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TWO NEW SPECIES OF *CLETOCAMPTUS* (COPEPODA: HARPACTICOIDA) FROM GALÁPAGOS, CLOSELY RELATED TO THE COSMOPOLITAN *C. DEITERSI*

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A B S T R A C T

Two new *Cletocamptus* species, *C. axi* and *C. schmidti*, collected from lagoons of the Islands of Santa Cruz and Floreana, Galápagos Archipelago, are described and illustrated. A careful morphological analysis established a close relationship, or even the identity, with the widely distributed species *C. deitersi*. The two forms differ slightly from each other in their body ornamentation and in the chaetotaxy of the exopodites of pereiopods 3 and 4. Nevertheless, they fit well in the often-documented variability of *C. deitersi*. Their co-occurrence at one study site, however, suggests the existence of two distinct species, without intermediates, in the Galápagos Islands. A map showing the distribution of both species known so far in the area of investigation is provided.

The situation of the genus *Cletocamptus* is complex and in some respects inconsistent. With regard to this point, Brehm (1959) stated that such a striking multitude of genus and species synonymies in such a small number of known species infers certain difficulties in their systematics (synopsis of genus names in Lang, 1948; Dussart and Defaye, 1990). Species of this taxon were originally associated with genera like *Canthocamptus*, *Attheyella,* or *Mesochra* of the (heterogenous) family Canthocamptidae. Chappuis (1944) emphasized that habitus, maxillae, and maxillipeds were like those of the Canthocamptidae. Monard (1927) in his "Synopsis universalis generum Harpacticoidarum" classified the genera *Godetella*, *Marshia,* and *Wolterstorffia,* which were later synonymized with *Cletocamptus* (e.g., Kiefer, 1929; Chappuis, 1933; Lang, 1936), with the Canthocamptidae, and the genus *Cletocamptus* itself with the Cletodidae. Lang (1936) likewise placed *Cletocamptus* (as well as *Godetella*, *Marshia*, and *Wolterstorffia*) among the Cletodidae. Por (1986), on the other hand, again listed the genus with the Canthocamptidae, however, as "incertae sedis" (adopted by Huys *et al.*, 1996; Bodin, 1997). This uncertainty is due to the conjecture that the two families, Canthocamptidae and Cletodidae, appear to be poly- or paraphyletic assemblages.

The current species number is difficult to ascertain. Lang (1936) stated 11 species and one subspecies. Fleeger (1980) also listed 12 species, although six new species had been described since Lang's compilation: *C. affinis* Kiefer, 1957; *C. feei* (Shen, 1956); *C. gabrieli* Löffler, 1961; *C. gravihiatus* (Shen and Sung, 1963); *C. helobius* Fleeger, 1980; and *C. xenuus* Por, 1968. Of these, a new genus, *Dahlakia*, was established for the last one. Furthermore, Fleeger (1980) interpreted *C. gabrieli* as a "junior synonym of *C. deitersi.*" Other species listed by Lang were also synonymized; however, the opinions of the different authors were not always in accordance. Because of the proven variability of the species, this situation is indeed unavoidable. The morphological criteria provided are insufficient to solve the problem of species separation.

During the Göttingen Galápagos Meiofauna Expedition (Ax and Schmidt, 1973; Westheide, 1991), a number of *Cletocamptus* specimens was collected from three sites at the Islands of Santa Cruz and Floreana. The morphological analysis revealed the existence of two species, which are described and discussed below.

MATERIALS AND METHODS

The material was obtained during the Göttingen Galápagos Meiofauna Expedition (February 1972–March 1973). The animals were extracted by the seawater-ice technique, combined with an intensive washing of the sediment (see Ax and Schmidt, 1973). The specimens were fixed in a 4% Formalin/seawater solution, kept in vials, and transported to the Zoological Institute of Göt-

tingen for further treatment. Nineteen individuals were dissected and embedded in W15 medium (Zeiss); occasionally a version of Hoyer's medium was used. The cover glass was sealed with Eukitt and DePeX. Drawings were made with the aid of a camera lucida. The interpretation of body, mouth parts, and thoracopods is adopted from Lang (1948, 1965). With respect to the mouth parts, the interpretation of the components according to Huys and Boxshall (1991) is given in parentheses. The Roman-Arabic combination of numerals referring to the localities corresponds with that of Ax and Schmidt (1973). The material has been deposited in the collections of the Zoological Museum of the University of Göttingen.

DESCRIPTIONS

Canthocamptidae *incertae sedis*
Cletocamptus Schmankevitch, 1875
Cletocamptus axi, new species
Figs. 1–3

Material Examined.—Santa Cruz: Lagoon of Puerto Nuñez (IX,4; 29 February 1972); 1 ♀, 1 ♂; both animals were dissected (reg. nos. I Gal 1132 and 1133). Floreana: Lagoon behind the beach (*Locus typicus.* XII,1; 1 June 1972); 11 ♀♀, 32 ovigerous ♀♀, 58 ♂♂, 10 copepodites. Holotype: Dissected ♀, reg. no. I Gal 1127; paratypes: 2 dissected ♀♀ (reg. nos. I Gal 1128, II Gal 82a–m), 3 dissected ♂♂ (reg. nos. I Gal 1129–1131).

Female.—Body length of four dissected ♀♀ from tip of rostrum to the end of furcal rami 0.77–0.84 mm. Rostrum tongue-shaped, subdistally on each side with sensillum; pore located somewhat distal to centre. Row of spinules extends on underside of frontal margin (Fig. 1C). Genital double-somite subdivided dorsolaterally. Abdominal somites intensely spinulose on ventral surface and on lateral and distal margins. Anal somite ventrally with inverse V-shaped incision. Anal operculum slightly curved, with 5 or 6 spinules on surface. Furcal rami about twice as long as broad. Proximally on outer margin, 2 slender setae insert; more proximally, vestigial seta arises. Distal part of furcal rami spinulose. Apical edge with 3 setae; inner one short, middle one about 3 times as long as outer one. Approximately in middle of inner part of furcal rami 1 slender dorsal seta inserts, bipartite at base (Fig. 1A, B).

Antennula (Fig. 1C) of 6 segments; 4th and elongated 6th segment each with aesthetasc.

Antenna (Fig. 1D, F), coxa furnished with several rows of spinules. Allobasis with 2 setae on anterior margin. Free endopodite segment laterally and apically with rows of spinules, 7 slender spines and short seta. Exopodite 1-segmented; laterally with 1, apically with 1 or 2 setae. One animal can have this different armature. Furthermore, some well-developed spinules can be seen.

Mandible (Fig. 1G), corpus mandibulae elongated, proximally with rows of spinules, chewing edge with several teeth and slender, unipinnate seta. Palpus vestigial, furnished with 2 naked setae, unequal in length; nearby small seta inserts.

Maxillula (Fig. 2A), arthrite of praecoxa with 7 spines and 1 short plumose seta apically, 1 stout plumose seta subapically, and 1 seta on surface. Coxa has 2 setae and some spinules on surface. Basis apically with 2 slender setae and 1 stout appendage. Segments of endo- and exopodite lacking; each ramus obviously represented by 3 setae.

Maxilla (Fig. 1H), syncoxa with 2 endites, each furnished with 3 elements. Proximal endite bears 1 stout, terminally saw-like spine, 1 spine with long spinules, and 1 slightly bent seta. Distal endite has 2 setae and 1 spine with long spinules. Basis (allobasis) with 1 stout claw and 1 accompanying seta. Endopodite consisting of vestigial segment bearing 3 setae.

Maxilliped (Fig. 1I), basis (syncoxa) armed with several rows of spinules and 1 short, slender seta. Proximal endopodite segment (basis) with several rows of spinules. Distal endopodite segment (endopodite) has 1 slender claw, which carries accompanying setule basally.

Pereiopod 1 (Fig. 2B), basis with inner spine, outer seta, and several rows of spinules on surface and on margins. Exopodite with 3 segments furnished with slender spines and spinules on outer and distal margins. Middle segment bears 1 plumose seta on inner margin. Distal segment has 4 appendages. Endopodite 2-segmented; inner and outer margins spinulose. Proximal segment has 1 inner seta. Distal segment elongated, bearing 3 setae.

Pereiopod 2 (Fig. 2D), basis with several rows of spinules and 1 slender outer spine. Exopodite 3-segmented. Proximal and middle segments each with 1 slender spine and spinules on outer and distal margins; middle segment has 1 inner plumose seta. Distal segment bears 1 inner seta, 2 apical plumose setae, and 2 outer slender spines. Endopodite 2-segmented. Proximal segment dwarfed; distal segment elongated, spinulose, bearing 3 setae, middle longest.

Pereiopod 3 (Fig. 3A) more or less as in pereiopod 2. Outer element of basis represented by slender seta.

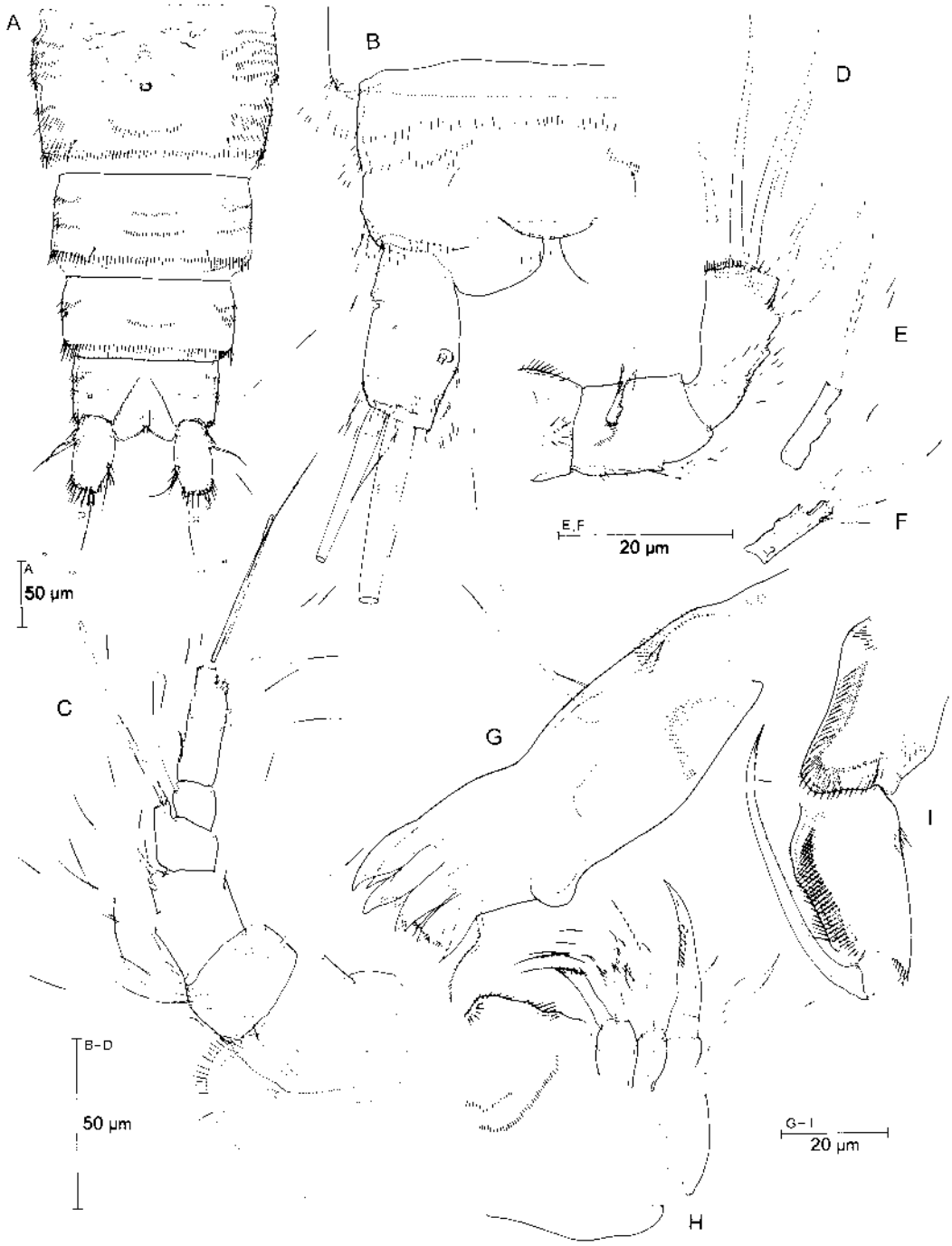

Fig. 1. *Cletocamptus axi*, new species. A, abdomen ♀, ventral view; B, caudal part ♀, dorsal view; C, rostrum and antennula ♀; D, antenna ♀; E, exopodite of antenna ♂; F, exopodite of antenna, other ♀; G, mandible ♀; H, maxilla ♀; I, maxilliped ♀.

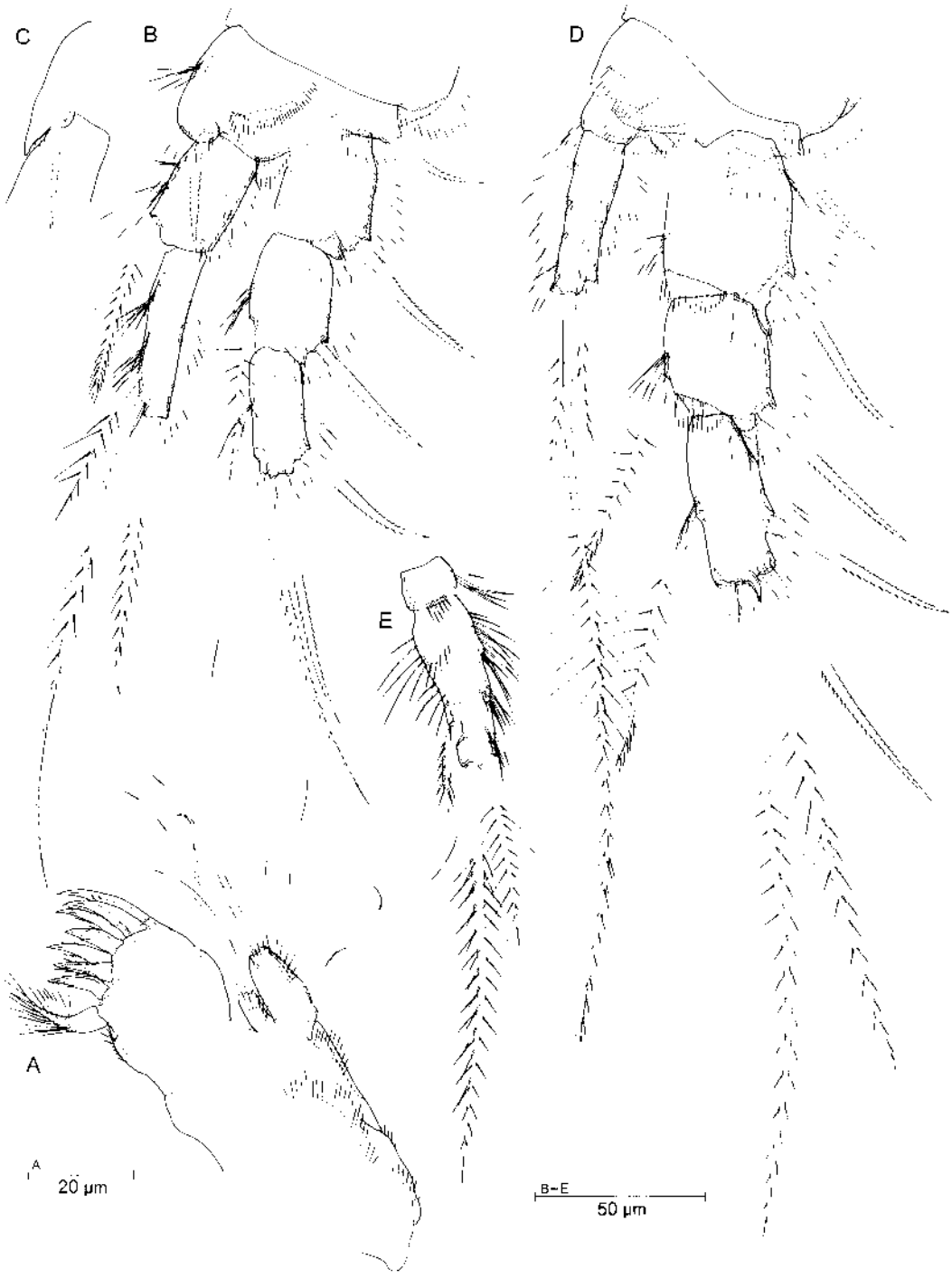

Fig. 2. *Cletocamptus axi*, new species. A, maxillula ♀; B, pereiopod 1 ♀; C, inner edge of basis and inner seta of pereiopod 1 ♂; D, pereiopod 2 ♀; E, endopodite of pereiopod 2 ♂.

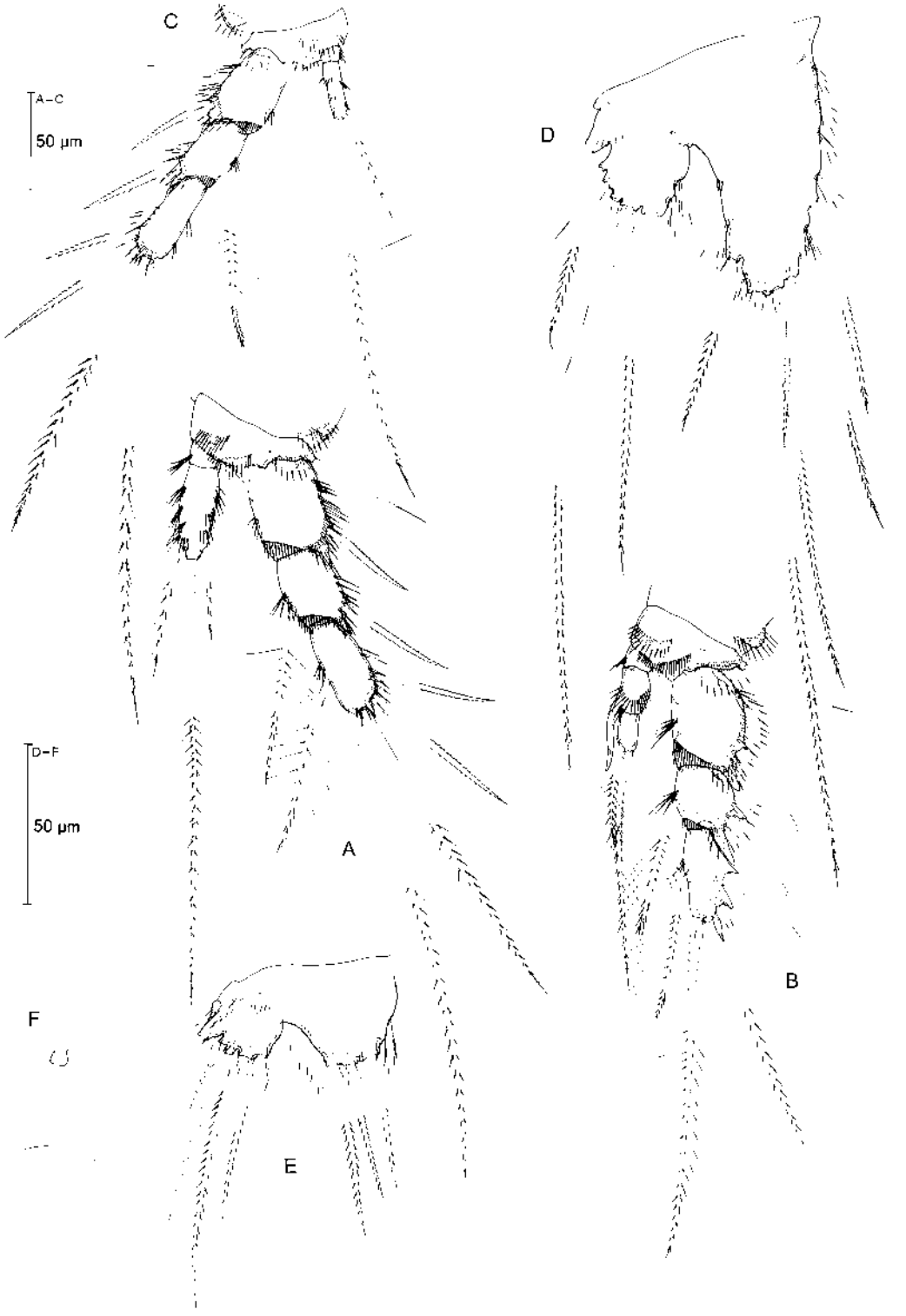

Fig. 3. *Cletocamptus axi*, new species. A, pereiopod 3 ♀; B, pereiopod 3 ♂; C, pereiopod 4 ♀; D, pereiopod 5 ♀; E, pereiopod 5 ♂; F, pereiopod 6 ♂.

Pereiopod 4 (Fig. 3C), exopodite more or less as in pereiopods 2 and 3 but somewhat more slender, and distal segment lacks seta on inner margin. Endopodite 2-segmented. Proximal segment very short. Distal segment slender, spinulose, bearing 2 setae, outer distinctly longer.

Seta and spine formula:

	Exopodite	Endopodite
Pereiopod 1	(0.1.022)	(1.120)
Pereiopod 2	(0.1.122)	(0.021)
Pereiopod 3	(0.1.122)	(0.111)
Pereiopod 4	(0.1.022)	(0.020)

Pereiopod 5 (Fig. 3D), baseoendopodite and exopodite fused. Inner part of benp. elongated, margins spinulose, with 6 setae. Exopodite about as long as broad, bearing 5 setae of different lengths.

Male.—Differs from the female in the following respects: Body length of four dissected specimens 0.69–0.77 mm. Spinulation on surface of abdominal somites more distinct. Antennula subchirocer. As in female, exopodite of antenna somewhat variable in setation (2 or 3 setae) and armature with spinules; spinules may be lacking (Fig. 1E) or weakly developed. Pereiopod 1 (Fig. 2C), inner edge of basis tooth-like, extended, inner element seta-like. Pereiopod 2 (Fig. 2E), outer spines of exopodite stouter; apical setae of distal segment shorter; subapical outer element of distal segment of endopodite spinelike. Pereiopod 3 (Fig. 3B), outer spines of exopodite stouter, apical setae of distal segment of exopodite shorter; endopodite 3-segmented; middle segment tooth-like elongated on distal inner part; terminal segment bearing 2 setae, unequal in lengths. Pereiopod 4, distal outer tooth of middle segment of exopodite more distinct. Pereiopod 5 (Fig. 3E), baseoendopodite and exopodite fused; inner part of benp. bears 3 setae; exp. has 4 setae of different lengths; innermost but one seta of exp. can be longer than figured. Pereiopod 6 (Fig. 3F) consisting of plate, broader than long; outer part with slender seta, inserting on a socle. Obviously this feature may be lacking.

Variability.—Except for the examples given in the text above it should be mentioned that the length of the setae can differ (occasionally on left and right member of a pair). One female has 4 setae on distal segment of endopodite of pereiopod 3 (0.211). The distance between the insertion points of inner terminal seta and seta on inner margin of distal segment of exopodite of pereiopod 2 can differ.

Etymology.—The species is dedicated to Prof. Dr. Peter Ax, University of Göttingen, Germany, the initiator of the Göttingen Galápagos Meiofauna Expedition.

Discussion.—Following next species.

Cletocamptus schmidti, new species
Figs. 4–6

Material Examined.—Santa Cruz: Lagoon at the North coast; animals collected from the surface (IX,1; 30 March 1972); 1 ♀, 2 ♂♂; all animals were dissected (reg. nos. I Gal 1142–1144). Santa Cruz: Lagoon of Puerto Nuñez (*Locus typicus*. IX,4; 29 February 1972); 2 ♀♀, 17 ovigerous ♀♀, 31 ♂♂. Holotype: Dissected ♀, reg. no. I Gal 1134; paratypes: 3 dissected ♀♀ (reg. nos. I Gal 1135–1137), 4 dissected ♂♂ (reg. nos. I Gal 1138–1141).

Short description (comparison with *Cletocamptus axi,* new species)

Female.—Body length of 5 dissected ♀♀ from tip of rostrum to end of furcal rami 0.66–0.71 mm. Ornamentation of abdominal somites somewhat different to that of *Cletocamptus axi*, the spinules are generally shorter. Anal operculum set with more spinules on distal margin, accompanied by another row of spinules subdistally (Fig. 4A). Exopodite of antenna (Fig. 4B) seems to be more uniform than in *Cletocamptus axi*. Mandible, maxillula, maxilla, and maxilliped largely agree with those of *Cletocamptus axi*.

Seta and spine formula of pereiopods 1–4 (differences to *Cletocamptus axi* extra bold print; Figs. 4C, 5A, 6A, 5C):

	Exopodite	Endopodite
Pereiopod 1	(0.1.022)	(1.120)
Pereiopod 2	(0.1.122)	(0.111)
Pereiopod 3	(0.1.**2**22)	(0.111)
Pereiopod 4	(0.1.**1**22)	(0.020)

Pereiopod 5 (Fig. 4E), baseoendopodite and exopodite fused, with 12 setae altogether as in *Cletocamptus axi*. Innermost but one seta relatively shorter.

Male.—Body length of 6 dissected specimens 0.64–0.72 mm. Sexual dimorphisms correspond to those of *Cletocamptus axi*. Spinulation of abdominal somites more distinct. Antennula subchirocer. Inner edge of basis of pereiopod 1 (Fig. 4D) tooth-like, extended. Endopodite of pereiopod 2 (Fig. 5B) weakly

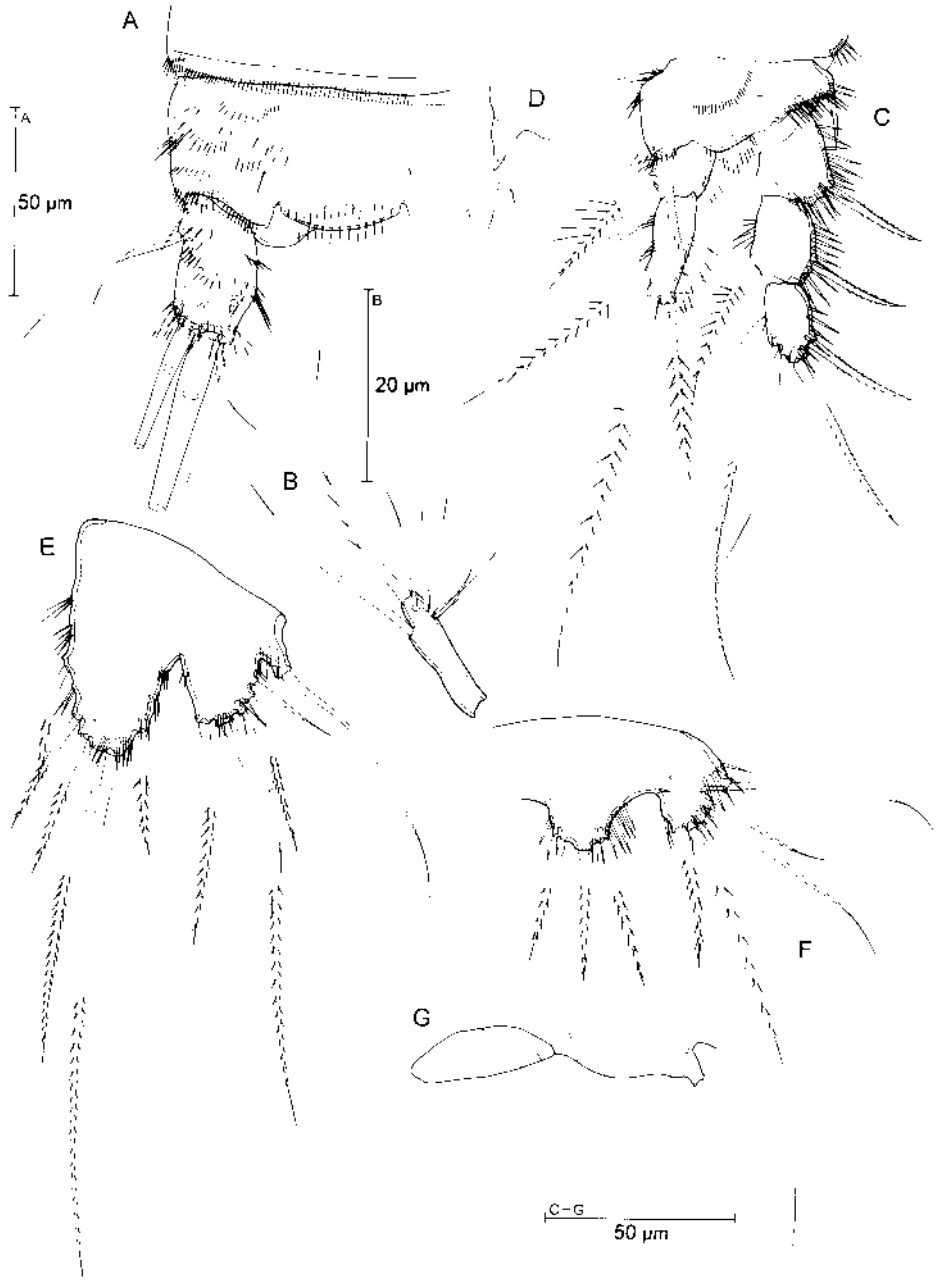

Fig. 4. *Cletocamptus schmidti*, new species. A, caudal part ♀, dorsal view; B, exopodite of antenna ♀; C, pereiopod 1 ♀; D, inner edge of basis of pereiopod 1 ♂; E, pereiopod 5 ♀; F, pereiopod 5 ♂; G, both pereiopods 6 ♂.

modified. Pereiopod 3 (Fig. 6B) distinctly modified; terminal segment of exopodite with 2 setae on inner margin and spine-like outer distal element. In *Cletocamptus axi* this element is seta-like; the inner margin bears only 1 seta. Pereiopod 5 (Fig. 4F), baseoendopodite and exopodite fused, with 8 setae altogether. Pereiopod 6 only occasionally with 1 seta as drawn in Fig. 4G.

Etymology.—The species is dedicated to Prof. Dr. Peter Schmidt, University of Aachen, Ger-

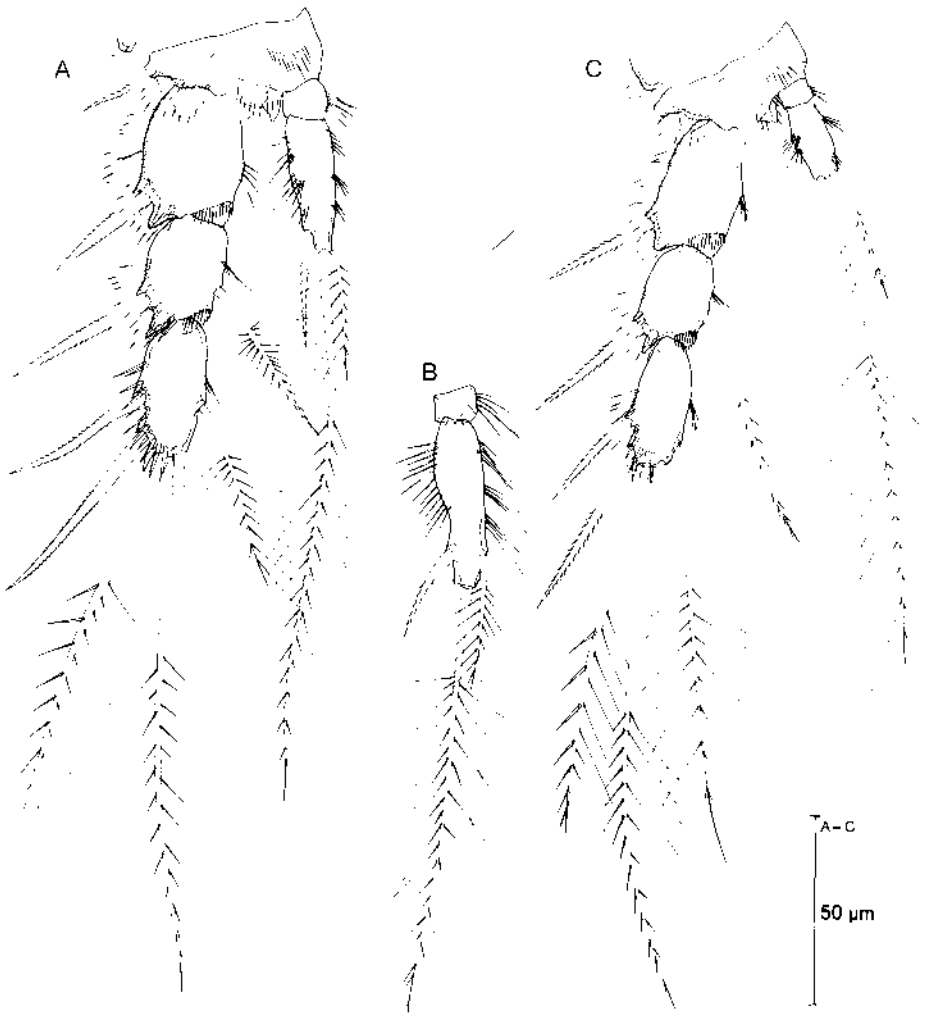

Fig. 5. *Cletocamptus schmidti*, new species. A, pereiopod 2 ♀; B, endopodite of pereiopod 2 ♂; C, pereiopod 4 ♀.

many, organizer and collector of most of the material of the Göttingen Galápagos Meiofauna Expedition.

Discussion.—Without doubt, the two new *Cletocamptus* species from the Galápagos Archipelago, *C. axi* and *C. schmidti*, are closely related to the almost cosmopolitan *C. deitersi* (Richard, 1897). The colonization centre of this species seems to be in the neotropical realm, but, to my knowledge, the species has also been recorded from the other continents except for Europe. However, Yeatman (1962) speculated that the species has probably reached Europe via the Gulf Stream and could have become established there if it were "ecologically adaptable." A current compilation of habitats and countries is given by Dexter (1995). Some other countries can be added: Peru and Bolivia (Harding, 1955), India (Ranga Reddy and Radhakrishna, 1979), China (Tai and Song, 1979), Brazil (Reid and Esteves, 1984; Reid, 1998), French Guyana (Defaye and Dussart, 1988), Venezuela (Escaravage and Castel, 1989: 14), Mexico (Suárez Morales *et al.*, 1996; Suárez Morales and Reid, 1998).

Several authors have stressed the variable morphology of *C. deitersi*. Lang (1948) stated that there is a considerable difference in the existing descriptions. Yeatman (1963) reported that "the armature of the appendages

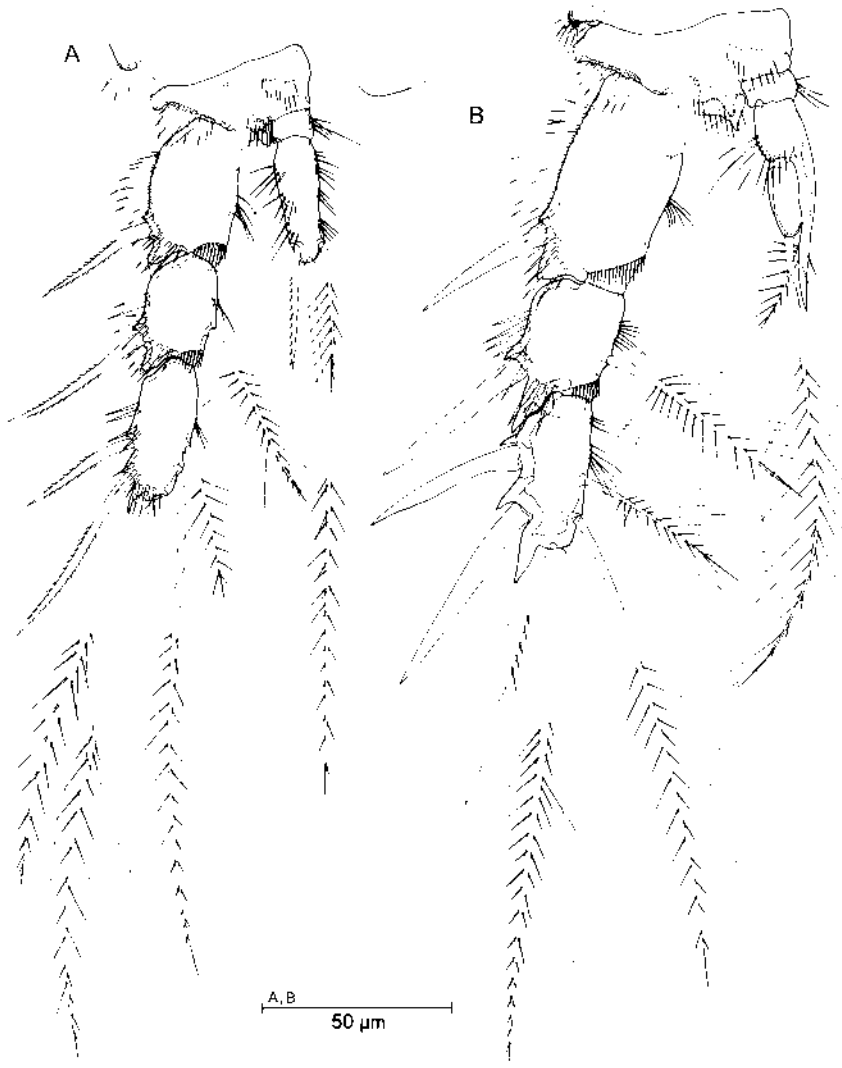

Fig. 6. *Cletocamptus schmidti*, new species. A, pereiopod 3 ♀; B, pereiopod 3 ♂.

on one side may differ from that on the other side of the same specimen." Fleeger (1980) presented a table of "Variations in setal formulae." According to these statements, both forms of Galápagos specimens could also be classed with this species without any problems. However, although partial populations of so-called cosmopolitan species can show morphological discrepancies, the common occurrence in the same area (above all locality IX,4; but microscale distribution unknown) is rather an indication of the existence of two distinct species. Both Galápagos species reveal some slight intraspecific variability. On the other hand, no intermediate animal was found in the nineteen dissected specimens. The following differences can be emphasized: (1) ornamentation of somites; (2) spinulation of anal operculum; (3) number of inner setae on distal segment of exopodites of pereiopods 3 and 4 (♀ and ♂); (4) distal outer appendage on terminal segment of exopodite of pereiopod 3 ♂ seta-like in *Cletocamptus axi* and spine-like in *Cletocamptus schmidti*.

If Richard's (1897) original description of *C. deitersi* is taken as a basis for comparison, then *Cletocamptus axi* most closely resembles this species, which was found in Napusta Grande, a streamlet near the Rio de la Plata in Argentina. There are indeed some dif-

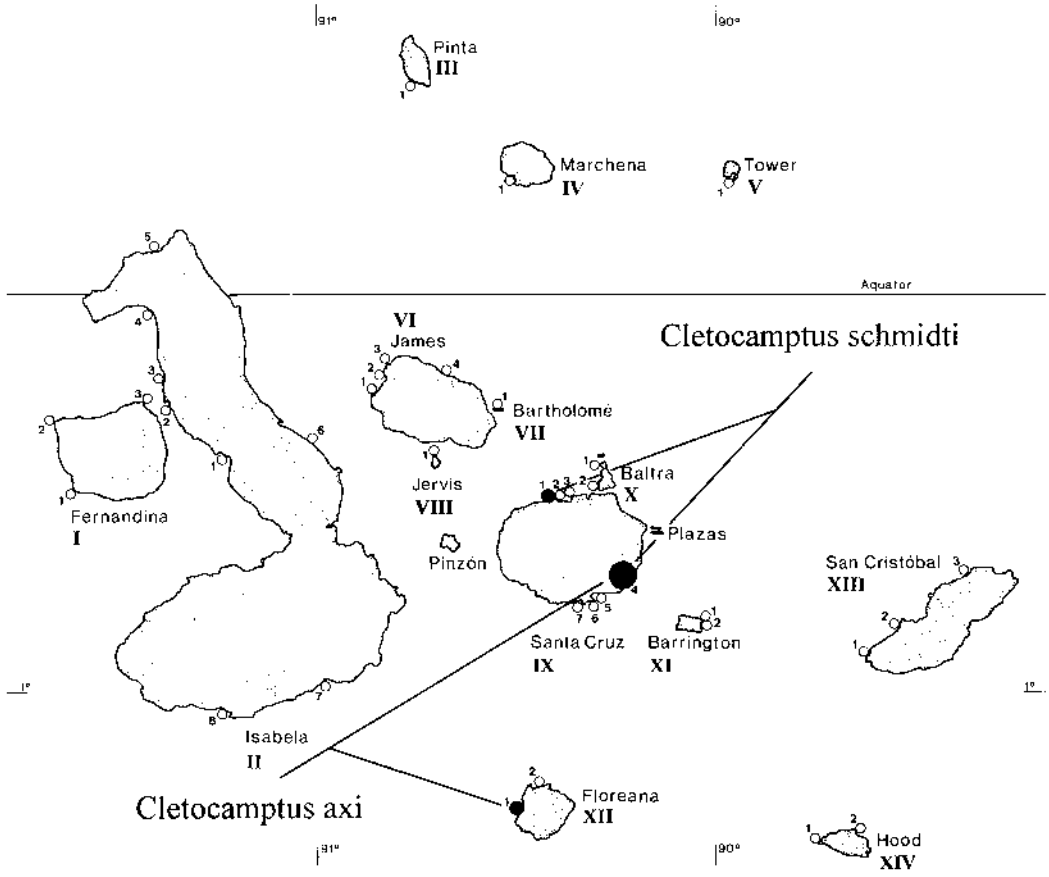

Fig. 7. The localities of *Cletocamptus* in the Galápagos Archipelago. Small solid points = single occurrence of *C. axi* (locality XII,1 of Floreana) and *C. schmidti* (locality IX,1 of Santa Cruz). Big solid point = common occurrence of both species (locality IX,4 of Santa Cruz).

ferences between Richard's and the present drawings; however, this could be due to the different interpretation of the minute body appendages. According to the text the distal segment of exopodite of pereiopod 3 has only 1 inner seta. Richard stated that the distal segment of exopodite of pereiopod 4 bears 1 seta but "extrêmement ténue, rudimentaire." Presumably he mistook a spinule for a seta as he did for the basal segments of endopodites of pereiopods 2 and 3. Furthermore, Richard obviously gave an incorrect interpretation of the pereiopod 5 ♂ which should have a separated exopodite bearing 5 setae.

Other presentations of *C. deitersi* that were discussed in Lang (1948) or published subsequently, e.g., Herbst (1960), Yeatman (1963), Löffler (1963; *C. deitersi ecuadorianus*), Hamond (1973), Dussart (1974), Tai and Song (1979), Defaye (1988), Suárez Morales *et al.* (1996), either show great similarities to *Cletocamptus axi* or to *Cletocamptus schmidti* or manifest certain differences compared with both.

Because of its widespread distribution, its occurrence in very different habitats (standing or flowing water, freshwater or high saline water, benthos or plankton) and its "especially plastic morphology" (Fleeger, 1980), Dexter (1995; see also Suárez Morales *et al.*, 1996) supposes that *C. deitersi* in reality consists of a "number of morphologically indistinguishable sibling species." The presence of at least two forms in the Galápagos Islands supports this idea, rather, their common occurrence at locality IX,4 (Santa Cruz) excludes the existence of simple local forms of *C. deitersi* but consequentially implies the occurrence of two different species, described herein as *C. axi* and *C. schmidti*.

Distribution.—Until now, only 3 sites in the Galápagos are known for both new *Cletocamptus* species (Fig. 7). *Cletocamptus axi* lives in similar habitats of the Islands of Santa Cruz and Floreana; *Cletocamptus schmidti* lives as well on both sides of Santa Cruz. These restricted findings are mainly explicable by the real object of the Göttingen Galápagos Meiofauna Expedition, i.e., the investigation of the interstitial fauna of sand beaches. Localities like rock pools, mangrove sediments, or lagoons were neglected for the most part. The two widely separated localities of *Cletocamptus axi* infers a broader distribution of the genus within the Galápagos Archipelago.

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