	I : 1
Re-2	:	—	—	—	—	I : 1	I : 1
Re-3	:	III : I : 3	II : I : 4	III : I : 5	III : I : 5	III : I : 5	III : I : 5
Total setae	:	9	13	15	17	19	19

TABLE 3 (*Contd.*)

	C-I	C-II	C-III	C-IV	C-V	Adult
P-3 :						
B-1 :		0	1	1	1	1
B-2 :		0	0	0	0	0
Ri-1 :		—	—	—	3 : 0	3 : 0
Ri-2 :		3 : 2 : 1	4 : 2 : 2	4 : 2 : 2	4 : 2 : 2	4 : 2 : 2
Re-1		—	—	—	I : 1	I : 1
Re-2 :		—	I : 0	I : 1	I : 1	I : 1
Re-3 :		III : I : 4	III : I : 4	III : I : 5	III : I : 5	III : I : 5
Total setae :		10	13	15	19	19
P-4 :						
B-1 :			0	1	1	1
B-2 :			0	0	0	0
Ri-1 :			—	—	3 : 0	3 : 0
Ri-2 :			3 : 2 : 1	4 : 2 : 2	3 : 2 : 2	3 : 2 : 2
Re-1 :			—	—	I : 1	I : 1
Re-2 :			—	I : 0	I : 1	I : 1
Re-3 :			III : I : 3	III : I : 5	III : I : 5	III : I : 5
Total setae :			9	14	18	18

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