

## Description of *Phyllodiaptomus christineae* n.sp. from Thailand, and distinction of two subgenera within *Phyllodiaptomus* Kiefer, 1936 (Copepoda, Calanoida)

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### Abstract

*Phyllodiaptomus christineae* n.sp. is described from Thailand. It stands out, in the male, by the shape and the armature of the second exopodite-segment of the right P5 and by the elongate apical process and ornamentation of the second exopodite-segment of the left P5; in the female, by the reduced lateral wings of the fifth pediger, and by the form of the genital somite. Together with *P. blanci*, *P. tunguidus* and *P. longipes*, the new species constitutes the blanci-group, here raised to the level of a subgenus (*Phyllodiaptomus* s.s.) with representatives in Central Asia, China, Borneo and Thailand. A second subgenus (*Ctenodiaptomus* subgen. nov.) is created to accommodate the four Asian species of the annae-group.

### Introduction

In our continuing study of diaptomid copepods from Thailand, we have come across another new species of the genus *Phyllodiaptomus* Kiefer, 1936. It is the eighth species in the genus and the second *Phyllodiaptomus* in Thailand (see Differential diagnosis and relationships). This paper gives an illustrated description of the new species and relates its affinity to its congeners, which fall in two natural groups.

*Phyllodiaptomus christineae* n.sp.

(Figures 1–49).

Synonymy

*Diaptomus* sp.: Lai & Fernando, 1981: 170–172, Figures 64–72

Type locality and material examined: Bung Boraphet, a natural, shallow lake in Nakhon Sawan province, Thailand. 10 ♂♂, 2 ♀♀ from a plankton sample, May 2, 1993. Water temp. 33 °C, pH 5.0, conductivity

370  $\mu\text{S cm}^{-1}$ .

Other localities: (1) Sakaekrungs river, Uthai Thani province, Thailand. 5 ♂♂. May 2, 1993. Water temp. 36 °C, pH 6.0., conductivity 190  $\mu\text{S cm}^{-1}$ . (2) Chao Phya reservoir, Chai Nat province, Thailand. 6 ♂♂, 2 ♀♀. May 2, 1993. Water temp. 37 °C, pH 5.6, conductivity 180  $\mu\text{S cm}^{-1}$ . (3) Mun river, Ubolratchathani province, 22 May 1993. Water temperature 32 °C, pH 7.8, conductivity 370  $\mu\text{S cm}^{-1}$ .

Male holotype, female allotype, 5 male paratypes from type locality, and 5 paratypes each from 1st and 2nd localities deposited in the British Museum (Natural History), London. Registration numbers; ♂ holotype: 1995-870; ♀ allotype: 1995-871; paratypes: 15 ♂♂, 1995-872-886. All type-specimens preserved whole, in 10% formalin.

## Diagnosis

### Male

Urosome 2 with ventral hair-like setae. Lateral caudal seta unmodified. Right antennule with spine on segments 8 and 10–16; spine on segment 8 rudimentary, like on segment 12; spine on segment 15 longer than that on segment 14. Comb on antepenultimate segment large. Right P5: coxal plate triangular, obliquely oriented and blunt. Basis rectangular, about 1.5 times as long as wide, with narrow hyaline lamella on proximal inner margin. First exopodite-segment with relatively small spinous process at distal outer corner. Second segment massive, spherical to oval and armed with 2 lateral spines; principal spine large, somewhat distal to mid-outer margin and doubly curved, and accessory spine small, close to end-claw. Endopodite large, somewhat triangular. Left P5: Basis with elongate hyaline lamella on distal inner margin. Second exopodite-segment produced into elongate digitiform process; fan-like outgrowth rudimentary, represented by serrate margin and field of spinules. Endopodite elongate, flask-shaped.

### Female

Lateral wings of fifth pediger poorly developed; right wing smaller than left wing; both wings laterally directed; spines on left wing larger than on right wing. Genital somite symmetrical, proximally dilated; right genital spine much smaller than left one; both spines lying opposite to each other on dorso-lateral surface, just below proximal bulge. P5: coxal spine moderate-sized. Sensory seta on basis short. Third exopodite-segment small; inner setiform spine relatively short. Endopodite divided into 2 unequal segments and  $2/3$  as long as inner margin of first exopodite-segment.

## Description

### Adult male (Figures 1–32, 40–46)

Total length (exclusive of caudal setae) 1.05–1.33 mm, mean 1.25 mm ( $n=27$ ). Rostral spines (Figure 4) strongly developed and acute. Fourth and fifth pedigers separated by distinct septum. Third and fourth pedigers with fine spinules arranged in transverse rows at posterior border, visible only on SEMs (Figure 40); each wing with apical spine and inner sensillum; apical

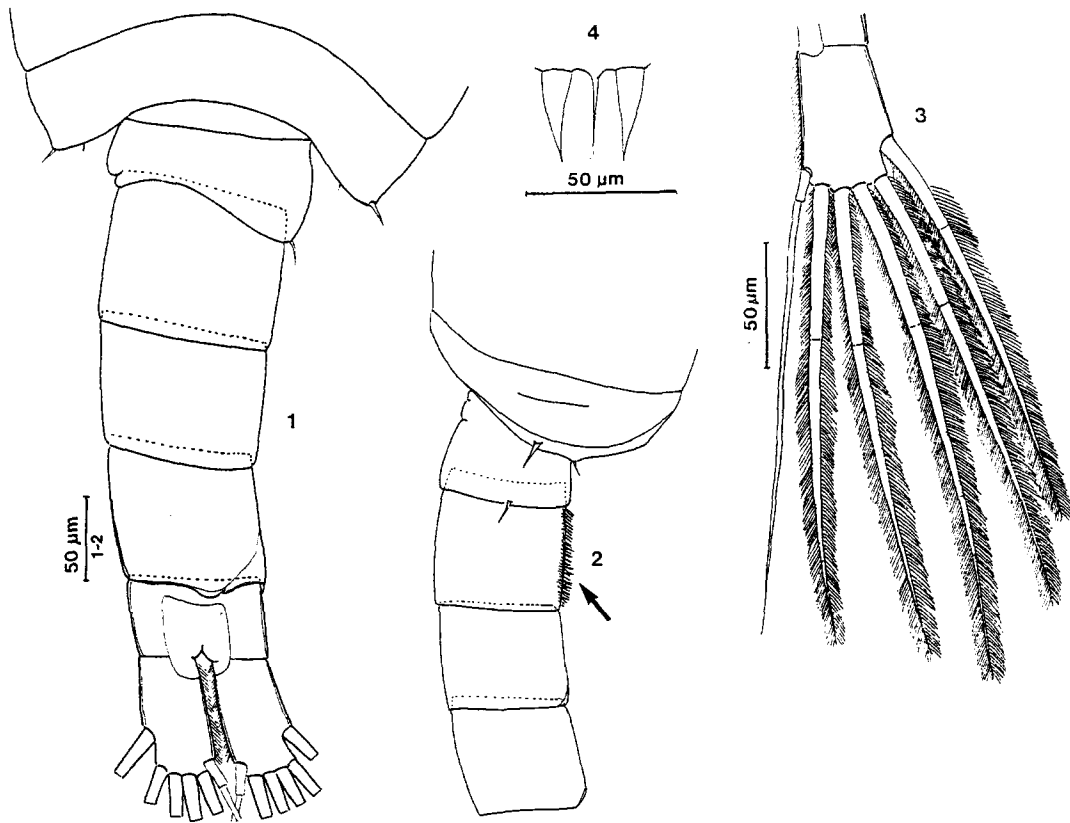
spine of right wing larger than that of left wing and of genital somite.

Urosome of 5 somites, bent to right side. Genital somite (Figure 1) wider, with weak spine at right distal corner. Second urosomite with short hair-like setae on ventral margin. Third urosomite bare. Fourth urosomite asymmetrical, posterior border produced into short, medial lobe. Caudal rami symmetrical, nearly twice as long as wide, with hairy inner margins, but without any special armature. Lateral caudal seta similar to other setae. Dorsal seta almost as long as innermost seta.

Antennules: left antennule consisting of 25 segments, details of armature as in Figures 5–7. Right antennule geniculate, 22-segmented; geniculation between segments 18 and 19; spines on segments 8 and 9–16 (Figure 8); spine on segment 13 longest, subparallel to antennular axis and with incised tip; spines on segments 8 and 12 rudimentary, as in female; relative lengths of spines in decreasing order as follows:  $13 > 15 > 14 > 11 > 10 > 12 > 8 < 16$ ; comb on antepenultimate segment generally large, consisting of 6–8, sometimes 3, teeth, below which lies a narrow hyaline membrane (Figures 9, 10, 46).

Antenna, mandible, maxillula, maxilla and maxilliped as in Figures 9–13. Legs 1–4 with normal complement of setae and spines (Figures 14–17). Second endopodite-segment of leg 2 without Schmeil's organ. Coxal seta on leg 4 of normal length, as in female.

Right P5 (Figures 21–30, 41–44) sturdily built. Coxa somewhat squarish, produced at distal inner corner into roughly triangular, obliquely oriented, blunt hyaline plate (Figures 21–23); spine moderately large, mounted on small lobe. Basis rectangular, 1.4–1.6 times as long as wide and provided with narrow hyaline lamella on proximal inner margin, longitudinal chitinous ridge over proximal mid-posterior surface and short sensory seta at distal-medial corner. First exopodite-segment about twice as wide as long, produced into relatively small, generally acute spinous process (Figures 19, 21). Second exopodite-segment spherical to oval in outline, thin, leaf-like, concave on posterior surface, armed with 2 lateral spines. Principal lateral spine shorter than segment, doubly curved and articulated to posterior surface, slightly distal to mid-outer margin; apical region unusually slender and curved. Accessory lateral spine small, straight or some-



Figures 1–4. *Phylloidiaptomus christineae* n.sp. Male. 1, pedigers 4, 5 and urosome, dorsal; 2, same (without anal somite and caudal rami), lateral (arrow points to hair-like setae on second urosomite); 3, right caudal ramus, dorsal; 4, rostral spines.

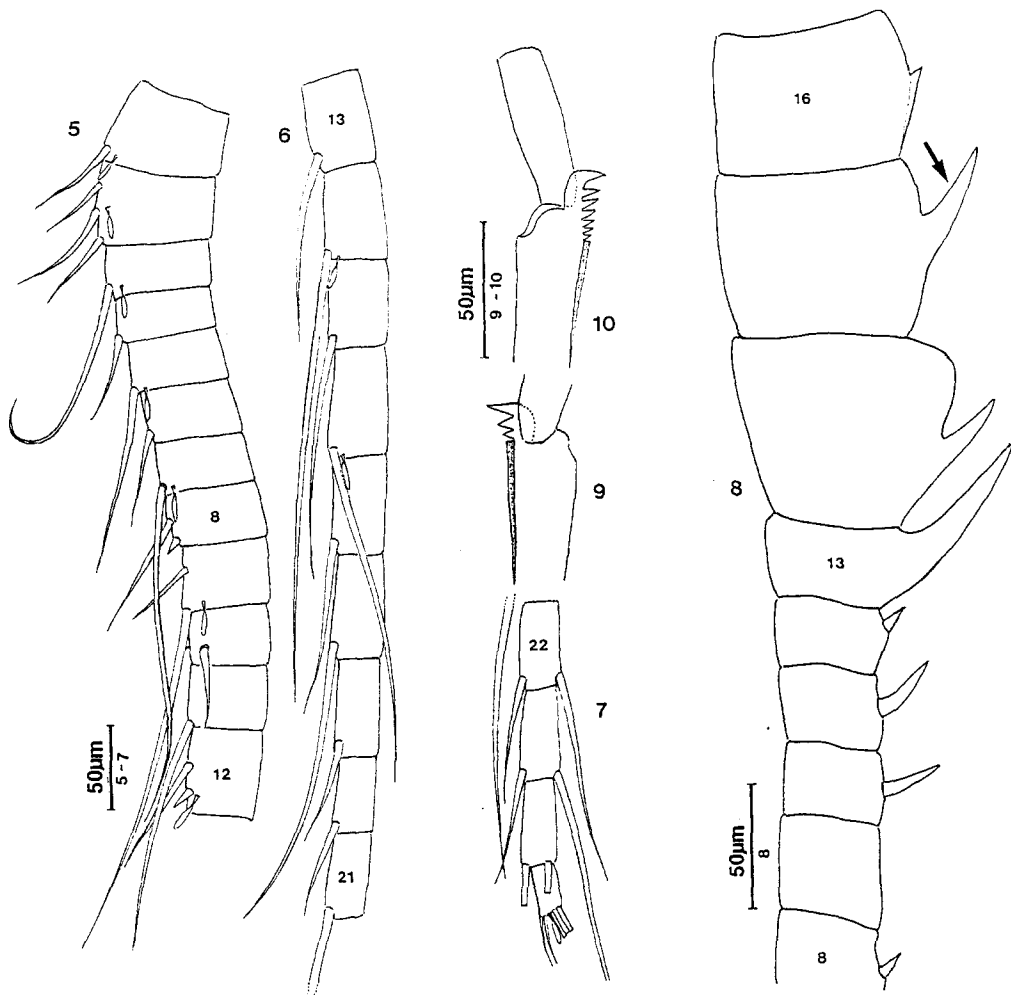
what curved, located close to end-claw. A small triangular chitinous process at base of principal lateral spine on posterior surface. End-claw sturdy, 1.6 times as long as exopodite, smoothly curved, almost sickle-shaped; tip blunt; distal 2/3 of inner margin fringed with narrow hyaline lamella (not figured). Endopodite large, much dilated at base, roughly triangular, overreaching first exopodite-segment and carrying subapical row of spinules.

Left P5 (Figure 21) distinctly slenderer than right P5. Coxa somewhat rectangular, armed with long, slender setiform spine near distal inner corner. Basis also rectangular, outer margin almost straight, inner margin convex and with narrow, elongate hyaline lamella on distal half, protruding beyond distal border (N.B. the position and appearance of the hyaline lamellae in drawings vary slightly in different slide preparations); sensory seta at distomedial corner short. First exopodite-segment with large hairy lobe near inner

margin. Second segment with finely serrate inner margin, characteristic configuration of spinules on posterior surface and hairy lobe at proximal inner corner (Figures 31, 32). Apical process elongate, straight, digitiform and lined with narrow hyaline lamella on inner margin and apex. Seta large, proximal third dilated, faintly jointed and studded with fine spinules. Endopodite flask-shaped, with dilated base and reaching middle of second exopodite-segment, inner margin with hyaline lamella at about the middle; apex obliquely truncate, with row of spinules and inner spine.

#### *Adult female (Figures 33–38, 47–49)*

Total length c. 1.30 mm. Rostral spines as in Figure 37; Body widest at first pediger. Cephalosome gradually attenuating anteriorly; anterior end broadly rounded. Fourth and fifth pedigers fused, indented laterally, showing fine dorsal spinules on SEMs, but no spine (N.B. what appears as a dorsal spine in SEM is



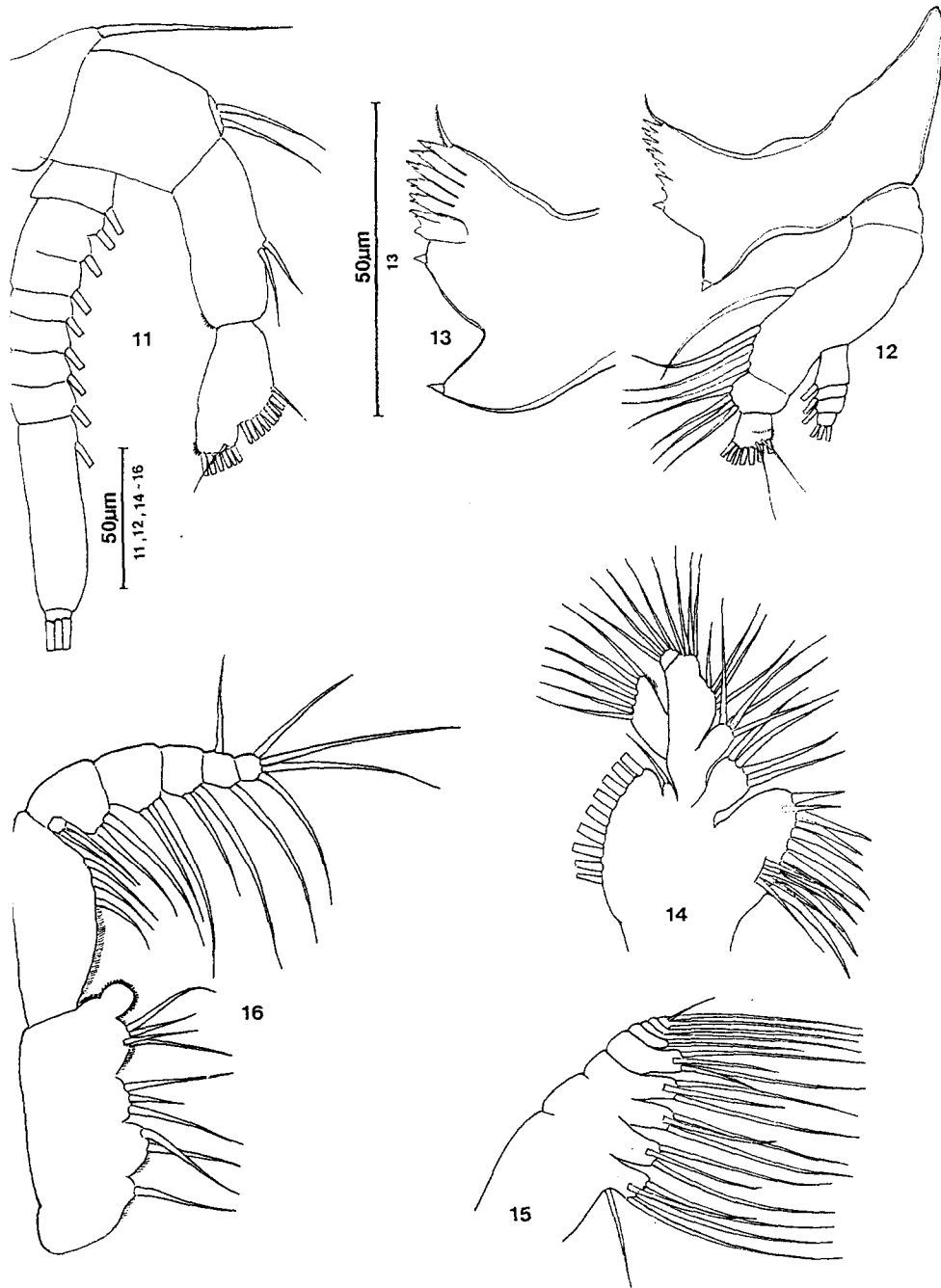
Figures 5–10. *Phylloidiaptomus christineae* n.sp. Male. 5, left antennule, segments 1–12; 6, same, segments 13–21; 7, same, segments 22–25; 8, right antennule, segments 8–16 (arrow points to spinous process longer than that of preceding segment); 9, 10, same, comb on antepenultimate segment.

an artefact) (Figure 48). Lateral wings of fifth pediger poorly developed, right wing somewhat smaller than left wing; either wing subtriangular, laterally directed and provided with one apical and one inner, somewhat smaller hyaline spine; spines on left wing larger than on right wing.

Urosome of three somites. Genital somite 1.6 times as long as succeeding two somites plus caudal rami, proximally dilated and symmetrical; genital spines unequal, left spine much larger than right one; both spines standing opposite to each other dorsolaterally, just below proximal bulge and posterolaterally directed; left margin somewhat smoother than right margin;

clasping site (Figure 48) a shallow depression of uniform width and extending obliquely from below the right genital spine to left margin. Genital field as in Figure 36. Second urosomite smallest with its proximal third telescoped into genital somite. Anal somite as long as caudal rami. Caudal rami parallel, symmetrical, about 1.5 times as long as wide, with hairy lateral margins; setae normal.

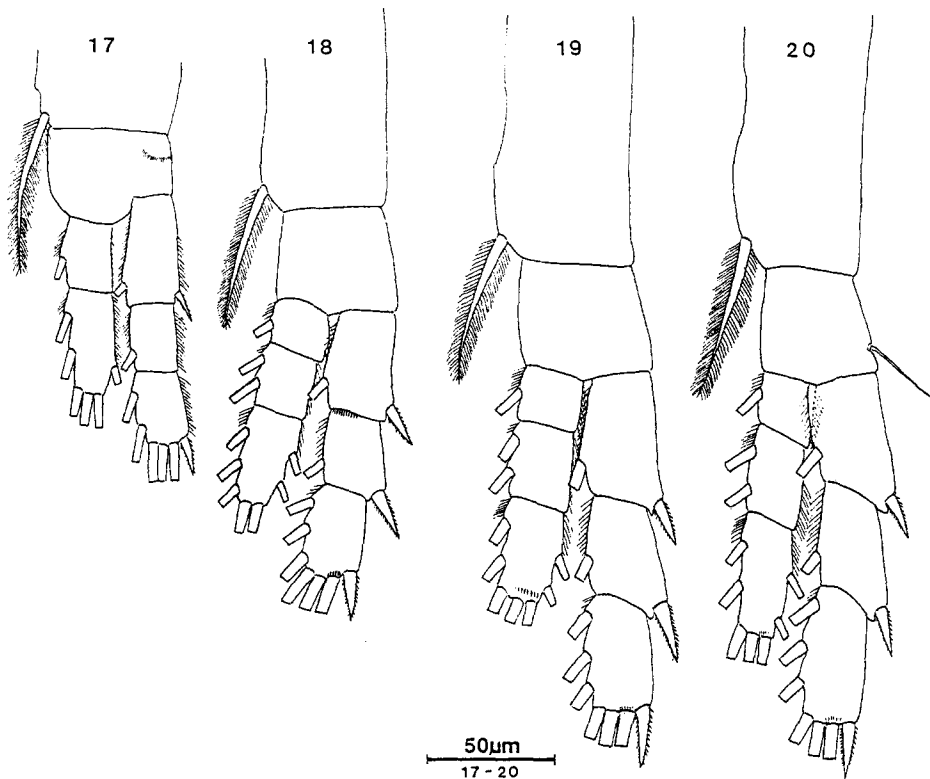
Antennule 25-segmented, extending beyond caudal setae by last 2 or 3 segments; armature as in male left antennule except for segmental and setal lengths (no figure). Other cephalic appendages and natatory legs as in male.



Figures 11–16. *Phyllodiptomus christineae* n.sp. Male 11, antenna; 12, mandible; 13, same, gnathal lobe; 14, maxillula; 15, maxilla; 16, maxilliped.

P5 (Figure 38) asymmetrical, left P5 having elongate exo- and endopodite-segments. Coxal spine moderately large, conical, pointed and mounted on hyaline lobe. Sensory seta on basis short, barely reach-

ing proximal third of first exopodite-segment. First exopodite-segment 1.6–1.8 times as long as wide, with convex outer margin and straight inner margin. Lateral spine on second exopodite-segment about as long as



Figures 17–20. *Phyllodiptomus christineae* n.sp. Male. 17, P1; 18, P2; 19, P3; 20, P4.

outer spine on third exopodite-segment; both spines smooth. Terminal claw straight; outer and inner margins with c. 15 and 25 spinules, respectively; nature of conveyor canal not clear from available SEM pictures. Third exopodite-segment small but distinct, subquadrate, well-defined at base; inner setiform spine with serrate margins and extending to about proximal third of end-claw. Endopodite sturdy, about 2/3 as long as inner margin of first exopodite-segment and divided into two unequal segments by faint septum; apex rounded, with transverse row of close-set spinules and one inner spine.

Ovigerous females with c. 25 eggs in large, spherical egg sac of c. 0.44 mm diameter.

### Etymology

The species name *christineae* is a noun (feminine gender, genitive singular) derived from the name of Mrs Christine De Clerck, after whom the species is

named, in recognition of her untiring work for the Laboratory of Animal Ecology, University of Gent.

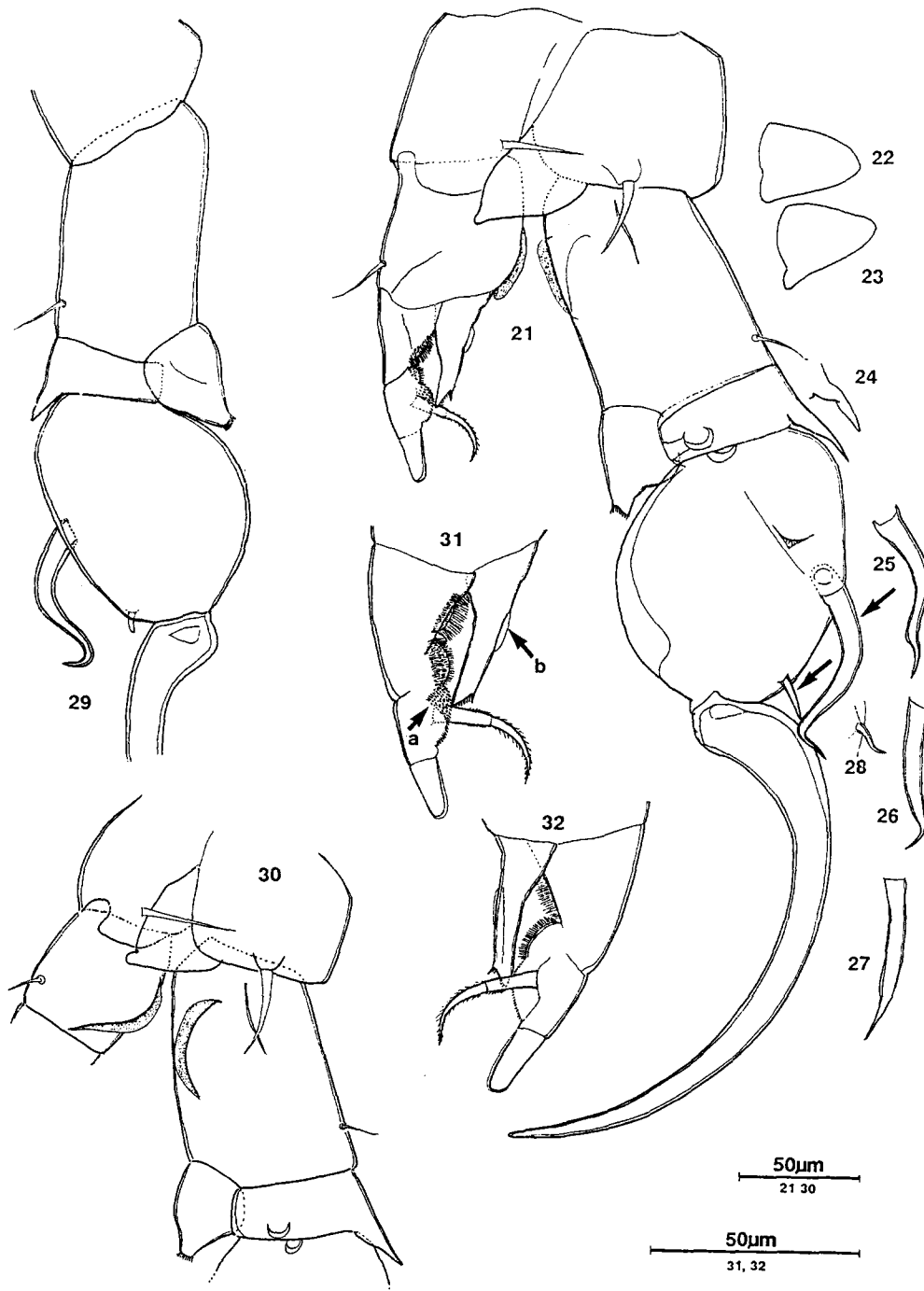
### Distribution

*P. christineae* n.sp. appears to be endemic to Thailand. It occurs in rivers, lakes and reservoirs, with males numerically dominant. In the samples under examination, the new species was interspersed with numerous *Neodiptomus botulifer* Kiefer.

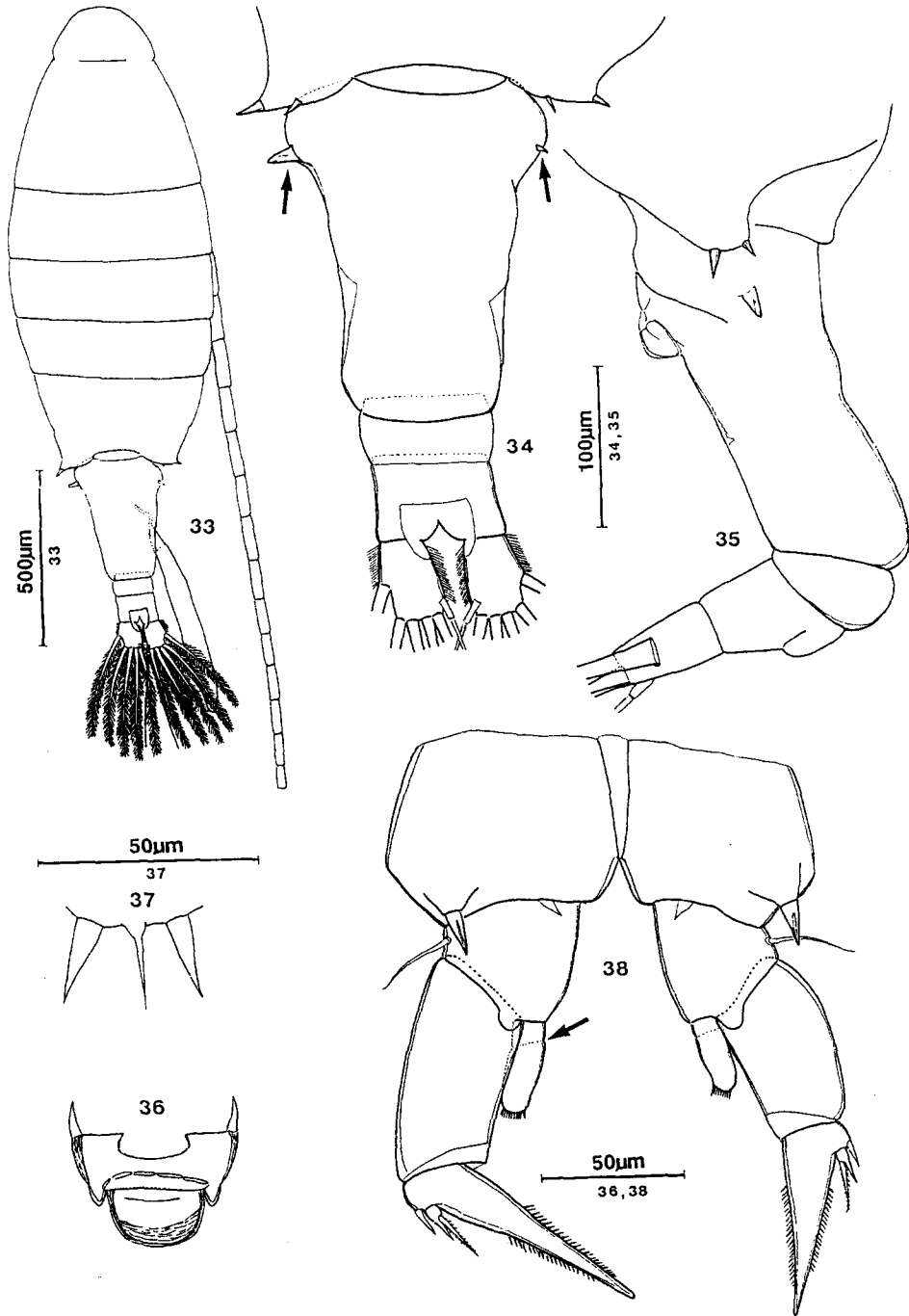
### Differential diagnosis and relationships

Lai & Fernando's (1981) *Diptomus* sp. (under species *incertae sedis* from Thailand) is identical to *Phyllodiptomus christineae* n.sp.

The new species shows diagnostic features of the genus *Phyllodiptomus* s.l. (see Dumont & Reddy, 1993). In the male, the large coxal (or intercoxal) plate and the leaf-like second exopodite-segment and

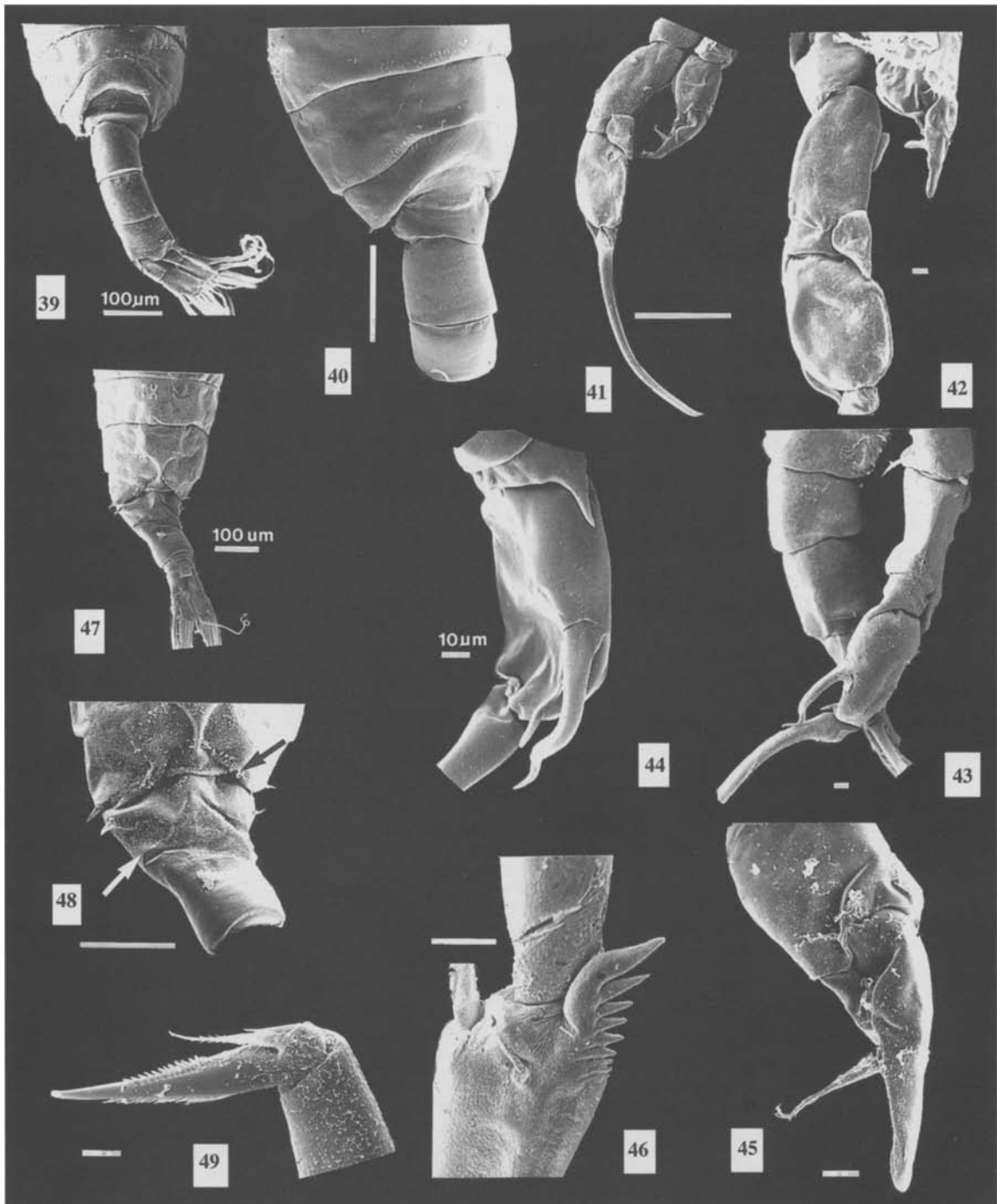


Figures 21–32. *Phyllodiaptomus christineae* n.sp. Male. 21, P5, posterior (arrows point to lateral spines); 22, 23 right P5, coxal plate; 24, same, spinous process on first exopodite segment; 25–27, same spine, principal lateral on second exopodite segment; 28, accessory lateral spine; 29, same, anterior; 30, P5 (in part), posterior; 31, left P5, exo- and endopodites, posterior (arrow a: field of spinules on second exopodite-segement of left P5; arrow b: hyaline lamella on left endopodite).



Figures 33–38. *Phylloidiaptomus christineae* n.sp. Female. 33, habitus, dorsal; 34, pediger 4 and urosome, dorsal (arrows point to dissimilar genital spines); 35, same, lateral; 36, genital field; 37, rostral spines; 38, P5 (arrow points to vague septum on endopodite).





Figures 39–49. SEM of *Phyllodiaptomus christineae* n.sp. Male: 39, pedigers 3–5 and urosome, dorsal (arrow points to normal lateral seta); 40, same (without posterior part of urosome), dorsolateral; 41, 42, P5, anterior; 43, urosome and right P5, lateral; 44, right P5, exopodite-segments, lateral; 45, left P5 (in part), anterior (arrow points to hyaline lamella); 46, right antennule, comb on antepenultimate segment. Female: 47, pedigers 3–5 and urosome, dorsal; 48, pedigers 4, 5 and genital somite, dorsal (arrow a: clasping site; arrow b: spinules); 49, P5, end-claw and third exopodite-segment.

its armature on right P5, ornamentation of the second exopodite-segment on left P5, and the large comb on the antepenultimate segment of the grasping antennule are typical of the genus. A comparison with its congeners shows that it resembles the Chinese *P. tunguidus*, but is remote from the *annae*-group of species which includes the Thai endemic *P. praedictus*. The close kinship with *P. tunguidus* is revealed, inter alia, by a transformation of the 'fan' into a field of spinules, and a relatively large apical process on the second exopodite-segment of the left male P5 (Dumont & Reddy, 1993, Figure 112), the size and shape of the second exopodite-segment and endopodite of the right male P5, and the structure of the female P5, especially the short endopodites. In all other respects, the two species are quite distinct from each other. In regard to the ornamentation of the second exopodite-segment of the left male P5, which in itself is a significant taxonomic feature, *P. christineae* n.sp. displays a close affinity to *P. longipes* Kiefer, 1965, from Borneo. The eight known species of *Phyllodiptomus* s.l. are thus seen to fall into two distinct groups: the *annae*-group, with *P. annae* (Apstein, 1907), *P. sasikumari* (Reddy & Venkateswarlu, 1989), *P. wellekensae* Dumont & Reddy, 1993, and *P. praedictus* Dumont & Reddy,

1994, which we here raise to the level of a subgenus (*Ctenodiptomus* subgen.nov.), based on the distinctive characters listed above, and referring, in particular, to the comb-shaped fan of the male P5 and with *P. (C.) annae* as its type species. The *blanci*-group, likewise, comprising *P. tunguidus* Shen & Tai, 1964 from China, *P. longipes* Kiefer, 1965 from Borneo and *P. christineae* n.sp. constitutes the subgenus *Phyllodiptomus* s.s., with *P. (P.) blanci* as its type species.

### Acknowledgments

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