

## A new species of *Tropodiatomus* (Copepoda, Calanoida) from Lake Turkana, Kenya

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*Tropodiatomus turkanae* sp. nov. is described from Lake Turkana (formerly Lake Rudolph), Kenya. After years of confusion with *T. banforanus*, the identity of this taxon as an endemic of Lake Turkana is established. The species is described, and its relationship with other *Tropodiatomus* species discussed.

ADDITIONAL KEY WORDS:—*Tropodiatomus turkanae* sp. nov. – Diaptomidae – taxonomy – East Africa.

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### INTRODUCTION

The genus *Tropodiatomus* is widespread in Africa and Asia. Many species are endemic to small areas, and a fair number of insufficiently described species exist. One of these controversial taxa is the *Tropodiatomus banforanus* Kiefer, 1932 of Lake Turkana.

In a publication of 1936, Lowndes recorded '*Diaptomus banforanus*' from some East African lakes. The exact locality at which the species was found is not clear: Lowndes' text mentions it from Lakes Naivasha and George, but it was listed from Lake Rudolph in the accompanying table. In Lake George, *T. neumanni* (Van Douwe, 1912) and *T. worthingtoni* (Lowndes, 1936) have been recorded (Verheye & Dumont, 1984), whereas *T. neumanni* has also been recorded from Lake Naivasha (Lowndes, 1933). Both these species differ, however, distinctly from Lowndes' material.

Lowndes' (1936) figures of '*Diaptomus banforanus*' depict a taxon that only superficially resembles the true *Tropodiatomus banforanus*, as described by Kiefer

(1932, 1933) from West Africa. Although the first description of *T. banforanus* was published in 1932, an illustrated account appeared only one year later. Lowndes' (1936) remark that 'the species was originally described (without illustrations) by Kiefer from West Africa', indicates that he did not have access to Kiefer's (1933) publication, and therefore had insufficient means of identifying his material.

Samples from Lake Turkana, collected by one of us (J. Green) contained a *Tropodiptomus*-species, matching Lowndes' (1936) description of '*Diaptomus banforanus*'. A comparison of these specimens with topotypical material of *Tropodiptomus banforanus* from Upper Volta (Banfora, April 1980, leg. H. J. Dumont), revealed that the Lake Turkana specimens are not conspecific with *T. banforanus* and, in fact, represent a new species.

Additional material from Lake Turkana, collected on 18.04.1939 (British Museum (Nat. Hist.)) also turned out to belong to the new species.

#### MATERIAL AND METHODS

*Material examined.* Lake Turkana, 27/12/1979, (coll. J. Green): tube containing several specimens. Further, one adult male, extracted from a tube labelled *Diaptomus (Tropodiptomus) banforanus* Kiefer, 18.4.1939, 207-216, Lake Rudolf, E. Africa, on loan from the British Museum (Nat. Hist.).

Male holotype and female allotype, selected from the more recent material, both mounted in glycerine, deposited in the British Museum (Natural History), London. (accession numbers: ♂ holotype: 1992.1064; ♀ allotype: 1992.1065). Paratypes (3♂♂, 2♀♀), from the same tube, in the senior authors' collection.

Specimens were measured and dissected in glycerine, the dissected parts mounted on an aluminium slide-holder and sealed with glyceel. This method allows the study of both sides of the dissected parts. Males were examined by scanning electron microscopy (SEM, Jeol JSM-840 microscope). Specimens were put through an alcohol series for dehydration, critical-point dried, mounted on a stub and sputter-coated with gold.

#### RESULTS

Family Diaptomidae

Subfamily Diaptominae

Genus *Tropodiptomus* Kiefer, 1932

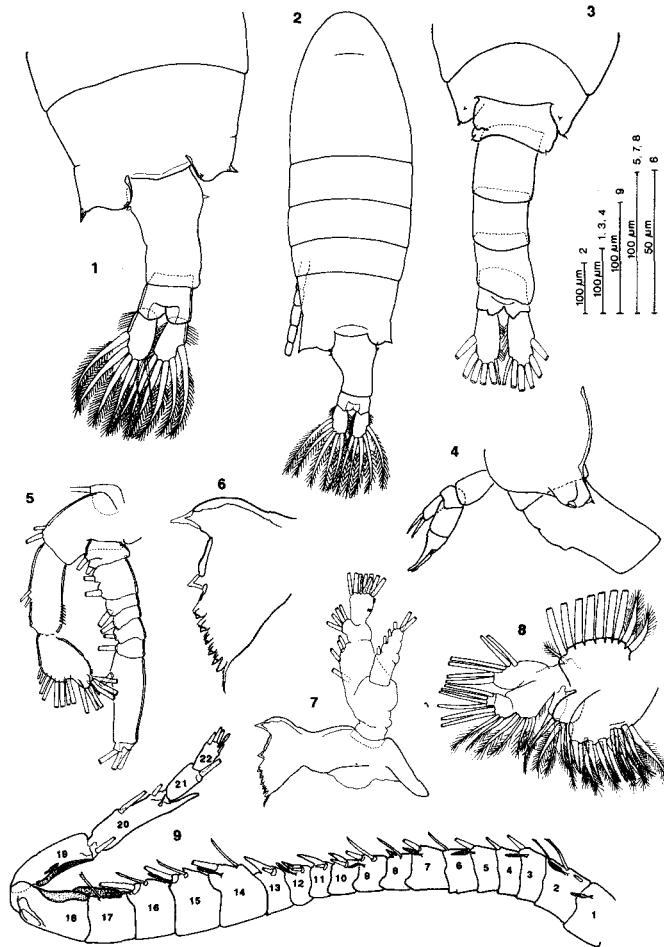
#### ***Tropodiptomus turkanae* sp. nov.**

*Synonymy.* *Diaptomus banforanus*: Lowndes, 1936

?*Diaptomus banforanus*: Worthington & Ricardo, 1936

*Etymology.* The species is named *Tropodiptomus turkanae* after its type locality, Lake Turkana (Kenya).

*Diagnosis.* A small, compactly built species. Right male P5 with several lamellae and outgrowths on the basipodite and a blunt, conical outgrowth on exopodite 2, near the implantation of the lateral spine. Left exopodite swollen, with an internal 'saw'. Female P5: endclaw of exopodite ornamented with two rows of



Figures 1–9. *Tropodiaptomus turkanae* sp. nov. 1. Female: last thoracic somites and urosome, dorsal view. 2. Female: habitus, dorsal view. 3. Male: last thoracic somites and urosome, dorsal view. 4. Female: last thoracic somites, P5 and urosome, lateral view. 5. Male: antenna; 6. Male: gnathobase of mandible. 7. Male: mandible. 8. Male: maxillule. 9. Male: right antennule.

spinules and tip of the endopodite with two long apical spines and a subterminal crown of spinules.

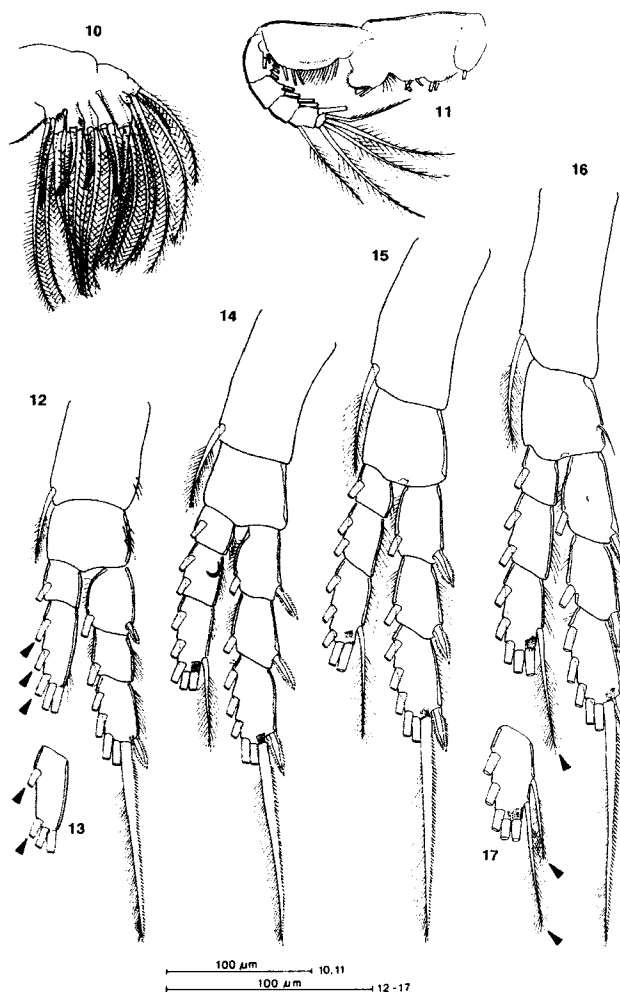
#### Description

*Male.* (Figs 3, 5–20, 23–36). Total length, excluding caudal setae 885–921  $\mu\text{m}$ , mean length 906  $\mu\text{m}$  ( $n=5$ ). More slenderly built than female. Thoracic wings small, more or less symmetrical with a slender lateral spine and a median sensillum on each wing.

Urosome of five somites, first somite somewhat broader with a slender spine on each side. Fourth urosome somite with asymmetrical posterior border (Fig. 3).

Caudal rami with setules along the inner margin only.

Antennules: left antennule composed of 25 segments, as in female. Right antennule geniculated, consisting of 22 segments. Geniculation between segments

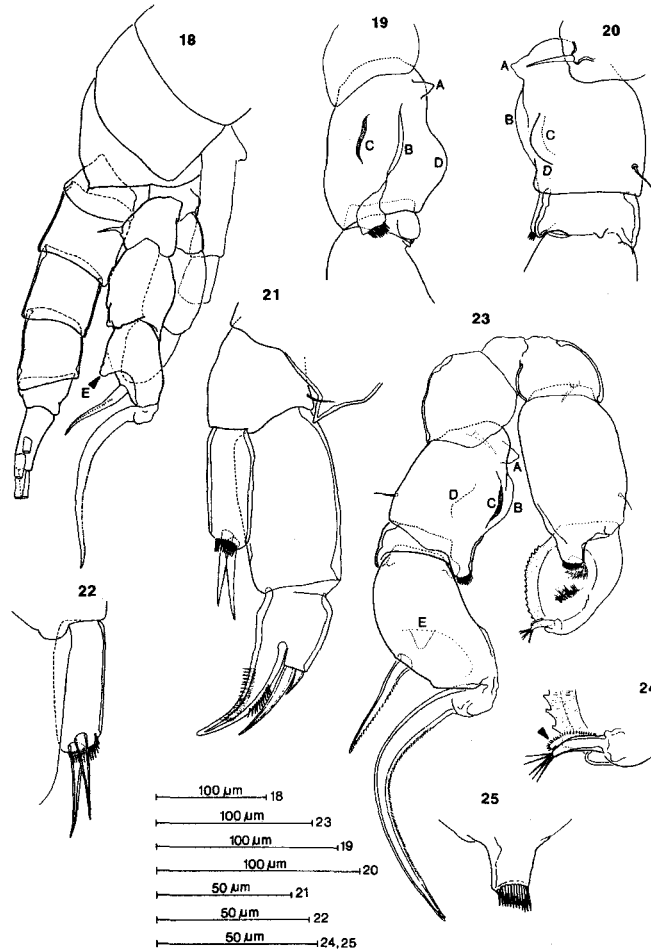


Figures 10-17. *Tropodiptomus turkanae* sp. nov. 10. Male: maxilla. 11. Male: maxilliped. 12. Male: P1. 13. Male: endopodite 2 of P1 abnormally carrying two (instead of three) external lateral setae (arrows). 14. Male: P2. 15. Male: P3. 16. Male: P4. 17. Male: endopodite 3 of P4 abnormally carrying two (instead of one) external lateral setae (arrows).

18 and 19. Spines on segments 8, 10, 11, 12, 13 and 15 as in Fig. 9. Largest spine on segment 13, smallest on segment 15. Digitiform expansion on penultimate segment moderate in length ( $\pm$  two third of length of segment 21) with upturned apex and straight margins. Fleeces occur on segments 17, 18 and 19.

Antenna, mandible, maxillula, maxilla and maxilliped as illustrated in Figs 5-8, 10 and 11, typical for genus insofar as known.

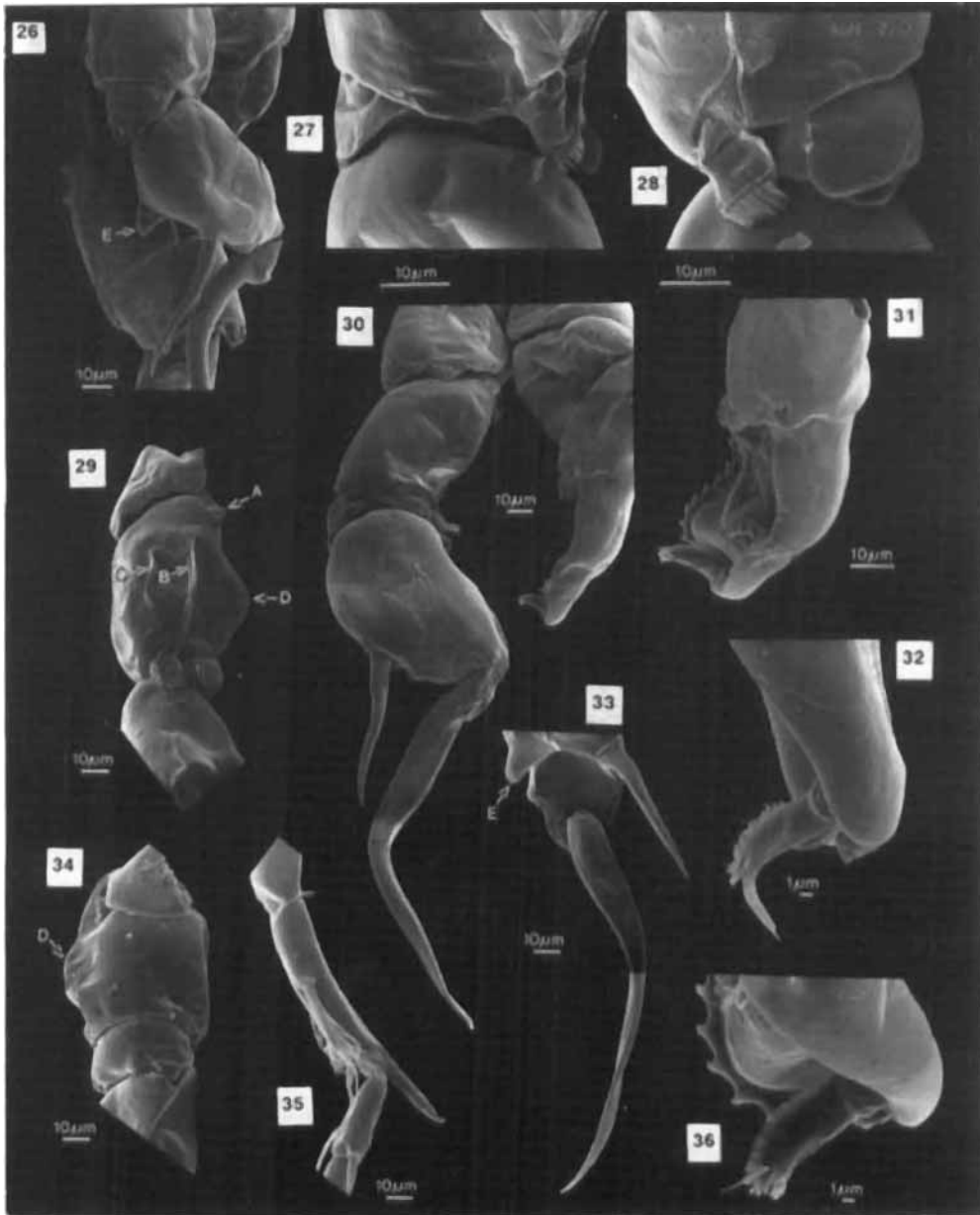
Legs 1-4: armature of legs as shown in Figs 12-17. Second endopodite of leg 2 with organ of Schmeil. Upon examination of several animals it was found that the number of setae shows variation. In one specimen, the second endopodite segment on one side of leg 1 carried two internal lateral setae (Fig. 13) instead of the usual three setae (Fig. 12). In another specimen, endopodite three of leg 4 showed two short external lateral setae (Fig. 17), instead of the



Figures 18–25. *Tropodiptomus turkanae* sp. nov. 18. Male: last thoracic somites, P5 and urosome, lateral view. 19. Male: right P5, internal lateral view, with outgrowths and lamellae (A, B, C, D). 20. Male: right P5, posterior view, with outgrowths and lamellae (A, B, C, D). 21. Female: P5, posterior view. 22. Female: endopodite of P5, anterior view. 23. Male: P5, anterior view, with outgrowths and lamellae (A, B, C, D, E). 24. Male: apical 'thumb-and-finger' on exopodite of left P5. 25. Male: endopodite of right P5.

usual single seta (Fig. 16). Leg 4 can be identified by the presence of a short sensory seta on the external margin of the basis. This seta is absent in all other legs.

P5 short and compactly built (Figs 18–20, 23–34, 36). Left and right coxopodites each with a slender spine on the posterior surface (Figs 20, 23). Right basipodite twice as long as broad, ornamented with several outgrowths and a membrane. A conical outgrowth proximal on the inner edge (A on Figs 19, 20, 23, 29); a rounded outgrowth as an extension of the proximal tip of the endopodite (B on Figs 19, 20, 23, 29); a thin rounded membrane on the anterior side, halfway the inner edge (C on Figs 19, 20, 23, 29); a rounded outgrowth on the posterior surface (D on Figs 19, 20, 23, 29, 34). Right endopodite fused with basipodite, slightly tapering towards apex, with subapical row of spinules (Figs 25, 27, 28). Right exopodite 1 with one internal, one



Figures 26–36. *Tropodiptomus turkanae* sp. nov. 26. Male: right P5, lateral view, with conical processus (arrow E). 27. Male: right P5, detail. 28. Male: right P5, detail. 29. Male: basipodite right P5, internal lateral view, with outgrowths and lamellae (arrows A, B, C, D). 30. Male: P5, anterior view. 31. Male: left P5 (internal dented edge or ‘saw’ collapsed during drying process). 32. Male: apical ‘thumb-and-finger’ on exopodite of left P5. 33. Male: exopodite 2 of right P5, showing lateral spine, end claw and conical processus (arrow E), lining depression. 34. Male: basipodite right P5, external lateral view, showing outgrowth (arrow D). 35. Male: antennule, antepenultimate segment with digitiform processus. 36. Male: apical ‘thumb-and-finger’ on exopodite of left P5.

medio-external and one external bulge, all three of moderate size (Figs 20, 27, 28). Right exopodite 2 with a lateral spine, spinulated along its inner edge and inserted just above halfway the length of the segment. Terminal claw swollen at its base, spinulated over most of its length and curved inwards. Posterior surface of exopodite with a concavity bordered by the lateral spine, the terminal claw and the conical outgrowth (E on Figs 18, 23, 26).

Left exopodite bulbously swollen with thin internal dented margin (=‘saw’), showing 12–15 teeth (Figs 23, 31, 36) (on the SEM-pictures: the collapsed exopodite is a drying artefact; only eight of the teeth are visible, the others are hidden behind the ‘finger’ and endopodite). The exopodite ends in a very small rounded thumb and a longer, more slender, finger, set with an apical bundle of long setae. Along the distal edge of the finger runs a crest of small spinules (Figs 24: arrow, 32, 36) (cf. *T. stuhlmanni* (Poppe & Mrazek) where it is the thumb which shows a similar crest of small spinules (Dumont & Maas, 1988)). Left endopodite short, rounded and with a subapical row of spinules, it partly covers the lowest of the two frontal setae-cushions.

*Female.* (Figs 1, 2, 4, 21, 22). Total length, excluding caudal setae 1135–1248  $\mu\text{m}$ , mean length 1180  $\mu\text{m}$  ( $n=4$ ). Body elongate, with cephalothorax about 70% of total bodylength; 4th and 5th thoracal somites fused. Thoracal wings weakly developed, slightly asymmetrical; left wing more outwardly projected. Each wing with two unequal spines: on the left wing a strong external hyaline spine and a rounded, blunt, internal one, on the right wing a strong external and a slender internal spine (Figs 1, 2, 4).

Urosome of two somites. Genital somite twice as long as broad and more or less symmetrical, widened at the subproximal part. Each side carries a slender spine.

Furcal rami symmetrical, their external and internal margins lined with setules (Fig. 1).

Antennules short, of 25 segments each, their tip reaching a little over the external spine of the left thoracal wing.

Mouthparts and legs 1–4 as in male.

P5 (Figs 21, 22) symmetrical, coxopodite with laterodistal spinous projection. Basipodite much smaller, with external sensory seta. Exopodite 1 long and cylindrical, twice as long as broad; exopodite 2 tapers to a strong, slightly inwardly curved claw, spinulated on both sides (internal margin with 10–12, external margin with 15–20 spinules). Exopodite 2 and 3 fused, bearing a long and a short spine, both naked. Exopodite 1 about 1.5 times longer than endopodite. Tip of endopodite with a subterminal crown of spinules and 2 long apical spines (a terminal and a subterminal one) of equal length (Figs 21, 22).

#### *Differential diagnosis*

The new species differs from other African *Tropodiptomus* species by its small size and its sturdy male P5: the combination of outgrowths and lamellae on the right basipodite, the ‘saw’ on the left exopodite and the broad conical outgrowth bordering the concavity on the caudal side of the right exopodite 2.

*Tropodiptomus turkanae* shows only a superficial resemblance, especially in the structure of the right male P5, to *T. banforanus*. Both taxa have an

earshaped lamella on the inner edge of the basipodite and both taxa show a conical outgrowth on the posterior surface of the exopodite 2. This can lead to confusion of the two taxa. A closer examination of *T. turkanae*, however, reveals important differences: left exopodite of male P5 rounded and swollen, with internal dented margin (=‘saw’) (elongated and more slender in *T. banforanus*, and with inner margin covered with several rows (a cushion) of small spines); right basipodite of male P5 with conical outgrowth on the proximal inner edge (absent in *T. banforanus*); this basipodite also ornamented with two rounded outgrowths and a membrane (one earshaped membrane in *T. banforanus*); right exopodite 2 of male P5 with blunt, conical outgrowth in addition to the lateral spine and endclaw (smaller, pointed outgrowth in *T. banforanus*), terminal claw of female P5 set with two rows of spinules (one row in *T. banforanus*).

#### DISCUSSION

It is unlikely that the true *T. banforanus* is, or was, present in modern Lake Turkana. No specimens of this taxon were found in any of our samples. Worthington & Ricardo (1936) reported on the vertical distribution of a dense population of what they identified as *T. banforanus* in Lake Turkana, but it is likely that this was *T. turkanae*, not *T. banforanus*, since both species can only be separated after careful examination.

It is difficult to place *T. turkanae* near to any other African *Tropodiptomus* species. It has the sturdy male P5, found also in *T. kissi* Dussart, 1977 and *T. worthingtoni* (Lowndes, 1936), but with a different configuration of out-growths and lamellae.

Compared with the Asian *T. orientalis* (Brady, 1886) (redescribed by Dussart *et al.*, 1984 and Dussart, 1989), a similarity in the structure of the male left P5 exopodite is apparent, especially in the structure of the ‘saw’ (Fig. 23), composed of a single row of spinules along a striated margin. *T. turkanae* is one of the African representatives showing this typical Asian ‘saw’. If we hypothesize that the African taxa are derived from pre-pleistocene invaders from Asia to Africa, *T. turkanae* emerges as a taxon that has conserved several characteristics of its Asian ancestor.

*T. turkanae* probably became physically isolated from the Nile system by the closing of Lake Turkana, thus starting its disjunct evolution some 8500 years ago, and surviving the increasing late-holocene salinization of the lake (Beadle, 1981).

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