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Calanoid copepods from the lowland forest zone of Cameroon (West Africa), with the description of a new species of *Tropodiaptomus*

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Abstract

We illustrate four of the six calanoid copepods currently known from the lowland forest zone of Cameroon. Two are possibly shared with the savannah zone of West Africa. Of interest is a new record from the Korup forest of the recently discovered *Camerundiaptomus djamai*. A new species, *Tropodiaptomus njinei* is also described. It is closely related to *Tropodiaptomus loveni*. The composition of this highly endemic microfauna is discussed. It is suggested that *Camerundiaptomus* and *Thermodiaptomus* may share a common origin.

Introduction

The calanoid copepods of the inland waters of West Africa are comparatively well known in the zone between the Republic of Senegal and the lower Niger valley. An overview of the regional *Tropodiaptomus*, which includes ten species out of 35–40 known to occur in Africa (Dussart & Defaye, 2002) is given by Maas et al. (1992). Two species of *Thermodiaptomus* also occur in the same area (Kiefer, 1926; Dumont et al., 1981). South of the Niger valley, in Cameroon, Gabon and Congo, what little work has been done (Kiefer, 1926, 1928) seems to reflect a local rarity of calanoids. Only *Tropodiaptomus loveni* (De Guerne & Richard, 1890) is known from the south of Gabon, in an area (Mayoumbe) that is part of the Congo basin. In addition, *Tropodiaptomus processifer* and *Thermodiaptomus galebi* may, in fact, have been collected in the savannah part of Cameroon (Kiefer, 1926 – see further). Recently, Chiambeng & Dumont (1999) and Dumont & Chiambeng (2002) collected and examined about 500 plankton samples from the rainforest section of Cameroon, representing a wide range of waters, from the smallest to the largest, both stagnant and running. Three calanoid species were found, in extremely low numbers. Yet, surprisingly, these included a new genus, *Camerundiaptomus*, represented by two new species. Here, we continue the studies undertaken earlier, adding about 200 new samples to our collection, and re-examining a number of former samples.

Materials and methods

Qualitative plankton samples were collected between 1998 and 2002 either using a hand net or towing a plankton net (100 μm mesh size) across water and aquatic vegetation. The samples were preserved immediately in 5% formaldehyde. Climatic data on the zones sampled can be found in Chiambeng & Dumont (1999) and Dumont & Chiambeng (2002). In the laboratory, specimens were selected from the samples under a Wild M3 stereomicroscope, dissected using tungsten needles, and mounted on glass slides in glycerol. Identifications were carried out under a Kyowa medilux-12 and Olympus BX40 microscope equipped

with phase contrast. All figures were made under oil immersion.

Of the approximately 700 samples analysed only four contained calanoid copepods. Details of the localities are as follows:

Locality 1. Boumba-Mbek forest, SE Cameroon near border with Congo. Samples from littoral macrophytes in stagnant section of River Boumba at level of Mikel village, 25 June 1999. This is also the type locality of *Camerundiaptomus christineae* Dumont & Chiambeng, 2002. A re-examination of the samples yielded four specimens of a *Tropodiaptomus*, hereinafter described as new.

Locality 2. Seasonal pond at Limbe (Middle Farms Camp Bota), September 2001: a depression that fills up during the summer rains in July–August and dries out by November–December.

Locality 3. Mount Cameroon forest: permanent pool in bed of mountain river draining Mt Cameroon, mile 10 from Batoke village, Limbe area, March 2002.

Locality 4. Korup forest: a series of pools in the forest, March 2002.

Results

We found four out of the six currently known calanoid species of Cameroon.

Tropodiaptomus njinei *n. sp*. (Figs 1–11)

Material examined: three males, one female, locality 1.
Holotype: a male, dissected and spread over two sealed glass slides, deposited at the Royal Institute of Natural Sciences (KBIN) Brussels under accession number IG 29.718
Allotype: a female, spread over two sealed glass slides, accession number IG 29.718
Paratype: a dissected male, mounted on a sealed glass slide, accession number IG 29. 718.
Derviatio nominis: the species is named in honour of Prof. Dr Thomas Njine of the University of Yaounde, in recognition of his efforts for stimulating limnological studies in Cameroon.

Diagnosis

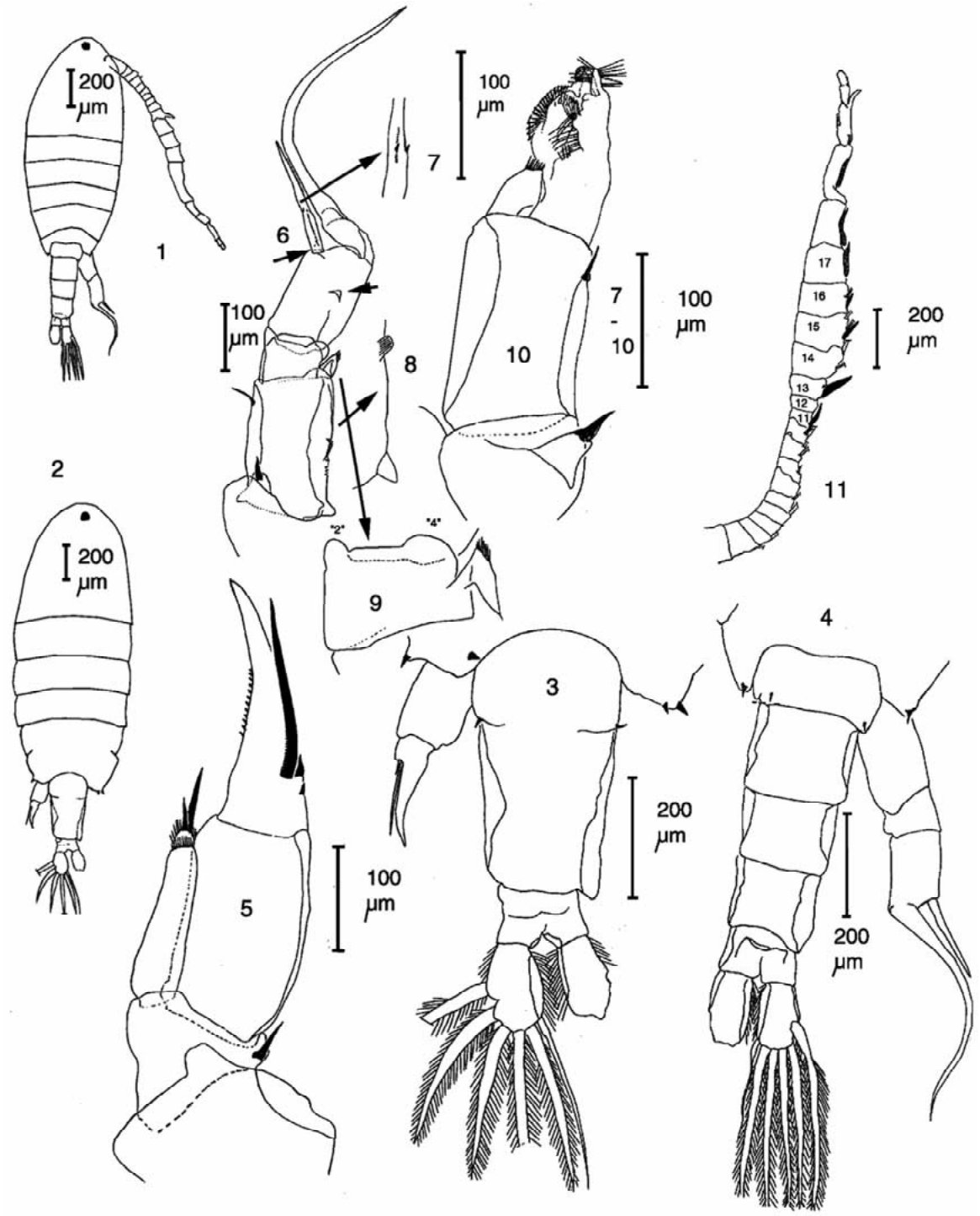
A *Tropodiaptomus* of medium size, without a spine on segment 12 of the male antennule but with a spine on segment 16. Second exopodite segment of right male P5 squarish, with straight lateral spine, in terminal position, without flanking chitin outgrowth of the segment itself. Endopodite shorter than segment 1 of exopodite. Internal margin of basipodite with triangular widening at base and hyaline flange slightly below mid-length. Endopodite of left P5 less than half the length of the exopodite. Female P5 with strong end-claw at exopodite, a long lateral seta, almost reaching to tip of claw, and two very short lateral spine setae. Endopodite with two apical setae, the shorter of which is about half as long as the longer.

Description

Male

Length 1.3 mm. Cephalosome fusiform, with long P5 extruding well beyond, the apical spine of the right exopodite almost reaching to tip of furcal setae (Figs 1 and 4). Antennule of 22 segments; geniculated antennule with spines on segments 10, 11, 13, 15 and 16; hence, segments 12 and 14 spineless. Mouth parts and trunk limbs 1–4 as for genus. Fifth pair of limbs (P5) diagnostic (Figs 6–10). Right P5 with inner margin of basipodite triangularly widened at base, with a protruding hyaline lamella slightly below half its length (Fig. 8). Endopodite apically denticulated, shorter than exopodite segment 1. Anterior surface of apical rim of exopodite 1 with exterior (smaller) and interior (larger) swellings, similar to those in *T. loveni* (compare with positions '2' and '4' on Fig. 44 of Dumont & Maas, 1987) (Fig. 9). Second exopodite elongated, robust, not hollowed out; lateral spine far displaced, almost to apex of segment, rendering the whole segment more or less rectangular in shape (Fig. 6). Lateral spine straight, not curved outwardly, denticulated over most of its length; about halfway its length, two juxtaposed, stronger spinules (Fig. 7). A semicircular, hyaline membrane on body of inner surface of segment. Apical spine long, curved, finely pointed apically.

Left P5 (Fig. 10) with apical exopodite provided with curved row of spinules and the usual combs of setae. Apical finger with long setules, flanked by a spinulated bulb (Fig. 10). Endopodite apically narrowed, spinulated, less than half as long as exopodite.



Figures 1–11. Tropodiaptomus njinei n. sp. **1.** Male, habitus. **2.** Female, habitus. **3.** Female, urosome. **4**. Male, urosome. **5.** Female, P5. **6.** Male, right P5. **7–9.** Enlarged details from 6. **10.** Male, left P5. **11.** Male geniculated antennule.

Furcal rami (Fig. 4) with a row of setules along their inner and outer borders.

Female

Length 1.45 mm (Fig. 2). Terminal segment of cephalosome with spines, asymmetric but slightly distorted by mounting (Fig. 3). Genital somite also asymmetric; furcal rami with inner and outer row of setules. Mouth parts and trunk limbs 1–4 not studied. Fifth trunk limb (P5) with end-claw of exopodite robust and provided with a short row of denticles on its inner surface (Fig. 5). Externally, one long seta, almost reaching to tip of end-claw, as well as two shortest spiniform setae. Endopodite with double apical crown of spinules and two apical setae, of which the shorter is about half as long as the longer.

Differential diagnosis

We compared *T. njinei* with all its regional congeners, of which the ranges have been mapped by Maas et al. (1992). Four species could theoretically co-occur with it: *T. lateralis* Kiefer, 1932, *T. gemini* Brehm, 1951, *T. agegedensis* (Wright & Tressler, 1928), and *T. loveni* (De Guerne & Richard, 1890). *Tropodiaptomus lateralis* was redescribed in great detail by Maas et al. (1992) and has a very different exopodite of the male right P5. The first exopodite segment has a long and filiform external outgrowth, and the second segment has a hyaline membrane between the lateral and apical spines, which are well distant from each other. Of *T. gemini*, from the present Lagos area in Nigeria, the type material is lost, but the published figures show a male right P5 with the second exopodite segment distinctly hollowed out (Brehm compares it to a *Phyllodiaptomus*, where this segment is indeed typically spoon-shaped), and with a lateral spine that is characteristically broken at right angles close to its base. This unique arrangement is totally different from what is seen in *T. njinei. Tropodiaptomus agegedensis* is another Lagos-area species, of which we re-examined the male holotype, preserved at the Smithsonian Institution in Washington. This species too can only be a distant relative to *T. njinei*. Here, the second segment of the exopodite of the right P5 is large and inwardly bent, elongated, and with the lateral spine implanted quite close to the segment base (Fig. 12). Below the apical spine, a semi-circular hyaline membrane is found (Fig. 12, arrow). Some details of structure not shown on the original description are the extremely small endopodite of the right P5, contrasting with the large endopodite of the left P5. Also characteristic is the massive outgrowth on the right basipodite, terminating in a nipple-shaped apex (Fig. 12, arrow).

Another related species, *T. loveni*, was redescribed by Dumont & Maas (1987). It is most similar to the new species, but the male end-claws of P5 are different in shape. The Exp2 lateral claw is straight in *T. njinei*, and curved outwardly in *T. loveni*. At the base of the lateral claw there is an extension of Exp2 in *T. loveni* which does not occur in *T. njinei*. The segment of Exp2 in *T. njinei* is rectangular and oblong in *T. loveni.* We conclude from this comparison that the two might well form a species-pair that vicariates in space, and shares a common ancestry.

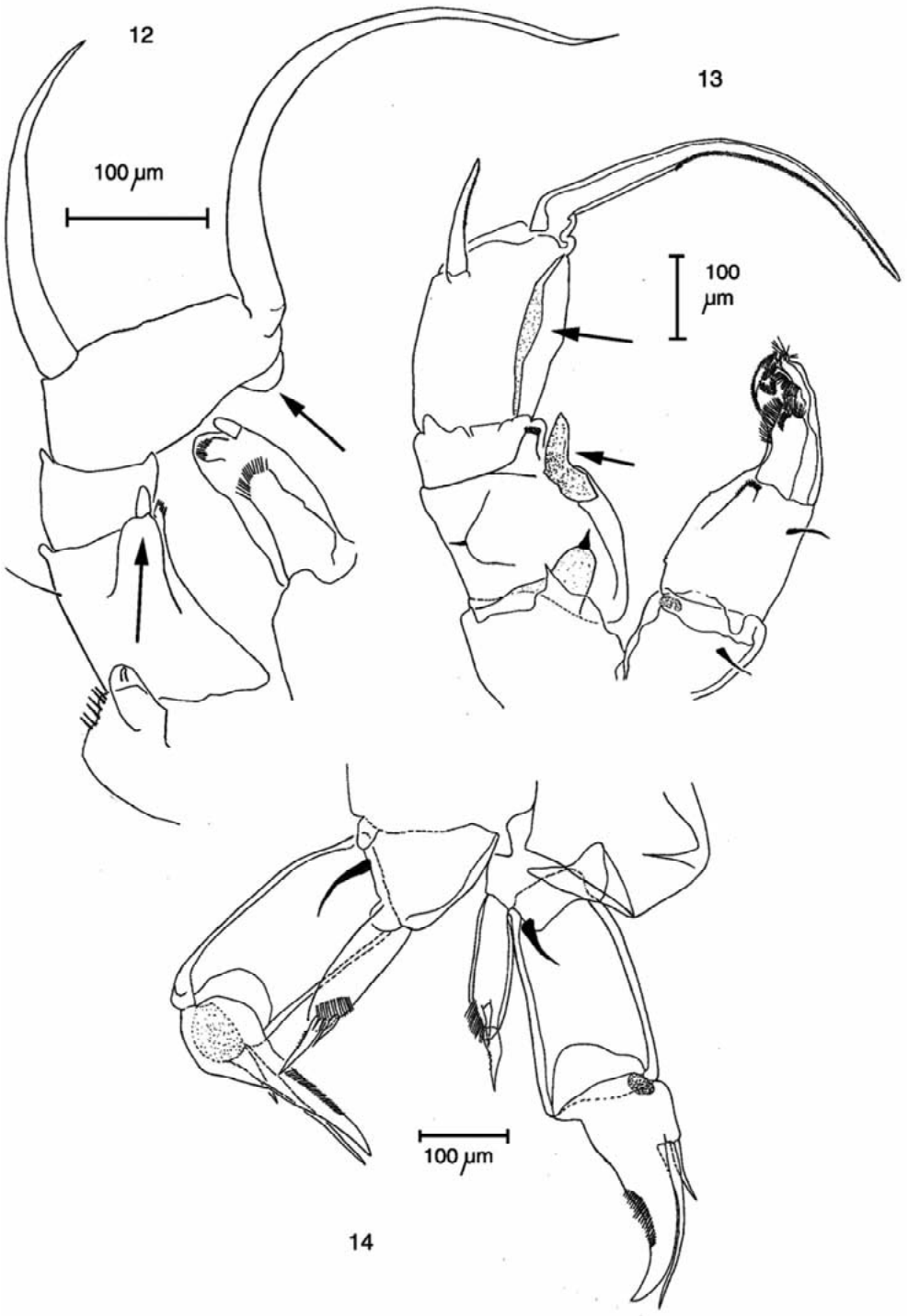
Tropodiaptomus processifer (Kiefer, 1926) (Figs 13–14)

Syn. *T. malianus* Hume*s,* 1960.

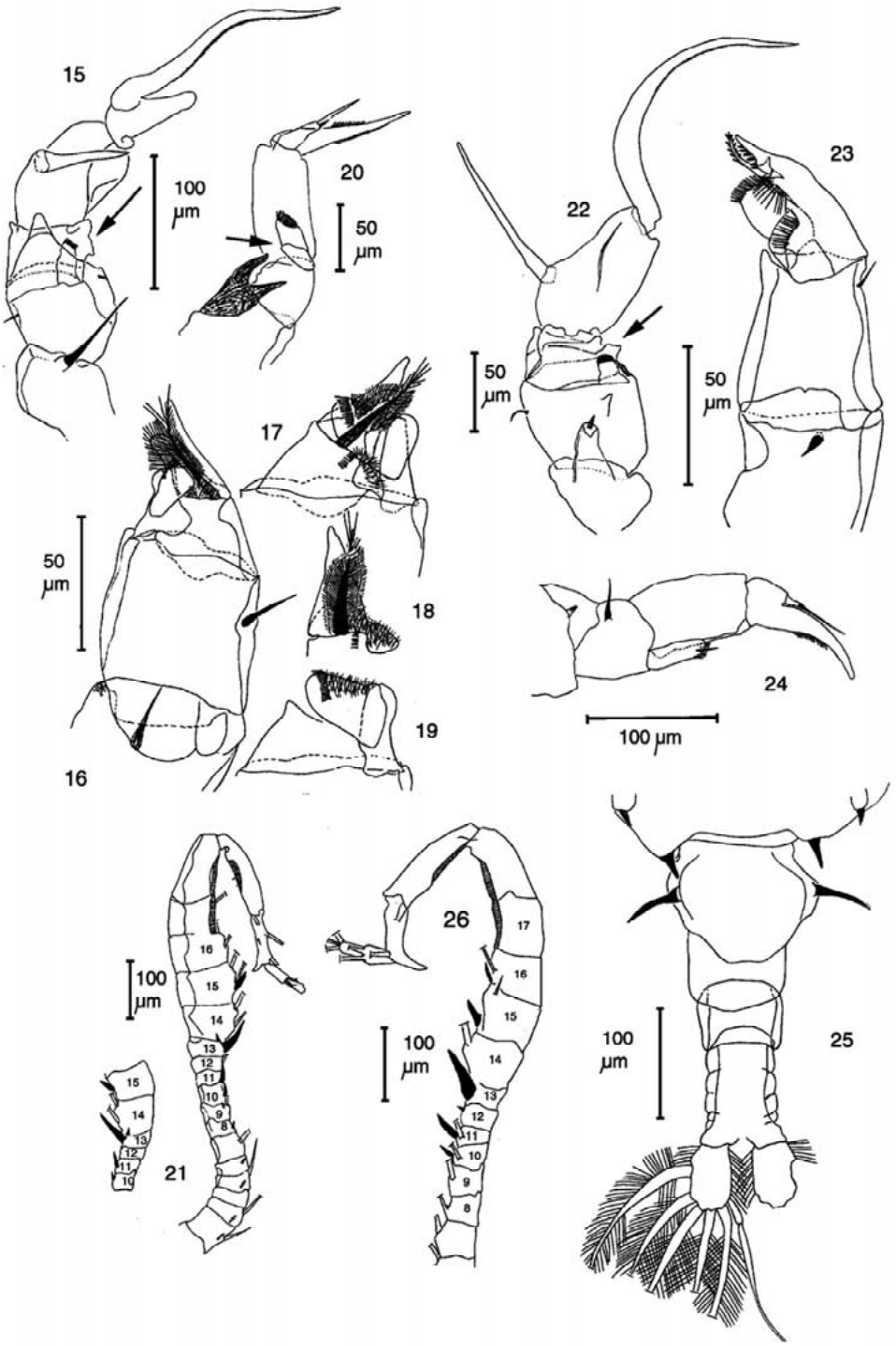
Material examined: one male, one female, loc 3.

This taxon was originally described from Cameroon, where Kiefer found it together with *Thermodiaptomus galebi* (Barrois, 1891), a species widespread in the Nile and Chad basins. This convinced Verheye & Dumont (1984) that the type locality, the rivers Uham and Lo, must be situated in the northern, Sahel part of the country, that waters down to the River Niger or to Lake Chad. This is all the more probable since we found a second species of *Thermodiaptomus* (see hereunder) in south Cameroon, and there are no known co-occurrences of species in this genus. The water divide between the Atlantic Ocean and the River Niger–Lake Chad is therefore believed to also separate both *Thermodiaptomus* species. Structurally, the specimens from Limbe area conform to 'typical' specimens from Mali and Ivory Coast, except that the hyaline membrane that runs along the second exopodite segment of the right male P5 is slightly more pronounced (Fig. 13, arrow), and the 'bird's beak' on the basipodite of the right P5 is more robust. In the female (Fig. 14), the most distal of the two spines on the endopodite of P5 is relatively longer and more apically pointed than in Sahel specimens. The presence of *T. processifer* at the latitude of Limbe represents a range extension of this species, from a steppe, savannah, and altitudinal environment to a lowland equatorial forest zone.

Thermodiaptomus yabensis (Wright & Tressler, 1928) (Figs 22–26)



Figures 12–14. **12.** *Tropodiaptomus agegedensis*, male P5. **13.** *Tropodiaptomus processifer*, male P5. **14**. *T. processifer*, female P5.



Figures 15–26. Camerudiaptomus djamae. **15.** Male right P5. **16.** Male left P5. **17–19.** Enlarged details of left P5. **20.** Female P5. **21.** Male geniculated antennule of two different specimens. *Thermodiaptomus yabensis*. **22.** Male right P5. **23.** Male left P5. **24.** Female P5. **25.** Female urosome and hind border of prosome. **26.** Male geniculated antennule.

Material examined: several males and females, locality 2.

This is another species that was originally described from Nigeria, and later found to occur in great abundance as far West as Mali (Dumont at al., 1981). It now appears to be a vicariant species to *T. galebi* (Barrois), with the borderline separating both species' ranges running through Cameroon, presumably the water divide indicated earlier. *Thermodiaptomus yabensis* females have characteristic large lateral spines on the genital somite of the female (Fig. 25) and a diagnostic male P5 (Figs 22–23). Of considerable interest is the presence of a massive outgrowth on the inner margin of the first exopodite segment of the male's right P5 (Fig. 22, arrow). This outgrowth is present in the whole genus, but has a specific shape in each species. The left P5 terminates in a type of pincer, composed of a denticulated 'thumb' and a setulated 'finger' (Fig. 23). The endopodite of the female P5 has only one subapical seta, beside a crown of spinules (Fig. 24).

Camerundiaptomus djamae Dumont & Chiambeng, 2002 (Figs 15–21)

Material examined: two males, one female, locality 4.

Korup forest is a new site for this recently discovered species, which was first found in Campo Ma'an forest. This suggests its range across Cameroon forests, and possibly beyond, might be rather wide. The second species in the genus, *C. christineae*, is currently known only from its type locality, Boumba-Mbek forest (Locality 1), where it co-occurs with *T. njinei*. A comparison of the new material with the types reveals structural similarity in most diagnostic characters of the antennules, and of P5 in both sexes. The left male P5, which has a complex structure consisting of a robust endopodite and an exopodite ending in two leaf-shaped lamellae with interposed seta (Figs 16–19) is exactly as in the type. However, the genus-specific triangular outgrowth at the base of the end-claw of the right male P5 is relatively longer than in the types (Fig. 15). Further, the basipodite of the right P5 was found to carry an apically tapering appendix, not seen in the type (Fig. 15), and the female had a bifid spine at the base of the fifth limb (Fig. 20). Another unique detail of structure, not emphasised in the original description, is the presence of two spines (one long, one short) on segment 13 of the geniculated male antennule (Fig. 21).

Chiambeng & Dumont (2002) refrained from speculating about the intergeneric relationship of *Camerundiaptomus*. However, here we attract attention to the internal outgrowth of exopodite segment 1 of the right male P5 (Fig. 15, arrow), which appears to be similar to what is seen in *Thermodiaptomus* (in *T. yabensis*: Fig. 22, arrow). This similarity might suggest a phylogenetic relationship, and it is therefore suggested that *Camerundiaptomus* and *Thermodiaptomus*, two genera endemic to Africa, may share a direct ancestor.

Conclusion

Calanoids in the tropical lowland forest of Africa are exceedingly rare. Possible reasons for this, as outlined by Dumont & Chiambeng (2002), include high and continuous predation pressure by a multitude of small fish species, beside effects of past climatic change. However, the few species recorded so far indicate both diversity and great endemism. Additional collecting in Cameroon, Gabon and Congo is certainly warranted, and it is predicted this may lead to the discovery of additional new species in the three genera of calanoids of Central Africa's lowlands.

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