

## Recent Candoninae (Crustacea, Ostracoda) of North America

I. Karanovic

Western Australian Museum, Locked Bag 49, Welshpool DC, Western Australia 6986, Australia

**Abstract** – A total of 66 species of Candoninae have been described or recorded from North America in the period between the years 1894 and 1990. The majority of these species are known from the United States of America and their type material is kept in the Smithsonian Museum of Natural History in Washington. Since they were described, many new genera have been established in the subfamily Candoninae and more important morphological features for generic discrimination have been found. The descriptions of the North American Candoninae species are not sufficient to enable a proper generic designation or to establish their relationships with other World representatives of the subfamily. This paper is the result of re-examination of almost the entire collection of North American Candoninae from the Smithsonian Museum, and has resulted in a description of one new species and supplementary descriptions of 23 species. Seventeen species and four subspecies known from North America are synonymized, and four species known from elsewhere are synonymized with some of the North American species. Several species are found to be misidentified and three are considered *incerte sedis*. As a result of this revision, with the addition of the synonyms already recognized, the number of North American Candoninae is reduced to 40 species. A key for their identification is provided. In addition, a key to the World representatives of the *caribbeana*-group of species of the genus *Typhlocypris* Vejdovský, 1882 is given. The morphological characteristics of some examined species necessitate redefinition of the genera *Candona* Baird, 1845, *Eucandona* Daday, 1900 and *Fabaeformiscandona* Krstić, 1972. In the present paper the genus *Candona* is divided into two subgenera: *Candona s.str.* and *Neglectocandona* Krstić, 1993. The nominal subgenus is further divided into three species groups: *candida*-, *acuminata*-, and *intermedia*-group. *Neglectocandona* is divided into *neglecta*- and *triangulata*-group. The groups *intermedia* and *triangulata* are established here for the first time. The former group is endemic to North America, while the latter is endemic to Ohrid Lake. The generic diagnosis of the genera *Eucandona* and *Fabaeformiscandona* are narrowed and a discussion on the systematics of all three genera is given. The majority of the North American Candoninae, i.e. 47%, belong to the genus *Candona*, 32% to the genus *Typhlocypris*, 13% to *Eucandona*, while *Nannocandona* Ekman, 1914, *Paracandona* Hartwig, 1899 and *Fabaeformiscandona* have one representative each (2.5%) in the North American fauna. Total of 14 species recorded in North America are also known from elsewhere, while 26 species are endemic to this region.

### INTRODUCTION

The family Candonidae Kaufmann, 1900 is one of the major groups of freshwater ostracods, having the second largest non-marine radiation (Martens *et al.* 1998). Although, the subfamily Cyclocypridinae Kaufmann, 1900 has the greatest number of species in this family, the subfamily Candoninae Kaufmann, 1900 has the broadest ecological tolerance. Its representatives inhabit both surface and subterranean waters, occur in semi-terrestrial habitats, and have a high biodiversity in ancient deep-lakes. Meisch (1996) estimated that there are about 300 Recent and fossil species, but this number is much higher and Meisch's (1996) estimation would hardly encompass even Recent species alone. Today there are 27 Recent genera in this subfamily

(Karanovic 2005a), and most genera are restricted to one or two continents. The reason is probably due to the long evolutionary history of this subfamily, which started about 360 millions of years ago (Krstić and Guan 2000).

Investigation of the Candoninae fauna of North American has a long history, almost as long as that in Europe, but less intensive. *Candona crogmaniana* Turner, 1894 was the first species described from North America (Turner 1894). Shortly after that he (Turner 1895) described two new species from Minnesota and recorded another three, two of them already known from Europe. Sharpe (1897) described four new species of North American Candoninae, and subsequently provided an illustrated key to the ostracods of the United

States, repeating all previous findings (Sharpe 1918). Sars (1926) expanded investigations northwards and, among other ostracod species, he described two new Candoninae: one from Alaska, the other one from Canada. Klie (1931) provided the first insight into the subterranean Candoninae of North America describing two new species from Marengo Cave, Indiana. Extensive studies of the Ohio ostracods by Furtos (1933) yielded 12 new species and one new subspecies. Furtos (1935) described another two Candoninae subspecies from Massachusetts, while a year later she newly recorded two previously named species from North America (Furtos 1936). Dobbin (1941) described one new species and one new subspecies from Washington. Similar to Furtos (1933), Hoff (1942) gave an extensive study of the Illinois ostracods with descriptions of seven new Candoninae. During the 1950 and 1960 eight species were described, all from the United States (Tressler 1954, 1957, Ferguson 1953, 1958, 1966, Cole 1965). Research of the freshwater free-living ostracods of the United States has long been completely neglected, and only recently Marmonier and Ward (1990) described two new species from interstitial waters of South Platte River (Colorado), one of which belongs to the subfamily Candoninae. On the other hand, Delorme (1967a, 1970) greatly enriched our knowledge of the Canadian Candoninae and reported a total of 33 species, three of them new to science.

A total of 66 Recent Candoninae species have been recorded in North America, 45 being endemic to this region. According to the original descriptions and reports all species belong to four genera: *Candona* Baird, 1845; *Fabaeformiscandona* Krstić, 1972; *Nannocandona* Ekman, 1914; and *Paracandona* Hartwig, 1899. The last two genera have one representative each in the North American fauna, *Fabaeformiscandona* has two, while the genus *Candona* holds the greatest number and almost all of the endemic species. *Candona* has the greatest number of assigned species in the subfamily Candoninae. According to Kempf's (1980, 1997) index of the non-marine ostracods, about 1000 Recent and fossil species and subspecies have been described or subsequently assigned to *Candona*. This genus once accommodated almost all Candoninae with the second antenna without swimming setae. After the description of the genera *Candonopsis* Vávra, 1891, *Cryptocandona* Kaufmann, 1900, *Nannocandona*, *Paracandona*, and *Pseudocandona* Kaufmann, 1900 only a few species were removed from the genus *Candona*, and it still remained polyphyletic. Latter on, all species with smooth gamma seta on the mandibular palp were transferred to the genus *Fabaeformiscandona*, which was considered a junior synonym of the genus *Eucandona* Daday, 1900 by Petkovski and

Karanovic (2000). In the extensive review of some Candoninae genera Meisch (1996) described one new genus, and highlighted some important taxonomic differences between *Candona s.sl.* and *Pseudocandona*. In consequence, the number of species in the genus *Candona* was drastically reduced, and today it includes some 40 Recent species in the whole Europe (Meisch 2000). North America, according to all published (and yet unrevised) information, has 44 endemic species of this genus. Unfortunately, almost all of the original descriptions of North American Candoninae are very poor. In an attempt to reveal the detailed morphology of these species and their relations to other Candoninae, I borrowed and studied almost the complete collection of the North American Candoninae deposited in the Invertebrate Collection of the Smithsonian Museum of Natural History in Washington.

Here I describe one new species of Candoninae and provide additional morphological details for 23 species. Seventeen species and four subspecies known from North America are synonymized, and four species known from other parts of the World are synonymized with North American species. Several species were found to be misidentified and three are considered *incerte sedis*. This has reduced the number of North American Candoninae from 66 to 40 species and these are listed at the end of the paper. I provide a key to the species of North American Candoninae, and a key to the World representatives of the *caribbeana*-group of the genus *Typhlocypris* Vejvodský, 1882, a genus recently redefined by Karanovic (2005c). The morphological characteristics of the North American Candoninae suggest that the difference in morphology of the gamma seta between the genera *Candona* and *Eucandona s.sl.* has been exaggerated and lacks strong phylogenetic significance. On the other hand, the characteristics of the male prehensile palp, male antenna and hemipenis, and of the female genital field, have greater phylogenetic significance and are here used to redefine the genera *Candona*, *Fabaeformiscandona* and *Eucandona*. At the end of the paper I discuss the systematics of these three genera and the characteristics of the North American Candoninae fauna.

#### List of the Recent species and subspecies recorded in North America

This list includes all the Recent Candoninae species recorded from North America. They are listed in alphabetical order, in the generic designation as they are reported for North America originally, and with the authors who recorded them between square brackets.

1. *Candona acuminata* (Fisher, 1954) [Turner 1895, Sharp 1897, 1918, Delorme 1970]

2. *Candona acuta* Hoff, 1942 [Hoff 1942, Delorme 1970]
3. *Candona acutula* Delorme, 1970 [Delorme 1970]
4. *Candona albicans* Brady, 1864 [Hoff 1942, Delorme, 1970; Marmonier and Ward 1990]
5. *Candona annae* Méhes, 1914 [Furtos 1936]
6. *Candona annae septentrionalis* Furtos, 1935 [Furtos 1935]
7. *Candona balatonica* Daday, 1894 [Furtos, 1936; Dobbin 1941]
8. *Candona biangulata* Hoff, 1942 [Hoff 1942]
9. *Candona candida* (Müller, 1776) [Sharpe 1918, Dobbin 1841, Delorme 1970, Marmonier and Ward 1990, Külköylüoglu and Vinyard 2000]
10. *Candona caudata* Kaufmann, 1900 [Hoff 1942, Delorme 1970]
11. *Candona caudata* var. *ciliata* Furtos, 1935 [Furtos 1935]
12. *Candona caudata* var. *occidentalis* Dobbin, 1941 [Dobbin 1941]
13. *Candona compressa* Koch, 1835 [Delorme 1970]
14. *Candona crogmaniana* Turner, 1894 [Turner 1894, Sharpe 1918, Furtos 1933, Hoff 1942, Delorme 1970]
15. *Candona decora* Furtos, 1933 [Furtos 1933, Tressler 1957]
16. *Candona delawarensis* Turner, 1894 [Turner 1895, Sharpe 1918]
17. *Candona distincta* Furtos, 1933 [Furtos 1933, Hoff 1942, Delorme 1970]
18. *Candona elliptica* Furtos, 1933 [Furtos 1933, Delorme 1970]
19. *Candona eriensis* Furtos, 1933 [Furtos 1933]
20. *Candona exilis* Furtos, 1933 [Furtos 1933]
21. *Candona fabaeformis* (Fisher, 1851) [Turner 1895, Sharpe 1897, 1918, Ferguson 1958]
22. *Candona facetus* Delorme, 1970 [Delorme 1970]
23. *Candona fluviatilis* Hoff, 1942 [Hoff 1942]
24. *Candona fossulensis* Hoff, 1942 [Hoff 1942]
25. *Candona foviolata* Dobbin, 1941 [Dobbin 1941]
26. *Candona hartwigi* Müller, 1900 [Delorme 1970]
27. *Candona hipolitensis* Tressler, 1954 [Tressler 1954]
28. *Candona hoffi* Ferguson, 1953 [Ferguson 1953]
29. *Candona indigena* Hoff, 1942 [Hoff 1942]
30. *Candona inopinata* Furtos, 1933 [Furtos 1933, Delorme 1970]
31. *Candona intermedia* Furtos, 1933 [Furtos 1933, Tressler 1954]
32. *Candona jeanneli* Klie, 1931 [Klie 1931]
33. *Candona lingulata* Cole, 1965 [Cole 1965]
34. *Candona marengoensis* Klie, 1931 [Klie 1931]
35. *Candona michoa* Tressler, 1954 [Tressler 1954]
36. *Candona ohioensis* Furtos, 1933 [Furtos 1933, Delorme 1970]
37. *Candona orangeburgensis* Ferguson, 1958 [Ferguson 1958]
38. *Candona parallela* Müller, 1900 [Sharpe 1918, Furtos 1933, Dobbin 1941]
39. *Candona paraohioensis* Staplin, 1963 [Delorme 1970]
40. *Candona parvula* Sars, 1926 [Sars 1926]
41. *Candona patzcuaro* Tressler, 1954 [Tressler 1954, Delorme 1970]
42. *Candona peircei* Turner, 1895 [Turner 1895, Sharpe 1918]
43. *Candona punctata* Furtos, 1933 [Furtos 1933]
44. *Candona rawsoni* Tressler, 1957 [Tressler 1957, Delorme 1970]
45. *Candona recticaudata* Sharpe, 1897 [Sharpe 1897, 1918, Hoff 1942]
46. *Candona reflexa* Sharpe, 1897 [Sharpe 1897, 1918]
47. *Candona renoensis* Gutentag and Benson, 1962 [Delorme 1970]
48. *Candona rostrata* Brady and Norman, 1889 [Delorme 1970]
49. *Candona sarsi* Hartwig, 1899 [Delorme 1970]
50. *Candona scopulosa* Furtos, 1933 [Furtos 1933]
51. *Candona sharpei* Hoff, 1942 [Hoff 1942]
52. *Candona sigmoides* Sharpe, 1897 [Sharpe 1897, 1918, Hoff 1942, Delorme 1970]
53. *Candona simpsoni* Sharpe, 1897 [Sharpe 1897, 1918, Hoff 1942]
54. *Candona stagnalis* Sars, 1890 [Delorme 1970]
55. *Candona stagnalis* var. *longisetosa* Furtos, 1933 [Furtos 1933]
56. *Candona subacuminata* Delorme, 1970 [Delorme 1970]
57. *Candona subgibba* Sars, 1926 [Sars 1926]
58. *Candona subtriangulata* Benson and MacDonald, 1963 [Delorme 1970]
59. *Candona suburbana* Hoff, 1942 [Hoff 1942, Delorme 1970]
60. *Candona tahoensis* Ferguson, 1966 [Ferguson 1966]
61. *Candona truncata* Furtos, 1933 [Furtos 1933]
62. *Candona uliginosa* Furtos, 1933 [Furtos 1933]
63. *Fabaeformiscandona pennaki* Marmonier and Ward, 1990 [Marmonier and Ward 1990]
64. *Fabaeformiscandona wegelini* (Petkovski, 19620) [Marmonier and Ward 1990]
65. *Nannocandona faba* Ekman, 1919 [Marmonier and Ward 1990]
66. *Paracandona euplectella* (Brady and Norman, 1889) [Sharpe 1918, Furtos 1933, Delorme 1970]

#### MATERIAL AND METHODS

Appendages and carapaces were examined using a Leica DMLS brightfield compound microscope with C-plan achromatic objectives. All drawings were prepared using a drawing tube attachment to the same microscope.

### Abbreviations used in text and figures

a – lateral lobe on hemipenis; A1 – antennula; A2 – antenna; b – medial lobe on hemipenis; CB – coxobasis; CB1, CB2 – setae on coxobasis; e – *bursa copulatrix*; En – endopod; Ex1, Ex2 – exopodal setae; d1, d2, dp – setae on basal segment T3; Fu – furca; g – part M (middle chitinous part) of hemipenis; G1, G2, G3, GM, Gm – antennal claws; H – height; h – part D (distal chitinous part) on hemipenis; L – length; LV – left valve; Md – mandible; Mxl – maxillula; RV – right valve; Ta, Tb, Td – setae on T1; Te, Tf, Tg, Th1, Th2, Th3 – setae on endopodal segments T3; T1, T2, T3 – first, second and third thoracopods; t1–t4 – medial setae on the second endopodal segment A2; W – width; Y, ya, y1, y2, y3 – aesthetascs; z1, z2, z3 – apical setae on the second endopodal segment A2.

### Abbreviations for repositories

GSC – Geological Survey of Canada; ZMA – Zoological Museum (Amsterdam); USNM – United States National Museum (Smithsonian Museum of Natural History).

### Terminology

The names of all appendages follow Martens (1998). The terminology of A1 follows Karanovic (2005c). Martens (1987) revised the terminology for A2 given originally by Broodbakker and Danielopol (1982). The present paper follows Martens (1987) except that the short claw on the male terminal segment is considered to be homologous with female GM claw, while the long one is homologous with female Gm claw. The terminology for the Md follows Broodbakker and Danielopol (1982), and for the T3 Meisch (1996). Lobes on the hemipenis are labeled according to Danielopol (1969).

## SYSTEMATICS

### Family Candonidae Kaufmann, 1900

### Subfamily Candoninae Kaufmann, 1900

### Genus *Candona* Baird, 1845

#### Revised diagnosis

Carapace subtriangular, subreniform, or subtrapezoidal. Valve surface not ornamented, but covered with pronounced warts from which setae originate. Inner calcified lamella always narrow, i.e., never more than 20% of total L. LV overlaps RV. Marginal pore canals short, straight, never branched. A1 7-segmented. Coxa and basis fused with both CB setae present. Exopod reduced to two long setae. Endopod 6-segmented. En1 and En2 each with only one anterior seta. En3 and En4 each with two anterior and one posterior seta. En5 with two anterior and two posterior setae (En5d seta

present), alpha seta present. En6 with most posterior seta transformed into claw, most anterior seta transformed into aesthetasc. A2 sexually dimorphic: in male protopod 4-segmented, in female 3-segmented. Male sexual bristles present. Claws G1 and G3 in male reduced, seta z2 transformed into claws, seta z1 most usually also transformed into claw (which subequally long as z2, or at the most 2/3 of its L). Sometimes z1 seta-like, but much longer than terminal segment; z3 always seta-like. In both sexes exopod transformed in plate with one long and two short setae. Md with total of eight rays in exopod; palp 4-segmented with two setae externally on second and three setae on penultimate segment. Second segment internally with 4+2 or 5+2 setae. Terminal segment with two claws, central one narrowly fused with segment. Gamma seta plumed or smooth. Terminal segment on Mxl rectangular. Vibratory plate on T1 with two rays. Male with transformed palps. T2 5-segmented. Basal segment with one seta. T3 4- or 5-segmented. Basal segment with two setae (d1 and dp); terminal segment with two long (Th2 and Th3) and one short (Th1) seta, which never shorter than terminal segment itself. Furca with both claws and both setae present. Posterior seta always at least reaches distal end of posterior margin, usually being much longer. Part "g" on hemipenis well sclerified. Lobes "a" and "h" present. Zenker's organ with seven whorls of spine. Female genital lobe with or without extension.

#### Type species

*Candona candida* (Müller, 1776)

### Subgenus *Candona* Baird, 1845

#### Revised diagnosis

Both z1 and z2 setae transformed into claws. Md with 4+2 setae in bunch (*acuminata*- and *intermedia*-group) or 5+2 setae (*candida*-group). Male palps both with hook-shaped fingers (*acuminata*-group) or left palp with elongated finger (*candida*- and *intermedia*-group). Right and left palp subequally big, or right one bigger. Genital lobe well developed (*acuminata*- and *intermedia*-group) or very small even flat (*candida*-group). Most dorsal margin of the dorsal extension of lobe "a" never parallel with main hemipenis body.

#### Type species

*Candona candida* (Müller, 1776).

#### North American representatives of the subgenus

1.) *acuminata*-group: *Candona* (*Candona*) *acuminata* (Fischer, 1851); *C. (C.) acutula* Delorme, 1967; *C. (C.) caudata* Kaufmann, 1900; *C. (C.) decora* Furtos, 1933; *C. (C.) lingulata* Cole, 1965; *C. (C.)*

*ohioensis* Furtos, 1933; *C. (C.) peircei* Turner, 1895; *C. (C.) sigmoides* Sharpe, 1897; *C. (C.) suburbana* Hoff, 1942; *C. (C.) tahoensis* Ferguson, 1966; *Candona (C.) uliginosa* Furtos, 1933. 2.) *intermedia*-group: *Candona (Candona) acuta* Hoff, 1942; *C. (C.) crogmaniana* Turner, 1894; *C. (C.) inopinata* Furtos, 1933; *C. (C.) intermedia* Furtos, 1933; *C. (C.) paraohioensis* Staplin, 1963; *C. (C.) subacuminata* Delorme, 1970; *C. (C.) subtriangulata* Benson and MacDonald, 1963.

### *Candona (Candona) acutula* Delorme, 1967

Figure 1

*Candona acutula* n.sp. Delorme 1967: 358, Plate 1, Figures 3–6.

*Candona acutula* Delorme, 1967: Delorme 1970: 1100, Figures 18–33.

*Candona balatonica* Daday, 1894: Furtos 1936: 518, Figure 14; Dobbin 1941: 243, Plate 3, Figures 8–10 [misidentification].

#### Material examined

One female (dissected on one slide – USNM 138231; labeled as *Candona balatonica* Daday, 1894) from: USA, Florida, 1 1/2 miles E of Elfers, Pool in Cypress shade, 24 August 1932, collector N. C. Furtos.

#### Redescription

*Female.* Carapace subtriangular in lateral view, with greatest H situated behind middle. Valves L varies from 0.9 to 1.2 mm. Greatest H equals about 54% of L. Dorsal margin evenly sloping down towards anterior end, and inclined towards posterior end. Anterior margin rounded, posterior margin inclined (almost straight). Ventral margin concave around mouth region. Valve surface covered with warts and hairs. Inner calcified lamellae narrow on both ends. Marginal pore canals short, dense and straight.

A1 (Figure 1F): 7-segmented. Seta En1a exceeds distal end of En2; seta En2a reaches distal end of En3. Segment En3 with two long and thin setae (En3a and En3b); seta En3d short and only reaches distal end of following segment. Segment En4 also with two long thin setae (En4a and En4b); seta En4d missing. Penultimate segment with two long, thin setae (En5a and En5b); seta En5c 2.5 times longer than terminal segment, while seta En5d stronger, claw-like and exceeding distal end of terminal segment. Segment En6 with two short setae (En6a and En6d) while seta En6c thin and long. Aesthetasc ya short, only about as long as terminal segment. L ratios of endopodal segments equal 1 : 1 : 1.3 : 1.2 : 1.3 : 1.3.

A2 (Figure 1A): 4-segmented. All t-setae present. Seta z1 slightly stronger than other two z-setae.

Claw G2 three times longer than terminal segment. Claws G1 and G3 subequally long, and as long as first endopodal segment. Claw GM about 0.76 times as long as first endopodal segment. Claw Gm 2.7 times as long as terminal segment. All aesthetasc present and short. L ratios of three distal endopodal segments equal 4.4 : 2.4 : 1.

Md (Figure 1B) with 4+2 setae in bunch on second segment. Gamma seta smooth. Terminal segment with two claws and three setae.

Rake-like organ (Figure 1H): with numerous small teeth.

T1 (Figure 1D): Setae Ta, Tb and Td present.

T2 (Figure 1C): 5-segmented. Basal segment with one seta. First and second segment with one seta each, reaching distal end of following segments. Penultimate segment with two setae. Terminal segment with two setae and a claw, which serrated and 1.2 times as long as three distal segments combined.

T3 (Figure 1E): 5-segmented. Basal segment with d1 and dp setae. Only Tg seta present and well exceeding distal end of terminal segment. Terminal segment with two long and one shorter seta. L ratios of Th1, Th2 and Th3 equal 1 : 2.2 : 2.5.

Fu and genital field (Figure 1G): L ratio of anterior Fu margin, anterior and posterior claws equal 1.75 : 1.3 : 1. Posterior Fu margin with short hairs. Posterior Fu seta exceeds distal end of posterior margin. Anterior Fu seta equals 1/3 of anterior claw. Both claws strongly serrated. Fu ramus curved. Genital field with finger-like process, which with blunt tip. Extension equals 64% of L of anterior furcal margin. Fu attachment shown on Figure 1I.

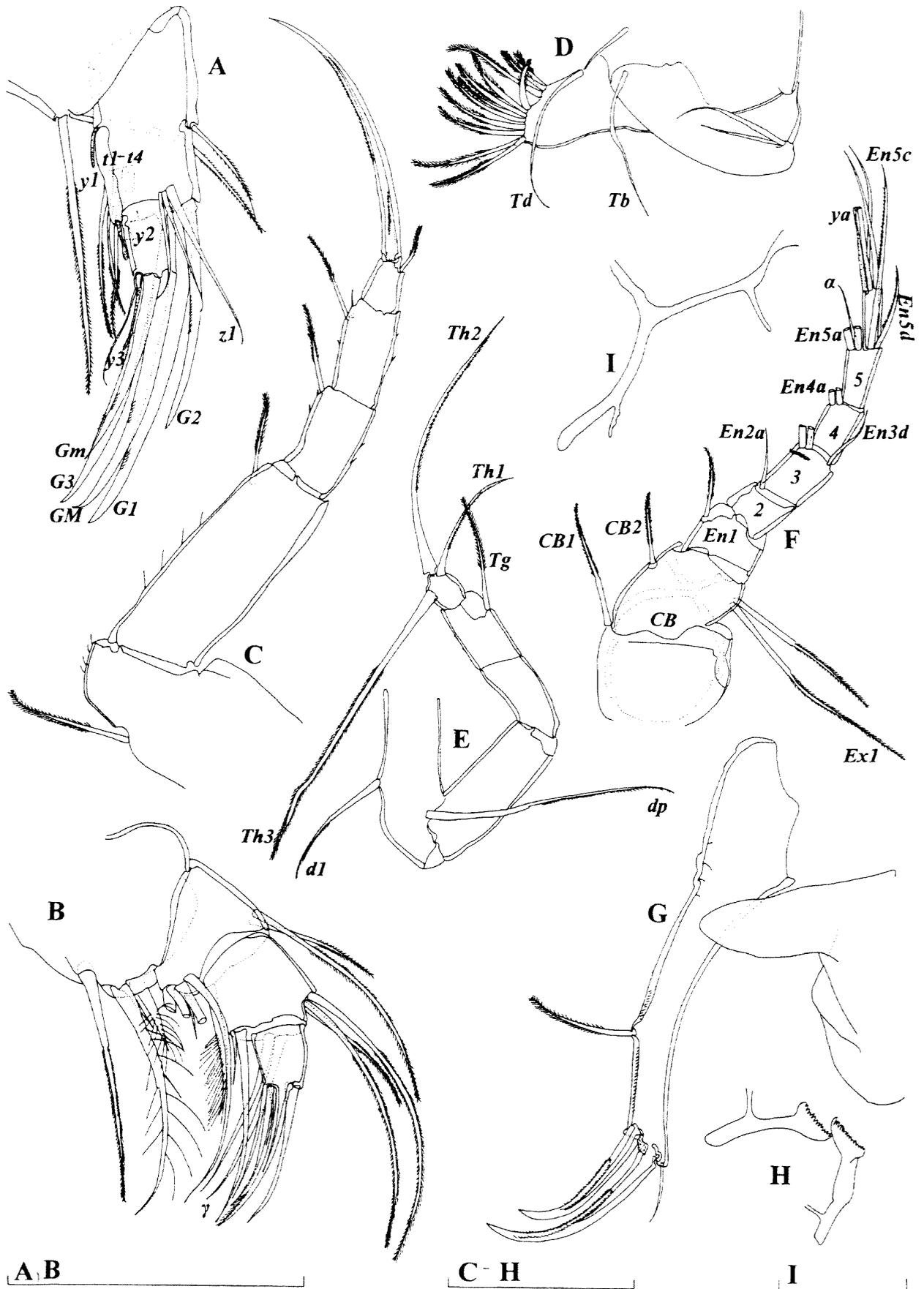
*Male.* Carapace appearance very similar to female, only with one slight recession medially on dorsal margin.

Prehensile palps: Almost symmetrical, both with hook-shape fingers and with thin sclerified structures.

Hemipenis: Lobe a extended and elliptical, with sinusoid most dorsal margin. Lobe b rounded, lobe h small, rounded, and slightly extended. Part g well sclerified.

#### Variability

The specimens collected by Delorme (1967a) in Canada are slightly bigger than those collected by Furtos (1936) and Dobbin (1941). There are also minor differences in the appearance of the prehensile palps between the Canadian specimens and those collected in Florida (Furtos 1933). Namely, Furtos (1936) drew the right prehensile palp slightly more robust than the left one, while both palps are, according to Delorme's (1970) photographs, absolutely symmetrical. Dobbin (1941) reported only females.



**Figure 1** *Candona (Candona) acutula* Delorme, 1967. Female (USNM 138231): A - A2 (two terminal segments); B - Md-palp; C - T2; D - T1; E - T3; F - A1; G - Fu and genital process; H - rake-like organ; I - furcal attachment. Scales = 0.1 mm.

### Remarks and affinities

*Candona balatonica* Daday, 1894 was reported twice from North America. Once from Florida (Furtos 1933) and once from Alaska (Dobbin 1941). The species collected by Furtos (1936) proved to be *Candona acutula*. I have not checked the material of *C. balatonica* from Alaska, but, according to Dobbin's (1942) descriptions and drawings, there is no doubt that he was dealing with *C. acutula*. This species belongs to the *acuminata*-group, and has a finger-like genital process like the following *Candona* species: *C. acuminata* (Fischer 1854); *C. caudata* Kaufmann, 1900, *C. danielopoli* (Yin and Martens 1997) n. comb., *C. decora* Furtos, 1933, *C. lingulata* Cole, 1965, *C. ohioensis* Furtos, 1933, *C. sigmoides* Sharpe, 1897, *C. siliquosa* Brady, 1910, and *C. uliginosa* Furtos, 1933. Females of the first species have much more inclined posterior margin on the carapace, and a longer genital process, while males have flat distal-most margin of the dorsal extension of the lobe "a". *Candona caudata* has a markedly developed postero-ventral keel on LV. *Candona danielopoli* has a long, pointed extension on lobe "a". Also the prehensile palps are much stouter (see Yin and Martens 1997). Males of *C. decora* have much more asymmetrical prehensile palps and a different shape of lobe "a", while females have a thinner genital process. Females of *C. lingulata* have a much smaller genital process and considerably longer En1a, En3d and En4d setae than *C. acutula*. Lobe "a" in *C. ohioensis* is very similar to that in *C. acutula*, but the two species differ by the appearance of the left prehensile palp, which has a ventral chitinous bump in the former species. In addition, *C. ohioensis* has longer setae En1a, En3d and En4d, and generally shorter and stouter swimming setae on A1. The genital process in *C. acutula* and *C. sigmoides* is almost identical but the latter species has much shorter and stouter swimming setae on A1, the rake-like organ has less teeth and lobe "a" has a pointed tip. *Candona siliquosa* has a similar genital process to *C. acutula* and it belongs to the same species-group. This species differs from *C. acutula* by the much lower carapace and shorter posterior furcal seta. In *C. uliginosa*, the genital process is thinner and it is also longer compared to the anterior furcal ramus than in *C. acutula*. The furcal claws are almost identically long in *C. uliginosa*, while in *C. acutula* the posterior one is considerably shorter. In addition, the posterior margin in *C. acutula* is inclined, while it is rounded in *C. uliginosa*.

### Distribution

*Candona acutula* was recorded from Canada (Delorme 1970), Florida (Furtos 1933) and Alaska (Dobbin 1941), and probably has wider distribution in North America.

### *Candona (Candona) caudata* Kaufmann, 1900

Figure 2

*Candona caudata* Kaufmann 1900: 365, Plate 24, Figures 16–20, Plate 26, Figures 17–23.

*Candona caudata* Kaufmann, 1900: Hoff 1942: 80, Plate 3, Figures 33–35.

*Candona caudata* Kaufmann var. *ciliata* Furtos 1935: p. 539, Figure 5. [new synonymy]

*Candona caudata* Kaufmann var. *occidentalis* Dobbin 1941: 240, Plate 4, Figures 1–3, Plate 5, Figures 13–14. [new synonymy]

*Fabaeformiscandona caudata* (Kaufmann, 1900): Meisch 2000: 113, Figures 44–45.

### Material examined

Three females and one male (dissected on two slides – USNM 180440, labeled as *Candona caudata occidentalis*) from: USA, Washington, Lake Washington, 11 May 1933, collector C. N. Dobbin.

### Additional description

*Female*. Valves subrectangular. LV with characteristic protrusion postero-ventrally (Figures 2A, B), while on RV this protrusion not markedly developed. In dorsal view valves with serrated distal parts (Figure 2C), which also developed in different degrees.

A1 (Figure 2F) with short and stout swimming setae. L ratio of endopodal segments equal 1.4 : 1 : 1 : 1.4 : 1.4 : 1.4.

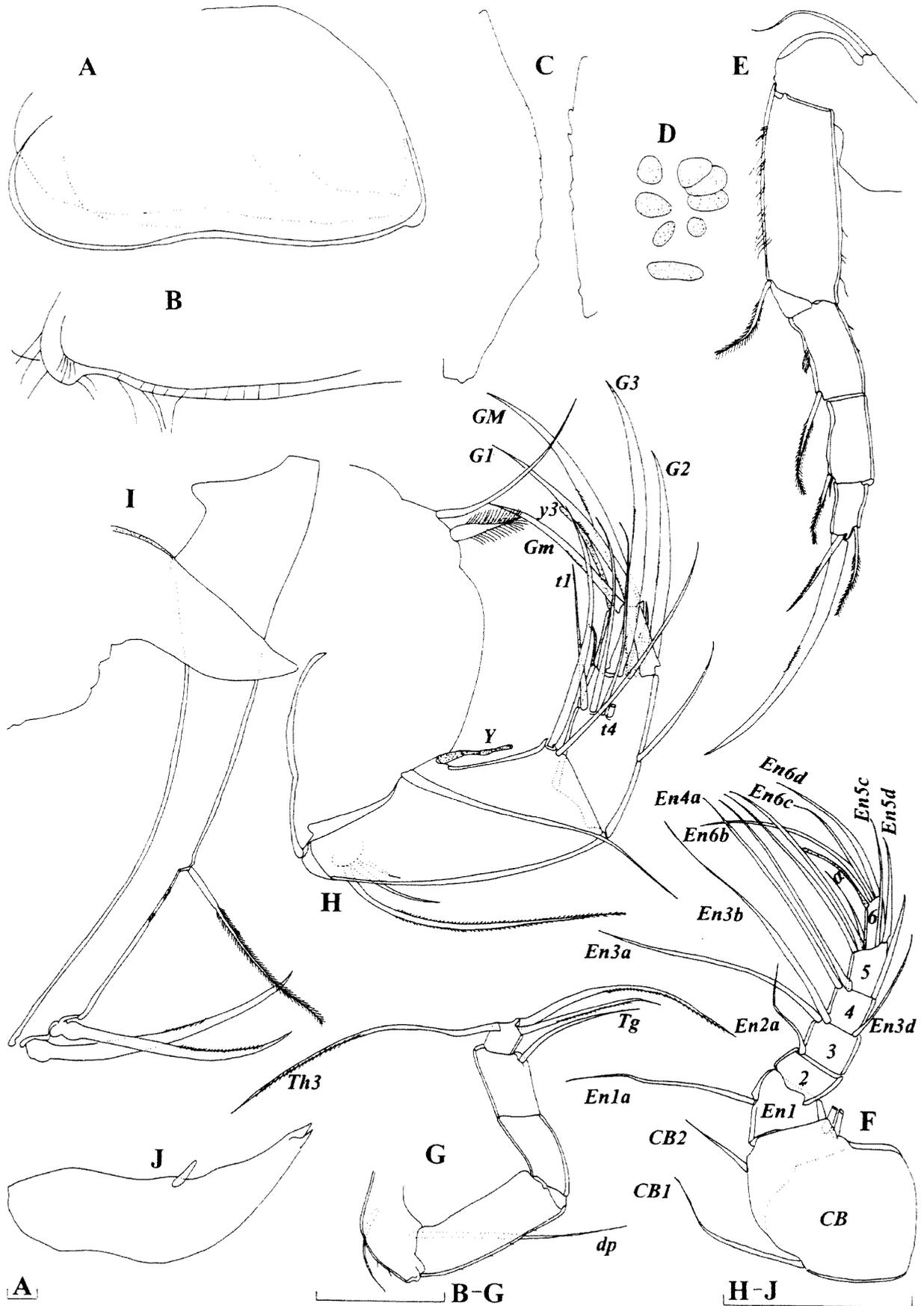
A2 (Figure 2H): With all t-setae well developed. Seta z1 claw-like and very short only reaching distal end of terminal segment. L ratios of three endopodal segments equal 4.2 : 2.4 : 1.

Fu and genital field (Figure 2I): L ratio of anterior Fu margin, anterior and posterior Fu claw equal 2 : 1.15 : 1. Posterior Fu seta reaching distal end of posterior furcal margin. Furcal ramus slightly curved. Genital field with finger like extension with pointed tip. Extension equals 50% of L of anterior furcal margin.

*Male*. Only juvenile males were found in Massachusetts (Furtos 1935) and Washington (Dobbin 1941).

### Variability

Two subspecies have been described from North America based on the level of the postero-ventral keel development. However, they are synonymized with the nominal subspecies because in some other species of the genus (see further text) this feature can also be present to some extent. The specimens from Washington (Dobbin 1941) I have observed differ from the original description (Kaufmann 1900) in the absence of a strongly serrated postero-dorsal lobe-like extension on the valves. The Washington specimens have serrated postero-dorsal



**Figure 2** *Candona (Candona) caudata* Kaufmann, 1900. A, C, D, E, G, I, Female, no. 1 (USNM 180440); B, H, F, Female, no. 2 (USNM 180440); J, Juvenile male (USNM 180440): A – Carapace, lateral view from left side; B – Postero-ventral part of carapace; C – postero-distal part of carapace; D – muscle scar inprints (upside down); E – T2; F – A1; G – T3; H – A2; I – Fu with genital process. Scales = 0.1 mm.

margin, but the lobes are not expressed. North American specimens have more finger-like genital process, but this might be a result of the slide preparation.

### Remarks and affinities

Delorme (1970) reported a bisexual population of *Candona caudata* from Canada. However, these females have an almost undeveloped postero-ventral keel, therefore Delorme's (1970) record is not certain. It is possible that in the bisexual populations the ventro-distal keel might be less developed in females. This has to await finding of more material of the bisexual populations. Because of the variability in the appearance of the valves and the uncertain presence of males it is very hard to tell the differences between *C. caudata* and other representatives of the *acuminata*-group. Hence this species is not included in the key at the end of the present paper. *Candona caudata* can only be distinguished from the other representatives which have a finger-like genital process by the more developed postero-ventral keel on its valves.

### Distribution

It is widely distributed in the Holarctic region.

### *Candona (Candona) decora* Furtos, 1933

Figures 3, 4

*Candona decora* Furtos 1933: 477, Plate 8, Figures 4-5, Plate 9, Figures 21-22, Plate 11, Figures 5-6.

*Candona decora* Furtos, 1933: Tressler 1957: 418, Figures 3-4.

*Candona fossulensis* Hoff 1942: 92, Plate 5, Figures 58-64. [new synonymy]

*Candona facetus* Delorme 1970: 1108, Figures 137-149. [new synonymy]

### Material examined

#### Paratype

Male (dissected on one slide, USNM 67867), USA, Ohio, Marengo, temporary pond, 06 April 1932, collector N. C. Furtos.

#### Other Material

One male (dissected on one slide - USNM 81069, labeled as *Candona fossulensis*, Holotype) and one female (dissected on one slide - USNM 81065, labeled as *Candona fossulensis*, Allotype), USA, Illinois, Champaign County, road side dish, 01 April 1940, collector C. C. Hoff.

### Redescription

*Male*. Carapace subreniform to subtriangular in lateral view (Figure 3B, C). L of carapace varies

from 1.1 mm to 1.5 mm. Greatest H lies behind middle and equals about 50% of L. Dorsal margin highly arched on posterior end, sloping evenly towards anterior end, and becoming rounded towards posterior end. Both posterior and anterior margins evenly rounded, anterior one being much wider than posterior. Ventral margin markedly concave around mouth region and with small protrusion on its first third. Inner calcified lamella very narrow, especially posteriorly. Marginal pore canals short, straight and dense. Selvage peripheral and narrow. Short inner list present antero-ventrally. Carapace surface covered with warts and short dense hairs.

A1 (Figure 4D): 7-segmented. Swimming setae long and thin. Seta En1a reaching distal end of En3. Seta En2a reaching middle of En4. En3 with two long, thin anterior setae (En3a and En3b), and short En3d (reaching only middle of following segment). En4 with two long thin anterior setae (En4a and En4b) and short posterior setae (En4d) which not reaching distal end of En5. Penultimate segment with three long, thin setae (En5a, En5b and En5c), and short En5d (reaching distal end of terminal segment). Alpha seta short. Terminal segment (Figure 4E) with two long, thin setae (En6b, En6c) and short En6d. Aesthetasc ya short, two times longer than En6. L ratios of endopodal segments equal 1.4 : 1 : 1.7 : 1.9 : 1.9 : 1.7.

A2 (Figure 4B): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, latter one seta-like and both two times longer than terminal segment. Claw G2 long and as long as first endopodal segment. Claw GM reduced and 1.8 times longer than terminal segment. Claw Gm well developed and 0.8 times as long as first endopodal segment. Setae z1 and z2 transformed into claws, z1 slightly shorter than z2 and both approximately as long as first endopodal segment. All claws serrated. Seta z3 slightly longer than terminal segment. Only aesthetasc Y and y3 observed, both being short. L ratios of endopodal segments equal 5.3 : 2.4 : 1.2 : 1.

Mx1 (Figure 4A): 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 4C) with numerous small teeth.

T1 (Figure 3G, H): Palps asymmetrical - right one (Figure 3G) with helmet-shaped finger, left one (Figure 3H) with thinner finger. On both palps fingers hook-shaped, subterminal sclerified structures thin. Right palp on dorsal margin with a row of very short hairs. One Ta, Tb and Td seta present.

T2: Terminal claw as long as three distal segments combined.



**Figure 3** *Candona (Candona) decora* Furtos, 1933. A, J, Female (USNM 81065); B-I, K, Male (USNM 81069): A - LV, internal view; B - LV, internal view; C - RV, internal view; D - Ejaculatory process, distal part; E - Part "g"; F - Ejaculatory process, proximal part; G - T1 and right prehensile palp; H - left prehensile palp; I - Hemipenis, distal part; J - Endopod, T1; K - Hemipenis. Scales = 0.1 mm.

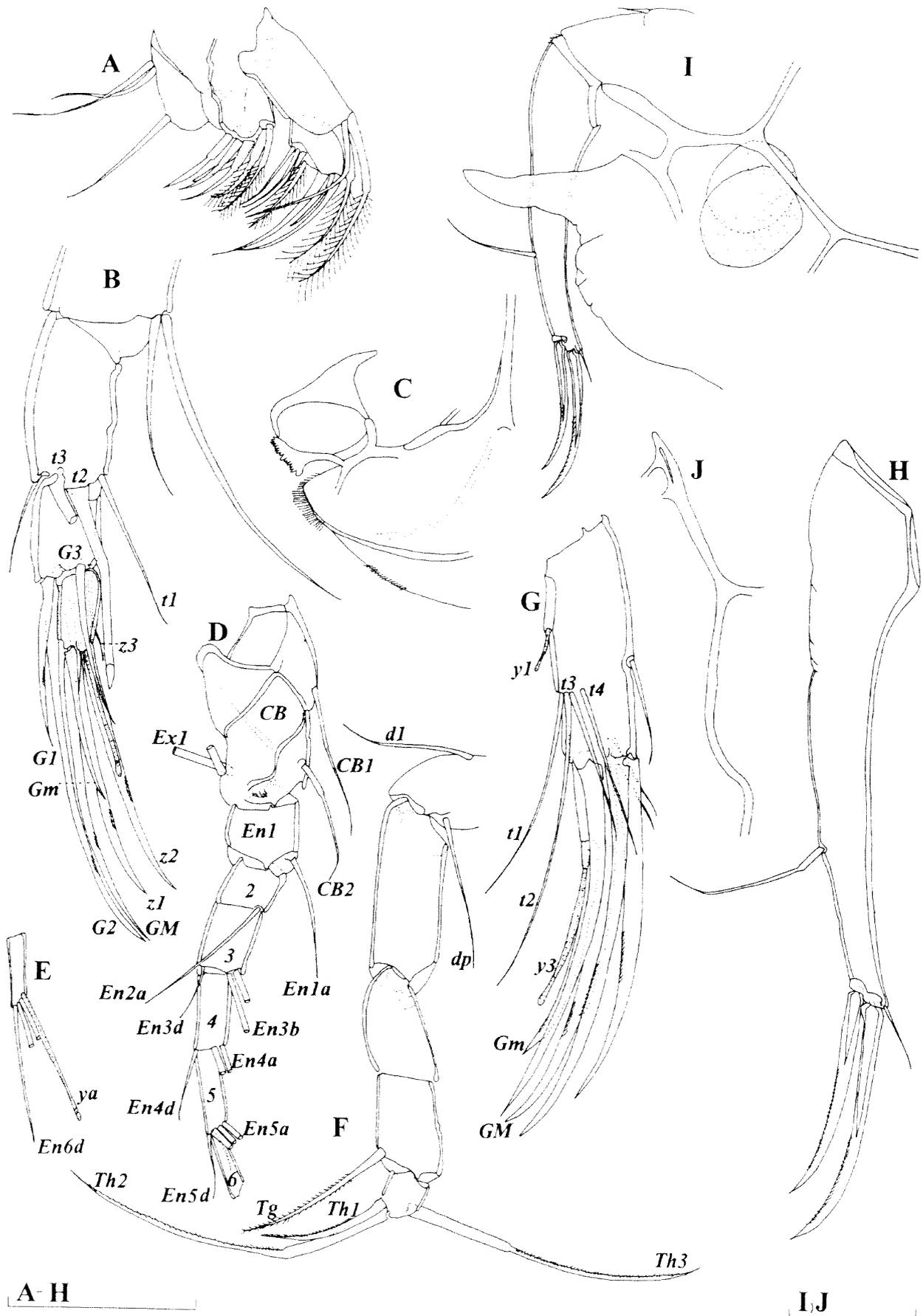


Figure 4 *Candona (Candona) decora* Furtos, 1933. A-F, H, J, Male (USNM 81069), G, I, Female (USNM 81065): A - Mx1; B - A2 (three terminal segments); C - Rake-like organ; D - A1; E - Terminal segment A1; F - T3; G - A2 (two terminal segments); H - Fu; I - Fu with genital process; J - Furcal attachment. Scales = 0.1 mm.

T3 (Figure 4F): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 2.5 : 2.4. Th1 seta 2.7 times longer than terminal segment.

Fu (Figure 4H): L ratios of anterior margin, anterior and posterior claws equal 2 : 1.2 : 1. Anterior seta reaching 1/3 of anterior claw; posterior seta exceeding distal end of posterior margin. Both claws serrated. Furcal ramus slightly curved. Furcal attachment shown on Figure 4J.

Hemipenis (Figure 3I, K). Lobe a elliptical and with blunt tip. Lobe b rounded. Lobe h rounded and small, part g foot-like (Figure 3E) and distally serrated. Ejaculatory process (Figure 3D, F) "S"-shaped and with sharp, pointed tip. Lobes a and b ornamented with chitinized patches.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace (Figure 3A) less triangular than in male, ventral margin almost straight. L varies from 1 mm to 1.3 mm. Greatest H situated on last third and equals about 50% of L. Calcified inner lamella very narrow. No inner lists present. Selvage peripheral and narrow.

A2 (Figure 4G): all t-setae present. Seta z1 not observed, while z2 and z3 reaching distal end of terminal segment. Claw G2 long and 0.96 times as long as first endopodal segment. Claws G1 and G3 subequally long and 1.1 times longer than first endopodal segment. Claw GM as long as G2; Gm 2.6 times longer than terminal segment. All claws serrated. L ratios of three endopodal segments equal 3.8 : 2.5 : 1.

T1 (Figure 3J): L ratios of three endopodal setae equal 1 : 1.5 : 2.

Fu and genital field (Figure 4I): L ratios of anterior margin, anterior and posterior claw equal 1.8 : 1.2 : 1. Anterior seta very short (reaching only 1/4 of anterior claw), posterior seta exceeding distal end of posterior margin. Furcal ramus with bunch of hairs proximally. Caudal seta short. Genital field with finger-shaped extension which thin and with pointed tip. Genital process equals 73% of L of anterior furcal margin.

All other soft parts same as in male.

### Variability

Except of the L, no other variability has ever been recorded.

### Remarks and affinities

*Candona decora* was originally described from Ohio (Furtos 1933). Hoff (1942) and Delorme (1970) described each a new species from Illinois, and Canada, respectively. After examination of the type material of the Illinois species I could not find any difference between it and *C. decora*, and therefore *C. fossulensis* Hoff, 1942 is synonymized with *C. decora*. This species is characterized by a row of

very short hairs on right prehensile palp, and distinctly serrated distal margin of the part "g". Following these characteristics alone, *Candona decora* could not be confused with any other *Candona* species. Unfortunately, I was unable to trace Delorme's (1970) material, but, according to his descriptions and photographs, there is no doubt that *Candona facetus* Delorme, 1970 is also a junior synonym of *C. decora*.

### Distribution

Distributed in the northern part of North America.

### *Candona (Candona) lingulata* Cole, 1965

Figure 5

*Candona lingulata* Cole 1965: 132, Figures 1–11.

### Material examined

#### *Holotype*

Female (dissected on one slide – USNM 120553), USA, Tennessee, Cheatham Country, Kingston Springs, woodland pond, 18 October 1958, collector M. E. Cole.

#### *Allotype*

Male (dissected on one slide – USNM 120554), USA, Tennessee, Cheatham Country, Kingston Springs, woodland pond, 18 October 1958, collector M. E. Cole.

### Redescription

*Male.* Carapace elongated in lateral view. L of carapace equals 1.2 mm. Greatest H lies behind middle and equals about 50% of L. Dorsal margin almost straight. Both posterior and anterior margins evenly rounded, and almost equally wide. Ventral margin markedly concave around mouth region. Inner calcified lamella very narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with warts and short dense hairs.

A1 (Figure 5A): 7-segmented. Seta En1a reaching distal end of En5. En3 with two anterior setae (En3a and En3b) which reach slightly beyond terminal segment, and shorter En3d (reaching middle of En5). En4 also with two longer setae (En4a and En4b) and shorter posterior seta (En4d) reaching distal end of En6. Penultimate segment with two long setae: En5a and En5b; En5c and En5d both claw-like and about three times longer than terminal segment. Alpha seta 1.5 times longer than terminal segment. Terminal segment with one long setae (En6b); setae En6c and En6d both short, latter one claw-like. Aesthetasc ya short, 1.5 times longer than En6. L ratios of endopodal segments equal 1.3 : 1 : 1.3 : 1.3 : 1.5 : 1.3.

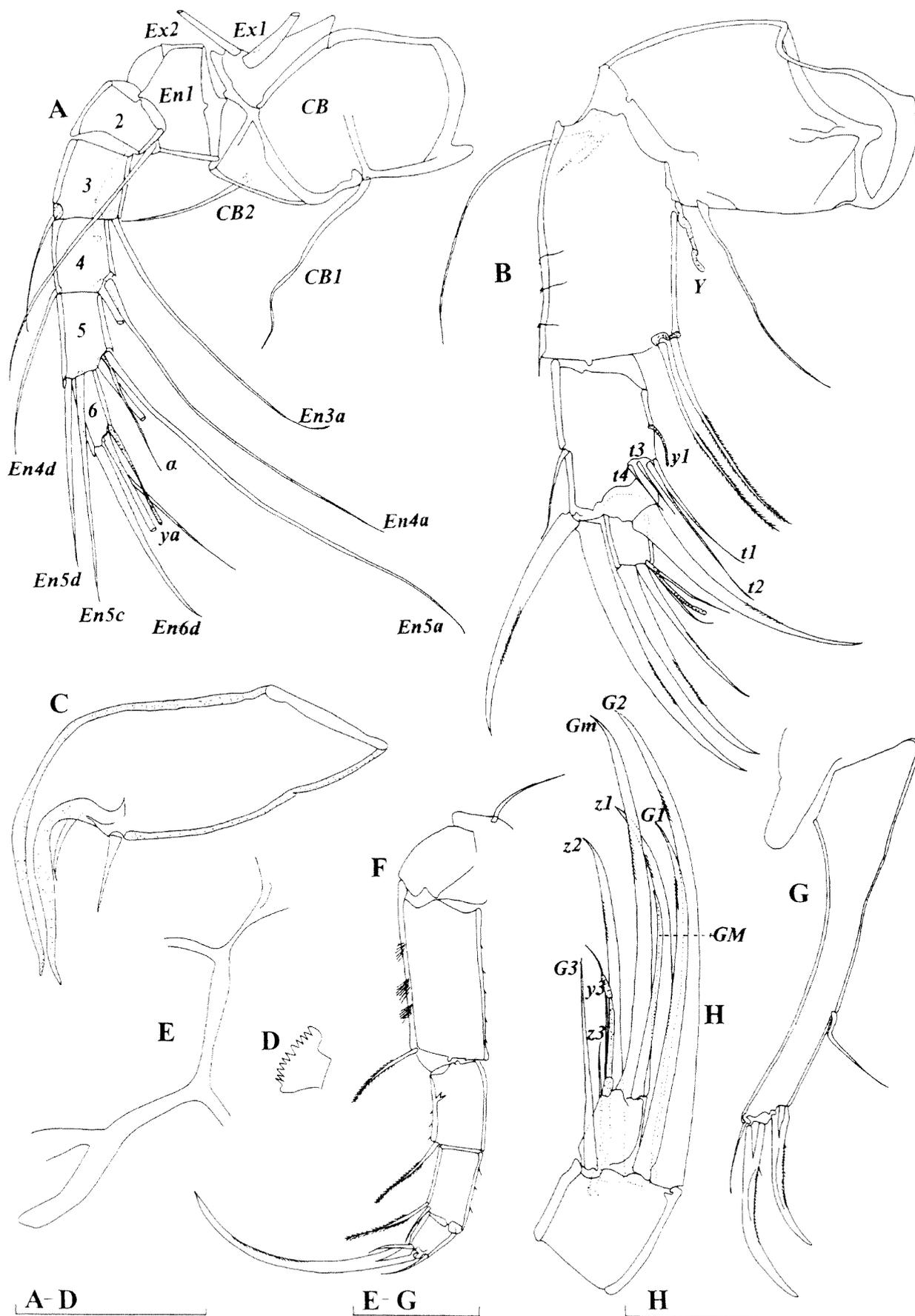


Figure 5 *Candona (Candona) lingulata* Cole, 1965. A, C, Allotype male (USNM 120554); B, D-H, Holotype female (USNM 120553): A - A1; B - A2; C - Right prehensile palp; D - Rake-like organ; E - Furcal attachment; F - T2; G - Fu with genital process; H - A2 (two terminal segments). Scales = 0.1 mm.

A2 (Figure 5H): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, latter one seta-like and 2.9 times longer than terminal segment; claw G1 five times longer than same segment. Claw G2 long and 1.2 times longer than first endopodal segment. Claw GM reduced and 2.8 times longer than terminal segment. Claw Gm well developed and as long as first endopodal segment. Setae z1 and z2 transformed into claws, both approximately as long as first endopodal segment. All claws serrated. Seta z3 two times longer than terminal segment. L ratios of endopodal segments equal 5 : 2.2 : 1.4 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md: With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 5D): with 11 and 12 small teeth.

T1 (Figure 5C): Palps almost symmetrical – fingers hook-shaped, subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2: Terminal claw 1.2 times longer than three distal segments combined.

T3: Similar to previous species.

Fu: L ratios of anterior margin, anterior and posterior claws equal 2 : 1.2 : 1. Anterior seta reaching 1/4 of anterior claw; posterior seta exceeding distal end of posterior margin. Both claws serrated. Furcal ramus curved.

Hemipenis: Dorsal extension of lobe a subdivided in to two thong-like parts; proximal one with blunt tip, distal one with pointed tip. Lobe b rounded. Lobe h rounded and small, part g foot-like.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace with more rounded dorsal margin than in male, ventral margin almost straight. L of carapace equals 1.3 mm. Greatest H situated on last third and equals about 50% of L. Calcified inner lamella very narrow. No inner lists present.

A2 (Figure 5B): all t-setae present. Setae z1, z2 and z3 not observed. Claw G2 long and as long as first endopodal segment. Claws G1 and G3 subequally long and 1.2 times longer than first endopodal segment. Claw GM as long as G2; Gm 2.5 times longer than terminal segment. All claws serrated. L ratios of three endopodal segments equal 1.8 : 2 : 1.

Fu and genital field (Figure 5G): L ratios of anterior margin, anterior and posterior claw equal 2.2 : 1.3 : 1. Anterior seta short (reaching 1/3 of anterior claw), posterior seta exceeding distal end of posterior margin. Caudal seta short. Genital lobe with finger-shaped extension which thick and with blunt tip. Genital process equals only about 40% of L of anterior furcal margin. Furcal attachment shown on Figure 5E.

### Variability

Not known in this species.

### Remarks and affinities

This species also belongs to the *acuminata*-group and can be distinguished from the other representatives of this group by a completely subdivided dorsal extension of the lobe "a". In many species of the subgenus *Candona* this lobe is subdivided to some extent, but not as markedly as in *C. lingulata*. Unfortunately, the slide of the allotype male is in very poor condition so the drawings of the hemipenis are not provided in this paper. The appearance of the genital process is most similar to *Candona uliginosa* Furtos, 1933, species known only from females. However, the two species differ in the appearance of the rake-like organ and carapace. In addition, the genital process is somewhat smaller in *Candona lingulata*, and distinctly more rounded.

### Distribution

Known only from Tennessee (Cole 1965).

### *Candona (Candona) ohioensis* Furtos, 1933

Figure 6

*Candona ohioensis* Furtos, 1933: 475, Plate 9, Figures 19–20, Plate 10, Figures 8–12.

*Candona ohioensis* Furtos, 1933 – Delorme (1970): p. 1111, Figures 171–184.

### Material examined

#### *Paratype*

Male (dissected on one slide – USNM 67874), USA, Ohio, Bass Lake, 15 November 1931, collector N. C. Furtos.

### Redescription

*Male.* Carapace elongated in lateral view. L approximately 1.8 mm. Greatest H lies on last third of carapace and equals about 40% of L. Dorsal margin almost straight and slightly inclined towards anterior end. Both posterior and anterior margins evenly rounded, and almost equally wide. Ventral margin markedly concave around mouth region. Inner calcified lamella very narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with warts and short dense hairs.

A1 (Figure 6C): 7-segmented. Swimming setae thick and relatively short. Seta En1a reaching distal end of En5. Seta En2a reaching middle of En4. En3 with two long, thick anterior setae (En3a and En3b), and short En3d (reaching only of En5). En4 also with two long thick anterior setae (En4a and En4b) and short posterior setae, En4d exceeding distal end

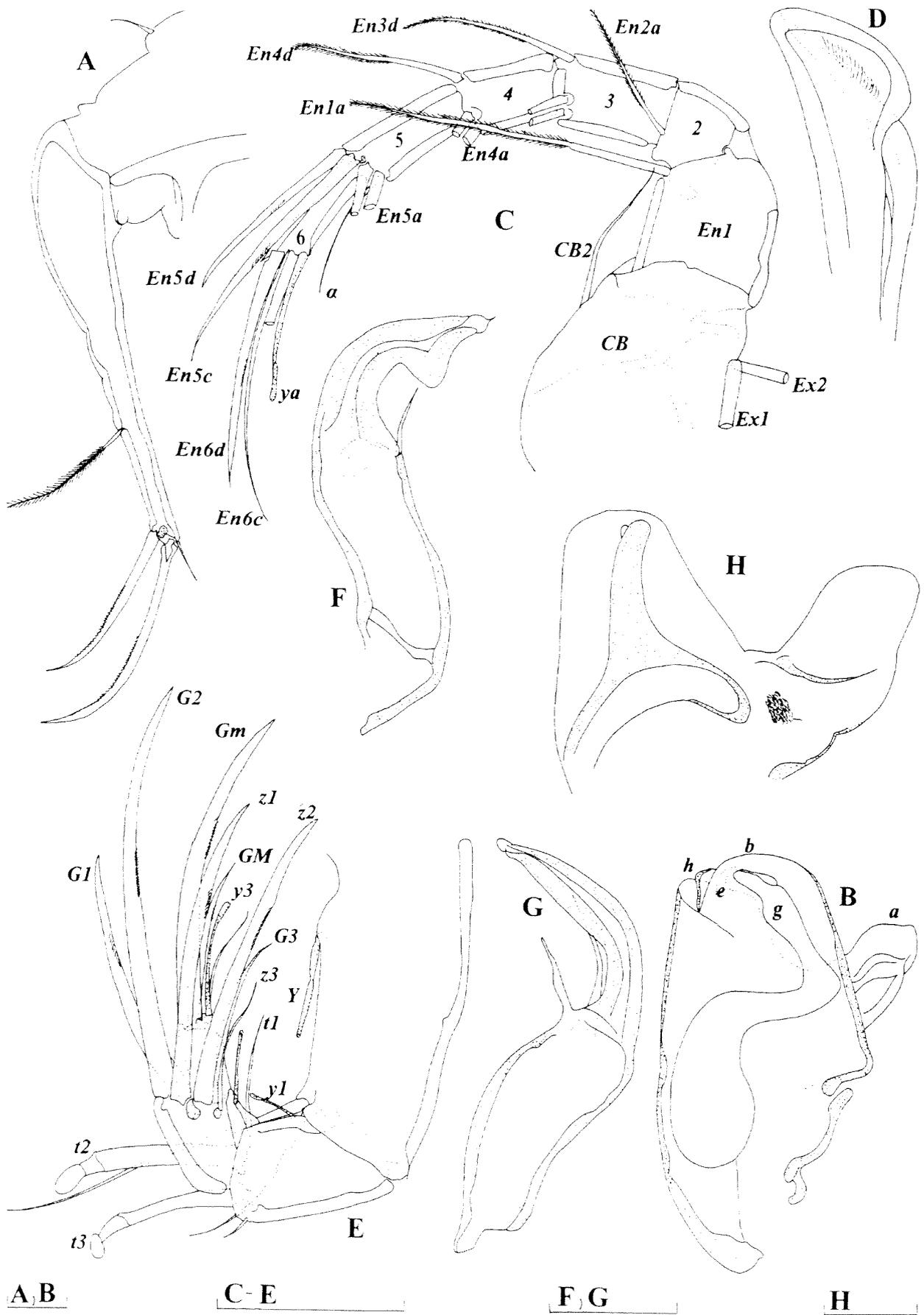


Figure 6 *Candona (Candona) ohioensis* Furtos, 1933. Paratype male (USNM 67874): A - Fu; B - Hemipenis; C - A1; D - Distal part of "g"; E - A2; F - Left prehensile palp; G - Right prehensile palp; H - distal part of hemipenis. Scales = 0.1 mm.

of En6. Penultimate segment with two long thick setae (En5a, En5b). Setae En5c and En5d claw-like and exceeding distal end of terminal segment. Alpha seta reaching distal end of terminal segment. Terminal segment with one long, thick seta (En6c) and two short ones – En6c and En6d, which subequally long, latter one also claw-like. Aesthetasc ya as long as En6. L ratios of endopodal segments equal 1.8 : 1 : 1.7 : 1.4 : 1.8 : 1.8.

A2 (Figure 6E): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, latter one seta-like and 1.9 times longer than terminal segment. Claw G1 2.9 times longer than terminal segment. Claw G2 long and 1.3 times longer than first endopodal segment. Claw GM reduced and 1.8 times longer than terminal segment. Claw Gm well developed and as long as first endopodal segment. Setae z1 and z2 transformed into claws, equally long and slightly shorter than first endopodal segment. All claws serrated. Seta z3 exceeds distal end of terminal segment. All aesthetascs observed, all short. L ratios of endopodal segments equal 3.7 : 1.6 : 1.1 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md: With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

T1 (Figure 6F, G): Palps asymmetrical – left one (Figure 6F) with ventral bump on finger. On both palps fingers hook-shaped, subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2: Terminal claw 1.2 times longer than three distal segments combined.

T3: 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 1.9 : 2.6. Th1 seta 3.5 times longer than terminal segment.

Fu (Figure 6A): L ratios of anterior margin, anterior and posterior claws equal 1.8 : 1.3 : 1. Anterior seta reaching 1/4 of anterior claw; posterior seta exceeding distal end of posterior margin. Both claws serrated. Furcal ramus straight. Caudal seta short.

Hemipenis (Figure 6B): Lobe a elliptical and with blunt tip (Figure 6H). Lobe b rounded. Lobe h rounded and small, part g foot-like (Figure 6D). Ejaculatory process (Figure 3D, F) "S"-shaped and with sharp, pointed tip. Lobes a and b ornamented with chitinized patches.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace with more inclined dorsal margin towards posterior margin, posterior margin clearly narrower than anterior one. Greatest H situated on last third and equals about 44% of L. Calcified inner lamella very narrow.

Fu and genital field: L ratios of anterior margin, anterior and posterior claw equal 2.1 : 1.1 : 1. Anterior seta very short (reaching only 1/4 of anterior claw), posterior seta exceeding distal end of posterior margin. Genital field with finger-shaped extension which thin and with pointed tip. Genital process equals 76% of L of anterior furcal margin.

### Variability

No significant variability is recorded.

### Remarks and affinities

This species can be distinguished from other representatives of the *acuminata*-group by the presence of the ventral, well-chitinized bump on the finger of the left prehensile palp. Part "g" is very similar to that of *Candona peircei* Turner, 1895, *C. sigmoides* Sharpe, 1897, *C. tahoensis* Ferguson, 1966, *C. decora* Furtos, 1933 and *C. levanderi* Hirschmann, 1912. The first species additionally differs from *C. ohioensis* by the shape of lobe "a" and the genital process. *Candona sigmoides* has characteristically "S"-shaped furcal claws and a much shorter swimming setae on A1. *Candona tahoensis* has a typical appearance of the valves with well-expressed inner list, and the right prehensile palp is more stocky than in *C. ohioensis*. *Candona decora* has a typical appearance of lobe "g" and the prehensile palps (see previously). *Candona levanderi* differs from *C. ohioensis* by a distinct subdivision of the dorsal extension of the lobe "a".

### Distribution

Known from Canada (Delorme 1970) and Ohio (Furtos 1933).

### *Candona (Candona) peircei* Turner, 1895

Figures 7, 8

*Candona Peircei* Turner, 1895: 301, Plate 80.

*Candona eriensis* Furtos, 1933: p. Plate 8, Figures 11–14; Plate 12, Figures 8–10. [new synonymy]

*Typhlocypris peircei* Turner, 1895: Sharpe 1918: p. 823, Figure 1292.

### Material examined

One female (dissected on one slide – USNM 67870, labeled as *Candona eriensis*, Holotype) and one male (dissected on one slide – USNM 67870, labeled as *Candona eriensis*, Paratype), USA, Ohio, Lake Erie, 12 Jun 1932, collector N. C. Furtos.

### Redescription

*Male.* Carapace elongated, slightly reniform in lateral view. L of carapace equals 1.15 mm. Greatest

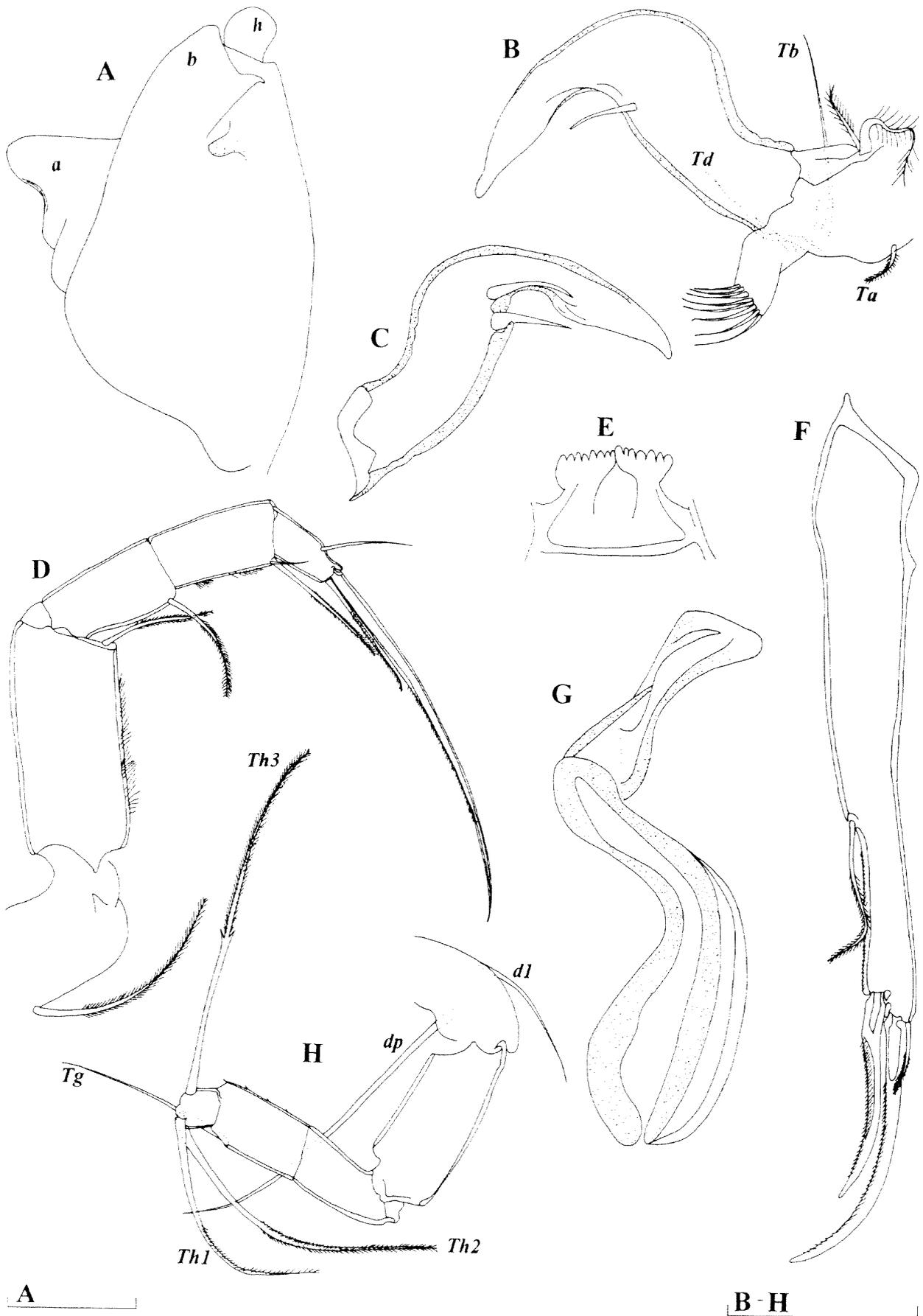


Figure 7 *Candona (Candona) peircei* Turner, 1895. A-D, F, G, Male (USNM 67870); E, H, Female (USNM 67870): A - Hemipenis; B - right prehensile palp; C - Left prehensile palp; D - T2; E - Rake-like organ; F - furca; G - Part "g"; H - T3. Scales = 0.1 mm.

H lies on last third and equals about 50% of L. Dorsal margin sloping evenly towards anterior end, and inclined towards posterior end. Both posterior and anterior margins rounded, anterior one being wider than posterior. Ventral margin markedly concave around mouth region. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with warts and short dense hairs.

A1: 7-segmented. Swimming setae thick and relatively short. Seta En1a reaching distal end of En6. Seta En2a reaching distal end of En3. En3 with two thick anterior setae (En3a and En3b), posteriorly with seta En3d (reaching distal end of En6). En4 with two thick anterior setae (En4a and En4b) and posterior seta (En4d) exceeding distal end of En6. Penultimate segment with two thick setae En5a, En5b; En5c and En5d claw-like and exceeding distal end of En6. Alpha seta also exceeds distal end of terminal segment. Only seta En6d on terminal segment observed, which claw-like. Aesthetasc ya short, two times longer than En6. L ratios of endopodal segments equal 1.4 : 1.3 : 1.4 : 1 : 1.2 : 1.5.

A2 (Figure 8F): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, latter one seta-like, while G1 claw-like and 4.5 times longer than terminal segment. Claw G2 1.6 times longer than first endopodal segment. Claw GM reduced and 2.5 times longer than terminal segment. Claw Gm 1.3 times longer than first endopodal segment. Setae z1 and z2 transformed into claws, subequally long and both 1.2 times longer than first endopodal segment. All claws serrated. Seta z3 exceeds distal end of terminal segment. Aeshetasc Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 3.7 : 1.7 : 1.4 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md (Figure 8C): With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 7E): With seven and eight teeth.

T1 (Figure 7B, C): Palps symmetrical. On both palps fingers hook-shaped, subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2 (Figure 7D): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, exceeding distal end of following segment. Penultimate segment with two setae, longer one 1.2 times longer than same segment. Terminal segment with two setae and claw, which 1.3 times longer than three distal segments combined.

T3 (Figure 7H): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of

three terminal setae equal 1 : 1.4 : 1.8. Th1 seta five times longer than terminal segment.

Fu (Figure 7F): L ratios of anterior margin, anterior and posterior claws equal 2.6 : 1.3 : 1. Anterior seta reaching 1/4 of anterior claw; posterior seta slightly exceeding distal end of posterior margin. Both claws serrated. Furcal ramus not curved.

Hemipenis (Figure 7A): Lobe a elliptical and with blunt tip; its dorsal margin sinusoid and semi-divided with incomplete septa. Lobe b rounded. Lobe h rounded and small, part g foot-like (Figure 7G), heel not pronounced, part g also with flat distal margin. Lobe b ornamented with one chitinized patch, which looks like duck beak.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace more elongated than in male, ventral margin almost straight. L approximately 1.15 mm. Greatest H situated on last third and equals about 42% of L. Calcified inner lamella narrow.

A2 (Figure 8E): all t-setae present. Seta z1 not observed, while z2 and z3 not reaching distal end of terminal segment. Claw G2 four times longer than last segment. Claws G1 and G3 subequally long and 1.4 times longer than first endopodal segment. Claw GM slightly longer than first endopodal segment; Gm 4.2 times longer than terminal segment. All claws serrated. L ratios of three endopodal segments equal 5 : 2.7 : 1.

Fu and genital field (Figure 8D): L ratios of anterior margin, anterior and posterior claw equal 2.6 : 1.3 : 1. Anterior seta short (reaching only 1/4 of anterior claw), posterior seta reaching distal end of posterior margin. Furcal ramus with bunch of hairs proximally, also ramus slightly curved. Caudal seta short. Genital field with more conically shaped extension which thin and with pointed tip, generally looking like pipette. Genital process equals 50% of L of anterior furcal margin.

A1 (Figure 8A) and other soft parts same as in male.

### Variability

According to the Turner's (1895) drawings, the dorsal extension of lobe "a" is much smaller than is presented in Figure 7A in this paper. However, the original drawings of the whole hemipenis is very inaccurate and obscure.

### Remarks and affinities

After rechecking the type material of *Candona eriensis*, described from Ohio (Furtos 1933) it became clear that this is a junior synonym of *Candona peircei*, because they share a low carapace, almost symmetrical prehensile palps (both with strongly sinusoidal dorsal margin), both have short and stout swimming setae on the A1, the posterior

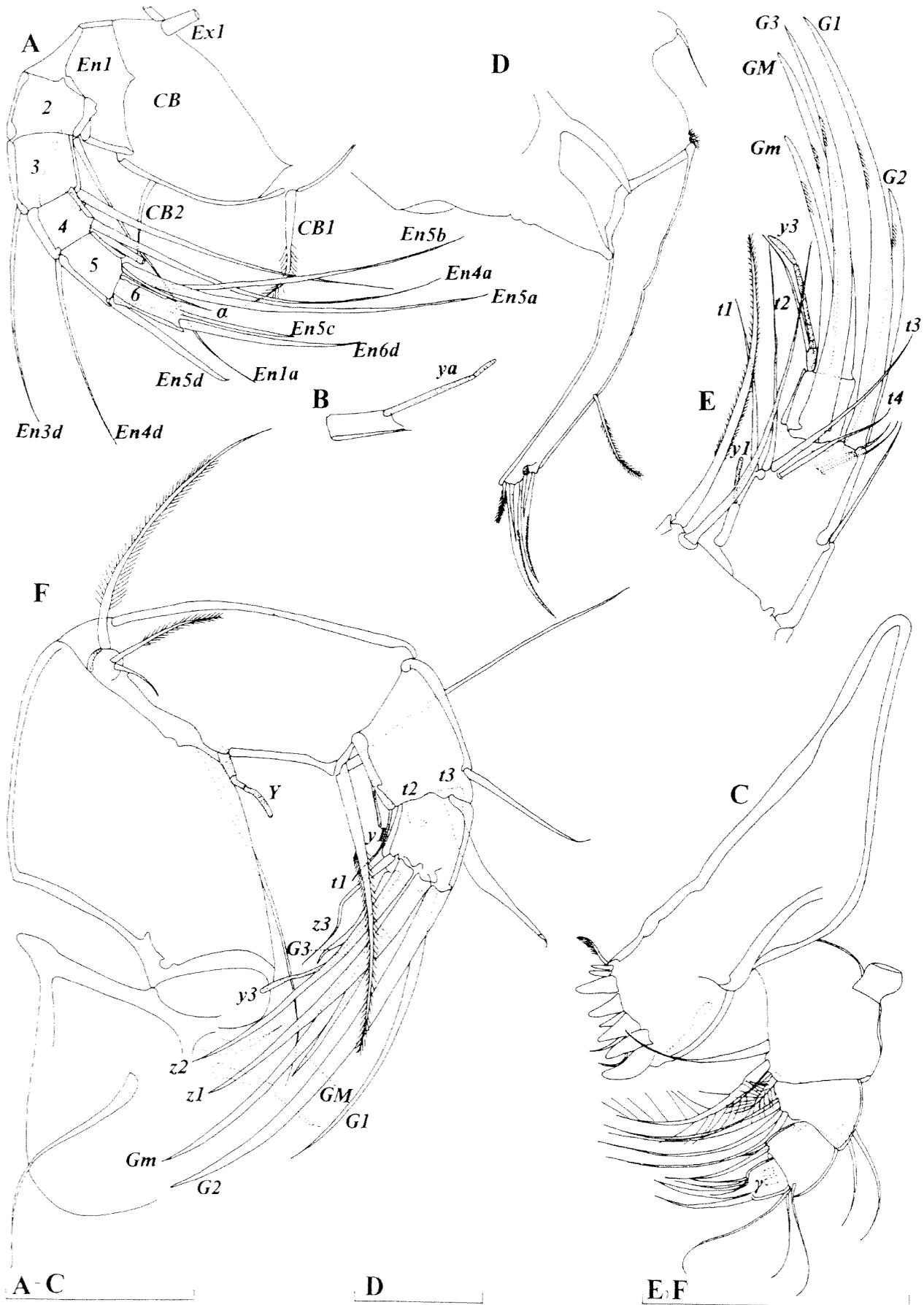


Figure 8 *Candona (Candona) peircei* Turner, 1895. A, B, D, E, Female (USNM 67870); C, F, Male (USNM 67870): A - A1; B - Terminal segment A1; C - Md-palp; D - Fu with genital process; E - A2 (two terminal segments); F - A2. Scales = 0.1 mm.

furcal claw is much shorter than the anterior one (especially prominent in females). *Candona peircei* is most closely related to *Candona levanderi* with which it shares a similar hemipenis appearance, and almost identical prehensile palps. However, these two species differ by many other details, the major ones are: 1. the higher valves in *C. levanderi*; 2. a different shape of the distal part of the part "g"; 3. the genital process is more finger-shaped in *C. levanderi*, while it is conical in *C. peircei*. The combinations of the following characteristics clearly separates *C. peircei* from all the other species of the genus *Candona*: the part "g" has flat distal margin; the genital process is conical and it terminates with a pipette-like tip; and the posterior furcal claw is prominently shorter than the anterior one.

### Distribution

The species is known from Georgia and Ohio (Furtos 1933).

### *Candona (Candona) sigmoides* Sharpe, 1897

Figures 9, 10

*Candona sigmoides* Sharpe, 1897: 455; Plate 45, Figures 4–11.

*Candona sigmoides* Sharpe, 1897: Sharpe 1918: 825, Figure 1298; Hoff 1942: 82, Plate 3, Figures 36–38; Delorme 1970: 1119, Figures 283–294.

*Candona simpsoni* Sharpe, 1897: 452, Plate 46, Figures 1–6. [new synonymy]

*Candona simpsoni* Sharpe, 1897: Sharpe 1918: 825, Figure 1296; Hoff 1942: 62, Plate 2, Figures 12–17.

*Candona scopulosa* Furtos, 1933: 479, Plate 8, Figures 7–10, Plate 12, Figures 11–13. [new synonymy]

*Candona candida* (O. F. Müller, 1776): Dobbin 1941: 242, Plate 4, Figures 4–11. [misidentification]

### Material examined

One female (dissected on one slide – USNM 67876, labeled as *Candona scopulosa*, Holotype) and one male (dissected on one slide – USNM 67876, labeled as *Candona scopulosa*, Paratype) from: USA, Ohio, Lake Erie, Starve Island, 11 July 1931, collector N. C. Furtos.

### Redescription

*Male*. Carapace elongated, slightly reniform in lateral view. L of carapace varies from 1.18 mm to 1.4 mm. Greatest H lies on last third and equals about 51% of L. Dorsal margin sloping evenly towards anterior end, and rounded towards posterior end. Both posterior and anterior margins rounded, anterior one being wider than posterior. Ventral margin markedly concave around mouth

region. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with warts and short dense hairs. Selvage peripheral.

A1 (Figure 10E): 7-segmented. Swimming setae thick and relatively short. Seta En1a reaching distal end of En5. Seta En2a as long as En1a. En3 with two thick anterior setae (En3a and En3b), posteriorly with seta En3d (reaching distal end of En5). En4 with two thick anterior setae (En4a and En4b) and posterior seta (En4d) reaching distal end of En6. Penultimate segment with two thick setae En5a, En5b; En5c and En5d claw-like and exceeding distal end of En6. Alpha seta also exceeds distal end of terminal segment. Terminal segment with only En6b seta-like, other setae claw-like and short. Aesthetasc ya short, 1.7 longer than En6. L ratios of endopodal segments equal 1.4 : 1 : 1.4 : 1 : 1.25 : 1.1.

A2 (Figure 9G): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, latter one seta-like, while G1 claw-like and 3.5 times longer than terminal segment. Claw G2 1.3 times longer than first endopodal segment. Claw GM reduced and three times longer than terminal segment. Claw Gm well developed and as long as first endopodal segment. Setae z1 and z2 transformed into claws, subequally long and both as long as first endopodal segment. All claws serrated. Seta z3 exceeds distal end of terminal segment. Only Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 4.8 : 2 : 1.4 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md: With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 9I): With seven and eight teeth.

T1 (Figure 9B, C): Palps symmetrical. On both palps fingers hook-shaped, subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2 (Figure 10D): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, exceeding distal end of following segment. Penultimate segment with two setae, longer one 1.2 times longer than same segment. Terminal segment with two setae and claw, which 1.2 times longer than three distal segments combined.

T3 (Figure 10C): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 1.9 : 2. Th1 seta 3.5 times longer than terminal segment.

Fu (Figure 9D): L ratios of anterior margin, anterior and posterior claws equal 2 : 1.1 : 1. Anterior seta reaching 1/3 of anterior claw;

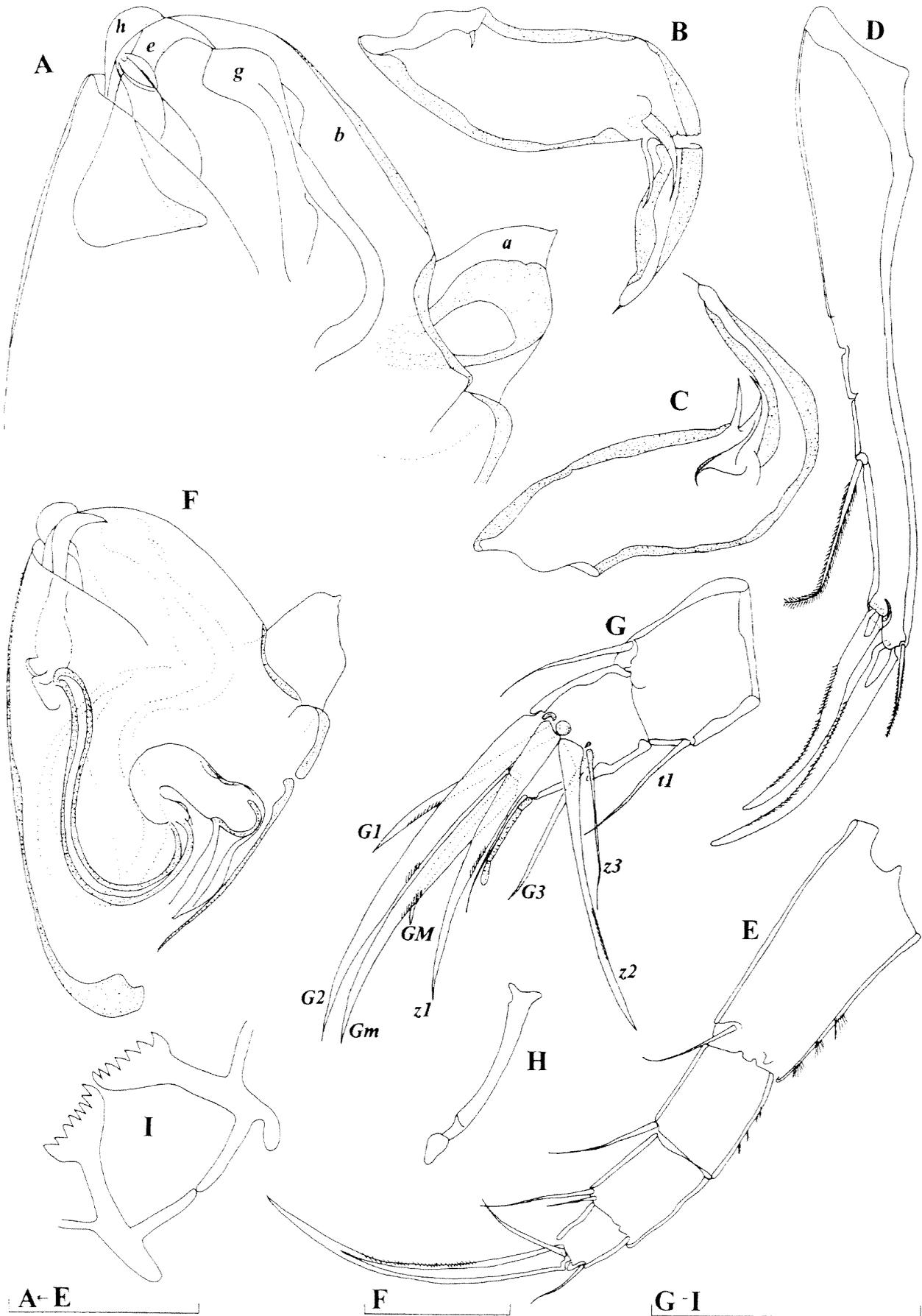
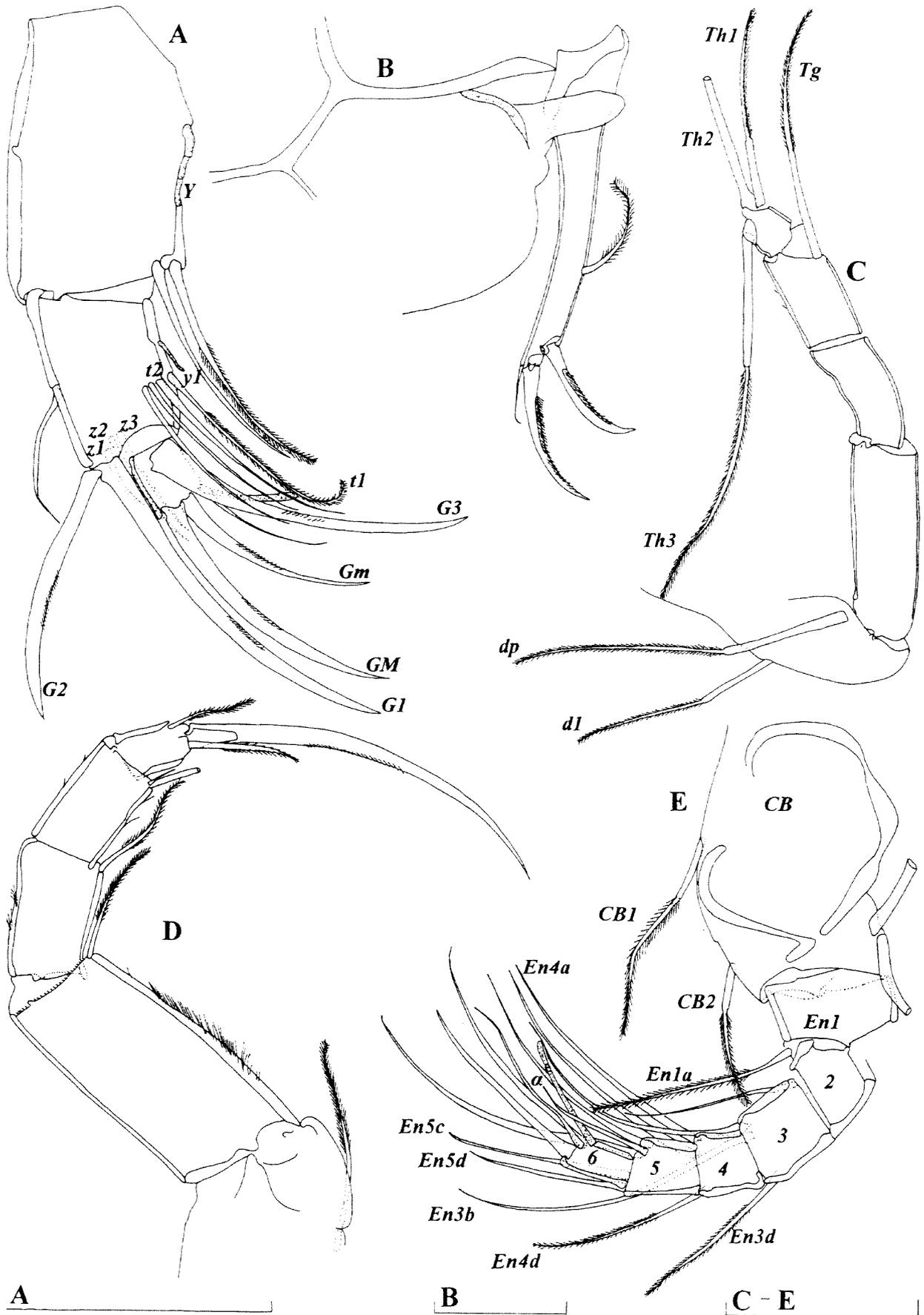


Figure 9 *Candona (Candona) sigmoides* Sharpe, 1897. A-D, F-H, Male (USNM 67876), E, I, Female (USNM 67876): A - Hemipenis, distal part; B - Left prehensile palp; C - Right prehensile palp; D - Fu; E - T2; F - Hemipenis; G - A2 (three distal segments); H - Male sexual bristle; I - Rake-like organ. Scales = 0.1 mm.



**Figure 10** *Candona (Candona) sigmoides* Sharpe, 1897. A, B, Female (USNM 67876); C-E, Male (USNM 67876); A - A2; B - Fu with genital prosecc; C - T3; D - T2; E - A1. Scales = 0.1 mm.

posterior seta exceeding distal end of posterior margin. Both claws serrated. Furcal ramus slightly curved. Posterior claw "S"-shaped.

Hemipenis (Figure 9A, F): Lobe a elliptical and with slightly pointed tip. Lobe b rounded. Lobe h rounded and small, part g foot-like, with short ventral part, generally more like boxing glove. Ejaculatory process "S"-shaped and with sharp tip. Lobes b and a ornamented with chitinized patches.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace slightly trapezoidal, ventral margin almost straight. L varies from 0.93 mm to 1.00 mm. Greatest H situated on last third and equals about 51% of L. Calcified inner lamella narrow. Selvage peripheral.

A2 (Figure 10A): all t-setae present. Seta z1 claw-like and very short (not reaching distal end of terminal segment). Setae z2 and z3 exceeding distal end of terminal segment. Claw G2 four times longer than last segment. Claws G1 and G3 subequally long and 1.25 times longer than first endopodal segment. Claw GM as long as first endopodal segment; Gm three times longer than terminal segment. All claws serrated. L ratios of three endopodal segments equal 5 : 2.6 : 1.

T2 (Figure 9E): claw shorter than in male.

Fu and genital field (Figure 10B): L ratios of anterior margin, anterior and posterior claws equal 2.1 : 1.2 : 1. Anterior seta short (reaching 1/3 of anterior claw), posterior seta reaching distal end of posterior margin. Ramus slightly curved. Claws serrated. Genital field with finger-shaped extension which thin and with blunt tip. Genital process equals 44% of L of anterior furcal margin.

Other soft parts same as in male.

### Variability

There is a small variability in the appearance of the prehensile palps. According to Sharpe's (1897) drawings, right prehensile palp has a much more elongated finger than described by other authors who reported *C. sigmoides* or its junior synonyms (Furtos 1933, Dobbin 1941, Hoff 1942, Delorme 1970). In addition, some variability exists in the appearance of the furcal claws (see further in the text)

### Remarks and affinities

The characteristically "S"-shaped posterior furcal claw in male is the major reason why I synonymized *C. scopulosa* with *C. sigmoides*. Although Sharpe (1897) did not provide drawings of the hemipenis, further report of this species support this new synonym. Dobbin (1941) reported *Candona candida* (Brady, 1845) from Oregon. However, the prehensile palps, illustrated by Dobbin (1941), are very different from *C. candida*, and actually they look like the prehensile palps of

*C. sigmoides*. In addition, other details of Dobbin's (1941) record are very similar to the latter species. Hoff (1942) also recorded *Candona sigmoides*, however the female of this species has a carapace similar to *C. caudata*. On the other hand, males are almost identical with the original description. It is possible that Hoff (1942) had a female of *C. caudata* Kuafmann, 1900 and a male of *C. sigmoides*. Unfortunately, I was unable to obtain this material. Sharpe (1897) described the species *C. simpsoni*, but only from a juvenile specimen. This species has also a "S"-shaped furcal claw, which is why it is synonymized with *C. sigmoides*. Hoff (1942) reported a population of *Candona simpsoni* from Illinois with variable appearance of the furcal claws: some specimens with "S"-shaped, some with completely straight claw. *Candona sigmoides* is most closely related to *Candona levanderi* Hirschmann, 1912 from which it differs by the appearance of the dorsal extension of the lobe "a" (it has a clear suture in the latter species), and by the appearance of the carapace in dorsal view (in *C. levanderi* LV has a lobe-like, serrated extension situated postero-distally). *Candona sigmoides* is also similar to *C. peircei* Turner, 1895 from which it differs by the appearance of the lobes "a" and "g" and the shape of the genital process. *Candona sigmoides* can be easily confused with the other representatives of the group known only from females that also have a finger-like genital process. These species are: *C. caudata*, *C. siliquosa* (Brady, 1910) and *C. uliginosa* Furtos, 1933. From the first species *C. sigmoides* should differ by the absence of a keel on the valves (but see previous remarks in *C. caudata*, and the remarks on the Hoff's records) and by a more blunted genital process. *C. siliquosa* is lower than *C. sigmoides*, while *C. uliginosa* has a shorter En1a seta, more curved furcal ramus, more pointed genital process and the rake-like organ with small, numerous teeth.

### Distribution

This species has a wide North American distribution.

### *Candona (Candona) suburbana* Hoff, 1942

Figures 11, 12

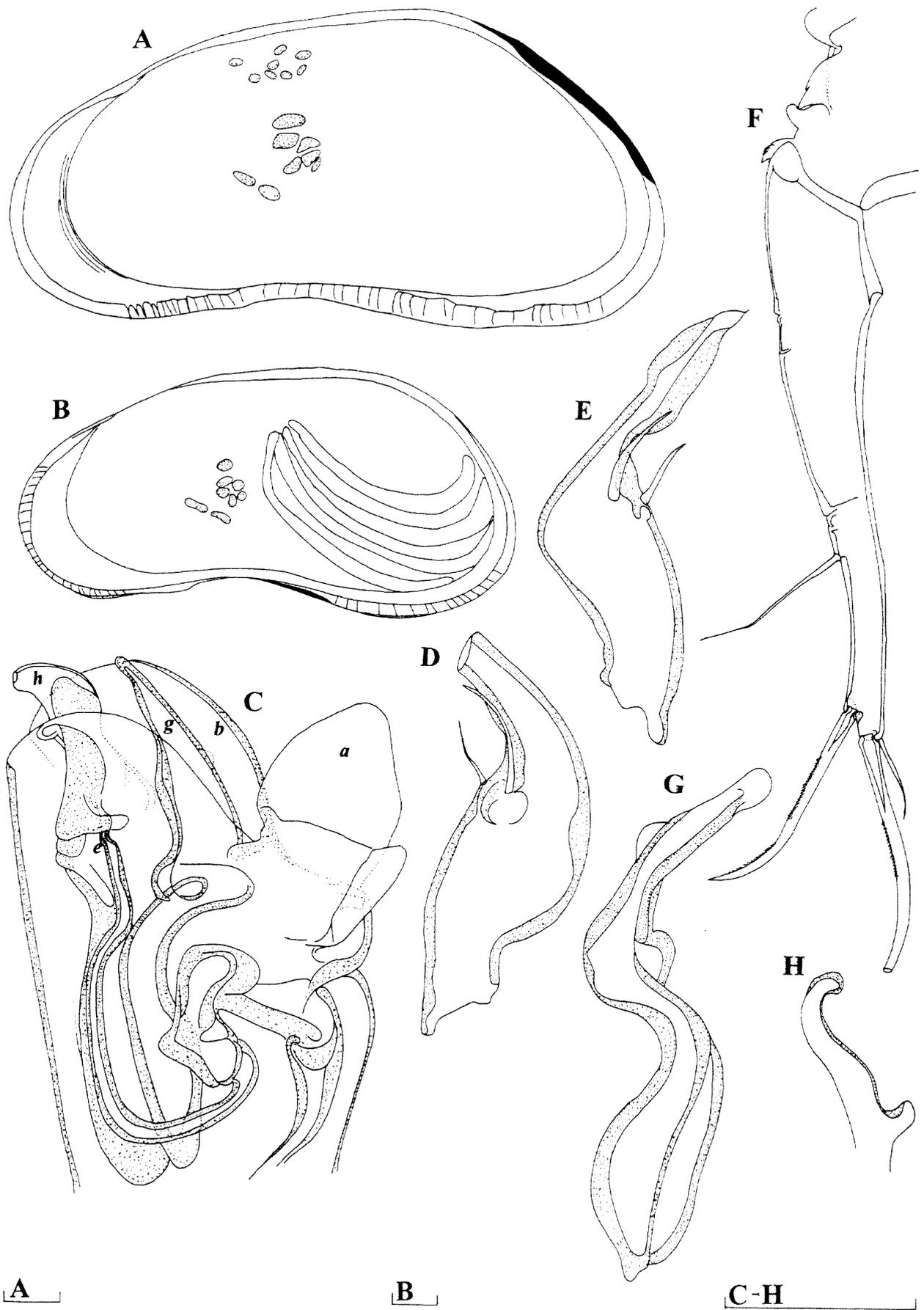
*Candona suburbana* Hoff, 1942: 88, Plate 4, Figures 49–54, Plate 5, Figures 55–57.

[non] *Candona suburbana* Hoff, 1942: Delorme 1970: 1121, Figures 332–339. [misidentification]

### Material examined

#### *Holotype*

Male (dissected on one slide – USNM 81073) and allotype female (dissected on one slide – USNM 81072) from (Type Locality): USA, Illinois,



**Figure 11** *Candona (Candona) suburbana* Hoff, 1942. A, Allotype female (USNM 81072); B-H, Holotype male (USNM 81073): A - RV, internal view; B - RV, internal view; C - Hemipenis; D - Right prehensile palp; E - Left prehensile palp; F - Fu; G - part "g"; H - distal part of ejaculatory process. Scales = 0.1 mm.

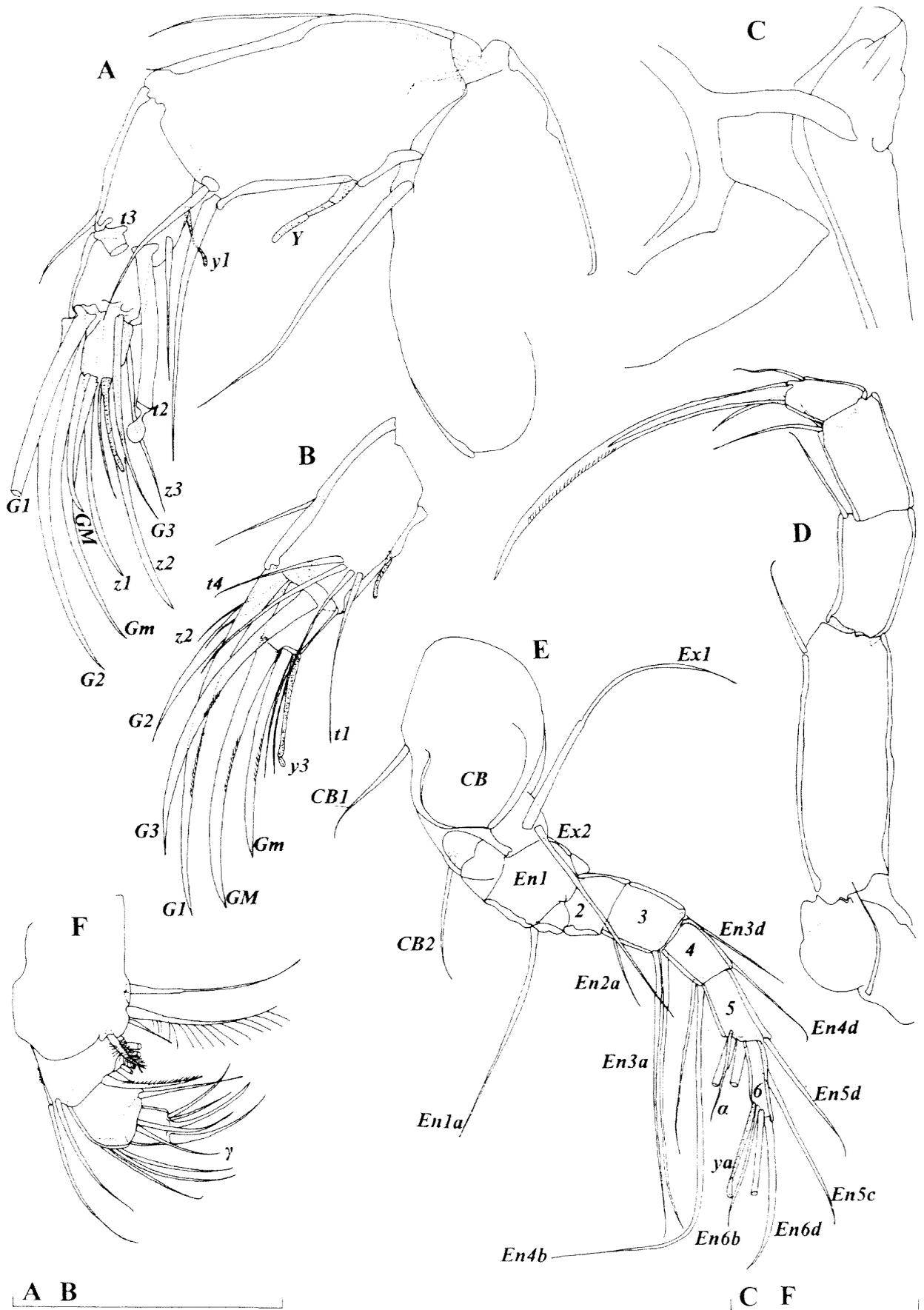


Figure 12 *Candona (Candona) suburbana* Hoff, 1942. A, D-F, Holotype male (USNM 81073); B, C, Allotype female (USNM 81072): A - A2; B - A2 (two distal segments); C - Proximal part of Fu with genital process; D - T2; E - A1; F - Md-palp. Scales = 0.1 mm.

Champaign Country, Urbana, Bussey's pasture, 09 June 1940, collector C. C. Hoff.

### Redescription

*Male.* Carapace subreniform in lateral view (Figure 11B). L of carapace approximately 1.14 mm. Greatest H lies behind middle and equals about 50% of L. Dorsal margin gradually sloping down towards anterior margin, and slightly inclined towards posterior one. Both posterior and anterior margins widely rounded, anterior one being wider than posterior. Ventral margin markedly concave around mouth region and with small protrusion on its first third. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Selvage peripheral and narrow. Carapace surface covered with warts and short dense hairs.

A1 (Figure 12E): 7-segmented. Swimming setae thin, but relatively short. Seta En1a reaching distal end of En5. Seta En2a reaching middle of En4. En3 with two anterior setae (En3a and En3b), and posterior seta – En3d (reaching only middle of En5). En4 with two anterior setae (En4a and En4b) and posterior setae (En4d) which not reaching distal end of En5. Penultimate segment with two longer setae En5a, En5b; setae En5c and En5d claw-like and both well exceeding distal end of terminal segment. Alpha seta short. Terminal segment with one long, thin seta (En6c), seta En6b short; En6d claw-like. Aesthetasc ya short, only slightly longer than En6. L ratios of endopodal segments equal 1.6 : 1 : 1.4 : 1.2 : 1.6 : 1.6.

A2 (Figure 12A): 5-segmented. Male bristles (t2 and t3) developed. Claws G3 reduced, latter one seta-like. G2 broken, but obviously long and claw-like. Claw GM reduced and two times longer than terminal segment. Claw Gm 0.9 times as long as first endopodal segment. Setae z1 and z2 transformed into claws, z1 slightly shorter than z2 and both approximately as long as first endopodal segment. All claws serrated. Seta z3 almost three times longer than terminal segment. Only aesthetascs Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 4.4 : 1.9 : 1.1 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md (Figure 12F): With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and two setae.

T1 (Figure 11D, E): Palps almost symmetrical. Left one (Figure 3H) with proximally slightly curved finger. On both palps fingers hook-shaped, subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2 (Figure 12D): 5-segmented. Basal segment with one seta. First two endopodal segments with one

seta each. Seta on first segment reaching middle of following segment, seta on second segment reaching distal end of following segment. Penultimate segment with two setae; longer one shorter than penultimate segment. Terminal segment with two setae and claw 1.2 times longer than three segments combined.

T3: 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 1.8 : 2. Th1 seta 3.7 times longer than terminal segment.

Fu (Figure 11F): L ratios of anterior margin, anterior and posterior claws equal 2.4 : 1.3 : 1. Anterior seta reaching 1/3 of anterior claw; posterior seta exceeding distal end of posterior margin. Both claws serrated. Furcal ramus slightly curved.

Hemipenis (Figure 11C): Lobe a elliptical and with blunt tip. Its dorsal margin semi-divided with incomplete septa Lobe b rounded. Lobe h elongated and directed ventrally. Part g (Figure 11G) with small, rounded tip, sometimes even slightly pointed (Figure 11C). Ejaculatory process (Figure 11H) not "S"-shaped, only with curved well chitinized, distal margin.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace (Figure 11A) very similar to male. Ventral margin straighter than in male. L approximately 1.1 mm. Greatest H situated on last third and equals about 50% of L. Calcified inner lamella very narrow. Several inner lists present close to calcified inner margin. Selvage not observed.

A2 (Figure 12B): all t-setae present. Seta z1 not observed, while z2 and z3 exceeding distal end of terminal segment. Claw G2 2.9 times longer than terminal segment. Claws G1 longer than G3, 1.2 times longer than first endopodal segment; while G3 0.96 times as long as same segment. Claw GM 0.86 times longer than first endopodal segment, Gm 2.6 times longer than terminal segment. Claws serrated. L ratios of three endopodal segments equal 3.9 : 2.2 : 1.

Fu and genital field (Figure 12C): Both furcal rami broken. Genital field with triangular extension with pointed tip.

All other soft parts same as in male.

### Variability

Not recorded in this species.

### Remarks and affinities

Delorme (1970) reported only females of *Candona suburbana* from Canada, but this species is not the same as Hoff (1942) described. It has a finger-shaped genital process and different appearance of the carapace. Delorme's (1970) specimen more

closely resemble *C. acuminata* (Fischer, 1854). *Candona suburbana* is indeed very similar to *C. acuminata* but the former species has a conical genital process, and more elliptical dorsal extension of lobe "a". The appearance of the genital process of *C. suburbana* resembles that of *C. hyalina* Brady and Robertson, 1870 but the two species have completely different carapace appearance and the morphology of the hemipenis and prehensile palps.

### Distribution

Known only from Illinois (Hoff 1942).

### *Candona (Candona) tahoensis* Ferguson, 1966

Figure 13

*Candona tahoensis* Ferguson, 1966: 318, Figures 16–18.

### Material examined

#### Holotype

Male (dissected on one slide – USNM 113015) and paratype male (dissected on one slide – USNM 113016) from (Type Locality): USA, Nevada, Lake Tahoe, collector T. C. Frantz. Date of collection unknown.

### Redescription

*Male*. Carapace almost rectangular in lateral view (Figure 13A, B). L of carapace equals approximately 1.18 mm. Greatest H lies on last third and equals about 53% of L. Dorsal margin gradually sloping down towards anterior end, and acutely inclined towards posterior end. Posterior margin almost straight, anterior widely rounded. Ventral margin markedly concave around mouth region, and with small protrusion on its first third. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Inner list strongly developed and running both anteriorly and posteriorly on RV. Carapace surface covered with warts and short dense hairs, surface also ornamented with typical, diamond shaped patterns.

A1 (Figure 13C): 7-segmented. Swimming setae thick and relatively short. Seta En1a reaching distal end of En5. Seta En2a reaching distal end of En4. En3 with two thick anterior setae (En3a and En3b), posteriorly with claw-like En3d (reaching middle of En5). En4 with two thick anterior setae (En4a and En4b) and posterior claw-like En4d (reaching distal end of En6). Penultimate segment with three thick, longer, setae En5a, En5b and En5c; En5d claw-like and exceeding distal end of En6. Alpha seta not reaching distal end of terminal segment. Seta En6d on terminal segment claw-like, segment En6 lacks En 6c. Aesthetasc ya short, two times longer than En6. L ratios of endopodal segments equal 1 : 1 : 1.5 : 1.4 : 1.8 : 1.6.

A2 (Figure 13D): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, latter one seta-like, while G1 claw-like and 4.5 times longer than terminal segment. Claw G2 as long as first endopodal segment. Claw GM reduced and 2.3 times longer than terminal segment. Claw Gm well developed and 0.78 times as long as first endopodal segment. Setae z1 and z2 transformed into claws, subequally long and both 0.7 times as long as first endopodal segment. Seta z3 exceeds distal end of terminal segment. Only aesthetascs Y and y3 observed, both being short. L ratios of endopodal segments equal 5.3 : 2.4 : 1.6 : 1.

Mx1: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md: With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

T1 (Figure 13G, H): Palps symmetrical. Right one with proximal part more helmet shaped. On both palps fingers hook-shaped, subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2 (Figure 13L): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, exceeding distal end of following segment. Penultimate segment with two setae, longer one only slightly longer than terminal segment. Terminal segment with two setae and claw, which slightly sinusoidal, and about 1.2 times longer than three distal segments combined.

T3 (Figure 13K): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 1.5 : 1.5. Th1 seta seven times longer than terminal segment.

Fu (Figure 13I): L ratios of anterior margin, anterior and posterior claws equal 2.2 : 1.1 : 1. Anterior seta reaching 1/4 of anterior claw; posterior seta reaching distal end of posterior margin. Both claws serrated. Furcal ramus slightly curved.

Hemipenis (Figure 13J): Lobe a elliptical and with blunt tip; its dorsal margin semi-divided with incomplete septa. Lobe b rounded. Lobe h rounded and small, part g foot-like (Figure 13F), ventral part beak-like. Lobe b ornamented with one chitinized patch, which looks like duck beak.

Zenker's organ: consists of seven whorls of spines.

*Female*. Carapace very similar to male. L same as in male.

Genital field: Genital field with finger-shaped extension.

### Variability

Not known in this species.

### Remarks and affinities

*Candona tahoensis* is a very distinct species

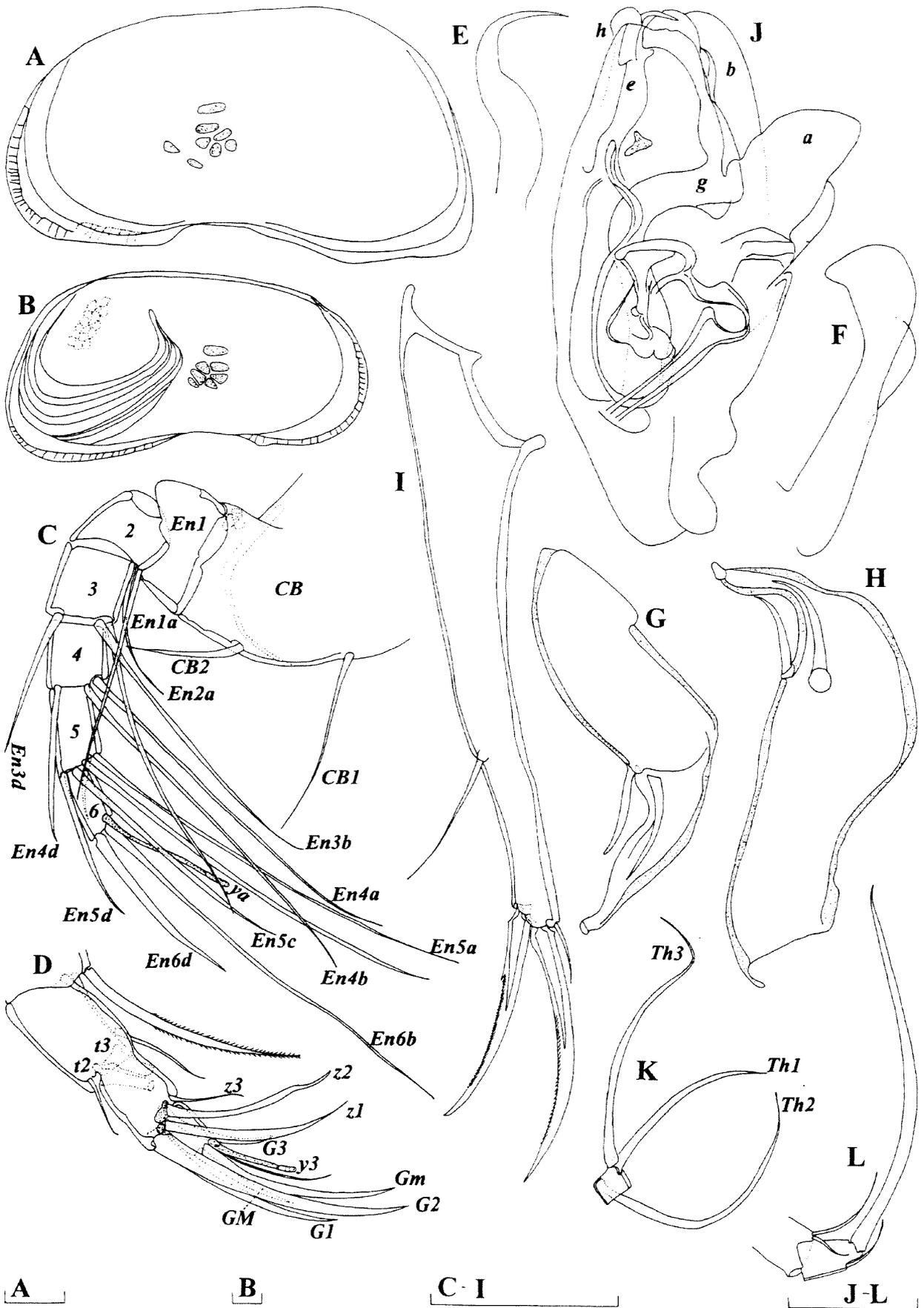
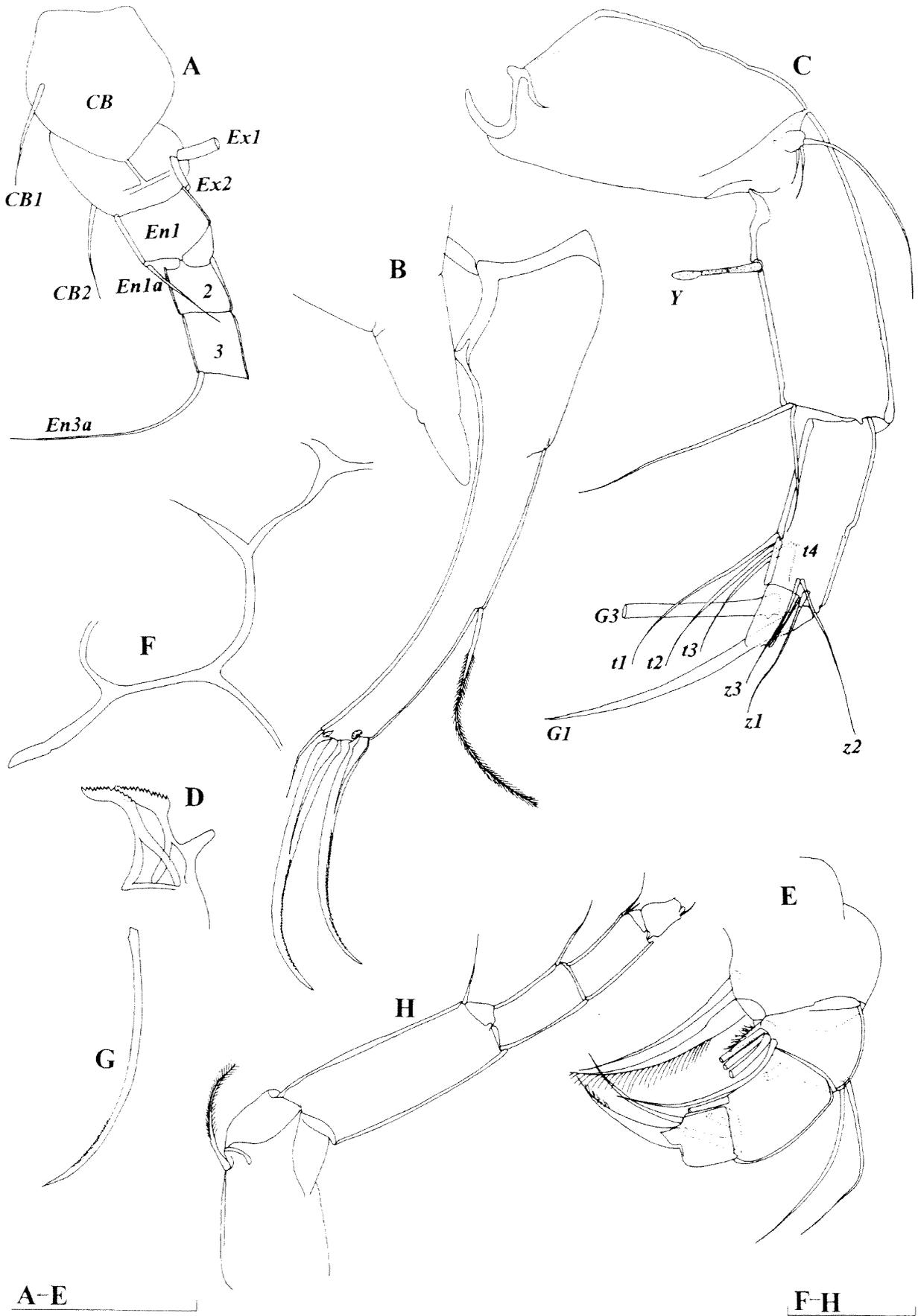


Figure 13 *Candona (Candona) tahoensis* Ferguson, 1966. A, Holotype male (USNM 113015); B-L, Paratype male (USNM 113016): A - RV, internal view; B - LV, internal view; C - A1; D - A2 (three distal segments); E - Distal part of "e"; F - Distal part of "g"; G - Left prehensile palp; H - Right prehensile palp; I - Fu; J - Hemipenis; K - terminal segment T3; L - terminal segment T2. Scales = 0.1 mm.



**Figure 14** *Candona (Candona) uliginosa* Furtos, 1933. Female (USNM 195828): A - A1 (incomplete); B - Fu with genital process; C - A2 (incomplete); D - Rake-like organ; E - Md-palp (incomplete); F - Furcal attachment; G - Terminal claw on T2; H - T2. Scales = 0.1 mm.

characterized by a finely ornamented carapace and a prominent inner list. The appearance of the hemipenis, especially of part "g", relates *C. tahoensis* to *C. ohioensis* Furtos, 1933, *C. sigmoides* Sharpe, 1893 and *C. levanderi* Hirschmann, 1912. However, they differ by the morphology and outline of the carapace and the appearance of the prehensile palps. Ferguson (1966) reported females, and also designated one female as the holotype. I examined two slides of this species: one labeled as the holotype, the other as a paratype male. However, both slides contain dissected males. The author described the female genital process to be finger-like but this could not be checked.

#### Distribution

This species is known only from Nevada (Ferguson 1966).

#### *Candona (Candona) uliginosa* Furtos, 1933

Figure 14

*Candona uliginosa* Furtos, 1933: 477, Plate 8, Figure 6, Plate 10, Figure 13.

*Candona hoffi* Ferguson, 1953: 196, Figures 1–10. [new synonymy]

#### Material examined

One female (dissected on one slide – USNM 195828, labeled as *Candona hoffi*, Paratype) from: USA, Maryland, Somerset Country, Eldon Hall, drainage ditch, 11 January 1951, collector F. Ferguson.

#### Redescription

*Female*. Carapace almost rectangular in lateral view, with greatest H situated behind middle. Valves L equals approximately 1.4 mm. Greatest H equals about 50% of L. Dorsal margin almost straight, gradually sloping towards anterior end and rounded towards posterior end. Both anterior and posterior margins rounded, and almost equally wide. Ventral margin slightly concave around mouth region. Valve surface covered with warts and hairs. Inner calcified lamellae narrow on both ends. Marginal pore canals short, dense and straight.

A1 (Figure 14A): 7-segmented. Swimming setae thin and relatively long. Seta En1a exceeds distal end of En2. Other details of its chaetotaxy and segmental ratios unknown.

A2 (Figure 14C): 4-segmented. All t-setae present. All z setae also present. Claw G1 long and as long as first endopodal segment. L ratios of three distal endopodal segments equal 4 : 3.5 : 1.

Md (Figure 14E): With 4+2 setae in bunch on second segment. Gamma seta smooth.

Rake-like organ (Figure 1D): With numerous small teeth.

T2 (Figure 14H): 5-segmented. Basal segment with one seta. First and second segment with one seta each, reaching distal end of following segments. Penultimate segment with two setae, longer one only slightly longer than terminal segment. Terminal segment with two setae and a claw (Figure 14G) which serrated and 1.2 times as long as three distal segments combined.

Fu and genital field (Figure 14B): L ratio of anterior furcal margin, anterior and posterior claws equal 1.76 : 1.1 : 1. Posterior furcal seta exceeds distal end of posterior margin. Anterior furcal seta equals 1/3 of anterior claw. Both claws serrated. Fu ramus curved. Genital field with finger-like extension which with slightly pointed tip. Extension equals 68% of L of anterior furcal margin. Fu attachment shown on Figure 14F.

*Male*. Only juvenile males collected.

#### Variability

There is a slight variability in the shape of the female carapace.

#### Remarks and affinities

Ferguson (1953) described *Candona hoffi* from Maryland with the bifurcated genital process. I observed the type material of this species and have found out that the genital process is finger-like and is not bifurcated. The author was probably confused with the other genital process. Ferguson (1953) described the valves of this species with a truncate part postero-dorsally. The valves are not preserved, so this character could not be checked. The author also reported males (according to the drawings probably juveniles), but I was not able to obtain them. All other details of the morphology of its soft parts resembles a lot to *C. uliginosa* so this species is considered to be the senior synonym of *C. hoffi*. *Candona uliginosa* is very similar to all species with the finger-like genital process. The main differences between *C. uliginosa* and these species are given previously.

#### Distribution

Known from Ohio (Furtos 1933) and Maryland (Ferguson 1953).

#### *Candona (Candona) acuta* Hoff, 1942

Figures 15–17

*Candona acuta* Hoff, 1942: 96, Plate 5, Figures 65–69, Plate 6, Figures 70–72.

*Candona acuta* Hoff, 1942: Delorme 1970: 1100, Figures 4–17.

#### Material examined

##### *Holotype*

Female (dissected on one slide – USNM 81074),

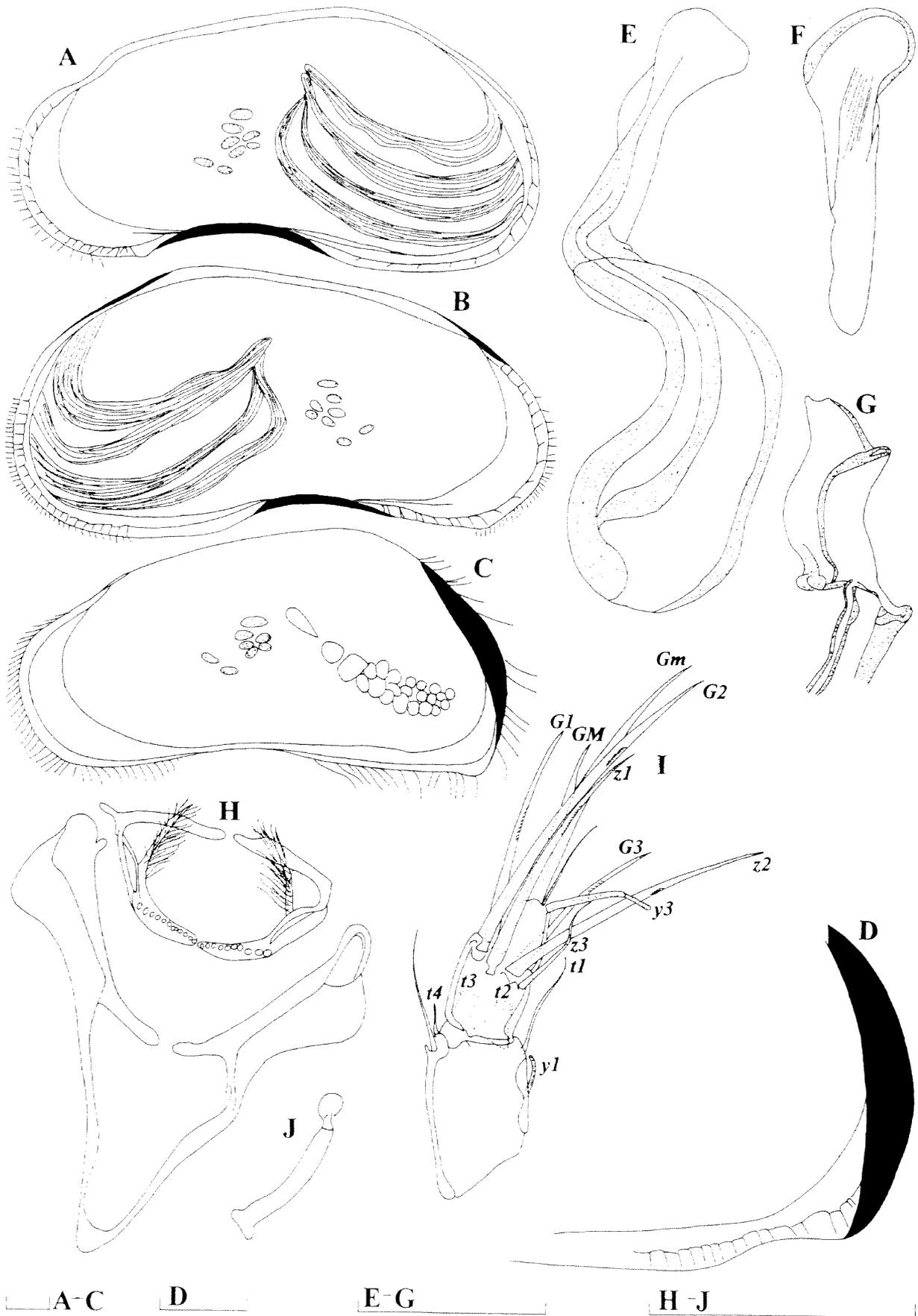


Figure 15 *Candona (Candona) acuta* Hoff, 1941. A, B, E-J, Paratype male (USNM 81077); C, D, Holotype female (USNM 81074): A - RV, internal view; B - LV, internal view; C - RV, internal view; D - Posterior part of RV; E - Part "g"; F - lobe "h"; G - Distal part of "e"; H - Lower lip and rake-like organ; I - A2 (three distal segments); J - Male sexual bristle. Scales = 0.1 mm.

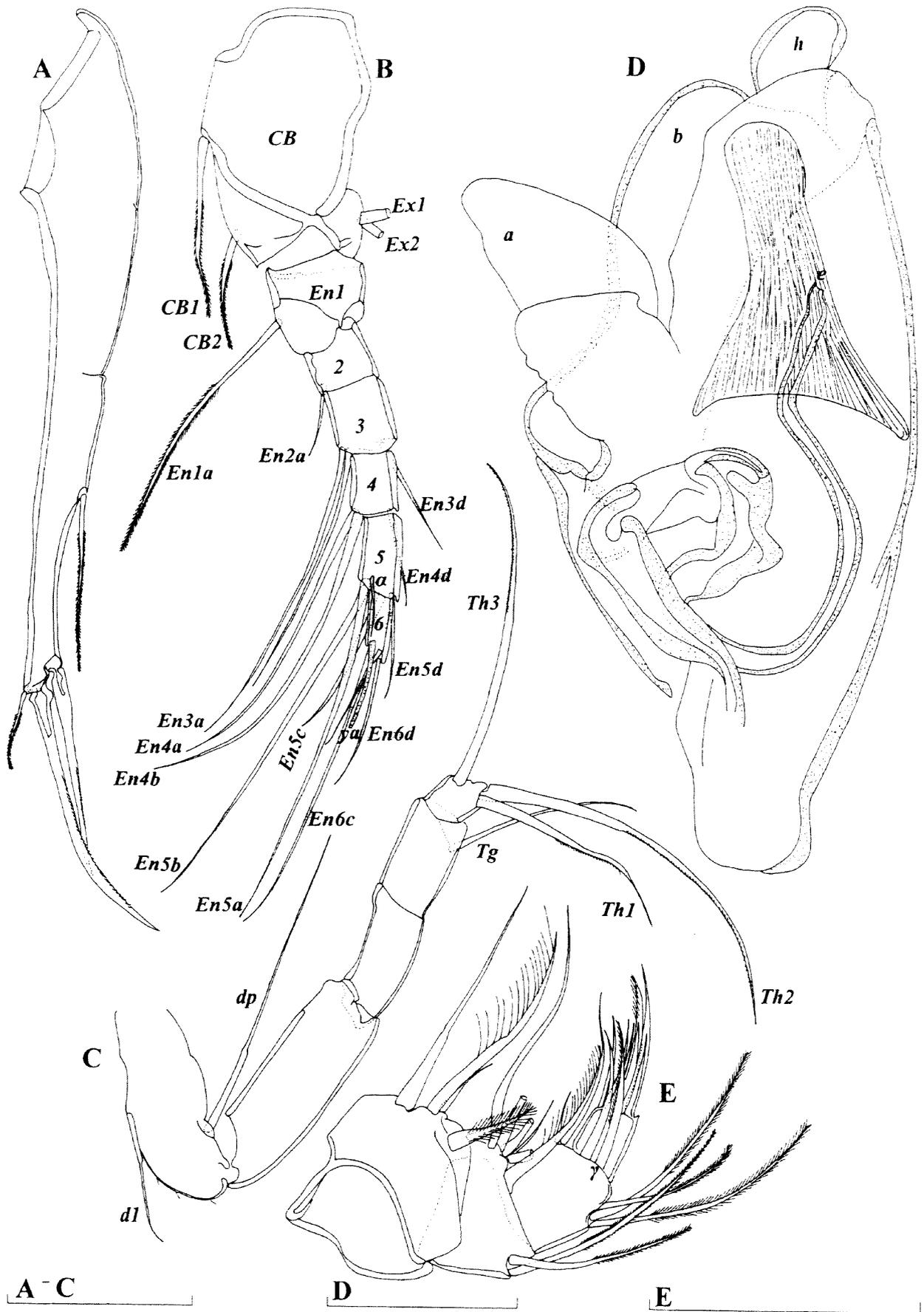


Figure 16 *Candona (Candona) acuta* Hoff, 1941. Paratype male (USNM 81077): A - Fu; B - A1; C - T3; D - Hemipenis; E - Md-palp. Scales = 0.1 mm.

USA, Illinois, Champaign Country, 11 May 1940, collector C. C. Hoff.

#### Paratype

Male (dissected on one slide – USNM 81077), USA, Illinois, Champaign Country, 11 May 1940, collector C. C. Hoff.

#### Redescription

*Male.* Carapace reniform in lateral view (Figure 15A, B). L of carapace equals 1.2 mm. Greatest H lies on last third and equals about 50% of L. Dorsal margin gradually sloping towards anterior end, with sinusoid intrusion on its first third. Dorsal margin rounded towards posterior end. Both posterior and anterior margins rounded, anterior one being slightly wider than posterior. Ventral margin markedly concave around mouth region and with small protrusion on its first third. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Inner list developed antero-ventrally on both valves. Carapace surface covered with warts and short dense hairs.

A1 (Figure 16B): 7-segmented. Swimming setae relatively thick and short. Seta En1a reaching middle of En6. Seta En2a reaching distal end of En3. En3 with two anterior setae (En3a and En3b), posteriorly with seta En3d (reaching middle of En5). En4 also with two anterior setae (En4a and En4b) and posterior seta (En4d) slightly exceeding distal end of En5. Penultimate segment with two thick setae En5a, En5b; En5c claw-like, while En5d seta-like. Alpha seta not reaching distal end of terminal segment. Seta En6c long, setae En6b and En6d short. Aesthetasc ya short, 1.4 times longer than En6. L ratios of endopodal segments equal 1.3 : 1 : 1.3 : 1 : 1.5 : 1.2.

A2 (Figure 15I): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, but both claw-like; G1 3.3 times longer than terminal segment, G3 2.6 times longer than same segment. Claw G2 1.2 times longer than first endopodal segment. Claw GM reduced and 2.5 times longer than terminal segment. Claw Gm well developed and as long as first endopodal segment. Setae z1 and z2 transformed into claws, subequally long and both as long as first endopodal segment. All claws serrated. Seta z3 exceeds distal end of terminal segment. Aesthetascs Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 4 : 2 : 1.3 : 1.

Mx1 (Figure 17C): 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md (Figure 16E): With 4+2 setae in bunch internally on second segment. Gamma seta plumed. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 15H) with 12 and 11 teeth.

T1 (Figure 17D, E): Palps asymmetrical. Left palp with elongated finger, not hook-shaped. On both palps subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2 (Figure 17F): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, exceeding distal end of following segment. Penultimate segment with two setae, longer one as long as same segment. Terminal segment with two setae and claw, which sinusoidal and 1.2 times longer than three distal segments combined.

T3 (Figure 16C): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 1.7 : 1.5. Th1 seta 3.5 times longer than terminal segment.

Fu (Figure 16A): L ratios of anterior margin, anterior and posterior claws equal 2.3 : 1.3 : 1. Anterior seta reaching 1/4 of anterior claw; posterior seta slightly exceeding distal end of posterior margin. Both claws serrated. Furcal ramus curved.

Hemipenis (Figure 16D): Lobe a elliptical and with blunt tip; its dorsal margin semi-divided with incomplete septa. Lobe b rounded. Lobe h rounded and small, part g boxing glove like (Figure 15E). Lobe a ornamented with one chitinated patch. Ejaculatory process (Figure 15G) flag-shaped.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace (Figure 15C) with wider anterior margin than in male, with flange markedly developed on posterior margin (Figure 15D) and small protrusion postero-distally (Figure 15D). L approximately 1.12 mm. Greatest H situated on last third and equals 50% of L. Calcified inner lamella narrow.

A2 (Figure 17B): All t-setae present. Seta z1 shorter than z2 and z3, and more claw-like. Claw G2 four times longer than last segment. Claws G1 and G3 subequally long and 1.2 times longer than first endopodal segment. Claw GM slightly shorter than first endopodal segment; Gm 2.6 times longer than terminal segment. All claws serrated. L ratios of three endopodal segments equal 3.5 : 2.4 : 1.

Fu and genital field (Figure 17A): L ratios of anterior margin, anterior and posterior claw equal 2.5 : 1.16 : 1. Anterior seta short (reaching 1/3 of anterior claw), posterior seta not reaching distal end of posterior margin. Furcal ramus with row of short setae postero-distally, also ramus slightly curved. Caudal seta short. Genital field with triangular extension with broad base and slightly pointed. Genital process equals 60% of L of anterior furcal margin.

All other soft parts same as in male.



**Figure 17** *Candona (Candona) acuta* Hoff, 1941. A, B, Holotype female (USNM 81074); C-F, Paratype male (USNM 81077): A - Fu with genital process; B - A2; C - Mxl; D - Left prehensile palp; E - T1 and right prehensile palp; F - T2. Scales = 0.1 mm.

**Variability**

Not recorded.

**Remarks and affinities**

The main distinctive feature of *Candona acuta* is the appearance of the female genital process which is triangular and slightly pointed. In addition, females have a well developed flange posteriorly on the valves. Males are characterized with the boxing-glove-like part "g" and the asymmetrical prehensile palps: the right palp is hook-like, the left has an elongated finger. *Candona acuta* is most closely related to *Candona intermedia* Furtos, 1933, but they differ by the appearance of the carapace and part "g" which is more stick-shaped in *C. intermedia*. *Candona acuta* has a very similar hemipenis appearance and the morphology of the prehensile palps like *Candona (C.) improvisa* Ostermeyer, 1937, but this species has 5+2 setae in the bunch on the Md palp, and therefore belongs to the *candida*-group.

**Distribution**

Known from Illinois (Hoff 1942) and Canada (Delorme 1970).

***Candona (Candona) crogmaniana* Turner, 1894**

Figures 18, 19

*Candona crogmaniana* Turner, 1894: 20, Plate 8, Figures 4–5.

*Candona crogmaniana* Turner, 1894: Furtos 1933: 476, Plate 8, Figures 1–3, Plate 9, Figures 17–18, Plate 11, Figures 9–10; Hoff 1942: 79, Plate 3, Figures 31–32.

[non] *Candona cf. crogmaniana* Turner, 1894: Delorme 1970: 1105, Figures 89–98. [misidentification].

*Candona crogmani* Turner, 1894: Turner 1895: 300, Plate 71, Figures 24–33, Plate 81, Figures 4–5; Sharpe 1918: 824, Figure 1295.

*Candona recticaudata* Sharpe, 1897: 451, Plate 46, Figures 7–11. [new synonymy]

*Candona recticaudata* Sharpe, 1897: Sharpe 1918: 826, Figure 1299; Hoff 1942: 75.

*Candona reflexa* Sharpe, 1897: 457, Plate 47, Figures 1–3. [new synonymy]

**Material examined**

One male (dissected on one slide – USNM 67893) and one female (dissected on one slide – USNM 67893), USA, Ohio, Medina, Temporary pond, 06 November 1932, collector N. C. Furtos.

**Redescription**

*Male*. Carapace reniform in lateral view. L of

carapace equals 1.5 mm. Greatest H lies on last third and equals about 50% of L. Dorsal margin gradually sloping towards anterior end, with sinusoid intrusion on its first third. Dorsal margin rounded towards posterior end. Both posterior and anterior margins rounded. Ventral margin markedly concave around mouth region and with small protrusion on its first third. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with warts and short, dense hairs.

A1 (Figure 19B): 7-segmented. Swimming setae thin and long. Seta En1a reaching middle of En5. Seta En2a reaching distal end of En4. En3 with two anterior setae (En3a and En3b), posteriorly with seta En3d (not reaching distal end of En4). En4 also with two anterior setae (En4a and En4b) and posterior seta (En4d) slightly exceeding distal end of En5. Penultimate segment with two long setae En5a, En5b; En5c three times longer than terminal segment, while En5d seta-like and slightly exceeds distal end of terminal segment. Alpha seta reaching distal end of terminal segment. Seta En6b long, setae En6c and En6d short (Figure 19C). Aesthetasc ya short, 1.4 times longer than En6. L ratios of endopodal segments equal 1.4 : 1 : 1.6 : 1.6 : 1.9 : 1.9.

A2 (Figure 19A): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, former one claw-like and three times longer than terminal segment; G3 seta-like and two times longer than same segment. Claw G2 1.2 times longer than first endopodal segment. Claw GM reduced and 2.5 times longer than terminal segment. Claw Gm well developed and 0.9 times as long as first endopodal segment. Setae z1 and z2 transformed into claws, former one shorter than latter one. All claws serrated. Seta z3 reaches distal end of terminal segment. Aesthetascs Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 5 : 2.1 : 1.2 : 1.

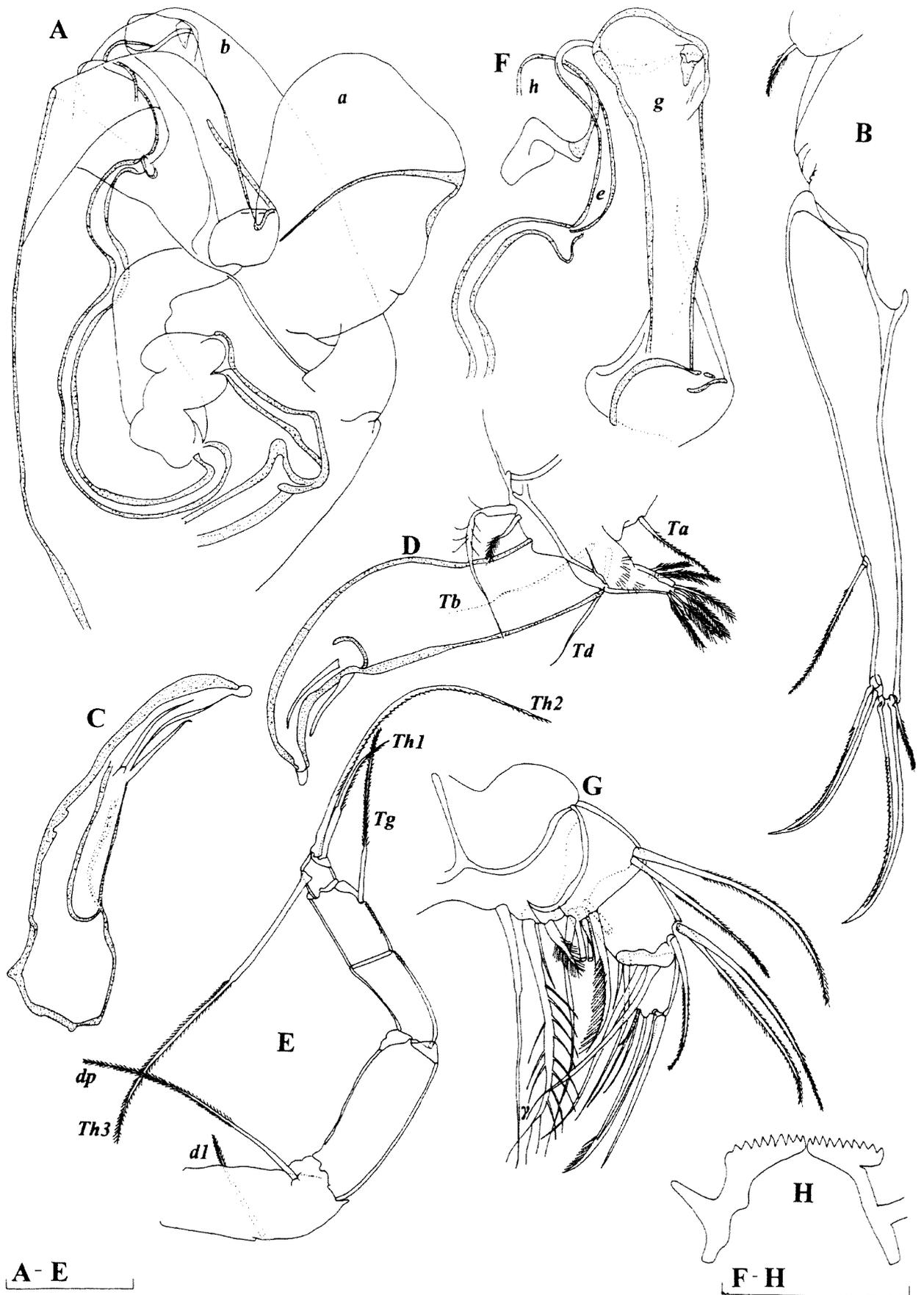
Mx1: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md (Figure 18G): With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 18H) with nine and ten teeth.

T1 (Figure 18C, D): Palps asymmetrical. Left palp (Figure 18C) with elongated finger, not hook-shaped. Right palp (Figure 18D) with stocky finger, but hook-shaped. On both palps subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2 (Figure 19E): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, reaching distal end of following segment. Penultimate segment with two setae, longer one as



**Figure 18** *Candona (Candona) crogmaniana* Turner, 1895. Male (USNM 67893); A - Hemipenis; B - Fu; C - Left prehensile palp; D - Right prehensile palp; E - T3; F - Distal parts of "h", "g" and "e"; G - Md-palp; H - Rake-like orgean. Scales = 0.1 mm.

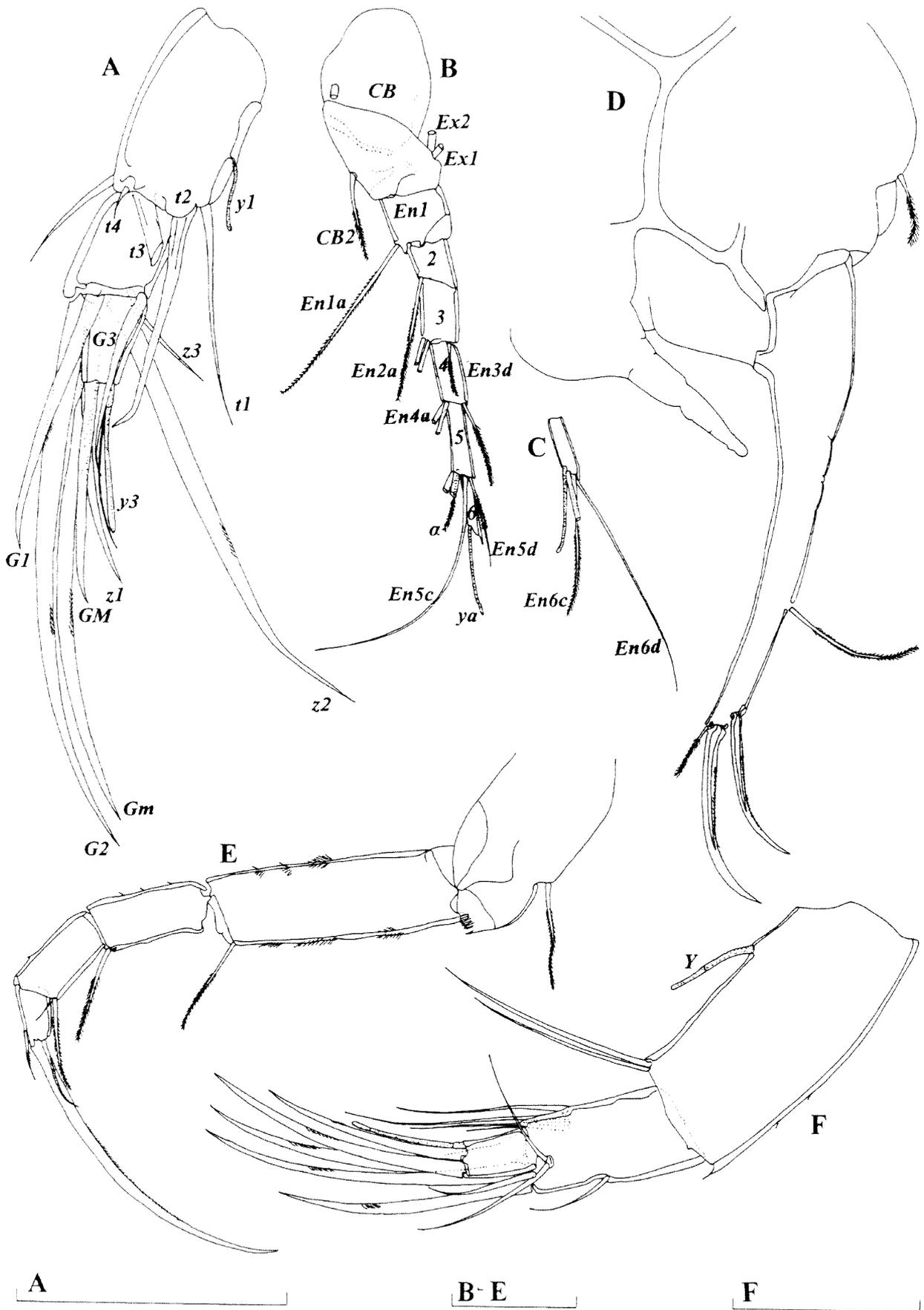


Figure 19 *Candona (Candona) crogmaniana* Turner, 1895. A-C, E, Male (USNM 67893); D, F, Female (USNM 67893): A - A2 (three terminal segments); B - A1; C - Terminal segment of A1; D - Fu with genital process; E - T2; F - A2. Scales = 0.1 mm.

long as same segment. Terminal segment with two setae and claw, which 1.3 times longer than three distal segments combined.

T3 (Figure 18E): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 2.3 : 2.4. Th1 seta 3.3 times longer than terminal segment.

Fu (Figure 18B): L ratios of anterior margin, anterior and posterior claws equal 2.25 : 1.3 : 1. Anterior seta reaching 1/3 of anterior claw; posterior seta exceeds distal end of posterior margin. Both claws serrated. Furcal ramus curved.

Hemipenis (Figure 18A): Lobe a slightly square shape, but with most dorsal margin inclined (not parallel) comparing to ventral side of hemipenis. Lobe b rounded. Lobe h rounded and very small, very slightly protruding. Part g boxing glove like (Figure 18F), distally with tear-shape chitinized structure. Lobe a ornamented with one chitinized patch. Ejaculatory process (Figure 18F) S-shaped

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace with wider anterior margin than in male, and with more inclined posterior margin. L approximately 1.45 mm. Greatest H situated on last third and equals 47% of L. Calcified inner lamella narrow.

A2 (Figure 19F): All t-setae present. Seta z1 shorter than z2 and z3, and more claw-like. Claw G2 3.4 times longer than last segment. Claws G1 and G3 subequally long and as long as first endopodal segment. Claw GM slightly shorter than first endopodal segment; Gm 2.7 times longer than terminal segment. All claws serrated. L ratios of three endopodal segments equal 4 : 2.3 : 1.

Fu and genital field (Figure 19D): L ratios of anterior margin, anterior and posterior claw equal 2.4 : 1.2 : 1. Anterior seta short (reaching 1/4 of anterior claw), posterior seta exceeding distal end of posterior margin. Caudal seta short. Genital field with very thin, finger-shaped extension, with blunt tip. Genital process equals 70% of L of anterior furcal margin.

All other soft parts same as in male.

### Variability

Not recorded.

### Remarks and affinities

A very characteristic appearance of the prehensile palps, i.e. very stocky right one and elongated finger on the left palp, is the main reason why *Candona recticaudata* Sharpe, 1897 is synonymized with *C. crogmaniana*. Additionally, the appearance of the male furca in two species is identical. In the same paper Sharpe (1897) described the species *C. reflexa*, based solely on juveniles. I consider this species also a junior synonym of *C. crogmaniana*.

Delorme (1970) reported this species from Canada, but the appearance of the valves is completely different and more closely resembles *Candona bretzi* Staplin, 1963, a species known only as fossil. The prehensile palps of the Delorme's specimens resemble more to *Candona acuminata* and other species with almost symmetrical, hook-shaped palps. However, they differ by other details so it cannot be claimed with a great certainty if Delorme (1970) dealt with *C. bretzi* or with some other species from the *acuminata*-group. *Candona crogmaniana* is most closely related to *Candona inopinata* Furtos, 1933, and they differ in the appearance of lobe "a" which is distinctly subdivided in the latter species. *Candona crogmaniana* does not have other close relatives in the *intermedia*-group, but the appearance of the hemipenis and prehensile palps, as well as the carapace shape, closely resembles *Candona candida* (Müller, 1776). They differ by the number of setae in the bunch on the Md palp, and the appearance of the genital process. In *C. candida* this process is very poorly developed.

### Distribution

Throughout North America.

### *Candona (Candona) inopinata* Furtos, 1933

Figures 20, 21

*Candona inopinata* Furtos, 1933: 481, Plate 9, Figures 6–12.

*Candona inopinata* Furtos, 1933: Delorme 1970: 1111, Figures 165–170.

*Candona truncata* Furtos, 1933: 480, Plate 9, Figures 1–5, Plate 11, Figures 7–8. [new synonymy]

*Candona indigena* Hoff, 1942: 85, Plate 3, Figure 39, Plate 4, Figures 40–48.

### Material examined

1) One female (dissected on one slide – USNM 67877, labeled as *Candona truncata*, Holotype) and one male (dissected on one slide – USNM 67873, labeled as *Candona truncata*, Paratype), USA, Ohio, Temporary pond south of Medina, 16 November 1931, collector N. C. Furtos); 2) One female (dissected on one slide – USNM 81070, labeled as *Candona indigena*, Holotype) and one male (dissected on one slide – USNM 81071, labeled as *Candona indigena*, Allotype), USA, Illinois, Seymour Prairie, Champaign Country, 15 April 1940, collector C. C. Hoff.

### Redescription

*Male.* Carapace almost subtriangular in lateral view (Figure 20A, B). L of carapace equals varies between 1.0 mm and 1.2 mm. Greatest H lies on last

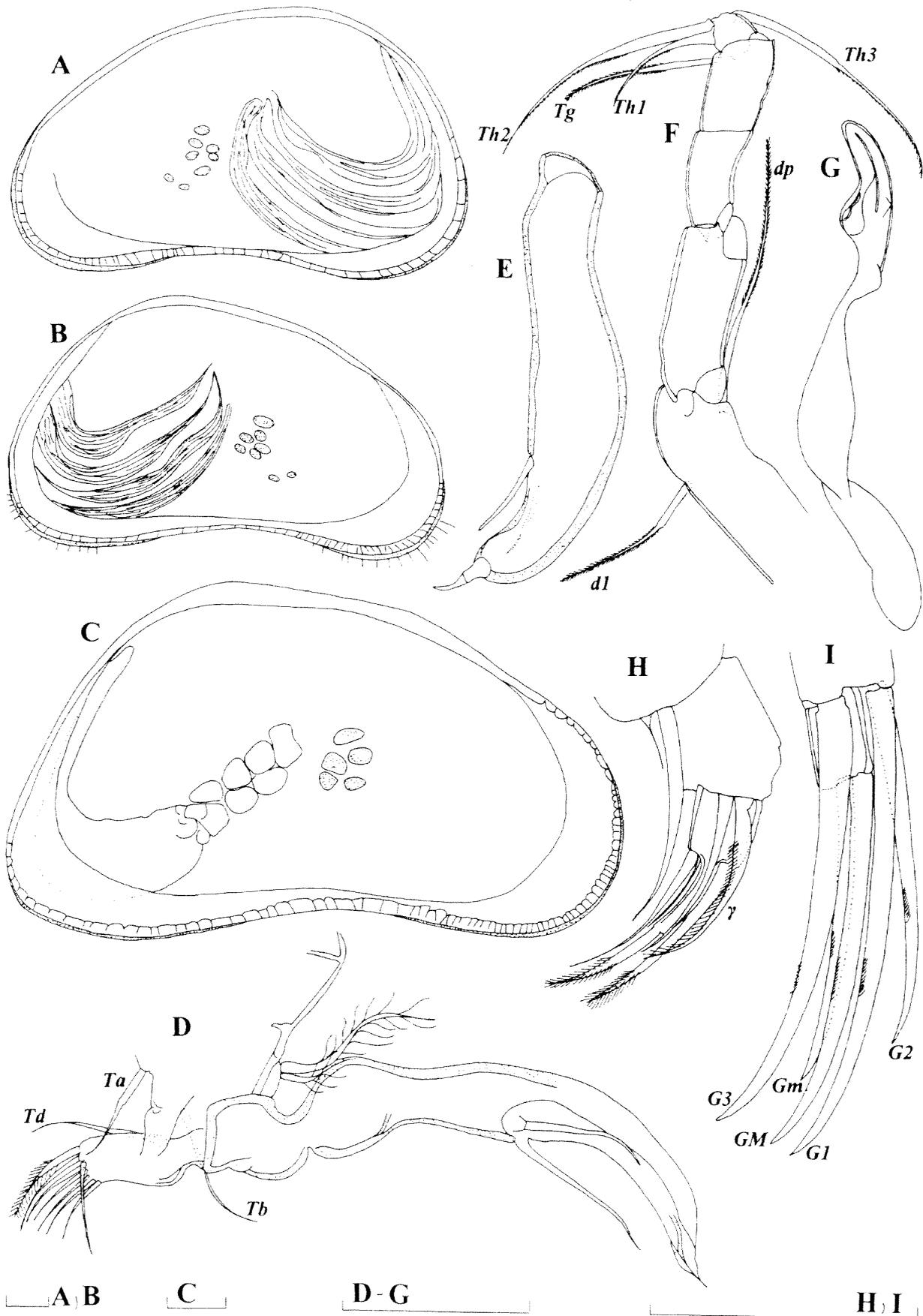


Figure 20 *Candona (Candona) inopinata* Furtos (1933). A, B, D-H, Male (USNM 81071); C, I, Female (USNM 81070): A - RV, internal view; B - RV, internal view; C - RV, internal view; D - T1 and left prehensile palp; E - Right prehensile palp; F - T3; G - chitinized part of hemipenis; H - Md-palp (incomplete); I - Two distal segments of A2 (incomplete). Scales = 0.1 mm.

third and equals about 57% of L. Dorsal margin sharply inclined towards both ends, however more towards posterior than towards anterior margin. Both posterior and anterior margins widely rounded, anterior one being slightly wider than posterior. Ventral margin markedly concave around mouth region. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Selvage peripheral. Carapace surface covered with warts and short dense hairs.

A1 (Figure 21C): 7-segmented. Swimming setae long and thin. Seta En1a reaching middle of En3. Seta En2a reaching middle of En4. En3 with two anterior setae (En3a and En3b), posteriorly with seta En3d (reaching distal end of En4). En4 also with two anterior setae (En4a and En4b) and posterior seta (En4d) slightly exceeding distal end of En5. Penultimate segment with three long setae: En5a, En5b and En5c; En5d seta-like and exceeds distal end of En6. Alpha seta exceeds distal end of terminal segment. Seta En6b long, setae En6c and En6d shorter, latter one claw-like. Aesthetasc ya short, 1.2 times longer than En6. L ratios of endopodal segments equal 1.5 : 1 : 1.8 : 1.6 : 2.1 : 1.6.

A2 (Figure 21E): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, former one claw-like and three times longer than terminal segment, G3 seta-like and 2.4 times longer than same segment. Claw G2 1.2 times longer than first endopodal segment. Claw GM reduced and 2.5 times longer than terminal segment. Claw Gm well developed and slightly shorter than first endopodal segment. Setae z1 and z2 transformed into claws, former one shorter than latter one and 0.9 times as long as first endopodal segment, while z2 1.1 times as long as same segment. All claws serrated. Seta z3 exceeds distal end of terminal segment. Aeshetasc Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 4.6 : 2.6 : 1.2 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md (Figure 20H): With 4+2 setae in bunch internally on second segment. Gamma seta plumed. Terminal segment with two strong claws and two setae.

T1 (Figure 20D, E): Palps asymmetrical. Left palp with elongated finger (Figure 20D), not hook-shaped. Right palp (Figure 20E) with stocky-like finger, and not hook-shaped. On both palps subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2: 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, reaching distal end of following segment. Penultimate segment with two setae, longer one 0.8 times as long as same segment. Terminal segment with two setae and claw, which sinusoidal and 1.3 times longer than three distal segments combined.

T3 (Figure 20F): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 2 : 2. Th1 seta 2.7 times longer than terminal segment.

Fu (Figure 21B): L ratios of anterior margin, anterior and posterior claws equal 1.8 : 1 : 1. Anterior seta reaching 1/3 of anterior claw; posterior seta well exceeds distal end of posterior margin. Both claws serrated. Furcal ramus not curved. Furcal ramus with bunch of hairs proximally and row of small setae distally.

Hemipenis (Figure 21A): Lobe a with markedly subdivided dorsal extension. Lobe b rounded. Lobe h rounded and small, part g without any terminal enlargements (not boxing, or foot-like) finishing with one small, wart-like extrusion. Lobe a ornamented with chitinized patch. Ejaculatory process similar in shape with part g.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace shape (Figure 20C) almost identical with male. L varies from 1 mm to 1.4 mm. Greatest H situated on last third and equals 60% of L. Calcified inner lamella narrow.

A2 (Figure 20I): Incomplete on slide. Setae z1, z2 and z3 not observed. Claw G2 four times longer than last segment. Claws G1 and G3 subequally long; Gm 3.5 times longer than last endopodal segment. All claws serrated.

Fu and genital field (Figure 21D): L ratios of anterior margin, anterior and posterior claw equal 1.6 : 1 : 1. Anterior seta short (reaching 1/3 of anterior claw), posterior seta exceeds distal end of posterior margin. Furcal ramus proximally with bunch of hairs. Genital field with pointed, thin extension which approximately equals 70% of L of anterior furcal margin.

All other soft parts same as in male.

### Variability

There is a variability in the L of genital process and the appearance of lobe "a", i.e. its dorsal extension can be more or less subdivided.

### Remarks and affinities

*Candona indigena* was synonymized with *C. inopinata* by Delorme (1970), a decision that is accepted in the present paper after rechecking the type material of the former species. They have identical appearance of the carapace, hemipenis and prehensile palps, and the appearance of the genital process. I have observed also the type material of *Candona truncata* Furtos, 1933 and it appears that this species has a completely different appearance of the hemipenis than is illustrated by Furtos (1933), and is almost identical with *C. inopinata*. There are some differences in the appearance of the genital process: in *C. truncata* it is longer than in *C.*

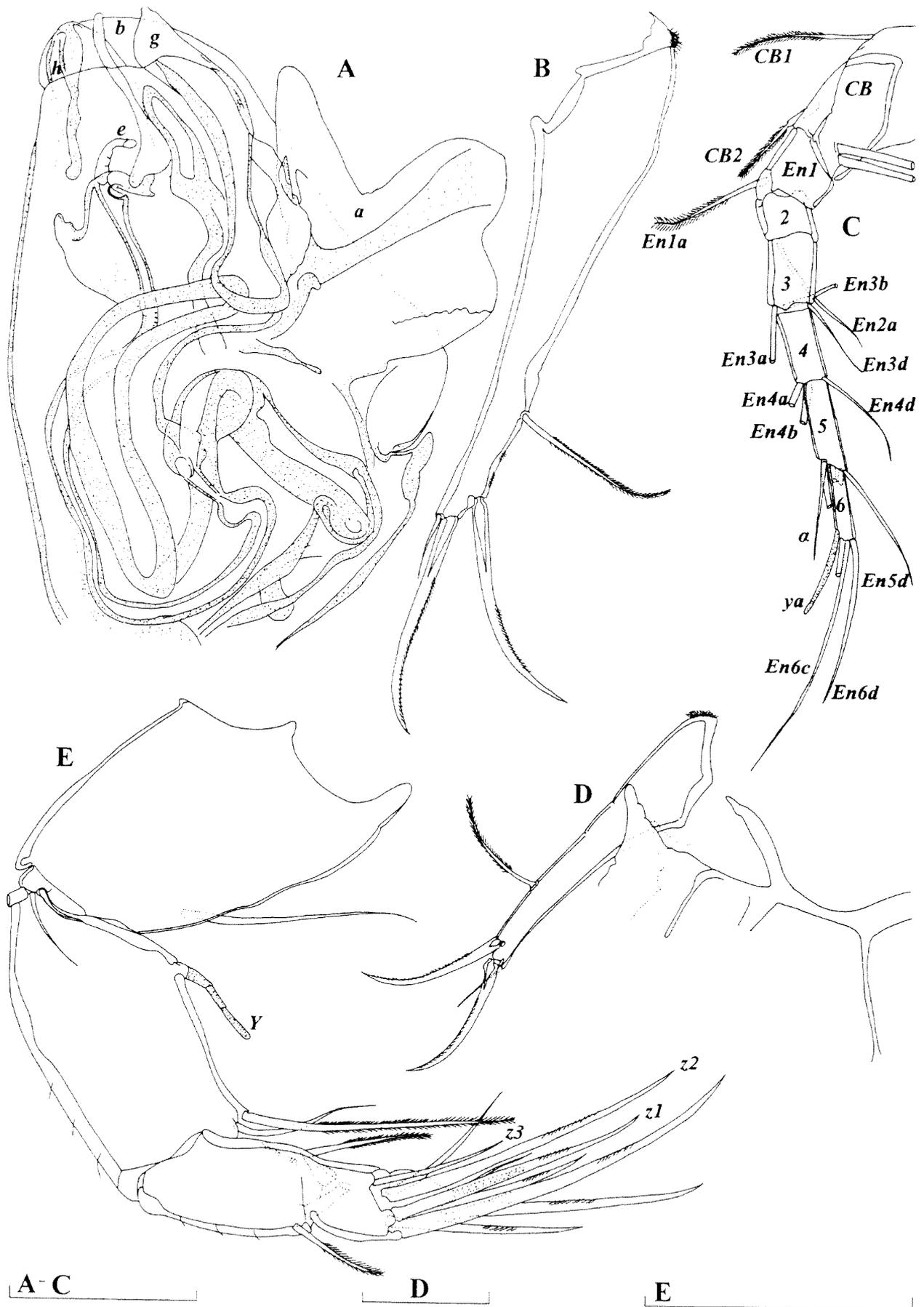


Figure 21 *Candona (Candona) inopinata* Furtos (1933). A-C, E, Male (USNM 81071); D, Female (USNM 81070): A - Hemipenis; B - Fu; C - A1; D - Fu with genital process; E - A2. Scales = 0.1 mm.

*inopinata*. However, the difference is not as prominent as Furtos (1933) illustrated, and it is not as long as the author described. Therefore, there seems not to be any clear difference between *C. decora* and *C. inopinata*, so the former species is synonymized with the latter. The whole appearance of the hemipenis is so characteristic that this species could not be confused with any other species of the genus. It is most closely related to the previous species.

### Distribution

Northern part of North America.

### *Candona (Candona) intermedia* Furtos, 1933

Figures 22, 23

*Candona intermedia* Furtos, 1933: 474, Plate 10, Figures 1-7.

*Candona intermedia* Furtos, 1933: Tressler 1954: 139, Figures 2-3.

### Material examined

#### Holotype

Female (dissected on one slide – USNM 67873) and paratype male (dissected on one slide – USNM 67873), USA, Ohio, Newark, cold spring run, 25 May 1932, collector N. C. Furtos.

### Redescription

*Male*. Carapace reniform in lateral view. L of carapace approximately 1.7 mm. Greatest H lies on last third and equals about 55% of L. Dorsal margin gradually sloping towards anterior end. Dorsal margin rounded towards posterior end. Both posterior and anterior margins widely and equally rounded. Ventral margin markedly concave around mouth region and with small protrusion on its first third. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with warts and short dense hairs.

A1 (Figure 22A): 7-segmented. Swimming setae relatively thick and relatively short. Seta En1a reaching distal end of En4. Seta En2a reaching middle of En4. En3 with two anterior setae (En3a and En3b), posteriorly with seta En3d (reaching distal end of En5). En4 also with two anterior setae (En4a and En4b) and posterior seta (En4d) reaching distal end of En5. Penultimate segment with two longer setae En5a, En5b; En5c and En5d shorter and claw-like, former one two times, while latter one 1.4 times longer than terminal segment. Alpha seta exceeds distal end of terminal segment. Seta En6c longer, setae En6b and En6d short, last one claw-like (Figure 22B). Aesthetasc ya as long as terminal segment. L ratios of endopodal segments equal 1.5 : 1 : 1.6 : 1.6 : 1.8 : 1.8.

A2 (Figure 22F): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, but both claw-like; G1 2.9 times longer than terminal segment, G3 2.3 times longer than same segment. Claw G2 1.2 times longer than first endopodal segment. Claw GM reduced and 2.6 times longer than terminal segment. Claw Gm well developed and as long as first endopodal segment. Setae z1 and z2 transformed into claws, latter one longer than former one. Seta z1 0.7 times as long as first endopodal segment, seta z2 as long as same segment. All claws serrated. Seta z3 exceeds distal end of terminal segment. All aesthetascs observed, all short. L ratios of endopodal segments equal 5 : 2 : 1.2 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md: With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 23E): With eight and nine teeth.

T1 (Figure 22D, E): Palps asymmetrical. Left palp with elongated finger, not hook-shaped, also dorsal margin irregularly serrated (Figure 22E). Right palp (Figure 22D) with stocky finger and only slightly hook-shaped. On both palps subterminal sclerified structures thin. One Ta, Tb and Td seta present.

T2 (Figure 23D): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, exceeding distal end of following segment. Penultimate segment with two setae, longer one 1.4 times longer than same segment. Terminal segment with two setae and claw, which as long as three distal segments combined.

T3 (Figure 23B): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 2 : 2. Th1 seta 3.8 times longer than terminal segment.

Fu (Figure 23A): L ratios of anterior margin, anterior and posterior claws equal 1.9 : 1.2 : 1. Anterior seta reaching 1/3 of anterior claw; posterior seta well exceeds distal end of posterior margin. Both claws serrated. Furcal ramus almost straight and with row of short setae postero-distally.

Hemipenis (Figure 22G): Lobe a with elliptical dorsal extension which dorsally with small intrusion. Lobe b rounded. Lobe h rounded and small, part g with bulging proximal part, while distally thin and rounded (Figure 22C). Proximal part of ejaculatory tube shown on Figure 22H

Zenker's organ: consists of seven whorls of spines.

*Female*. Carapace with dorsal margin more acutely sloping towards anterior margin, while posterior margin almost straight. Posterior margin

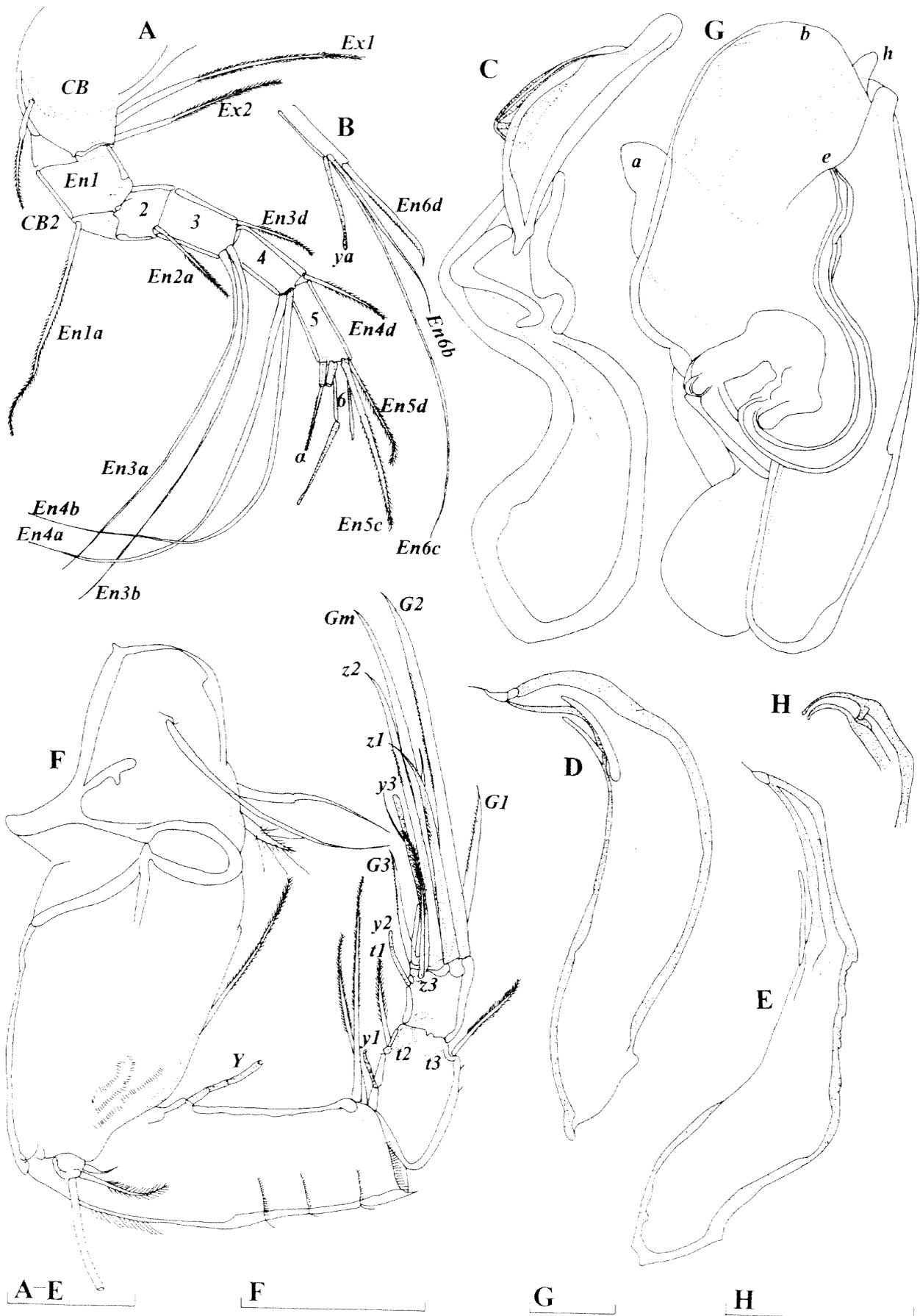
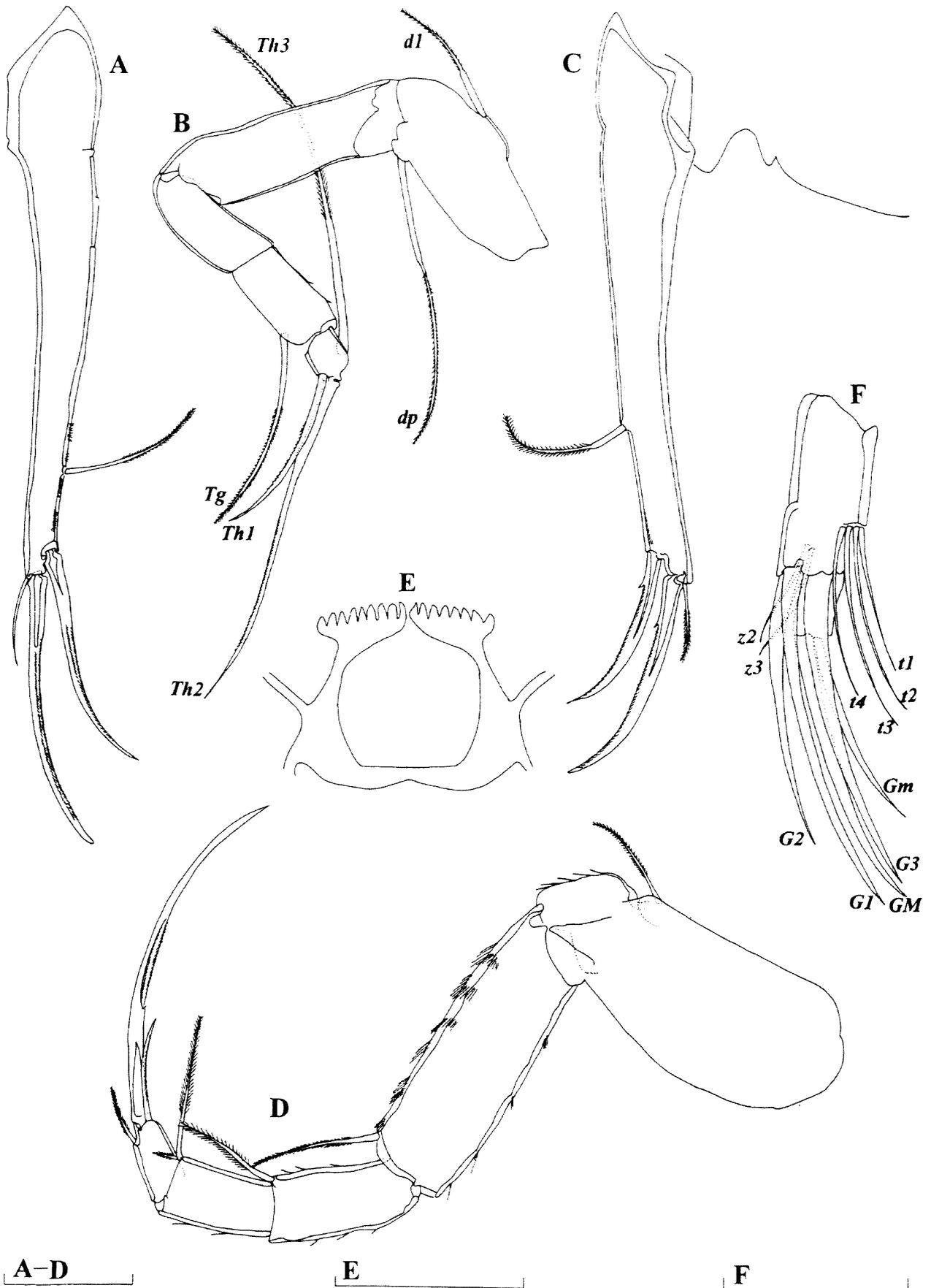


Figure 22 *Candona (Candona) intermedia* Furtos, 1933. Paratype male (USNM 67873): A - A1; B - Terminal segment A1; C - Part "g"; D - Right prehensile palp; E - Left prehensile palp; F - A2; G - Hemipenis. Scales = 0.1 mm.



**Figure 23** *Candona (Candona) intermedia* Furtos, 1933. A, B, D, Paratype male (USNM 67873); C, E, F, Holotype female (USNM 67873): A - Fu; B - T3; C - Fu with genital process; D - T2; E - Rake-like organ; F - A2 (two terminal segments). Scales = 0.1 mm.

with small carapace protrusion postero-distally. L approximately 1.7 mm. Greatest H situated on last third and equals 55% of L. Calcified inner lamella narrow.

A2 (Figure 23F): All t-setae present. Seta z1 not observed, setae z2 and z3 slightly exceed distal end of terminal segment. Claw G2 3.6 longer than last segment. Claws G1 and G3 subequally long and as long as first endopodal segment. Claw GM 0.88 times as long as first endopodal segment; Gm 2.6 times longer than terminal segment. L ratios of three endopodal segments equal 4 : 2 : 1.

Fu and genital field (Figure 23C): L ratios of anterior margin, anterior and posterior claw equal 2.5 : 1.3 : 1. Anterior seta short (reaching 1/3 of anterior claw), posterior seta exceeds distal end of posterior margin. Furcal ramus with row of short setae postero-distally. Genital field with small, blunt square-shaped extension which equals only 20% of L of anterior furcal margin.

All other soft parts same as in male.

### Variability

Not recorded.

### Remarks and affinities

*Candona intermedia* is a very distinct species, characterized by a very small genital process, and a stick-like appearance of the part "g". This lobe also has a bulging, well chitinized part close to the distal end. This species is most closely related to *C. acuta* Hoff, 1942, and their differences are undelined. On the other hand the appearance of the hemipenis is very similar to *Candona suburbana* Hoff, 1942 but the latter species has bigger lobe "a" and different appearance of the prehensile palps. Another closely related species is *Candona acuminata* (Fischer, 1854). The two species share similar appearance of the part "g", but they differ by the morphology of the prehensile palps and the genital process. Furtos (1933) provided drawings of the female genital process which is much bigger than it actually is.

### Distribution

Known from Ohio (Furtos 1933) and Texas (Tressler 1954).

## Genus *Eucandona* Daday, 1900

### Revised diagnosis

Carapace subreniform, or subtrapezoidal, often with truncate extension. Valve surface not ornamented. Inner calcified lamella always narrow, i. e. never more than 20% of total L. LV overlaps RV. Marginal pore canals short, straight, never branched. A1 7-segmented. Coxa and basis fused with both CB setae present. Exopod reduced into two long setae. Endopod 6-segmented. En1 and En2

with only one anterior seta each. En3 and En4 with two anterior and one posterior seta each. En5 with two anterior and two posterior setae present (En5d seta present), alpha seta also present. En6 with most posterior seta transformed into claw, most anterior seta transformed into aesthetasc. All anterior setae long, posterior short. A2 sexually dimorphic: in male protopod 4-segmented, in female 3-segmented. Male sexual bristles present. Claws G1 and G3 in male reduced, seta z2 transformed into claw, seta z1 very short, and not exceeding distal end of terminal segment; z3 always seta-like. In both sexes exopod transformed in plate with one long and two short setae. Md with total of eight rays in exopod; palp 4-segmented with two setae externally on second and three setae on penultimate segment. Second segment internally with 3+2, 4+2 or 5+2 setae. Terminal segment with two claws, central one narrowly fused with segment. Terminal segment on Mx1 rectangular. Vibratory plate on T1 with two rays. Male with transformed palps: right one stocky, but with hook-shaped finger, left palp with elongated finger. T2 5-segmented. Basal segment with one seta. T3 4- or 5-segmented. Basal segment with two setae (d1 and dp); terminal segment with two long (Th2 and Th3) and one short (Th1) seta, which never shorter than terminal segment itself. Furca with both claws and both setae present. Posterior seta at least reaches distal end of posterior margin, usually being much longer. Part "g" on hemipenis well sclerified. Lob "h" absent. Zenker's organ with seven whorls of spine. Female genital lobe with or without extension, often this lobe strongly chitinized all around its margins.

### Type species

*Candona balatonica* Daday, 1894

### North American representatives of the genus

*Eucandona biangulata* (Hoff, 1942) n. comb.; *E. obtusa* (Bronstein, 1947) comb. nov.; *E. pedata* (Alm, 1914) n. comb.; *E. pennaki* (Marmonier and Ward, 1990) comb. nov.; *E. rectangulata* (Alm, 1914) n. comb.

### *Eucandona biangulata* (Hoff, 1942) comb. nov.

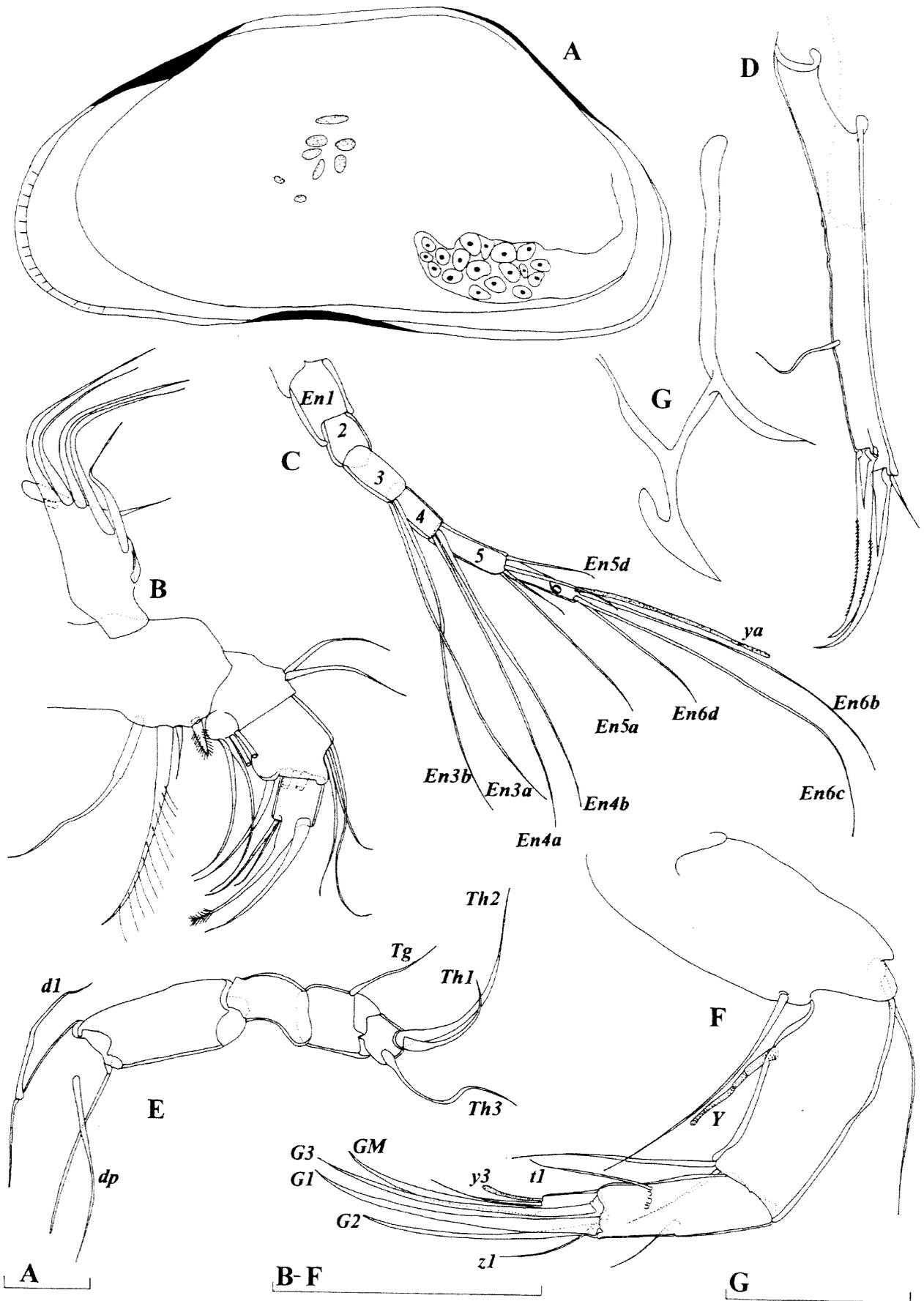
Figure 24

*Candona biangulata* Hoff, 1942: 70, Plate 2, Figures 24–25, Plate 3, Figures 26–28.

*Candona orangeburgensis* Ferguson, 1958: 112, Figures 9–15. [new synonymy]

*Candona wegeli* Petkovski, 1962: 23, Figures 4–10. [new synonymy]

*Fabaeformiscandona wegeli* Petkovski, 1962: Marmonier and Ward 1990: 232, Figures 5 (E–H), 6 (A–D); Meisch 2000: 129, Figure 52.



**Figure 24** *Eucandona biangulata* (Hoff, 1942): A, C-E, G, H, Holotype female (USNM 81067); B, F, Female (USNM 97707): A - LV, internal view; B - Md-palp; C - A1 (incomplete); D - Fu with genital process; E - T3; F - A2; G - Furcal attachment. Scales = 0.1 mm.

**Material examined***Holotype*

Female (dissected on one slide – USNM 81067, labeled as *Candona biangulata*), USA, Illinois, Will Country, 30 June 1940, collector C. C. Hoff.

*Other material*

One female (dissected on one slide – USNM 97707, labeled as *Candona orangeburgensis* Paratype), USA, South Carolina, Orangeburg, 01 April 1954, collector F. Ferguson.

**Additional description**

*Female.* Carapace subtrapezoidal in lateral view (Figure 24A), with greatest H situated on last third of L and equals 50% of L. Valves L varies between 0.6 mm to 0.77 mm. Dorsal margin straight in middle, then gradually sloping down towards anterior end and acutely inclined towards posterior end. Anterior margin rounded, posterior margin slightly protruded. Ventral margin weakly concave around mouth region. Valve surface covered with hairs. Inner calcified lamellae narrow on both ends. Marginal pore canals short, dense and straight.

A1 (Figure 24C): 7-segmented. Setae on En1a, En2, as well as posterior setae on En3 and En4 not observed. Remaining setae long and thin. Penultimate segment with setae En5b, En5c and En5d subequally long, and all short. Seta En5a longer. Alpha seta not observed. Segment En6 with long setae En6b and En6c, while seta En6d shorter but thin. Aesthetasc ya long, and 2.5 times longer than terminal segment. L ratios of endopodal segments equal 1.5 : 1 : 1.2 : 1.2 : 1.5 : 1.5.

A2 (Figure 24F): 4-segmented. All t-setae present. Only one z seta observed. Claw G2 3.8 times longer than terminal segment. Claws G1 and G3 subequally long and 1.3 times longer than first endopodal segment. Claw Gm slightly shorter than first endopodal segment. Claw Gm not observed. L ratios of three distal endopodal segments equal 3.8 : 2.7 : 1.

Md (Figure 24B): With 4+2 setae in bunch on second segment. Gamma seta smooth. Terminal segment with two claws and two setae.

T2: 5-segmented. Basal segment with one seta. First and second segment with one seta each, reaching distal end of following segments. Penultimate segment with two setae, longer one as long as same segment. Terminal segment with two setae and a claw which 1.3 times as long as three distal segments combined.

T3 (Figure 24E): 5-segmented. Basal segment with d1 and dp setae. Only Tg seta present and well exceeding distal end of terminal segment. Terminal segment with two long and one shorter seta. L ratios of Th1, Th2 and Th3 equal 1 : 1.9 : 1.45. Seta Th1 about three times longer than terminal segment.

Fu and genital field (Figure 24D): L ratio of anterior Furcal margin, anterior and posterior claws equal 1.9 : 1.1 : 1. Posterior Fu seta reaches distal end of posterior margin. Anterior Fu seta equals 1/3 of anterior claw. Both claws strongly serrated. Fu ramus curved. Genital field with protruding extension with tapering process. Fu attachment shown on Figure 24G.

*Male.* Not recorded until now.

**Variability**

The penultimate segment on the T3 can be completely, or incompletely subdivided.

**Remarks and affinities**

*Candona biangulata* Hoff, 1942 and *C. orangeburgensis* Ferguson, 1958 are both very poorly described and illustrated. On the other hand, *Candona wegelini* was originally well described (Petkovski 1962), and subsequently redescribed several times (Marmonier and Ward 1990, Meisch 2000). After rechecking the type material of *C. biangulata* and *C. orangeburgensis*, and comparing it with the descriptions of *C. wegelini* it became clear that they all represent the same species. *Eucandona biangulata* is very closely related to *Eucandona fabella* (Nüchterlein, 1969) n. comb. and *Eucandona lapponica* (Ekman, 1908) n. comb. The former species has 3+2 setae in the bunch of the Md palp, while the latter species has a more subtrapezoidal carapace appearance, without pronounced posterior part. Meisch (2000) assigned *Candona lapponica* to the genus *Fabaeformiscandona*, giving it an uncertain position, because of the unknown setal number in the bunch of the Md palp. I checked the type material of *Candona lapponica arctica* Alm, 1914 deposited in the Swedish Museum of Natural History (collection number 5773) and found that the number of setae varies in this species. Namely, on a single specimen one Md palp carries 3+2 setae, while the other one has 5+2 setae. Additionally, the genital field carries a process very similar to the one found in *E. biangulata* and it is chitinized like in the majority of species of the genus. The complete redescription of this species will be given elsewhere.

**Distribution**

North Holarctic.

***Eucandona obtusa* (Bronstein, 1947) comb. nov.**

Figure 25

*Candona* sp.: Bronstein, 1930: 144, Plate 4, Figures 17–21 (*vide* Bronstein, 1947)

*Candona obtusa* Bronstein, 1947: 252, Figure 157.

*Candona obtusa* Bronstein, 1947: Delorme 1967b: p. 792, Figure 1.

*Candona michoa* Tressler, 1954: 142, Figures 9–12. [new synonymy]

*Candona patzcuaro* Tressler, 1954: 139, Figures 4–8. [new synonymy]

*Candona patzcuaro* Tressler, 1954: Delorme 1970: 1113, Figures 198–213.

*Candona rawsoni* Tressler, 1957: 420, Figures 5–11.

*Candona rawsoni* Tressler, 1957: Delorme 1970: 1115, Figures 229–243; Pietrzeniuk 1977: p. 344, Figures 6–7, Plate 10, Figures 1–4.

#### Material examined

Female (dissected on one slide – USNM 96048, labeled as *Candona michoa*, Holotype), Mexico, Michoacán, Lago de Patzcuaro, 10 July 1941, collector Dr Deevey; 2) one female (dissected on one slide – USNM 100865, labeled as *Candona rawsoni*, Holotype) and one male (dissected on one slide – USNM 100878, labeled as *Candona rawsoni*, Paratype), Canada, Great Slave Lake, Resolution Bay, collector D. S. Rawson. Date of collection unknown.

#### Additional description

*Female*. Carapace subreniform in lateral view. L of carapace approximately 1.19 mm. Greatest H lies on last third and equals about 50% of L. Dorsal margin gradually sloping towards anterior end. Posterior margin with protruding truncate end. Ventral margin concave around mouth region. Carapace surface covered with warts and short dense hairs.

A1 (Figure 25I): 7-segmented. Swimming setae relatively thick and short. Seta En1a reaching distal end of En4. Seta En2a reaching middle of En5. En3 with two anterior setae (En3a and En3b), posteriorly with seta En3d (reaching middle of En6). En4 also with two anterior setae (En4a and En4b) and posterior seta (En4d) almost reaching distal end of En6. Penultimate segment with two longer setae En5a, En5b; En5c and En5d shorter and claw-like, former one 2.7 times, while latter one 1.7 times longer than terminal segment. Alpha seta long, two times longer than terminal segment. Seta En6c long, setae En6b and En6d short, latter one claw-like. Aesthetasc ya two times longer than terminal segment. L ratios of endopodal segments equal 1.6 : 1 : 1.6 : 1.5 : 1.7 : 1.7.

A2 (Figure 25H): 4-segmented. Claws G1 and G3 subequally long, G2 3.4 times longer than terminal segment. All t-setae present. Seta z1 not observed, while z2 and z3 present. All claws serrated.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md: With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

T2 (Figure 25C): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, exceeding distal end of following segment. Penultimate segment with two setae, longer one 1.4 times longer than same segment. Terminal segment with two setae and claw, which 1.3 times as long as three distal segments combined.

T3 (Figure 25G): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 1.5 : 1.6. Th1 seta 3.8 times longer than terminal segment.

Fu and genital field (Figure 25A): L ratios of anterior margin, anterior and posterior claws equal 1.9 : 1.2 : 1. Anterior seta reaching 1/4 of anterior claw; posterior seta well exceeds distal end of posterior margin. Both claws serrated. Furcal ramus almost straight. Genital field with one square-shaped (Figure 25A) or finger-shaped (Figure 25E) process which well sclerotized and equals approximately 50% of ramus.

*Male*. Carapace with dorsal margin almost evenly rounded. Posterior margin without truncate termination. L approximately 1.26 mm.

Fu (Figure 25B): L ratios of anterior margin and posterior claw equals 2.3 : 1.

Hemipenis (Figure 25F): Lobe a with elliptical dorsal extension. Lobe b rounded. Part g with boxing glove-like proximal part (Figure 25D)

Zenker's organ: consists of seven whorls of spines.

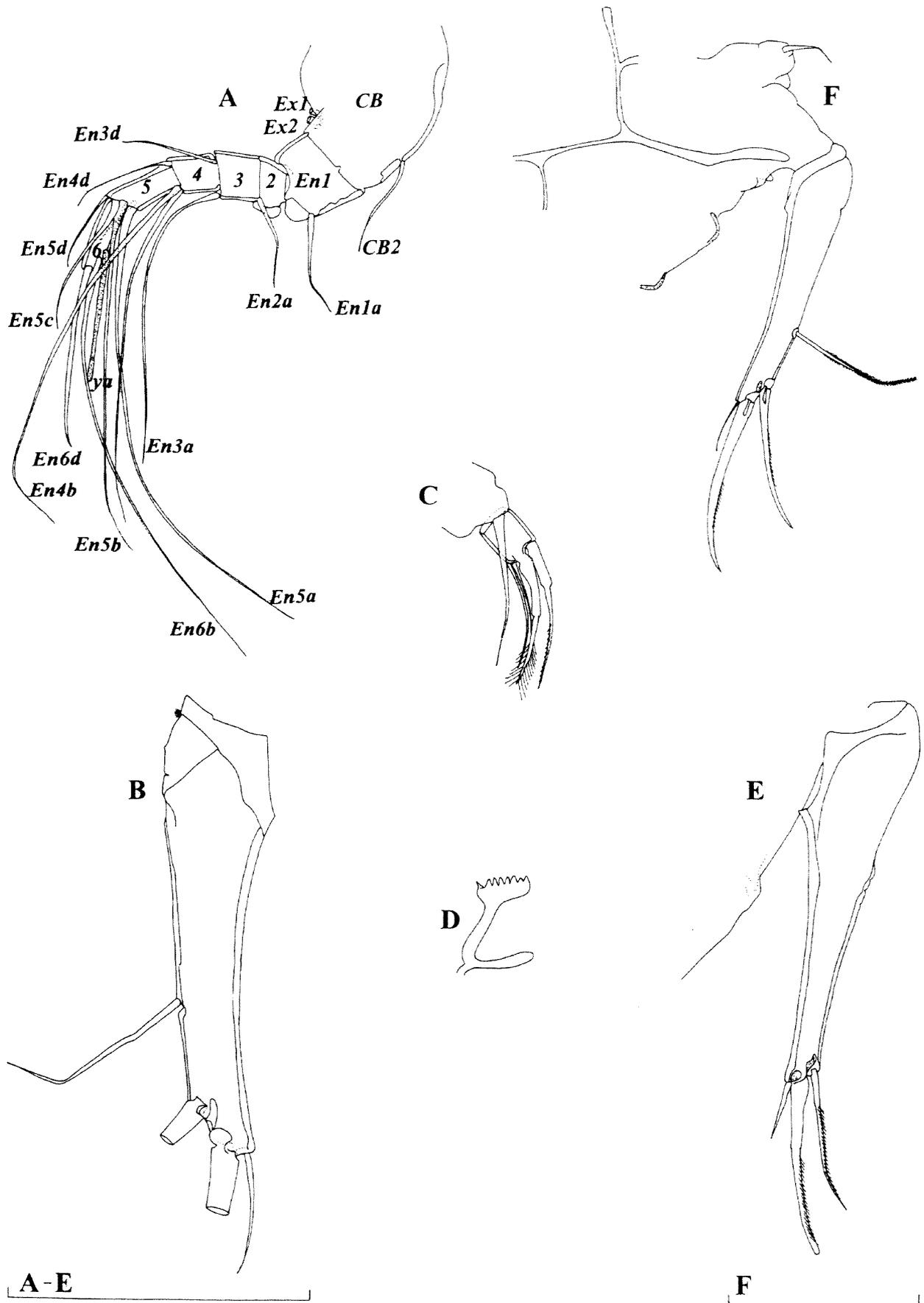
#### Variability

There is a variability in the appearance of the genital process, which can be more elongated (Figure 25E) or more square-shaped (Figure 25A). In addition, the typical truncate part of the posterior margin can be more or less pronounced. Two setae on the En1 in one specimen (Figure 25I) is probably an abnormality.

#### Remarks and affinities

Delorme (1967b) synonymized the following species with *Candona obtusa*: *C. rawsoni* Tressler, 1957; *C. nyensis* Gutentag and Benson, 1962; and *C. swaini* Staplin, 1963. Only the first species is the Recent one. In the present paper two new synonyms are added: *Candona michoa* Tressler, 1954 and *C. patzcuaro* Tressler, 1954. I have checked the type material of *C. rawsoni* and *C. michoa* and, although the slide of the latter species is in a very bad condition, I could not find enough differences to distinguish the two species. Unfortunately, the only male available is not dissected, but preserved *in toto* on the slide, so the appearance of both soft and hard parts are





**Figure 26** *Eucandona pennaki* (Marmonier and Ward, 1990). A, C, F, Paratype female (USNM 193909); B, Holotype female (USNM 193908); D, E Paratype female (USNM 193910): a – A1; B – Fu (incomplete); C – Md-palp (incomplete); D – Rake-like organ; E – Fu. Scales = 0.1 mm.

inaccurate. The morphology of *Candona patzcuaro* is poorly described and illustrated by Tressler (1954). However, Delorme (1970) reported this species from Canada, and following his descriptions and photographs there is no differences between this species and *Candona obtusa*. *Candona obtusa* is assigned to the genus *Eucandona* because of the strongly chitinized genital process. However, the morphology of male needs to be confirmed to be more certain about its position within the genus.

### Distribution

Holarctic.

#### *Eucandona pennaki* (Marmonier and Ward, 1990)

comb. nov.

Figure 26

*Fabaeformiscandona pennaki* Marmonier and Ward, 1990: 226, Figures 1–3.

### Material examined

#### Holotype

Female (dissected on one slide – USNM 193908), USA, Colorado, South Plate River, Station 1, January 1988, collector J. Ward.

#### Paratypes

Two females (dissected one slide each – USNM 193909 and USNM 193910), USA, Colorado, South Plate River, Station 1, January 1988, collector J. Ward.

### Additional description

*Female*. A1 (Figure 26A): 7-segmented. Setae thin and long. Seta En1a reaching distal end of En3. Seta En2a reaching middle of En5. Seta En3b missing, En3a long, En3d reaching middle of En5. En4 with two long anterior setae (En4a, En4b), posterior seta En4d short, slightly exceeds distal end of En5. Penultimate segment with long En5a and En5b, while En5c and En5d short, former one two times, latter one as long as terminal segment. Aesthetasc ya two times longer than terminal segment. L ratios of endopodal segments equal 2.6 : 1 : 1.6 : 1.8 : 2.8 : 3.

Rake-like organ (Figure 26D): with eight and nine small teeth.

Genital field (Figure 26E, F): with very small, triangular process hardly visible.

### Variability

One female paratype lacks posterior furcal seta (Figure 26F).

### Remarks and affinities

This species is illustrated and described in detail

by Marmonier and Ward (1990). However, the authors did not mention a small genital process, very similar in shape to *Eucandona lapponica* and *Eucandona wegelini*, but much shorter. This species is, like the majority of the *breulli*-group (Meisch 2000), assigned to the genus *Eucandona*. However, the position of some of them remains questionable because of their parthenogenetic reproduction and therefore unknown male morphology. *Eucandona pennaki* is very similar to *E. breuli* (Paris, 1920) and they differ by the carapace shape which is in the former species more protruded posteriorly.

### Distribution

Known only from Colorado (Marmonier and Ward 1990).

#### *Eucandona rectangulata* (Alm, 1914) comb. nov.

Figures 27, 28

*Candona rectangulata* Alm, 1914: 12, Figure 5.

*Candona rectangulata* Alm, 1914: Olofsson 1918: 521, Figures 34–35; Bronstein 1947: 246, Figure 151.

*Candona distincta* Furtos, 1933: 478, Plate 8, Figure 15, Plate 9, Figures 13–16, Plate 12, Figures 21–22. [new synonymy]

*Candona distincta* Furtos, 1942: Hoff 1942: 77, Plate 3, Figures 29–30; Delorme 1970: 1107, Figures 112–125.

### Material examined

One male (dissected on one slide – USNM 67868, labeled as *Candona distincta*, Paratype) and one female (dissected on one slide – USNM 67868, labeled as *Candona distincta*, Paratype), USA, Ohio, Canal south of Columbus, 29 March 1931, collector N. C. Furtos.

### Redescription

*Male*. Carapace subreniform in lateral view. L of carapace approximately 1 mm. Greatest H lies on last third and equals about 55% of L. Dorsal margin gradually sloping towards anterior end. Dorsal margin settled towards posterior end. Both posterior and anterior margins widely and subequally rounded. Posterior margin slightly bulging. Ventral margin markedly concave around mouth region and with small protrusion on its first third. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with warts and short dense hairs.

A1: 7-segmented. Swimming setae long and thin. Seta En1a reaching distal end of En3. Seta En2a reaching middle of En4. En3 with two anterior setae (En3a and En3b), posteriorly with short seta En3d

(reaching distal end of En4). En4 also with two long anterior setae (En4a and En4b) and short posterior seta (En4d) reaching distal end of En5. Penultimate segment with two longer setae En5a, En5b; En5c and En5d shorter, former one four times, while latter one 2.9 times longer than terminal segment. Alpha seta exceeds distal end of terminal segment, and two times longer than same segment. Seta En6c longer, setae En6b and En6d short, last one claw-like. Aesthetasc ya three times longer than terminal segment. L ratios of endopodal segments equal 1.8 : 1 : 2 : 1.9 : 1.9 : 1.

A2 (Figure 28A): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, G1 claw-like and three times longer than terminal segment, G3 2.3 times longer than same segment. Claw G2 as long as first endopodal segment. Claw GM reduced and 2.3 times longer than terminal segment. Claw Gm well developed and 0.84 times as long as first endopodal segment. Seta z2 well developed, as long as first endopodal segment, z1 very short, not even reaching distal end of terminal segment (Figure 28F). All claws serrated. Seta z3 exceeds distal end of terminal segment. Aeshetasc Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 5.6 : 2.3 : 1.3 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md (Figure 28B): With 4+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 27H): With numerous small teeth.

T1 (Figure 27E, F): Palps asymmetrical. On both palps fingers hook-shaped, and both with thin subterminal sclerified structures. One Ta, Tb and Td seta present.

T2 (Figure 27G): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, not reaching distal end of following segment. Penultimate segment with two setae, longer one only 0.74 times as long as same segment. Terminal segment with two setae and claw, which as long as three distal segments combined.

T3 (Figure 28D): 5-segmented. Basal segment with dp and d1 seta. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 2.4 : 2. Th1 seta three times longer than terminal segment.

Fu (Figure 28E): L ratios of anterior margin, anterior and posterior claws equal 2.2 : 1.2 : 1. Anterior seta reaches 1/4 of anterior claw; posterior seta well exceeds distal end of posterior margin. Both claws serrated. Furcal ramus almost straight and with row of short setae postero-medially.

Hemipenis (Figure 27A, C). Lobe a with elliptical dorsal extension. Lobe b rounded. Lobe h do not

exist. Part g (Figure 27D) with boxing-glove like distal part. Proximal part of ejaculatory process shown on Figure 27B. Lobes a and b ornamented with chitinized and bush-like patches.

Zenker's organ: consists of seven whorls of spines.

### Redescription

*Female*. Carapace with dorsal margin more acutely sloping towards anterior and posterior margins. Posterior margin slightly bulging and being narrower than anterior one. L approximately 1 mm. Greatest H situated on last third and equals 55% of L. Calcified inner lamella narrow.

A2 (Figure 28G): All t-setae present. Seta z1 not observed, setae z2 and z3 not reaching distal end of terminal segment. Claw G2 3.75 longer than last segment. Claws G1 and G3 subequally long. Claw Gm 2.9 times longer than terminal segment.

Fu and genital field (Figure 28C): L ratios of anterior margin, anterior and posterior claw equal 2 : 1.1 : 1. Anterior seta almost reaching 1/2 of anterior claw, posterior seta exceeds distal end of posterior margin. Furcal ramus with row of short setae postero-distally. Genital field with square-shaped sclerified extension, with concave ventral margin, and equals 75% of anterior furcal margin.

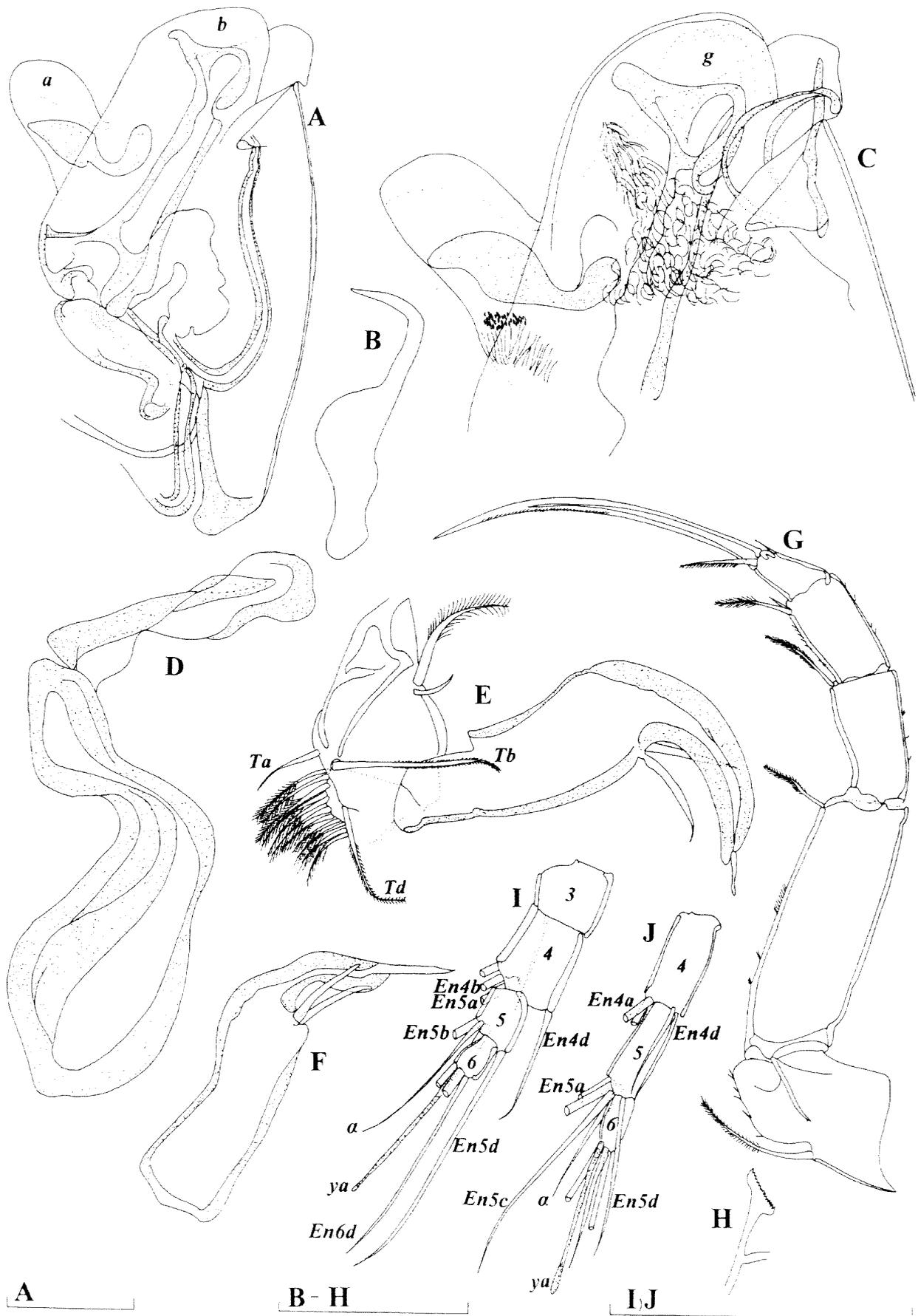
A1 (Figure 27J) and all other soft parts same as in male.

### Variability

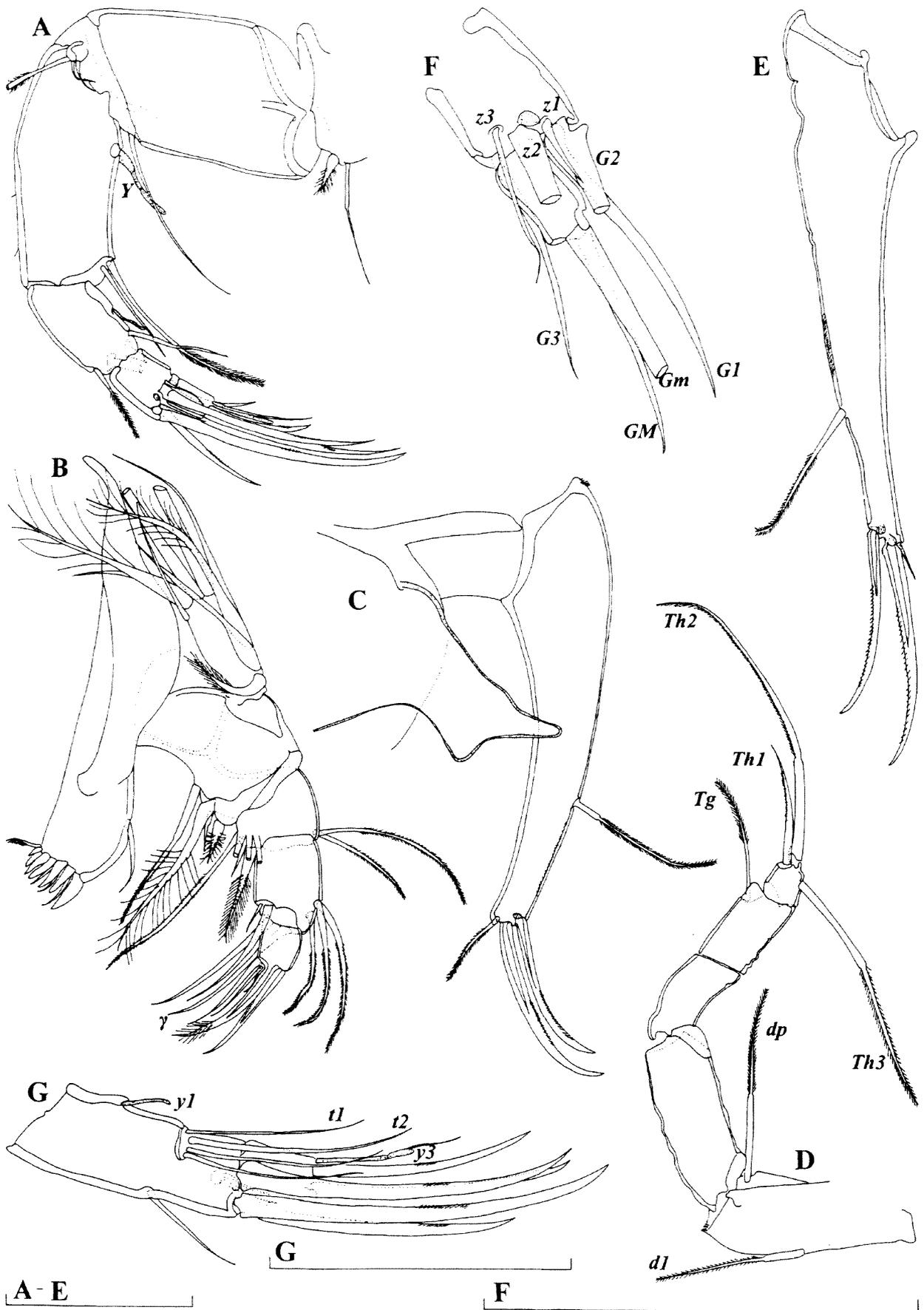
There is a small variability in the shape of the female carapace and the genital process in the parthenogenetic populations. The carapace can be with more or less protruded posterior part (see Alm 1914), while the ventral margin of the genital process can be more or less sinusoid (see Olofsson 1918). One observed specimen has an abnormal chaetotaxy of the A1 (Figure 27I, J).

### Remarks and affinities

*Candona rectangularata* is placed in the genus *Eucandona* because of the following three characters: the seta z1 is very short, females have a chitinized genital process, and the appearance of the carapace is very similar to *E. biangulata* (Hoff, 1942) and *E. fabella* (Nüchterlein, 1969). The presence of lobe "h" is not certain. However, it seems that the ventro-distal extension on the hemipenis is completely fused with lobe "a". *Eucandona rectangularata* is a clearly defined species, and it is most closely related to *Eucandona pedata* (Alm, 1914). They share a similar appearance of the genital process, but they differ by the shape of the carapace which is considerably lower in the latter species and has a more protruded posterior end. In addition, males of *E. pedata* have a much bigger lobe "a". *Candona delawarensis* Turner, 1894 has a



**Figure 27** *Eucandona rectangularata* (Alm, 1914). A-H, Male (USNM 67868); I, J, Female (USNM 67865): A - Hemipenis; B - Distal part of "e"; C - Distal part of hemipenis; D - part "g"; E - T1 and right prehensile palp; F - left prehensile palp; G - T2; H - Rake-like organ; I, J - A1 (incomplete). Scales = 0.1 mm.



**Figure 28** *Eucandona rectangularata* (Alm, 1914). A, B, D-F, Male (USNM 67868); C, G, Female (USNM 67865): A - A2; B - Md; C - Fu and genital process; D - T3; E - Fu; F - A2 (detail); G - A2 (two terminal segments). Scales = 0.1 mm.

very similar carapace shape as *E. rectangulata*, but with almost straight anterior margin. Details of the internal morphology are insufficiently described (Turner 1894) so it is not clear if the two species are synonyms or not. In addition, because of such descriptions, *C. delawarensis* is here considered as *incertae sedis*.

### Distribution

North Holarctic.

## Genus *Typhlocypris* Vejdovský, 1882

### Subgenus *Typhlocypris* Vejdovský, 1882

#### North American representatives of the subgenus

1.) *rostrata*-group: *Typhlocypris* (*Typhlocypris*) *rostrata* (Brady and Norman, 1889); 2.) *caribbeana*-group: *Typhlocypris* (*Typhlocypris*) *annae* (Méhes, 1914); *T. (T.) delormei* new species; *T. (T.) elliptica* (Furtos, 1933); *T. (T.) fluviatilis* (Hoff, 1942); *T. (T.) jeanneli* (Klie, 1931); *T. (T.) marengoensis* (Klie, 1931); *T. (T.) parvula* (Sars, 1926); *T.(T.) punctata* (Furtos, 1933); *T.(T.) renoensis* (Gutentag and Benson, 1962); *T. (T.) stagnalis* Sars, 1890.

#### *Typhlocypris* (*Typhlocypris*) *annae* (Méhes, 1914)

Figure 29

*Candona annae* Méhes, 1914: 653, Figures 9–12.

*Candona annae* Méhes, 1914: Furtos, 1936: 520, Figure 15.

*Candona annae* Méhes var. *septentrionalis* Furtos, 1935: 541, Figure 6. [new synonymy]

*Pseudocandona antilliana* Broodbakker, 1983: 296, Figures 4–5. [new synonymy]

#### Material examined

One male (dissected on one slide – USNM 71421, labeled as *Candona annae septentrionalis*, Holotype), USA, Massachusetts, Cape Cod, Woods Hole, 12 June 1933, collector N. C. Furtos; 2) One female (dissected on one slide – ZMA Ost. 150.789, labeled as *Pseudocandona antilliana*, Paratype), Haiti, Well of Emile Magloire at Ti Mouillage, about 40–50 m from the littoral. Date and collector unknown.

#### Redescription

*Male*. Carapace subreniform in lateral view. L of carapace approximately 0.9 mm. Greatest H lies on last third and equals about 50% of L. Dorsal margin gradually sloping towards anterior end, and rounded towards posterior one. Both posterior and anterior margins widely and subequally rounded. Ventral margin very weakly concave around mouth region. Inner calcified lamella narrow, especially

posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with hairs.

A1 (Figure 29G): 7-segmented. Swimming setae long and thin. Seta En1a reaching distal end of En4. Seta En2a also reaching distal end of En4. En3 with two long anterior setae (En3a and En3b), posteriorly with short seta En3d (not reaching distal end of En4). En4 also with two long anterior setae (En4a and En4b) and short posterior seta (En4d) almost reaching distal end of En5. Penultimate segment with two longer setae En5a, En5b; seta En5c two times longer than terminal segment. Alpha seta reaches distal end of terminal segment. Seta En6b long, setae En6c and En6d short, last one claw-like. Aesthetasc ya 1.4 times longer than terminal segment. L ratios of endopodal segments equal 1.5 : 1 : 1.4 : 1.3 : 1.6 : 1.5.

A2 (Figure 29H): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, G1 claw-like and 2.8 times longer than terminal segment, G3 seta-like and 2.3 times longer than same segment. Claw G2 1.3 times longer than first endopodal segment. Claw GM reduced and two times longer than terminal segment. Claw Gm well developed and 0.86 times as long as first endopodal segment. Seta z1 claw-like and as long as first endopodal segment, z2 and z3 subequally long, seta-like and 3.3 times longer than terminal segment. All claws serrated. Aeshetasc Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 4.3 : 1.8 : 1.4 : 1.

Mxl: 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

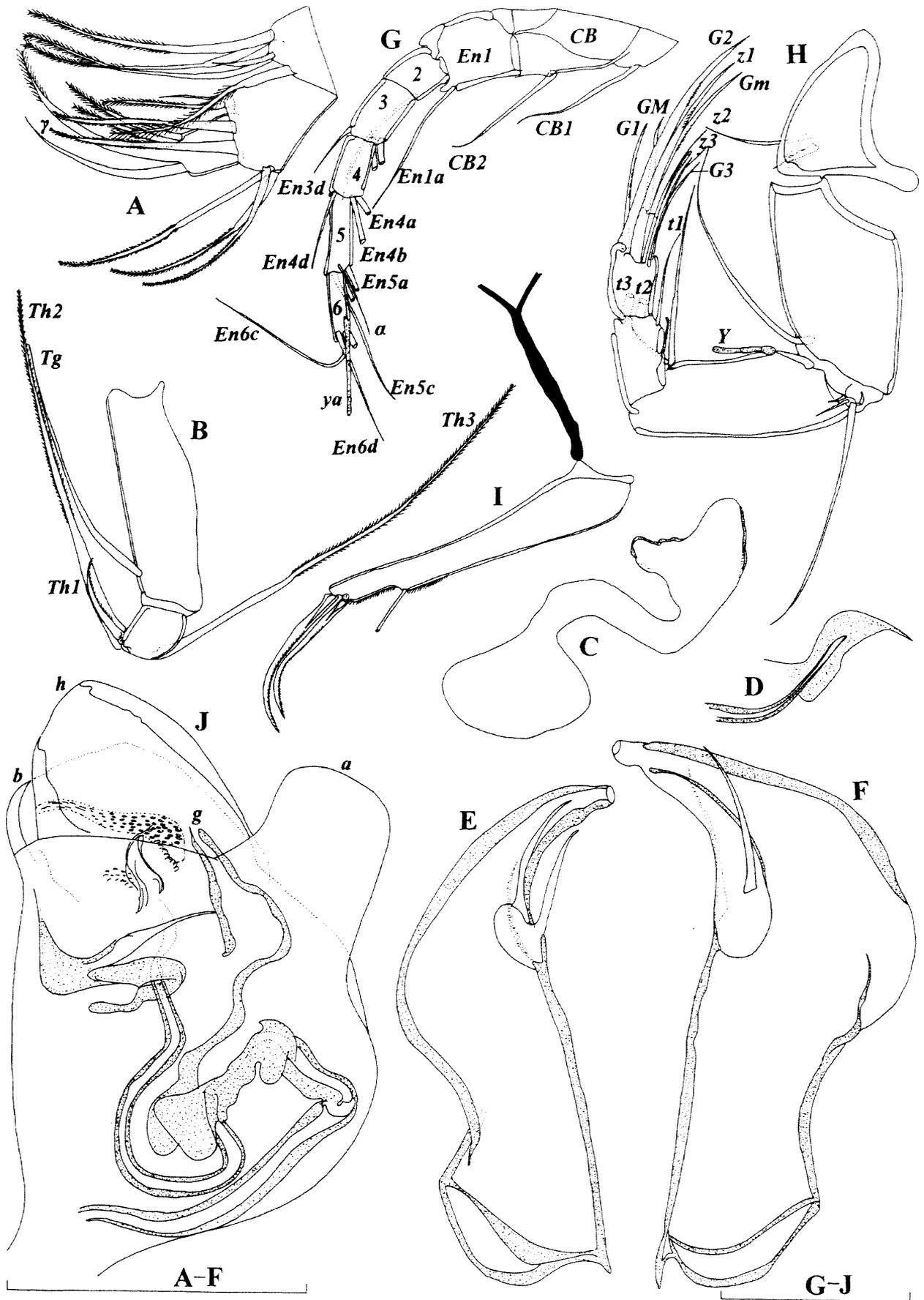
Md (Figure 29A): With 3+2 setae in bunch internally on second segment. Gamma seta plumed. Terminal segment with two strong claws and two setae.

T1 (Figure 29E, F): Palps asymmetrical. Right one (Figure 29F) helmet shaped, while left one (Figure 29E) thinner. On both palps fingers broadly fused with base, and both with thin subterminal sclerified structures. One Ta, Tb and Td seta present.

T2: 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, exceeding distal end of following segment. Penultimate segment with two setae, longer one as long as same segment. Terminal segment with two setae and claw, which as long as three distal segments combined.

T3 (Figure 29B): 4-segmented. Second and third endopodal segments fused. Basal segment with dp, d1 and d2 setae. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of three terminal setae equal 1 : 4.1 : 4.95. Th1 seta 1.6 times longer than terminal segment.

Fu (Figure 29I): L ratios of anterior margin, anterior and posterior claws equal 1.8 : 1.1 : 1. Posterior furcal seta well exceeds distal end of



**Figure 29** *Typhlocypris (Typhlocypris) annae* (Méhés, 1913). Male (USNM 71421): A – Md-palp (incomplete); B – Two terminal segments of T3; C – Part “g”; D – “e”; E – left prehensile palp; F – Right prehensile palp; G – A1; H – A2; I – Fu; J – Hemipenis. Scales = 0.1 mm.

posterior margin. Both claws serrated. Furcal ramus almost straight and with row of short setae posterodistally.

Hemipenis (Figure 29J): Lobe a with small square-shaped dorsal extension, which much lower than other lobes. Lobe b rounded, ventrally double folded. Lobe h big and subtriangular, same lobe dorsally and ventrally double folded. Part g (Figure 29C) weakly sclerified. Ejaculatory process shown on Figure 28D. Lobes a and b ornamented with chitinized and mesh-like patches.

Zenker's organ: consists of seven whorls of spines.

*Female.* For description see Méhes (1914) and Broodbakker (1983)

### Variability

This species has variable shape and L of the carapace and furca.

### Remarks and affinities

*Candona annae* was originally described from Columbia (Méhes 1913). Furtos (1936) recorded this species in Florida, while Furtos (1935) described a variety - *Candona annae septentrionalis* from Massachusetts. This variety, according to Furtos (1935), differ from the nominal form by the carapace appearance and by the morphology of the furca. Broodbakker (1983) described *Pseudocandona antilliana* from Haiti, and recorded an intrapopulation variation in the carapace and the furcal appearance. The same author noted that *P. antilliana* might be the same species as *P. annae*, and stressed that his species resembles *C. annae* reported from Florida by Furtos (1935). After examining the type material of *P. antilliana* and *C. annae septentrionalis* I synonymized them with *Typhlocypris (T.) annae* (Méhes, 1913). The variability recorded by Broodbakker (1983) excludes the validity of the subspecies. *Typhlocypris annae* is most closely related to *T. elliptica* (Furtos, 1933), but the two species differ by the appearance of the hemipenis which, in the latter species, has a widely rounded lobe "h", while the lobe "a" has a higher position. *Typhlocypris annae* is also similar with *T. parvula* (Sars, 1926) but they differ by the appearance of the hemipenis which is in the latter species more similar to *T. elliptica*.

### Distribution

This species is distributed in the southern part of North America, and in Central and South America as well.

### *Typhlocypris (Typhlocypris) delormei* sp. nov.

*Candona hartwigi* Müller, 1900: Delorme 1970: 1109, Figures 159-162

*Candona sarsi* Hartwig, 1899: Delorme 1970: 1118, Figures 270-282.

### Type material

Holotype male (GSC 26774), allotype female (GSC 26773), two paratype females (GSC 26769 and 26770), and two paratype males (GSC 26771 and 26772).

### Type locality

Canada, Manitoba, Lake Winnipeg (C-5191), collector D. L. Delorme (see Delorme, 1970).

### Etymology

The species is named after Dr L. D. Delorme. It is to be treated as a noun in the genitive singular.

### Description

*Male.* Carapace subreniform in lateral view. L around 1.2 mm. Greatest H situated on last third of L and equals 60% of L. Dorsal margin acutely sloping towards anterior margin. Both anterior and posterior margins rounded but posterior one much broader than anterior. Inner calcified lamella narrow on both ends.

Prehensile palps: asymmetrical: right helmet shaped, left more slender. Both palps with hook-like fingers.

T3: 4-segmented. Penultimate segment not divided. Terminal segment with shortest seta not hook-shaped and approximately two times longer than terminal segment.

Furca: short ramus, claws subequal, both curved.

Hemipenis: All lobes developed. Lobe a square/elliptical in shape and in cross position to lobe b and h.

Zenker's organ: with seven whorls of spines.

### Description

*Female.* Carapace almost identical with male. Other details of morphology not unknown.

### Remarks and affinities

Delorme (1970) recorded *Candona hartwigi* Müller, 1900 and *Candona sarsi* Hartwig, 1899 from Canada. However, his descriptions and photographs of these two species are so similar, suggesting a single species. It is here described as new, because the appearance of its carapace, hemipenis, prehensile palps and T3 are very different from both *C. hartwigi* and *C. sarsi*. First of all, these two species belong to the *rostrata*-group, meaning they have a short, hook-shaped Th1 seta. Also, in both species T3 is 5-segmented. The new species has a more similar furca and hemipenis with *T. sarsi*, but the two species additionally differ by the appearance of the prehensile palps (*T. sarsi* has much shorter fingers). *Typhlocypris hartwigi*

has similar prehensile palps as the new species, but it has different hemipenis and morphology of the furca. *Typhlocypris delormei* is most closely related to *T. (T.) renoensis* (Gutentag and Benson, 1962), as they share similar appearance of the hemipenis, but in the latter species the inner calcified lamella does not follow the line of the outer margin, which is their main differential feature. The latter species also has a more stocky appearance of the right prehensile palp. The new species is described from Delorme's (1970) descriptions and photographs. I was unable to trace the type material. However, Delorme (1970) provided details both for locality and deposition of the material he examined, so the holotype, allotype and paratypes are designated according to this.

### Distribution

Known only from Canada.

### *Typhlocypris (Typhlocypris) elliptica* (Furtos, 1933)

Figures 30, 31

*Candona elliptica* Furtos, 1933: p. 482, Plate 12, Figures 1–7.

*Candona elliptica* Furtos, 1933: Delorme 1970: 1108, Figures 126–136.

### Material examined

#### Paratype

Male (dissected on one slide – USNM 67869) and paratype female (dissected on one slide – USNM 67869), USA, Ohio, South Bass Island, Terwilliger Pond, 27 July 1931, collector N. C. Furtos.

### Redescription

*Male.* Carapace elliptical in lateral view. L of carapace about 0.92 mm. Greatest H lies behind middle equals about 45% of L. Dorsal margin almost evenly rounded. Both posterior and anterior margins widely rounded, anterior one slightly wider. Ventral margin almost straight. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with hairs.

A1 (Figure 31G): 7-segmented. Swimming setae long and thin. Seta En1a reaching middle of En3. Seta En2a exceeds distal end of En3. En3 with two long anterior setae (En3a and En3b), posteriorly with short seta En3d (not reaching distal end of En4). En4 also with two long anterior setae (En4a and En4b) and short posterior seta (En4d), not reaching distal end of En5. Penultimate segment with two longer setae En5a, En5b; seta En5c two times longer than terminal segment. Alpha seta tiny, reaching middle of terminal segment. Setae

En6b and En6c long, seta En6d short and slightly claw-like. Aesthetasc ya only 0.5 times as long as terminal segment. L ratios of endopodal segments equal 2.2 : 1 : 1.5 : 1.5 : 1.9 : 1.

A2 (Figure 31A): 5-segmented. Male bristles (t2 and t3) developed. Claws G1 and G3 reduced, G1 claw-like and three times longer than terminal segment, G3 2.5 times longer than same segment. Claw G2 1.2 times as long as first endopodal segment. Claw Gm well developed and 0.9 times as long as first endopodal segment. Seta z1 claw-like, well developed, as long as first endopodal segment, z2 and z3 seta-like and short. All claws serrated. Aeshetasc Y, y1 and y3 observed, all being short. L ratios of endopodal segments equal 5.5 : 2.4 : 1.7 : 1.

Mxl (Figure 31B, F): 2-segmented endopod. First segment with four plumed setae. Second segment with two claws and four setae.

Md (Figure 31C): With 3+2 setae in bunch internally on second segment. Gamma seta plumed. Terminal segment with two strong claws and three setae.

Rake-like organ (Figure 30J): With 10 and 11 teeth.

T1 (Figure 30C): Palps asymmetrical. Right one helmet shaped, while left one thinner. On both palps fingers broadly fused with base, and both with thin subterminal sclerified structures. One Ta, Tb and Td seta present.

T2 (Figure 30E): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, reaching distal end of following segment. Penultimate segment with two setae, longer one only 0.9 times as long as same segment. Terminal segment with two setae and claw, which as long as three distal segments combined.

T3 (Figure 30B): 4-segmented. Second and third segments fused. Basal segment with dp, d1 and d2 setae. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of Th1 and Th2 setae equals 1 : 3.6. Th1 seta two times longer than terminal segment.

Fu (Figure 30F): L ratios of anterior margin, anterior and posterior claws equal 1.79 : 1.1 : 1. Anterior seta very tiny; posterior seta exceeds distal end of posterior margin. Both claws serrated. Furcal ramus almost straight and with row of short setae postero-distally.

Hemipenis (Figure 30A): Lobe a with small square-shaped dorsal extension which in approximately same level as other lobes. Lobe b rounded, bended towards ventral side of hemipenis. Lobe h big and rounded, same lobe double folded. Part g weakly sclerified and stick-like.

Zenker's organ: consists of seven whorls of spines.

*Female.* Carapace almost identical with male. L varies between 0.78 mm and 0.9 mm.

A2 (Figure 31D, E): All t-setae present. Seta z1

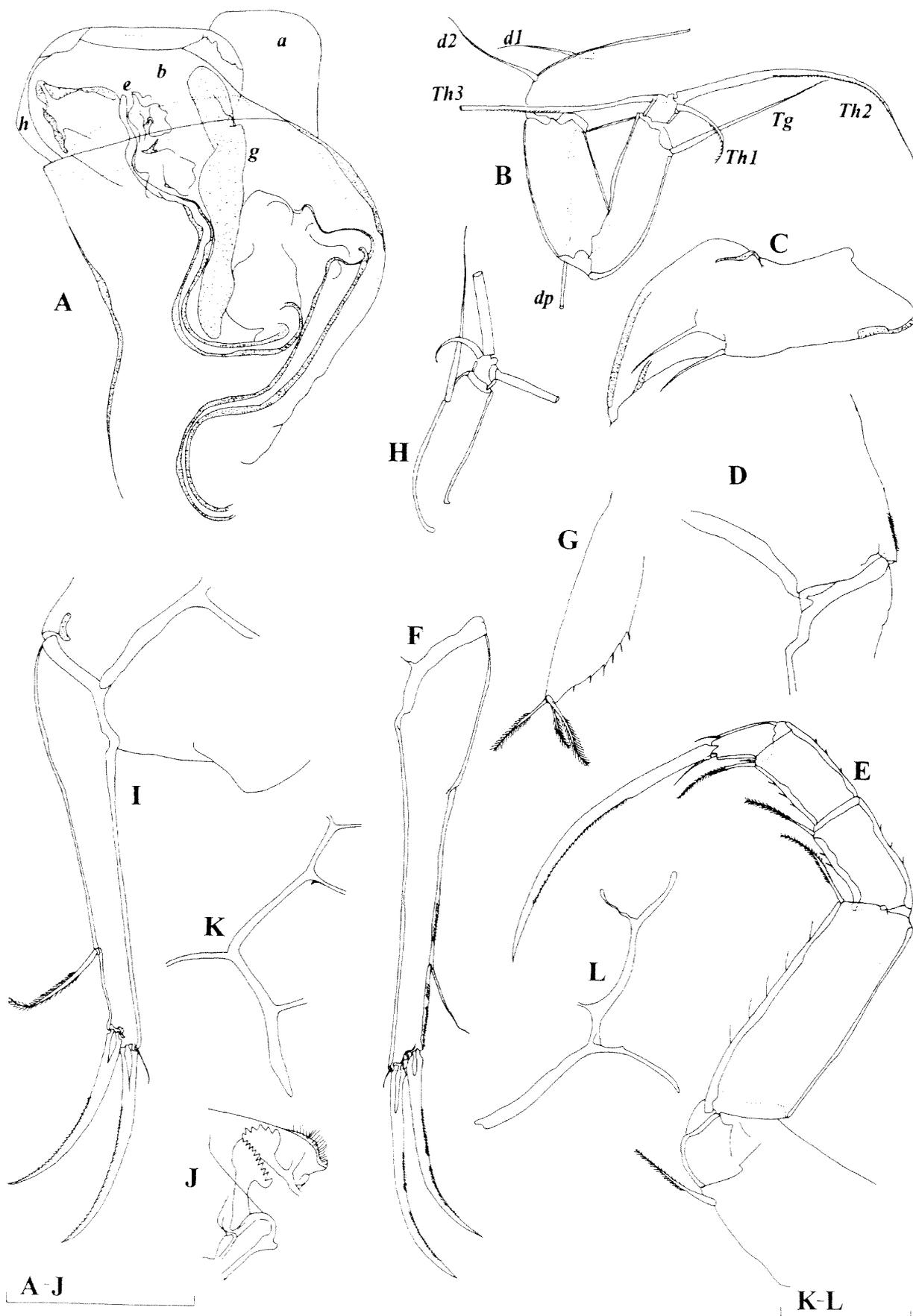


Figure 30 *Typhlocypris (Typhlocypris) elliptica* (Furtos, 1933). A-F, J, L, Paratype male (USNM 67869); G, H, I, K, Paratype female (USNM 67869): A - Hemipenis; B - T3; C - Right prehensile palp; D - Proximal part of Fu; E - T2; F - Fu; G - endopod T1; H - Two distal segments of T3; I - Fu and genital field; J - Rake-like organ; K, L - Furcal attachments. Scales = 0.1 mm.

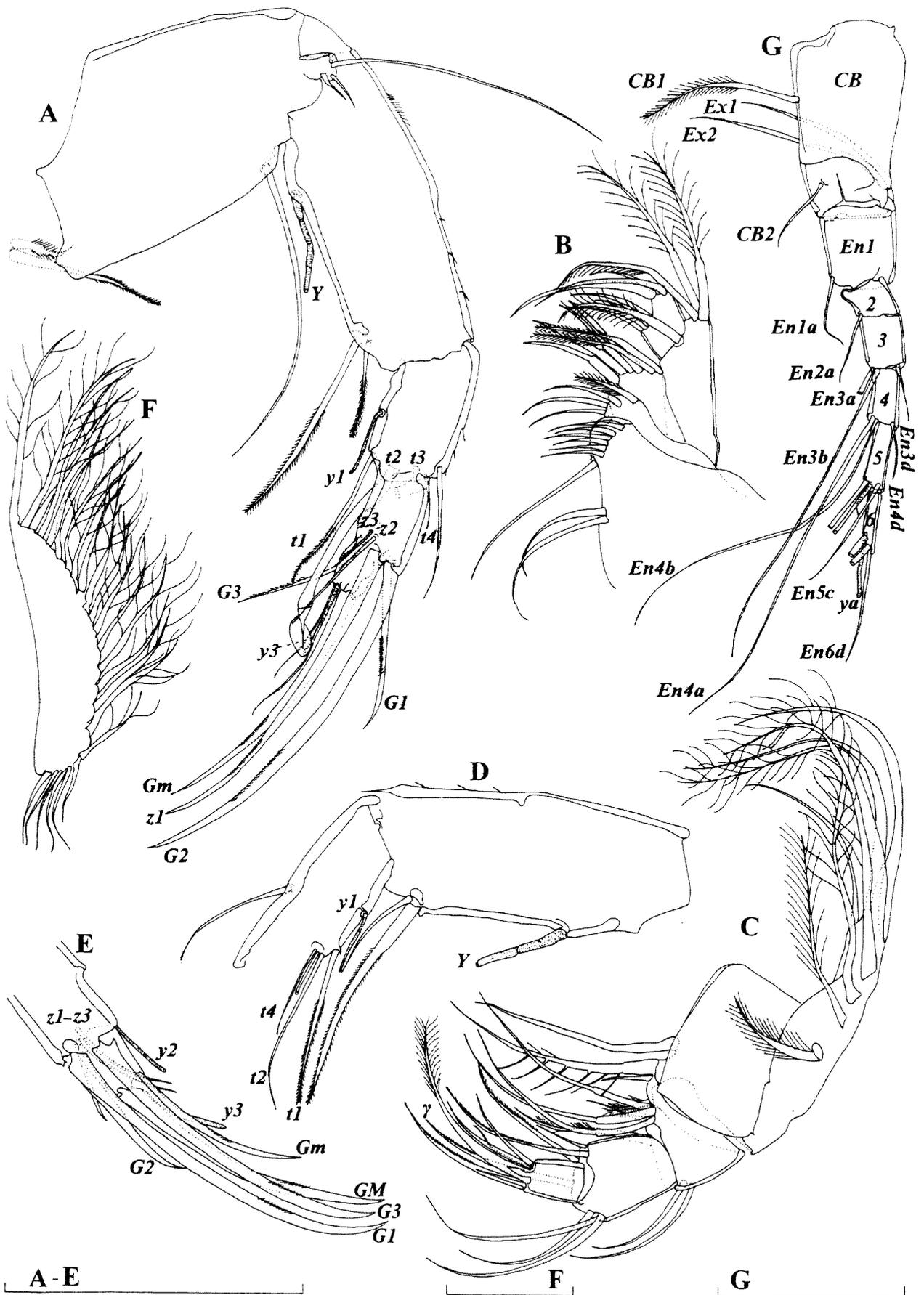


Figure 31 *Typhlocypris (Typhlocypris) elliptica* (Furtos, 1933). A-C, F, G, Paratype male (USNM 67869); D, E, Paratype female (USNM 67869): A - A2; B - Mxl palp; C - Md; D - A2; E - A2; F - Exopod Mxl; G - A1. Scales = 0.1 mm.

claw-like and exceeds distal end of terminal segment. Setae z2 and z3 thinner and slightly longer. Claw G2 two times longer than last segment. Claws G1 and G3 subequally long and as long as first endopodal segment. Claw GM 0.9 times as long as first endopodal segment, Gm 2.2 times longer than terminal segment. All aesthetascs observed, all short.

Fu and genital field (Figure 30I): L ratios of anterior margin, anterior and posterior claw equal 1.7 : 1.1 : 1. Anterior seta slightly longer than in male, posterior seta exceeds distal end of posterior margin. Genital field without any extensions, and rounded.

All other soft parts same as in male.

### Variability

Seta Th1 can be more (Figure 30H) or less (Figure 30B) curved.

### Remarks and affinities

The elliptical appearance of the carapace makes this species very distinct. It is most closely related to *T. parvula* (Sars, 1926). They share a similar hemipenis, but lobes "b" and "h" are more stocky in *T. elliptica*, and additionally, lobe "b" is double-folded in *T. parvula*. The latter species also has a shorter furcal ramus and considerably longer than the longest seta on the penultimate segment of T2.

### Distribution

Known from Ohio and Canada.

### *Typhlocypris (Typhlocypris) fluviatilis* (Hoff, 1942)

Figure 32

*Candona fluviatilis* Hoff, 1942: 60, Plate 1, Figures 6-9, Plate 2, Figures 10-11.

### Material examined

#### Paratypes

Female and juvenile male (together dissected on one slide - USNM 81066), USA, Ford Country, near Roberts, 18 May 1940, collector C. C. Hoff.

### Additional description

*Female*. Carapace trapezoidal in lateral view (Figure 32A). L of carapace about 0.75 mm. Greatest H lies medially, equals 43% of L. Dorsal margin straight, then gradually sloping towards anterior end, and slightly curved towards posterior end. Both posterior and anterior margins widely rounded, anterior wider than posterior. Ventral margin almost straight. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with hairs and ornamented with small circular bumps.

A1 (Figure 32F): 7-segmented. Aesthetasc ya long (Figure 32I) and four times longer than terminal segment. L ratios of endopodal segments equal 1.9 : 1 : 1.9 : 1.5 : 1.75 : 2.

A2 (Figure 32C, D): All t-setae present. Seta z1 claw-like and only slightly exceeds distal end of terminal segment. Setae z2 and z3 two times longer. Claw G2 not observed. Claws G1, G3 and GM subequally long and 1.5 times as long as first endopodal segment. Aesthetascs Y equals 50% of first endopodal segment, y3 as long as same segment.

Md (Figure 32E): With 3+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and two setae.

Rake-like organ: with eight and nine teeth.

T1 (Figure 32G): One Ta, Tb and Td seta present.

T2: 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each, not reaching distal end of following segment. Penultimate segment with two setae, longer one only 0.54 times as long as same segment. Terminal segment with two setae and claw, which 1.3 times longer than three distal segments combined.

*Male*. Only juvenile male collected (Figure 32B, H, K and J).

### Variability

Not recorded.

### Remarks and affinities

This species is easily distinguished from its congeners by the ornamentation of the carapace. Hoff (1942) deposited one slide of this species in the Smithsonian Museum, which contains an adult female and a juvenile male. This male has the initiation of the hemipenis what was mistakenly interpreted by Hoff as a female genital process. The actual genital lobe is completely flat and without any extensions. *Typhlocypris fluviatilis* has a similar carapace shape to two species described from Marengo Cave in North America by Klie (1931): *Candona marengoensis* Klie, 1931 and *Candona jeanneli* Klie, 1931. It is also similar to the two species described from the West Indies (Broodbakker 1983): *Pseudocandona cubensis* and *P. caribbeana*. All these four species have an ornamented carapace. According to Broodbakker (1983), the carapaces of the West Indies species are pitted, while Klie (1931) described two species from the Marengo Cave with a reticulated pattern on their carapace. Unfortunately, all five species are known only from females, so other significant differences between them are unknown.

### Distribution

Known only from Illinois.

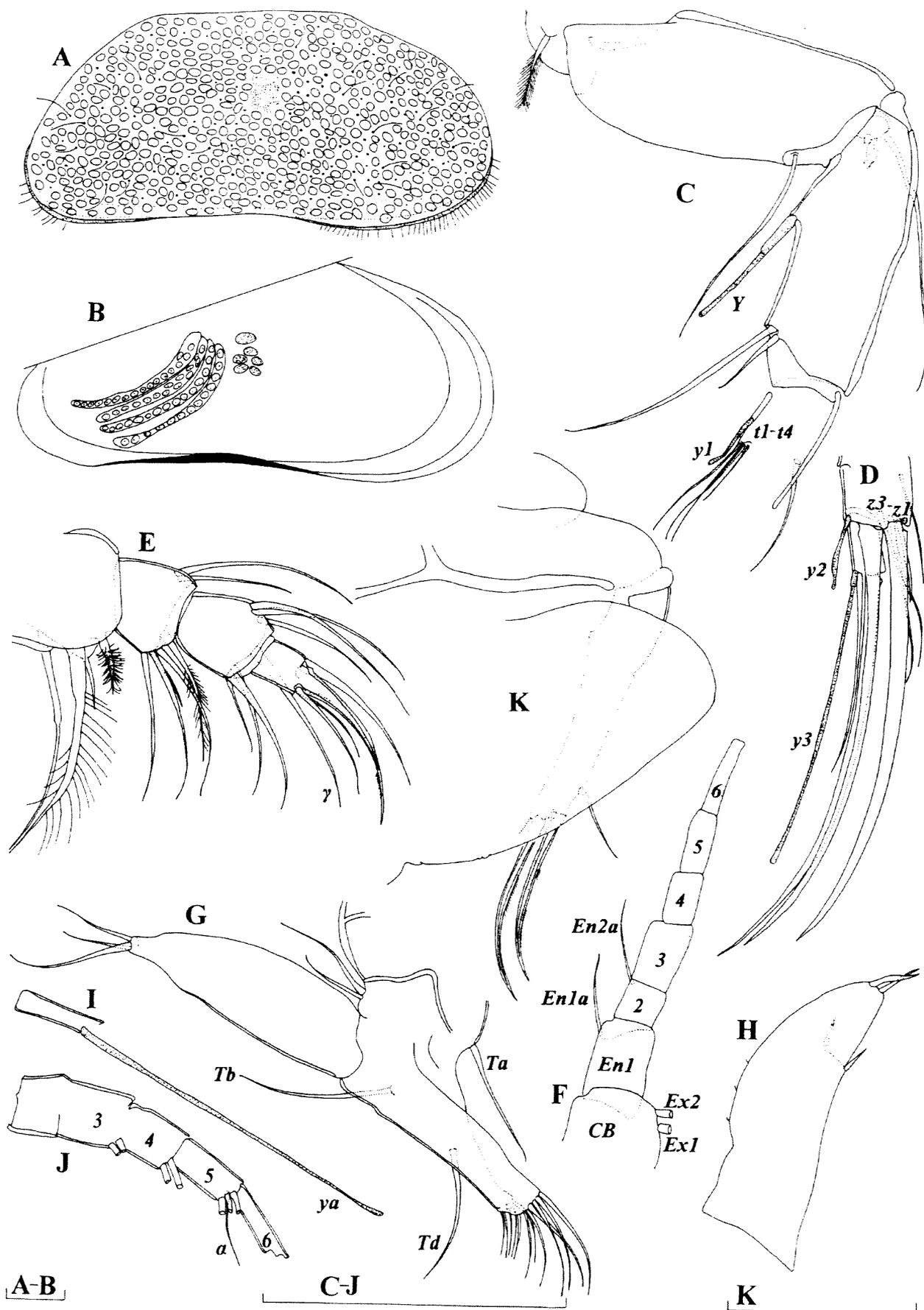


Figure 32 *Typhlocypris (Typhlocypris) fluviatilis* (Hoff, 1942). A, C-G, Paratype female (USNM 81066); B, H-J, Paratype male (juvenile, USNM 81066): A - RV, external view; B - LV, internal view; C, D - A2; E - Md-palp; F - A1; G - T1; H - Initiation of prehensile palp; I - terminal segment of A1; J - A1. Scales = 0.1 mm.

*Typhlocypris (Typhlocypris) parvula* (Sars, 1926)

Figure 33

*Candona parvula* Sars, 1926: 9, Plate 4, Figures 10–15.*Candona exilis* Furtos, 1933: 483, Plate 12, Figures 14–17. [new synonymy]*Pseudocandona geratsi* Broodbakker, 1983: 292, Figures 2, 3. [new synonymy]**Material examined**

One female (dissected on one slide – USNM 67871, labeled as *Candona exilis* Holotype), USA, Ohio, Columbus, Temporary Pond, 27 April 1932, collector N. C. Furtos.

**Redescription**

*Female*. Carapace oval in lateral view. Average L of carapace 0.65 mm. Greatest H lies medially, and about 50% of L. Dorsal margin straight, then gradually sloping towards anterior end, and slightly curved towards posterior end. Both posterior and anterior margins widely and equally rounded. Ventral margin almost straight. Inner calcified lamella narrow, especially. Marginal pore canals short, straight and dense. Carapace surface covered with hairs.

A1 (Figure 33A): 7-segmented. Swimming setae thin and long. Seta En1a almost reaches distal end of En3. Seta En2a reaches middle of En4. En3 with two long anterior setae (En3a and En3b), posterior seta (En3d) short, reaching only middle of following segment. Anterior setae on En4 long, posterior seta reaches only middle of En5. Penultimate segment (Figure 33B) with long En5a and En5b, while En5c 2.8 times longer than terminal segment. Alpha seta almost reaches distal end of terminal segment. L ratios of endopodal segments equal 1.8 : 1 : 1.6 : 1.7 : 1.8 : 1.6.

A2 (Figure 33C): All t-setae present. All z setae subequally long, not reaching distal end of terminal segment. Claw G2 about two times longer than terminal segment. Claws G1 and G3 as long as first endopodal segment. GM 0.8 times as long as first endopodal segment, Gm three times longer than terminal segment. All aesthetascs observed and all being short. L ratios of endopodal segment equal 5 : 3.3 : 1.

Mxl (Figure 33J): 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md (Figure 33D): With 3+2 setae in bunch internally on second segment. Gamma seta plumed. Terminal segment with two strong claws and three setae.

T1 (Figure 33E): One Ta, Tb and Td seta present.

T2 (Figure 33H): 5-segmented. Basal segment with one seta. First two endopodal segments with one seta each. Penultimate segment with two setae,

longer one as long as same segment. Terminal segment with two setae and claw, which as long as three distal segments combined.

T3 (Figure 33F): 4-segmented, second and third segments completely fused. Basal segment with three setae, only Tg seta present on penultimate segment and well exceeds distal end of terminal segment. L ratios of three distal setae equal 1 : 2.5 : 2.5. Seta Th1 two times longer than terminal segment.

Fu and genital field (Figure 33G): L ratios of anterior margin, anterior and posterior claw equal 2 : 1.2 : 1. Anterior seta 1/3 L of anterior claw; posterior seta exceeds distal end of anterior margin. Claws serrated. Genital field without any extensions and rounded. Furcal attachment shown of Figure 33I.

*Male*. Recorded from West Indies.

**Variability**

Sars (1926) illustrated this species with only one seta on the basal segment of T3. The same feature is not mentioned in the text. It must be pointed out that such variability is not rare in the genus *Typhlocypris* (Karanovic 2005b).

**Remarks and affinities**

*Candona exilis* was described from Ohio (Furtos 1933) but after examining the type material I could not find enough differences to distinguish it from *T. parvula*. The two species have an identical carapace and furcal appearance.

**Distribution**

Distributed in the whole North America, in the West Indies and recently found also in Australia (Karanovic 2005a).

*Typhlocypris (Typhlocypris) punctata* (Furtos, 1933)

Figures 34, 35

*Candona punctata* Furtos, 1933: 485, Plate 13, Figures 2–8.**Material examined***Paratype*

Male (dissected on one slide – USNM 67875) and paratype female (dissected on one slide – USNM 67875), USA, Ohio, Bass Lake, 18 April 1931, collector N. C. Furtos.

**Redescription**

*Male*. Carapace subtrapezoidal in lateral view. Valve highly asymmetrical, LV much higher and longer than RV. L of carapace about 0.93 mm. Greatest H lies behind middle equals about 60% of L. Dorsal margin acutely inclined towards anterior

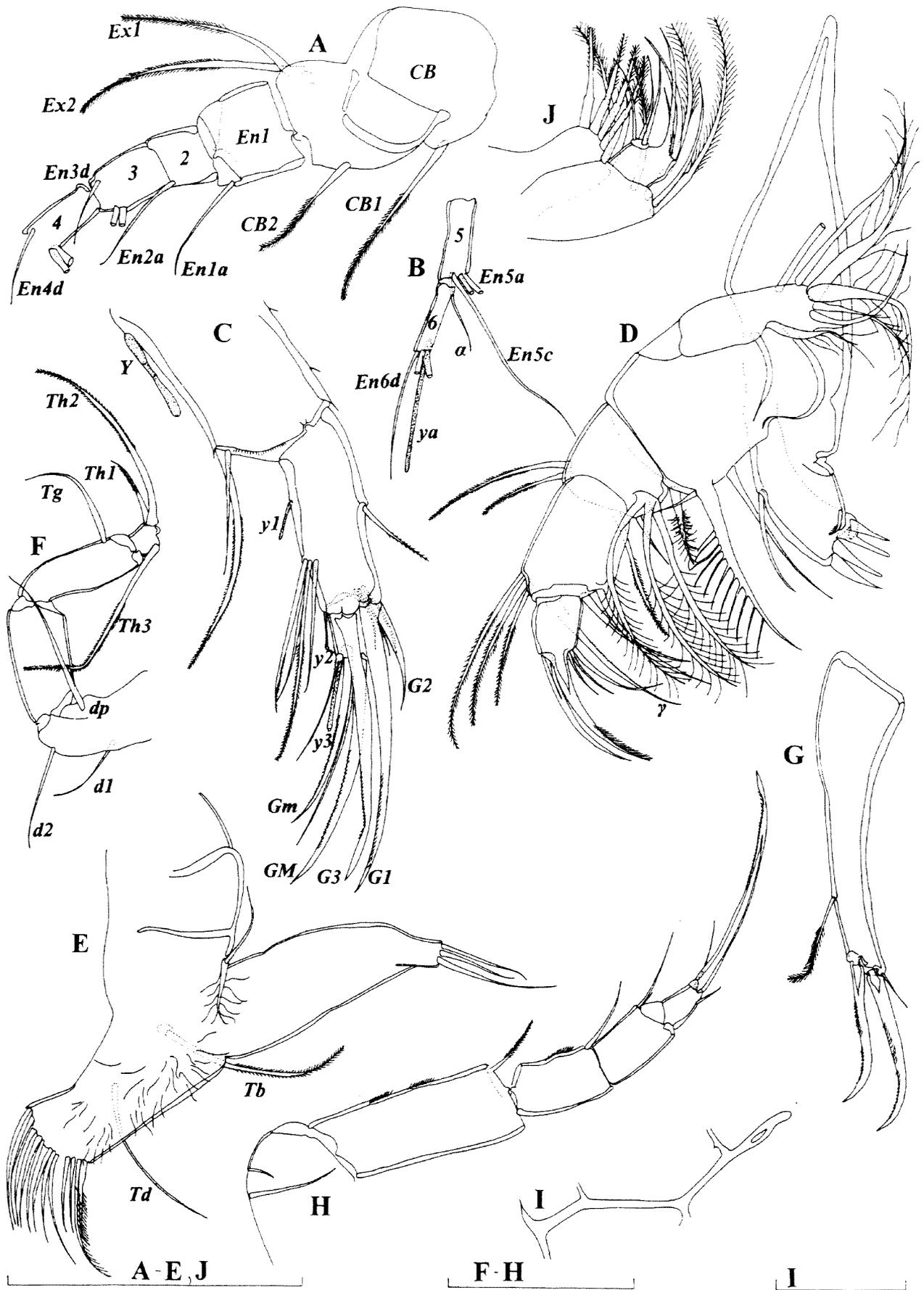


Figure 33 *Typhlocypris (T.) parvula* (Sars, 1926). Female (USNM 67871): A - A1; B - Two terminal segments A1; C - A2; D - Md; E - T1; F - T3; G - Fu; H - T2; I - Furcal attachment. Scales = 0.1 mm.

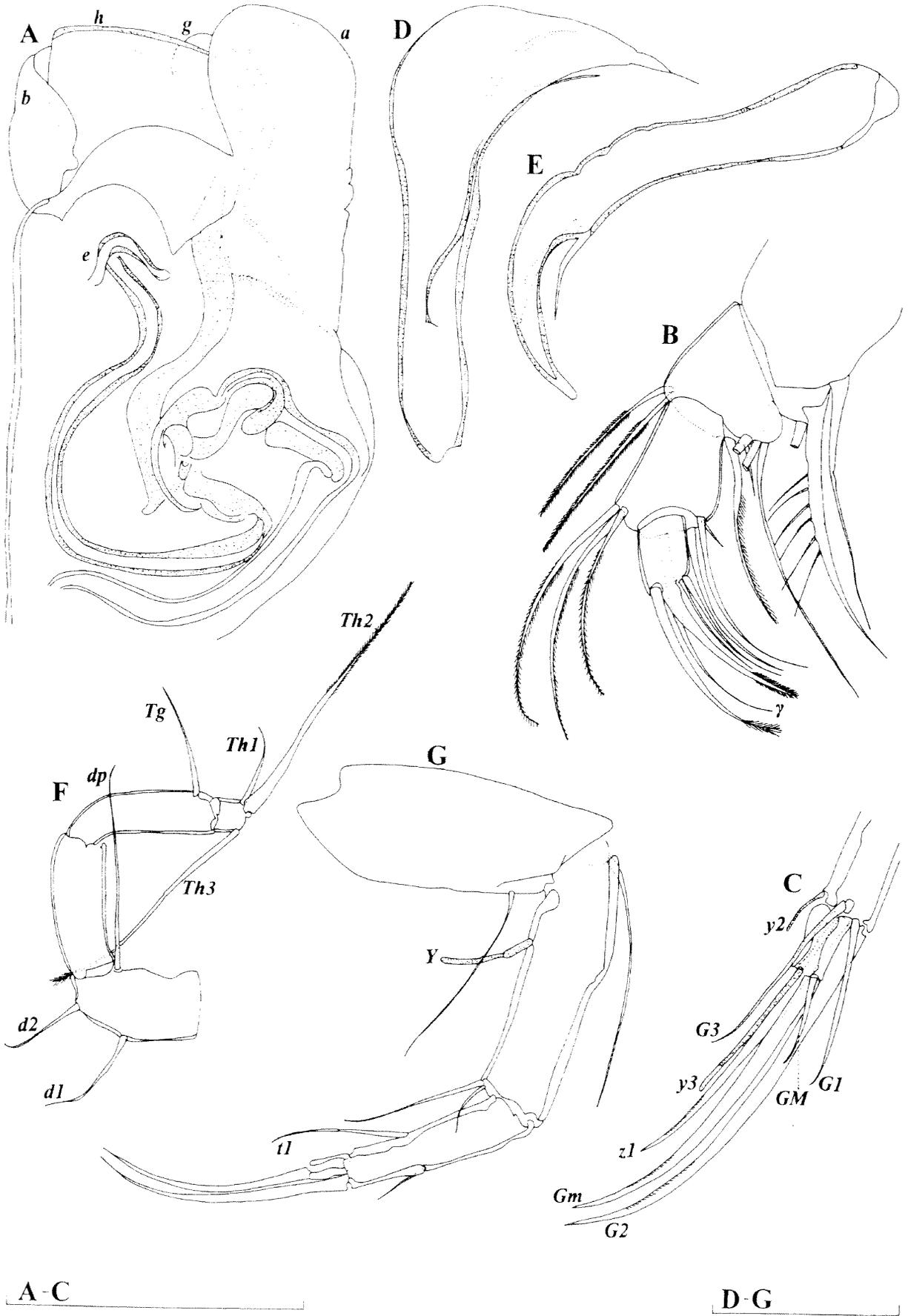
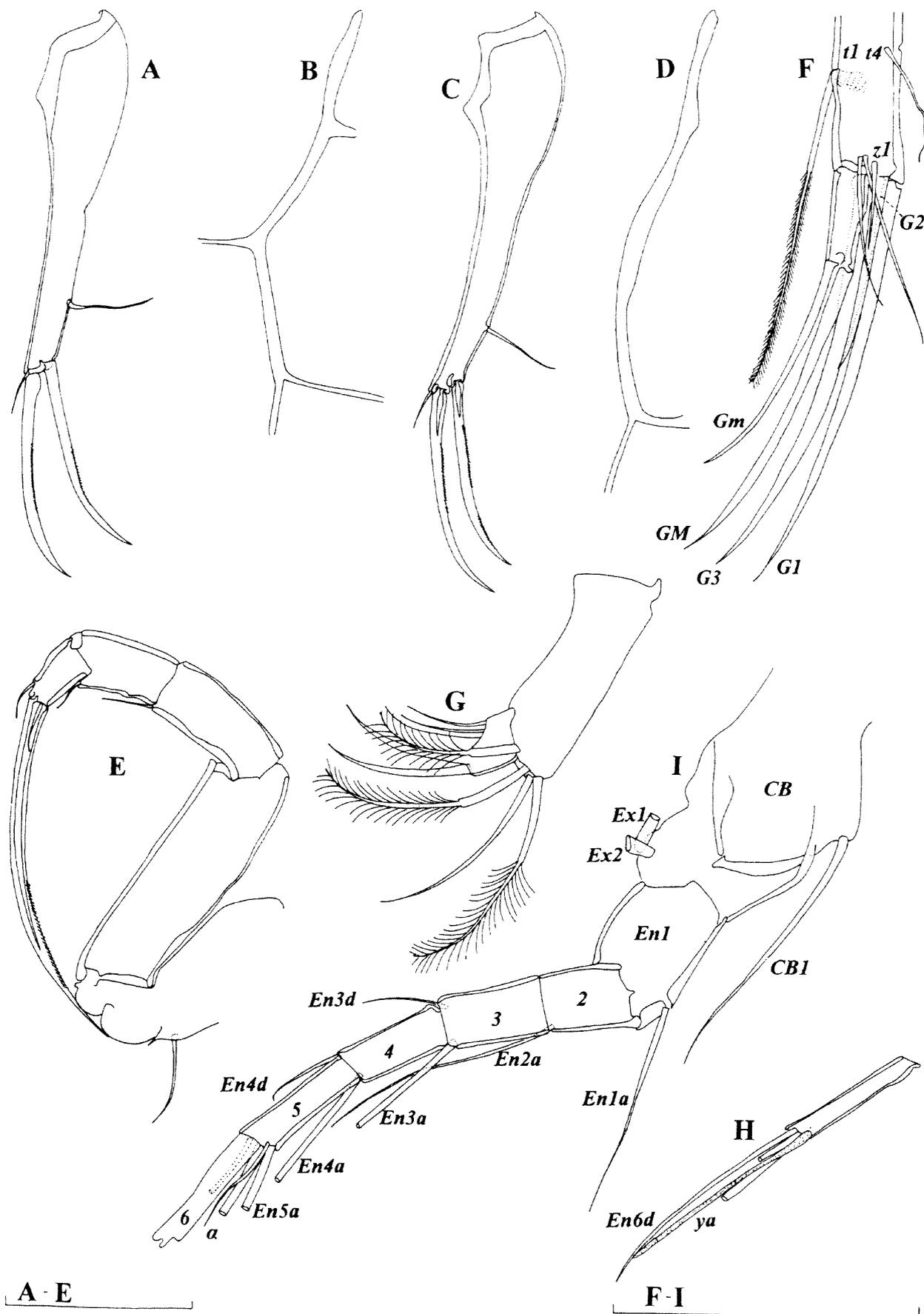


Figure 34 *Typhlocypris (Typhlocypris) punctata* (Furtos, 1933). A-E, G, Paratype male (USNM 67875); F, Paratype female (USNM 67875); A - Hemipenis; B - Md-palp; C - Two terminal segments A2; D - Right prehensile palp; E - Left prehensile palp; F - T3; G - A2. Scales = 0.1 mm.



**Figure 35** *Typhlocypris (Typhlocypris) punctata* (Furtos, 1933). A, B, F, Paratype female (USNM 67875); C, D, E, G-I, Paratype male (USNM 67875): A - Fu; B - Furcal attachment; C - Fu; D - Furcal attachments; E - T2; F - A2, two terminal segments; G - Mxl-palp; H - Terminal segment A1; I - A1. Scales = 0.1 mm.

end, rounded towards posterior one. Anterior part of valves slightly bulging. Both anterior and posterior margins rounded, former more widely. Ventral margin almost straight. Inner calcified lamella narrow, especially posteriorly. Marginal pore canals short, straight and dense. Carapace surface covered with hairs and ornamented with shallow pits.

A1 (Figure 35I, H): 7-segmented. Swimming setae long and thin. Seta En1a reaching middle of En3. Seta En2a exceeds distal end of En4. En3 with only one long anterior seta (En3a), posteriorly with short seta En3d (not reaching distal end of En4). En4 also with only one long anterior setae (En4a) and short posterior seta (En4d) not reaching distal end of En5. Penultimate segment with three long setae En5a, En5b, and En5c. Seta En5d lacks. Alpha seta tiny, reaching middle of terminal segment. Setae En6b and En6c long, seta En6d short and slightly claw-like. Aesthetasc ya only 1.6 times as long as terminal segment. L ratios of endopodal segments equal 1.6 : 1 : 1.2 : 1.2 : 1.4 : 1.7.

A2 (Figure 34C, G): 4-segmented. Male bristles not developed. Claws G1 and G3 reduced, both claw-like, and 2.5 times longer than terminal segment. Claw G2 1.2 as long as first endopodal segment. Claw Gm well developed and 0.8 times as long as first endopodal segment. Seta z1 claw-like, well developed, as long as first endopodal segment, z2 seta-like and very short, z3 missing. All claws serrated. Aesthetascs Y, y2 and y3 observed, all being relatively short. L ratios of endopodal segments equal 6.1 : 4.4 : 1.

Mx1 (Figure 35G): 2-segmented endopod. First segment with three plumed and one smooth seta. Second segment with two claws and four setae.

Md (Figure 34B): With 3+2 setae in bunch internally on second segment. Gamma seta smooth. Terminal segment with two strong claws and two setae.

T1 (Figure 34D, E): Palps asymmetrical. Right one helmet shaped (Figure 34D) with highly arched dorsal margin, while left one (Figure 34E) thinner, with elongated finger. Both palps with thin subterminal sclerified structures. One Ta, Tb and Td seta present.

T2 (Figure 35E): 5-segmented. Basal segment with one seta. First endopodal segment without any seta, second segment with one seta which not reaching distal end of following segment. Penultimate segment with only one seta observed. Terminal segment with two setae and claw, which 1.2 times as long as three distal segments combined.

T3 (Figure 34F): 4-segmented. Second and third segments fused. Basal segment with dp, d1 and d2 setae. Only Tg seta present and well exceeds distal end of terminal segment. L ratios of Th1, Th2 and Th3 setae equals 1 : 3.7 : 3. Th1 seta 2.4 times longer than terminal segment.

Fu (Figure 35C): L ratios of anterior margin, anterior and posterior claws equal 1.45 : 1 : 1. Anterior seta very tiny and about 1/4 of anterior furcal ramus; posterior seta exceeds distal end of posterior margin. Both claws serrated. Furcal ramus slightly curved. Furcal attachment shown on Figure 35C.

Hemipenis (Figure 34A): Lobe a with rectangular-shaped dorsal extension, which situated very close to lobes b and h. Lobe b rounded, folded ventrally. Lobe h big and slightly square-shaped. Part g weakly sclerified and slightly protruding between lobes h and a.

Zenker's organ: consists of seven whorls of spines.

### Redescription

*Female.* Carapace identical with male. L varies between 0.85 mm and 0.9 mm.

A2 (Figure 35F): All t-setae present. Seta z1 claw-like and not reaching distal end of terminal segment. Setae z2 and z3 much thinner and longer. Claw G2 1.2 times longer than last segment. Claws G1 and G3 subequally long and 0.9 times longer than first endopodal segment. Claw GM 0.7 times as long as first endopodal segment, Gm 2.6 times longer than terminal segment. L ratios of endopodal segments 4.52 : 2.7 : 1.

Fu and genital field (Figure 35A): L ratios of anterior margin, anterior and posterior claw equal 1.4 : 1 : 1. Anterior seta 1/4 of anterior claw, posterior seta exceeds distal end of posterior margin. Genital field without any extensions, and rounded.

All other soft parts same as in male.

### Variability

Unknown.

### Remarks and affinities

This species is characterized by a high, trapezoidal carapace, ornamented valves, the absence of CB1 seta, the absence of the male sexual bristles, the right prehensile palp not helmet shaped, and a protruded part "g". It cannot be confused with any known species of the *caribbeana*-group. Some species of the *eremita*-group lack male bristles and have an asymmetrical valves, but they have a different hemipenis and a hook-shaped Th1 seta. Actually, the most closely related species is *Candona microdorsoconca* Mazepova, 1984 found in Baikal Lake (Mazepova 1990). These two species share almost identical prehensile palps, and similar appearance of the carapace and hemipenis. However, the latter species has male sexual bristle, and a concave dorsal margin. There are probably even more species in Baikal Lake that are closely related to *T. punctata*, but unfortunately poor

description unable further allegation. Because of the isolated position of *T. punctata* in the group and in the whole subgenus, it is possible that this species, together with some Baikal species, belongs to a separate subgenus, or even a genus. This has to await better understanding of the morphology of Baikal Candoninae.

#### Distribution

Known only from Ohio.

#### Subgenus *Pseudocandona* Kaufmann, 1900

##### North American representatives of the subgenus

*Typhlocypris* (*Pseudocandona*) *albicans* (Brady, 1864); *T. (P.) compressa* (Koch, 1835)

### DISCUSSION

The only difference between the genera *Candona s.str.* Baird, 1845 and *Eucandona* Daday, 1900 *sensu* Petkovski and Karanovic (2000) (= *Fabaeformiscandona* Krstić, 1972 *sensu* Meisch, 2000) was considered to be the appearance of the gamma seta on the mandibular palp: this seta is smooth in the genus *Eucandona*, but it is plumed in the genus *Candona*. This difference is acknowledged by many modern ostracodologists (Yin and Martens, 1997; Meisch, 1996; 2000; Karanovic 1999, 2000, Petkovski and Karanovic 2001, etc.). Some authors considered the presence of a postero-dorsal keel on the carapace to be an additional feature of the genus *Eucandona*, but they all agree that this feature is very variable. The genus *Candona* was further divided into two species groups: *candida*- (with 5+2 setae in the bunch on the mandibular palp) and *neglecta*-group (with 4+2 setae in the bunch). The genus *Eucandona* is, on the other hand, divided into three species groups: *fabaeformis*- (with 3+2 setae in the bunch); *acuminata*- (with 4+2 setae) and *balatonica*-group (with 5+2 setae). The former genus, as defined by modern authors, represents a group of phylogenetically closely related species. This is not the case with the genus *Eucandona*, which is clearly a polyphyletic genus. The discovery of some species in North America that should, according to the generic diagnosis, belong in the genus *Eucandona* but with an unusual combination of characters further support this. The appearance of the gamma seta is found to be an overestimated generic character, while other features (especially of the male morphology) prove to have more phylogenetic importance. Because of that, in this paper I divide the genus *Candona* into two subgenera, and narrow the diagnoses of the genera *Eucandona* and *Fabaeformiscandona*.

#### Systematics of the genus *Candona*

In the present paper the genus *Candona* is subdivided into two subgenera: *Candona* Baird, 1945 and *Neglectocandona* Krstić, 1972. The nominal subgenus has a total of 19 species in North America, and approximately 15 additional species worldwide. This subgenus is characterized by the following features: 1. seta En5d is present; 2. the prehensile palps have thin subterminal sclerified structures; 3. male z1 seta is always transformed into a long claw. The subgenus *Candona* is further divided into three species groups: *candida*-; *acuminata*-; and *intermedia*-group. The first group encompasses species with 5+2 setae in the bunch on the mandibular palp and with the left prehensile palp having elongated finger. The second group differs from the *candida*-group by having 4+2 setae in the bunch and hook-shaped fingers on both palps. The last group contains species with 4+2 setae in the bunch, but with the prehensile palps the same as in the *candida*-group. The last two species groups usually have a well developed genital process, but this feature is not taken into account because it can be very variable. However, it can be generalized that the representatives of the *candida*-group have less pronounced genital process than the representatives of the last two groups. The members of the *acuminata*-group were previously assigned to the genus *Eucandona* (= *Fabaeformiscandona*). The representatives of the newly formed *intermedia*-group were all described from North America and originally assigned to the genus *Candona*. Some of them Hoff (1942) assigned to the *acuminata*-group. The *intermedia*-group comprises species with some morphological characters between *acuminata* and *candida*-group. For example, *Candona acuta* Hoff, 1942 and *C. inopinata* Furtos, 1933 (both members of the *intermedia*-group) have plumed gamma seta on the mandibular palp, like all species of the *candida*-group, while in other species of this group the gamma seta is smooth, as in the *acuminata*-group. On the other hand, *C. acuta* is undoubtedly most closely related to *C. intermedia* Furtos, 1933, while *C. inopinata* Furtos, 1933 has its closest relative in *C. crogmaniana* Turner, 1894. The appearance of the gamma seta is therefore proven to be irrelevant for distinguishing between *Candona* and *Eucandona*. Also, in some Candoninae genera, like *Typhlocypris*, the appearance of this seta is different in different species. In some other genera this character can be variable even in the same species. For example, I have found in Australia (unpublished data) a population of *Fabaeformiscandona holzkampfi* (Hartwig, 1900) with this seta plumed. The appearance of the part "g" on the hemipenis is constant in the *candida*-group (boxing-glove-like), while in the other two groups it can be boxing-glove-like, stick-like, or

even foot-like. Petkovski (1966) described several forms of this type of the hemipenis, a feature that seems to be a good specific character.

The subgenus *Neglectocandona* was described by Krstić (1993) and it is here used to encompass species of the *neglecta*-group, which has numerous representatives on the Balkan Peninsula and especially in Ohrid Lake. It is not represented in North America. The main difference between *Neglectocandona* and *Candona s.str.* is the appearance of the prehensile palps. In the former subgenus the left palp is more robust than the right one, and both palps have thick subterminal sclerified structures. No other feature separates the two subgenera. Most of the species of *Neglectocandona* have a subrectangular carapace, square shaped "a" lobe, and both z1 and z2 setae transformed into long claws in males. Three species are exceptions: *Candona paloski* Petkovski, Schäfer and Keyser, 2002; *C. triangulata* Klie, 1939 and *C. litoralis* Mikuliæ, 1961. They have a subtriangular carapace and triangular lobe "a". Petkovski *et al.* (2002) also stated that in all three species z-setae on the male antenna are not transformed into claws. This seems to be true only partly. Namely, Petkovski *et al.* (2002) incorrectly labeled claws on the antenna and, following their drawings, z1 and z3 are actually seta-like, while z2 is claw-like. However, the seta z1 is much longer than the terminal segment. The appearance of the prehensile palps suggests that these three species are closely related to other representatives of the subgenus, but they form a separate group that could be named the *triangulata*-group, following the characteristic shape of the carapace. All three species are endemic to Ohrid Lake. *Candona muelleri* Hartwig, 1899, a former member of the *neglecta*-group, should not belong in the subgenus *Neglectocandona*, but in the subgenus *Candona* and in the *acuminata*-group. In this species the left prehensile palp is clearly smaller than the right one, both have hook-shaped fingers, and thin the subterminal sclerified structures. Additionally, the genital process is triangular, while in *Neglectocandona* this process, if present, is very small. *Candona muelleri* has a patterned carapace, a very common feature of the subgenus *Neglectocandona*, a feature also found in the nominal subgenus, like in the species *C. tahoensis* Ferguson, 1966.

All species of the genus *Candona* have three clear lobes on the hemipenis, and all except the three species of the *triangulata*-group have the z1 and z2 setae on the male antenna transformed into claws. Those claws are usually subequally long or z1 is at least 2/3 of z3.

#### Systematics of the genus *Eucandona*

In the genus *Eucandona* Daday, 1900 lobe "h" on the hemipenis is absent, and only the seta z2

transformed into a long claw, while z1 is very short and does not reach the distal margin of the terminal segment. The appearance of the genital process varies and can be well developed and chitinized; well developed but not chitinized; or very small, even flat. In addition, the number of setae in the bunch on the mandibular palp can be 3+2, 4+2 or 5+2. This subgenus has five species in the North American fauna.

The type species of the genus, *Candona balatonica* Daday, 1894 and *Eucandona forma* Karanovic, 1999 described from Montenegro (Karanovic 1999) are members of the *balatonica*-group, formed by Karanovic (1999). However, the latter species should be included in the *candida*-group of the genus *Candona*, because all three lobes of the hemipenis are well developed, and z1 and z2 are both claw-like. Except the *balatonica*-group, the genus *Eucandona* encompasses some species of the *fabaeformis*-group, namely *Candona brisiaca* Klie, 1938 and *Candona fabella* Nüchterlein, 1969. *Candona angusta* Ostermeyer, 1937 and *C. tyrolensis* Löffler, 1963 (also members of the *fabaeformis*-group, see Meisch 2000) have a similar carapace appearance as *C. brisiaca* but their possible placement in the genus *Eucandona* is uncertain, because they are both known only from females. The genus *Eucandona* also includes the species of the *breuli*-group. This group was formed by Meisch (2000) to encompass species of the genus *Fabaeformiscandona* with 4+2 setae in the bunch on the mandibular palp, small carapace and undeveloped genital process. This group comprises four species: *Candona latens* Klie, 1940; *C. breuli* Paris, 1920, *Candona bilobata* Klie, 1938 and *C. bilobatoides* Löffler, 1961. *Candona bilobata* is very similar to *C. brisiaca* differing only in the number of setae in the bunch on the mandibular palp. The genus *Eucandona* includes at least the following *Candona* species from the Baikal Lake (see Mazepova 1990): *Candona intersita* Bronstein, 1947; *C. limpida* Mazepova, 1984; *C. prava* Mazepova, 1984; *C. walukani* Mazepova, 1984. Probably, many more species from this lake belong to the genus *Eucandona*, but this will be established only when the morphology of the Baikal Candoninae is better known. Although the species of the genus *Eucandona* can be arranged into at least three groups (*breuli*-group being one of them), this is not pursued here owing to the poor knowledge of the Baikal fauna.

#### Systematics of the genus *Fabaeformiscandona*

Petkovski and Karanovic (2000) synonymized the genus *Fabaeformiscandona* Krstić, 1972 (the type species *Candona fabaeformis* Fischer, 1851) with *Eucandona* Daday, 1900 (the type species *Candona balatonica* Daday, 1898). Separation had arisen owing to the poor knowledge of the internal

morphology of *Candona balatonica* on one side, and a diagnosis of the genus *Fabaeformiscandona* that was too broad. Petkovski and Karanovic (2000) redescribed *Candona balatonica*, and showed that this species has a smooth gamma seta on the mandibular palp which would place it in the genus *Fabaeformiscandona*, however it was already the type species of the genus *Eucandona*. Following previous rearrangements and redefinitions of the genera *Candona* and *Eucandona*, the genus *Fabaeformiscandona* regains a new position in the subfamily Candoninae and is now more homogenous than either *Candona* and *Eucandona*. It encompasses only the species of the *fabaeformis*-group that have 3+2 setae in the bunch on the mandibular palp, and that also include the following characteristics: 1. a very low carapace; 2. the most posterior seta on En5 absent; 3. the right prehensile palp extremely helmet-shaped, stocky and with finger not pronounced, while the left palp has pronounced finger, but it also has several bumps and intrusions; 4. z1 and z2 setae in males are both claw-like; 5. all the lobes on hemipenis are present; 6. the genital process is well expressed, triangular, with a rounded tip and broad base. This genus has approximately 10 Recent species, and only *Fabaeformiscandona fabaeformis* was recorded in North America by Turner (1845), Sharpe (1897, 1918) and Ferguson (1958). None of these records is certain. Hoff (1942) even gave a new name (*Candona sharpei*) to the Sharpe's (1897) record. However, Hoff's species is considered in the present paper as *incertae sedis*.

#### Systematics of the genus *Typhlocypris*

The history and the systematics of the genus *Typhlocypris* Vejdovský, 1882 is elaborated in detail by Karanovic (2005c). Almost all North American species of this genus belong to the nominal subgenus and in the *caribbeana*-group formed by Broodbakker (1983). When discussing this group Karanovic (2005c) omitted to give a key to the world representatives of this group. The majority is redescribed in the present paper, and because of that the key is given here. There are 13 species in North America.

#### Characteristics of the North American Candoninae fauna

The North American Candoninae comprises 40 Recent species. The majority (47%) belongs to the genus *Candona*, and the rest are members of the genera *Eucandona* (13%), *Typhlocypris* (32.5%), *Nannocandona* (2.5%) and *Paracandona* (2.5%). The presence of one species of *Fabaeformiscandona* (2.5%) is uncertain. The following 14 species are recorded outside North America: 1. *Candona* (*C.*) *acuminata* (Fischer, 1854), 2. *C. (C.) caudata* Kaufmann, 1900, 3. *C. (C.) candida* (Müller, 1776),

4. *Eucandona biangulata* (Hoff, 1942), 5. *E. obtusa* (Bronstein, 1947), 6. *E. pedata* (Alm, 1914), 7. *Nannocandona faba* Ekman, 1919, 8. *Paracandona euplectella* (Brady and Norman, 1889), 9. *Typhlocypris (Pseudocandona) compressa* (Koch, 1835), 10. *T. (P.) albicans* (Brady, 1864), 11. *T. (Typhlocypris) parvula* (Sars, 1926), 12. *T. (T.) rostrata* (Brady and Norman, 1889), 13. *T. (T.) annae* (Méhes, 1914), and 14. *T. (T.) stagnalis* (Sars, 1890). The three *Candona* species have a Holarctic distribution, and *Candona candida* is also recorded from the southern Hemisphere (Karanovic 2005b). All other species of the genus *Candona* are endemic to North America including the whole *intermedia*-group of species. Three *Eucandona* species are known also from northern Europe, while only *E. rectangularata* is endemic to North America. Most of the *Eucandona* species are found in central and northern Europe. Some species are known from the interstitial and/or subterranean waters of the Balkan Peninsula, while about a dozen species live in Baikal Lake. This genus probably evolved in the Pliocene when the climate began to cool, and they are now mostly cold water animals. The centre of their origin might be Baikal Lake which during the Pliocene shifted from predominantly tropical conditions to the present continental climate (Frogley *et al.* 2002). It is needless to say that with the Pleistocene epoch of Ice Ages the majority of species disappeared. Very few of them successfully colonized subterranean waters.

According to the present state of knowledge, about 2/3 of all representatives of the *caribbeana*-group of the genus *Typhlocypris* are known from North America, where they are mostly endemic. *Typhlocypris annae* and *T. parvula* are also recorded in South and Central America, the latter also being found in Australia (Karanovic 2005b). *Typhlocypris (T.) rostrata* is the only representative of the *rostrata*-group in North America and it has a Holarctic distributions. The two species of the subgenus *Pseudocandona* have broad distribution. *Typhlocypris (P.) albicans* was also recently found in Australia (Karanovic 2005b).

The absence of endemic genera of Candoninae in North America (only endemic species) can be explained by the recent isolation of the continent from Europe. Marmonier and Ward (1990) postulated two possibilities for the faunal exchange between North America and Europe based on two species: *Nannocandona faba* and *Eucandona biangulata (Fabaeformiscandona wegeli)* in Marmonier and Ward 1990). The first possibility is an exchange that happened when the bridge between two continents existed between the Tertiary and Pleistocene. The other possibility is a Quaternary exchange by one of the agents of passive transport. Although Marmonier and Ward (1990) did not exclude either of possibilities, they

favoured the first one because of the present ecology of two species which are both cold water, and interstitial animals, a proposition I support. On the other hand, species that live in open waters, and have broad ecological tolerance, like *C. candida*, *T. compressa*, *T. albicans*, *T. rostrata*, *T. stagnalis* and *Paracandona euplectella*, can migrate more easily between continents, and the exchange could be happening.

#### REVISED LIST OF THE NORTH AMERICAN CANDONINAE

This revised list of the North American Candoninae lists species in alphabetical order and it includes the synonyms established in this paper, but excludes the misidentifications.

1. *Candona (Candona) acuminata* (Fischer, 1851)
2. *Candona (Candona) acuta* Hoff, 1942
3. *Candona (Candona) acutula* Delorme, 1967
4. *Candona (Candona) candida* (Müller, 1776)
5. *Candona (Candona) caudata* Kaufmann, 1900  
= *Candona caudata ciliata* Furtos, 1935  
= *Candona caudata occidentalis* Dobbin, 1941
6. *Candona (Candona) crogmaniana* Turner, 1894  
= *Candona recticaudata* Sharpe, 1897  
= *Candona reflexa* Sharpe, 1897
7. *Candona (Candona) decora* Furtos, 1933  
= *Candona facetus* Delorme, 1970  
= *Candona fossulensis* Hoff, 1942
8. *Candona (Candona) inopinata* Furtos, 1933  
= *Candona indigena* Hoff, 1942  
= *Candona truncata* Furtos, 1933
9. *Candona (Candona) intermedia* Furtos, 1933
10. *Candona (Candona) lingulata* Cole, 1965
11. *Candona (Candona) ohioensis* Furtos, 1933
12. *Candona (Candona) paraohioensis* Staplin, 1963
13. *Candona (Candona) peircei* Turner, 1895  
= *Candona eriensis* Furtos, 1933
14. *Candona (Candona) sigmoides* Sharpe, 1897  
= *Candona scopulosa* Furtos, 1933  
= *Candona simpsoni* Sharpe, 1897
15. *Candona (Candona) subacuminata* Delorme, 1970
16. *Candona (Candona) subtriangulata* Benson and MacDonald, 1963
17. *Candona (Candona) suburbana* Hoff, 1942
18. *Candona (Candona) tahoensis* Ferguson, 1966
19. *Candona (Candona) uliginosa* Furtos, 1933  
= *Candona hoffi* Ferguson, 1953
20. *Eucandona biangulata* (Hoff, 1942)  
= *Candona orangeburgensis* Ferguson, 1958  
= *Candona wegelini* Petkovski, 1962
21. *Eucandona obtusa* (Bronstein, 1947)  
= *Candona michoa* Tressler, 1954  
= *Candona patzcuaro* Tressler, 1954  
= *Candona rawsoni* Tressler, 1957
22. *Eucandona pedata* (Alm, 1914)  
= *Candona subgibba* Sars, 1926
23. *Eucandona pennaki* (Marmonier and Ward, 1990)
24. *Eucandona rectangulata* (Alm, 1914)  
= *Candona distincta* Furtos, 1933
25. *Fabaeformiscandona fabaeformis* (Fisher, 1851)
26. *Nannocandona faba* Ekman, 1919
27. *Paracandona euplectella* (Brady and Norman, 1889)
28. *Typhlocypris (Pseudocandona) compressa* (Koch, 1835)
29. *Typhlocypris (Pseudocandona) albicans* (Brady, 1864)
30. *Typhlocypris (Typhlocypris) annae* (Méhes, 1914)  
= *Candona annae septentrionalis* Furtos, 1933  
= *Pseudocandona antilliana* Broodbakker, 1983
31. *Typhlocypris (Typhlocypris) delormei* new species
32. *Typhlocypris (Typhlocypris) elliptica* (Furtos, 1933)
33. *Typhlocypris (Typhlocypris) fluviatilis* (Hoff, 1942)
34. *Typhlocypris (Typhlocypris) jeanneli* (Klie, 1931)
35. *Typhlocypris (Typhlocypris) marengoensis* (Klie, 1931)
36. *Typhlocypris (Typhlocypris) parvula* (Sars, 1926)  
= *Candona exilis* Furtos, 1933  
= *Pseudocandona geratsi* Broodbakker, 1983
37. *Typhlocypris (Typhlocypris) punctata* (Furtos, 1933)
38. *Typhlocypris (Typhlocypris) renoensis* (Gutentag and Benson, 1962)
39. *Typhlocypris (Typhlocypris) rostrata* (Brady and Norman, 1889)
40. *Typhlocypris (Typhlocypris) stagnalis* Sars, 1890  
= *Candona stagnalis longisetosa* Furtos, 1933

#### KEY TO THE NORTH AMERICAN CANDONINAE

1. Seta Tf on T3 present .....  
... *Paracandona euplectella* (Robertson, 1889)
- Seta Tf on T3 absent ..... 2
2. A1 5-segmented .. *Nannocandona faba* Ekman, 1914
- A1 7-segmented ..... 3
3. Part "g" on hemipenis weakly chitinized ..... 4
- Part "g" well sclerified ..... 16
4. 5+2 setae in the bunch on Md-palp ..... 5
- 3+2 setae in the bunch on Md-palp ..... 6

5. Both z1 and z2 setae on male antenna transformed into claws .....  
 .... *Typhlocypris (P.) compressa* (Koch, 1838)
- Only z1 seta claw-like .....  
 ..... *Typhlocypris (P.) albicans* (Brady, 1864)
6. Th1 seta on T3 hook-like, and smaller than terminal segment, T3 5-segmented .....  
 .... *Typhlocypris (T.) rostrata* (Hartwig, 1889)
- Th1 seta longer than terminal segment, t3 4-segmented ..... 7
7. Carapace trapezoidal and ornamented ..... 8
- Carapace not trapezoidal and not ornamented ..... 11
8. Valves asymmetrical, CB2 seta absent .....  
 ..... *Typhlocypris (T.) punctata* (Furtos, 1933)
- Valves symmetrical, CB2 seta present ..... 9
9. Surface covered with circular bumps .....  
 ..... *Typhlocypris (T.) fluviatilis* (Hoff, 1942)
- Surface covered with reticulated patterns .... 10
10. Greatest W>35% of L .....  
 . *Typhlocypris (T.) marengoensis* (Klie, 1931)
- Greatest W<35% of L *Typhlocypris (T.) jeanneli* (Klie, 1931)
11. Carapace sub-reniform in lateral view, dorsal margin acutely sloping towards anterior end, greatest H>55% of L ..... 12
- Carapace reniform or elliptical, dorsal margin gently sloping towards anterior end, greatest H<50% of L ..... 14
12. Lobe "a" tongue-like, in cross position with "h" and "b" lobes ..... 13
- Lobe "a" square-shaped, in parallel position with "h" and "b" lobes .....  
 ..... *Typhlocypris (T.) stagnalis* (Sars, 1890)
13. Inner calcified lamella does not follow the outer margin ..... *Typhlocypris (T.) renoensis* (Gutentag and Benson, 1962)
- Inner calcified lamella follows the outer margin *Typhlocypris (T.) delormei* new species
14. Lobe "h" subtriangular .....  
 ..... *Typhlocypris (T.) annae* (Méhes, 1914)
- Lobe "h" broadly rounded ..... 15
15. Carapace elliptical, lobe "b" not double-folded .....  
 ..... *Typhlocypris (T.) elliptica* (Furtos, 1933)
- Carapace reniform, lobe "b" double-folded .....  
 ..... *Typhlocypris (T.) parvula* (Sars, 1926)
16. Seta En5d missing ..... *Fabaeformiscandona fabaeformis* (Koch, 1851)
- Seta En5d present ..... 17
17. Carapace subtrapezoidal, lobe "h" missing .. 18
- Carapace subreniform, or subtriangular, lobe "h" present ..... 22
18. Seta t4 missing, genital process minute .....  
*Eucandona pennaki* (Marmonier and Ward, 1990)
- Genital lobe well developed ..... 19
19. Genital process foot-like, ventrally concave . 20
- Genital process different ..... 21
20. Lobe "a" very high above other parts, triangular in shape .....  
 ..... *Eucandona pedata* (Alm, 1914)
- Lobe "a" lower than other lobes, elliptical in shape ... *Eucandona rectangulata* (Alm, 1914)
21. Carapace with truncate extension .....  
 ..... *Eucandona obtusa* (Bronstein, 1947)
- Carapace without such process .....  
 ..... *Eucandona biangulata* (Hoff, 1942)
22. 5+2 setae in the bunch on the Md-palp .....  
 ..... *Candona (C.) candida* (Muller, 1776)
- 4+2 setae in the bunch on the Md-palp ..... 23
23. Female carapace with rounded posterior margin ..... 24
- Female carapace with narrow posterior margin, which more or less acutely inclined ..... 29
24. Genital process subtriangular to conical ..... 25
- Genital process finger-shaped ..... 26
25. Part "g" with boxing-glove-like distal part .....  
 ..... *Candona (C.) acuta* Hoff, 1942
- Part "g" with narrow distal part .....  
 ..... *Candona (C.) suburbana* Hoff, 1942
26. Rake-like organ with big teeth (10 at the most), swimming setae on A1 stout and short .....  
 ..... *Candona (C.) sigmoides* Sharpe, 1897
- Rake-like organ with small numerous teeth . 27
27. Genital process small, and with blunt tip .....  
 ..... *Candona (C.) lingulata* Cole, 1965
- Genital extension longer and with pointed tip ..... 28
28. Dorsal margin straight with sinusoid intrusion on first third, furcal claws subequal .....  
 ..... *Candona (C.) uliginosa* Furtos, 1933
- Dorsal margin gradually sloping, no sinusoid intrusion, posterior furcal claw considerably shorter than anterior one .....  
 ..... *Candona (C.) decora* Furtos, 1933
29. Both prehensile palps with hook-shaped fingers ..... 30
- Left palp with elongated finger, not hook-shaped ..... 35

30. Inner list markedly developed .....  
 ..... *Candona (C.) tahoensis* Ferguson, 1966  
 - Inner list, if present, very short and not  
 markedly developed ..... 31
31. Genital process conical with pipette-like tip ....  
 ..... *Candona (C.) peircei* Turner, 1895  
 - Genital process finger-shaped ..... 32
32. Left prehensile palp with ventral chitinous  
 bump .... *Candona (C.) ohioensis* Furtos, 1933  
 - Left palp without ventral chitinous bump .... 33
33. Dorsal extension of lobe "a" with flat distal  
 margin, almost rectangular .....  
 ..... *Candona (C.) acuminata* (Fisher, 1851)  
 - Dorsal extension of lobe "a" elliptical and with  
 rounded distal margin ..... 34
34. Dorsal extension of lobe "a" positioned parallel  
 to rest of hemipenis, males with settling  
 between dorsal and posterior margin .....  
 ..... *Candona (C.) paraohioensis* Staplin, 1963  
 - Dorsal extension of "a" lobe extended, males  
 without settling, posterior margin acutely  
 sloping down .....  
 ..... *Candona (C.) acutula* Delorme, 1967
35. Dorsal extension of lobe "a" with deep suture  
 ..... *Candona (C.) inopinata* Furtos, 1933  
 - Dorsal extension of "a" lobe without suture 36
36. Dorsal extension of lobe "a" square-shaped ....  
 ..... *Candona (C.) crogmaniana* Turner, 1894  
 - Dorsal extension of "a" lobe elliptical ..... 37
37. Lobe "b" rounded distally ..... 38  
 - Lobe "b" with straight distal margin, which  
 inclined dorsally .....  
 ... *Candona (C.) subacuminata* Delorme, 1970
38. Genital process thin, long and finger-shaped ...  
*Candona (C.) subtriangulata* Benson and  
 MacDonald, 1963  
 - Genital process small and square-shaped .....  
 ..... *Candona (C.) intermedia* Furtos, 1933
3. Surface covered with pits ..... 4  
 - Surface different ..... 5
4. Basal segment of T3 with two setae .....  
*Typhlocypris (T.) cubensis* (Broodbakker,  
 1983)  
 - Basal segment of T3 with three setae .....  
*Typhlocypris (T.) caribbeana* (Broodbakker,  
 1983)
5. Surface covered with circular bumps .....  
 ..... *Typhlocypris (T.) fluviatilis* (Hoff, 1942)  
 - Surface covered with reticulated patterns ..... 6
6. Greatest W<35% of L .....  
 ..... *Typhlocypris (T.) jeanneli* (Klie, 1931)  
 - Greatest W>35% of L .....  
*Typhlocypris (T.) marengoensis* (Klie, 1931)
7. Carapace with highly arched dorsal margin,  
 greatest H in middle, almost triangular  
 appearance, H=57% of L .....  
 ..... *Typhlocypris (T.) arcuata* (Klie, 1932)  
 - Carapace different ..... 8
8. Carapace reniform in lateral view, dorsal  
 margin acutely sloping towards frontal  
 margin, greatest H>55% of L ..... 9  
 - Carapace reniform or elliptical in lateral view,  
 dorsal margin gently sloping towards frontal  
 margin, greatest H < or = 50% of L ..... 13
9. Lobe "a" tongue-like ..... 10  
 - Lobe "a" different ..... 11
10. Calcified inner margin not following outer  
 margin .....  
*Typhlocypris (T.) renoensis* (Gutentag and  
 Benson, 1962)  
 - Calcified inner margin following outer margin  
 ..... *Typhlocypris (T.) delormei* new species
11. Lobe "a" snail-foot shaped, greatest H=57% of  
 L .... *Typhlocypris (T.) capsularis* (Klie, 1935)  
 - Lobe "a" square-shaped, greatest H=55% of L...12
12. Fingers on prehensile palps stocky .....  
 ..... *Typhlocypris (T.) stagnalis* (Sars, 1890)  
 - Fingers on prehensile palps elongated .....  
*Typhlocypris (T.) semicognita* Schäfer, 1934
13. Lobe "h" triangular ..... 14  
 - Lobe "h" rounded ..... 15
14. Carapace reniform, dorsal extension of lobe "a"  
 clearly separated from the rest of hemipenis,  
 same extension clearly lower than other lobes  
 ..... *Typhlocypris (T.) annae* (Méhes, 1914)  
 - Carapace elliptical, dorsal extension of lobe "a"  
 closely attached to the hemipenis, same  
 extension almost as high as other parts .....  
 ..... *Typhlocypris (T.) pedropalensis* (Méhes,  
 1914)

KEY TO THE WORLD REPRESENTATIVES OF  
 THE CARIBBEANA-GROUP OF THE GENUS  
 TYPHLOCYPRIS

1. Carapace trapezoidal and ornamented ..... 2  
 - Carapace different ..... 7
2. Valves very asymmetrical in lateral view,  
 ornamented with pits, CB2 seta absent .....  
 ..... *Typhlocypris (T.) punctata* (Furtos, 1933)  
 - Valves symmetrical in lateral view, CB2 seta  
 present ..... 3

15. Carapace elliptical, lobe "b" not double-folded, longest seta on penultimate segment on T2 shorter than same segment .....  
 ..... *Typhlocypris (T.) elliptica* (Furtos, 1933)
- Carapace reniform, lobe "b" double-folded, longest seta on penultimate segment on T2 longer than same segment .....  
 ..... *Typhlocypris (T.) parvula* (Sars, 1926)

#### ACKNOWLEDGEMENTS

I am very grateful to Ms Elizabeth Harrison Nelson from the Smithsonian Museum of Natural History (Washington) for kindly sending me the collection of Candoninae deposited in the Museum. I also wish to thank Ms Karin Sindemark (Swedish Museum of Natural History, Stockholm) and Mr Dirk Platvoet (Zoological Museum, Amsterdam) for landing me some other Candoninae species. I am also very thankful to Dr William F. Humphreys and Dr Mark Harvey (both from the Western Australian Museum, Perth) for reading the first version of the manuscript and suggesting important improvements. This paper is a part of the project financed from the Australian Biological Resources Study (ABRS) grant.

#### REFERENCES

- Alm, G. (1914). Beiträge zur Kenntnis der nördlichen und arktischen Ostracodenfauna. *Arkiv för Zoologi* 9: 1-20.
- Bronstein, Z. S. (1947). Rakoobraznyie 2, Ostracoda presnyh vod. In A. A. Shtakelyberg (ed.), Fauna SSSR, 31. *Zoologicheskii Institut Akademii Nauk SSSR, Moskva*: 1-339.
- Broodbakker, N. W. (1983). The subfamily Candoninae (Crustacea, Ostracoda) in the West Indies. *Bijdragen tot de Dierkunde* 53: 287-326.
- Broodbakker, N. W. and Danielopol, D. L. (1982). The chaetotaxy of Cypridacea (Crustacea, Ostracoda) limbs: proposals for a descriptive model. *Bijdragen tot de Dierkunde* 52: 103-120.
- Cole, M. E. (1965). Seven new species of ostracods from Tennessee (Cypridae: Candocyprinae and Cypridopsinae). *Journal of the Tennessee Academy of Sciences* 40: 132-142.
- Danielopol, D. L. (1969). Recherches sur la morphologie de l'organe copulateur mâle chez quelques ostracodes du genre *Candona* Baird (fam. Cyprididae Baird). In J. W. Neale (ed.), The taxonomy, morphology and ecology of recent ostracoda. Oliver and Boyd Ltd. Edinburgh: 136-153.
- Delorme, L. D. (1967a). New freshwater ostracoda from Saskatchewan, Canada. *Canadian Journal of Zoology* 45: 357-363.
- Delorme, L. D. (1967b). Freshwater ostracode synonyms. *Journal of Paleontology* 41: 792-794.
- Delorme, L. D. (1970). Freshwater ostracodes of Canada. Part III. Family Candonidae. *Canadian Journal of Zoology* 48: 1099-1127.
- Dobbin, C. N. (1941). Fresh-water ostracoda from Washington and other western localities. *University of Washington Publications in Biology* 4: 175-246.
- Ferguson, E., Jr. (1953). A new Cyprid Ostracod from Maryland. *Journal of the Washington Academy of Science* 43: 194-197.
- Ferguson, E. Jr. (1958). Freshwater ostracods from South Carolina. *The American Midland Naturalist* 59: 111-118.
- Ferguson, E., Jr. (1966). Some freshwater ostracods from the western United States. *Transactions of the American Microscopic Society* 85: 313-318.
- Frogley, M. R., H. I. Griffiths and Martens, K. 2002. Modern and Fossil ostracods from Ancient Lakes. In J. A. Holmes and A. R. Chivas (eds), The ostracoda. Application in quaternary research. *Geophysical Monographs* 131: 167-184.
- Furtos, N. C. (1933). The ostracoda of Ohio. *Ohio Biological Survey* 5: 413-524.
- Furtos, N. C. (1935). Fresh-water ostracoda from Massachusetts. *Journal of the Washington Academy of Science* 25: 530-544.
- Furtos, N. C. (1936). Fresh-water ostracoda from Florida and North Carolina. *The American Midland Naturalist* 17: 491-522.
- Hoff, C. C. (1942). The ostracods of Illinois. *Illinois Biological Monographs* 19: 1-196.
- Karanovic, I. (1999). Two interesting species of Candoninae (Crustacea, Ostracoda) from Montenegro (SE Europe). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie* 69: 47-56.
- Karanovic, I. (2001). *Meischcondona* gen. nov. from Africa, with a key to the genera of the Subfamily Candoninae (Crustacea, Ostracoda). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie* 71: 93-99.
- Karanovic, I. (2003). Towards a revision of Candoninae (Crustacea: Ostracoda): description of two new genera from Australian groundwaters. *Species Diversity* 8: 353-383.
- Karanovic, I. (2005a). Towards a revision of candoninae (Crustacea, Ostracoda): Australian representatives of the subfamily, with descriptions of three new genera and seven new species. *New Zealand Journal of Marine and Freshwater Research* 39:
- Karanovic, I. (2005b). -On the genus *Typhlocypris* Vejdovský, 1882 (Crustacea, Ostracoda, Candoninae) with description of two new species. *Systematics and Biodiversity*.
- Karanovic, I. (2005c). Comparative morphology of the Candoninae antennula, with remarks on the ancestral state in ostracods (Crustacea, Ostracoda) and proposed new terminology. *Spixiana*.
- Kaufmann, A. (1900). Cypriden und Darwinuliden der Schwiz. *Revue Suisse de Zoologie* 8: 209-423.
- Kempf, E. K. (1980). Index and bibliography of non-marine ostracoda, 1. Index A. *Geologisches Institut der Universität zu Köln Sonderveröffentlichungen* 35: 1-188.
- Kempf, E. K. (1997). Index and bibliography of non-marine ostracoda, 6. Index A, supplement 1. *Geologisches Institut der Universität zu Köln Sonderveröffentlichungen* 109: 1-142.

- Klie, W. (1931). Campagne spéologique de C. Bolivar et R. Jeannel dans l'Amérique du Nord (1928), 3: Crustacés Ostracodes. *Biospeologica* 51: 333-344.
- Krstiæ, N. (1993). Some new taxons of the Plio-Quaternary Ostracodes (with the column of a borehole from Ugrinovi). *Geological annals of the Balkan Peninsula* 57: 117-139.
- Krstiæ, N. and Guan, S. (2000). A proposal for the systematics of the Subfamily Candoninae (Ostracoda) with the description of the *Macedocandona*, new genus. *Geologia Macedonica* 14: 25-48.
- Külköylüoğlu, O. and Vinyard, G. L. (2000). Distribution and ecology of freshwater ostracoda (Crustacea) collected from springs of Nevada, Idaho and Oregon: a preliminary study. *Western North American Naturalist* 60: 291-303.
- Marmonier, P. and Ward, J. (1990). Superficial and interstitial ostracoda of the South Platte River (Colorado, U.S.A.) - systematics and biogeography. *Stygologia* 5: 225-239.
- Mazepova, G. F. (1990). Rakushkovye Rachki (Ostracoda) Baykala. Akademija Nauk SSSR, Sibirskoe Otdelenie, Limnologicheskii Institut, pp. 1-471.
- Martens, K. (1987). Homology and functional morphology of the sexual dimorphism in the antenna of *Sclerocypris* Sars, 1924 (Crustacea, Ostracoda, Megalocypridinae). *Bijdragen tot de Dierkunde* 57: 183-190.
- Martens, K. (1998). General morphology of non-marine ostracods. In K. Martens (ed.), Sex and parthenogenesis: evolutionary ecology of reproductive modes in non-marine ostracods. Backhuys Publ. Leiden, The Netherlands: 57-75
- Martens, K., D. J. Horne and Griffiths, H. I. (1998). Age and diversity of non-marine ostracods. In K. Martens (ed.), Sex and parthenogenesis: evolutionary ecology of reproductive modes in non-marine ostracods. Backhuys Publ. Leiden, The Netherlands: 37-55.
- Méhes, G. (1913). Süßwasser-ostracoden aus columbien und argentinien. *Mémoires de la Société neuchâteloise des Sciences naturelles* 5, 639-663.
- Meisch, C. (1996). Contribution to the taxonomy of *Pseudocandona* and four related genera, with the description of *Schellencandona* nov. gen., a list of the Candoninae genera, and a key to the European genera of the subfamily (Crustacea, Ostracoda). *Bulletin de la Société des Naturalistes luxembourgeois* 97, 211-237.
- Meisch, C. (2000). Freshwater Ostracoda of Western and Central Europe. In J. Schwoerbel and P. Zwick (eds), Süßwasserfauna von Mitteleuropa. Spektrum Akademischer Verlag, GmbH, Heidelberg, Berlin 8/3: 1-522.
- Olofsson, O. (1918). Studien über die süßwasserfauna spitzbergens. *Zoologische Beiträge aus Uppsala* 6: 512-526.
- Petkovski, T. (1962). Beitrag zur Kenntnis der Ostrakodenfauna Mitteldeutschlands (Thüringen - Sachsen). *Acta Musei Macedonici Scientiarum Naturalium* 74: 117-133.
- Petkovski, T. K. (1966). Ostracoden aus einigen quellen der slowakei. *Acta Musei Macedonici Scientiarum Naturalium* 87: 91-107.
- Petkovski, T. and Karanovic, I. (2000). On *Eucandona balatonica* (Daday, 1894) and *Eucandona levanderi* (Hirschman, 1912), two rare and little known ostracod species (Crustacea, Ostracoda). *Mésogée* 58: 77-84.
- Petkovski, T., B. Schärf and Keyser, D. (2002). New and little known species of the genus *Candona* (Crustacea, Ostracoda) from Macedonia and other Balkan areas. *Limnologica*, 32: 114-130.
- Pietrzeniuk, E. (1977). Ostracoden aus Thermokarstseen und Altwässern in Zentral-Jakutien. *Mitteilungen aus dem Zoologischen Museum in Berlin* 53: 331-364.
- Sars, G. O. (1926). Freshwater ostracoda from Canada and Alaska. *Reports of the Canadian Arctic expedition 1913-1918* 7: 3-23.
- Sharpe, R. W. (1897). Contribution to a knowledge of the north american fresh-water ostracoda included in the families cytheridae and cyprididae. *Bulletin of the Illinois State Laboratory of Natural History* 4: 414-489.
- Sharpe, R. W. (1918). The ostracoda. In H. B. Ward and G. C. Whipple (eds), Fresh-water biology. John Wiley and Sons, Inc. New York: 790-827.
- Tressler, W. L. (1954). Fresh-water ostracoda from Texas and Mexico. *Journal of the Washington Academy of Sciences* 44: 138-149.
- Tressler, W. L. (1957). The ostracoda of Great Slave Lake. *Journal of the Washington Academy of Sciences* 47: 415-423.
- Turner, C. H. (1894). Notes on American ostracoda, with descriptions of new species. *Bulletin of the Scientific Laboratories of Denison University* 8: 13-26.
- Turner, C. H. (1895). Fresh-water ostracoda of the United States. *Geological and Natural History Survey of Minnesota, Zoological Series* 2: 277-337.
- Yin, Y. and Martens, K. (1997). On a new species of *Fabaeformiscandona* Krstic, 1972 (Crustacea, Ostracoda) from China, with a preliminary checklist of recent Chinese non-marine ostracods. *Hydrobiologia* 357: 117-128.