

Ostracoda of the Lake Flirt Formation (Pleistocene) of southern Florida

ABSTRACT

Seventeen predominantly freshwater ostracode species, including 5 new taxa, are recorded from the Lake Flirt Formation (Pleistocene), exposed along the Caloosahatchee River, Florida. Eight sections within a lateral distance of 10 km. and with a thickness ranging up to 1.5 m thick, were measured and sampled every 5 cm. The medial, marly part of each section provided an abundant ostracode fauna. Three species, *Cyprideis salebrosa* van den Bold, *Physocypria denticulata* (Daday) and *Limnocythere floridensis* Keyser, together make up an average of 86% of the ostracode fauna. *Cyprideis salebrosa* is most common in the lower part of each section and is progressively replaced upward by *P. denticulata* and *L. floridensis*. This inverse relationship suggests initial oligohaline conditions grading upward to mesohaline.

INTRODUCTION

Lake Flirt was first systematically surveyed by J. L. Meigs in 1879 during a study of the feasibility of constructing a shipping canal along the Caloosahatchee River between Fort Myers and Lake Okeechobee. Meigs (1879) noted that the principal advantage arising from such a canal would be the partial drainage of the saw-grass marsh bordering the upper Caloosahatchee River, thereby lessening the flooding experienced by local farmers. This canal was eventually completed by 1886, the year that Heilprin ascended the river in his epic paleontological study. Heilprin (1887) noted that Lake Flirt was, "... at the time of our visit scarcely more than a swamp tract largely overgrown with grass, flag and various water plants ..." In the same paper Heilprin mentioned that dragging in Lake Flirt retrieved nothing but black vegetable muck.

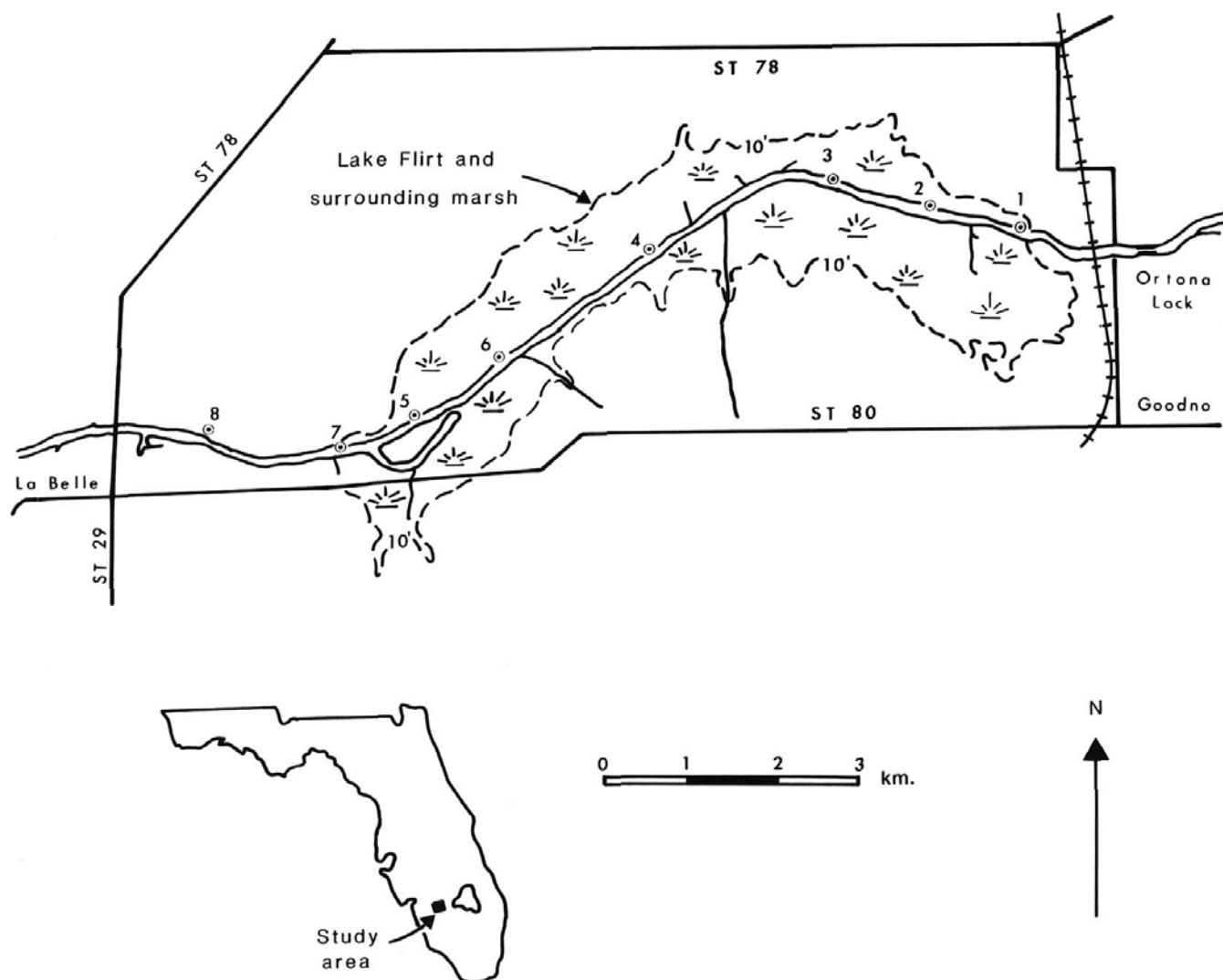
Meigs (1879) described Lake Flirt (Lake Flint in his report) as being 8.9 km (5½ mi) long, and varying in width from 0.4 to 2.4 km (¼ to 1½ mi). He further noted that the lake was traversed by a somewhat tortuous channel or numerous channels, with floating masses of vegetation, and that it ranged from approximately 0.3 to 1.8 m (1 to 6 ft) in depth. Meigs's report was supposedly accompanied by an index map which I have regrettably been unable to locate. His detailed description (p. 866) is inadequate to locate the channels and open expanses accurately without reference to the original map. It appears, however, that Lake Flirt and its surrounding marsh were approximately encompassed by the 3.0-m (10-ft) topographic contour line, as is indicated in text-figure 1.

STRATIGRAPHY

The Lake Flirt Marl was originally recognized by Sellards (1919), who described it as a calcareous mud containing freshwater shells, chiefly gastropods, with a thickness of 0.9 to 1.2 m (3 to 4 ft). He noted that it extended from Old Fort Thompson to Coffee Mill Hammock on the Caloosahatchee River overlying the Coffee Mill Hammock Marl and that it "may be quite recent in age."

Cooke (1945) and others have extended the Lake Flirt Marl to include similar marls underlying the peaty accumulations of the Everglades. He also noted that it may overlie the Pamlico sand or other Pleistocene or Pliocene beds in addition to the Coffee Mill Hammock Marl. Cooke stated that the deposition probably began in the late Wisconsin and may have locally continued into the Recent.

Brooks (1968) studied the Lake Flirt Marl and older units along the Caloosahatchee River. He concluded that it is impractical to separate



TEXT-FIGURE 1
Section locations, Lake Flirt Formation, Caloosahatchee River, Florida.

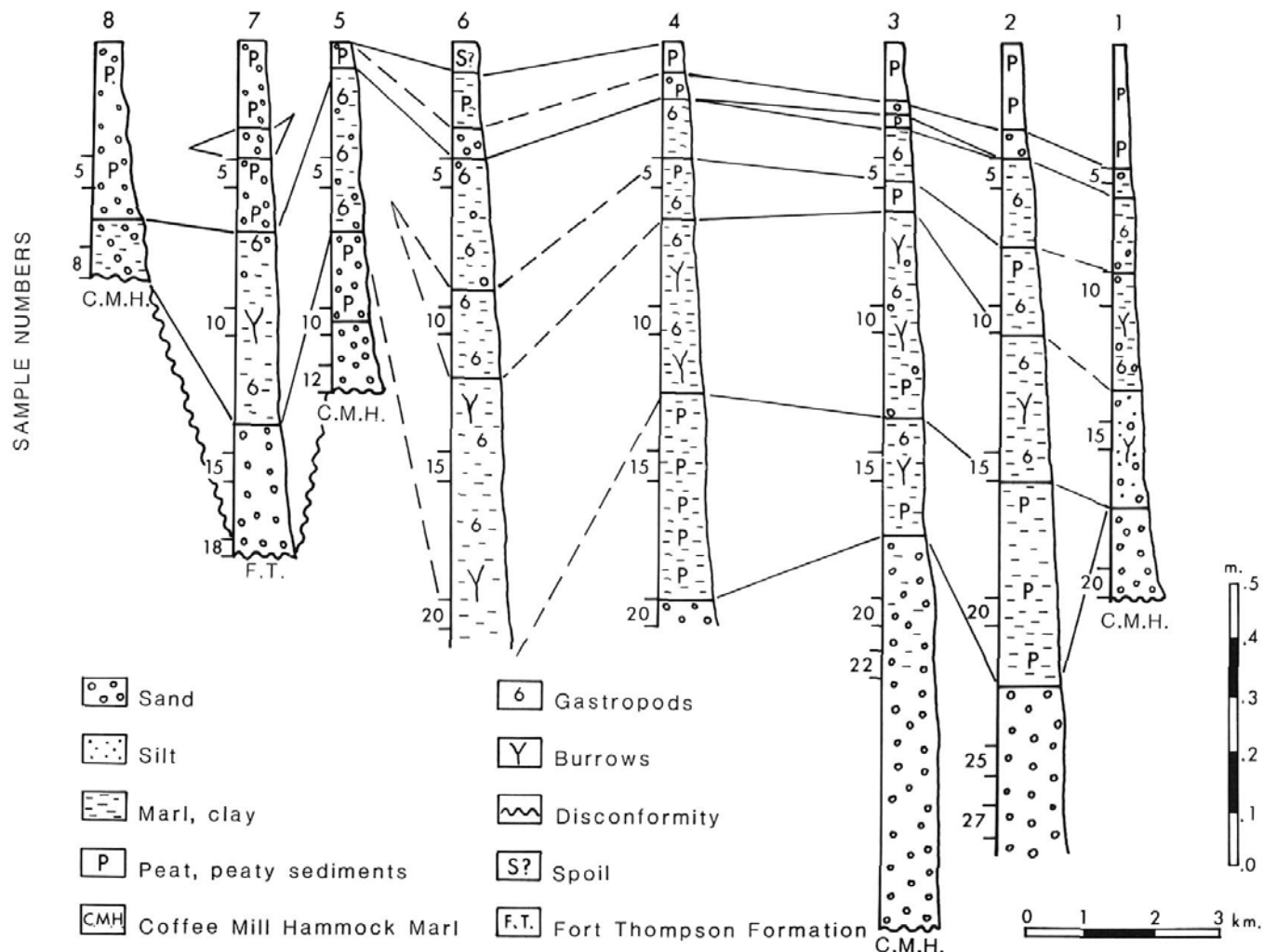
the overlying (vegetable) "muck" from the rest of the Lake Flirt beds. He also recognized 3 distinct marl beds separated by "mucks" exposed over part of the area. A radiocarbon date of approximately 20,900 years was obtained from the lowest "muck" and Brooks conjectured dates of 17,000 to 18,000 and 11,000 to 12,500 years on the 2 overlying marls. Because of its variable lithology, ranging from "mucky" sands to marls, Brooks referred to the entire unit as the Lake Flirt Formation.

In this study, 8 sections (text-figs. 1, 2) were studied from Ortona Lock west almost to La Belle. Of these, 5 are complete, extending down to the underlying unit which, at 4 localities, is the Coffee Mill Hammock Marl and at one location the Fort Thompson Formation. The sections vary in thickness from approximately 0.45 to just over 1.5 m (1½ to just over 5 ft).

Approaching Ortona Lock and La Belle the sections

become thinner, sandier and less fossiliferous. The interior sections (2, 3, 4, 6) have a higher concentration of marl and peaty material ("muck" of Brooks, 1968). The lowest interval, resting on the underlying formation, in each section is a barren sand (Pamlico sand of Cooke) ranging in thickness from 10 cm (4 inches) to slightly in excess of 0.6 m (2 ft). Sections 2, 3 and 4 reveal a stratigraphic sequence comparable to that described by Brooks (1968) with 2 peat-bearing beds ("mucks") dividing the sections into an upper and middle marl. The lower peaty unit which is almost completely barren of calcareous fossils, rests on the above-mentioned sand, not a marl as Brooks stated. Most of the marls exhibit burrows containing sediment from the overlying units. The upper few centimeters of most sections consist of a thin layer of sand usually overlain by slightly thicker peat or "muck." The 2 westernmost sections are capped by approximately 1 ft of "mucky" sand.

SECTIONS



TEXT-FIGURE 2

Stratigraphy of the Lake Flirt Formation, Caloosahatchee River, Florida.

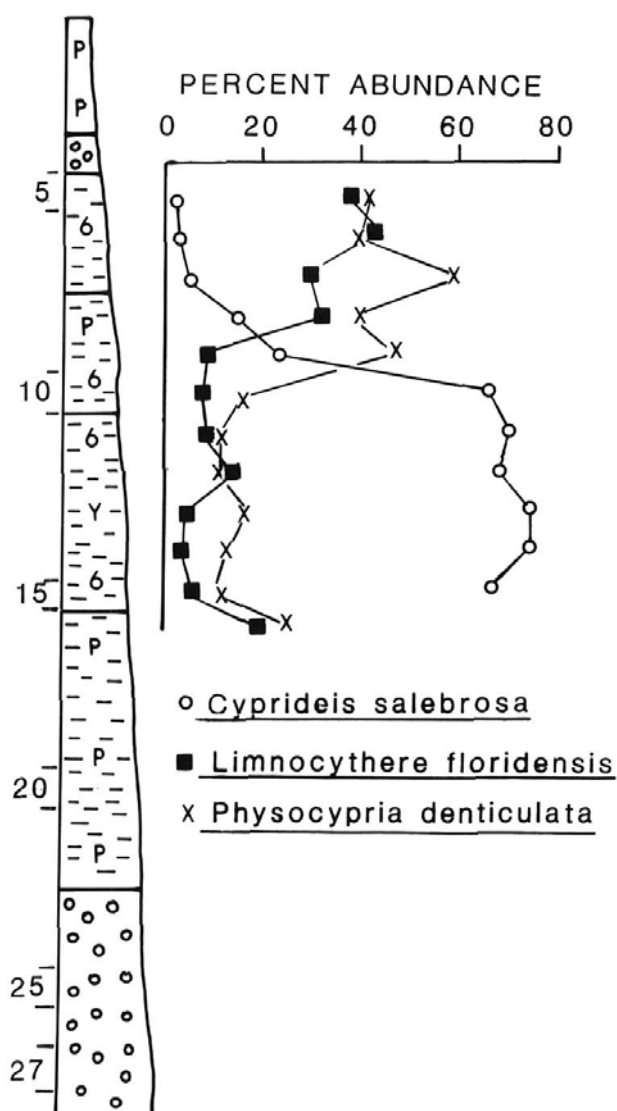
Each section was measured and described in the field and sampled throughout primarily using 5.0-cm (2-inch) sample intervals. In some sections it was necessary to take samples for as much as 0.4 m below water level of the Caloosahatchee River.

OSTRACODE DISTRIBUTIONS

Dried 100-gm splits of the 147 samples were disaggregated and wet-seived to remove the fraction finer than 75 μ m. The remaining fraction was dried and split to yield a sample size convenient for counting. To approximate the total number of individuals within each split only complete carapaces and right valves were recorded. Adults and juveniles were distinguished as was the sex of the adults where possible. After counting, the percentage abundance of the taxa in each sample was calculated and, depending on the number of times the washed residue was split, the total ostracode

abundance per 100 gm of unwashed sample was determined.

Where ostracodes are present their total abundance ranges from trace amounts to more than 140,000 individuals per 100 gm of unwashed sample. In the 81 ostracode-bearing samples the average abundance was 11,600. With one exception, ostracodes are absent from the upper and lower intervals of each section where "mucks" and sands, respectively, typically occur. The total ostracode abundance also declines within each section where sands and "mucks" occur. Such declines may reflect solution by plant acids in the "mucks" or acid ground water in the porous sands. However, examination of specimens from low-abundance intervals reveals no obvious solution whereas some specimens from marl units are solution-pitted. Presumably, ostracode absences and low abundances



TEXT-FIGURE 3
Percent abundance of the 3 major ostracode species in section 2 (stratigraphic symbols as in fig. 2).

in sands and "mucks" reflect hostile depositional rather than post-depositional conditions.

In nearly all samples juveniles outnumber adults, suggesting that current sorting is of minor significance.

Of the 16 species of ostracodes observed in this study, 3 constitute a clear majority in all samples. *Physocypria denticulata* (Daday), *Cyprideis salebrosa* van den Bold, and *Limnocythere floridensis* Keyser range from 44 to 100% with an average of 86%. *Physocypria denticulata* and *L. floridensis* exhibit an inverse abundance relationship with *C. salebrosa* in each section. Furthermore, *C. salebrosa* is the most abundant ostracode in the lower half of all sections and shows a steady upward decline. *Physocypria denticulata* and *L. floridensis* increase steadily upward (text-fig. 3).

Much of the evidence in the literature (LeRoy and Riley, 1959; Sandberg, 1964; Gutentag and Benson, 1962; van den Bold, 1976) suggesting that *Cyprideis salebrosa* is a brackish-water species, is based on empty carapaces. Keyser (1977) found salinity to be the controlling factor in the distribution of live ostracodes in southwest Florida. He noted that the salinity range for *C. salebrosa* was approximately 0.5 to 4.0 ‰ (parts per thousand) and for *Limnocythere floridensis* was approximately 3.0 to 12.0 ‰ with the maximum abundance of this species occurring between 5.0 and 10.0 ‰. Thus the inverse abundance between these 2 species suggests slightly increasing salinities upward at the time of deposition of the marls of the Lake Flirt Formation.

The Lake Flirt fauna contains several minor species also recorded live by Keyser (1977). These species and their salinity ranges are *Cytheridella ilosvayi* Daday (*C. alosa* of Keyser): 0.0 to approximately 0.5 ‰; *Candona furtosae* n. sp. (*C. ?balatonica* of Keyser): approximately 0.5 to 2.5 ‰; *C. annae* Mehes: approximately 1.0 to 8.5 ‰ and *Cyprinotus putei* Furtos (probably *Heterocypris punctata* of Keyser): 2.5 to 10.5 ‰. Ideally, these species might be expected to succeed each other upward in response to the interpreted slightly increasing salinities. However, the minor species exhibit a rather random distribution in all sections and do not support a picture of progressively changing salinities. Because of their very low abundance the minor species may not accurately reflect the average environmental conditions.

Sandberg (1964), in a summary of the literature, suggested that nodosity, characteristic of many species of *Cyprideis*, may be caused by hypersaline conditions, or, more commonly, by hyposaline conditions where there appears to be a negative correlation between nodosity and salinity. Van den Bold (1976) noted that nodosity is promoted by low salinity primarily, but it may also be controlled by the availability of calcium carbonate. He pointed out that some low-salinity assemblages have smooth shells possibly because not enough calcium carbonate was available to form nodes. Based on the abundance of calcareous fossils in the Lake Flirt samples there appears to have been adequate calcium carbonate for shell formation. Therefore, any variation in nodosity should reflect salinity variation. To test this, 100 representatives of the same valve of *C. salebrosa* were selected from a total of 9 intervals in 2 sections. The specimens from each interval include 20 adult males and 20 adult females and 30 each from the A-1 and A-2 instars. The notation system of Sandberg (1964) was used to record the numbers of nodes in different locations. The degree of development of the nodes was arbitrarily recorded as weak or

strong. It was anticipated that the total number and degree of development of nodes would decrease upward in each section. However, no trends were observed. It may be that because of its low range (less than 4.0 ‰), salinity does not control the development of nodes in *C. salebrosa*. Perhaps the nodes of *C. salebrosa* are genotypic rather than ecotypic. Therefore, although the evidence is equivocal, ecological data for 2 of the 3 most abundant species suggests a slight increase in salinity with time within the Lake Flirt basin. Based on the ecological requirements of *Limnocythere floridensis*, salinities may have reached a maximum of 12.0 ‰, although for other species to have survived it was probably less.

Inland waters of much of the southern third of Florida today contain chloride ion in concentrations of 25 to 100 ppm (equivalent to salinities of approximately 0.05 to 0.18 ‰). Odum (1953) suggested that this salt has been introduced primarily as a result of ground-water flushing older porous deposits that were invaded by sea water during recent higher stands of sea level. Through continued flushing, the amount of salt entering surface drainage should diminish with time. Climate also influences the concentration of salts in rivers and lakes. During drier times evaporation serves to increase the concentration. Watts (1975) demonstrated that from 4715 to 37,000 R.C.Y.B.P. (radio-carbon years before present) the climate in south-central Florida was drier to much drier than it is at present. Although Watts did not interpret any gradual climatic changes during this interval, the drier climate and its increased evaporation could have promoted the higher salinities suggested by some of the Lake Flirt ostracode species.

SYSTEMATIC PALEONTOLOGY

New types are housed in the American Museum of Natural History (AMNH). Other types are housed in the University of Akron Paleontological Collections (UAPC).

Genus CANDONA Baird, 1845

Candona annae Mehes, 1913

Plate 1, figures 1–3

Candona annae MEHES, 1913, pp. 653–658, figs. 9–12.—FURTOS, 1936b, pp. 520–522, fig. 15.—KEYSER, 1975, pp. 490, 492, fig. 2; 1977, pp. 208, 213, figs. 1–4.

Diagnosis: A species of *Candona* identified by its subtrapezoidal outline and size.

Dimensions: Average of 3 right valves: length 0.95 mm, height 0.49 mm. Average of 2 left valves: length 1.00 mm, height 0.50 mm.

Specimens: UAPC 1001–1003.

Remarks: The Lake Flirt specimens are identical in outline and are only slightly larger than the live specimens recorded by Mehes (1913) and Furtos (1936b). Furtos's record is the only occurrence from North America, although the species has previously been recorded from South America. Only males were observed in this study. Keyser (1977) noted that this species tolerates a salinity range of approximately 1.0–8.5 ‰ with maximum abundance occurring at less than 3.0 ‰. *Candona annae*, according to Keyser (1977) prefers substrates of organic debris and tolerates a temperature range of approximately 19 to 30°Cel.

Candona enigmatica Teeter, n. sp.

Plate 1, figures 4–7

Etymology: Named for its enigmatic external resemblance to the bythocyprid genus *Triangulocypris*.

Diagnosis: A species of *Candona* characterized by its distinctive, somewhat triangular outline.

Description: Outline subtriangular. Dorsal margin evenly, broadly arched. Anterior margin broadly rounded. Posterior margin narrowly rounded. Ventral margin slightly concave. Left valve overlapping right on all margins except mid-dorsal. Surface smooth in reflected light. Shell finely reticulate in transmitted light. Gonad impressions not observed. Typical *Candona* muscle scar faint under transmitted light, more obvious under scanning electron microscope. Posteroventral secondary adductor scar may be divided. Wide anterior and posterior vestibules.

Dimensions: Average of 9 right valves: length 0.88 mm, height 0.41 mm. Average of 6 left valves: length 0.91 mm, height 0.42 mm.

Specimens: Holotype, AMNH 42692; paratypes, AMNH 42693–42695.

Type locality: Section 6, 2 cm from top of section, shelly silt.

Remarks: The outline of this species is unlike that of any other *Candona* species known to me.

Candona fabalis Teeter, n. sp.

Plate 2, figures 1–3

Etymology: From the latin *fabalis*, meaning relating to bean.

Diagnosis: A large species of *Candona* characterized by its large individual adductor muscle scars and evenly rounded, beanlike profile.

Description: Female with dorsal margin rounded, gently sloping anteriorly, more steeply sloping posteriorly. Anterior and posterior ends broadly rounded. Ventral

margin shallowly concave. Male outline similar to female, except dorsal margin lower and less sloping anteriorly. Individual adductor muscle scars unusually large. Surface smooth.

Dimensions: Female—average of 2 left valves: length 1.53 mm, height 0.80 mm; right valve: length 1.45 mm, height 0.75 mm. Male—left valve: length 1.50 mm, height 0.76 mm.

Specimens: Holotype, AMNH 42699; paratypes, AMNH 42700, 42701.

Type locality: Section 4, 61 cm. from top of section, cream-colored marl.

Remarks: The male of *C. fabalis* resembles that of *C. eriensis* Furtos, 1933 and *C. scopulosa* Furtos, 1933, however the outlines of the females are markedly different and the latter 2 species are significantly smaller. The outline of the females of *C. fabalis* and *C. suburbana* Hoff, 1942 are similar but the males are distinctly different, and the former species is considerably larger than the latter.

***Candona flirtensis* Teeter, n. sp.**

Plate 2, figures 4–7

Etymology: Named for Lake Flirt, in whose sediments its remains have been found.

Diagnosis: A species of *Candona* identified by its small size, subequally rounded ends and greatest height anterior to the middle.

Description: Dorsal margin gently arched with greatest height slightly anterior to middle. Anterior and posterior almost evenly and subequally rounded in left valve and more pointedly rounded posteriorly in right valve. Ventral margin slightly concave. Left valve overlapping all margins except middle third, dorsally. Surface smooth. No impressions of gonads observed.

Dimensions: average of 6 left valves: length 0.83 mm, height 0.43 mm. Average of 2 right valves: length 0.80 mm, height 0.41 mm.

Specimens: Holotype, AMNH 42702; paratypes, AMNH 42703–42705.

Type locality: Section 6, 2 cm from top of section, shelly silt.

Remarks: This species resembles several previously described species, especially in size. *Candona simpsoni* Sharpe, 1897 is much more pointed posteriorly. *Candona elliptica* Furtos, 1933 is highest in the middle (male) to posterior third (female) and has a much wider inner lamella. Delorme (1970) observed much larger specimens of *C. elliptica* than previously recorded. *Candona exilis* Furtos, 1933 is more arched

dorsally and has its greatest height posterior to the middle. Also Furtos's illustration shows a finely pitted surface. In *C. havanaensis* Staplin, 1963, the greatest height appears to lie in the middle or posterior third and this species tends to be longer. *Candona flirtensis* has less bluntly rounded anterior and posterior margins and is consistently larger than the specimens of *C. wanlessi* Staplin, 1963, observed in this study.

***Candona furtosae* Teeter, n. sp.**

Plate 1, figures 8–10

Candona balatonica Daday [not *C. balatonica* Daday].—FURTOS, 1936b, pp. 518–520, fig. 14.

Candona ? balatonica Daday, 1894.—KEYSER, 1977, pp. 208, 213, figs. 1–4.

Etymology: Named in honor of Norma C. Furtos, for her extensive contributions to the study of freshwater ostracodes.

Diagnosis: A species of *Candona* identified by its obliquely truncated posterior margin, bluntly pointed posteroventral angle, slightly depressed anterodorsal margin and size.

Description: Males and females similar in outline. Dorsal margin straight, slightly depressed anterodorsally and obliquely truncate posteriorly. Ventral margin sinuate. Anterior margin broadly rounded. Posteroventral angle bluntly pointed in male, more sharply so in female, especially right valve. Surface smooth. No whole carapaces observed.

Dimensions: Female—average of 3 right valves: length 0.94 mm, height 0.49 mm; left valve: length 0.89 mm, height 0.49 mm. Male—average of 2 left valves: length 1.03 mm, height 0.55 mm; right valve: length 1.01 mm, height 0.51 mm.

Specimens: Holotype, AMNH 42696; paratypes, AMNH 42697, 42698.

Type locality: Section 1, 25 cm from top of section; medium brown colored, shelly, sandy clay.

Remarks: This species is definitely not conspecific with *C. balatonica*. Although *C. balatonica* varies in size, it is at least slightly larger than *C. furtosae*. More significantly, the carapace outline, especially of the males differs considerably. The posteroventral angle of the male of *C. balatonica* is rounded, that of *C. furtosae* bluntly pointed.

Furtos (1936b) found this species in wayside pools in southern Florida. Keyser (1977) noted that this species is restricted to salinities of 0.3–5.0 ‰, prefers organic debris substrates and temperatures of 28 to 30°C.

***Candona magnacaudata* Teeter, n. sp.**

Plate 3, figures 1–5

Etymology: Named for its large size and the sharply pointed posteroventral angle in the female.

Diagnosis: A large species of *Candona* characterized by an acutely pointed posteroventral angle in the female.

Description: Female—dorsal margin gently inclined anteriorly. Anterior margin evenly rounded. Posterior margin slightly convex, sloping at about 45° to acutely pointed posteroventral angle. Ventral margin gently concave medially with slight inflection just anterior to posteroventral angle. Surface smooth.

Male—similar in outline to female, except posterior margin more rounded, posteroventral angle bluntly rounded and absence of posterior inflection on ventral margin.

Dimensions: Female—average of 2 left valves: length 1.69 mm, height 0.79 mm; average of 4 right valves: length 1.58 mm, height 0.78 mm. Male—left valve: length 1.90 mm, height 0.94 mm, average of 3 right valves: length 1.66 mm, height 0.82 mm.

Specimens: Holotype, AMNH 42706; paratypes, AMNH 42707–42710.

Type locality: Section 4, 61 cm from top of section, cream colored marl.

Remarks: *C. magnacaudata* is similar in outline to *C. acuminata* Fischer, 1854, *C. caudata* Kaufmann, 1900, *C. croghaniana* Turner, 1894, *C. eriensis* Furtos, 1933 and *C. subacuminata* Delorme, 1970 but differs in being larger and more acutely pointed posteroventrally, especially in the females. *Candona ohioensis* Furtos, 1933 is comparable in size and outline but is more rounded posteroventrally. *Candona intermedia* Furtos, 1933 is similar in size and the outline of the female, but the male is much more rounded posteroventrally than *C. magnacaudata*. The specimens which Benson and MacDonald (1963) assigned to *C. caudata* are smaller, more hooked posteroventrally and more convex posteriorly in the females, and much more rounded posteroventrally in the males than *C. magnacaudata*.

***Candona patzcuaro* Tressler, 1954**

Plate 4, figures 1–6

Candona patzcuaro TRESSLER, 1954, p. 139, figs. 4–8.—DELORME, 1970, pp. 1113–1114, figs. 198–213.

Candona hipolitensis TRESSLER, 1954, p. 142, figs. 13–15.

Candona marchica Hartwig [not *C. marchica* Hartwig].—SWAIN, 1955, p. 609, pl. 59, figs. 3a, b, text-fig. 38, 3a–d.

Candona cf. *C. marchica* Hartwig [not *C. marchica* Hartwig].—CURTIS, 1960, pl. 3, fig. 1.

Candona swaini sappaensis STAPLIN, 1963a, p. 786, pl. 91, figs. 8, 9.

Candona obtusa Bronstein [not *C. obtusa* Bronstein, not *C. weltneri obtusa* Müller].—SWAIN, 1955, p. 607, pl. 59, figs. 1a, b, text-fig. 38, 2a, b.

Candona verretensis LEROY, 1964, p. 1098, pl. 170, figs. 1a–e.

Candona sappaensis Staplin.—DELORME, 1967, p. 793.

Candona sp. aff. *C. patzcuaro* Tressler.—Swain, 1977, p. 312, pl. 1, figs. 4, 7.

Candona sp. cf. *C. cromagniana* Turner [not *C. cromagniana* Turner].—SWAIN, 1977, pl. fig. 3.

Diagnosis: A species of *Candona* distinguished by a blunt posterior margin and posterodorsal angulation in the female left valve and marginal anteroventral tubercle on male right valves.

Dimensions: Average of 2 female right valves: length 1.11 mm, height 0.64 mm; average of 3 female left valves: length 1.16 mm, height 0.66 mm. Male—right valve: length 1.31 mm, height 0.76 mm. Average of 2 male left valves: length 1.34 mm, height 0.80 mm.

Specimens: UAPC 1017–1022.

Remarks: Delorme (1970) noted the close relationship between this species and *C. rawsoni* Tressler, 1957, based on comparison of soft parts. The only distinguishing shell characteristic is that of the posterodorsal angulation of the female left valve, which in *C. rawsoni* is much more flaring.

***Candona wanlessi* Staplin, 1963a**

Plate 1, figures 11–13

Candona wanlessi STAPLIN, 1963a, pp. 789–790, pl. 93, figs. 3, 4.—TEETER, 1970, p. 590, fig. 10.

Diagnosis: A species of *Candona* characterized by its small size and reniform outline.

Dimensions: Average of 5 left valves: length 0.69 mm, height 0.38 mm.

Specimens: UAPC 1004–1006.

Remarks: The specimens from Lake Flirt are identical in size and outline with those from the Fairlawn, Ohio, Mastodon site and very close to those originally described by Staplin. The distribution of normal pore canals in the Fairlawn and Lake Flirt material differs. No gonad traces were observed in the present material.

Genus POTAMOCYPRIS Brady, 1870

***Potamocypris variegata* (Brady and Norman), 1889**

Plate 4, figures 7–9

Cypridopsis variegata BRADY and NORMAN, 1889, p. 91, pl. 8, figs. 20, 21.

Candonella albida VAVRA, 1898, p. 12.

Potamocypris variegata (Brady and Norman).—DADAY, 1900, p. 193.—MÜLLER, 1900, p. 84, pl. 18, figs. 3, 4, 15–17.—FURTOS, 1933, p. 434, pl. 7, figs. 6–10.—TRESSLER, 1959, p. 723, fig. 28.168.—STAPLIN, 1963b, p. 1185–1186, pl. 159, figs. 44, 45.—TEETER, 1970, p. 591, fig. 13.

Diagnosis: A small species of *Potamocypris* distinguished by its pitted surface.

Dimensions: Average of 3 right valves: length 0.48 mm, height 0.30 mm; average of 3 left valves: length 0.47 mm, height 0.28 mm.

Specimens: UAPC 1023–1025.

Genus *PHYSOCYPRIA* Vavra, 1898

Physocypris denticulata (Daday), 1905
Plate 2, figures 8–11

Cypris denticulata DADAY, 1905, p. 254, pl. 16, figs. 5–9.
Physocypris denticulata (Daday).—MÜLLER, 1912, p. 133.—
FURTOS, 1936a, pp. 112–113, figs. 47–54.

Diagnosis: A species of *Physocypris* characterized by slight dorsal overlap of right valve and marginal tubercles of right valve anteriorly, ventrally and posteroventrally.

Dimensions: Average of 6 left valves: length 0.61 mm, height 0.42 mm; average of 7 right valves: length 0.59 mm, height 0.41 mm.

Specimens: UAPC 1010–1013.

Genus *CYPRINOTUS* Brady, 1886

Cyprinotus putei Furtos, 1936a
Plate 5, figures 1–3

Cyprinotus putei FURTOS, 1936a, pp. 105–106, figs. 94–101.
(?) *Cyprinotus* sp. 2 KEYSER, 1975, p. 494, fig. 2.
(?) *Heterocypris punctata* KEYSER, 1977, p. 275–277, text-fig. 13, pl. 12, figs. 10, 11.

Diagnosis: A species of *Cyprinotus* characterized by its conspicuously pitted surface and boldly arched dorsal margin.

Dimensions: Female—average of 6 right valves: length 1.25 mm, height 0.73 mm; average of 9 left valves: length 1.26 mm, height 0.76 mm. Male—average of 2 right valves: length 1.17 mm, height 0.68 mm.

Specimens: UAPC 1026–1028.

Remarks: Although varying slightly in size, the present specimens are identical in outline with those of Furtos and also have approximately 65 marginal tubercles in the right valve. Males are much less common than females.

Cyprinotus fluviatilis Furtos, 1933
Plate 5, figures 4–6

Cyprinotus fluviatilis FURTOS, 1933, pp. 445–446, pl. v., figs. 1–8.

Diagnosis: A smooth-shelled species of *Cyprinotus* characterized by its size, bluntly rounded posterior margin and evenly arched dorsal margin.

Dimensions: Female—average of 6 left valves: length 1.30 mm, height 0.69 mm; average of 10 right valves: length 1.30 mm, height 0.68 mm. Male—left valve: length 1.21 mm, height 0.64 mm.

Specimens: UAPC 1029–1031.

Remarks: The Lake Flirt specimens agree closely in size and outline with those of Furtos (1933). They differ slightly in that the posterior of the present specimens is more pointedly rounded. Males are extremely rare and are smaller and more rounded posteriorly than the females.

Genus *CYPRETTA* Vavra, 1895

Cypretta bilicis Furtos, 1936b
Plate 3, figures 6–8

PLATE 1

1–3 *Candona annae* Mehes

1, left valve exterior, hypotype UAPC 1001, × 61; 2, right valve interior, hypotype UAPC 1002, × 61; 3, right valve exterior, hypotype UAPC 1003, × 58.

4–7 *Candona enigmatica* Teeter, n. sp.

4, complete carapace viewed from right, holotype AMNH 42692, × 78; 5, left valve exterior, paratype AMNH 42693, × 73; 6, right valve interior, paratype AMNH 42694, × 77; 7, left valve interior, paratype AMNH 42695, × 74.

8–10 *Candona furtosae* Teeter, n. sp.

8, female right valve interior, holotype AMNH

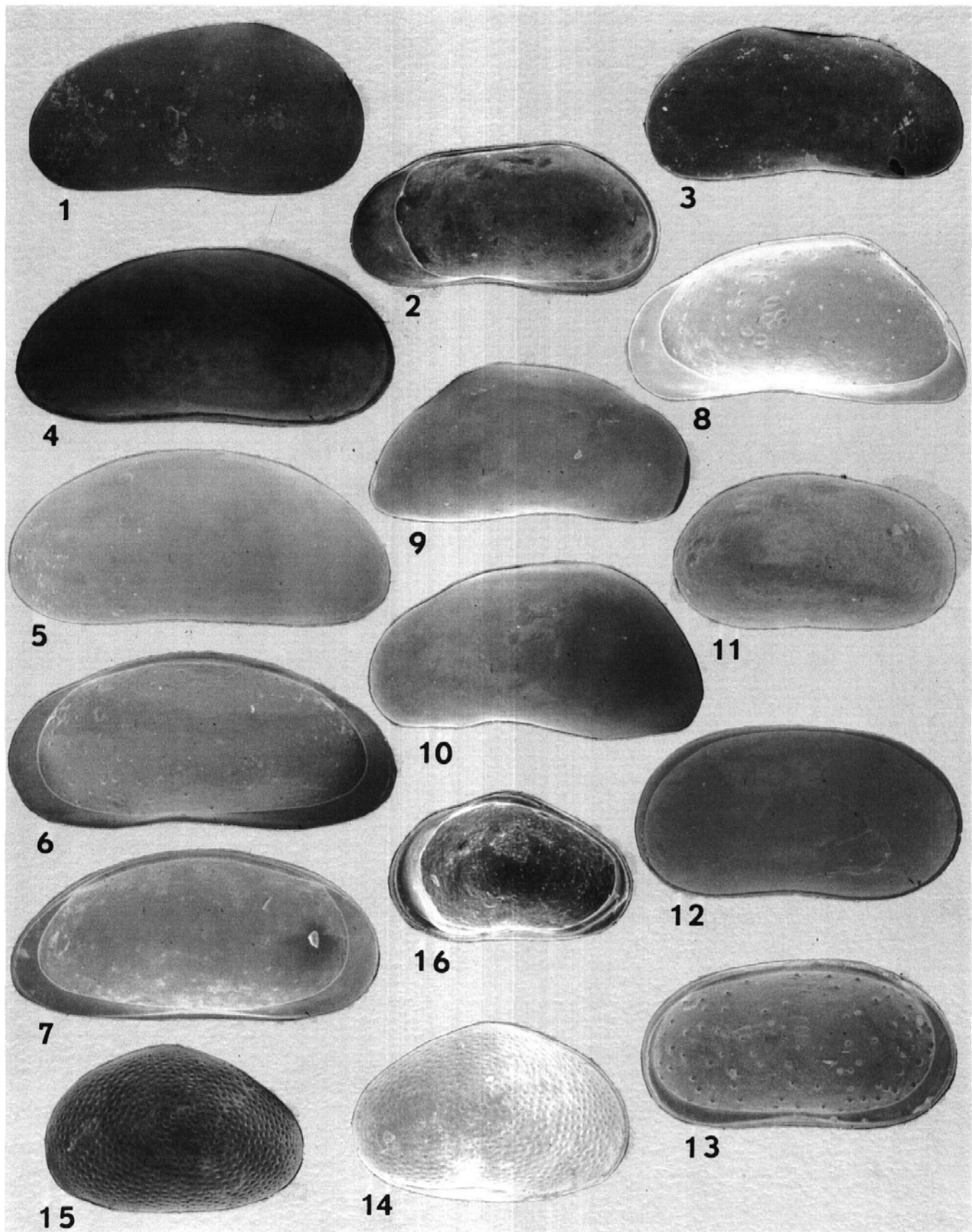
42696, × 65; 9, female right valve exterior, paratype AMNH 42697, × 62; 10, male left valve exterior, paratype AMNH 42698, × 59.

11–13 *Candona wanlessi* Staplin

11, left valve exterior, hypotype UAPC 1004, × 80; 12, complete carapace viewed from right, hypotype UAPC 1005, × 82; 13, left valve interior, hypotype UAPC 1006, × 83.

14–16 *Cypridopsis vidua* O. F. Müller

14, complete carapace viewed from right, hypotype UAPC 1007, × 80; 15, left valve exterior, hypotype UAPC 1008, × 78; 16, right valve interior, hypotype UAPC 1009, × 82.



Cyprina bilicis FURTOS, 1936b, pp. 495, 497–498, fig. 3.

Diagnosis: A species of *Cyprina* distinguished by its large size and longitudinal dark band on valves of living specimens.

Dimensions: Average of 6 right valves: length 0.94 mm, height 0.72 mm; average of 8 left valves: length 0.97 mm, height 0.73 mm.

Specimens: UAPC 1014–1016.

Remarks: The Lake Flirt specimens are similar in size and outline, although somewhat more angular postero-dorsally than those of Furtos. Unlike Furtos's specimens the surface is minutely pitted, and the fossils show no trace of the shell pigmentation of the living specimens. The anterior "radiating canals" or "septa" of Furtos are indistinct in some and invisible in most valves. Where visible they appear to number 9 to 11. The posteroventral margin of the right valve is finely denticulate. Dimorphism was not observed.

Genus CYPRIDOPSIS Brady, 1867

Cypridopsis vidua (O. F. Müller), 1776

Plate 1, figures 14–16

Cypris vidua O. F. MÜLLER, 1776, p. 199.—HERRICK, 1879, p. 112, pl. 17, fig. 1.

Cypridopsis vidua (O. F. Müller).—BRADY, 1867, p. 117.—TURNER, 1892, p. 73.—SHARPE, 1918, p. 807, fig. 1253.—HOFF, 1942, p. 151–153, pl. 8, figs. 115–117.—KESLING, 1951, pp. 2–116, pl.—GUTENTAG and BENSON, 1962, pp. 26–28, fig. 6, pl. 1, fig. 10.—BENSON and MACDONALD, 1963, p. 21, pl. 2, fig. 5.—STAPLIN, 1963b, pp. 1183–1184, pl. 159, figs. 30–36.—TEETER, 1970, p. 591, fig. 12.—KAESLER, 1975, pp. 225–244.

Cypridopella tumida KAUFMANN, 1900, p. 131.

Pionocypris vidua SARS, 1925 [1922–1928], p. 135, pl. 63.

Cypridopsis vidua vidua (O. F. Müller).—FURTOS, 1933, pp. 430–431, pl. 6, figs. 1–4.

Cypridopsis vidua obesa FURTOS, 1933 (not Brady and Norman, 1889), p. 431.

Cypridopsis pustulosa FURTOS, 1933, pp. 431–432, pl. 6, figs. 5–9.

Diagnosis: A species of *Cypridopsis* characterized by its small size, tumid outline from above and pitted surface.

Dimensions: Average of 7 right valves: length 0.58 mm, height 0.37 mm; average of 5 left valves: length 0.58 mm, height 0.38 mm.

Specimens: UAPC 1007–1009.

Genus CYPRIDEIS Jones, 1857

Cyprideis salebrosa van den Bold, 1963

Plate 5, figures 7–10

Cythere americana SHARPE, 1908, p. 420 (part) [not *Cythere americana* Dana, 1853, p. 1283, pl. 89, fig. 9a–b].

Cyprideis locketti (Stephenson).—SWAIN, 1955 (part), p. 615, pl. 59, fig. 10a–c (not pl. 64, fig. 13 = *Cyprideis bensoni* Sandberg, 1966).

Cyprideis torosa (Jones).—SWAIN, 1955, p. 616, pl. 59, fig. 8a–b, text-fig. 32c; 1977, p. 313, pl. 2, figs. 20–25 [not *Candona torosa* Jones, 1850, pl. 3, fig. 6a–e].

Cyprideis littoralis (Brady).—BYRNE, LEROY and RILEY, 1959, p. 240, pl. 4, fig. 11; pl. 5, fig. 12; pl. 6, fig. 14.—GUTENTAG and BENSON, 1962, p. 47, pl. 2, figs. 4–7, text-fig. 14a–d [not *Cytheridea littoralis* Brady 1868, p. 125 = *Cyprideis torosa* (Jones)].

Cyprideis sp. BYRNE, LEROY and RILEY, 1959, p. 240, pl. 6, figs. 10, 11.

Cyprideis salebrosa VAN DEN BOLD, 1963, p. 377, pl. 7, fig. 9a–d; p. 11, fig. 1a–c.—SANDBERG, 1964, p. 144, pl. 8, figs. 1–25; pl. 9, figs. 1–12; pl. 14, figs. 1–3; pl. 17, fig. 3a–f; pl. 18, fig. 10; pl. 20, figs. 5–10; pl. 22, figs. 5–8.—VAN DEN BOLD, 1971, text-figs. 2, 4; 1972, table 1.—SANDBERG and PLUS-QUELLEC, 1974, p. 22, pl. 1, fig. 20; pl. 2, figs. 1–3; text-figs. 2e, 11, 12.—VAN DEN BOLD, 1975a, pp. 579, 582, 586, 596, 598, 599, 601, 602, 604, 605, 607, tables 2–4, 6–9, 11; 1975b, pp. 32–33, tables 1, 2; 1975c, p. 133, tables 4, 5; 1976, pp. 6, 8, 9, 13, 14, 16, 19, 21, 22, text-figs. 1, 2, 6–9, 13, 14, tables 5–10.—KEYSER, 1975, pp. 490, 493, 496, fig. 3; 1977, pp. 208, 211, 213, 219, figs. 1–5.

Cyprideis gigantea LEROY, 1964, p. 1099, pl. 170, figs. 2a–f, 3a–c.

Cyprideis swaini HALL, 1965, p. 42, pl. 10, figs. 5–17.

Cyprideis hartmanni RAMIREZ, 1967, p. 40, pl. 11, figs. 74–79, pl. 12, figs. 80–89.

PLATE 2

1–3 *Candona fabalis* Teeter, n. sp.

1, female left valve interior, holotype AMNH 42699, × 59; 2, male left valve interior, paratype AMNH 42700, × 59; 3, male right valve interior, paratype AMNH 42701, × 59.

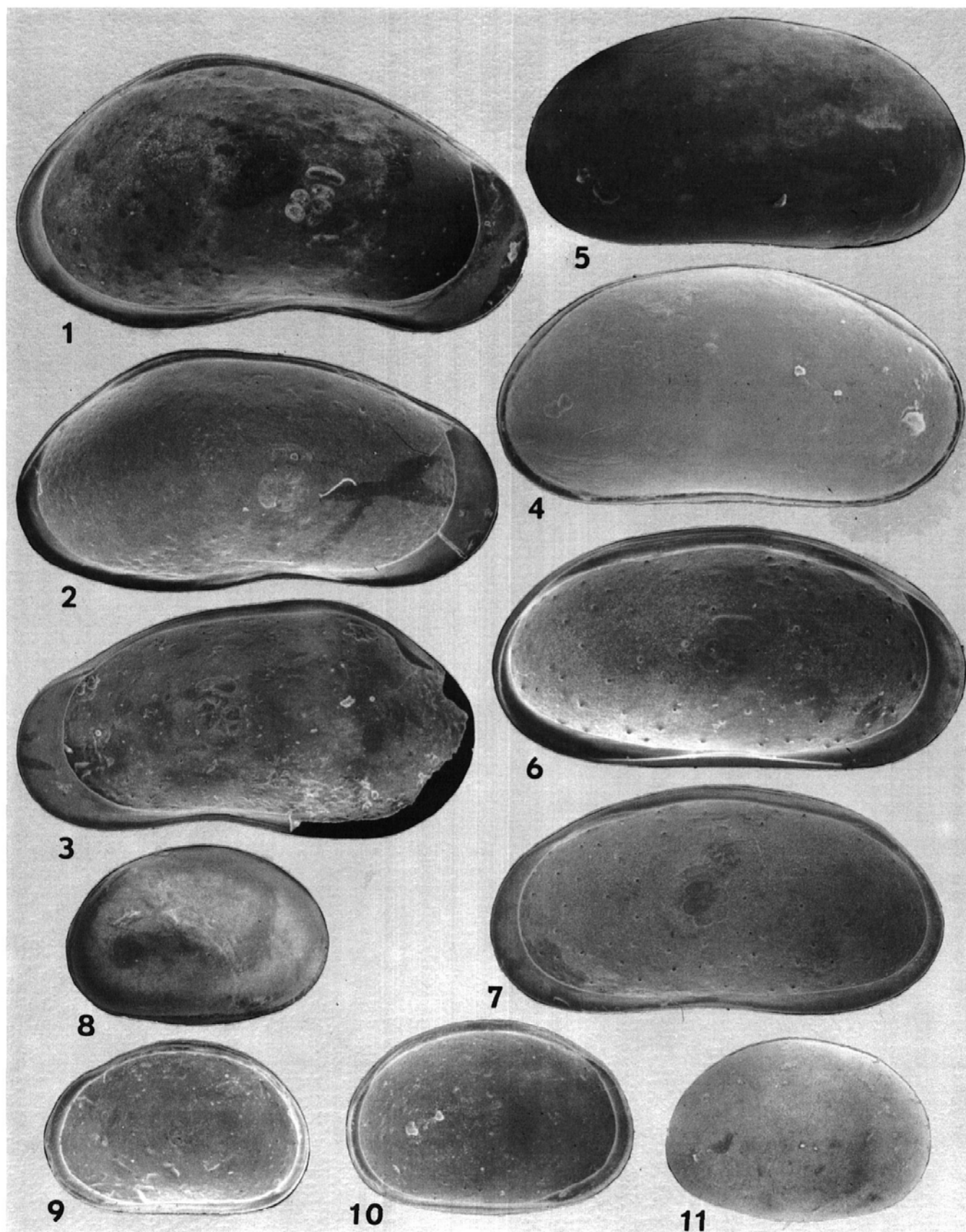
4–7 *Candona flirtensis* Teeter, n. sp.

4, complete carapace viewed from right, holotype AMNH 42702, × 106; 5, right valve exterior, paratype AMNH 42703, × 101; 6, left

valve interior, paratype AMNH 42704, × 102; 7, right valve interior, paratype AMNH 42705, × 104.

8–11 *Physocypris denticulata* (Daday)

8, complete carapace viewed from right, hypotype UAPC 1010, × 87; 9, right valve interior, hypotype UAPC 1011, × 84; 10, left valve interior, hypotype UAPC 1012, × 87; 11, complete carapace viewed from left, hypotype UAPC 1013, × 83.



Diagnosis: A species of *Cyprideis* characterized by its outline, lack of anterior marginal denticulations, and circular to oval normal pore canal openings.

Dimensions: Female—average of 4 right valves: length 1.07 mm, height 0.63 mm; average of 4 left valves: length 1.07 mm, height 0.64 mm. Male—average of 4 right valves: length 1.24 mm, height 0.66 mm; average of 3 left valves: length 1.23 mm, height 0.68 mm.

Specimens: UAPC 1032–1035.

Genus LIMNOCYHERE Brady, 1868

Limnocythere floridensis Keyser, 1976

Plate 6, figures 1–3

Limnocythere sp. cf. *L. friabilis* Benson and MacDonald.—VAN DEN BOLD, 1975a, p. 612, pl. 59, fig. 10 [not *Limnocythere friabilis* Benson and MacDonald, 1963, p. 24, pl. 3, figs. 1–4].

Limnocythere sp. KING and KORNICKER, 1970, pp. 40, 41, pl. 8, fig. 2a–b; pl. 19, figs. 3–6.

Limnocythere sanctipatricii Brady and Robertson.—ENGEL and SWAIN, 1967, p. 413, pl. 2, fig. 30a–c [not *Limnocythere sanctipatricii* Brady and Robertson, 1869, p. 369, pl. 18, figs. 8–11; pl. 21, fig. 4].

Limnocythere ? *sanctipatricii* Brady and Robertson.—KEYSER, 1975, pp. 490, 493, 495, 496.

Limnocythere floridensis KEYSER, 1976, p. 259–261, text-fig. 3, pl. 20, figs. 5–11; 1977, pp. 208, 215, figs. 1–5.

Diagnosis: A species of *Limnocythere* characterized by its small size and strongly developed nodes, especially in the female.

Dimensions: Female—average of 3 left valves: length 0.52 mm, height 0.29 mm; average of 5 right valves: length 0.53 mm, height 0.30 mm. Male—average of 3 left valves: length 0.60 mm, height 0.27 mm; right valve: length 0.57 mm, height 0.26 mm.

Specimens: UAPC 1042–1044.

Genus CYTHERIDELLA Daday, 1905

Cytheridella ilosvayi Daday, 1905

Plate 6, figures 4–9

Cytheridella ilosvayi DADAY, 1905, pp. 262–267, pl. 17, figs. 1–11.—KLIE, 1930, p. 246–247.—PINTO and SANGUINETTI, 1962, p. 33, pl. 1, fig. 4; pl. 2, fig. 4.—PURPER, 1974, p. 635–662, pls. 1–9.

Cythereis ilosvayi (Daday).—MÜLLER, 1912, p. 338.

Onchocythere alosa TRESSLER, 1939, pp. 337–339, fig. 1–11.

Cytheridella alosa (Tressler) 1939. KEYSER, 1977, p. 208, 211, 213, figs. 1–5.

Metacypris ? sp. VAN DEN BOLD, 1958, p. 74, text-fig. 3.

Cytheridella sp. PINTO and SANGUINETTI, 1962, p. 32.

Metacypris ometepensis SWAIN and GILBY, 1964, p. 361–365, 369–382, pl. 1, fig. 4a–d; pl. 2, figs. 1–5; pl. 3, figs. 1–3, 5; pl. 4, figs. 1–3, 5, 6; pl. 5, fig. 11.

Diagnosis: A species of *Cytheridella* in which the left valve is slightly larger than the right and, in dorsal view, the female is evenly inflated posteriorly.

Dimensions: Female—average of 10 left valves: length 0.98 mm, height 0.56 mm; average of 10 right valves: length 0.97 mm, height 0.56 mm. Thickness (average of 2 specimens) 0.76 mm. Male—left valve: length 0.87 mm, height 0.50 mm; right valve, length 0.81 mm, height 0.46 mm. Thickness (one specimen) 0.55 mm.

Specimens: UAPC 1036–1041.

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PLATE 3

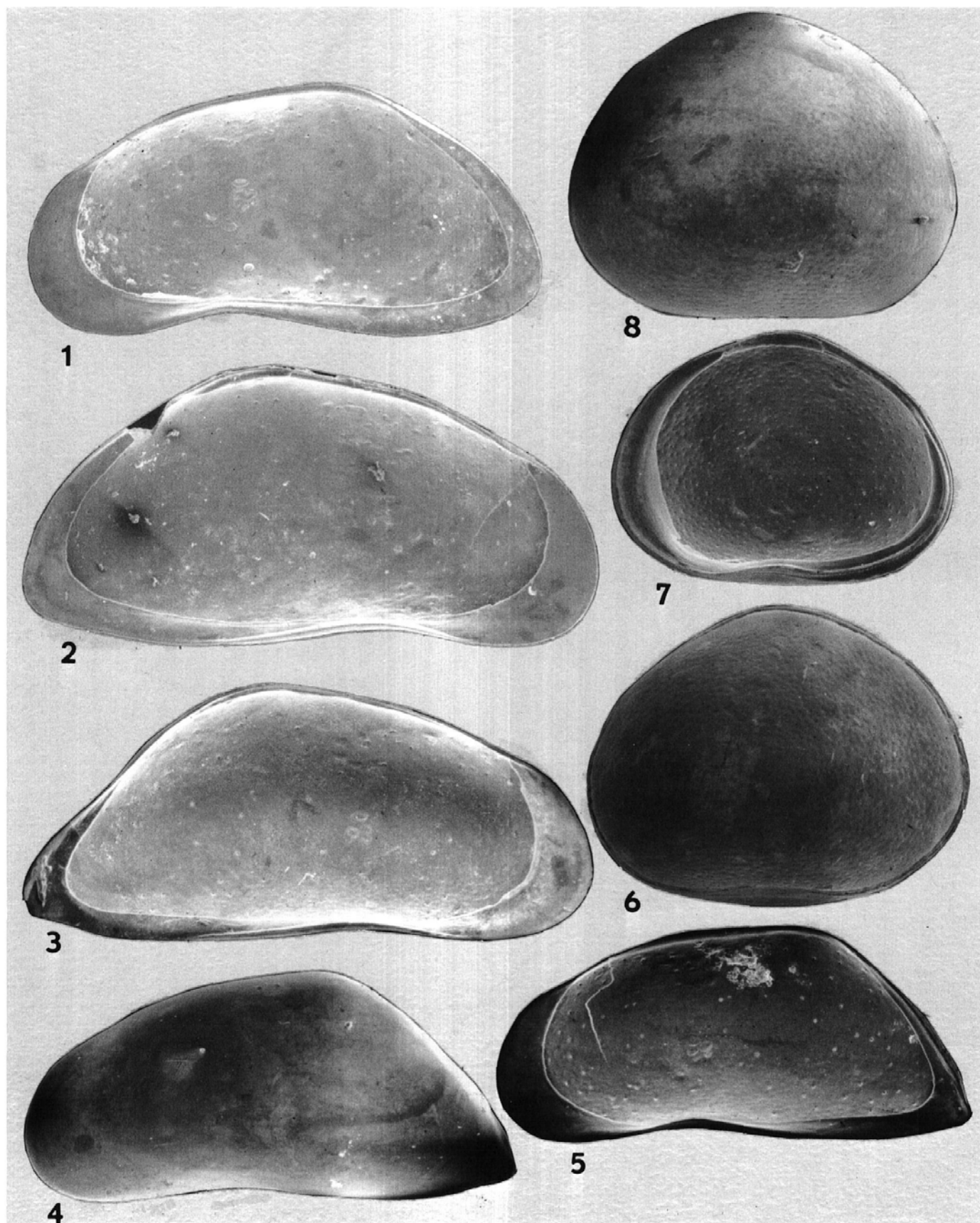
1–5 *Candona magnacaudata* Teeter, n. sp.

1, male right valve interior, paratype AMNH 42707, × 57; 2, male left valve interior, paratype AMNH 42708, × 56; 3, female left valve interior, holotype AMNH 42706, × 59; 4, female left valve exterior, paratype AMNH 42709, × 58;

5, female right valve interior, paratype AMNH 42710, × 57.

6–8 *Cypretta bilicis* Furtos

6, complete carapace viewed from right, hypotype UAPC 1014, × 76; 7, right valve interior, hypotype UAPC 1015, × 61; 8, left valve exterior, hypotype UAPC 1016, × 72.



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PLATE 4

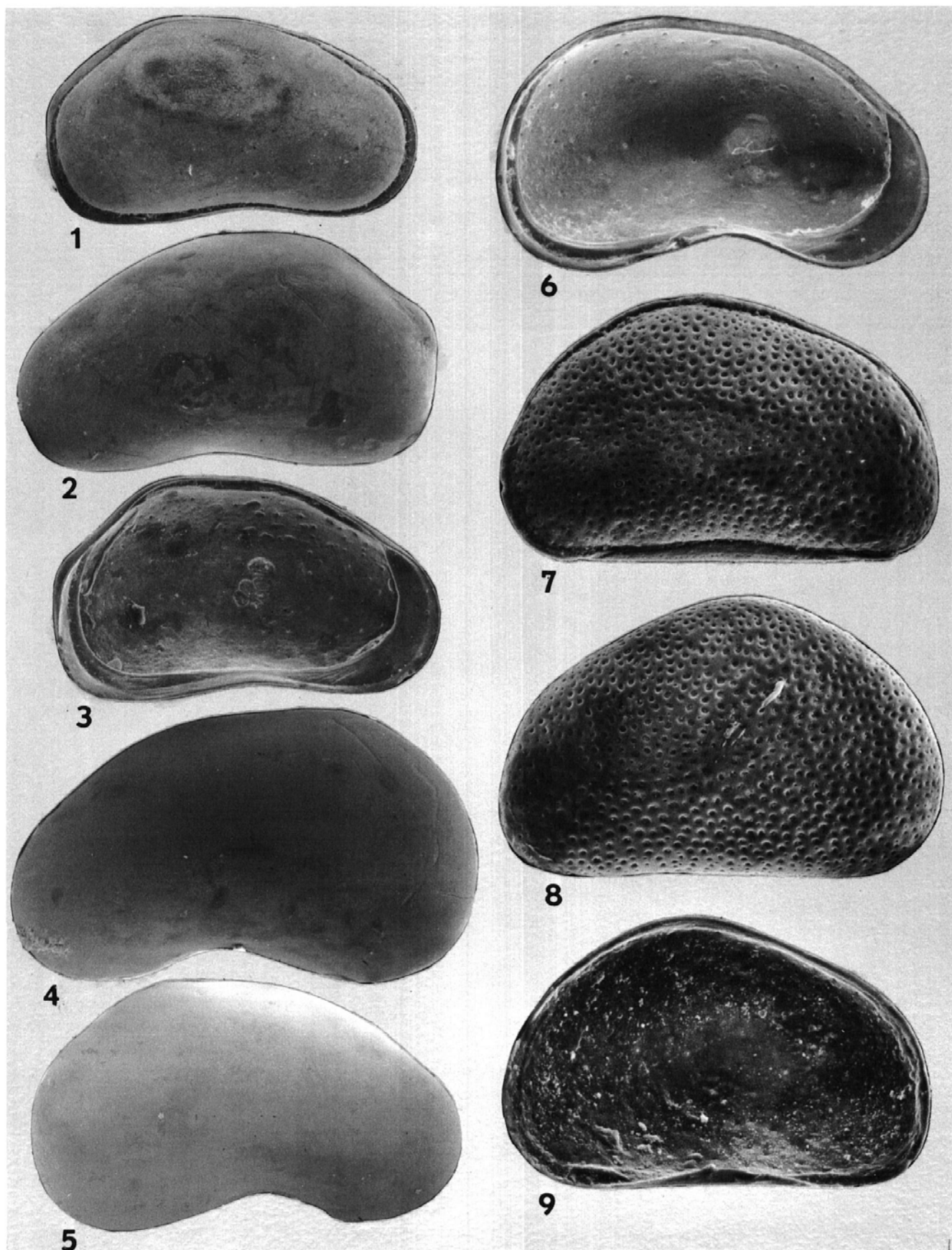
1–6 *Candona patzcuaro* Tressler

1, female complete carapace viewed from right, hypotype UAPC 1017, × 63; 2, female left valve exterior, hypotype UAPC 1018, × 62; 3, female left valve interior, hypotype UAPC 1019, × 62; 4, male left valve exterior, hypotype UAPC 1020, × 61; 5, male right valve exterior, hypo-

type UAPC 1021, × 60; 6, male left valve interior, hypotype UAPC 1022, × 62.

7–9 *Potamocypris variegata* (Brady and Norman)

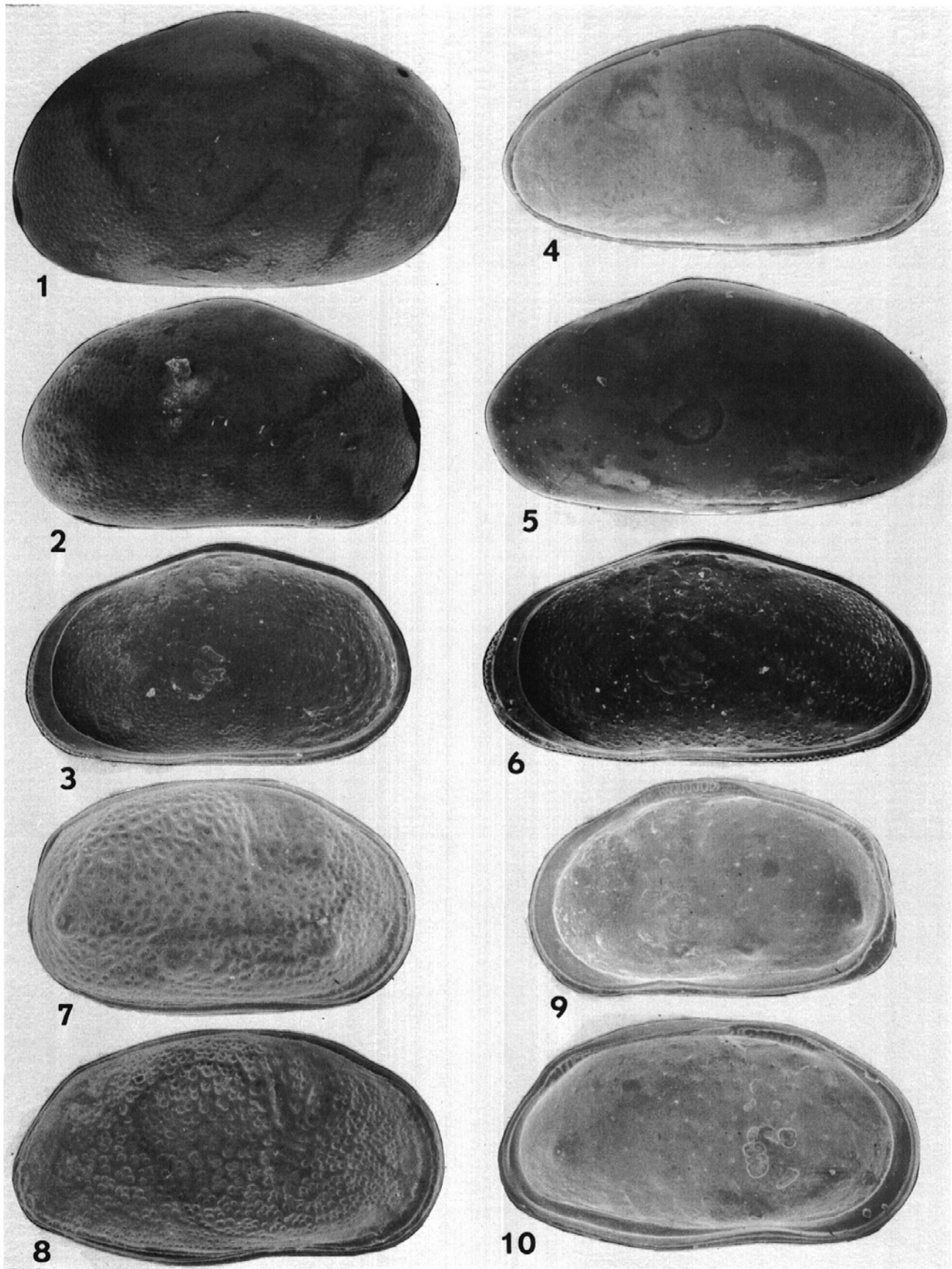
7, complete carapace viewed from left, hypotype UAPC 1023, × 162; 8, right valve exterior, hypotype UAPC 1024, × 164; 9, right valve interior, UAPC 1025, × 158.



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PLATE 5

- 1–3 *Cyprinotus putei* Furtos
1, female left valve exterior, hypotype UAPC 1026, × 59; 2, female right valve exterior, hypotype UAPC 1027, × 60; 3, male right valve interior, hypotype UAPC 1028, × 60.
- 4–6 *Cyprinotus fluviatilis* Furtos
4, female complete carapace viewed from right, hypotype UAPC 1029, × 61; 5, female left valve exterior, hypotype UAPC 1030, × 59; 6, female right valve interior, hypotype UAPC 1031, × 61.
- 7–10 *Cyprideis salebrosa* van den Bold
7, female complete carapace viewed from right, hypotype UAPC 1032, × 61; 8, male complete carapace viewed from right, hypotype UAPC 1033, × 62; 9, female right valve interior, hypotype UAPC 1034, × 61; 10, male left valve interior, hypotype UAPC 1035, × 63.



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PLATE 6

- 1-3 *Limnocythere floridensis* Keyser
1, female right valve exterior, hypotype UAPC 1042, × 153; 2, male left valve exterior, hypotype UAPC 1043, × 143; 3, female left valve interior, hypotype UAPC 1044, × 162.
- 4-9 *Cytheridella ilosvayi* Daday
4, female complete carapace viewed from above,

hypotype UAPC 1036, × 75; 5, male complete carapace viewed from above, hypotype UAPC 1037, × 81; 6, female left valve exterior, hypotype UAPC 1038, × 75; 7, female right valve exterior, hypotype UAPC 1039, × 79; 8, female right valve interior, hypotype UAPC 1040, × 78; 9, female left valve interior, hypotype UAPC 1041, × 77.

