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A THIRD GENUS OF FRESHWATER CALANOIDS (COPEPODA, DIAPTOMIDAE, DIAPTOMINAE) IN LOWLAND TROPICAL AFRICA: *CAMERUNDIAPTOMUS*, NEW GENUS

Henri J. Dumont and George Y. Chiambeng

(HJD, correspondence) Laboratory of Animal Ecology, Ghent University, Ledeganckstraat, 35, B-9000 Ghent, Belgium (Henri.Dumont@rug.ac.be);
(GYC) Research Station for Fisheries and Oceanography, Limbe, Cameroon

ABSTRACT

We describe two new species in the new calanoid genus *Camerundiaptomus*. The new genus is currently known only from the rainforests of Cameroon, where its abundance is extremely low. The only other calanoid found was a known species of *Tropodiaptomus*. It was rare as well. Fish predation is cited as one among possible reasons for the rarity of calanoids in the Cameroon forest zone specifically, and for the generically impoverished calanoid fauna of tropical lowland Africa in general.

One of the deepest and least discussed enigmas of the aquatic biogeography of lowland equatorial Africa is the low generic diversity of its calanoids. In the tropical zone, only two diaptomine genera occur, *Tropodiaptomus* and *Thermodiaptomus*. The first is speciose and shared with Asia; the second is limited to Africa but includes only six species. In southern Africa, additional genera in the subfamily Paradiaptominae occur (Rayner, 1999), while in Mediterranean northern Africa as well, Paradiaptominae and Diaptominae, in all nine or ten genera, are relatively well represented (Dussart, 1989).

Tropical lowland Africa contrasts even more sharply with tropical Asia, where between 15 and 20 genera of Diaptominae are widely distributed (Dussart and Defaye, 2001).

The question arises whether this African impoverishment is fact or artefact. Is the African calanoid fauna really as impoverished as it seems, or have we overlooked most of it? The present paper attempts to provide some elements of an answer.

Materials and Methods

Our investigation was carried out in the rainforest section of Cameroon. An intensive sampling effort was carried out there since 1999, aimed at producing an exhaustive inventory of the local crustacean zooplankton of this area (Chiambeng and Dumont, 1999). All accessible types of aquatic environments, such as rivers, lakes, ponds, and puddles, were sampled using a 100-μm plankton net. The weedy littoral as well as the open water were sampled, resulting in a total of over 500 samples. Only three of these, from two environments, contained a new genus and a known species of calanoids. The two sites for the new genus are as follows: (1) Campo Ma'aan forest; a forest situated in the Ocean and Ntem division of South Cameroon, between 2°05′–2°10′E and 9°50′–10°50′N. The vegetation is Atlantic Biafran forest. The climate is tropical monsoonal, with mean average temperature 25°C and about 2,836 mm of annual rainfall. Calanoids were found in samples collected in the littoral of the municipal lake of Adjap village (2°48′E, 10°11′N), close to the highway leading to Ebolowa, on 10 October 2000. (2) Boumba-Bek forest; a forest situated in southeast Cameroon between Yokadouma and Mouloundou, fringing the border with Congo (15°33′–16°11′E, 2°54′–2°30′N). It is a dense forest of the evergreen Cameroon-Congolese type, with average rainfall 1,600–1,700 mm per annum and average monthly temperature 25–27°C. Samples were collected from the littoral vegetation in apparently stagnant sections of the Boumba River at the level of Mikel village on the way to Mouloundoiu on 25 June 1999.

Samples were qualitative and collected by towing a plankton net with mesh size 100 μm through the littoral vegetation. They were preserved in 5% formaldehyde solution on the spot.

In the laboratory, specimens were picked out under a Wild M3 stereoscope, dissected, and mounted in glycerol. Identifications and drawings were carried out under a Kyowa Medilux-12 compound microscope, using oil immersion.

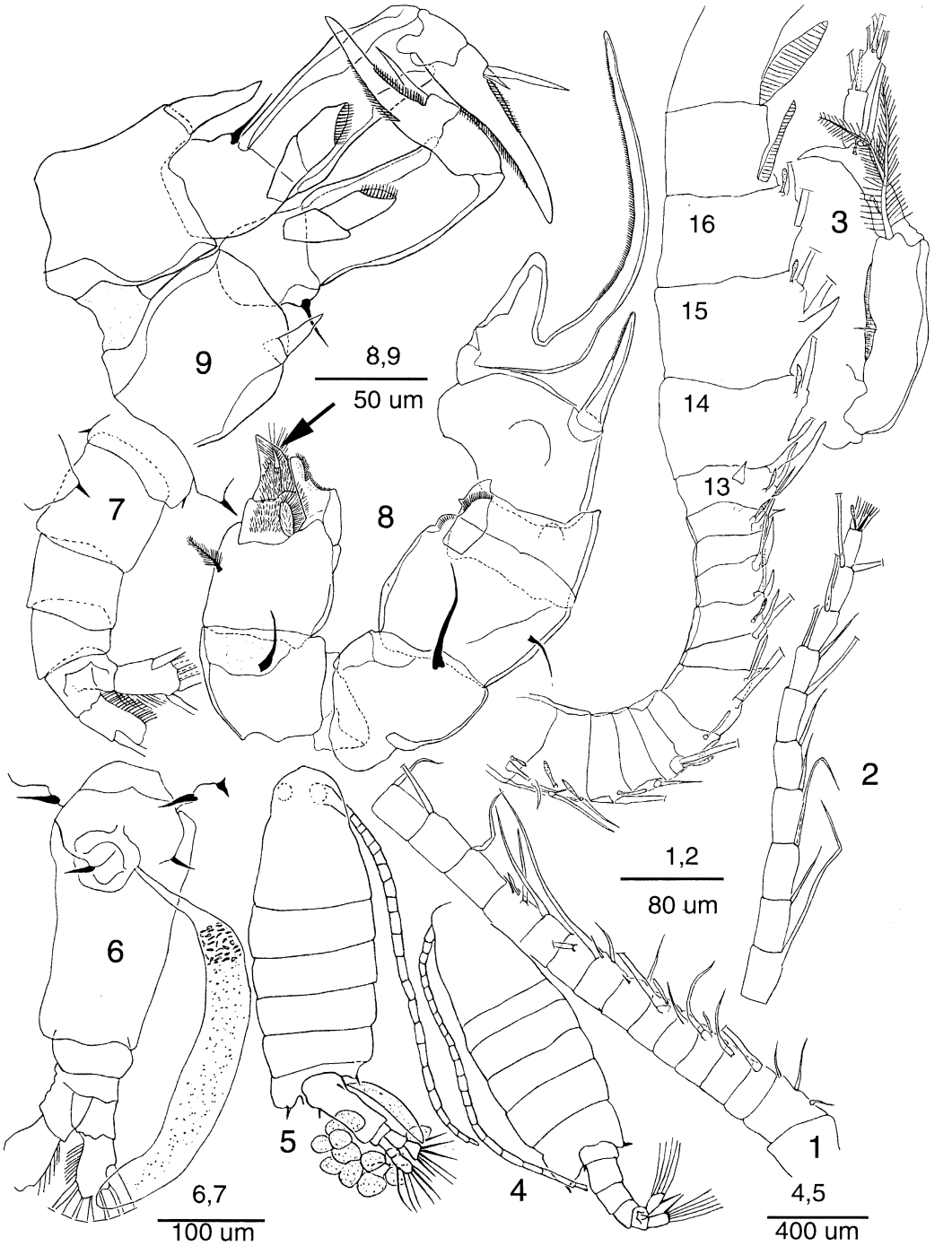
Results

We found *Tropodiaptomus processifer* (Kiefer, 1926) in addition to a new genus, which was represented by two new species.

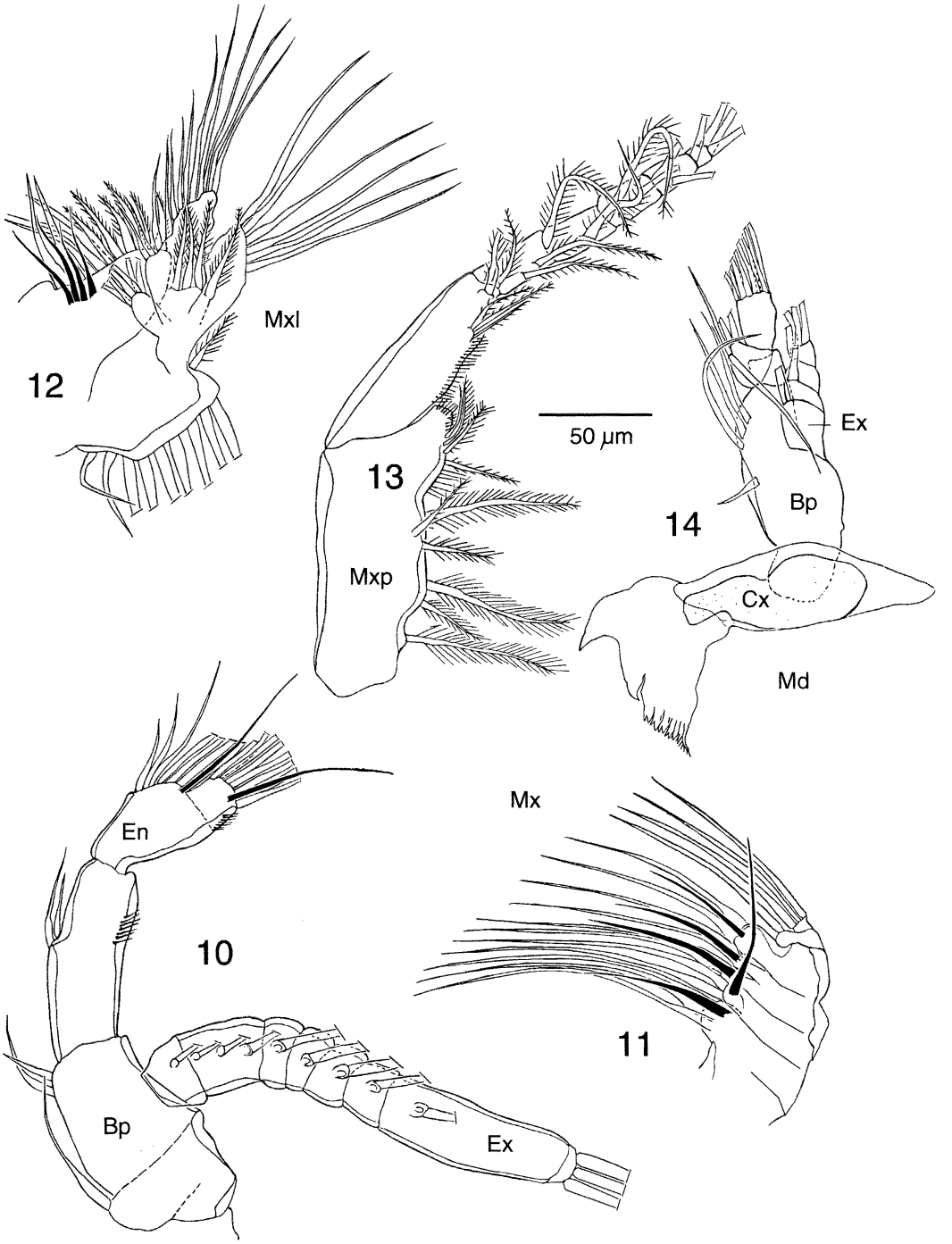
Camerundiaptomus, new genus

Type Species.—*Camerundiaptomus djamai* Dumont and Chiambeng.

Diagnosis.—A medium-sized genus with antennae (Fig. 10) and mouthparts (Figs. 11–14) typical of the subfamily Diaptominae. Trunk

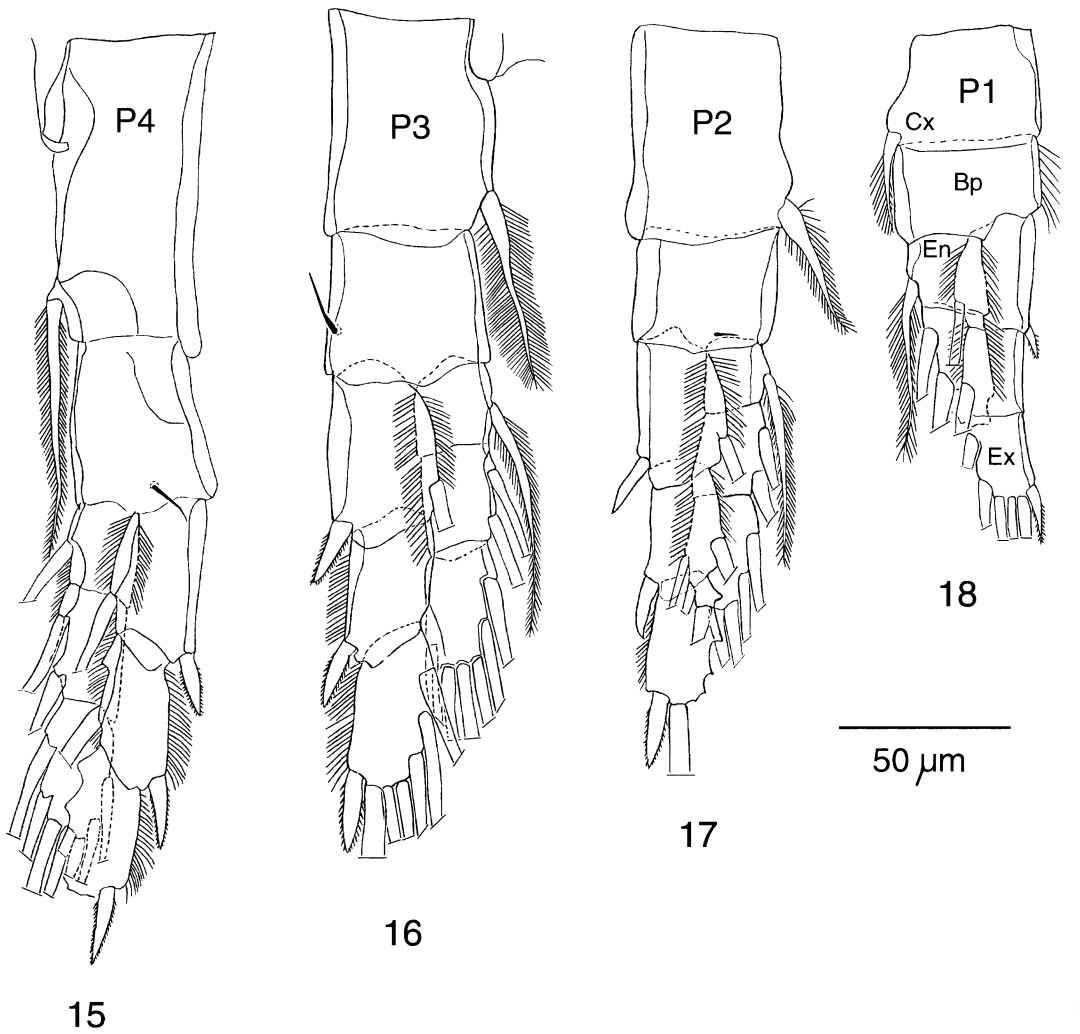


Figs. 1–9. *Camerundiaptomus djamai*, new genus, new species. Male holotype and female paratype. 1–2, Female antennula; 3, Geniculated male antennula; 4, Male habitus; 5, Female habitus; 6, Female urosome with attached spermatophore; 7, Male urosome; 8, Male P5; 9, Female P5.



Figs. 10–14. *Camerundiaptomus djamai*, new genus, new species. Male holotype. 10, Antenna; 11, Maxilla; 12, Maxillula; 13, Maxilliped; 14, Mandible.

limbs with all exopodites three-segmented, endopodite of P1 two-segmented, all other endopodites three-segmented (Figs. 15–18). Middle segment of exopodite of P1 without external spine. Schmeil organ absent. Cephalothorax of both males and females posteriorly somewhat asymmetrical (Figs. 25–26, 4–7), without dorsal bulges (Fig. 26).

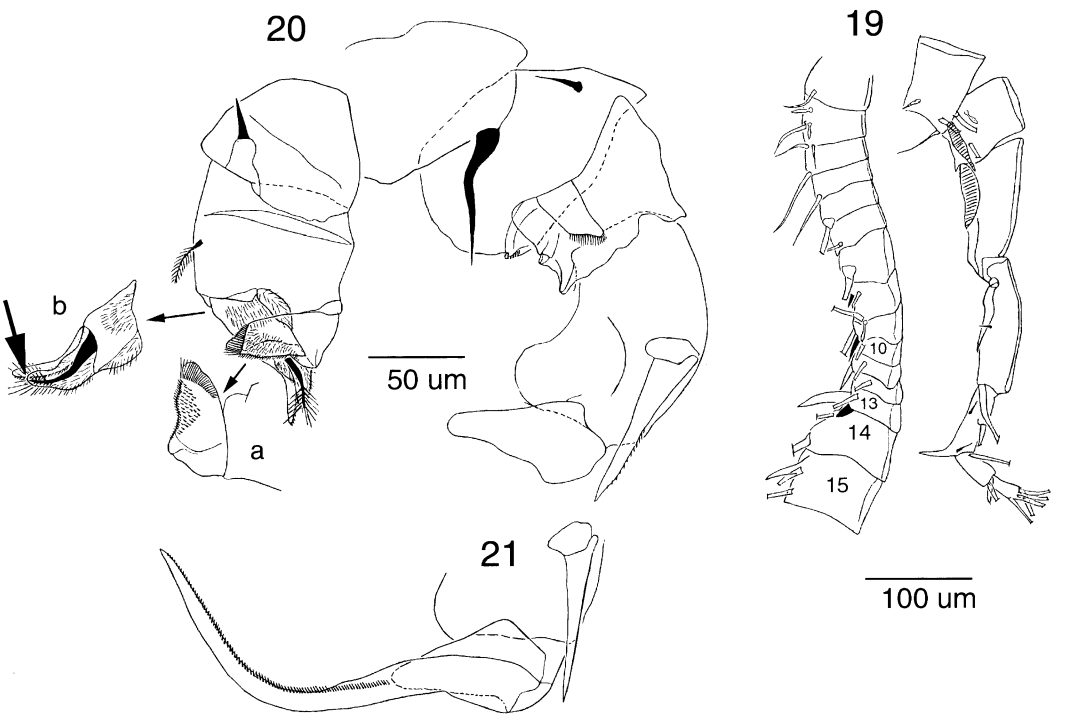


Figs. 15–18. *Camerundiaptomus djamai*, new genus, new species. Male holotype. Thoracopods 1–4.

Female antennules of the usual 25 segments (Figs. 1, 2); male prehensile antennule dilated beyond segment 12, with small lateral spines on segments 9, 10, 12, with two spines (one big, one small) on segment 13, and with strong spine on segment 15 (Figs. 3, 19, 24). Antepenultimate segment with a smooth-edged spur, standing at an angle to the segment.

Female P5 of the usual diaptomine appearance (Figs. 9, 23), but male P5 distinctive. Right P5 with terminal exopodite segment ending in spine with strong, triangular expansion at base (Figs. 8, 20, 22). Left P5 short, stout, of hairy appearance; second segment reduced to triangular, more-or-less acutely tipped spine, with a seta at its foot and, in addition, a second, membranaceous, scale-like, apically pointed or rounded outgrowth, perhaps juxtaposed to it, and possibly fused to it at base. Endopodite of one segment, fairly robust, ribbed or smooth, lined with spines and setules (Figs. 8, 20, 22).

Differential Diagnosis.—No other diaptomid genus shows the peculiar triangular outgrowth at the base of the apical claw of the right exopodite of P5, nor the arrangement on the left endopods and exopods of P5 in the male. Also helpful are the absence of a spine on segment 14 of the prehensile antenna of the male and the smooth-sided spur on the antepenultimate segment of the same, standing at an angle to the segment that bears it. Beyond that of the subfamily



Figs. 19–21. *Camerundiaptomus djamai*, new genus, new species. Male paratype. 19, Geniculated antennula; 20, P5; 21, Apical segment of right male P5.

diaptominae, no immediate relationship with any of its described genera is apparent, however.

Camerundiaptomus djamai, new species
Figs. 1–21

Material Examined.—Male holotype, a male paratype, one female paratype, all deposited at the Royal Institute of Natural Sciences, Brussels (accession number 29.337, copepods 4557–4559). The holotype was dissected and was spread over nine slides. A paratype male and a paratype female were dissected and mounted on two slides each. Three female paratypes are preserved whole in glycerol.

Type Locality.—A pond in the Campo Ma'aan forest. For details, see above.

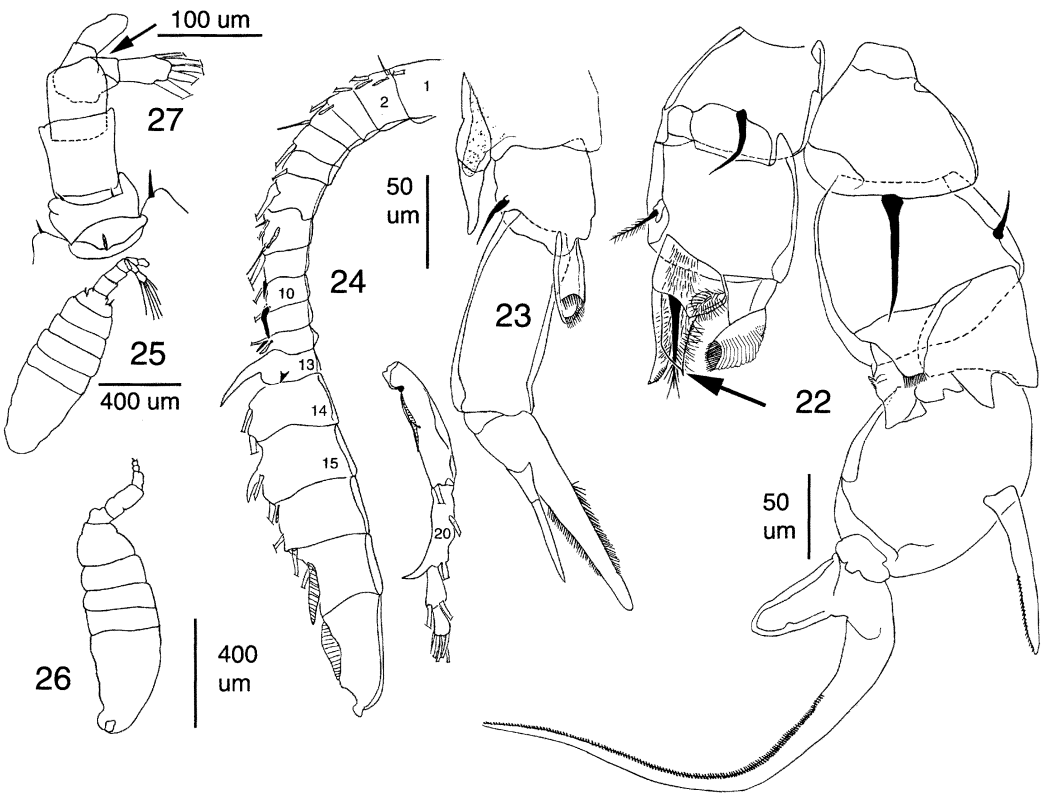
Derivatio Nominis.—The genus is named after the African country Cameroon. The species is named after Mr. Theodore Djama, head of fisheries research at Limbe, Cameroon, who helped the junior author with his field work.

Diagnosis.—A *Camerundiaptomus* with the second exopodite segment of the right P5 swollen and flattened. Endopodite of left P5 triangular, covered in spinules. Endopodite of female P5 of two segments.

Description.—A medium-sized species (male 1.35 mm, female 1.45 mm).

Male. Body fusiform, rather strongly asymmetric at junction of urosome and cephalosome (Fig. 4). No bulges. Straight antenna extending to about halfway of urosome. Geniculated antenna expanded between segments 13 and 18, adorned with spines, as in *C. christineae*, but spine on segment 15 only somewhat smaller than big spine on segment 13 (Figs. 3, 19). Spur on antepenultimate segment almost at right angle with segment. Second antenna (Fig. 10), maxilla (Fig. 11), maxillula (Fig. 12), maxilliped (Fig. 13), and mandible (Fig. 14) as other diaptomine genera. Thoracopods (Figs. 15–18) with three-segmented exopodites; each segment with apical external spine, except segment two of P1. Endopodite of P1 two-segmented; all other endopodites three-segmented. No Schmeil organ present.

P5 strongly asymmetrical (Figs. 8, 20). Right P5 with endopodite as long as first segment of exopodite, not widened at base, with apical crown of spinules. Distal margin of first segment of exopodite pointed externally, internally widened, and with short row of spinules, very much as in *C. christineae*. Apical segment with



Figs. 22–27. *Camerundiaptomus christineae*, new genus, new species. 22, P5 of male; 23, P5 of female; 24, Geniculated antennula of male; 25–26, Habitus of male in dorsal and lateral view; 27, Urosome of female.

strong external spine, provided with row of spinules on distal half of inner surface. Inner margin of segment strongly expanded and flattened. A concavity on the body of the segment. Apical spine as in *C. christineae*, but slightly less slender.

Left P5 with basipodite provided with plumose seta on its external surface. Endopodite triangular, set with numerous spinules and subapical crown of setules (Fig. 20), but, as shown in a second specimen, slightly differently oriented (Fig. 8), of complex relief. Basal segment of exopodite sturdy, hairy. Finger-shaped apical segment and seta as in *C. christineae*, but additional "scale" rounded, not pointed.

Female. A little larger than the male, with body strongly asymmetrical in the urosome-cephalosome articulation area. The single female examined had an elongated spermatophore attached to her genital region (Fig. 6). Antennae almost reaching to the base of the furcal rami. Mouthparts and trunk limbs as in male, except P5, which is symmetrical, has a two-segmented endopodite, and two lateral spines on the end-claw (Fig. 9).

Camerundiaptomus christineae, new species
Figs. 22–27

Material Examined.—Male holotype, four female paratypes. The type material is deposited at the Royal Institute of Natural Sciences, Brussels (accession number 29.337, copepods 4560–4562). The holotype was dissected and is spread out over three glass slides, sealed with depex. One female paratype is dissected and mounted on two slides. One male and female paratype are preserved whole in glycerol.

Type Locality.—Stagnant portion of the River Boumba, as stated above.

Derivatio Nominis.—The species is named after Mrs. C. De Clerck, secretary of the laboratory of animal ecology at Ghent University.

Diagnosis.—A *Camerundiaptomus* in which the apical segment of the exopodite of the right male P5 is barrel-shaped. Endopodite of left P5 swollen, ribbed. Endopodite of female P5 of one segment.

Description.—A medium-sized diaptomid (male holotype 1.4 mm long, female paratype 1.6 mm long).

Male. Body fusiform, slightly asymmetric at the level of the junction of urosome and cephalosome; no dorsal or lateral bulges (Figs. 25, 26). Straight antenna extending to beyond halfway of urosome. Geniculated antenna expanded between segments 13 and 18, with small spines on segments 9, 10, and 12. One long, strong and one short, stout spine on segment 13. Segment 15 with one fairly strong spine, about half as long as that on segment 13. Antepenultimate segment with pointed spur, turned away from segment at oblique angle. Second antenna, mouthparts, and thoracopods 1–4 as in the preceding species, where they were extensively figured.

P5 strongly asymmetrical (Fig. 22). Right P5 with endopodite widened at base, about as long as first segment of exopodite, with apical crown of setules. External margin of segment 1 of exopodite rounded, but conspicuous tooth on margin, and inner margin angularly produced and with short row of spinules. Second exopodite segment barrel shaped, with strong external spine, spinulated on inner surface only, slightly shorter than the segment itself. Apical spine with internal triangular expansion; spine itself strongly curved, denticulated on inner margin. Left P5 with plumose seta on basipodite. Endopodite well developed, rounded, with pattern of fine ridges and apical crown of fine spinules. Exopodite short, stout. Basal segment hairy with setules. Apical segment thumb-shaped, hairy, pointed at tip. A plumose seta at its base, and a second, scale-like expansion beside it. The scale is apically pointed (arrowed on Fig. 22) and its margin is finely denticulated. Possibly the scale is fused with the "thumb" at its base.

Female. Slightly more robust than male, body somewhat asymmetrical at articulation between cephalosome and urosome (Fig. 27). Trunk limbs as in male, except P5 (Fig. 23), which is symmetrical and has a short, one-segmented endopodite with subapical circle of spinules, a claw with two rows of spinules, and a single external spine.

Discussion

The new genus, whose discovery came as a surprise, appears difficult to relate to any of the known diaptomine genera, especially the two known from equatorial lowland Africa. No genus has the triangularly widened spine of the apex of the right endopodite of P5, or the peculiar arrangement of the left endopodite P5. Of considerable interest is the fact that two related but clearly distinct species could be discovered in a relatively limited area. The only other calanoid that was found in the same forest zone of Cameroon was *Tropodiaptomus processifer* Kiefer. This species is widely distributed in the Sahel zone of Africa, including the Nile and Niger basins (Verheye and Dumont, 1984), and Lake Chad (Dussart and Gras, 1966). Its presence in the forest zone of Cameroon represents a range extension, but it should be added that, once again, it was represented by only a few specimens in a single sample from the Muyuka and Mt. Cameroon forests.

It can be concluded that calanoid copepods in African equatorial lowlands are extremely sparse but do occur. The reason for this scarcity can hardly be environmental; like in the large cladocerans, especially the *Daphnia* species, it is probably the relentlessly elevated level of fish predation that either excludes them or keeps their abundance so consistently low that a considerable sampling effort is required to detect their presence.

It is, of course, extremely difficult to provide direct proof of this hypothesis, but some circumstantial evidence can be cited in support of it. In Nigeria, Maas *et al.* (1992) found *Tropodiaptomus lateralis* Kiefer plentifully in Lake Oguta, a floodplain lake of the Niger River. This species was reputed to be rare before this find, but it turned out that Lake Oguta had been subject to a major hydrological change following the damming of the Niger at Kainji; unlike in the past, it was no longer flooded by the river during monsoon, and the pelagic sardines that came to reproduce in the lake at high waters no longer had access to their traditional spawning ground. As a consequence, the zooplankton in the lake was released from sardine predation, and a huge stock of a previously very rare prey copepods could build up.

We predict, therefore, that lowland tropical Africa still houses a considerable number of undisclosed species and, perhaps, a high generic richness in calanoid copepods. We therefore expect the gap in generic diversity between Africa and Asia to narrow in the future, but the gap is so large that it is unlikely that it will ever be closed. Because the predation argument holds for tropical Asia as well, specific reasons must exist for Africa's impoverished calanoid fauna.

These remain to be discovered, but might well be historical and relate to the climate changes that occurred on this continent during the Pleistocene.

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