Mem. Qd Mus. **16**(3): 471–83. [1973]

A REVIEW OF *CLETODES* (CRUSTACEA: HARPACTICOIDA), WITH THE DESCRIPTION OF A NEW SPECIES FROM QUEENSLAND

R. HAMOND
C.S.I.R.O., Cronulla, N.S.W.*

ABSTRACT

Cletodes millerorum sp. nov. is described and figured from a single female associated with a hermit crab, *Dardanus megistos* (Herbst), between tide-marks at Green Island, near Cairns (North Queensland). It is shown that in those species of *Cletodes* in which both sexes are adequately known, the nature of the endopod of P3 in the male is fully correlated with the setation of this ramus (and partly correlated with that of certain other rami) in the homospecific female; on this basis, the above species of *Cletodes* fall into three groups. Assuming that these correlations hold good for poorly known species, the undiscovered male of *C. millerorum* probably has an unmodified third endopod.

The possible taxonomic values of the somitic and opercular sensillae, the opercular teeth, the rami of the maxillule, and the 'membraneous tubes', are discussed; all these features are difficult to see and have therefore been largely ignored in the past, but would repay careful study in all species.

It has been found impracticable to contain all the species now known in a single key covering both sexes, as hitherto; separate keys to each sex are therefore provided.

Since the last key to *Cletodes* (Lang, 1965, p. 426), the number of known species has almost doubled; the additions are *C. reyssi* Soyer, 1964, *C. latirostris* Drzycimski, 1967, *C. spinulipes* Por, 1967, *C. yotabis* Por, 1967, *C. smirnovi* Bodin, 1970, and *C. pseudodissimilis* Coull, 1971. A further species (Krishnaswamy, 1957, p. 78, as *Enhydrosoma* sp.) was referred to *Cletodes* by Lang (1965, p. 431) but omitted from his key, probably because of insufficient descriptions and figures (cf. Lang, 1965, p. 7); not having been able to consult Krishnaswamy's paper, I have had to leave out this species altogether.

The discovery of yet another species, the first *Cletodes* to be reported from Australian waters, affords a convenient pretext for taking stock of certain characters which may throw light on relationships within this genus.

*c/o Zoology Department, University of Melbourne, Vic.

MATERIAL AND METHODS

Among the washings of a gastropod shell tenanted by the pagurid *Dardanus megistos* (Herbst), collected by me at low tide on 20.vii.1970 about 400 m north of the main landing-jetty on Green Island (off Cairns, Queensland), were the following organisms:

KINORHYNCHA

1 echinoderid sp.

MYSIDACEA

A few of ?*Heteromysis* sp.

DECAPODA

1 *Aretopsis* sp. (Alphaeidae)

HARPACTICOIDA

6, 3, 7, 4, *Paraidya major* Sewell (i.e. 6 females of which 3 were ovigerous, 7 males, and 4 copepodites); 6, 5, 6, 0, *Porcellidium* (?*ovatum* Haller); 2, 0, 0, 0, *Dactylopodia tisboides* (Claus); 1, 0, 0, 0, *Robertsonia barnesi* Hamond (in press); and 1, 0, 0, 0, *Cletodes millerorum*, described below. Apart from the holotypes of the two new species, all harpacticoids are being retained in my own collection for comparison with material to be studied in future.

The copepods were studied by my usual methods (Hamond, 1969 and in press).

Cletodes millerorum sp.nov.

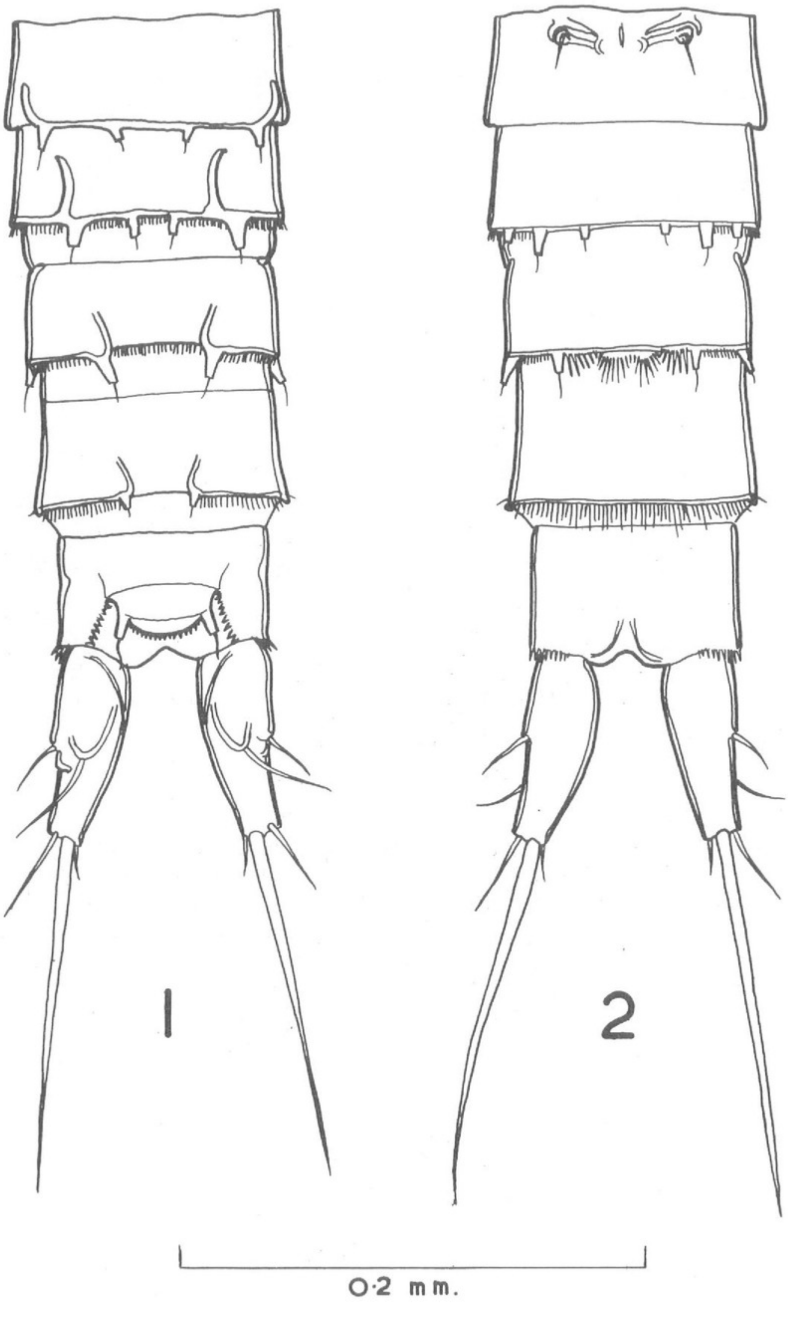
(Figs. 1–14)

HOLOTYPE: Female (apparently adult but not ovigerous), W3811 (Queensland Museum).

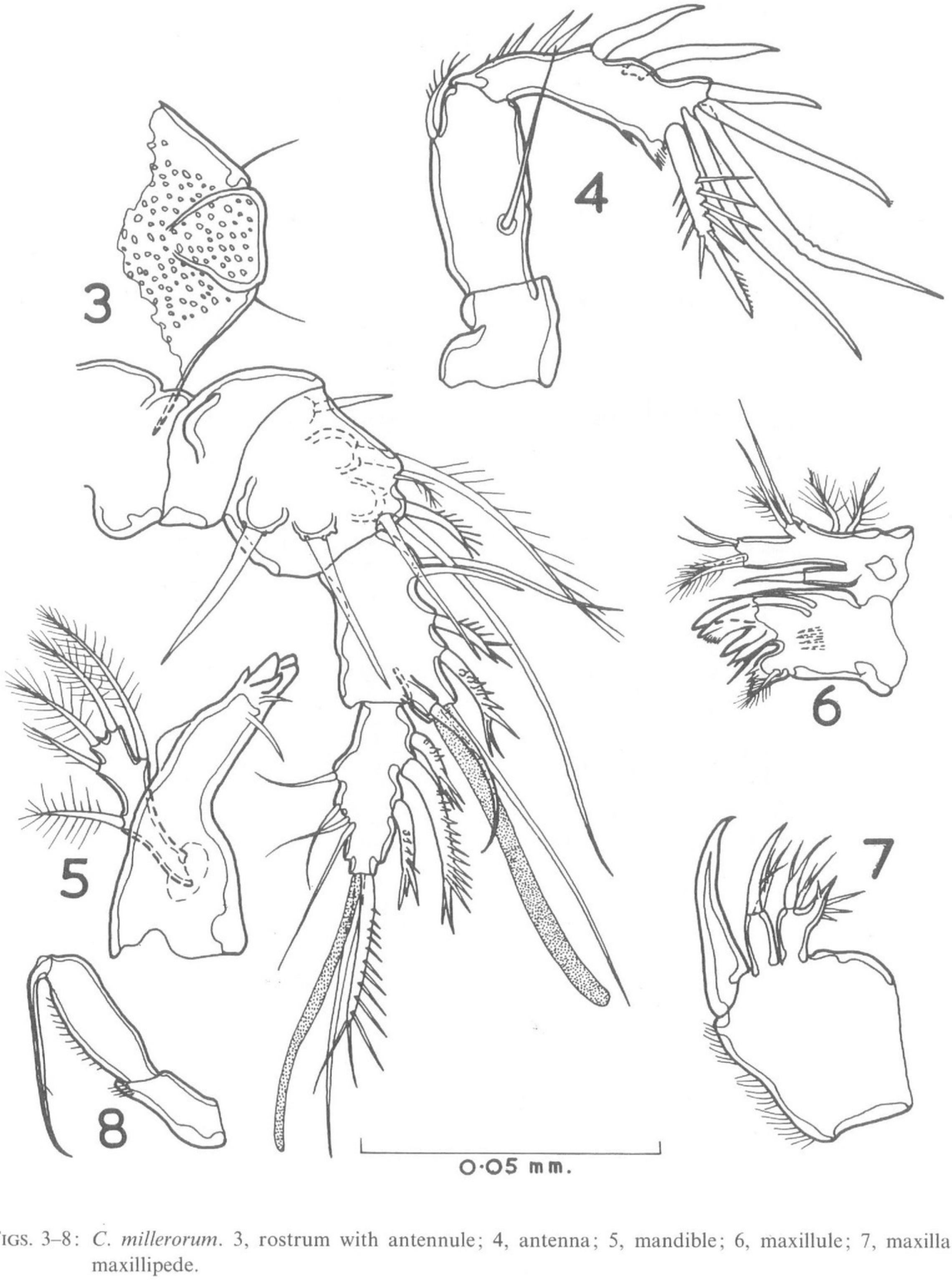
DESCRIPTION: Body 0·6 mm long, slender and tapering towards the furca. Rostrum (Fig. 3) short and blunt; abdomen (reconstructed in Figs. 1 and 2 from a squashed preparation) with the rear edge of each somite bearing combs of very small spinules interrupted by prominent sensillae. Genital double-somite divided distinctly on the dorsal side but much less clearly so on the ventral side. Operculum curved, with a sensilla at each end, and with sixteen very small triangular teeth inserted into an otherwise smooth edge. Furcal rami slightly divergent, separated at their bases by about the width of a ramus; each ramus is about three times as long as its greatest width, which is about one-quarter of the ramal length from the base, and curves slightly outwards. The ramus bears three terminal setae (of which the middle one is by far the largest), a dorsal seta arising from a protuberance, and a lateral seta arising from a step in the external wall.

Antennule (Fig. 3) with the small penultimate segment apparently fused with that proximal to it (i.e. the segment bearing the larger aesthetasc); on the other hand, the proximal part of the antennule appears to be divided into three segments, as shown, instead of the usual two segments, so that the whole antennule consists of five segments as in other *Cletodes* spp., although these segments are not morphologically equivalent to the segments in the latter. This may be an abnormality; however, it is identical in both antennules of the present specimen.

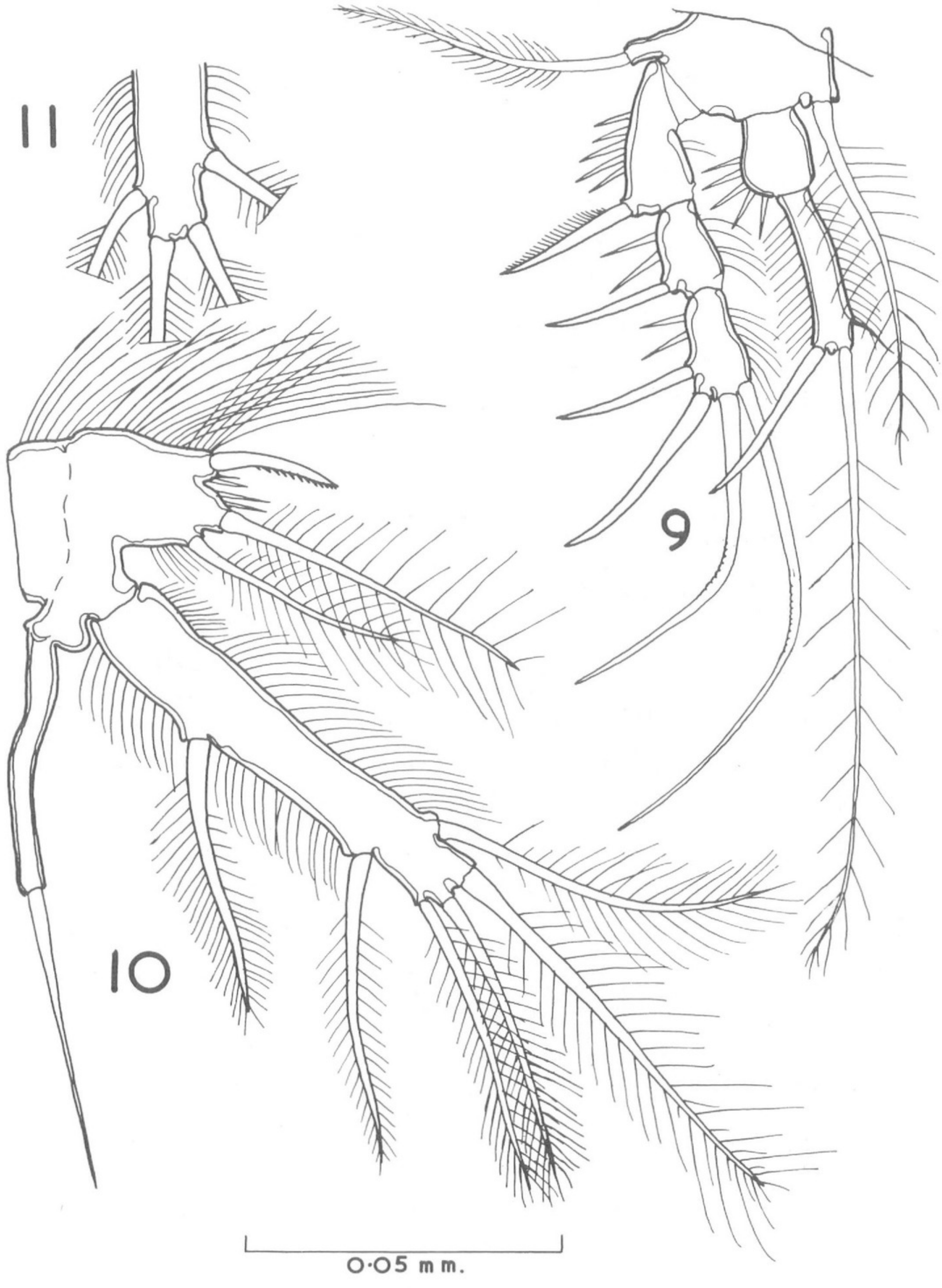
Antenna (Fig. 4) with the exopod represented only by a seta; mandible (Fig. 5) with a single-segmented exopod bearing five plumose setae; maxillule (Fig. 6) like that of *C. hartmanae* Lang, 1965, but with a much more elaborate cutting edge; maxilla (Fig. 7) with two endites; maxillipede (Fig. 8) with a very slender claw, and with a comb of setules along the palmar surface, but without any setae.



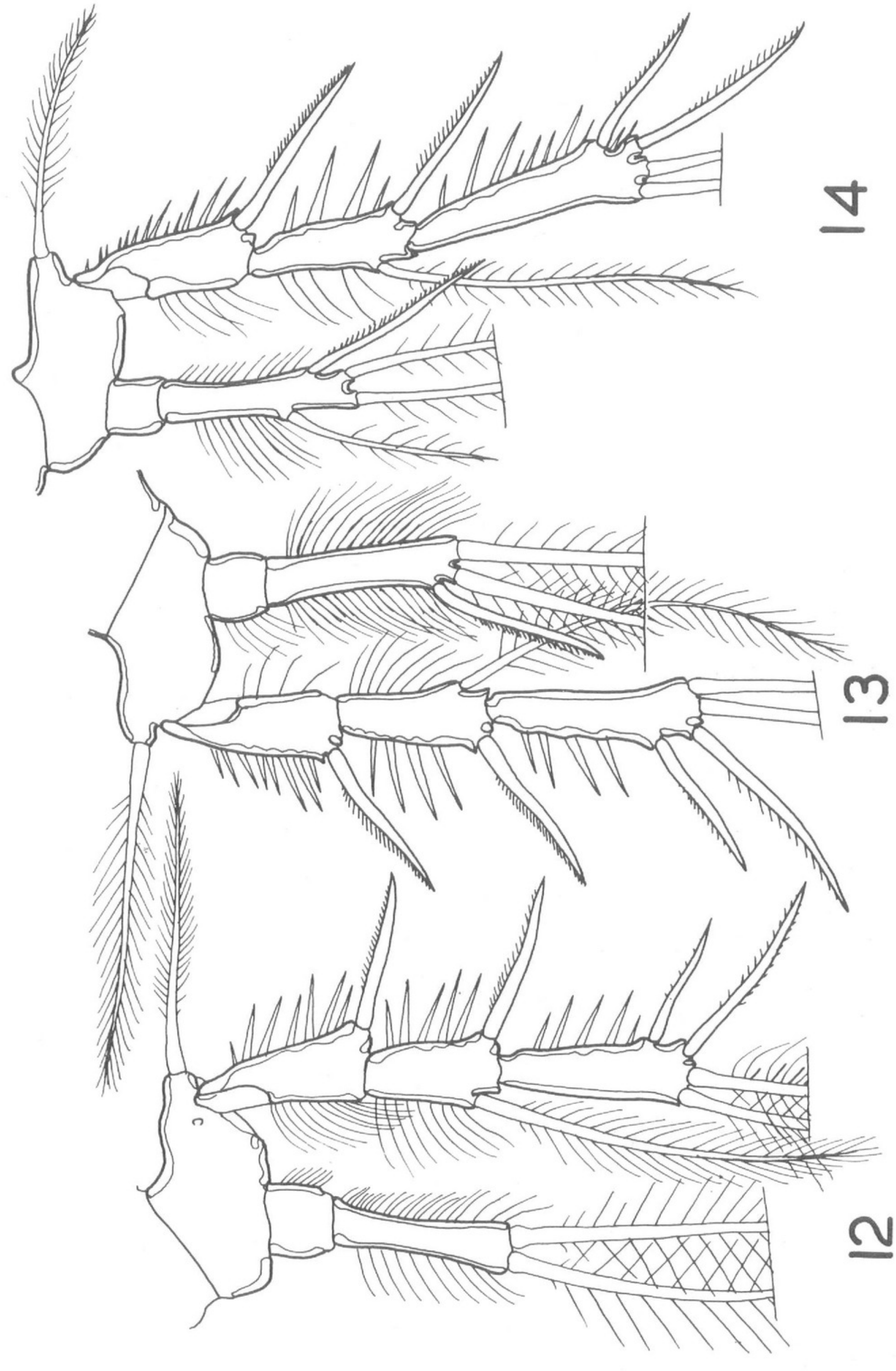
FIGS. 1, 2: *C. millerorum*, abdomen. 1, dorsal view; 2, ventral view.



FIGS. 3–8: *C. millerorum*. 3, rostrum with antennule; 4, antenna; 5, mandible; 6, maxillule; 7, maxilla; 8, maxillipede.



FIGS. 9–11: *C. millerorum*. 9, P1; 10, P5; 11, apex of other exopod of P5.



FIGS. 12–14: *C. millerorum*. 12, P2; 13, P3; 14, P4.

Swimming-legs each with the three-segmented exopod longer than the two-segmented endopod; in P1 (Fig. 9) the second endopod segment is the only one to have an inner seta. Setal formula is P2 (Fig. 12) exp 0.1.022, enp 0.020; P3 (Fig. 13) exp 0.1.022, enp 0.021; P4 (Fig. 14) exp 0.1.022, enp 0.121. P5 with discrete rami; one exopod has six setae (Fig. 10), the other only five (apex in Fig. 11). The two basiendopods are exactly alike, each with three setae, of which the innermost is spiniform with spinules confined to its outer (concave) edge.

Colour in life unknown; in formalin-sea water greyish white. Male hitherto unknown.

I have much pleasure in naming this species after Mr and Mrs Miller, the owners of the Green Island Aquarium in 1970, thanks to whose hospitality I was able to collect this and other harpacticoids on the shores of Green Island.

DISCUSSION

Using the keys by Lang (1948) and by Soyer (1964), *C. millerorum* comes nearest to *C. limicola* or *C. carthaginiensis*; Lang's later key (1965) brings it to *C. dissimilis*. From all these species, however, *C. millerorum* differs either in the form and setation of the female P5 or in the form of the furca. Attempts to make a new key covering both sexes were unsuccessful; separate keys to males and females are given below.

Further details about previously known species of *Cletodes* are given by Klie (1950), Soyer (1964), Bodin (1964a, 1970), and Por (1959, 1964); the taxonomically awkward variability of the furca, in material identified by Por (1964a) as *limicola*, is supposed by Bodin (1970) to be due to confusion with *C. spinulipes* or a similar species. Since *C. limicola* may have a small spine on the basiendopod in addition to the usual setae (Soyer, 1964, fig. 1E; Bodin, 1970, however, describes this as a membraneous tube), I can find no reason at present to maintain the var. *tunisensis* Monard, especially in view of the low standard of Monard's descriptions and figures and the fact (for which I am indebted to Professor J. G. Baer, Neuchatel) that Monard did not designate any type specimens or leave behind any harpacticoid material at his death. For these reasons, also, I have thought it advisable to exclude *C. carthaginiensis* Monard entirely, pending rediscovery and redescription.

TABLE 1

DIFFERENCES BETWEEN *C. spinulipes* POR (1967) AND *C. millerorum* NOV. SP.

Character	*C. spinulipes*	*C. millerorum*
Setae on mandibular palp	6	5
P1exp3, setae	3(?injury)	4
P2–P4, exp2 inner seta	not quite to end of exp3	nearly twice as far as end of exp3
♀P5benp, inner seta	setiform and high up the inner edge	spiniform and on a level with the two setiform setae
♀P5exp	about 3 times as long as benp	about 6 times as long as benp

The *C. tenuipes* of Klie (1950, fig. 139) is apparently *C. pusillus* (cf. Por, 1959, fig. 16); in both, the male P5 has four exopodal setae (of which the inner terminal is longer than the outer terminal) and no setae on the basiendopod. However, in Klie's figure the exopod of the male P5 is much longer than in Por's, and the setae on it are much less crowded together. The male P5 of the real *tenuipes* is shown by Bodin (1970, pl. 27).

In such a closely-knit genus as this, one should constantly be on the lookout for further characters which might be useful taxonomically or systematically, and four such possible characters will now be considered.

TABLE 2

Occurrences of Certain Characters in Various *Cletodes* spp., According to the Authors Cited

	Sars (1911)	Sars (1920)	Lang (1948)	Por (1959)	Por (1964)	Soyer (1964)	Lang (1965)	Drzycimski (1967)	Por (1967)	Bodin (1970)	Coull (1971)	Present paper
tenuipes	$^{-}$?a		b	$^{+}$bcd						$^{+}$e		
limicola	$^{-}$c		cd		$^{+}$c					$^{+}$d		
longicaudatus	$^{-}$cd		cd			$^{-}$b						
pusillus		$^{-}$ab	ab									
longifurca			$^{+}$c									
reyssi						$^{+}$bc						
hartmanae							$^{+}$b					
latirostris								$^{+}$e				
yotabis									$^{+}$a			
spinulipes									$^{+}$bc			
smirnovi										$^{+}$d		
pseudodissimilis											$^{+}$b	
millerorum												$^{+}$c

Key to table: $^{+}$ or $^{-}$, presence or absence of opercular sensillae; a to e, nature of opercular margin. a = smooth, no spinules or setules; b = smooth, with tiny spinules or setules let into the margin; c = smooth, with discrete teeth let into the margin; d = margin itself cut into small teeth; e = margin itself cut into large teeth.

(1). The sensillae at either end of the operculum have often been figured in the literature (Table 2); it may be wondered whether their apparent absence in the Norwegian material (as in Sars, 1911) of *C. limicola* and *C. tenuipes* is due to an oversight by Sars, or whether it constitutes a genuine difference between the Norwegian population on the one hand and the Black Sea and eastern Mediterranean populations (Por, 1959, 1964a) on the other. Neither Sars nor Soyer (1964) show opercular sensillae for *C. longicaudatus*, so it is possible that this species genuinely lacks them; for *C. pusillus* there are no later figures to confirm or contradict those of Sars, and all the other species in Table 2 are known to have opercular sensillae, placed at the very end of the operculum in all save *C. smirnovi*. The published figures of *C. carthaginiensis*, *C. dissimilis* and *C. pseudodissimilis* are not sufficient to establish either the presence or absence of opercular sensillae, but they are definitely present in a female paratype of *C. pseudodissimilis* which I have examined. The arrangement of the sensillae over the rest of the body is still less well known; *C. hartmanae* is the only species whose figures show this clearly and I very much regret that the type of *C. millerorum* had been dissected before the possible importance of this feature had occurred to me.

Also in Table 2 are included arbitrary categories into which the varieties of opercular margin appear to fall; however, new figures of nearly all known species are required for a realistic appraisal of these characters.

(2). Bodin (1970) shows 'membraneous tubes' on the limbs of several genera, including *Cletodes*, and gives reason for thinking that they have often been mistaken in the past for setae; I have not yet seen them on any harpacticoid, and they are definitely absent from the holotype of *C. millerorum*.

(3). In Table 3, the males of all adequately known species are arranged in three groups, A, B, and C, according to the nature of the second endopod segment of the third swimming-leg in the male (abbreviated as P3enp2); an attempt is made to correlate such modification with the setal formula of the homospecific female. As an example of how the table works, at the end of the generic setal formula at the top it will be seen that the exopod of P5 is given as 5 (i.e. every species of *Cletodes* has five setae on the female P5 exopod), whereas the basiendopod has the letter p. In the column marked p in the table, we find that every species in group A has three setae on the basiendopod, whereas the various species in the other groups may have from one to four basiendopodal setae (the specific number, however, being constant). Thus, in the generic setal formula, numbers denote parts of the formula which are constant at the generic level, and letters parts which are constant only at the specific level.

The only characters showing complete correlation with all three groups are h, j, and n; character p correlates completely with groups A and B, and characters g and l with groups B and C. It is tempting to use these correlations to predict the type of sexual modification in a known male for which this modification has not been described, such as *C. longifurca* Lang; the female of this species agrees perfectly with group B in the 'strong' characters h, j, and n, has only two basiendopod setae on P5 (thus group B or C but not A), and has character g = 1 and character l = 0; the last-named character indicates B rather than C but is neutral as to A, while g is the only character which runs directly counter to the others by indicating C or A rather than B. Thus it seems very

TABLE 3A

GENERIC SETAL FORMULA FOR FEMALE *Cletodes**

P1		P2		P3		P4		P5	
exp 0.0.a	enp 0.b	exp 0.c.4	enp 0.def	exp 0.g.4	enp 0.hij	exp 0.k.4	enp 0.1mn	exp 5	benp p

TABLE 3B

SPECIFIC SETAL FEATURES FOR SUBSTITUTION IN THE GENERIC FORMULA OF FEMALE *Cletodes*

Group	Male P3enp2	Species	a	b	c	d	e	f	g	h	i	j	k	l	m	n	p
		hartmanae	4	3	0	1	1	0	0	0	1	1	0	0	1	1	3
		limicola	4	3	1	0	2	0	1	0	2	1	1	0	2	1	3
A	unmodified	*longicaudatus*	4	3	1	0	2	0	1	0	2	1	1	0	2	1	3
		spinulipes	3	3	1	0	2	0	1	0	2	1	1	1	2	1	3
		pseudodissimilis	4	3	1	0	2	0	1	0	2	1	1	1	2	1	3
		smirnovi	4	2	0	0	2	0	0	0	1	0	1	0	1	0	2
B	modified one seta	*pulsillus*	4	3	1	0	1	0	0	0	2	0	0	0	2	0	2
		tenuipes	4	2	0	0	1	0	0	0	1	0	0	0	1	0	1
		reyssi	4	3	1	0	2	0	1	1	1	1	1	1	1	1	2
C	modified two setae	*latirostris*	4	3	1	1	2	1	1	1	2	1	1	1	2	1	3
		yotabis	4	3	1	0	2	0	1	1	2	1	1	1	2	1	4

*The letters a to p in table 3A refer to variable features which are further described in Table 3B which lists the species of *Cletodes* in three groups based on the nature of the male P3enp2.

likely that the male of *C. longifurca* will be found to belong to group B; in partial support of this, Lang (1948) says that the third endopod is indeed modified, but neither he nor Por (1964b, the only other find known to me of male *longifurca*) state how many setae it has. The female of *millerorum* has the same setal formula as *pseudodissimilis* (and, except for character a, as *spinulipes*), so the undiscovered male of *millerorum* will probably be found to belong in group A.

(4). Though very small and hard to see, the forms and setations of the rami of the maxillule are of potential taxonomic importance. In *longicaudatus*, *longifurcatus*, *pusillus*, *tenuipes* (all according to Lang, 1948), and *latirostris* (in Drzycimski, 1967), nothing is said about these rami except that (by implication) they both consist of setae arising directly from the basis, without any free segment. *C. pseudodissimilis* also has this kind of endopod (with two setae), and no sign whatever of an exopod. All the other species (*limicola*, *reyssi*, *smirnovi*, *spinulipes*, *millerorum*, *hartmanae*, and *yotabis*) have two setae on the exopod, which in *limicola* has a free segment bearing the setae, according to Lang (1948), but only the two setae unaccompanied by any free segment according to Soyer

(1964). As to the endopod, only *millerorum* has a free segment, which bears three setae (Fig. 6); in all the other species the endopodal setae, to the number of three (*reyssi*, *smirnovi*, Soyer's *limicola*), two (*hartmanae*, *spinulipes*, Lang's *limicola*), or one (*yotabis*), arise directly from the basis, as in *pseudodissimilis*. At present there appears to be no correlation between any of these characters and the grouping shown in Table 3.

Most species of *Cletodes* appear to be well-founded, but the amount of real or supposed variation in *C. limicola* calls for further investigation. The need to give the clearest possible figures of every feature of every species, whether newly discovered or well known, cannot be too strongly emphasised.

Revised Keys to Species of *Cletodes*

Females

1.	P3exp2 without, P4exp2 with, an inner seta	*smirnovi*
	These segments each without an inner seta	2
	These segments each with an inner seta	4
2.	P2exp2 with an inner seta; P2–P4, enp2 with 1, 2, and 2 setae respectively; P5benp with 2 setae; furca long and slender	*pusillus*
	P2exp2 without an inner seta; remaining characters not combined	3
3.	P3–P4, enp2 with 1 seta each; P5benp with 1 seta; furca slender, slightly bent at the base	*tenuipes*
	P3–P4, enp2 with 2 setae each; P5benp with 3 setae; furca elongate oval	*hartmanae*
4.	P2enp2 with 4 setae	*latirostris*
	P2enp2 with 2 setae	5
5.	P3enp2 with 3 setae, P4enp2 with 3 or 4 setae	6
	These segments each with 2 setae	*longifurca*
	These segments each with 4 setae	*yotabis*
6.	Furcal rami irregularly shaped	*dissimilis*
	Furcal rami broadest near the base, with or without a basal expansion, but in either case tapering more or less evenly towards the apex	7
7.	Furca about 7 times as long as broad; P5benp with 2 setae	*reyssi*
	Furca about 5 times as long as broad; P5benp with 3 setae	*longicaudatus*
	Furca between 2 and 3 times as long as broad; P5benp with 3 setae	8
8.	P5 rami fused(?)	*carthaginiensis*
	P5 rami discrete	9
9.	P1exp3 with 3 setae	*spinulipes*
	Plexp3 with 4 setae	10

10. P4enp2 with 3 setae . . . . *limicola*
P4enp2 with 4 setae 11

11. Furcal ramus markedly bulging outwards, short and pear-shaped; P4exp3 outer marginal spines, upper much shorter than lower . *pseudodissimilis*
Furcal ramus not bulging outwards, moderately slender and tapering evenly; P4exp3, the two outer marginal spines subequal . . *millerorum*

Males

1. P3 not modified, but resembles that of the female (group A in Table 3) . 6
P3enp2 with a terminal hook-like thorn, and one or two setae 2

2. P3enp2 with 1 terminal seta (group B) 3
P3enp2 with 2 terminal setae (group C) 5

3. P4exp2 with an inner seta; P5exp with 3 setae . . . . *smirnovi*
P4exp2 without an inner seta; P5exp with 2 or 4 setae 4

4. P5exp with 2 setae; P2exp2 with an inner seta . . . . *pusillus*
P5exp with 4 setae; P2exp2 without an inner seta . . . . *tenuipes*

5. P5exp with 5 setae; P2enp2 with 2 setae; P3enp2 with a very long outer terminal seta and a short inner terminal seta . . . . *reyssi*
P5exp with 5 setae; P2enp2 with 4 setae; P3enp2 with 2 terminal setae of about the same length . . . . *latirostris*
P5exp with 3 setae; P2enp2 with 2 setae; P3enp2 as in *latirostris* *yotabis*

6. P5, exp with 2 large terminal setae and a small outer seta, benp with no setae at all; furca at most twice as long as broad, and usually less; P3–P4, exp2 without an inner seta . . . . *hartmanae*
P5 variable; furca at least twice as long as broad; P3–P4, exp2 with an inner seta 7

7. P5exp with 2 setae (benp with 1 seta); furca about 5 times as long as broad . . . . *longicaudatus*
P5exp with 3 setae; furca less than 4 times as long as broad 8

8. P5benp with a seta . . . . *limicola*
P5benp without a seta 9

9. Furcal rami broadest near the base, tapering evenly; P5exp outermost seta small (as in *hartmanae*) . . . . *spinulipes*
Furcal rami irregular in form; P5exp outermost seta stout and spiniform . . . . *pseudodissimilis*

ACKNOWLEDGEMENTS

Besides Mr and Mrs Miller, I am most grateful to the Department of Primary Industries, Brisbane, for a permit to collect on Green Island; to Professor Baer for information about Monard's work, and for a complete set of Monard's papers; to Dr J. C. Yaldwyn for determining *Dardanus* and *Aretopsis*; to Dr B. C. Coull for the loan of the paratype of *C. pseudodissimilis* and for his helpful criticisms of the typescript; and to the Chief of the Division of Fisheries and Oceanography, Cronulla, for the loan of phase-contrast equipment.

LITERATURE CITED

BODIN, P., 1964. Recherches sur la systématique et la distribution des Copépodes Harpacticoides des substrats meubles des environs de Marseille. *Rec. Trav. Stn. mar. Endoume.* **51**(Bull.35): 107–83.

1970. Copépodes harpacticoides marins des environs de La Rochelle, 1. Espèces de la vase intertidale de Chatelaillon. *Tethys.* **2**(2): 385–436.

COULL, B. C., 1971. Meiobenthic Harpacticoida (Crustacea, Copepoda) from the North Carolina continental shelf. *Cah. Biol. Mar.* **12**: 195–237.

DRZYCIMSKI, I., 1967. Zwei neue Cletodidae (Copepoda Harpacticoida) aus dem westnorwegischen Küstengebiet. *Sarsia.* **29**: 199–206.

HAMOND, R., 1969. Methods of studying the copepods. *J. Quekett micr. Club.* **31**: 137–49.

In press. The Australian species of *Robertsonia* (Crustacea: Harpacticoida).

KLIE, W., 1950. Harpacticoida (Cop.) aus dem Bereich von Helgoland und der Kieler Bucht, II. *Kieler Meeresforsch.* **7**: 76–128.

KRISHNASWAMY, S., 1957. Studies on the Copepoda from Madras. Thesis, Univ. Madras (not seen; quoted by Lang, 1965).

LANG, K., 1948. 'Monographie der Harpacticiden.' (Hakan Ohlsson: Lund).

1965. Copepoda Harpacticoidea from the Californian Pacific coast. *Kgl. Svenska VetenskAkads. Handl.* (4)**10**(2): 1–560.

MONARD, A., 1935. Les harpacticoides marins de la région de Salammbo. *Bull. Stn. océanogr. Salammbo.* **34**: 1–94.

POR, F. D., 1959. Harpacticoide noi (Copepoda Crustacea) din milurile Marii Negre. *Studii Cercetari Biol. Acad. Rep. popul. Romine* (*Biol. anim.*) **4** (11): 347–68.

1964a. A study of the Levantine and Pontic Harpacticoida (Copepoda Crustacea) *Zool. Verh. Leiden.* **64**: 1–128.

1964b. Les Harpacticoides (Crustacea, Copepoda) des fonds meubles du Skagerack. *Cah. Biol. Mar.* **5**: 233–70.

1967. Level-bottom Harpacticoida (Crustacea, Copepoda) from Elat (Red Sea), part 1. *Israel J. Zool.* **16**: 101–65.

SARS, G. O., 1911. 'An account of the Crustacea of Norway, 5. Harpacticoida.' (Bergen Museum: Norway).

1920. 'An account of the Crustacea of Norway, 7. Copepoda (Suppl.).' (Bergen Museum: Norway).

SOYER. J., 1964. Copépodes Harpacticoides de l'étage bathyal de la région de Banyuls-sur-Mer: V. Cletodidae, T. Scott. *Vie Milieu.* **15** (3): 573–643.