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A REVISION OF THE GENUS CANDACIA (COPEPODA: CALANOIDA) WITH AN ANNOTATED LIST OF THE SPECIES AND A KEY FOR THEIR IDENTIFICATION [1])

by

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The genus *Candacia* [2]) was erected by Dana (1846) for certain copepods found in collections obtained by the U. S. Exploring Expedition of 1838-1842. When the species referable to this genus were first described three years later, Dana (1849) changed the generic name to *Candace*. Giesbrecht (1892) established the family Candacidae to accommodate *Candace* but six years later Giesbrecht & Schmeil (1898) used Dana's first proposed generic name, *Candacia,* and accordingly changed the family name to Candaciidae. These latter two names have been used by most authors since about 1900.

I wish to thank Dr. W. Vervoort for reading and criticizing the manuscript, Miss Abigail Hooper for checking literature references and for preparing distribution charts, and my wife, Joan, for help in preparing the illustrations. I also wish to thank Drs. T. E. Bowman and A. Fleminger for criticizing the key.

DIVISION OF THE GENUS AND A LIST OF THE SPECIES

Sars (1903) recognized that two types of males were included in the species then referable to *Candacia* and he indicated that the genus could

1) Contribution No. 1266 from the Woods Hole Oceanographic Institution. This work was supported in part by the U. S. Atomic Energy Commission under contract AT (30-1)-1918.

2) The generic name *Ifionyx* published in the binomen *Ifionyx typicus* Krøyer 1846(?) possibly predates *Candacia* Dana, 1846. Since the name *Candacia* is deeply entrenched in the literature whereas *Ifionyx* has been used only rarely, the International Commission on Zoological Nomenclature has been asked to suppress *Ifionyx* and to conserve *Candacia* (cf. Grice & Vervoort, 1963).

probably be divided into two genera. Twelve species have subsequently been described all of which are referable to one of the types recognized by Sars. The genus is here divided into two genera, *Paracandacia* nov. gen. and *Candacia* s. s. the diagnoses of which are given below.

Paracandacia nov. gen.

TYPE SPECIES. *Candace truncata* Dana, 1849 (= *Paracandacia truncata*). Since no types were mentioned by Dana and none of his specimens is apparently extant a female specimen collected in the Pacific Ocean (00°35'N 170°11'E) and deposited in the U. S. National Museum (Cat. No. 107600) is designated the neotype. In the original description, based on the female, Dana mentioned the species as occurring at "Kingsmill", a group of the Gilbert Islands (3°17'N-2°38'S 172°58'E-176°49'E) lying just south of the equator. The neotype has been examined and the diagnostic characteristic of the species including illustrations has been given (Grice, 1962).

DIAGNOSIS. In both sexes the basal tooth of the mandible is simple except in *P. simplex* (Giesbrecht) which has a minute point arising from the external side of the basal tooth near its tip. The proximal spine on the second basal segments of the second maxillae is approximately one-half the length of the distal spine and considerably thinner than the distal spine. In the female the terminal segments of the fifth feet end in a finger-like process which may be finely serrate on one or both margins. There are two setae on the inner lateral margins of these segments. In the male segments 17-18 and 19-20 of the right first antenna are fused and there are no teeth in the geniculate region of this antenna. The right fifth foot is not chelate. It ends in a long feather-like seta.

SPECIES. In the following tabulation for each species of *Paracandacia* and *Candacia* are references where figures and descriptions may be found, the latitudinal limits between which the more widely distributed species have been reported and remarks on synonymy and distribution for certain of the species. The distributional data were determined from charts on which were plotted the occurrences of the species as reported in 140 references, most of which were published since 1900. Because Fleminger & Bowman (1956) have shown that some of C. B. Wilson's identifications of *Candacia* were incorrect, the "Carnegie" (Wilson, 1942) and "Albatross" (Wilson, 1950) records of *Candacia* were not considered. Drs. T. E. Bowman, Abraham Fleminger and W. Vervoort have permitted me to use some of their unpublished distribution records and I have also included records for certain species that I examined in the U. S. National Museum collections. Three species are referable to the genus *Paracandacia*.

1. **Paracandacia bispinosa** (Claus, 1863)

Synonym. *Candace bispinosa* Claus, 1863.

Descriptions. Giesbrecht, 1892; Rose, 1933; Tanaka, 1935; Mori, 1937 (female); Grice, 1962.

Distribution. Atlantic (40°N to 30°S), Pacific (35°N to 34°S), Indian Ocean (N of 30°S).

2. **Paracandacia simplex** (Giesbrecht, 1889)

Synonyms. *Candace simplex* Giesbrecht, 1889; *Candacia parasimplex* Brodsky, 1962.

Descriptions. Giesbrecht, 1892; Rose, 1933; Mori, 1937; Grice, 1962.

Distribution. Atlantic (51°N to 26°S), Pacific (35°N to 34°S), Indian Ocean (N of 22°S).

Remarks. The description of *Candacia parasimplex* appears to be based on pre-adult specimens. The small size (1.57-1.62 mm) of the specimens and the figures of the genital segment and the fifth pair of feet indicate that they are sexually immature *P. simplex*.

3. **Paracandacia truncata** (Dana, 1849)

Synonyms. *Candace truncata* Dana, 1849; *Candacia turgida* Wilson, 1950.

Descriptions. Giesbrecht, 1892; Tanaka, 1935; Mori, 1937; Pesta, 1941; Grice, 1962.

Distribution. ?Atlantic (61°N to 9°S), Pacific (40°N to 35°S), Indian Ocean (N of 65°S?).

Remarks. The first report of this species from the Atlantic Ocean was by Brady (1883) whose figures of it represent at least 3 species. Giesbrecht (1892) discussed Brady's report as well as that of Thompson, who listed the species from the Madeira and Canary Islands area (1888a) and from near Malta in the Mediterranean Sea (1888b), and concluded that its presence in the Atlantic was not certain. Subsequently this species was reported from the Gulf of Guinea (T. Scott, 1894) but without figures or description. Thompson (1898) has also reported it from the Faeroe Channel, a record which Wolfenden (1904) doubted. Its presence in the Atlantic Ocean is therefore still in need of verification. Brady's (1883) record of *C. truncata* from 65°S in the Indian Ocean is also doubtful.

Candacia Dana, 1846

TYPE SPECIES. Fowler (1912) selected *Candace ornata* Dana, 1849, the first species described by Dana, as the type of the genus. The description

of *C. ornata* was based on immature specimens and the species is unrecognizable. The International Commission on Zoological Nomenclature has thus been asked (Grice & Vervoort, 1963) to set aside *C. ornata* and to replace it with *C. pachydactyla* Dana, 1849, the second species described by Dana, as the type of the genus.

As in the case of *Paracandacia truncata* (Dana, 1849) no type specimen of *Candacia pachydactyla* was designated by Dana. The original description is based on the male. A male specimen collected from the type locality in the Atlantic Ocean (1°-11°S 14°-30°W) and deposited in the U. S. National Museum (Cat. No. 107602) is designated the neotype. A diagnosis accompanied by illustrations (of Pacific specimens) is given of this species in a recent paper (Grice, 1962).

DIAGNOSIS. In both sexes the basal tooth of the mandible is usually divided into one or more pointed cusps. The two spines on the second basal segment of the second maxillae are variable in length and in thickness. In the female the terminal segments of the fifth pair of feet may end in one or more spine-like processes, a finger-like process, or a single long seta. Setae may or may not be present on the internal lateral margins of the terminal segments of the fifth feet. In the male, teeth are present on one or more segments in the geniculate region of the right first antenna. The right fifth foot is chelate.

SPECIES. Twenty-four species are referable to the genus *Candacia*.

1. **Candacia armata** (Boeck, 1873)

   Synonym. *Candace pectinata* Brady, 1878.
   Descriptions. Giesbrecht, 1892 (as *C. pectinata*); Sars, 1903.
   Distribution. Atlantic (75°N to 25°N).

2. **Candacia bipinnata** (Giesbrecht, 1889)

   Descriptions. Giesbrecht, 1892; Tanaka, 1935; Mori, 1937.
   Distribution. Atlantic (42°N to 35°S), Pacific (45°N to 35°S), Indian Ocean (0° to 35°S).

3. **Candacia bradyi** A. Scott, 1902

   Synonyms. *Candace tuberculata* Wolfenden, 1905; *Candacia curva* Mori, 1932.
   Descriptions. A. Scott, 1909 (male); Sewell, 1912 (female); Pesta, 1912 (female); Tanaka, 1935; Mori, 1937 (female); Pesta, 1941.
   Distribution. Western Pacific (35°N to 10°S), Indian Ocean (N of 15°S).

4. **Candacia catula** (Giesbrecht, 1889)

Descriptions. Giesbrecht, 1892; Tanaka, 1935; Mori, 1937; Grice, 1962; var. *similis* Wolfenden, 1905.

Distribution. Pacific (42°N to 35°S), Indian Ocean (N of 20°S). Var. *similis* from Indian Ocean (approx. 5°N 75°E).

5. **Candacia cheirura** Cleve, 1904

Descriptions. Cleve, 1904; Farran, 1929.

Distribution. South Atlantic (approx. 35°S 18°E), South Pacific (45°S to 52°S), South Indian Ocean (45°S 87°E).

Remarks. In the caption to plates 1 and 2 where the species is illustrated (Cleve, 1904) the name is spelled *C. chirura*.

6. **Candacia columbiae** Campbell, 1929

Synonym. *Candacia pacifica* Mori, 1937.

Descriptions. Campbell, 1929; Mori, 1937; Brodsky, 1950.

Distribution. Pacific Ocean (N of 35°N).

Remarks. It is probable that Tsuruta's et al. (1957) record of *C. pacifica* (= *C. columbiae*) from the tropical eastern Indian Ocean is a misidentification. *C. columbiae* is a north Pacific cold-water species.

7. **Candacia curta** (Dana, 1849)

Synonyms. *Candace intermedia* T. Scott, 1894; *Candacia bicornuta* Mori, 1932.

Descriptions. Giesbrecht, 1892; Tanaka, 1935; Mori, 1937; Pesta, 1941; Grice, 1962.

Distribution. Atlantic (47°N to 28°S), Pacific (35°N to 50°S), Indian Ocean (N of 32°S).

8. **Candacia discaudata** A. Scott, 1909

Descriptions. Carl, 1907 (as female *C. bradyi*); A. Scott, 1909; Mori, 1937.

Distribution. Western Pacific (51°N to 22°S), Indian Ocean (N of 15°S).

Remarks. Except for Chiba's (1956) statement that *C. discaudata* is typical of cold currents in the Japan area of the Pacific and his report of immature males (accompanied by figures) from 51°N, this species is known mostly from tropical areas especially the Indo-Pacific region.

9. **Candacia elongata** (Boeck, 1873)

Synonyms. *Candacia inermis* Cleve, 1904; *Candace rotunda* Wolfenden, 1904; *Candacia obtusa* Sars, 1905.

Description. Sars, 1924.

Distribution. Atlantic (62°N to 35°N, and Gulf of Guinea), Pacific (10°05'N 122°18'E), Indian Ocean (approx. 32°S 32°E).

Remarks. A comparison of the description of *C. elongata* given by Sars (1924) based on male and female specimens obtained in the North Atlantic Ocean and Mediterranean Sea and of *C. inermis* given by Cleve (1904) based on female specimens collected in the Indian Ocean off South Africa shows the following small differences: 1) the basal tooth of the mandible in *C. elongata* is only slightly bifurcate, in *C. inermis* it is deeply bifurcate; 2) the distal segment of the female fifth feet, although similar in both species, has spines in *C. elongata* and spine-like processes in *C. inermis*. The two species are here considered conspecific although it is recognized that the discovery and description of the male sex of *C. inermis* may result in the finding of specific differences between the two.

A female with the *C. inermis* type gnathal lobe and fifth feet was found in the U. S. National Museum collection identified under the name *Candacia norvegica* by Dr. C .B. Wilson. This specimen was collected in the western Pacific Ocean (position given above) in a sample obtained between 550 fathoms and the surface.

10. **Candacia ethiopica** (Dana, 1849)

Synonyms. ?*Ifionyx orientalis* Krøyer, 1849; *Candace melanopus* Claus, 1863.

Descriptions. Giesbrecht, 1892; Rose, 1933; Tanaka, 1935; Mori, 1937; Grice, 1962.

Distribution. Atlantic (47°N to 30°S), Pacific (45°N to 35°S), Indian Ocean (N of 25°S).

Remarks. Dr. T. E. Bowman has pointed out to me that the change in spelling of *ethiopica* to *aethiopica* by Giesbrecht & Schmeil (1898) has no justification and the original spelling is correct.

11. **Candacia falcifera** Farran, 1929

Descriptions. Farran, 1929; Jespersen, 1934.

Distribution. Atlantic (63°N to 39°N; 57°S to 68°S), Pacific (71°S), Indian Ocean (64°S to 66°S).

12. **Candacia guggenheimi** Grice & Jones, 1960

Description. Grice & Jones, 1960.

Distribution. Central Pacific Ocean (0° to 33°N).

13. **Candacia ketchumi** Grice, 1961

Description. Grice, 1961.

Distribution. Atlantic (northwest Sargasso Sea) and Pacific Ocean (8°17.5'S 129°10.5'E).

14. **Candacia longimana** (Claus, 1863)

Descriptions. Giesbrecht, 1892; Mori, 1937; Grice, 1962.

Distribution. Atlantic (49°N to 12°S), Western Pacific (34°N to 35°S), Indian Ocean (N of 20°S).

15. **Candacia magna** Sewell, 1932

Description. Sewell, 1932.

Distribution. Atlantic (Gulf of Guinea) and Indian Ocean (5°N to 7°N).

Remarks. Although Sewell (1948) indicated that this species is identical to *C. falcifera* Farran, they differ in a number of ways. In the female the fifth feet of *C. falcifera* (cf. Farran's fig. 28d) end in a seta which is equal in length to the distal segment. The fifth feet of *C. magna* (cf. Sewell's fig. 111g) end in a relatively short spine-like process. In the male the left fifth foot of *C. magna* lacks the long terminal spines on the distal segment as shown by Farran for *C. falcifera* although this spine could have been broken off in *C. magna*. The two species also differ in the structure of the terminal spine on the third exopodal segment of the third foot and the ratio of the lengths of this segment to the spine. In *C. magna* the spine is shown to be distinctly curved outward near the distal end whereas in *C. falcifera*, as figured by Jespersen (1934), the spine is straight throughout its length. The relative length of the third exopodal segment to the terminal spine is approximately 1 : 0.30 in *C. magna* and 1 : 0.41 in *C. falcifera*. *C. magna* is also larger (female 4.16, male 3.70 mm) than *C. falcifera* (female 3.7-3.9, male 3.3-3.8 mm). Pending examination and comparison of specimens, the species are here considered distinct.

16. **Candacia maxima** Vervoort, 1957

Description. Vervoort, 1957.
Distribution. Southern Indian Ocean (47°S to 64°S).

17. **Candacia norvegica** (Boeck, 1865)

Descriptions. Sars, 1903; Grice & Jones, 1960; var. *tropica* Sewell, 1932.
Distribution. North Atlantic (69°N to 41°N), South Atlantic (off West Coast of Africa between 8°S and 15°S), North Pacific Ocean (37°N 165°W, approx. 35°N 139°E). Var *tropica* from Indian Ocean (10°N 74°E).

18. **Candacia pachydactyla** (Dana, 1849)

Synonym. *Ifionyx typicus* Krøyer, 1846(?).
Descriptions. Giesbrecht, 1892; Rose, 1933; Tanaka, 1935; Mori, 1937; Grice, 1962.
Distribution. Atlantic (41°N to 37°S), Pacific (35°N to 40°S), Indian Ocean (N of 22°S).
Remarks. The International Commission on Zoological Nomenclature has been asked to suppress the name *I. typicus*, a name rarely used in the literature (Grice & Vervoort, 1963).

19. **Candacia paenelongimana** Fleminger & Bowman, 1956

Description. Fleminger & Bowman, 1956.
Distribution. Atlantic Ocean off South Carolina (32°N) and Florida (27°N) coasts, off Bahama Islands (24°N), in Gulf of Mexico (23°N) and Gulf of Guinea.

20. **Candacia parafalcifera** Brodsky, 1950

Description. Brodsky, 1950.
Distribution. Northwestern Pacific Ocean, southern Okhotsk Sea, and Gulf of California (26°15'N 110°36'W).
Remarks. The Gulf of California specimens were collected in an Isaacs-Kidd midwater trawl. The depth of sampling was estimated at 930 fathoms.

21. **Candacia pofi** Grice & Jones, 1960

Description. Grice & Jones, 1960.
Distribution. Eastern Pacific Ocean (1°S to 30°N).

22. **Candacia samassae** Pesta, 1941

Description. Pesta, 1941.
Distribution. Indian Ocean (Red Sea).
Remarks. Only the female of the species is known.

23. **Candacia tenuimana** (Giesbrecht, 1889)

Synonym. *Candacia gracilimana* Farran, 1908.
Descriptions. Giesbrecht, 1892; Rose, 1933; Grice, 1962.
Distribution. Atlantic (54°N to 22°N, and Gulf of Guinea), Pacific (off California, 34°N; 0° 149°W; 16°N 166°E; 1°S 127°E), Indian Ocean (off east coast of Africa, 32°S).

24. **Candacia varicans** (Giesbrecht, 1892)

Descriptions. Giesbrecht, 1892; Grice, 1962.
Distribution. Atlantic (47°N to 30°S), Pacific (sparingly between 34°N and 34°S), Indian Ocean (sparingly N of 32°S).

Nomina dubia

1. *Candace aucta* Dana, 1849
2. *Candace ornata* Dana, 1849
3. *Candace brevicornis* Thompson, 1888a
4. *Candace nigrocincta* Thompson, 1888a

Nomina nuda

1. *Candacia grandis* Tanaka, 1953
2. *Candacia gracillima* mentioned by Sewell, 1932
3. *Candacia tenuicauda* mentioned by Sewell, 1932
4. *Candacia violaceus* in list by Chiba et al., 1955

Key to the species of Candacia and Paracandacia

The key which follows is presented as an aid to identification. Since many of the species in the genera *Candacia* and *Paracandacia* are easily recognizable by (1) the structure of the abdominal segments, (2) the fifth pair of feet, and (3) the teeth and protuberances in the geniculate region of the male right first antenna, examination of the figures alone may be sufficient for preliminary identification. It is of course most desirable to check the identification derived from this key with the original description of the species or with subsequent descriptions. References to these sources are given in an earlier section of the paper.

Sex

1. First antennae symmetrical; abdomen consisting of 3 segments; right fifth foot similar to left fifth foot . . . . . female
— First antennae asymmetrical; the right antenna geniculate with one or more segments indented, swollen or toothed; abdomen consisting of 5 segments; right fifth foot unlike left foot, the former ending in either a chela or a long seta . . . . . male

Females [1])

1. Fifth feet ending in spine-like processes (fig. 1), in points (fig. 2) or in a single, long seta-like spine (figs. 19, 21) except in *C. guggenheimi* (see fig. 3); 0 to 3 setae on internal margin of distal segment of fifth feet; proximal spine on second basal segment of second maxilla variable in thickness and length (*Candacia*) 2
— Fifth feet ending in a long finger-like process (fig. 4); 2 setae on internal margin of distal segment of fifth feet; proximal spine on second basal segment of second maxilla slender and considerably shorter than distal spine (*Paracandacia*) 26
2. Posterior corners of thorax broadly rounded (fig. 5) . . *C. elongata*
— Posterior corners of thorax pointed (fig. 6) or otherwise produced . 3
3. Second abdominal segment with ventral protrusion (fig. 7), lamella (fig. 8), or spine-like process arising from ventral surface (fig. 9) 4
— Second abdominal segment without lateral or ventral protrusion and without spine-like process arising from ventral surface 10

1) *C. discaudata* appears twice in the key to the females.

Figs. 1-23. Females of *Candacia* and *Paracandacia*. 1, *C. norvegica* (Boeck), fifth foot; 2, *C. longimana* (Claus), fifth foot; 3, *C. guggenheimi* Grice & Jones, fifth foot; 4, *P. truncata* (Dana), fifth foot; 5, *C. elongata* (Boeck), dorsal view of last thoracic segment; 6, *C. curta* (Dana), dorsal view of last thoracic segment; 7, *C. armata* (Boeck), abdomen from left side; 8, *C. bipinnata* (Giesbrecht), abdomen from left side; 9, *C. bradyi* A. Scott, abdomen from right side; 10, *C. bipinnata* (Giesbrecht), abdomen in dorsal view; 11, *C. pofi* Grice & Jones, last thoracic segment and abdomen, dorsal view; 12, *C. armata* (Boeck), abdomen in dorsal view; 13, *C. paenelongimana* Fleminger & Bowman, abdomen from right side; 14, *C. paenelongimana* Fleminger & Bowman, fifth foot; 15, *C. cheirura* Cleve, abdomen from left side; 16, *C. cheirura* Cleve, fifth foot; 17, *C. curta* (Dana), abdomen from right side; 18, *C. tenuimana* (Giesbrecht), fifth foot; 19, *C. parafalcifera* Brodsky, fifth foot; 20, *C. magna* Sewell, fifth foot; 21, *C. falcifera* Farran, fifth foot; 22, *C. varicans* (Giesbrecht), fifth pair of feet; 23, *C. samassae* Pesta, fifth foot. 1, 3, 11 from Grice & Jones, 1960; 2, 4, 18, 22, from Grice, 1962; 5, from Sars, 1924; 6, 8, 9, 10, 12, 17, original; 7, from Sars, 1903; 13, 14, from Fleminger & Bowman, 1956; 15, 16, from Cleve, 1904; 19, from Brodsky, 1950; 20, from Sewell, 1932; 21, from Farran, 1929; 23, from Pesta, 1941. Figures not all to same scale.

The lamella subcolumellaris lies concealed behind the inferior lamella, only the lower end may be seen if one looks from below into the aperture. It ends inward at the left side just beyond the end of the inferior lamella.

The closing apparatus lies at the right side. The principal plica runs from the ventral side to dorsolateral-left and is about 3/4 whorl long. Below the plica principalis are 4 to 6 plicae (6 in the holotype) more or less parallel

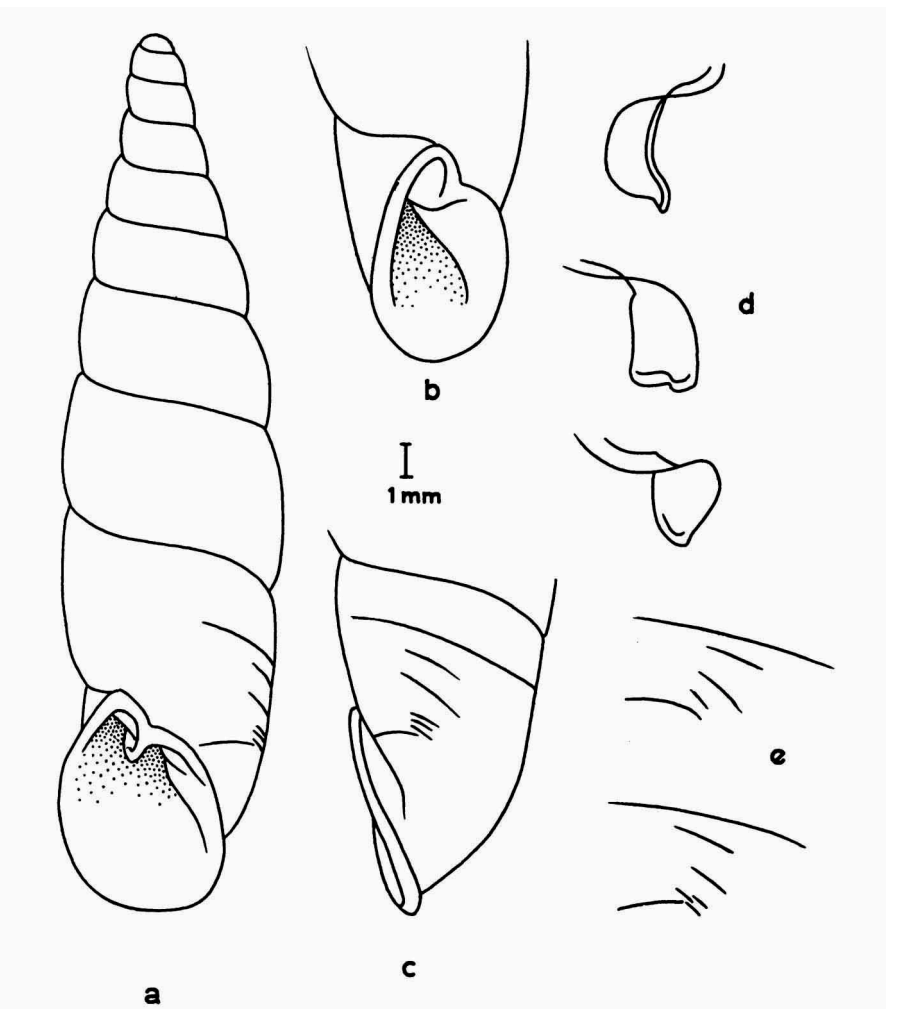


Fig. 5. *Acrophaedusa fornicata* spec. nov. a. holotype, ventral side; b. holotype, ventro-lateral-left side of the last whorl; c. holotype, right side of the last whorl with the plicae; d. clausilium of a paratype, three views to show the top and the slight angle at the columellar side; e. arrangement of the plicae palatales in two paratypes, the upper plica in each set is a part of the plica principalis.

4. Second abdominal segment with spine-like process arising from ventral side (fig. 9) . . . . . *C. bradyi*
— Second abdominal segment without spine-like process arising from ventral side 5
5. In dorsal view lateral margins of genital segment somewhat triangular and pointed (fig. 10); lamella on ventral surface of second abdominal segment (fig. 8) . . . . . *C. bipinnata*
— In dorsal view lateral margins of genital segment not pointed . . 6
6. In dorsal view protrusion of ventral surface of second abdominal segment visible on left (fig. 11) or right (fig. 12) side of segment; apex of fifth feet end in a long prong 7
— In dorsal view protrusion of ventral surface of second abdominal segment not visible; apex of fifth feet end in 2 or more points . . . 8
7. In dorsal view protrusion of ventral surface of second abdominal segment visible on left side (fig. 11); lateral margins of genital segment nearly straight (fig. 11) . . . . . *C. pofi*
— In dorsal view protrusion of ventral surface of second abdominal segment visible on right side (fig. 12); lateral margins of genital segment with knob-like protrusions (fig. 12) . . . . . *C. armata*
8. Proximal spine on second basal segment of second maxilla not notably thicker than distal one 9
— Proximal spine on second basal segment of second maxilla considerably thicker than distal one . . . . . *C. discaudata*
9. In lateral view ventral protrusion of second abdominal segment directed obliquely anteriad (fig. 13); terminal segment of fifth feet with 2 small, spine-like points on external margin and 2 small, subequal spine-like points at tip (fig. 14) . . . . . *C. paenelongimana*
— In lateral view ventral protrusion of second abdominal segment directed obliquely posteriad (fig. 15); terminal segment of fifth feet with 2 spine-like points on external margin and 3 spine-like points at distal end, the middle one of which is longest (fig. 16) . . . . . *C. cheirura*
10. No setae present on internal margin of terminal segment of fifth feet 11
— Two or three setae present on internal margin of terminal segment of fifth feet 18
11. Spine-like process present on ventral side of genital segment (fig. 17) . . . . . *C. curta*
— No spine-like process present on ventral side of genital segment . 12
12. Three spine-like points on terminal segment of fifth feet (fig. 18) . . . . . *C. tenuimana*
— Four or five spines or spine-like points on terminal segment of fifth

feet 13

13. Distal spine on terminal segment of fifth feet more than 1/2 length of segment (fig. 19) 14

— Distal spine or spine-like points on terminal segment of fifth feet less than 1/2 length of segment (fig. 20) 15

14. Distal spine on terminal segment of fifth feet approximately 2/3 length of segment (fig. 19); genital segment swollen ventrally . *C. parafalcifera*

— Distal spine on terminal segment of fifth feet approximately equal to length of segment (fig. 21); genital segment not swollen ventrally . . . . . *C. falcifera*

15. Apex of terminal segment of fifth feet with 3 subequal spine-like points (fig. 2) 16

— Apex of terminal segment of fifth feet with 1 spine-like point (fig. 20) or 2 unequal spine-like points (fig. 22) 17

16. Three small spine-like points at distal end of fifth feet (fig. 2); in dorsal view sides of genital segment distinctly swollen in middle . . . . . *C. longimana*

— Three large spine-like points at distal end of fifth feet, their margins crenulate (fig. 23); in dorsal view sides of genital segment slightly convex . . . . . *C. samassae*

17. Terminal segment of fifth feet with 2 spine-like points on external lateral side and one on each of distolateral corners (fig. 22) . *C. varicans*

— Terminal segment of fifth feet with 3 small spine-like points on external lateral side, one small spine-like point on outer distolateral corner and one large spine-like point distally (fig. 20) . . . . . *C. magna*

18. Spines or spine-like processes present on dorsal, lateral or ventral margins of genital segment 19

— No spines or spine-like processes present on genital segment . . 22

19. One small spine present on dorsal surface of each lateral swelling of genital segment (fig. 24) . . . . . *C. guggenheimi*

— No spines present on dorsal surface of genital segment . . . 20

20. In dorsal view one robust spine-like process extending obliquely posteriad from left side, and one robust spine extending posteriad from right side of genital segment; both surpass posterior margin of genital segment (fig. 25); animal pigmented . . . . . *C. pachydactyla*

— In dorsal view spines from left and right sides of genital segment smaller and not reaching posterior margin of genital segment (figs. 26, 27, 28); animal pigmented or pellucid 21

21. In lateral view small protuberance arising from ventral side of genital segment near posterior margin (fig. 29); distal 2 setae on internal mar-

gin of terminal segment of fifth feet coarse and unequal in length (fig. 30); animal pigmented . . . . . *C. ethiopica*

— In lateral view no protuberance on ventral surface of genital segment; distal 2 setae on internal margin of terminal segment of fifth feet thin and approximately equal in length (fig. 1); animal pellucid *C. norvegica*

22. Proximal spine on second basal joint of second maxilla considerably thicker than distal spine (fig. 31) 23

— Proximal spine on second basal joint of second maxilla not notably thicker than distal spine (fig. 32) 24

23. In dorsal view genital segment with distinctly convex protrusion on each side (fig. 33); in lateral view genital segment with ventral knob-like protrusion directed posteriad (fig. 34) . . . . . *C. catula*

— In dorsal view genital segment with nearly parallel sides; no ventral knob-like protrusion on genital segment . . . . . *C. discaudata*

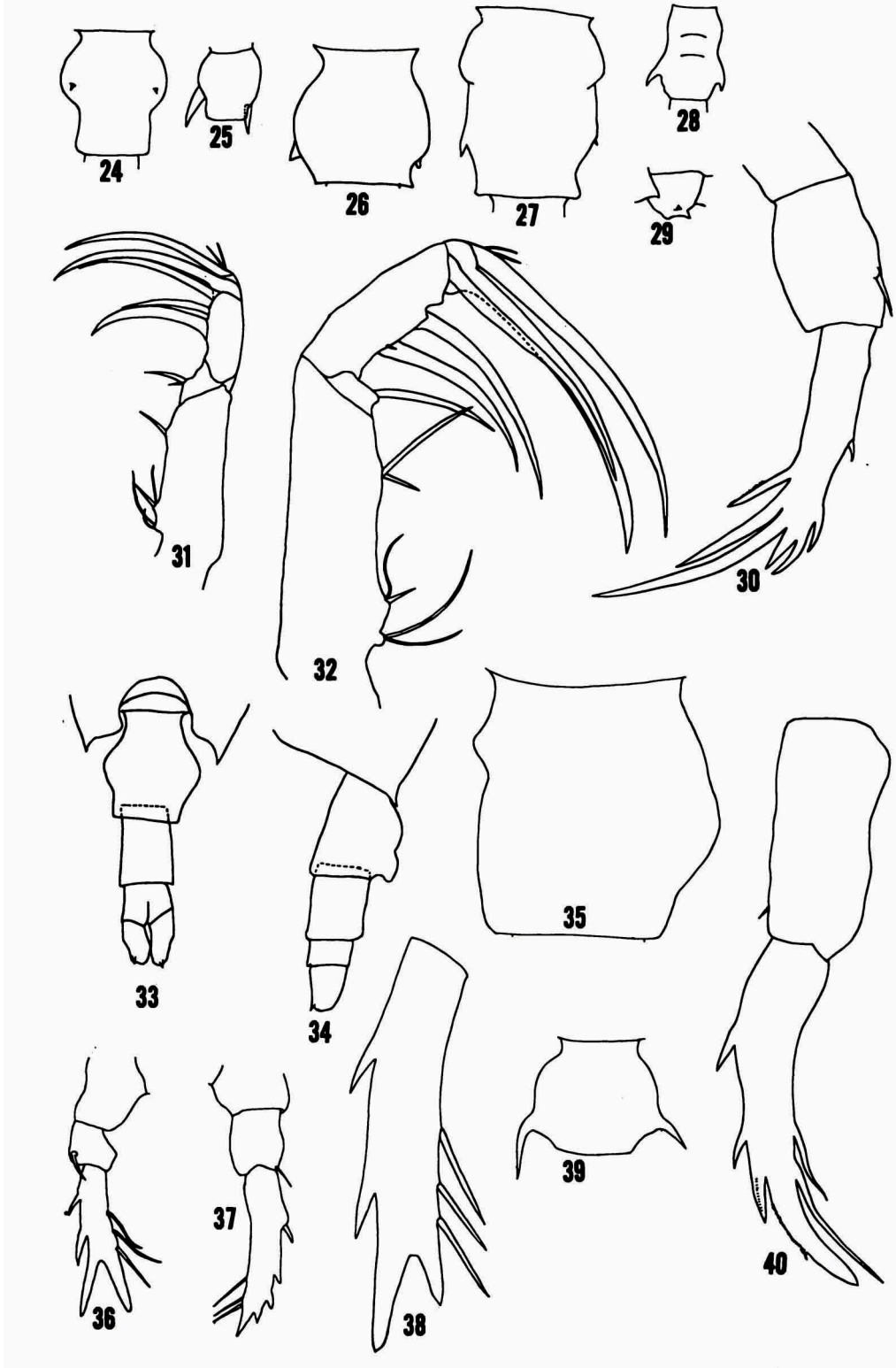
24. In dorsal view genital segment asymmetrical (fig. 35); distal segment of fifth feet ending in 2 long and subequal spine-like processes (fig. 36) . . . . . *C. columbiae*

— In dorsal view genital segment symmetrical or slightly asymmetrical; distal segment of fifth feet ending in 2 unequal spine-like points (figs. 37, 38) 25

25. In dorsal view genital segment symmetrical; inner spine-like point on apex of fifth feet longer than outer one; 2 distal spine-like points and 1 proximal spine on external margin of distal segment of fifth feet (fig. 37) . . . . . *C. maxima*

— In dorsal view genital segment slightly asymmetrical; outer spine-like point on apex of fifth feet longer than inner one; 1 distal spine-like point and 1 proximal spine-like point on external margin of distal segment of fifth feet (fig. 38) . . . . . *C. ketchumi*

Figs. 24-40. Females of *Candacia* and *Paracandacia*. 24, *C. guggenheimi* Grice & Jones, genital segment in dorsal view; 25, *C. pachydactyla* (Dana), genital segment in dorsal view; 26, *C. ethiopica* (Dana), genital segment in dorsal view; 27, *C. norvegica* (Boeck), genital segment in dorsal view; 28, *C. norvegica* var. *tropica* Sewell, genital segment in dorsal view; 29, *C. ethiopica* (Dana), genital segment from left side; 30, *C. ethiopica* (Dana), fifth foot; 31, *C. catula* (Giesbrecht), 2nd maxilla; 32, *C. ethiopica* (Dana), 2nd maxilla; 33, *C. catula* (Giesbrecht), last thoracic segment and abdomen, dorsal view; 34, *C. catula* (Giesbrecht), last thoracic segment and abdomen, right side; 35, *C. columbiae* Campbell, genital segment in dorsal view; 36, *C. columbiae* Campbell, fifth foot; 37, *C. maxima* Vervoort, fifth foot; 38, *C. ketchumi* Grice, apical segment of fifth foot; 39, *P. bispinosa* (Claus), dorsal view of genital segment; 40, *P. simplex* (Giesbrecht), fifth foot. 24, 27, from Grice & Jones, 1960; 25, 26, 29-34, 40, from Grice, 1962; 28, from Sewell, 1932; 35, 36, 38, 39, original; 37, from Vervoort, 1957. Figures not all to same scale.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26. In dorsal view genital segment with spine-like protrusion arising from each side and directed posteriorly (fig. 39) . . . . *P. bispinosa*

— In dorsal view genital segment without spine-like protrusions . . 27

27. Terminal finger-like process of fifth feet finely serrate proximally; distal seta on internal margin of fifth feet approximately twice as long as proximal one (fig. 40); points at posterior corners of thorax directed backwards . . . . . *P. simplex*

— Terminal finger-like process of fifth feet finely serrate distally; setae on internal margin of fifth feet subequal, the distal one slightly longer than proximal one (fig. 4); points at posterior corners of thorax directed ventrally, scarcely visible from above . . . . . *P. truncata*

Males

In the key to the males segments number 2 and 3 of the right first antennae are counted as separate segments even if fused. The fusion of these segments is indicated by the presence of two large spines rather than one on the apparent second segment (see figs. 49 and 50). *C. armata, C. maxima* and *C. discaudata* appear twice in the key and the male of *C. samassae* is not known.

1. Right fifth foot ending in a chela (fig. 41) (*Candacia*) . . . 2

— Right fifth foot ending in a long seta (fig. 42) (*Paracandacia*) . 27

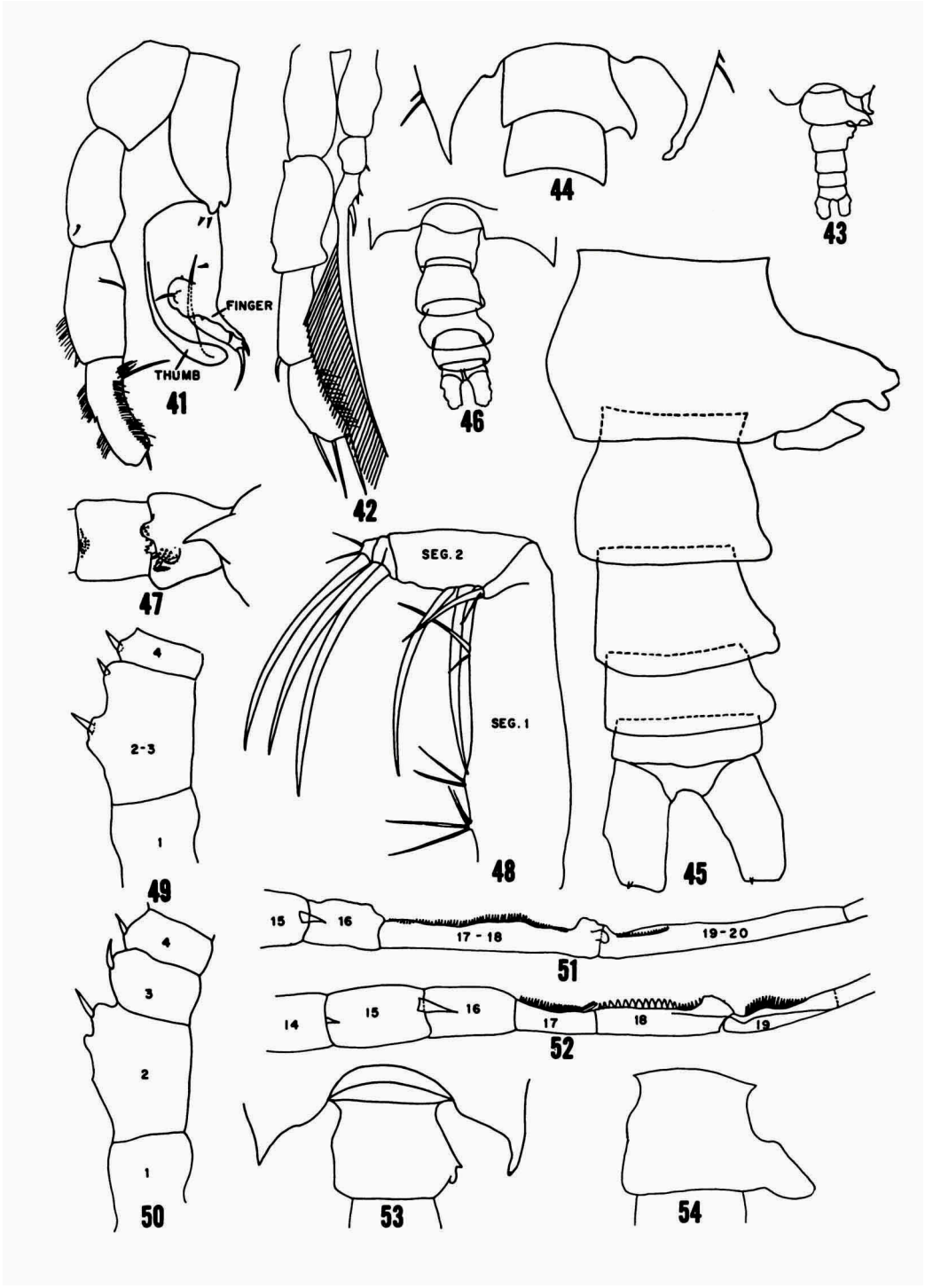
2. Left posterior corner of thorax rounded (fig. 43) . . . *C. elongata*

— Left posterior corner of thorax pointed (fig. 44) 3

3. In dorsal view second abdominal segment asymmetrical (figs. 45, 46) 4

— In dorsal view second abdominal segment symmetrical 6

Figs. 41-54. Males of *Candacia* and *Paracandacia*. 41, *C. curta* (Dana), fifth pair of feet; 42, *P. truncata* (Dana), fifth pair of feet; 43, *C. elongata* (Boeck), last thoracic segment and abdomen, dorsal view; 44, *C. bipinnata* (Giesbrecht), last thoracic segment and first two segments of abdomen, dorsal view; 45, *C. columbiae* Campbell, abdomen in dorsal view; 46, *C. maxima* Vervoort, last thoracic segment and abdomen, dorsal view; 47, *C. bradyi* A. Scott, last thoracic segment and first two segments of abdomen from right side; 48, *C. maxima* Vervoort, 2nd maxilla; 49, *C. pachydactyla* (Dana), proximal segments of first antenna; 50, *C. longimana* (Claus), proximal segments of first antenna; 51, *C. pachydactyla* (Dana), segments of right first antenna; 52, *C. curta* (Dana), segments of right first antenna; 53, *C. ethiopica* (Dana), last thoracic segment and first abdominal segment, dorsal view; 54, *C. pachydactyla* (Dana), dorsal view of first abdominal segment. 41, 42, 44, 53, 54, from Grice, 1962; 43, from Sars, 1924; 45, 49-52, original; 46 48, from Vervoort, 1957; 47, from Wolfenden, 1905 (as *C. tuberculata*). Figures not all to same scale.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4. In dorsal view genital segment without process extending laterally from right side (fig. 46) . . . . . *C. maxima*
— In dorsal view genital segment with process extending laterally from right side 5
5. Tip of right posterior thoracic segment not reaching beyond midpoint of genital segment (fig. 47); edge of genital process with spines and second abdominal segment with patch of small spines near posterior end (fig. 47) . . . . . *C. bradyi*
— Tip of right posterior thoracic segment reaching beyond mid-point of genital segment; edge of genital process without spines and no spines on second abdominal segment (fig. 45) . . . . . *C. columbiae*
6. In dorsal view genital segment without a process or a protrusion . 7
— In dorsal view genital segment with a process or a protrusion [3]) . 9
7. Proximal spine on second basal joint of second maxilla considerably thicker than distal spine (fig. 31) . . . . . *C. catula*
— Proximal spine on second basal joint of second maxilla not notably thicker than distal spine (fig. 48) 8
8. Segments 14 and 15 of right first antenna with dorsal spine, segment 16 without a spine, segment 17 with toothed lamella and distolateral spine onto which small teeth extend, segment 18 with coarse pigmented teeth, segments 19 and 20 fused and with very small teeth on proximal end of these fused segments . . . . . *C. varicans*
— Segments 14, 15 and 16 of right first antenna without spines, segment 17 with small toothed lamella and without distolateral spine, segment 18 with teeth, segments 19 and 20 separate . . . . . *C. maxima*
9. Right first antenna with segments 2 and 3 fused (fig. 49) . . . 10
— Right first antenna with segments 2 and 3 separate (fig. 50) . . 18
10. Right first antenna with segments 17 and 18 fused (fig. 51) . . 11
— Right first antenna with segments 17 and 18 separate (fig. 52) . . 12
11. In dorsal view process on right side of genital segment small, consisting of rounded knob in front of which is a pointed projection (fig. 53) . . . . *C. ethiopica*
— In dorsal view process on right side of genital segment large, consisting of single broad and rounded projection (fig. 54) . . *C. pachydactyla*

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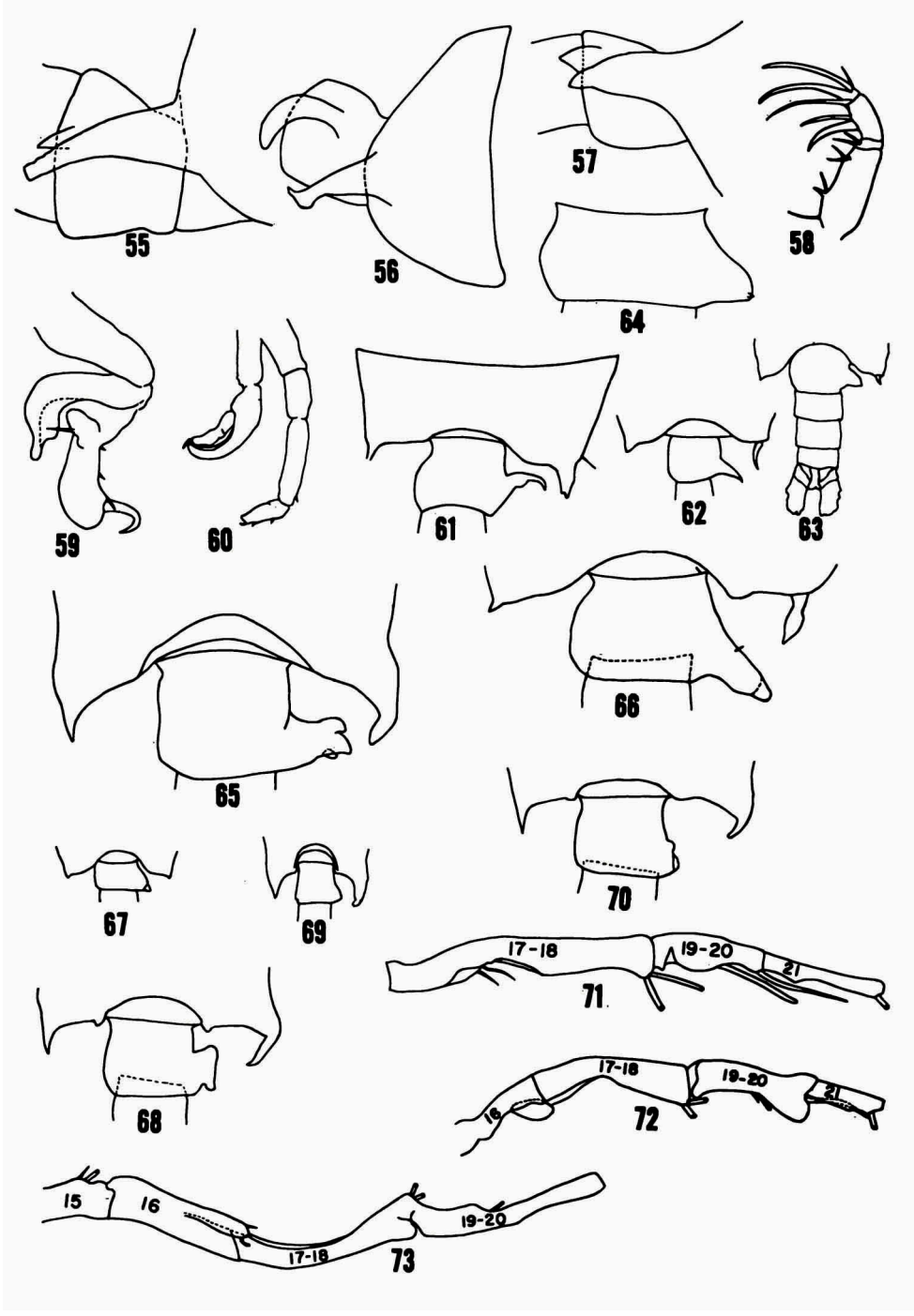
3) The brief description of the male of *C. magna* Sewell, 1932, does not include a figure or a detailed description of its genital process; see fig. 60 for the fifth feet of this species.

12. Right first antenna with segments 19 and 20 fused (fig. 51) or partially fused (fig. 52) 13
— Right first antenna with segments 19 and 20 separate 16
13. Proximal spine on second basal segment of second maxilla considerably thicker than distal one (fig. 58) . . . . . *C. discaudata*
— Proximal spine on second basal segment of second maxilla not notably thicker than distal one 14
14. In lateral view distal end of process on right posterior corner of thorax truncate (fig. 55); tip of process reaching beyond posterior end of genital segment (figs. 44, 55) . . . . . *C. bipinnata*
— In lateral view distal end of process on right posterior corner of thorax not truncate (figs. 56, 57); tip may or may not reach beyond posterior end of genital segment 15
15. In lateral view tip of process on right posterior thoracic corner not reaching posterior end of genital segment; tip of process turned upwards (fig. 56) . . . . . *C. curta*
— In lateral view tip of process on right posterior thoracic corner reaching posterior end of genital segment; apex of process turned slightly downwards (fig. 57) . . . . . *C. armata*
16. Proximal spine on second basal segment of second maxilla considerably thicker than distal one (fig. 58) . . . . . *C. discaudata*
— Proximal spine on second basal segment of second maxilla not notably thicker than distal one 17
17. Tip of thumb of chela on right fifth foot reaching to about mid-point of finger (fig. 59); total length less than 3.0 mm . . . . *C. armata*
— Tips of thumb and finger of right fifth foot subequal (fig. 60); total length 3.7 mm . . . . . *C. magna*
18. In dorsal view distal end of process on right side of genital segment ending in point 19
— In dorsal view distal end of process on right side of genital segment rounded or lobate 22
19. Distal segment of left fifth foot longer than penultimate segment . . . . . *C. cheirura*
— Distal segment of left fifth foot shorter than penultimate segment . 20
20. In dorsal view genital process directed outwards with distal end curved posteriorly (fig. 61); tip of process on right posterior thoracic corner notched (fig. 61) . . . . . *C. tenuimana*
— In dorsal view genital process not curved and directed somewhat obliquely posteriad (figs. 62, 63, 64); tip of process on right posterior thoracic corner not notched 21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21. Distal end of finger of chela of right fifth foot with 2 subequal spine-like points . . . . . *C. paenelongimana*
— Distal end of finger of chela of right fifth foot with 1 spine . . . . . *C. parafalcifera*
22. In dorsal view genital process, measured from right lateral margin perpendicular to sagittal plane of segment, more than 1/2 width of genital segment excluding process (figs. 65, 66) 23
— In dorsal view genital process, measured from right lateral margin perpendicular to sagittal plane of segment, less than 1/2 width of genital segment excluding process (figs. 67, 68, 69, 70) 24
23. In dorsal view apical end of genital process divided into two lobes (fig. 65) . . . . . *C. norvegica*
— In dorsal view apical end of genital process knob-like (fig. 66) . . . . . *C. longimana*
24. In dorsal view genital process straight and directed obliquely posteriad (fig. 67) . . . . . *C. falcifera*
— In dorsal view genital process otherwise conformed 25
25. In dorsal view genital process bilobed (fig. 68) . . . *C. guggenheimi*
— In dorsal view genital process not bilobed 26
26. In dorsal view tip of right posterior thoracic corner reaches at least to posterior margin of genital segment (fig. 69) . . . . *C. pofi*
— In dorsal view tip of right posterior thoracic corner reaches to about mid-point of genital segment (fig. 70) . . . . . *C. ketchumi*
27. Segments 16 and 19-20 (fused) of right first antenna without knob-like

Figs. 55-73. Males of *Candacia* and *Paracandacia*. 55, *C. bipinnata* (Giesbrecht), first segment of abdomen and last thoracic segment from right side; 56, *C. curta* (Dana), last thoracic segment and first abdominal segment from right side; 57, *C. armata* (Boeck), last thoracic segment and first abdominal segment, from right side; 58, *C. discaudata* A. Scott, 2nd maxilla (of female); 59, *C. armata* (Boeck), right fifth foot; 60, *C. magna* Sewell, fifth pair of feet; 61, *C. tenuimana* (Giesbrecht), last thoracic segment and first abdominal segment, dorsal view; 62, *C. paenelongimana* Fleminger & Bowman, last thoracic segment and first segment of abdomen, dorsal view; 63, *C. parafalcifera* Brodsky, last thoracic segment and abdomen, dorsal view; 64, *C. parafalcifera* Brodsky, first abdominal segment, dorsal view; 65, *C. norvegica* (Boeck), last thoracic segment and first segment of abdomen, dorsal view; 66, *C. longimana* (Claus), last thoracic segment and first segment of abdomen, dorsal view; 67, *C. falcifera* Farran, last thoracic segment and first segment of abdomen, dorsal view; 68, *C. guggenheimi* Grice & Jones, last thoracic segment and first abdominal segment, dorsal view; 69, *C. pofi* Grice & Jones, last thoracic segment and first segment of abdomen, dorsal view; 70, *C. ketchumi* Grice, last thoracic segment and first abdominal segment, dorsal view; 71, *P. simplex* (Giesbrecht), segments of right first antenna; 72, *P. bispinosa* (Claus), segments of right first antenna; 73, *P. truncata* (Dana), segments of right first antenna. 55, 56, 61, 66, 71-73, from Grice, 1962; 57, 59, 64, original; 58, from Scott, 1909; 60, from Sewell, 1932; 62, from Fleminger & Bowman, 1956; 63, from Brodsky, 1950; 65, 68, 69, from Grice & Jones, 1960; 67, from Farran, 1929; 70, from Grice, 1961.

or elongate protrusions (fig. 71) . . . . *P. simplex*

— One or both of these segments with rounded or elongate protrusions 28

28. Segment 16 with knob-like protrusion distally, segment 19-20 (fused) produced distally (fig. 72) . . . . *P. bispinosa*

— Segment 16 with elongate protrusion distally, segment 19-20 not produced (fig. 73) . . . . *P. truncata*

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