

Systematic Paleontology of Quaternary Ostracode Assemblages from the Gulf of Alaska, Part 3—Family Cytheruridae

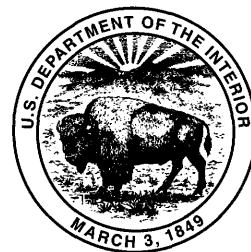
U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1544



Systematic Paleontology of Quaternary Ostracode Assemblages from the Gulf of Alaska, Part 3—Family Cytheruridae

By ELISABETH M. BROUWERS

U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1544



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2. Occurrence of species in the samples.

Systematic Paleontology of Quaternary Ostracode Assemblages from the Gulf of Alaska, Part 3—Family Cytheruridae

By Elisabeth M. Brouwers

ABSTRACT

Forty-six species of podocopid ostracodes are reported from Quaternary sediments of the Gulf of Alaska continental shelf. Twenty-seven new species are described (*Cytherura burroughsensis*, *C. wachusettensis*, *Semicytherura tauro-nae*, *S. balrogi*, *S. henryi*, *S. skagwayensis*, *Eucytherura hazeli*, *E. ishizakii*, *Hemicytherura dageletensis*, *H. lemesuriensis*, *H. sitakadayensis*, *Cytheropteron brokenoarsensis*, *C. carolae*, *C. chichagofensis*, *C. discoveria*, *C. dry-bayensis*, *C. eicheri*, *C. haydenensis*, *C. lordi*, *C. hopkinsi*, *C. foresteri*, *C. lituyaensis*, *C. midtimberensis*, *C. squirei*, *C. tarrensis*, *C. vernitichiensis*, *C. yakutatensis*), 11 previously described species are illustrated, and 8 species are placed in open nomenclature.

INTRODUCTION

The Gulf of Alaska comprises most of the cold-temperate Aleutian Zoogeographic Province, which has its northern boundary at the Aleutian Islands and its southern boundary at about lat 53° N. The latitudinal position, coastal morphology, and warm ocean currents combine to effect a warm maritime climate. The Gulf of Alaska represents a climatic transition between the mild- and cold-temperate North Pacific and the subfrigid and frigid Bering Sea and Arctic Ocean.

The modern ostracode fauna of the Gulf of Alaska is poorly known. Brouwers (1988) recognized five ostracode assemblages, each characterized by a unique combination of species diversity, abundance, dominant species, equitability distribution of species, percentage of living individuals, and associated fauna and flora. This report describes species occurrence in terms of these assemblages. Assemblage I occurs in the inner sublittoral zone (from shoreline to about 50 m). Assemblage II occurs in the middle sublittoral zone (from about 50 m to 100 m). Assemblage III occurs in the outer sublittoral zone (from about 100 m to 200 m). Assemblage IV occurs in the upper bathyal zone (from about 200 m to 350 m). Assemblage V consists of taxa that occur only as fossils.

From these assemblages, Brouwers (1990; part 1 of this study) reported on 32 ostracode species representing the Families Cytherellidae, Bairdiidae, Cytheridae, Leptocytheridae, Limnocytheridae, Eucytheridae, Krithidae, and Cushmaniidae. Part 2 (Brouwers, 1993) describes 27 ostracode species representing the Families Trachyleberididae, Hemicytheridae, Loxoconchidae, and Paracytherideidae. The present report describes 46 ostracode species, with all but one species belonging to the Family Cytheruridae.

STUDY AREA

This report is based on 198 bottom-grab samples collected during three cruises (EGAL-75-KC, DC1-79-EG, DC2-80-EG) to the northeast Gulf of Alaska (figs. 1, 2; table 1). Most of the samples are from the continental shelf and were taken in water depths ranging from 20 m to 256 m. The Van Veen sampler that was used took a large volume of bottom sediment, which provided large residues for examination. Micropaleontological subsamples ranged from 200 g to 1 kg (wet weight), depending on the size of the initial sample. Samples were washed on a 200-mesh sieve (75 µm) and examined down to and including material from the 80-mesh sieve (180 µm). All adult and juvenile specimens have been identified to species and have been counted (Brouwers, 1981, 1982a, b, 1983). Table 2 shows the occurrence of species in the samples.

SYSTEMATIC PALEONTOLOGY

All illustrated specimens are deposited in the U.S. National Museum of Natural History (USNM). Note that one carapace is counted as two valves. An asterisk (*) next to the assemblage type (in the occurrence section of each species) indicates that some of the specimens in the depth assemblage contain soft parts. Letters for species in open nomenclature are in keeping with previous usage (Brouwers, 1981, 1982a, b, 1983). Species left in open nomenclature have an insufficient number of specimens for identification and (or) description.

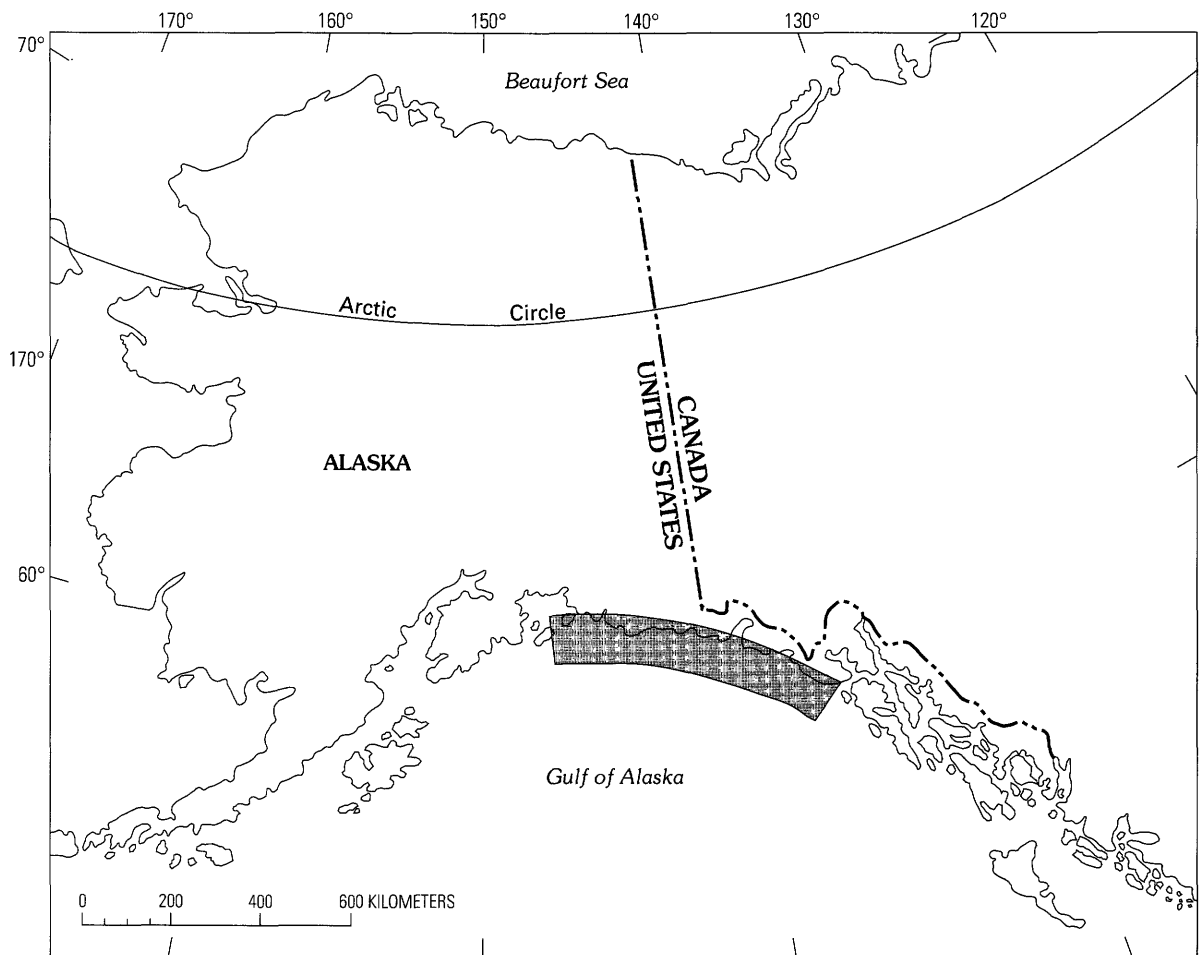


Figure 1. Map showing portion of continental shelf sampled for this study.

Class OSTRACODA Latrielle, 1806

Order PODOCOPIDA G.W. Mueller, 1894

Suborder PODOCOPA Sars, 1866

Family CYTHERURIDAE G.W. Mueller, 1894

Subfamily CYTHERURINAE G.W. Mueller, 1894

Genus CYTHERURA Sars, 1866

Type species.—*Cythere gibba* O.F. Mueller, 1785
(Type by subsequent designation)

***CYTHERURA BURROUGHSSENSIS* new species**

Plate 1, figure 2; plate 2, figures 1–4

Cytherura sp. C Brouwers, 1981, p. 10; Brouwers, 1982a, p. 11; Brouwers, 1983.

Etymology.—After Burroughs Glacier, which empties into the Muir Inlet of Glacier Bay, southeast Alaska.

Diagnosis.—Characterized by elongate, trapezoidal lateral outline; straight dorsum; broadly sinuous venter; pronounced, long, narrow caudal process; reticulate ornament; longitudinal Y-shaped ridge; thin dorsal ridge; strong, sharp

ventral ridge; distinctive secondary papillae located in small pits; and normal pores with apophysis.

Description.—Adult valves elongate, trapezoidal in lateral view. Dorsal margin nearly straight; anterodorsal margin concave in right valve; anteroventral margin drawn-out with apex near corner; ventral margin with subtle concavity; posteroventral margin concave; posterodorsal margin with pronounced, long, narrow caudal process. Several short anterior marginal denticles, weakly developed. Greatest length through caudal process; greatest height through anterior hinge element.

Valve surface covered with reticulation. Surface dominated by Y-shaped reticulation ridge originating at anterior and opening toward caudal process and posteroventral corner. Smaller reticulation ridges more chaotically arranged. Thin dorsal ridge originates at middle of anterior margin and ends along caudal process. Strong, sharp ventral ridge overhangs margin and ends posteriorly as sharp point. Solum floors covered with distinctive secondary papillate ornament, each occurring within small pit. Anterior margin with moderate, flattened flange. Twenty-seven simple-type normal pores evenly distributed over surface, both on

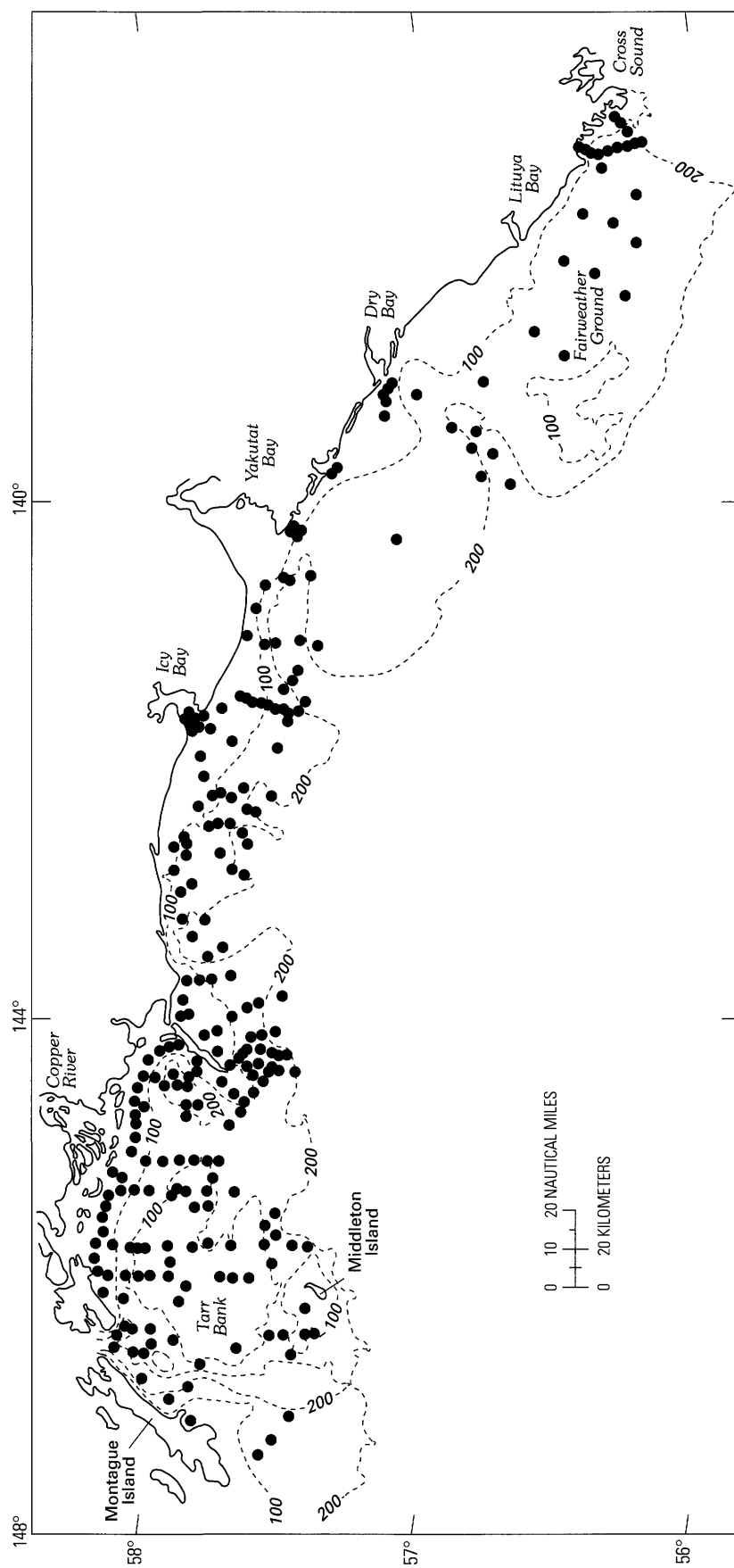


Figure 2. Map showing sample locations plotted against bathymetry.

solum floors and reticulation ridges. Normal pores with high, built-up mound surrounding each pore.

Inner margin and line of concrescence coincide. Inner margin parallels valve outline. Inner lamella moderate in width, even width throughout. Selvage well developed.

Remarks.—The inner lamella of *C. burroughsensis* specimens illustrated here is not well preserved, but additional material shows clearly that the species belongs to *Cytherura*.

Comparisons.—*Cytherura burroughsensis* n. sp. differs from *C. skipa* Hanai, 1957 (Holocene, central Japan) by having a high, short lateral outline; reticulate ornament; secondary pustules; and lack of strong oblique ridges. *C. burroughsensis* differs from *Semicytherura miurensis* (Hanai, 1957) (Quaternary, central Japan) by having a longer dorsum; drawn-out anterior; strong ventral ridge; strong reticulation; secondary pustules; and high, short valve outline. The Y-shaped ridge of *C. burroughsensis* is similar to that of *Kangarina pervadera* Ishizaki and Gunther, 1974 (Holocene, Gulf of Panama).

Occurrence.—Cruise EGAL-75-KC, localities 4, 6, 202. Cruise DC1-79-EG, localities 17, 45. Cruise DC2-80-EG, locality 174.

Distribution.—Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf.

Material.—Nine adult valves, two juvenile valves.

Type specimens.—Holotype: USNM 408413, left valve (pl. 1, fig. 2), locality EGAL-75-KC-202, length 0.43 mm, height 0.23 mm.

Paratypes: USNM 408414, left valve (pl. 2, figs. 1, 3), locality EGAL-75-KC-6, length 0.48 mm, height 0.26 mm. USNM 408415, right valve (pl. 2, figs. 2, 4), locality EGAL-75-KC-6, length 0.46 mm, height 0.26 mm.

CYTHERURA WACHUSETTENSIS new species

Plate 1, figure 6

Cytherura sp. D Brouwers, 1981, p. 10; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Wachusett Inlet, a small fiord of Muir Inlet, Glacier Bay.

Diagnosis.—Characterized by elongate, crescentic lateral outline; round, broad caudal process located ventral of midline; longitudinal reticulation; small secondary pits on solum floors; anterior arcuate vestibule; and large, crescentic posteroventral and ventral vestibules.

Description.—Adult valves are elongate, crescentic in lateral view. Dorsal margin broadly arched; anterior margin smoothly curved, with maximum width ventral of midline; ventral margin with wide, shallow concavity; posterior margin with rounded, broad caudal process, located ventral of midline. Greatest length through caudal process; greatest height through anterior hinge element.

Valve surface covered with reticulation network, predominantly longitudinal with scattered cross ridges. Small secondary pits arranged on solum floors. Thirty-five normal pores scattered over valve, occurring between ridges.

Inner margin and line of concrescence coincide at posterodorsal margin and concavity. Moderate, arcuate anterior vestibule. Small posterior vestibule at caudal process which connects with large, crescentic vestibular space along posteroventral and ventral margins. Inner lamella widest at anterior. Strong, well-developed selvage. Thirteen radial pore canals, most anterior. Radial pores are long, straight, and simple.

Hingement in right valve consists of elongate, crenulate terminal elements and finely crenulate median groove.

Comparisons.—*Cytherura wachusettensis* n. sp. differs from *C. johnsonoides* Swain, 1967 (Holocene, Gulf of California, Nicaragua) by having a long, low valve outline; blunt, weak caudal process; large secondary pits; different course of inner lamella; and different terminal hinge elements. *C. wachusettensis* differs from *C. miurensis* Hanai, 1957 (Holocene, central Japan) by having a squared valve shape; blunt, short caudal process; different hinge; and lack of a ventral ridge and a wide inner lamella at the anterior and posterior. *C. wachusettensis* differs from *Semicytherura wakamurasaki* Yajima, 1982 (late Pleistocene, central Japan) by having a less pronounced, wide caudal process; different size and shape of the vestibules; obtuse posterodorsal and antero-dorsal cardinal angles; and concave venter.

Occurrence.—Cruise EGAL-75-KC, localities 11, 17, 162, 428.

Distribution.—Pleistocene (?), Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf.

Material.—Seven adult valves, five juvenile valves.

Type specimens.—Holotype: USNM 408422, male right valve (pl. 1, fig. 6), locality EGAL-75-KC-11, length 0.53 mm, height 0.25 mm.

CYTHERURA sp. G

Plate 1, figure 5

Cytherura sp. G Brouwers, 1981, p. 10; Brouwers, 1982b, p. 9; Brouwers, 1983.

Diagnosis.—Characterized by subquadrate, squared valve outline; flattened, broad caudal process; concentrically arranged reticulate ornament; smooth anterior end.

Occurrence.—Cruise EGAL-75-KC, localities 39, 128, G4.

Distribution.—Pleistocene (?), Holocene: Gulf of Alaska, Pribilof Islands.

Material.—Three adult valves.

Illustrated specimen.—USNM 408418, female left valve (pl. 1, fig. 5), locality EGAL-75-KC-39, length 0.53 mm, height 0.30 mm.

CYTHERURA sp. H

Plate 1, figure 1

Cytherura sp. H Brouwers, 1982b, p. 9; Brouwers, 1983.

Diagnosis.—Characterized by elongate, subquadrate lateral outline; straight, subparallel dorsal and ventral margins; sharp caudal process located dorsal of midline; five blunt anterior marginal denticles; vertically arranged reticulation ridges; massive, overhanging ventral ala; and coincident inner margin and line of concrescence.

Occurrence.—Cruise EGAL-75-KC, localities 157, G4.

Distribution.—Pleistocene, Holocene (?): Gulf of Alaska, Cook Inlet, Kodiak Shelf.

Material.—One adult valve, one juvenile valve.

Illustrated specimen.—USNM 408412, left valve (pl. 1, fig. 1), locality EGAL-75-KC-157, length 0.44 mm, height 0.20 mm.

CYTHERURA sp. I

Plate 6, figure 6

Diagnosis.—Characterized by squat, subcylindrical lateral outline; subparallel dorsal and ventral margins; smooth valve surface; coincident inner margin and line of concrescence; inner lamella shallow at posterior, deep at anterior; well-developed selvage; radial pore canals enlarged terminally.

Distribution.—Holocene: Glacier Bay, Gulf of Alaska.

Occurrence.—Locality G4.

Material.—One adult valve.

Illustrated specimen.—USNM 408469, female left valve (pl. 6, fig. 6), locality G4, length 0.41 mm, height 0.25 mm.

CYTHERURA sp. J

Plate 1, figure 3

Cytherura sp. J Brouwers, 1982b, p. 9; Brouwers, 1983.

Diagnosis.—Characterized by subcylindrical lateral outline; wide concavity; subparallel dorsal and ventral margins; concentric reticulation; weak, sinuous ventral ridge; thin anterior marginal ridge; and coincident inner margin and line of concrescence.

Occurrence.—Cruise EGAL-75-KC, locality 69.

Distribution.—Pleistocene: Gulf of Alaska.

Material.—One adult valve.

Illustrated specimen.—USNM 408416, female left valve (pl. 1, fig. 3), length 0.54 mm, height 0.28 mm.

Genus *EUCYTHERURA* G.W. Mueller, 1894

Type species.—*Cythere complexa* Brady, 1867 (Type by subsequent designation)

EUCYTHERURA HAZELI new species

Plate 2, figures 9–14; plate 4, figures 14–15; figure 3

Eucytherura sp. C Brouwers, 1981, p. 10; Brouwers, 1982a, p. 11; Brouwers, 1983.

Etymology.—After Dr. Joseph E. Hazel, Louisiana State University, a specialist in ostracodes and chronostratigraphic methods.

Diagnosis.—Characterized by subquadrate to subrectangular lateral outline; sinuous ventral margin with pronounced concavity; ventral margin sharply inclined at posterodorsum; blunt caudal process; large, rounded, subvoid pits arranged concentrically at anterior and chaotically at posterior; rounded, heavily calcified reticulation ridges; large, high ventral tubercle that overreaches ventral margin; pore clusters; and secondary sponge-like ornament.

Description.—Adult valves short, subquadrate to subrectangular in lateral view. Dorsal margin straight; anterior margin smoothly curved, with greatest width ventral of midline; ventral margin with pronounced concavity; ventral margin inclined sharply toward posterodorsal; posterior margin truncated, with wide, blunt caudal process. Distinct, obtuse anterodorsal and posterodorsal cardinal angles. Left valve with truncated caudal process; broad, shallow concavity; and pronounced anterodorsal cardinal angle. Greatest length through midline of valve; greatest height through anterior hinge element.

Valve covered with low, massive reticulation network. Large, rounded, subvoid pits arranged in concentric pattern at anterior and chaotic at posterior. Reticulation ridges are broad, rounded, heavily calcified. Two parallel anterior marginal ridges; sinuous median ridge originates near anterodorsal corner, proceeds horizontally across valve, and splits into vertical posterior ridge. Narrow anterior and posterior marginal rim or flange. Large, prominent, highly arched ventral node or tubercle that proceeds obliquely along margin, overhanging posterior end. Each reticulation fossa with two to nine pore clusters. Secondary fine-scale sponge-like network rims each reticulation fossa. Simple-type normal pores on reticulation ridges; normal pores with recessed marginal rim. Small eye spot.

Wide inner lamella parallels valve outline. Selvage moderately developed.

Hingement in right valve consists of bifid anterior tooth complex, with subtriangular tooth and elongate, trapezoidal tooth; anteromedian small tooth and socket; finely crenulate median groove; and bifid, crescentic posterior tooth.

Four adductor muscle scars form vertical row. Dorsal scar is kidney-shaped; dorsomedian scar is dumbbell-shaped; ventromedian scar is elongate, with enlarged, ventrally drooping anterior; ventral scar is boomerang-shaped. Rounded, large fulcral point. Frontal scar forms rounded heart shape. Moderate number of irregularly shaped dorsal muscle scars.

Measurements.—X-Y plot based on 13 specimens (fig. 3).

Remarks.—*Typhlocythere* Bonaduce, Ciampo, and Masoli, 1975 is similar in ornamentation and shape to *Eucytherura* but differs in lacking eye spots. *Eucytherura hazeli* and *E. ishizakii* both have eye spots and hence are placed into *Eucytherura*.

Comparisons.—*Eucytherura hazeli* n. sp. differs from *E. utsusemi* Yajima, 1982 (upper Pleistocene, central Japan) by having a low, long valve outline; high ventral ridge with less ventral overhang; rounded reticulation pits; and a weakly developed eye spot.

Occurrence.—Cruise EGAL-75-KC, locality 52A. Cruise DC1-79-EG, locality 47. Cruise DC2-80-EG, localities 67, 73, 82, 86, 186, 195.

Distribution.—Pleistocene (?), Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf. Outer sublittoral.

Material.—Thirty-six adult valves.

Type specimens.—Holotype: USNM 408427, left valve (pl. 2, figs. 9, 12), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm.

Paratypes: USNM 408428, right valve (pl. 2, fig. 10), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm. USNM 408429, right valve (pl. 2, figs. 11, 13, 14; pl. 4, fig. 14), locality DC21-80-EG-195, length 0.36 mm, height 0.20 mm. USNM 408430, left valve (pl. 14, fig. 15), locality DC2-80-EG-195, length 0.35 mm, height 0.23 mm.

EUCYTHERURA ISHIZAKII new species

Plate 1, figure 8; plate 3, figure 1; plate 4, figures 6–13; figures 4, 5

Eucytherura sp. A Brouwers, 1981, p. 10; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 9; Brouwers, 1983.

Etymology.—After Dr. Kunihiro Ishizaki, Tohoku University, Japan.

Diagnosis.—Characterized by subtriangular lateral outline; pronounced concavity; wide, broad caudal process; dorsal and ventral margins converge at posterior; anteroventral marginal denticles; subtle dimorphism; low massive reticulation; ovoid pits arranged vertically in subparallel rows; inverted V-shaped anterior ridge; prominent, arcuate, overhanging ventral ridge; eye spot; smooth posterior marginal rim; crescentic anterior and arcuate posterior vestibules.

Description.—Adult valves short, subtriangular in lateral view. Dorsal margin broadly sinuous, inclined toward posterior; smoothly curved anterodorsal margin and irregularly curved anteroventral margin; anterior margin with greatest width ventral of midline; ventral margin with pronounced concavity; venter inclined sharply toward posterodorsal; posterior margin attenuated, with wide, broad caudal process. Dorsal and ventral margins converge toward posterior. Many small, sharp anteroventral marginal denticles. Right valve with low anterodorsal corner; convergent posterior; and inclined dorsum. Subtle dimorphism: males differ

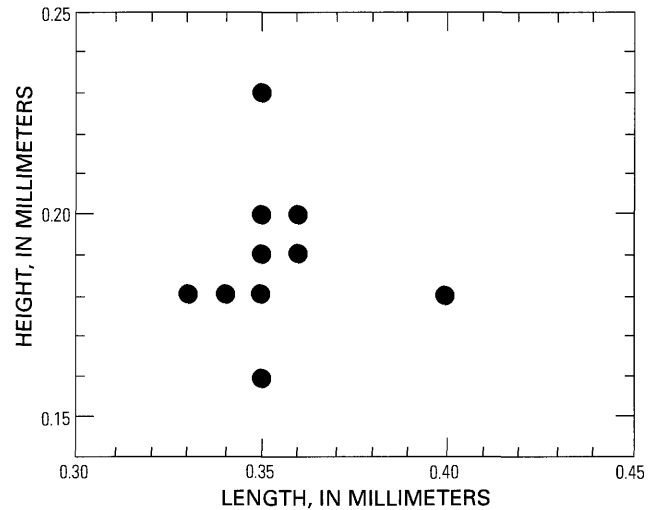


Figure 3. Plot of length versus height for *Eucytherura hazeli*. Dot may represent more than one specimen.

in having short, low valve outline, convergent posterior. Greatest length through midline of valve; greatest height through anterior hinge element.

Valve surface covered with low, massive reticulation. Pits are moderate in size, rounded, subovoid to elongate-ovoid; arranged in vertical pattern of subparallel rows. Reticulation ridges are broad, rounded, heavily calcified. Large anterior marginal ridge proceeds to anterodorsal corner, connecting with second vertical ridge, forming inverted V-shape. Ventral marginal ridge angles obliquely to middle of venter. Oblique ridge forms outer edge of prominent, arcuate ventral ridge which overhangs posteroventral margin and terminates as tubercle. Posterior margin with vertical ridge. Prominent, smooth, subovoid eye spot. Broad, flat, smooth posterior marginal rim. Sola pore clusters within ornament pits. Thirty-six simple-type normal pores scattered over surface, on reticulation ridges. Normal pores with subtle marginal rim.

Inner margin and line of concrescence coincide along venter. Deep, crescentic anterior vestibule; arcuate posterior vestibule. Selvage well developed.

Hingement in left valve consists of large, subquadrate anterior socket with heavy dorsal rim; finely crenulate median bar; and large, elongate, subovoid posterior socket. Median element enlarged terminally, sinuous in course. Anterior and posterior hinge element with reinforced, heavily calcified platform.

Four adductor muscle scars in a row, inclined posterodorsally. Dorsal scar is elongate-ellipsoidal; dorsomedian scar is subquadrate; ventromedian scar is elongate, subquadrate; ventral scar is semicircular. J-shaped frontal scar. Few, large dorsal muscle scars.

Measurements.—X-Y plot based on 32 specimens (fig. 4).

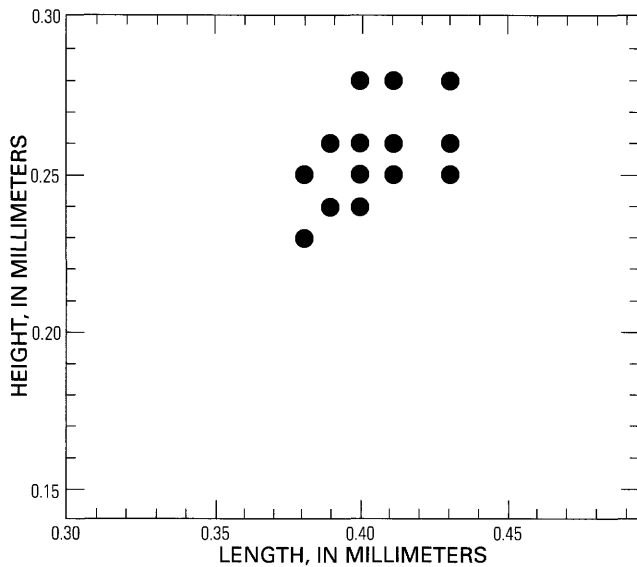


Figure 4. Plot of length versus height for *Eucytherura ishizakii*. Dot may represent more than one specimen.

Comparisons.—*Eucytherura ishizakii* n. sp. differs from *E. utsusemi* Yajima, 1982 (lower Pleistocene, central Japan) by having a triangular lateral outline; narrow posterior; wide, less pointed ventral ridge; V-shaped anterior ridge; ovoid pits; and pitting arranged in vertical rows.

Occurrence.—Assemblages II, III, IV. Table 2; figure 5.

Distribution.—Pleistocene through Holocene: Cook Inlet, Kodiak Shelf, Gulf of Alaska. Middle-outer sublittoral, upper bathyal.

Material.—One hundred twenty-eight adult valves, forty-three juvenile valves.

Type specimens.—Holotype: USNM 408431, female left valve (pl. 1, fig. 8), locality EGAL-75-KC-284, length 0.40 mm, height 0.28 mm.

Paratypes: USNM 408432, male left valve (pl. 3, fig. 1), locality EGAL-75-KC-284, length 0.41 mm, height 0.26

mm. USNM 408433, right valve (pl. 4, figs. 6, 8, 9), locality EGAL-75-KC-268, length 0.39 mm, height 0.26 mm. USNM 408434, left valve (pl. 4, fig. 7), locality EGAL-75-KC-268, length 0.40 mm, height 0.28 mm. USNM 408435, right valve (pl. 4, figs. 10, 12), locality EGAL-75-KC-268, length 0.40 mm, height 0.24 mm. USNM 408436, left valve (pl. 4, fig. 11), locality EGAL-75-KC-268, length 0.40 mm, height 0.25 mm. USNM 408437, right valve (pl. 4, fig. 13), locality EGAL-75-KC-268, length 0.41 mm, height 0.25 mm.

Genus *HEMICYTHERURA* Elofson, 1941

Type species.—*Cythere cellulosa* Norman, 1865 (Type by subsequent designation)

***HEMICYTHERURA DAGELETENSIS* new species**

Plate 3, figures 2, 3; plate 5, figures 1–3; figures 6, 7

Hemicytherura sp. A Brouwers, 1981, p. 10; Brouwers, 1982a, p. 12; Brouwers, 1982b, p. 9; Brouwers, 1983.

Hemicytherura sp. A Valentine, 1976, p. 22, pl. 6, figs. 5, 6.

Etymology.—After Mount Dagelet, the source of LaPerouse Glacier, central Fairweather Range.

Diagnosis.—Characterized by elongate-ovoid to subtriangular lateral outline; broadly convex ventral margin; T-shaped median ridge; strong, arcuate, overhanging ventral ridge; pits arranged in horizontal to arcuate pattern, following T-shaped ridge; secondary fine ridges on primary ridge and caudal process; coincident inner margin and line of concrescence; long, sinuous, simple radial pore canals.

Description.—Adult valves elongate-ovoid to subtriangular in lateral view. Left valve with broadly arched dorsal margin; anterior margin evenly curved, with greatest width ventral of midline; ventral margin broadly convex; posterior margin with distinct, broad, centrally located caudal process. Right valve with highly arched dorsal margin; concave

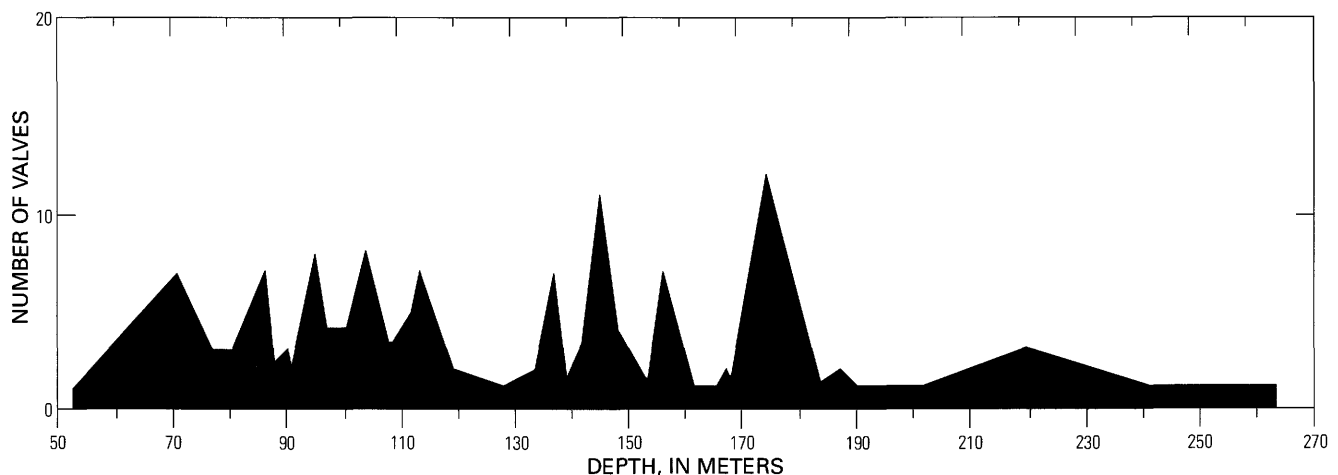


Figure 5. Plot of abundance versus water depth for *Eucytherura ishizakii*.

anterodorsal margin; attenuated anteroventral margin; sinuous ventral margin; posterior margin with small, sharp, distinct caudal process, located ventral of midline. Four long, sharp anteroventral marginal denticles. Left valve differs in having low, short valve dimensions; considerably less arched dorsum; centrally located, broad caudal process; and convex anterodorsal margin. Greatest length through caudal process; greatest height midvalve in right valve and through anterior hinge element in left valve.

Valve surface covered with reticulation and ridges. Ornament dominated by T-shaped ridge extending across valve midline; short vertical part of T-shape proceeds from midvalve to midventer. Strong, arcuate ventral ridge overhangs margin. Thin, weak marginal ridge runs from caudal process along dorsum, terminating anteriorly at T-shaped ridge. Reticulation pits are large, ovoid to elongate-ovoid; arranged in horizontal to arcuate pattern, paralleling horizontal part of T-ridge. Marginal pits very small. Secondary fine ridges on caudal process and primary ridges. Thirty-seven to thirty-nine simple-type normal pores evenly scattered over surface, on reticulation ridges. Normal pores with marginal rim.

Inner margin and line of concrescence coincide throughout; inner margin parallels valve outline. Inner lamella wide throughout, particularly along anterior. Strong, well-developed selvage. Twenty to twenty-four radial pore canals, three false radial pore canals, most anterior. Radial pores long, sinuous, simple. Radial pores enter anteroventral marginal denticles. Anterior radial pores cluster into groups of two to four.

Measurements.—X-Y plot based on 26 specimens (fig. 6).

Comparisons.—*Hemicytherura dageletensis* n. sp. differs from *H. santosensis* Swain and Gilby, 1974 (Holocene, Baja California) by having a higher, shorter valve outline; arched dorsum; T-shaped median ridge; and sharp caudal process. *H. dageletensis* differs from *H. cuneata* Hanai, 1957 (Holocene, Inland Sea, central Japan) by having an arched dorsum; T-shaped median ridge; short caudal process; and no secondary ornament. *H. dageletensis* differs from *H. clathrata* (Sars) (Quaternary, North Atlantic, European Arctic) by having a long, low lateral outline; T-shaped median ridge; less extended caudal process; no secondary ornament; and small reticulation pits.

Occurrence.—Assemblages II, III, V. Table 2; figure 7.

Distribution.—Pleistocene through Holocene: Gulf of Alaska, Cook Inlet and Kodiak Shelf, Pribilof Islands, central-northern California, Washington, and Oregon (Channel Islands to Puget Sound). Middle-outer sublittoral; warm to cold temperate.

Material.—One hundred seventy-nine adult valves, thirty-one juvenile valves.

Type specimens.—Holotype: USNM 408438, left valve (pl. 3, fig. 2), locality DC2-80-EG-195, length 0.40 mm, height 0.24 mm.

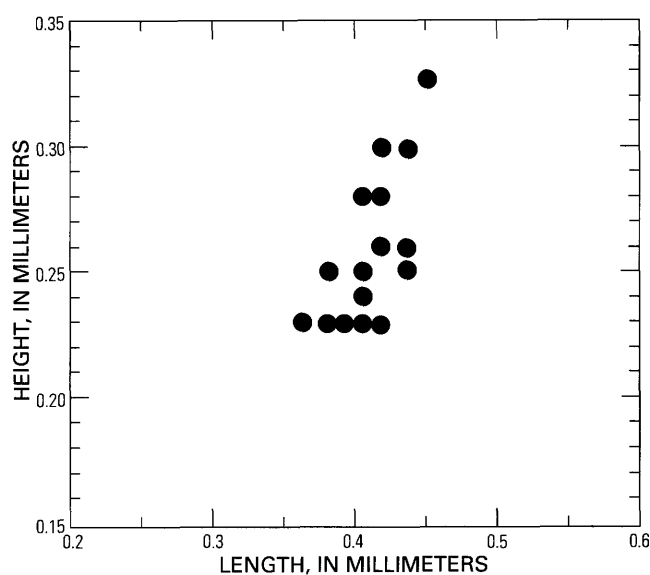


Figure 6. Plot of length versus height for *Hemicytherura dageletensis*. Dot may represent more than one specimen.

Paratypes: USNM 408439, right valve (pl. 3, fig. 3), locality DC2-80-EG-195, length 0.41 mm, height 0.26 mm. USNM 408440, left valve (pl. 5, figs. 1, 3), locality DC2-80-EG-195, length 0.41 mm, height 0.23 mm. USNM 408441, right valve (pl. 5, fig. 2), locality DC2-80-EG-195, length 0.43 mm, height 0.30 mm.

HEMICYTHERURA LEMESURIENSIS new species

Plate 3, figure 4; plate 5, figures 4–6; figure 8

Hemicytherura sp. J Valentine, 1976, p. 22, pl. 6, fig. 11.

Hemicytherura sp. C Brouwers, 1981, p. 10; Brouwers, 1982a, p. 12; Brouwers, 1982b, p. 9; Brouwers, 1983.

Etymology.—After Lemesurier Island in Icy Strait, southeast Alaska.

Diagnosis.—Characterized by straight anterodorsal margin; broadly concave venter; three longitudinal ridges; thin, overhanging ventral ridge; thin, semicircular dorsal ridge; large reticulation pits arranged horizontally at anterior and concentrically at posterior; fine marginal pits and ridges; and very wide anterior inner lamella.

Description.—Adult valves subtriangular in lateral outline. Dorsal margin arched; anterodorsal margin straight, inclined sharply toward anteroventer; anteroventral margin extended; greatest anterior margin width at anteroventer; ventral margin broadly concave; posterior margin with small, sharp, distinct caudal process located near midline. Four sharp anteroventral marginal denticles. Greatest length through midline of valve; greatest height through median hinge element.

Valve surface with reticulation and ridges. Three primary longitudinal ridges traverse valve; ridges originate together in posteromedian region and radiate toward anterior.

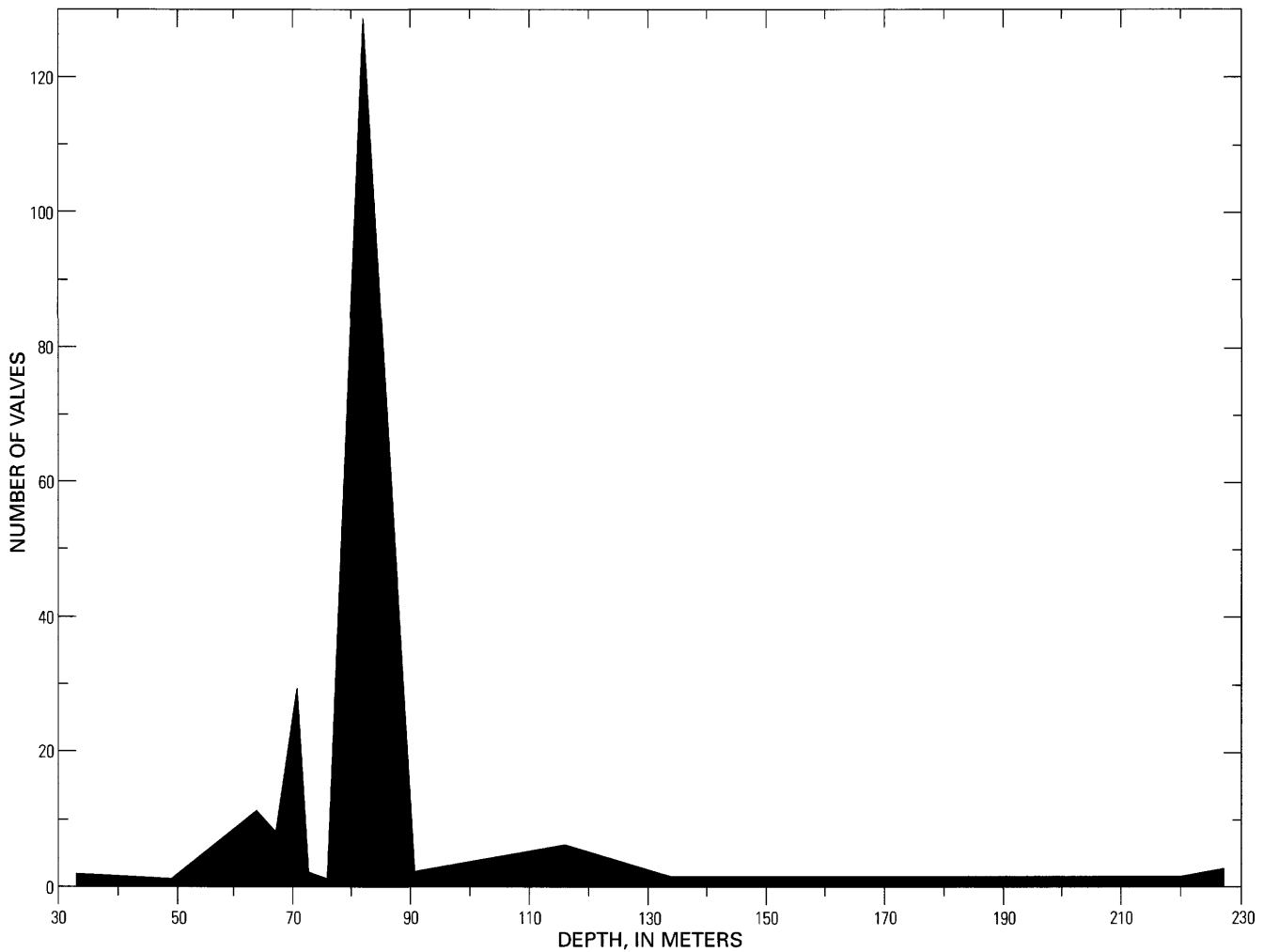


Figure 7. Plot of abundance versus water depth for *Hemicytherura dageletensis*.

Sinuuous dorsal ridge proceeds to anterodorsal corner. Median ridge proceeds to anterior margin. Ventral ridge proceeds obliquely to anteroventral corner. Thin ventral ridge proceeds obliquely to anteroventral corner. Thin, semicircular dorsal marginal ridge. Large, subovoid reticulation pits occur between ridges. Pits arranged horizontally at anterior and concentrically at posterior. Very small secondary pitting and fine ridges at margins. Twenty-one to twenty-seven normal pores evenly distributed over surface, on reticulation ridges.

Inner margin and line of concrescence coincide throughout; inner margin parallels valve outline. Inner lamella very wide at anterior, moderately wide at posterior. Well-developed selvage. Eleven radial pore canals, most anterior. Radial pores are long, sinuous, simple, and tend to cluster into groups of two to four. Radial pores enter anteroventral denticles.

Hingement in left valve consists of anterior quadrate socket; five small, quadrate anteromedian teeth; smooth median bar; seven small, quadrate posteromedian teeth; and elongate, rectangular posterior socket.

Four adductor muscle scars form vertical row. Dorsal scar is elongate-ellipsoidal; dorsomedian scar is elongate, subquadrate; ventromedian scar is elongate, with inflated anterior; ventral scar is semicircular. Few, large, ovoid dorsal muscle scars.

Measurements.—X-Y plot based on 11 specimens (fig. 8).

Comparisons.—*Hemicytherura lemesuriensis* n. sp. differs from *H. kajiyamai* Hanai, 1957 (Holocene, central Japan) by having a low, long valve outline; less arched dorsum; weak reticulation ridges; and numerous, small reticulation pits. *H. lemesuriensis* differs from *H. cuneata* Hanai, 1957 (Holocene, central Japan) by having a long, low lateral outline; less arched dorsum; straight anterodorsal margin; weak, short caudal process; and different arrangement of pits. *H. lemesuriensis* is distinguished from *H. santosensis* Swain and Gilby, 1974 (Holocene, Baja California) by having a less arched dorsum; small caudal process; straight anterodorsal margin; narrow reticulation ridges; numerous reticulation pits; and secondary marginal ornamentation.

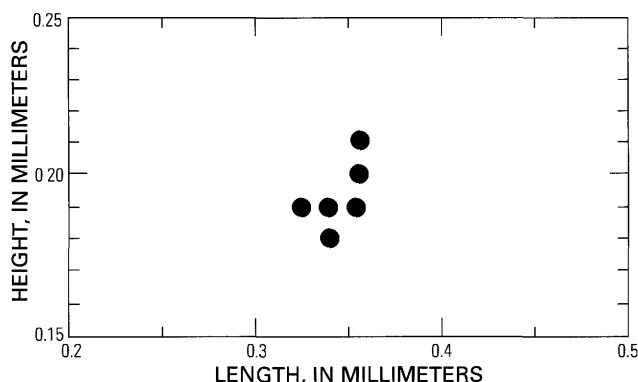


Figure 8. Plot of length versus height for *Hemicytherura lemesuriensis*. Dot may represent more than one specimen.

Occurrence.—Cruise EGAL-75-KC, localities 11, 159, 429. Cruise DC1-79-EG, locality 46. Cruise DC2-80-EG, locality 195. Assemblages II, V.

Distribution.—Upper Pliocene through Holocene: Gulf of Alaska, Baja California, California, Washington, and Oregon (northern Baja California to Puget Sound). Middle sublittoral; warm to cold temperate.

Material.—Twenty-five adult valves, three juvenile valves.

Type specimens.—Holotype: USNM 408442, left valve (pl. 3, fig. 4), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm.

Paratypes: USNM 408443, female right valve (pl. 5, fig. 4), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm. USNM 408444, female left valve (pl. 5, figs. 5, 6), locality DC2-80-EG-195, length 0.35 mm, height 0.19 mm.

HEMICYTHERURA SITAKADAYENSIS new species

Plate 3, figures 5, 6; plate 5, figures 7–14; figure 9

Hemicytherura sp. B Brouwers, 1981, p. 10; Brouwers, 1982a, p. 12; Brouwers, 1982b, p. 9; Brouwers, 1983.

Etymology.—After Sitakaday Narrows, located at the southern Beardslee Entrance to Glacier Bay, southeast Alaska.

Diagnosis.—Characterized by elongate subtriangular lateral outline; broadly convex ventral margin; sharply inclined posteroventral margin; subtle dimorphism; coarse reticulation-ridge system with sinuous longitudinal median ridge and evenly spaced ridges radiating to dorsum and venter; crescentic, overhanging ventral and dorsal ridges; fine connecting ridges forming large, rounded, irregular fossae; secondary fine-scale reticulation.

Description.—Adult valves elongate, subtriangular in lateral view. Left valve with broadly arched dorsal margin; anterior margin smoothly curved with greatest width ventral of midline; ventral margin broadly convex, with sharply inclined posteroventral corner; posterior margin with large,

broad caudal process dorsal of midline. Right valve with moderately arched dorsal margin; straight, inclined antero-dorsal margin; drawn-out anteroventral margin; greatest anterior margin width near anteroventral corner; ventral margin broadly concave; posterior margin with small, sharp, caudal process ventral of midline. Five sharp anteroventral marginal denticles. Left valve differs in less arched dorsum; large caudal process; and lower, longer valve outline. Subtle dimorphism: males differ in a lower, longer lateral outline; pronounced caudal process; less arched dorsum; and less concave anterodorsal margin. Greatest length through caudal process; greatest height through midline of valve.

Valve surface with coarse reticulation-ridge system. Primary, sinuous median ridge proceeds obliquely across valve from anterior margin to posterodorsal corner. Four ridges originate at median ridge and proceed obliquely to venter. Five ridges radiate from median ridge to dorsum. Two crescentic ridges overhang dorsal and ventral margins. Fine ridges connect large ridges, forming reticulation network with resultant very large, rounded, irregular fossae. Secondary fine-scale reticulation on solum floors. Thirty-one simple-type normal pores evenly distributed over surface, within fossae. Normal pores are celate with apophysis with marginal rim.

Inner margin and line of concrescence coincide throughout; inner margin parallels valve outline. Inner lamella very wide at anterior, moderately wide at posterior. Very strong, well-developed selvage. Nineteen radial pore canals, most anterior. Radial pores are long, sinuous, simple, with inflated median region. Pores occur in clusters of three to four pores. Radial pores enter marginal denticles.

Hingement in left valve consists of elongate, rectangular anterior socket; four quadrate anteromedian teeth; smooth median bar; six quadrate posteromedian teeth; and elongate-ellipsoidal posterior socket. Anteromedian and posteromedian elements formed by terminal enlargement of median element. Dorsal margin of right valve enfolded into accommodation groove to receive dorsal edge of left valve.

Four adductor muscle scars form vertical row. Dorsal scar is semicircular; dorsomedian scar is elongate, with inflated posterior; ventromedian scar is dumbbell-shaped; and ventral scar is oblate-ovoid. Frontal scar is rounded, subtriangular. Numerous large, irregularly shaped dorsal muscle scars.

Measurements.—X–Y plot based on 61 specimens (fig. 9).

Comparisons.—*Hemicytherura sitakadayensis* n. sp. differs from *H. sp. F* of Valentine, 1976 (Holocene, Baja California, southern-central California) by having a small, ventrally located caudal process; weak ventral ridge; concave anterodorsal margin; small, attenuated anteroventral corner; and different dorsal ridge. *H. sitakadayensis* differs from *H. santosensis* Swain and Gilby, 1974 (Holocene, Baja California) by having a low, long valve outline; high, strong reticulation ridges; large, few fossae; attenuated

anteroventral corner; and narrow, extended caudal process. *H. sitakadayensis* is different from *H. cuneata* Hanai, 1957 (Holocene, central Japan) by having an evenly curved dorsum; caudal process along the midline; single, strong, longitudinal median ridge; and few, large fossae. *H. sitakadayensis* differs from *H. clathrata* (Sars) (Quaternary, North Atlantic) by having a low, long valve outline; few, large reticulation pits; weak, less overhanging ventral ridge; and dorsal and ventral ridges radiating from median ridge.

Occurrence.—Assemblages II, V. Table 2.

Distribution.—Pleistocene through Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf. Middle sublittoral.

Material.—One hundred twenty-eight adult valves, twelve juvenile valves.

Type specimens.—Holotype: USNM 408445, left valve (pl. 3, fig. 5), locality DC2-80-EG-195, length 0.46 mm, height 0.23 mm.

Paratypes: USNM 408446, right valve (pl. 3, fig. 6), locality DC2-80-EG-195, length 0.47 mm, height 0.27 mm. USNM 408447, female left valve (pl. 5, fig. 7), locality DC2-80-EG-195, length 0.50 mm, height 0.26 mm. USNM 408448, female right valve (pl. 5, fig. 8), locality DC2-80-EG-195, length 0.46 mm, height 0.26 mm. USNM 408449, male left valve (pl. 5, figs. 9, 10), locality DC2-80-EG-195, length 0.44 mm, height 0.24 mm. USNM 408450, male right valve (pl. 5, fig. 11), locality DC2-80-EG-195, length 0.42 mm, height 0.25 mm. USNM 408451, male left valve (pl. 5, figs. 12, 14), locality DC2-80-EG-195, length 0.43 mm, height 0.22 mm. USNM 408452, female right valve (pl. 5, fig. 13), locality DC2-80-EG-195, length 0.43 mm, height 0.24 mm.

Genus *SEMICYTHERURA* Wagner, 1957

Type species.—*Cythere nigrescens* Baird, 1838 (Type by subsequent designation)

SEMICYTHERURA BALROGI new species

Plate 5, figures 15–18; plate 6, figures 1, 2; plate 7, figures 1–3, 6; figure 10

Semicytherura aff. *S. undata* (Sars, 1865). Brouwers, 1981, p. 12; Brouwers, 1982a, p. 12; Brouwers, 1982b, p. 10; Brouwers, 1983.

Etymology.—After the Balrog, an evil character in J.R.R. Tolkien's adventures of Middle Earth.

Diagnosis.—Characterized by subquadrate lateral outline; oblique posteroventral margin; short, broad caudal process; moderate dimorphism; two sinuous, obliquely arranged primary ridges; weak vertical ridges at anteromedian and posteromedian; fine-scale reticulation defining polygonal fossae; small, elongate to subovoid secondary pits with raised rim; simple-type normal pores with raised marginal rim.

Description.—Adult valves elongate, subquadrate in lateral view. Dorsal margin straight; anterior margin

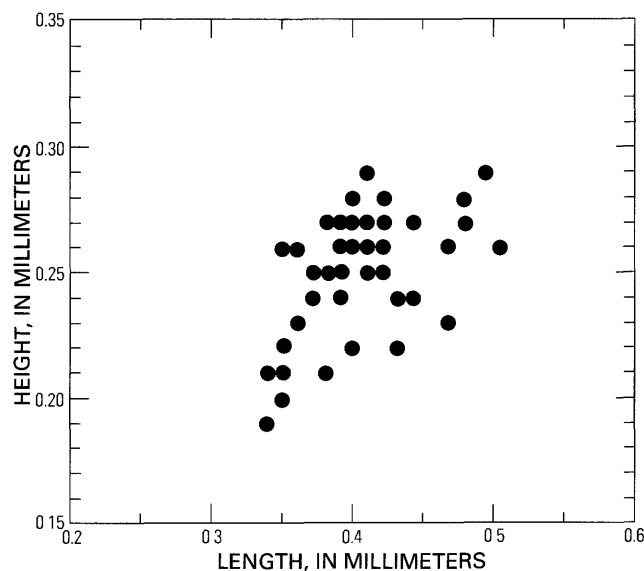


Figure 9. Plot of length versus height for *Hemicytherura sitakadayensis*. Dot may represent more than one specimen.

smoothly curved, with greatest width ventral of midline; ventral margin straight; posterior margin with steeply oblique posteroventral margin and short, broad caudal process dorsal of midline. Four short, blunt anteroventral marginal denticles. Right valve with more arched dorsum; ventrally slung anteroventral corner; and small, acute caudal process. Moderate dimorphism: males are longer, lower. Greatest length through caudal process; greatest height through anterior hinge element.

Valve surface covered with ridges and reticulation. Two sinuous oblique ridges proceed across valve. Dorsal ridge originates at anterior margin, proceeds obliquely toward posterodorsal corner, loops back to form U-shape. Ventral ridge parallel to margin. Weak vertical ridges connect longitudinal ridges at anteromedian and posteromedian. Sinuous, overhanging ventral ridge. Fine reticulation between. Fine polygonal fossae. Numerous small, elongate to subovoid secondary pits on solum floors and primary ridges. Secondary pits distinctive by raised rim which surrounds and highlights each pit. Thirteen to fifteen simple-type normal pores evenly distributed over surface, occurring on solum floors. Normal pores with prominent, raised marginal rim.

Inner lamella and line of concrescence coincide at anterior. Anterior inner lamella very wide. Radial pore canals are very long, sinuous, simple; radial pores tend to occur in clusters.

Measurements.—X–Y plot based on 16 specimens (fig. 10).

Comparisons.—*Semicytherura balrogi* n. sp. differs from *Hemicytherura tricarinata* Hanai, 1957 (Holocene, central Japan) by having a subquadrate lateral outline; broad caudal process; two horizontal ridges; and rimmed

secondary ornament pits. *S. balrogi* differs from *S. undata* (Sars) (Quaternary, North Atlantic) by having a high, short valve outline; straight dorsum; small, distinct caudal process; two horizontal ridges; distinctive secondary ornament; and different arrangement of vertical crossing ridges.

Occurrence.—Cruise EGAL-75-KC, localities 11, 157, 159. Cruise DC2-80-EG, locality 195. Assemblage V.

Distribution.—Pleistocene through Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf, Pribilof Islands.

Material.—Thirty-seven adult valves.

Type specimens.—Holotype: USNM 408453, female left valve (pl. 6, fig. 1), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm.

Paratypes: USNM 408454, female right valve (pl. 6, fig. 2), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm. USNM 408455, left valve (pl. 5, figs. 15, 18), locality DC2-80-EG-195, length 0.32 mm, height 0.16 mm. USNM 408456, left valve (pl. 5, figs. 16, 17), locality DC2-80-EG-195, length 0.32 mm, height 0.21 mm. USNM 408457, right valve (pl. 7, figs. 1–3, 6), locality DC2-80-EG-195, length 0.35 mm, height 0.21 mm.

SEMICYTHERURA HENRYI new species

Plate 6, figures 3, 4; plate 7, figures 4, 5, 7, 8

Semicytherura sp. D Brouwers, 1981, p. 12; Brouwers, 1983.

Etymology.—After Dr. T.W. Henry, U.S. Geological Survey, a specialist in upper Paleozoic mega-invertebrates.

Diagnosis.—Characterized by elongate, trapezoidal lateral outline; broadly concave dorsum; pronounced concavity; sharp caudal process located dorsal of midline; series of subparallel longitudinal ridges which converge at anterior and posterior; and longitudinal reticulation network with small, subovoid fossae.

Description.—Adult valves elongate, trapezoidal in lateral view. Dorsal margin straight; anterior margin smoothly curved, with greatest width ventral of midline; ventral margin with pronounced concavity; posterior margin with straight, sharply inclined ventral portion and small, sharp caudal process in dorsal portion; caudal process dorsal of midline. Left valve with attenuated caudal process; less evenly curved, more ventrally slung anteroventral corner; and posteriorly convergent dorsum. Greatest length through midline of valve; greatest height through anterior hinge element.

Valve surface with ridges and reticulation. Primary ornament is series of subparallel longitudinal ridges, converging at anteromedian and posteromedian. Moderate, sinuous, overhanging ventral marginal ridge. Reticulation network developed between longitudinal ridges, forming small subovoid fossae which are largest at median and smaller marginally. Reticulation arranged in longitudinal pattern, aligned with subparallel ridges. Thirteen to eighteen

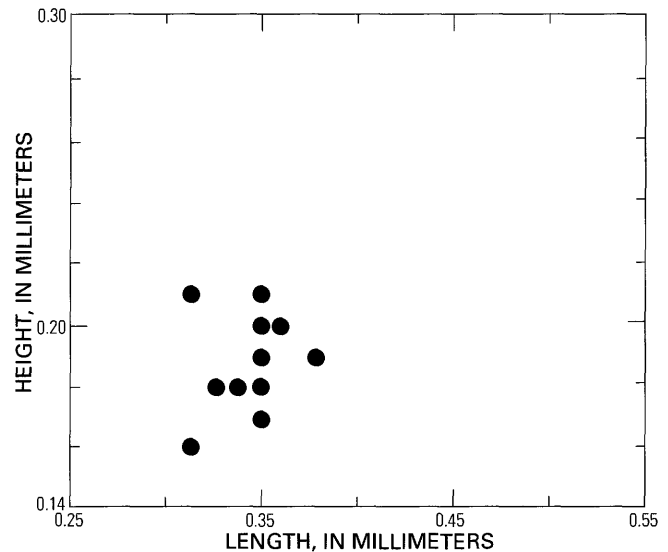


Figure 10. Plot of length versus height for *Semicytherura balrogi*. Dot may represent more than one specimen.

small, simple-type normal pore canals scattered over surface, most within fossae.

Nine to ten radial pore canals, most anterior. Radial pores long, straight, simple. Strong, well-developed selvage.

Comparisons.—*Semicytherura henryi* n. sp. differs from *Cytherura skipa* Hanai, 1957 (Holocene, central Japan) by having a large, high lateral outline; weak ventral ridge; numerous subparallel ridges; and reticulation. *S. henryi* differs from *S. mukaishimensis* Okubo, 1980 (Holocene, Inland Sea of Japan) by having a straight dorsum; evenly curved anterior; concave venter; short, dorsally located caudal process; subparallel longitudinal ridges; and fine reticulation.

Occurrence.—Cruise EGAL-75-KC, localities 4, 18. Cruise DC1-79-EG, locality 45.

Distribution.—Pleistocene, Holocene (?): Gulf of Alaska.

Material.—Nine adult valves.

Type specimens.—Holotype: USNM 408460, left valve (pl. 6, fig. 3), locality EGAL-75-KC-18, length 0.36 mm, height 0.18 mm.

Paratypes: USNM 408461, right valve (pl. 6, fig. 4), locality EGAL-75-KC-18, length 0.38 mm, height 0.18 mm. USNM 408462, left valve (pl. 7, figs. 4, 7), locality EGAL-75-KC-4, length 0.38 mm, height 0.19 mm. USNM 408463, right valve (pl. 7, figs. 5, 8), locality EGAL-75-KC-4, length 0.37 mm, height 0.19 mm.

SEMICYTHERURA MIURENSIS Hanai, 1957

Plate 2, figure 6

Cytherura miurensis Hanai, 1957, p. 18–19, pl. 2, figs. 4a,b; text-figs. 4a,b; Hanai, 1961, p. 358, text-fig. 2, figs. 4a,b; Ishizaki, 1968, p. 19, pl. 5, figs. 15, 16.

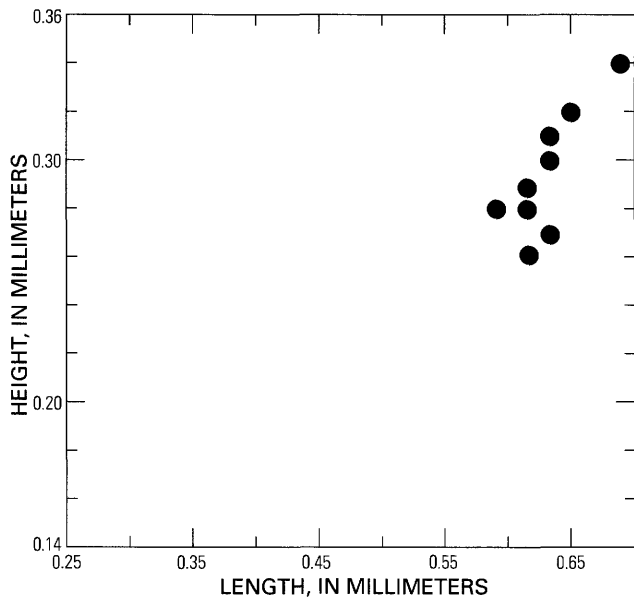


Figure 11. Plot of length versus height for *Semiccytherura skagwayensis*.

Semiccytherura miurensis Hanai. Yajima, 1988, pl. 1, fig. 11.

Cytherura sp. F Brouwers, 1981 (partim), p. 10; Brouwers, 1982b (partim), p. 8; Brouwers, 1983 (partim).

Diagnosis.—Characterized by subovoid-elongate lateral outline; broadly arched dorsum; concave venter; pronounced caudal process; fine reticulation network, with low ridges bordered by rows of small pits; solum floors smooth; weak, angular, ventral ridge.

Occurrence.—Cruise EGAL-75-KC, localities 144U, 181.

Distribution.—Early middle Miocene, Holocene: central Japan. Pleistocene, Holocene (?): Gulf of Alaska, Cook Inlet, Kodiak Shelf.

Comparisons.—*Semiccytherura miurensis* differs from *S. sp. 1* Whatley and others, 1988 (Holocene, southwest Atlantic) by having a more dorsally placed caudal process, weaker horizontal ridges, anterior denticles, and posteroventral flange; *S. miurensis* differs from *S. affinis* (Sars) Neale and Howe, 1975 (Holocene, Novaya Zemlya) by having finely punctate ornamentation.

Material.—Six adult valves, one juvenile valve.

Illustrated specimens.—USNM 408417, left valve (pl. 2, fig. 6), locality EGAL-75-KC-422, length 0.68 mm, height 0.34 mm.

SEMICCYTHERURA SKAGWAYENSIS new species

Plate 6, figure 5; plate 7, figures 9–16; figure 11

Semiccytherura sp. F Brouwers, 1981, p. 12; Brouwers, 1982a, p. 12; Brouwers, 1982b, p. 10; Brouwers, 1983.

Etymology.—After Skagway, northern Chilkoot Inlet, southeast Alaska.

Diagnosis.—Characterized by elongate-ellipsoidal lateral outline; broadly arched dorsum; wide, shallow concavity; narrow, pronounced caudal process; subtle dimorphism; weak reticulation, stronger marginally; small pits adjacent to reticulation ridges; marginal pits; low, arcuate, overhanging ventral ridge; and five low, radiating ridges at anteroventral region.

Description.—Adult valves elongate-ellipsoidal in lateral view. Dorsal margin straight; anterior margin smoothly curved; ventral margin broadly concave, with wide, shallow concavity; posterior margin with narrow, extended, pronounced caudal process. No cardinal angles; valve outline is rounded. Left valve with more arched dorsum; ventrally drooping anteroventral corner; and extended caudal process. Subtle dimorphism: males are slightly longer, lower. Greatest length through caudal process; greatest height through anterior hinge element.

Valve surface covered with weak reticulation, most developed at the margins. Ridges accentuated by series of small pits adjacent to ridges. Pitting covers entire solum floors at valve margins. Low, arcuate ridge occurs along and overhangs venter. Series of five low ridges radiate from anterior end of ventral ridge to anteroventral region. Thirty simple-type normal pores evenly distributed over valve surface, occurring within fossae. Normal pores with marginal rim.

Inner lamella and line of concrescence coincide throughout. Inner lamella very wide at anterior. Posterior inner margin forms broad, tongue-like extension into valve interior. Strong, well-developed selvage. Thirteen radial pores, two false radial pores, most anterior. Radial pore canals are long, slightly sinuous, and simple. Radial pores clustered in groups of two to four.

Hingement in right valve consists of bifid anterior tooth; smooth, large median groove; and trifid posterior tooth. Dorsal margin of right valve enfolded to form accommodation groove to accept dorsal edge of left valve.

Measurements.—X–Y plot based on nine specimens (fig. 11).

Comparisons.—*Semiccytherura skagwayensis* n. sp. differs from *S. kishinouyei* (Kajiyama, 1913) (Quaternary, central Japan) by having a weak ventral ridge; less convergent posterodorsal margin; few, small pits; and narrow, long caudal process. *S. skagwayensis* differs from *S. miurensis* (Hanai, 1957) (Quaternary, central Japan) by having a weak posteroventral ridge; long, straight dorsum; strong concavity; and weak reticulation. *S. skagwayensis* differs from *S. affinis* (Sars) (Quaternary, North Atlantic) by having a straight, less arched dorsum; strong concavity; weak reticulation; and few pits. *S. skagwayensis* differs from *Cytherura johnsonoides* Swain and Gilby, 1974 (Holocene, Baja California) by having a long, narrow caudal process; strong concavity; median sulcus; and weak

reticulation. *S. skagwayensis* differs from all of the above species by having a long, low lateral outline.

Occurrence.—Cruise EGAL-75-KC, localities 20, 159. Cruise DC2-80-EG, locality 195. Assemblage V.

Distribution.—Pleistocene (?), Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf, Pribilof Islands.

Material.—Twenty-five adult valves, nine juvenile valves.

Type specimens.—Holotype: USNM 408464, left valve (pl. 6, fig. 5), locality DC2-80-EG-195, length 0.65 mm, height 0.32 mm.

Paratypes: USNM 408465, left valve (pl. 7, figs. 9, 16), locality DC2-80-EG-195, length 0.69 mm, height 0.34 mm. USNM 408466, left valve (pl. 7, fig. 10), locality DC2-80-EG-195, length 0.62 mm, height 0.29 mm. USNM 408467, right valve (pl. 7, figs. 11, 12), locality DC2-80-EG-195, length 0.63 mm, height 0.30 mm. USNM 408468, right valve (pl. 7, figs. 13, 14, 15), locality DC2-80-EG-195, length 0.62 mm, height 0.26 mm.

SEMICYTHERURA TAURONAE new species

Plate 1, figure 4; plate 2, figures 5, 7–8

Cytherura sp. F Brouwers, 1981, p. 10 (partim); Brouwers, 1982b, p. 8 (partim); Brouwers, 1983 (partim).

Semicytherura sp. A Ishizaki and Matoba, 1985, p. 9, pl. 7, figs. 8, 9.

Etymology.—After Tauron, a character in J.R.R. Tolkien's adventures of Middle Earth.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; pronounced, narrow caudal process; small ovoid pitting which becomes finer marginally; narrow, angular, overhanging ventral ridge, ending at posterior as a flat flange and at anterior as fine radiating ridges; dorsal region with thickened smooth region; vertical median sulcus; and coincident inner margin and line of concrescence.

Description.—Adult valves subtriangular in lateral view. Dorsal margin highly arched; anterior margin smoothly curved, with greatest extent ventral of midline; ventral margin with subtle concavity; posterior margin with pronounced, narrow caudal process. Greatest length through caudal process; greatest height through median hinge element.

Valve surface with small ovoid pitting. Pits small in median valve region, becoming much finer marginally. Narrow, angular ridge overhangs venter, ending at posterior as flattened flange and at anterior as series of fine radiating ridges. Dorsal margin with thickened, smooth region. Vertical median sulcus. Smooth caudal process. Forty-six simple-type normal pores evenly distributed over valve.

Inner margin and line of concrescence coincide throughout. Inner lamella widest at anterior. Inner margin parallels valve outline. Eleven radial pore canals, most

anterior. Radial pore canals are long and straight; several radial pores bifurcate, most are simple. Weakly developed selvage.

Hingement in left valve consists of series of fine terminal crenulae forming elongate socket at anterior and posterior and smooth median bar.

Remarks.—*Semicytherura tauronae* n. sp. is similar to *Semicytherura* sp. A of Ishizaki and Matoba (1985) in pitted ornament, ventral ridges, and valve shape; *S. tauronae* differs from *S. sp. A* by having a more arched dorsum and slight differences in the radiating ventral ridges. These two taxa belong to the same species group, however, and I am synonymizing the two species.

Comparisons.—*Semicytherura tauronae* differs from *S. miurensis* by its lack of reticulation, larger ornament pits, less quadrate shape, and arched dorsum.

Occurrence.—Cruise EGAL-75-KC, localities 52A, 144U, 422.

Distribution.—Pleistocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf, central Japan.

Material.—Eight adult valves.

Type specimens.—Holotype: USNM 408419, female right valve (pl. 1, fig. 4), locality EGAL-75-KC-144U, length 0.58 mm, height 0.33 mm.

Paratypes: USNM 408420, left valve (pl. 2, fig. 5), locality EGAL-75-KC-144U, length 0.55 mm, height 0.30 mm. USNM 408421, right valve (pl. 2, figs. 7, 8), locality EGAL-75-KC-144U, length 0.54 mm, height 0.30 mm.

SEMICYTHERURA sp. E

Plate 3, figures 7, 8

Cytherura sp. E Brouwers, 1981, p. 10; Brouwers, 1983.

Diagnosis.—Characterized by squat, ovoid lateral outline; broadly arched dorsum; short, broad caudal process; ovoid pitted ornament; U-shaped indentation along posteroventral inner lamella; V-shaped indentation at posterodorsal inner lamella; strong selvage; radial pores clustering at anteroventral and posteroventral corners; and radial pores often as pairs.

Occurrence.—Cruise EGAL-75-KC, locality 11. Assemblage V.

Distribution.—Pleistocene: Gulf of Alaska.

Material.—Two adult valves.

Illustrated specimens.—USNM 408458, left valve (pl. 3, fig. 7), locality EGAL-75-KC-11, length 0.35 mm, height 0.19 mm. USNM 408459, right valve (pl. 3, fig. 8), locality EGAL-75-KC-11, length 0.35 mm, height 0.20 mm.

SEMICYTHERURA sp. F

Plate 6, figures 7, 8; plate 7, figures 17, 18

Semicytherura sp. E Brouwers, 1981, p. 12; Brouwers, 1983.

Diagnosis.—Characterized by rounded, rectangular lateral outline; broad, deep concavity; weak, low marginal

reticulation; wide anterior inner lamella; wedge-shaped posterior inner lamella; indentation of inner lamella at postero-dorsal and posteroventral corners; strong selvage; and long, sinuous radial pores in clusters of two to four.

Description.—Adult valves rounded, subcylindrical in lateral view. Dorsal margin broadly convex; anterior margin smoothly curved, with greatest width ventral of midline; ventral margin with broad, deep concavity; posterior margin with small, sharp caudal process. Greatest length through caudal process; greatest height through posterior hinge element.

Valve surface predominantly smooth. Weak, low reticulation network developed marginally. Subtle, low, arcuate ventral ridge overhangs concavity. Twenty to twenty-four simple-type normal pores scattered over surface. Normal pores with prominent marginal rim.

Inner margin and line of concrescence coincide throughout. Inner lamella very wide along anterior, parallels valve outline. Ventral inner lamella narrower, with concave inner margin. Posterior inner lamella with large, broad, wedge-shaped projection into valve interior. Posterodorsal and posteroventral corners of inner lamella with conspicuous indentation towards valve exterior. Strong, well-developed selvage. Nineteen to twenty-six radial pore canals, 6 to 13 false radial pore canals, most anterior. Radial pores very long, slightly sinuous, simple; radial pores in clusters of two to four, forming a distinct, small indentation of inner margin. Long posterior radial pores traverse length of wedge projection. Posterior radial pores originate at and near posterodorsal and posteroventral indentations.

Four adductor muscle scars form vertical row. Scars are large, ovoid in shape.

Comparisons.—*Semicytherura* sp. F differs from *S. hiberna* Okubo, 1980 (Holocene, Inland Sea of Japan) by having a straight dorsum; strong concavity; strong caudal process; small posterior extension of inner lamella; and few radial pore canals. *S.* sp. F differs from *Semicytherura* sp. B of Ishizaki and Matoba (1985) (lower Pleistocene, central Japan) by having a strong caudal process; strong concavity; less arched dorsum; and less median reticulation.

Occurrence.—Cruise EGAL-75-KC, locality 11.

Distribution.—Pleistocene: Gulf of Alaska.

Illustrated specimens.—USNM 408470, left valve (pl. 6, fig. 7), locality EGAL-75-KC-11, length 0.51 mm, height 0.27 mm. USNM 408471, right valve (pl. 6, fig. 8), locality EGAL-75-KC-11, length 0.51 mm, height 0.26 mm. USNM 408472, right valve (pl. 7, figs. 17, 18), locality EGAL-75-KC-11, length 0.53 mm, height 0.28 mm.

Subfamily CYTHEROPTERINAE Hanai, 1957

Genus CYTHEROPTERON Sars, 1866

Type species.—*Cythere latissima* Norman, 1865 (Type by subsequent designation)

CYTHEROPTERON BROKENOARENSIS new species

Plate 9, figure 2; plate 8, figures 7–11; figures 12, 13

Cytheropteron sp. G Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Broken Oar Cove, located in the southeastern part of Yakutat Bay, southeast Alaska.

Diagnosis.—Characterized by subtriangular lateral outline; moderately arched dorsum; broadly rounded anterior; convex venter; small, broad caudal process; ovoid pitting arranged in vertical rows, separated by low ridges; pitting smaller marginally; dorsal marginal sulcus; secondary reticulation between ridges and on caudal process.

Description.—Adult valves subtriangular in lateral view. Dorsal margin moderately arched; anterior margin broadly rounded, with greatest width ventral of midline; ventral margin with slight concavity; posterior margin with small, broad caudal process. Caudal process with maximum extent dorsal of midline. Left valve with less arched dorsal margin, more pronounced caudal process. Greatest length through midline; greatest height through median hinge.

Valve covered with ovoid pitting of various sizes arranged in vertical rows separated by low ridges. Ridge development strongest at posterior. Rows of pits arranged parallel to anterior margin. Pits largest near middle of valve, smaller toward margins. Dorsal marginal sulcus, especially developed in right valve. Secondary fine reticulation between ridges at posterior and on caudal process. Low, subdued ridge overhangs venter. Fifty-nine simple-type normal pores scattered over surface, occurring within pits.

Inner margin and line of concrescence coincide throughout; moderately developed selvage. Inner lamella of even width, follows valve outline. Eleven straight, simple radial pore canals.

Hingement in left valve consists of rectangular, elongate anterior sockets; smooth median bar which thickens and enlarges into anteromedian and posteromedian set of quadrate teeth; and rectangular, elongate posterior sockets. Median bar formed by dorsal edge of valve. Right valve with dorsal edge enfolded to form accommodation groove.

Four adductor muscle scars in vertical row. Frontal scar split into peanut-shaped posterior scar and smaller, round anterior scar. Small ovoid fulcral point posterodorsal of frontal scars.

Measurements.—X–Y plot based on 59 specimens (fig. 12).

Comparisons.—*Cytheropteron brokenoarensis* n. sp. differs from *C. dimlingtonensis* Neale and Howe, 1973 (Quaternary, North Atlantic) by its high, short valve outline; small caudal process; strong, rounded ventral ridge; and pits arranged in vertical rows. *C. brokenoarensis* differs from *C. latissimum* of Neale and Howe (1974) (Holocene, Novaya Zemlya) by its short valve outline; highly arched dorsum; weak caudal process; pronounced ventral ala; and large, numerous pits. *C. brokenoarensis* differs from *C. champlai-num* Cronin, 1981 (Quaternary, North Atlantic) by its short,

high valve outline; rounded ventral ridge; large, ovoid pits; and lack of large anterior marginal rim.

Occurrence.—Assemblages II, III, IV, V. Table 2; figure 13.

Distribution.—Pleistocene through Holocene: Cook Inlet, Kodiak Shelf, Gulf of Alaska. Middle-outer sublittoral, upper bathyal.

Material.—One hundred nine adult valves, forty juvenile valves.

Type specimens.—Holotype: USNM 408477, left valve (pl. 9, fig. 2), locality EGAL-75-KC-52A, length 0.52 mm, height 0.32 mm.

Paratypes: USNM 408478, left valve (pl. 8, figs. 7, 9), locality EGAL-75-KC-52A, length 0.53 mm, height 0.33 mm. USNM 408479, right valve (pl. 8, fig. 8), locality EGAL-75-KC-52A, length 0.51 mm, height 0.34 mm. USNM 408480, left valve (pl. 8, figs. 10, 11), locality EGAL-75-KC-52A, length 0.54 mm, height 0.33 mm.

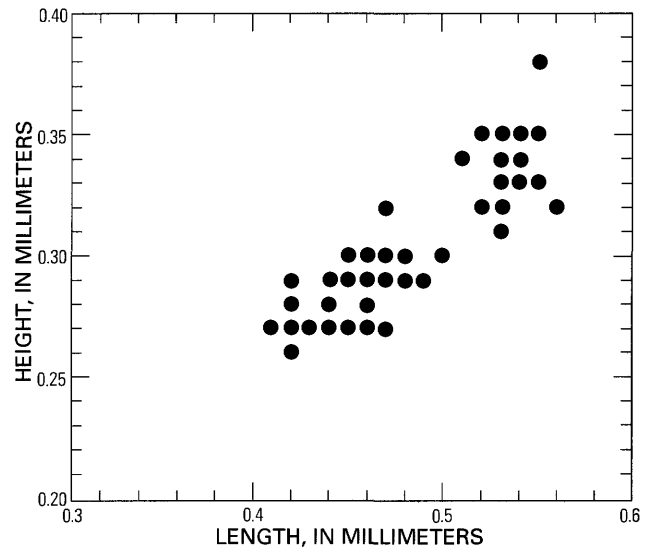


Figure 12. Plot of length versus height for *Cytheropteron brokenoarensis*. Dot may represent more than one specimen.

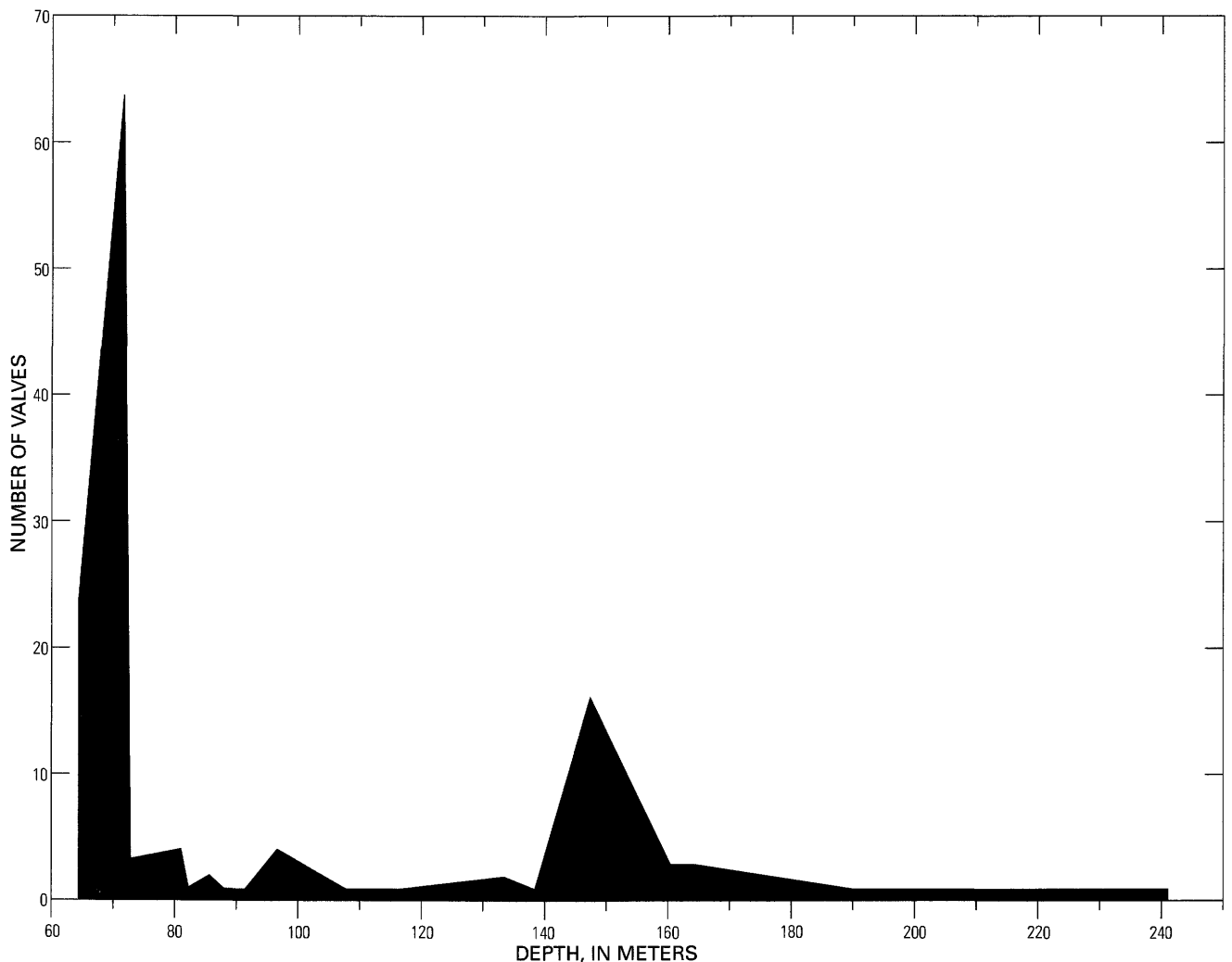


Figure 13. Plot of abundance versus water depth for *Cytheropteron brokenoarensis*.

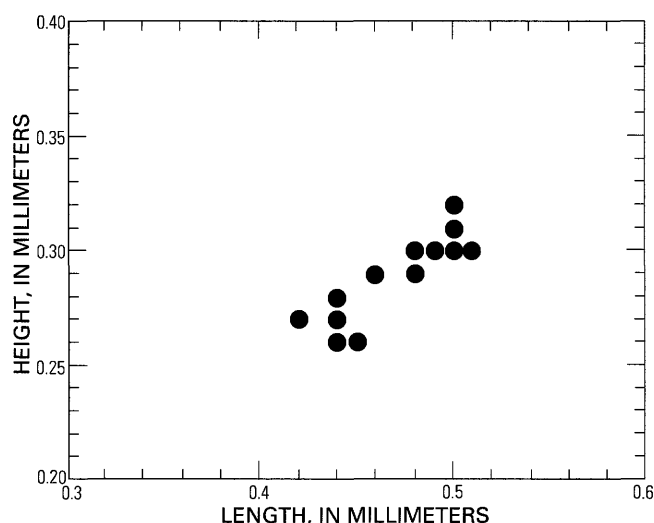


Figure 14. Plot of length versus height for *Cytheropteron carolae*. Dot may represent more than one specimen.

CYTHEROPTERON CAROLAE new species

Plate 9, figures 3, 4; plate 8, figures 12–14; figure 14

Cytheropteron sp. H Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11, Brouwers, 1982b, p. 8; Brouwers, 1983.

Cytheropteron sp. Ishizaki and Matoba, 1985, p. 9, pl. 3, figs. 9, 10.

Cytheropteron sp. 3 Tabuki, 1986, p. 102, pl. 17, figs. 11, 12.

Etymology.—After Carol Barnhard, a personal friend of the author.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; concave anterodorsal corner; sinuous venter with deep concavity; sharp caudal process located near posteroventral corner; subtle dimorphism; numerous, small, ovoid pits arranged in concentric pattern; and high ala forming large, flattened ventral surface.

Description.—Adult valves subtriangular in lateral view. Dorsal margin highly arched; anterodorsal corner concave; anterior margin smoothly curved, with greatest width ventral of midline; ventral margin sinuous, with pronounced, deep concavity; posterior margin with sharp, narrow caudal process located near posteroventral corner. Subtle dimorphism: males are slightly shorter, lower. Greatest length through caudal process; greatest height through median hinge element.

Valve surface covered with many small, ovoid pits arranged in concentric pattern. Pits become smaller marginally. Dorsal margin with subparallel ridge and sulcus. Venter with high ala, forming large flattened ventral surface. Leading edge of ala is heavily calcified, smooth. Thirty-four simple-type normal pores scattered over surface, occurring on ridges between pits. Normal pores with low marginal rim.

Inner margin and line of concrescence coincide throughout; inner margin follows valve outline. Inner

lamella wide, of even width throughout. At least seven radial pore canals, most anterior. Radial pore canals are short, straight, simple. Strong, well-developed selvage.

Hingement in right valve consists of small anterior tooth; seven small anteromedian sockets; smooth median groove; seven small posteromedian sockets; and elongate posterior tooth. Anteromedian and posteromedian elements formed by terminal enlargement of median element. Hinge is weak, not heavily calcified.

Measurements.—X–Y plot based on 18 specimens (fig. 14).

Occurrence.—Assemblages II, III, IV, V. Table 2.

Distribution.—Pliocene and Pleistocene: central Japan. Pleistocene through Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf, Pribilof Islands. Middle-outer sublittoral, upper bathyal.

Material.—Twenty-three adult valves, thirty-five juvenile valves.

Type specimens.—Holotype: USNM 408481, female right valve (pl. 9, fig. 3), locality EGAL-75-KC-68A, length 0.53 mm, height 0.35 mm.

Paratypes: USNM 408482, male right valve (pl. 9, fig. 4), locality EGAL-75-KC-68A, length 0.50 mm, height 0.33 mm. USNM 408483, right valve (pl. 8, figs. 12, 13), locality EGAL-75-KC-52A, length 0.45 mm, height 0.28 mm. USNM 408484, right valve (pl. 8, fig. 14), locality EGAL-75-KC-141, length 0.50 mm, height 0.28 mm.

CYTHEROPTERON CHAMPLAINUM Cronin, 1981

Plate 14, figure 8; plate 16, figure 18; plate 17, figures 1–6; figure 15

Cytheropteron champlainum Cronin, 1981, p. 404, pl. 8, figs. 7, 8; Cronin, 1988, p. 136, pl. 4, fig. 7.

Cytheropteron paralatissimum Swain. Neale and Howe, 1975, p. 429, pl. 6, figs. 7, 9; pl. 7, fig. 6.

Cytheropteron sp. W Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1983.

Diagnosis.—Characterized by subtriangular lateral outline; pronounced concavity; moderately arched dorsum; truncated caudal process; large, ovoid ornament pits at posterior, smaller at anterior; pits in vertical rows; and irregularly arranged posterior ridges.

Description.—Adult valves rounded, subtriangular in lateral view. Left valve with moderately arched dorsal margin; smoothly curved anterior margin with greatest width near anteroventral corner; ventral margin with pronounced concavity; posterior margin with broad, truncated caudal process. Right valve with more arched dorsum; concave anterodorsal corner; narrow, pronounced caudal process. Subtle dimorphism: males are slightly lower, longer. Greatest length through caudal process; greatest height through median hinge element.

Valve surface covered with pitting and fine ridges. Ornament pits are large, ovoid at posterior, becoming

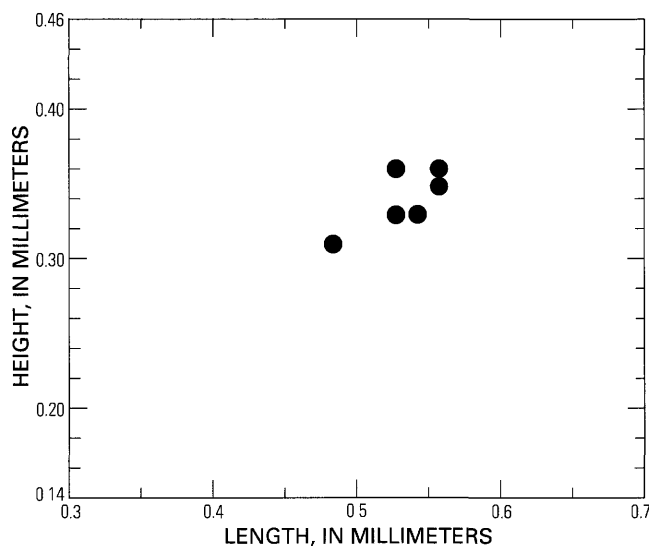


Figure 15. Plot of length versus height for *Cytherofteron champlainum*. Dot may represent more than one specimen.

smaller at anterior; pits arranged in vertical rows. Posterior rows separated by irregularly arranged ridges. Anterior and posterior margins with wide, flat, smooth area. Venter with heavy, smooth, crescentic ridge which overhangs concavity. Dorsum with marginal rim and sulcus. Secondary fine corrugation on floor of larger pits. Normal pores simple-type, with marginal rim. Normal pores both within pits and on surface.

Hingement in left valve consists of elongate anterior socket; coarsely crenulate median bar; and elongate posterior socket. Median element enlarged terminally, forming series of large quadrate teeth. Hinge highly arched, following course of dorsal margin.

Four adductor muscle scars form oblique row, inclined posterodorsally. Dorsal scar is quadrate; dorsomedian scar is trapezoidal; ventromedian scar is quadrate; ventral scar is elongate and quadrate. J-shaped frontal scar.

Measurements.—X-Y plot based on seven specimens (fig. 15).

Comparisons.—*Cytherofteron champlainum* differs from *C. dorsocostatum* Whatley and Masson, 1979 (Quaternary, northeast Atlantic) by having a rounded outline; arched dorsum; weak ventral ridge; and small, numerous ornament pits. *C. champlainum* differs from *C. dimlingtonensis* Neale and Howe, 1973 (Pleistocene, circum-arctic regions) by having a long, low valve outline; less arched dorsum; small caudal process; and small, numerous ornament pits.

Occurrence.—Cruise EGAL-75-KC, localities 6, 46, 260, 285. Cruise DC1-79-EG, locality 42. Assemblages II, III, V.

Distribution.—Pleistocene through Holocene: North Atlantic. Pleistocene: Gulf of Alaska. Middle-outer sublittoral.

Material.—Twenty-one adult valves, four juvenile valves.

Illustrated specimens.—USNM 408553, right valve (pl. 14, fig. 8), locality EGAL-75-KC-6, length 0.55 mm, height 0.36 mm. USNM 408554 left valve (pl. 16, fig. 18; pl. 17, figs. 1, 3), locality EGAL-75-KC-6, length 0.54 mm, height 0.33 mm. USNM 408555, right valve (pl. 17, fig. 2), locality EGAL-75-KC-6, length 0.53 mm, height 0.36 mm. USNM 408556, left valve (pl. 17, fig. 4), locality EGAL-75-KC-6, length 0.53 mm, height 0.33 mm. USNM 408557, left valve (pl. 17, figs. 5, 6), locality EGAL-75-KC-6, length 0.55 mm, height 0.35 mm.

CYTHEROPTERON CHICHAGOFENSIS new species

Plate 9, figures 7, 8; plate 10, figures 11–13; figure 16

Cytherofteron sp. X Brouwers, 1981, p. 10; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Chichagof Island, southern Cross Sound, near Juneau.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; anterior margin with greatest width ventral of midline; sinuous convex venter; small, sharp, centrally located caudal process; moderate-sized ovoid pits arranged in vertical rows at posterior, concentric at anterior; and large, arcuate, overhanging ala.

Description.—Adult valves subtriangular in lateral view. Dorsal margin highly arched; anterodorsal corner concave; anterior margin smoothly curved, with greatest extent ventral of midline; ventral margin sinuous, convex; posterior margin with small, sharp, centrally located caudal process. Left valve differs in a less arched dorsum; wide, broad caudal process; convex anterodorsal corner; and less ventrally extended anteroventral corner. Greatest length through caudal process; greatest height through median hinge element.

Valve covered with moderate-sized ovoid pits. Pits arranged in vertical rows at posterior, concentrically at anterior. Largest pits located medially and posteriorly, becoming smaller toward dorsal and anterior. Venter with large, arcuate ala which overhangs margin. Edge of ala is smooth, heavily calcified. Dorsum with thin marginal ridge and adjacent sulcus. Sixty-four to seventy-one simple-type normal pore canals scattered over surface, both on smooth surface and within ornament pits. Normal pores highlighted by marginal rim.

Inner lamella and line of concrescence coincide throughout; inner margin follows valve outline. Inner lamella of moderate, even width throughout. Strong, well-developed selvage. Eleven to thirteen radial pore canals, most anterior. Radial pore canals straight, simple.

Hingement in right valve consists of four elongate, quadrate anterior teeth; crenulate median groove; and six elongate, quadrate posterior teeth. Median element is enlarged terminally to form large crenulae.

Four adductor muscle scars form row, inclined slightly posterodorsally. Dorsal scar is elongate with enlarged anterior; dorsomedian and ventromedian scars are elongate, subrectangular; ventral scar is inflated, subquadrate.

Measurements.—X-Y plot based on eight specimens (fig. 16).

Comparisons.—*Cytheropteron chichagofensis* n. sp. differs from *C. champlainum* Cronin, 1981 (Quaternary, North Atlantic) by having a small, centrally located caudal process; round posterodorsal corner; dorsal sulcus; small, ovoid pits; and lack of ridges between rows of ornament pits. *C. chichagofensis* differs from *C. nodosum* Brady, 1868 (Quaternary, North Atlantic) by having a less arched dorsum; weak, rounded ala; and small, numerous, organized ornament pits. *C. chichagofensis* differs from *C. brokenoakensis* by having a larger size and more defined, narrow caudal process.

Occurrence.—Cruise EGAL-75-KC, localities 26, 84, 128, 141, 285, 341. Cruise DC2-80-EG, locality 67.

Distribution.—Pleistocene, Holocene (?): Gulf of Alaska. Upper bathyal.

Material.—Six adult valves, two juvenile valves.

Type specimens.—Holotype: USNM 408495, left valve (pl. 9, fig. 7), locality DC2-80-EG-67, length 0.58 mm, height 0.35 mm.

Paratypes: USNM 408496, right valve (pl. 9, fig. 8), locality DC2-80-EG-67, length 0.55 mm, height 0.35 mm. USNM 408497, right valve (pl. 10, figs. 11, 12, 13), locality EGAL-75-KC-141, length 0.53 mm, height 0.38 mm.

CYTHEROPTERON DIMLINGTONENSIS
Neale and Howe, 1973

Plate 8, figures 1–6; plate 9, figure 1; figure 17

Cytheropteron dimlingtonensis Neale and Howe, 1973, p. 242–243, pl. 1, figs. 3, 5a,b.

Cytheropteron sp. C Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Diagnosis.—Characterized by subtriangular lateral outline; broadly arched dorsum; sinuous venter with strong concavity; moderate caudal process; ovoid pitting arranged in vertical rows; small marginal pits with low marginal ridges; dorsal marginal sulcus; smooth, flattened rim at anterior and posterior; secondary marginal pitting; and strong, sinuous, overhanging posteroventral ridge.

Description.—Adult valves subtriangular in lateral view. Dorsal margin broadly arched; anterior margin broadly rounded, with greatest length ventral of midline; ventral margin sinuous, with strong concavity; posterior margin with broad caudal process. Caudal process most attenuated dorsal of midline. Left valve with less arched dorsum and broad, blunt development of caudal process. No dimorphism observed. Greatest length through midline of valve; greatest height through median hinge element.

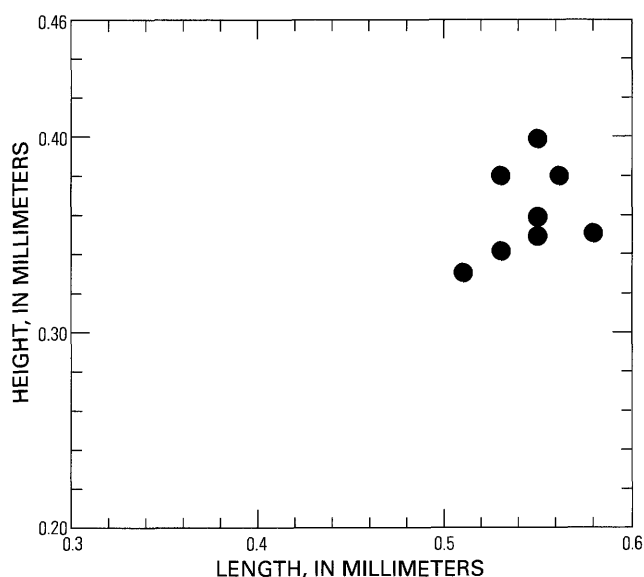


Figure 16. Plot of length versus height for *Cytheropteron chichagofensis*.

Valve covered with ovoid pitting of various sizes. Pits in vertical rows separated by low ridges near anterior and posterior margins. Pits are large, elongate at middle of valve, becoming smaller marginally. Subdued marginal sulcus along dorsum, especially developed in right valve. Smooth, flattened anterior and posterior rim. Secondary fine pitting along valve margins. Strong sinuous ridge overhangs posteroventral margin; ridge is strengthened by heavy calcification. Sixty-three simple-type normal pores evenly distributed over surface, most within pits. Normal pores with raised marginal rim.

Inner margin and line of concrescence coincide at posterior and venter; moderate, arcuate anterior vestibule. Inner lamella widest at anterior, of even width at posterior and venter. Inner margin parallels valve outline. Very well developed selvage. At least seven radial pores, most anterior; pores are straight, short, simple.

Hinge in left valve consists of two anterior quadrate sockets; weakly crenulate median bar which thickens and enlarges terminally into two anteromedian and three posteromedian quadrate teeth; and three posterior quadrate sockets. Median bar formed by dorsal valve edge. Right valve hingement with dorsal edge enfolded to form accommodation groove.

Four adductor muscle scars in row, inclined posterodorsally. Dorsal scar is dumbbell-shaped, with pinched middle; dorsomedian scar is sinuous, forming L-shape; ventromedian scar is quadrate; ventral scar is ovoid. Frontal scar split into larger, peanut-shaped posterior scar and small, round anterior scar. Two elongate, ellipsoidal mandibular scars located ventral of frontal scars. Dorsal scars are small, irregular in shape, few in number.

Measurements.—X-Y plot based on 10 specimens (fig. 17).

Comparisons.—*Cytheropteron dimlingtonensis* differs from *C. latissimum* (Norman, 1865) (Quaternary, North Atlantic) by having a rounded dorsum; weak ventral ridge; and large organized pitting. *C. dimlingtonensis* differs from *C. nodosoalatum* Neale and Howe, 1973 (Quaternary, north-east Atlantic) by having a quadrate shape; sinuous venter; broad caudal process; and vertically arranged ornament pits.

Occurrence.—Cruise EGAL-75-KC, localities 4, 26, 123, 127, 209, 257, 320.

Distribution.—Pleistocene: Northeast Atlantic. Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf.

Material.—Ten adult valves, one juvenile valve.

Illustrated specimens.—USNM 408473, left valve (pl. 9, fig. 1), locality EGAL-75-KC-127, length 0.57 mm, height 0.34 mm. USNM 408474, left valve (pl. 8, figs. 1, 3), locality EGAL-75-KC-123, length 0.51 mm, height 0.33 mm. USNM 408475, right valve (pl. 8, figs. 2, 6), locality EGAL-75-KC-123, length 0.50 mm, height 0.30 mm. USNM 408476, left valve (pl. 8, figs. 4, 5), locality EGAL-75-KC-320, length 0.52 mm, height 0.32 mm.

CYTHEROPTERON DISCOVERIA new species

Plate 11, figure 5; plate 13, figures 1–6, 9; figure 18

Cytheropteron sp. K Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1983.

Etymology.—After NOAA oceanographic vessel R/V Discoverer, utilized during cruises DC1-79-EG and DC2-80-EG.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; narrow, prolonged caudal process; sinuous posterodorsal corner; pronounced dimorphism; pitting oriented vertically at median, concentrically at margins; low anterior and posterior marginal ridges; strong right-angle posterior ridge; pronounced ventral ala; secondary fine corrugated ornament.

Description.—Adult valves subtriangular in lateral view. Dorsal margin highly arched; anterior margin evenly rounded; ventral margin sinuous, with pronounced concavity; posterior margin with highly attenuated, narrow caudal process; posterodorsal margin sinuous, predominantly concave. Caudal process located dorsal of midline. Left valve with less arched dorsal margin, less concave posterodorsal margin. Pronounced dimorphism: males considerably lower, somewhat shorter, with significantly less arched dorsal margin, less evenly rounded anterior margin, and dorsally located caudal process. Greatest length through caudal process; greatest height through median hinge element.

Valve surface covered with pitting and ridges. Pitting vertical at median and concentric at margins. Rows of pits separated by low ridges along anterior and posterior margins. Pits are ovoid in shape; largest pits toward venter,

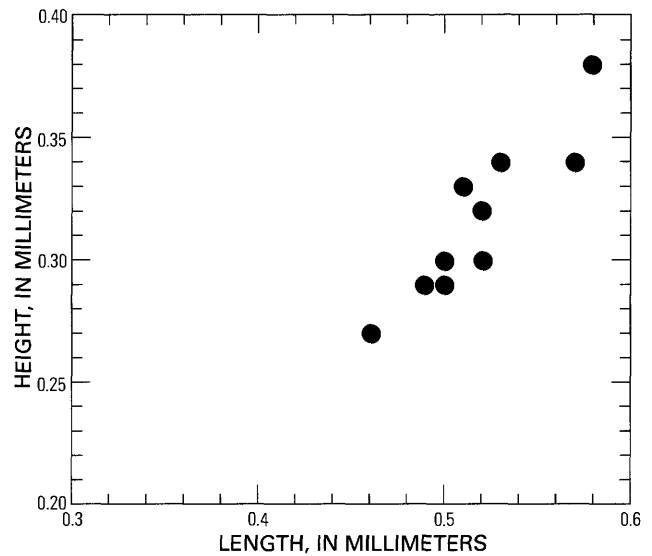


Figure 17. Plot of length versus height for *Cytheropteron dimlingtonensis*.

smaller toward anterior, dorsal, and posterior margins. Strong ridge originates at middle of dorsum, proceeds marginally to posterodorsal corner, where it forms a right angle and proceeds obliquely to venter. The ridge connects with a pronounced ventral alar ridge which originates at anterior and overhangs margin, terminating as prominent ala. Ventral edge of alar ridge strengthened by moderate calcification. V-shaped smooth region on caudal process. Secondary fine corrugation on solum floors. Twenty-eight simple-type normal pores evenly distributed over surface; most within pits, some on surface. Normal pores with subdued marginal rim.

Inner margin parallels valve outline. Weakly developed selvage.

Hinge in right valve consists of strong, quadrate, anterior tooth; crenulate median groove; posteromedian ovoid tooth; four quadrate sockets; and three ovoid posterior teeth. Hinge is sinuous in outline, following course of dorsal margin. Median groove is enlarged terminally.

Four adductor muscle scars form row, inclined posterodorsally. Dorsal scar is kidney-shaped; dorsomedian scar is elongate, crescentic; ventromedian scar is elongate, l-shaped; ventral scar is ellipsoidal. Frontal scar is l-shaped. Very weak fulcral point. Several large, ovoid dorsal muscle scars immediately above central muscle-scar field.

Measurements.—X-Y plot based on 17 specimens (fig. 18).

Comparisons.—*Cytheropteron discoveria* n. sp. differs from *C. punctatum* Brady, 1868 (Quaternary, northeast Atlantic, Adriatic) by having a strong, oblique posterior ridge; strong dimorphism; arched, sinuous dorsum; weaker ventral ala; and evenly rounded anterior. *C. discoveria* differs from *C. inornatum* Brady and Robertson, 1872 (Holocene, Britain, Adriatic Sea) by having an arched

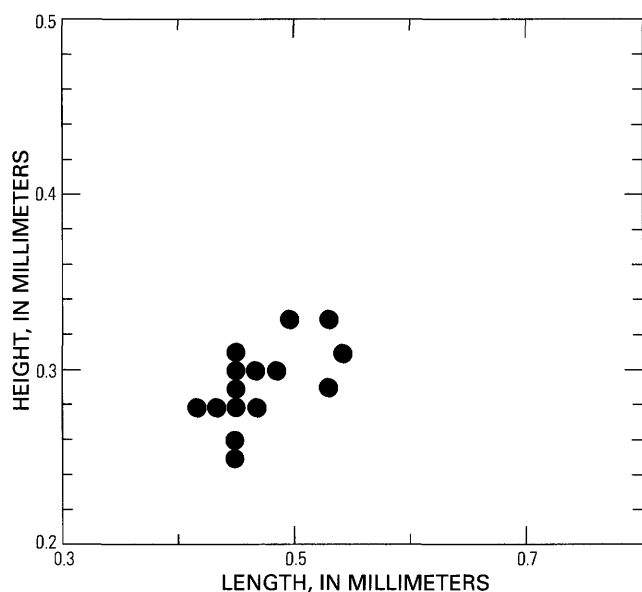


Figure 18. Plot of length versus height for *Cytheropteron discoveria*. Dot may represent more than one specimen.

dorsum; evenly rounded anterior; concave posterodorsal margin; and punctate ornament.

Occurrence.—Cruise EGAL-75-KC, localities 19, 52A, 150, 328. Cruise DC2-80-EG, localities 183, 186, 189, 195. Assemblage III.

Distribution.—Pleistocene through Holocene: Gulf of Alaska, Cook Inlet and the Kodiak Shelf, Pribilof Islands. Outer sublittoral.

Material.—Twenty-seven adult valves, three juvenile valves.

Type specimens.—Holotype: USNM 408516, left valve (pl. 11, fig. 5), locality DC2-80-EG-195, length 0.45 mm, height 0.26 mm.

Paratypes: USNM 408517, left valve (pl. 13, figs. 1, 3), locality DC2-80-EG-186, length 0.43 mm, height 0.28 mm. USNM 408518, right valve (pl. 13, fig. 2), locality DC2-80-EG-186, length 0.46 mm, height 0.28 mm. USNM 408519, left valve (pl. 13, fig. 4), locality EGAL-75-KC-150, length 0.53 mm, height 0.29 mm. USNM 408520, right valve (pl. 13, figs. 5, 6, 9), locality DC2-80-EG-186, length 0.45 mm, height 0.25 mm.

CYTHEROPTERON DRYBAYENSIS new species

Plate 11, figure 7; plate 13, figures 7–8, 10–15; plate 14, figure 7; plate 17, figures 7–12; plate 18, figure 1; figure 19

Cytheropteron sp. B Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Cytheropteron sp. Q Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983

Etymology.—After Dry Bay, at the mouth of the Alsek River, southeast Alaska.

Diagnosis.—Characterized by subtriangular lateral outline; highly sinuous venter with pronounced concavity; sharp caudal process; convergent anterior and posterior margins; mostly smooth surface with small ovoid pits; broad flat anterior and posterior marginal regions; strong, high ventral ala terminating as spine; large, deep, arcuate anterior vestibule; and small, irregular posterior vestibule.

Description.—Adult valves subtriangular to ellipsoidal in lateral view. Dorsal margin highly arched; anterior margin smoothly rounded, drawn-out; ventral margin highly sinuous, with broad, pronounced concavity; posterior margin with sharp caudal process. Dorsal and ventral margins converge at anterior and posterior. Caudal process dorsal of midline.

Valve surface primarily smooth, with small ovoid pits scattered over valve. Anterior and posterior margins with broad, flat regions. Posterodorsal corner with subtle ridge-depression region. Venter with strong, high ala terminating as a spine. Ala with several small, subtle, discontinuous ridges. Twenty-one simple-type normal pores, most at posterodorsum and anteroventer. Pores have raised marginal rim.

Inner margin and line of concrescence coincide along ventral and posteroventral margins. Large, deep, arcuate, anterior vestibule and small, irregular, posterior vestibule at caudal process. Inner margin parallels valve outline. Eight radial pore canals, most anterior. Radial pores are straight, short, simple.

Hinge in right valve consists of six quadrate anterior teeth; crenulate median groove; and small, quadrate, posterior teeth. Median element enlarged terminally into larger crenulae. Hinge is highly arched, sinuous, following course of dorsal margin.

Four adductor muscle scars form vertical row. Dorsal scar is subcylindrical; dorsomedian scar is I-shaped; ventromedian scar is elongate, with enlarged posterior; ventral scar is semicircular.

Measurements.—X–Y plot based on 13 specimens (fig. 19).

Comparisons.—*Cytheropteron drybayensis* n. sp. differs from *C. monoceros* Bonaduce, Ciampo, and Masoli, 1976 (Holocene, Britain, Adriatic Sea) by having a narrow, prolonged caudal process; fine ornament pits; and short, delicate ala. *C. drybayensis* differs from *C. volantium* Whatley and Masson, 1979 (Holocene, Scotland) by having a shorter valve shape; less prolonged caudal process; fine ornament pitting; and delicate ala. *C. drybayensis* differs from *C. alatum* Sars, 1866 (Holocene, northeast Atlantic) by having a shorter valve outline; narrow, prolonged caudal process; delicate ala; and fine ornament pitting. *C. drybayensis* n. sp. differs from *C. paralatissimum* Swain, 1963 (Quaternary, Arctic) by having a longer, lower valve

outline; smaller ala; narrow, prolonged caudal process; and scattered ornament pits.

Occurrence.—Assemblages II, III, IV. Table 2.

Distribution.—Pleistocene through Holocene: Gulf of Alaska. Middle-outer sublittoral, upper bathyal.

Material.—Fifty adult valves, sixty-six juvenile valves.

Type specimens.—Holotype: USNM 408522, right valve (pl. 11, fig. 7), locality EGAL-75-KC-95, length 0.55 mm, height 0.38 mm.

Paratypes: USNM 408523, left valve (pl. 13, fig. 7), locality EGAL-75-KC-128, length 0.63 mm, height 0.35 mm. USNM 408524, right valve (pl. 13, figs. 8, 11, 12), locality DC2-80-EG-186, length 0.60 mm, height 0.34 mm. USNM 408525, right valve (pl. 13, figs. 10, 13–15), locality EGAL-75-KC-128, length 0.65 mm, height 0.40 mm. USNM 408552, left valve (pl. 14, fig. 7), locality EGAL-75-KC-6, length 0.55 mm, height 0.35 mm. USNM 408558, right valve (pl. 18, fig. 1), locality EGAL-75-KC-124A, length 0.65 mm, height 0.38 mm. USNM 408559, left valve (pl. 17, figs. 7, 8, 9), locality EGAL-75-KC-123, length 0.68 mm, height 0.34 mm. USNM 408560, left valve (pl. 17, figs. 10, 11, 12), locality EGAL-75-KC-106, length 0.60 mm, height 0.31 mm.

CYTHEROPTERON EICHERI new species

Plate 11, figure 8; plate 15, figures 1–5; figure 20

Cytheropteron sp. O Brouwers, 1981, p. 9; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Dr. Don L. Eicher, University of Colorado, a specialist in Cretaceous foraminifers.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; sinuous venter with pronounced concavity; narrow, prolonged caudal process; two short posteroventral denticles; smooth valve surface; large, high ala with heavily calcified leading edge and spines at posterior; anterior marginal flange; small dorsal sulcus; strong selvage; and large, crescentic anterior vestibule.

Description.—Adult valves subtriangular in lateral view. Dorsal margin highly arched; anterior margin drawn-out, smoothly curved, with greatest width ventral of midline; ventral margin sinuous with pronounced concavity; posterior margin with narrow, drawn-out caudal process, centrally located. Anteroventral margin with crenulations; posteroventral margin with two short, blunt denticles. Greatest length through midline; greatest height through median hinge element.

Valve surface is smooth, dominated by very large, high ventral ala which forms broad, flat, triangular ventral surface or platform. Anterior side of alar structure is heavily calcified, with massive leading edge. Posterior ala contains numerous large, sharp denticles or spines. Posterior spines become progressively larger outward along ala, ending with large, long terminal spine at end of ala. Anterior margin with

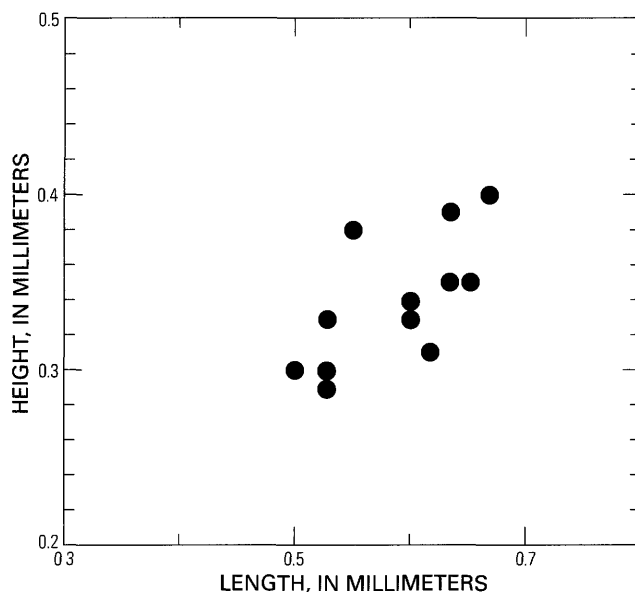


Figure 19. Plot of length versus height for *Cytheropteron dry-bayensis*. Dot may represent more than one specimen.

broad, flat flange. Dorsal margin with small, subtle sulcus. Forty-eight small, simple-type normal pores evenly distributed over surface.

Inner margin and line of concrescence coincide along venter and posterior; large, crescentic anterior vestibule. Inner margin follows valve outline. Inner lamella moderately wide at posterior, very wide at anterior. Strong, well-developed selvage. Nine radial pore canals, most anterior. Radial pores are short, straight, simple.

Hingement in left valve consists of narrow, elongate anterior socket; weakly crenulate median bar; and elongate, narrow posterior socket. Median bar enlarged terminally, forms larger, quadrate crenulae, expressed as anteromedian and posteromedian teeth. Anterior and posterior sockets with weak ventral rim. Hinge is arched, sinuous, follows course of dorsal margin.

Measurements.—X–Y plot based on four specimens (fig. 20).

Comparisons.—*Cytheropteron eicheri* n. sp. differs from *C. volantium* Whatley and Masson, 1979 (Holocene, Scotland) by having an arched dorsum; less extended caudal process; strong terminal spine on ala; and concave anterodorsal cardinal angle. *C. eicheri* differs from *C. alatum* Sars, 1866 (Holocene, northeast Atlantic) by having a narrow caudal process; arched dorsum; concave anterodorsal cardinal angle; and strong terminal spine on ala. *C. eicheri* differs from *C. paralatissimum* Swain, 1963 (Pleistocene, Alaska) by having a longer valve shape; extended caudal process; thinner ala; and lack of ornamentation.

Occurrence.—Cruise EGAL-75-KC, localities 52A, 77, 80, 209.

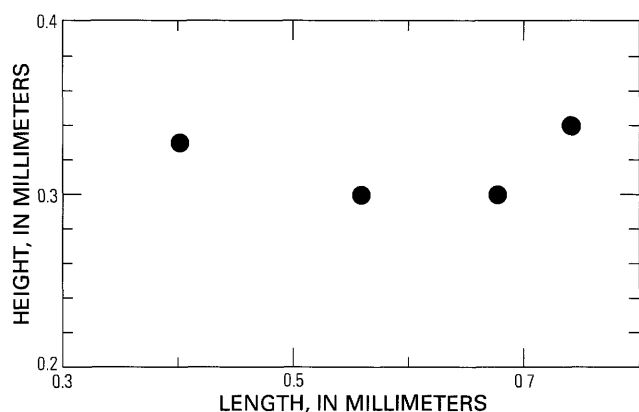


Figure 20. Plot of length versus height for *Cytheropteron eicheri*.

Distribution.—Pleistocene, Holocene (?): Gulf of Alaska. Middle sublittoral.

Material.—Three adult valves, one juvenile valve.

Type specimens.—Holotype: USNM 408526, right valve (pl. 11, fig. 8), locality EGAL-75-KC-77, length 0.56 mm, height 0.30 mm.

Paratypes: USNM 408527, right valve (pl. 15, figs. 1, 3), locality EGAL-75-KC-30, length 0.73 mm, height 0.34 mm. USNM 408528, left valve (pl. 15, figs. 2, 4, 5), locality EGAL-75-KC-30, length 0.68 mm, height 0.30 mm.

CYTHEROPTERON ELAENI Cronin, 1988

Plate 21, figure 2; plate 22, figures 11–13

Cytheropteron nealei Cronin, 1981, p. 406, pl. 7, fig. 7.

Cytheropteron elaeni Cronin, 1988, p. 138, pl. 5, fig. 8.

Cytheropteron sp. Y Brouwers, 1981, p. 10; Brouwers, 1982b, p. 8; Brouwers, 1983.

Diagnosis.—Characterized by subtriangular shape; highly arched anterodorsum, concave posterodorsum; sinuous venter; attenuated posterior; broad, elongate caudal process; pits in rows at posterior, concentric at anterior; overhanging ala; large posteroventral tubercle; and split frontal scar.

Description.—Adult valves subtriangular in lateral view. Highly arched anterodorsum, concave posterodorsum; anterior margin smoothly curved with greatest width ventral of midline; ventral margin sinuous with pronounced concavity; posterior margin attenuated, with broad, elongate caudal process. Obtuse posterodorsal cardinal angle. Greatest length through caudal process; greatest height anterior of midvalve.

Valve predominantly smooth; scattered small pits mostly at margins. Pits oriented in oblique rows at posterior and concentric to anterior margin. Low, strong, heavily calcified ala overhangs venter; ala is sinuous in shape, originating as bifurcated ridge at anterior and terminating as large tubercle at posteroventer. Posterior margin with oblique

ridges between pit rows. Seventy simple-type normal pores evenly distributed over surface, both in pits and on surface. Normal pores with distinct marginal rim.

Inner margin and line of concrescence coincide throughout. Inner lamella narrow, of even width throughout, parallels valve outline. Ten radial pores, one false radial pore, most anterior.

Hingement in right valve consists of three small, quadrate anterior teeth; crenulate median bar; and four to five quadrate posterior teeth. Anterior and posterior teeth form the enlarged terminus of median bar. Median element formed by dorsal edge of valve.

Four adductor muscle scars form vertical row. Dorsal scar is ellipsoidal, sharply inclined; dorsomedian scar is elongate, teardrop-shaped; ventromedian scar is elongate, ellipsoidal; ventral scar is ovoid, inflated. Frontal scar split into ventral L-shaped scar and dorsal, small, circular scar. Weak fulcral point impression. Few, paired, irregularly shaped dorsal muscle scars.

Comparisons.—*Cytheropteron elaeni* is distinctive and does not resemble any described species of *Cytheropteron*.

Occurrence.—Cruise EGAL-75-KC, localities 53, 55, 122A, 157, 159. Assemblage V.

Distribution.—Pleistocene: Champlain Sea. Holocene: Novaya Zemlya. Pleistocene, Holocene (?): Gulf of Alaska, Bering Sea, Beaufort Sea.

Illustrated specimens.—USNM 408602, left valve (pl. 21, fig. 2), locality EGAL-75-KC-159, length 0.43 mm, height 0.28 mm. USNM 408603, left valve (pl. 22, figs. 11, 12, 13), locality EGAL-75-KC-55, length 0.41 mm, height 0.28 mm.

CYTHEROPTERON EREMITUM Hanai, 1959

Plate 11, figure 4; plate 12, figures 8–17; figure 21

Cytheropteron rarum Hanai, 1957, p. 28–29, pl. 4, fig. 3.

Cytheropteron eremitum Hanai, 1959a, p. 418.

Cytheropteron eremitum Hanai. Ishizaki and Matoba, 1985, pl. 3, figs. 5, 6.

Cytheropteron sp. AA Brouwers, 1982a, p. 8; Brouwers, 1983.

Diagnosis.—Characterized by drawn-out anterior margin; sinuous venter with pronounced concavity; dorsal and ventral margins converge at posterior; subdued reticulation consisting of low, narrow, vertical ridges; weak ventral ala; central muscle scars reflected externally; anterior and posterior with flattened marginal rim; and secondary fine pitted ornament.

Description.—Adult valves subtriangular in lateral view. Right valve with highly arched dorsal margin; anterodorsal corner markedly concave; anterior margin drawn-out, smoothly curved; ventral margin sinuous, with pronounced concavity; posterior margin with small, attenuated caudal process. Left valve differs in large, broad caudal process;

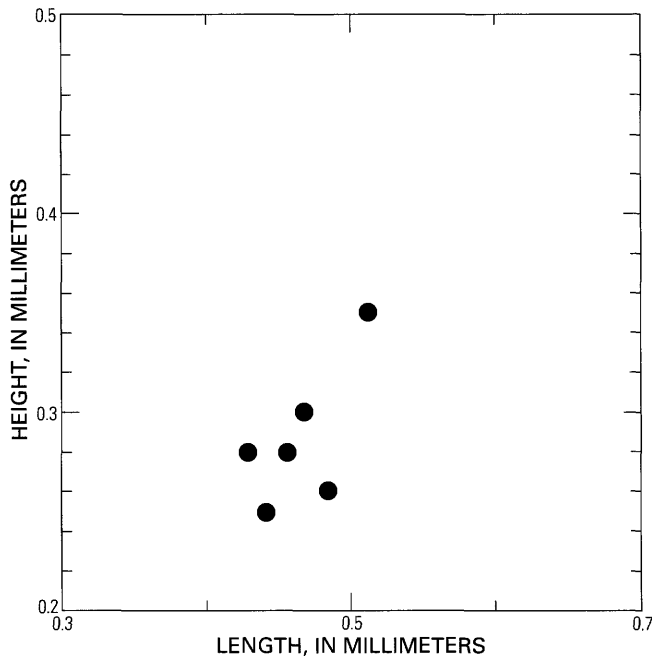


Figure 21. Plot of length versus height for *Cythero- pteron eremitum*.

convex anterodorsal margin; flattened, broadly arched dor- sum; and smoothly curved ventral margin. Dorsal and ven- tral margins converge at posterior. Slight dimorphism: males are lower, longer. Greatest length through caudal process; greatest height through anterior hinge element.

Valve surface covered with subdued reticulation pat- tern. Ridges are narrow and low, occurring as longitudinal ovoids oriented in vertical rows. Slightly thickened ridges along dorsal margin and at edge of ventral ala. Ventral ala is weak, forming smooth arch over concavity. Central muscle- scar field reflected externally as thickened smooth regions. Anterior and posterior have flattened rim. Secondary fine pitting over surface between ridges. Fifty-eight normal pores evenly distributed over surface, occurring on or imme- diately adjacent to reticulum ridges. Normal pores simple type, with raised marginal rim. Normal pore setae of two types: long, straight, and simple, and short and multi- branched.

Inner margin and line of concrescence coincide throughout; inner margin parallels valve outline. Inner lamella of even width throughout. Weakly developed sel- vage. At least eight radial pores; pores are straight, short, and simple.

Hinge in left valve consists of three anterior quadrate sockets; crenulate median bar expanded terminally into strong, elongate, quadrate anteromedian and posteromedian tooth elements; and three posterior sockets. Median bar formed in part by dorsal edge of valve. Right valve hinge- ment with dorsal edge enfolded to form accommodation groove. Anterior and posterior hinge sockets rimmed dor- sally by expanded hinge "ears."

Four adductor muscle scars in row, inclined posterodor- sally. Dorsal scar is an inclined trapezoid; dorsomedian scar is elongate, quadrate; ventromedian scar is I-shaped; ventral scar is subtriangular. Frontal scar split into larger, L-shaped posterior scar and small, round anterior scar. Numerous small, ovoid dorsal scars scattered above central scar field.

Measurements.—X-Y plot based on six specimens (fig. 21).

Comparisons.—*Cythero- pteron eremitum* differs from *C. nodosum* Brady, 1868 (Quaternary, North Atlantic) by having a low, broad dorsum; weak ventral ridge; thin vertical ridges; externally reflected central muscle scars; and fine secondary ornament pitting. *C. eremitum* differs from *C. dimlingtonensis* Neale and Howe, 1973 (Pleistocene, north- east Atlantic) by having a long, low valve outline; low broad dorsum; thin vertical ridges; fine secondary ornament pits; and externally reflected central muscle scars.

Occurrence.—Cruise EGAL-75-KC, localities 106, BFM-78-1.

Distribution.—Holocene: Gulf of Alaska.

Material.—Eight adult valves, thirty-four juvenile valves.

Illustrated specimens.—USNM 408511, left valve (pl. 11, fig. 4), locality BFM-78-1, length 0.48 mm, height 0.26 mm. USNM 408512, female right valve (pl. 12, figs. 8, 9, 14), locality BFM-78-1, length 0.46 mm, height 0.30 mm. USNM 408513, male left valve (pl. 12, figs. 10, 12, 13), locality BFM-78-1, length 0.45 mm, height 0.28 mm. USNM 408514, male right valve (pl. 12, fig. 11), locality BFM-78-1, length 0.43 mm, height 0.28 mm. USNM 408515, male left valve (pl. 12, figs. 15, 16, 17), locality BFM-78-1, length 0.44 mm, height 0.25 mm.

CYTHEROPTERON FORESTERI new species

Plate 17, figures 13–18; plate 18, figures 2, 3, 6; plate 19, figures 1–4; plate 20, figures 10, 11; figures 22, 23

Cythero- pteron sp. A Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Cythero- pteron sp. S Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Richard M. Forester, U.S. Geologi- cal Survey, a specialist in nonmarine systems and hydro- chemistry.

Diagnosis.—Characterized by subtriangular lateral out- line; moderately arched dorsum; pronounced concavity; broad, pronounced caudal process; posteriorly convergent dorsum and venter; four small, blunt, anterior marginal den- ticles; smooth surface with few pits; low, subdued, over- hanging ventral ala with posterior terminal spine; weak eyespot; and arcuate anterior vestibule.

Description.—Adult valves subtriangular in lateral view. Dorsal margin moderately arched; anterior margin broadly rounded, with greatest width ventral of midline;

ventral margin sinuous with pronounced concavity; posterior margin with broad, pronounced caudal process. Dorsal and ventral margins converge posteriorly. Caudal process with greatest extent ventral of midline. Four small blunt anterior marginal denticles. Left valve with less arched dorsum and broad, less extended caudal process. Females differ in being slightly shorter, higher in lateral view.

Valve surface primarily smooth, with small number of pits evenly distributed over surface. Low, subdued ventral ala, bearing several median blunt tubercles, overhangs venter. Ala terminates at posterior as sharp spine-like structure. Subtle anterior marginal sulcus. Slight elongate ridge forms weak eyespot. Sixty-five to seventy-two simple-type normal pores evenly distributed over surface, occurring within pits. Normal pores with raised marginal rim.

Inner margin and line of concrescence coincide at posterior and venter; moderate, arcuate anterior vestibule. Inner margin parallels valve outline. Weakly developed selvage. Nine to eleven radial pores, one false radial pore; pores are straight, short, simple.

Hinge in left valve consists of three quadrate anterior sockets; four small rounded anteromedian teeth; coarsely crenulate median bar; five rounded posteromedian teeth; and two elongate posterior sockets. Anteromedian and posteromedian teeth form enlarged terminal ends of median element. Median bar formed by dorsal valve edge. Right valve with dorsal edge enfolded to form accommodation groove.

Four adductor muscle scars in vertical row; dorsal scar elongate, dorsomedian scar elongate-sinuous, ventromedian scar I-shaped, ventral scar subrounded. Frontal scar split into peanut-shaped posterior scar and small, round anterior scar. Small ovoid fulcral point located posterodorsal of frontal scars. Many smaller subtriangular to subelliptical dorsal scars above adductor row; elongate, larger dorsal scars just below hinge.

Measurements.—X-Y plot based on 29 specimens (fig. 22).

Comparisons.—*Cytheropteron foresteri* n. sp. differs from *C. hyalinosa* Hanai, 1957 (lower Pleistocene, Hokkaido, northern Honshu) by its smaller ala; less drawn out posterior; less arched dorsum; and presence of small ornament pits.

Occurrence.—Assemblages II*, III*, IV, V. Table 2; figure 23.

Distribution.—Pleistocene through Holocene: Gulf of Alaska, Pribilof Islands. Middle-outer sublittoral, upper bathyal.

Material.—Two hundred ninety-seven adult valves, three hundred twenty-two juvenile valves.

Type specimens.—Holotype: USNM 408561, female left valve (pl. 18, fig. 2), locality EGAL-75-KC-432, length 0.51 mm, height 0.30 mm.

Paratypes: USNM 408562, male right valve (pl. 18, fig. 3), locality EGAL-75-KC-432, length 0.54 mm, height 0.30 mm. USNM 408563, female left valve (pl. 17, figs. 13, 15),

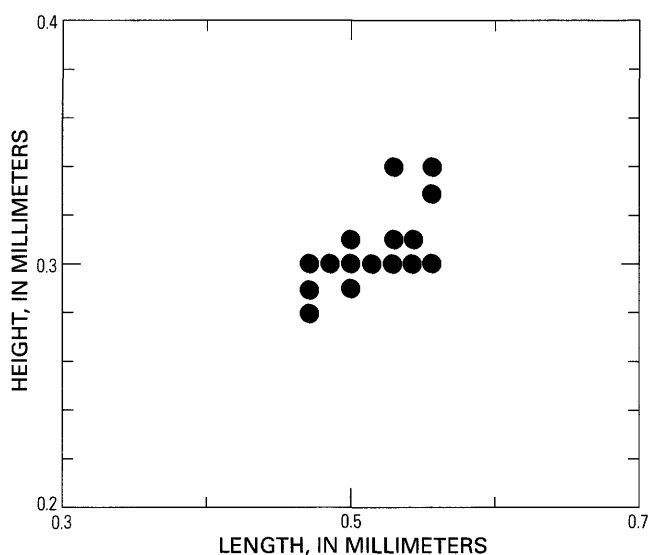


Figure 22. Plot of length versus height for *Cytheropteron foresteri*. Dot may represent more than one specimen.

locality EGAL-75-KC-432, length 0.53 mm, height 0.30 mm. USNM 408564, female right valve (pl. 17, figs. 14, 18), locality EGAL-75-KC-432, length 0.53 mm, height 0.31 mm. USNM 408565, male left valve (pl. 17, fig. 16), locality EGAL-75-KC-432, length 0.55 mm, height 0.30 mm. USNM 408566, male right valve (pl. 17, fig. 17), locality EGAL-75-KC-432, length 0.49 mm, height 0.30 mm. USNM 408567, female right valve (pl. 19, fig. 1), locality EGAL-75-KC-432, length 0.48 mm, height 0.30 mm. USNM 408568, female left valve (pl. 19, figs. 2, 3, 4), locality EGAL-75-KC-432, length 0.50 mm, height 0.30 mm. USNM 408586, right valve (pl. 18, fig. 6), locality EGAL-75-KC-117, length 0.50 mm, height 0.31 mm. USNM 408587, left valve (pl. 20, figs. 10, 11), locality DC2-80-EG-195, length 0.53 mm, height 0.30 mm.

CYTHEROPTERON HAYDENENSIS new species

Plate 14, figures 2, 3; plate 15, figures 6–15; figure 24

Cytheropteron sp. T Brouwers, 1981, p. 9; Brouwers, 1983.

Etymology.—After Hayden Glacier, adjacent to Malaspina Glacier, southeast Alaska.

Diagnosis.—Characterized by rounded, subtriangular lateral outline; moderately arched dorsum; sinuous venter with small concavity; truncated caudal process; concave posterodorsal corner; pronounced dimorphism; ovoid ornament pits separated by low ridges; pits arranged in vertical rows at posterior and concentrically at anterior; low, massive, crescentic ridge along and overhanging venter; and secondary fine papillae and wart-like ornament.

Description.—Adult valves subtriangular, rounded in lateral view. Left valve with moderately arched dorsal margin; smoothly curved anterior margin with greatest width

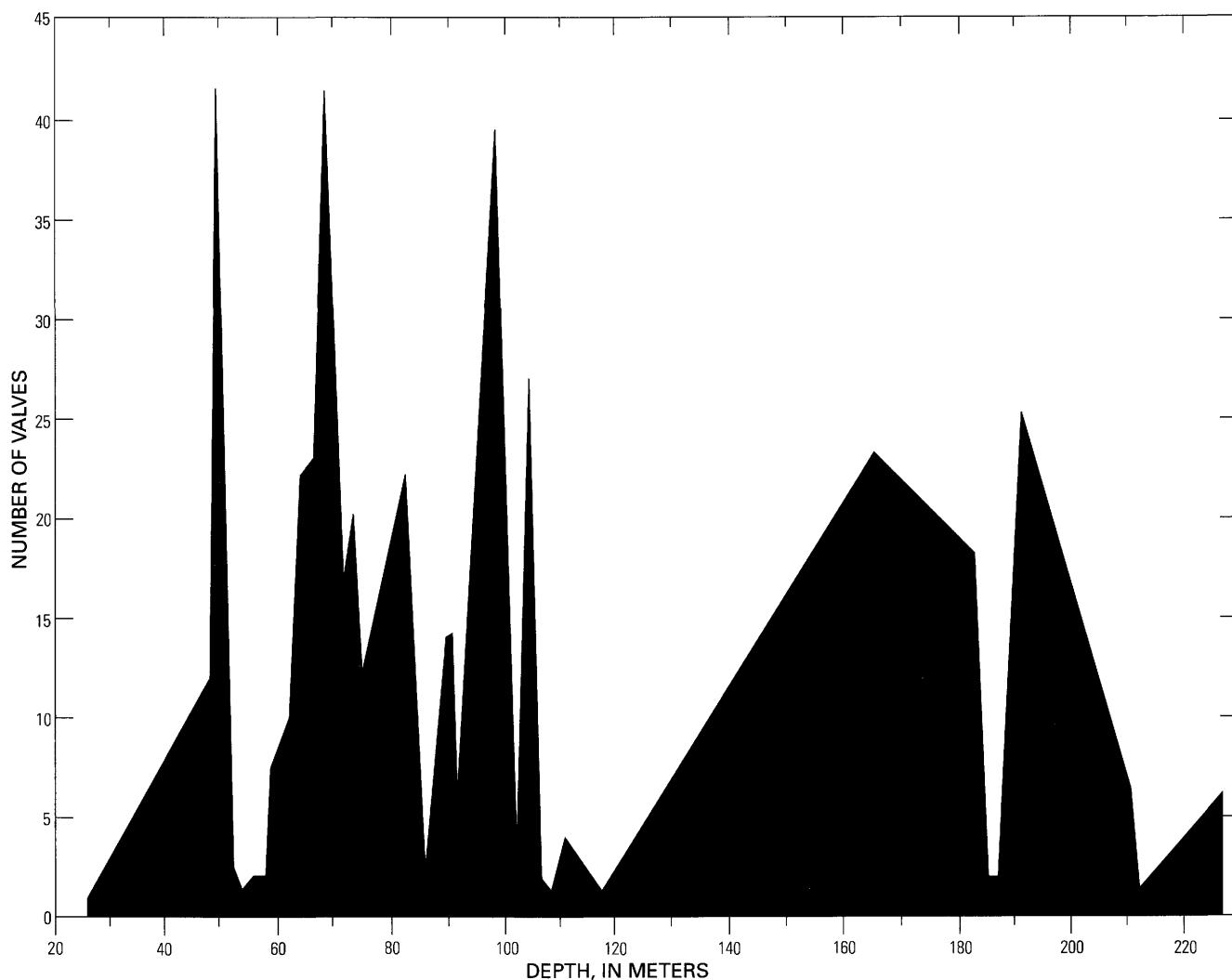


Figure 23. Plot of abundance versus water depth for *Cytheropteron foresteri*.

ventral of midline; ventral margin sinuous, with shallow, small concavity; posterior margin with truncated caudal process. Posterodorsal corner concave, with rounded, obtuse cardinal angle. Right valve differs in highly arched dorsum; narrow, prolonged caudal process; strong posterodorsal cardinal angle; concave anterodorsal corner; and down-slung anterior margin. Pronounced dimorphism: males somewhat lower, longer. Greatest length through caudal process; greatest height through median hinge element.

Valve surface covered with ovoid pits. Pits arranged in rows, trending vertically at posterior and concentric to margin at anterior. Pits are largest in median region, smaller marginally. Posterior rows of pits separated by series of low ridges. Low, smooth, massive, crescentic ridge along and overhangs venter. Secondary fine papillae and wart-like projections cover solum floors. Sixty simple-type normal pores evenly scattered over surface, both within pits and on surface. Pores within pits are celate; pores on surface have thickened marginal rim.

Inner margin and line of concrescence coincide ventrally. Deep, crescentic anterior vestibule; small, shallow, irregularly shaped posterior vestibule. Inner margin parallels valve outline. Fused inner lamella narrow at anterior, wider at posterior. Moderately developed selvage. Eight radial pore canals, most anterior. Radial pores are short, straight, simple.

Hingement in right valve consists of smooth, elongate anterior tooth; six quadrate anteromedian sockets; coarsely crenulate median groove; seven quadrate posteromedian sockets; and massive, elongate posterior tooth. Median element enlarged terminally to form anteromedian and posteromedian sockets. Hinge arcuate in shape, following course of dorsal margin.

Four adductor muscle scars form oblique row, inclined posterodorsally. Frontal scar is J-shaped.

Measurements.—X-Y plot based on 13 specimens (fig. 24).

Comparisons.—*Cytheropteron haydenensis* n. sp. differs from *C. arcticum* Neale and Howe, 1973 (Quaternary, North Atlantic) by its weak, smooth ventral ridge; sharp, narrow caudal process; less arched dorsum; narrow anterior; and vertically aligned ornament pits. *C. haydenensis* differs from *C. champlainum* Cronin, 1981 (upper Pleistocene, northwest Atlantic) by its wide anterior; rounded, massive ventral ridge; narrow caudal process; and small, ovoid ornament pits.

Occurrence.—Cruise EGAL-75-KC, localities 17, 46, 283, 341. Cruise DC1-79-EG, localities 5, 41, 46. Assemblages II, V.

Distribution.—Pleistocene, Holocene (?): Gulf of Alaska, Pribilof Islands. Middle sublittoral.

Material.—Twenty-one adult valves, thirteen juvenile valves.

Type specimens.—Holotype: USNM 408530, left valve (pl. 14, fig. 2), locality EGAL-75-KC-46, length 0.45 mm, height 0.25 mm.

Paratypes: USNM 408531, right valve (pl. 14, fig. 3), locality EGAL-75-KC-46, length 0.45 mm, height 0.25 mm. USNM 408532, left valve (pl. 15, figs. 6, 7, 9), locality EGAL-75-KC-46, length 0.45 mm, height 0.30 mm. USNM 408533, right valve (pl. 15, fig. 8), locality EGAL-75-KC-46, length 0.44 mm, height 0.28 mm. USNM 408534, left valve (pl. 15, figs. 10, 11, 12), locality EGAL-75-KC-46, length 0.45 mm, height 0.28 mm. USNM 408535, right valve (pl. 15, figs. 13, 15), locality EGAL-75-KC-46, length 0.44 mm, height 0.26 mm. USNM 408536, left valve (pl. 15, fig. 14), locality EGAL-75-KC-46, length 0.40 mm, height 0.26 mm.

CYTHEROPTERON HOPKINSI new species

Plate 14, figure 6; plate 16, figures 10–17; figure 25

Cytheropteron sp. L Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Dr. David M. Hopkins, University of Alaska, specialist in glaciomarine sedimentology of northern Alaska and Beringia.

Diagnosis.—Characterized by subtriangular lateral outline; broadly arched dorsum; sinuous venter with strong concavity; sharp, narrow caudal process; subtle dimorphism; ovoid pitting in concentric rows, smaller marginally; series of low posterior ridges which splay out dorsally and posteriorly; and strong, overhanging ventral ridge with tubercle at posterodorsal terminus.

Description.—Adult valves subtriangular in lateral view. Dorsal margin broadly arched; anterior margin broadly rounded, with greatest extent ventral of midline; ventral margin with strong concavity; posterior margin with sharp, narrow caudal process. Posterodorsal margin concave. Left valve with less arched dorsal margin, broad caudal process. Subtle dimorphism: males lower, with less

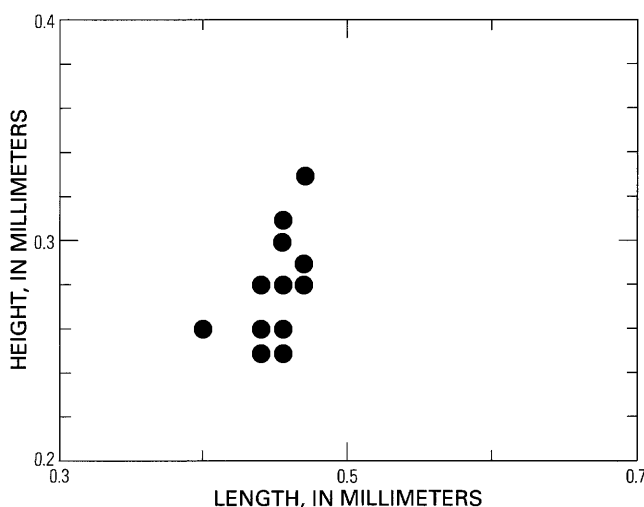


Figure 24. Plot of length versus height for *Cytheropteron haydenensis*. Dot may represent more than one specimen.

pronounced caudal process. Greatest length through caudal process; greatest height through median hinge element.

Valve covered with ovoid pitting of various sizes, occurring in rows parallel to valve outline. Pits are large, circular at middle of valve, smaller marginally. Posterior rows of pits separated by series of low ridges which originate at posteroventral corner and splay out dorsally and posteriorly. Smooth, flattened anterior and posterior rims. Overhanging ventral ridge, strongly calcified along outer edge; postero-dorsal terminus of ala forms tubercle. Two small anterior ridges extend toward median valve from ventral ridge; ridges separated by two depressed regions. Caudal process is smooth, flat. Thirty-five simple-type normal pores distributed over surface, most anterior; pores on surface between pits. Normal pores with low marginal rim.

Inner margin and line of concrescence coincide at posterior and venter; arcuate anterior vestibule. Fused inner lamella of even width throughout. Weakly developed sel-vage. Inner margin parallels valve outline. Eleven radial pore canals, most anterior. Radial pores are straight, simple; posterior radial pores longer than anterior.

Hingement in right valve consists of large, tabular anterior tooth; four anteromedian teeth and sockets; weakly crenulate median groove, enlarged terminally; four postero-median teeth and sockets; and narrow, elongate posterior tooth. Dorsal edge of valve enfolded to form accommodation groove.

Four adductor muscle scars in row, inclined posterodorsally. Dorsal scar is ovoid; dorsomedian scar is narrow, elongate; ventromedian scar is subrectangular, elongate; ventral scar is subcircular. Frontal scar split into larger, kidney-shaped posterior scar and small, round anterior scar. Fulcral point ovoid, located above posterior frontal scar. Dorsal scars are large, irregular in shape, few in number.

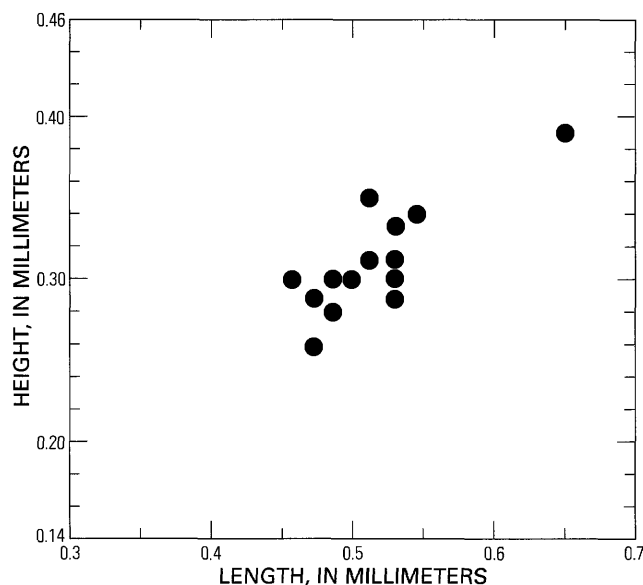


Figure 25. Plot of length versus height for *Cytherofteron hopkinsi*. Dot may represent more than one specimen.

Measurements.—X–Y plot based on 16 specimens (fig. 25).

Comparisons.—*Cytherofteron hopkinsi* n. sp. differs from *C. pararticum* Whatley and Masson, 1979 (Pleistocene, Britain) by its high arched dorsum; high ala; large ornament pits; and long, narrow caudal process. *C. hopkinsi* differs from *C. punctatum* Brady, 1868 (Quaternary, northeast Atlantic) by its long, low valve outline; thin, high ala; long caudal process; and large ornament pits.

Occurrence.—Assemblages II, III, IV. Table 2.

Distribution.—Pleistocene through Holocene: Gulf of Alaska. Middle-outer sublittoral, upper bathyal.

Material.—Twenty-five adult valves, twenty-five juvenile valves.

Type specimens.—Holotype: USNM 408546, right valve (pl. 14, fig. 6), locality EGAL-75-KC-11, length 0.53 mm, height 0.33 mm.

Paratypes: USNM 408547, left valve (pl. 16, figs. 10, 15), locality EGAL-75-KC-5, length 0.48 mm, height 0.26 mm. USNM 408548, right valve (pl. 16, figs. 11, 12), locality EGAL-75-KC-263, length 0.53 mm, height 0.31 mm. USNM 408549, left valve (pl. 16, figs. 13, 14), locality EGAL-75-KC-333, length 0.53 mm, height 0.29 mm. USNM 408550, right valve (pl. 16, fig. 16), locality EGAL-75-KC-333, length 0.50 mm, height 0.30 mm. USNM 408551, right valve (pl. 16, fig. 17), locality EGAL-75-KC-6, length 0.51 mm, height 0.35 mm.

CYTHEROPTERON LITUYAENSIS new species

Plate 19, figures 5–7, 9; figures 26, 27

Cytherofteron aff. *C. latissimum* of Neale and Howe (1975).

Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1982c, p. 2; Brouwers, 1983.

Etymology.—After Lituya Bay, a fiord near the Fairweather Range, southeast Alaska.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; small, well-developed caudal process; convex posterodorsal corner; shallow, ovoid ornament pits arranged vertically at median and concentrically at margins; low subdued ridges that separate pit rows; smoothly curved, strong, overhanging ventral ridge, bifurcates at anterior.

Description.—Adult valves subtriangular in lateral view. Right valve with highly arched dorsal margin; smoothly curved anterior margin with maximum width ventral of midline; ventral margin sinuous with pronounced concavity; posterior margin with small, well-developed caudal process and convex posterodorsal corner. Left valve differs in a lower, sinuous dorsum; broad, less protruding caudal process; less concave ventral margin. Greatest length through caudal process; greatest width through median dorsal margin.

Valve covered with moderate-sized, ovoid, shallow pits oriented in vertical rows at middle; rows curve to follow anterior and posterior margins. Low, subdued ridges between rows of pits. Broad, shallow dorsal sulcus; sulcus floor covered by small ovoid pits. Smoothly curved, strong ridge overhangs venter; anterior end of ridge bifurcates near margin. Shallow, subtle sulcus proceeds from middle of ventral ridge, terminates at median valve region. Fifty-one to sixty-two simple-type normal pores evenly distributed over surface; normal pores both within pits and on low ridges.

Inner margin and line of concrescence coincide throughout; inner margin follows valve outline. Inner lamella of even width throughout. Moderately developed

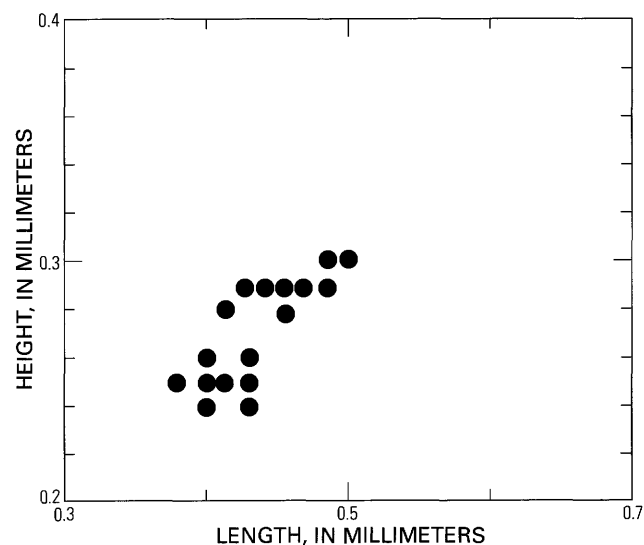


Figure 26. Plot of length versus height for *Cytherofteron lituyaensis*. Dot may represent more than one specimen.

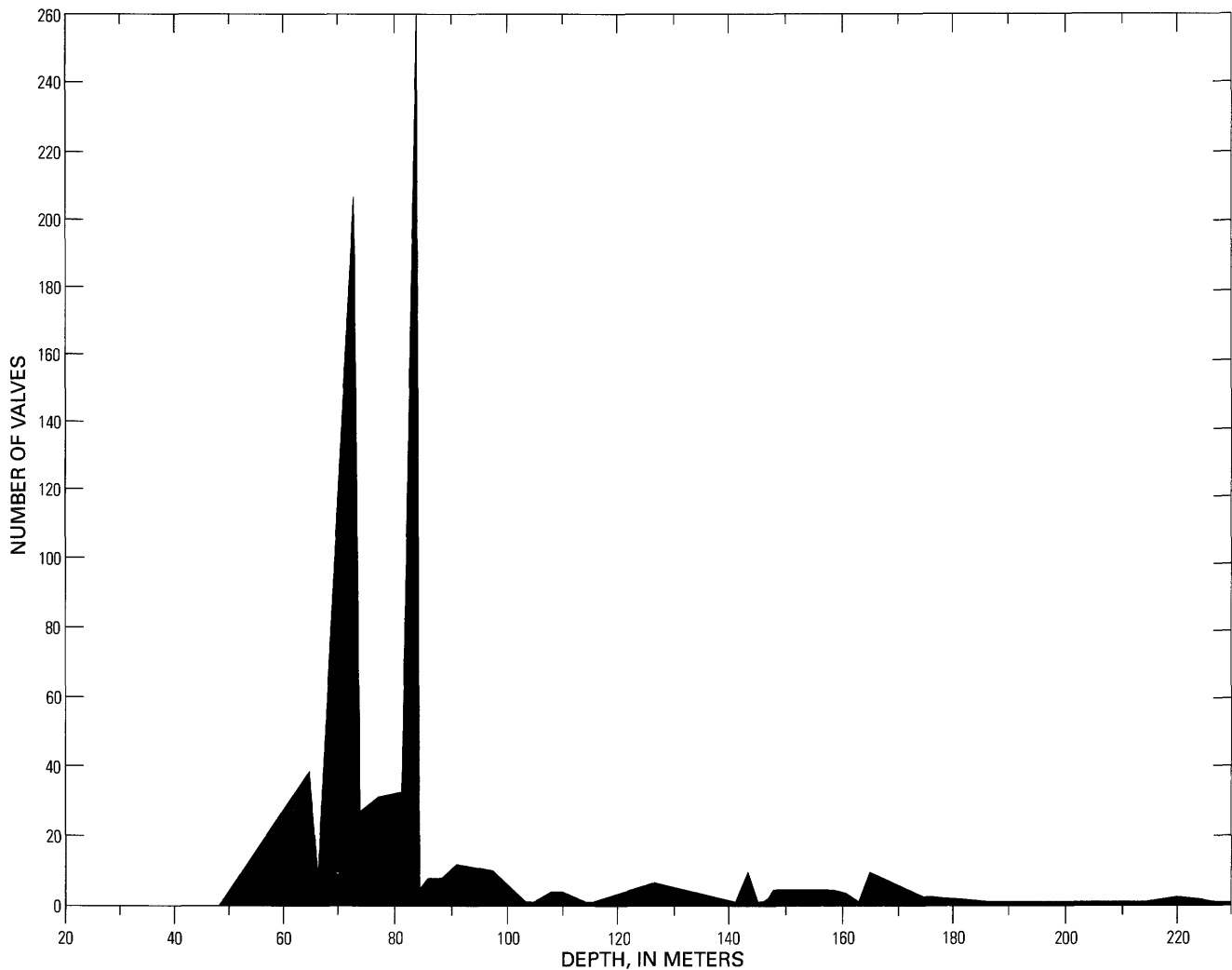


Figure 27. Plot of abundance versus water depth for *Cytheropteron lituyaensis*.

selvage, strongest along anterior. Eight radial pore canals, most anterior; radial pores are short, straight, simple.

Hingement in right valve consists of bifid anterior tooth; six elongate, quadrate, anteromedian teeth; coarsely crenulate median groove; seven elongate, quadrate, postero-median teeth; strong, rounded, bifid posterior tooth.

Adductor muscle scars form vertical row. Dorsal scar is squat, ovoid; dorsomedian scar is elongate, l-shaped; ventro-median scar is elongate, subquadrate; ventral scar is narrow, elongate. Numerous small, ovoid dorsal muscle scars.

Measurements.—X-Y plot based on 25 specimens (fig. 26).

Comparisons.—*Cytheropteron lituyaensis* n. sp. differs from *C. nodosum* Brady, 1868 (Quaternary, North Atlantic) by having a small size; sharp caudal process; rounded ventral ridge; and small, organized ornament pits. *C. lituyaensis* differs from *C. dimlingtonensis* Neale and Howe, 1973 (Pleistocene, North Atlantic, Beaufort Sea) by having a small size; less arched dorsum; small, sharp caudal process; and small, organized ornament pits. *C. lituyaensis*

differs from *C. latissimum* (Norman, 1864) (upper Pliocene through Holocene, North Atlantic) by having a small size; arched dorsum; small, sharp caudal process; rounded ventral ridge; and organized ornament pits.

Occurrence.—Assemblages II, III, IV, V. Table 2; figure 27.

Distribution.—Pleistocene through Holocene: Gulf of Alaska, Cook Inlet and Kodiak Shelf. Middle-outer sublittoral, upper bathyal.

Material.—Four hundred ninety-nine adult valves, three hundred seventy-seven juvenile valves.

Type specimens.—Holotype: USNM 408571, right valve (pl. 19, figs. 5, 6), locality EGAL-75-KC-17, length 0.38 mm, height 0.25 mm.

Paratypes: USNM 408569, left valve, locality EGAL-75-KC-17, length 0.43 mm, height 0.26 mm. USNM 408570, right valve, locality EGAL-75-KC-17, length 0.43 mm, height 0.25 mm. USNM 408572, right valve (pl. 19, figs. 7, 9), locality EGAL-75-KC-17, length 0.40 mm, height 0.24 mm.

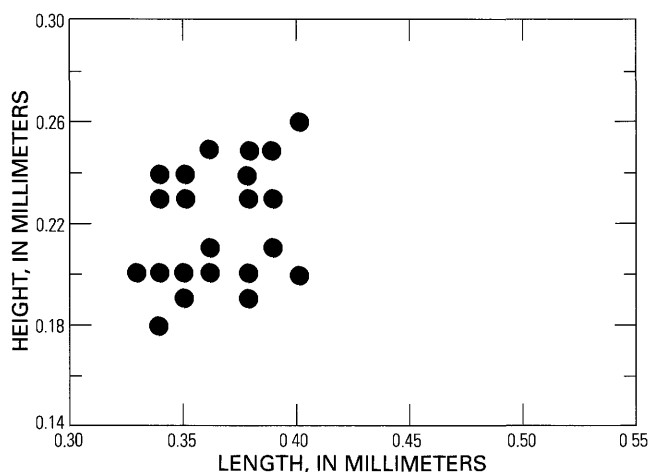


Figure 28. Plot of length versus height for *Cytheropteron lordi*. Dot may represent more than one specimen.

CYTHEROPTERON LORDI new species

Plate 14, figures 4, 5; plate 16, figures 1–9; figures 28, 29

Cytheropteron sp. D Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Alan Lord, University College of London.

Diagnosis.—Characterized by small size; subtriangular lateral outline; highly arched dorsum; deeply indented concavity; small, sharp caudal process; subtle dimorphism; strong, smooth, heavily calcified, overhanging ventral ridge; large posteroventral tubercle; series of thin, vertical ridges and sulci at posterior; arcuate sulcus and thin ridge along dorsum; and marginal pitting.

Description.—Adult valves subtriangular in lateral view. Right valve with highly arched dorsal margin; concave anterodorsal corner; smoothly curved anterior margin, with greatest width ventral of midline; ventral margin sinuous with deeply indented concavity; posterior margin with small, sharp caudal process. Left valve with less arched dorsal margin, broad caudal process, and posterodorsal hinge ear. Subtle dimorphism: males lower, with pronounced posterodorsal cardinal angle.

Valve surface covered with pits and ridges. Strong ridge overhangs venter, originating at posteroventral corner and terminating as wide ridge at anterior. Ventral ridge is smooth, heavily calcified. Three large trapezoidal depressions prominent along dorsal edge of ventral ridge, located at middle of ridge. Large subcircular tubercle posterior of depressions. Series of thin vertical ridges and wider sulci dominate posterior, proceeding from dorsum to ventral margin or to ventral ridge. Arcuate sulcus and thin ridge along dorsum. Dorsal valve edge thickened to form prominent raised rim. Anterior margin with smooth, flat rim or flange. Pitting along dorsal, anterior, and ventral margins; median valve region and posterior margin are smooth. Pits are ovoid,

tend to occur in concentric rows paralleling valve outline. Forty-three to fifty-six simple-type normal pores evenly distributed over surface, both within pits and on surface. Pores with raised marginal rim.

Inner lamella and line of concrescence coincide ventrally. Shallow arcuate vestibule at caudal process. Inner lamella widest at anterior. Strong, well-developed selvage. Eight to twelve radial pore canals, most anterior. Radial pores are short, straight, simple.

Hingement in right valve consists of two strong, large, quadrate anterior teeth; strongly crenulate median groove which expands terminally; strong, large, triangular postero-medial tooth and ovoid socket; and two large, ovoid, posterior teeth. Dorsal edge of right valve enfolded to form accommodation groove for dorsal edge of left valve. Hingement strong, well developed; most specimens occur as carapaces, and splitting the valves is very difficult.

Adductor muscle scars form inclined row, with ventral two scars within ornament tubercle. Dorsal scar is semicircular; dorsomedian scar is elongate, subquadrate; ventromedian scar is elongate, with inflated ends. Frontal scar forms upside-down J-shape, with long axis oriented posterior and vertical. Numerous subovoid to subquadrate dorsal muscle scars between central scar field and hinge line. Dorsal scars occur in pairs.

Measurements.—X–Y plot based on 31 specimens (fig. 28).

Comparisons.—*Cytheropteron lordi* is a very distinct taxon that is not morphologically similar to any described or illustrated forms.

Occurrence.—Assemblages II*, III, IV. Table 2; figure 29.

Distribution.—Pleistocene through Holocene: Gulf of Alaska.

Material.—One hundred fifty-five adult valves, four juvenile valves.

Type specimens.—Holotype: USNM 408537, left valve (pl. 14, fig. 4), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm.

Paratypes: USNM 408538, right valve (pl. 14, fig. 5), locality DC2-80-EG-195, length 0.35 mm, height 0.19 mm. USNM 408539, female left valve (pl. 16, fig. 1), locality DC2-80-EG-86, length 0.38 mm, height 0.24 mm. USNM 408540, female right valve (pl. 16, figs. 2, 3), locality DC2-80-EG-195, length 0.36 mm, height 0.25 mm. USNM 408541, male left valve (pl. 16, fig. 4), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm. USNM 408542, male right valve (pl. 16, fig. 5), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm. USNM 408543, left valve (pl. 16, figs. 6, 8), locality DC2-80-EG-86, length 0.34 mm, height 0.18 mm. USNM 408544, right valve (pl. 16, fig. 7), locality DC2-80-EG-86, length 0.38 mm, height 0.20 mm. USNM 408545, left valve (pl. 16, fig. 9), locality DC2-80-EG-195, length 0.40 mm, height 0.20 mm.

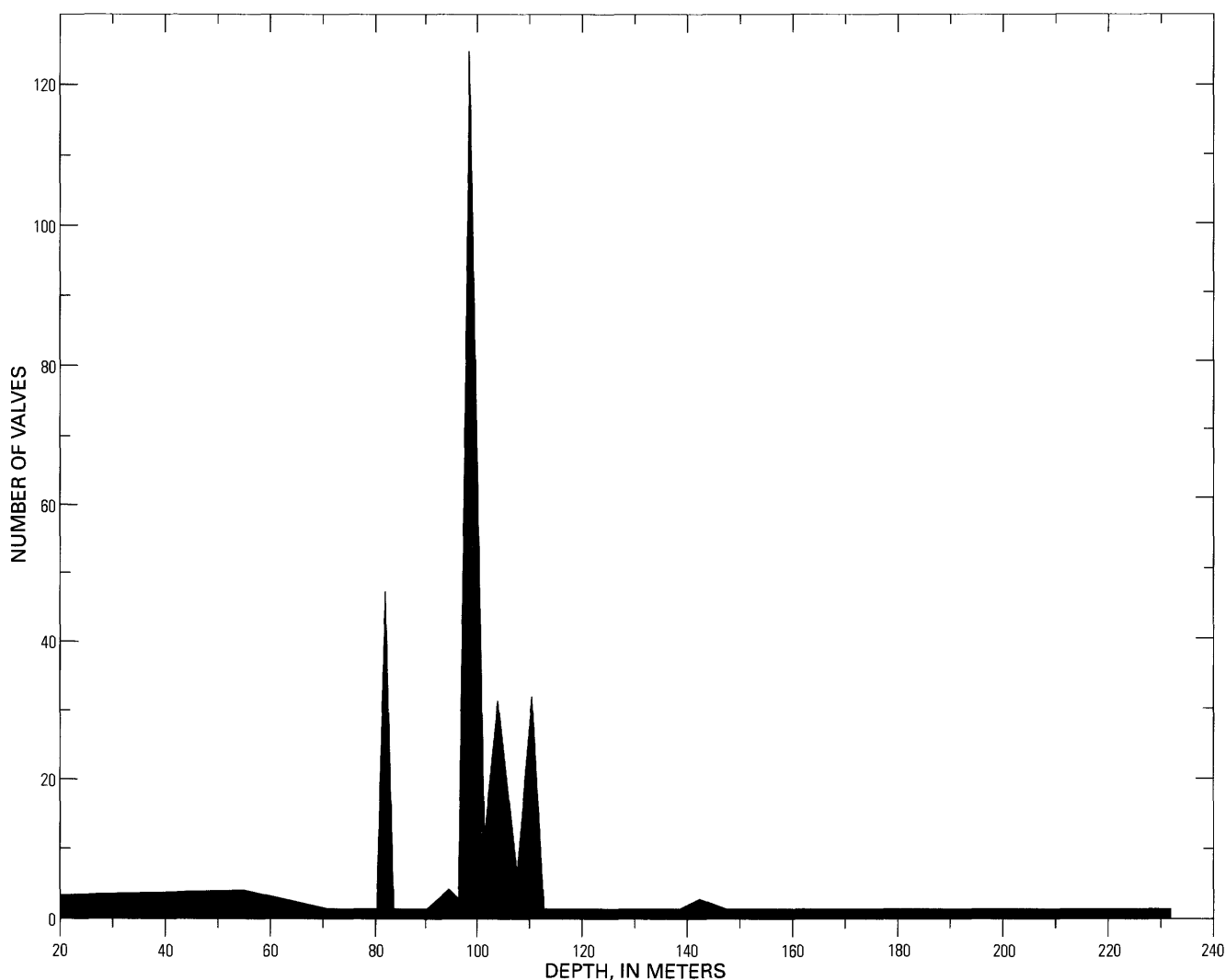


Figure 29. Plot of abundance versus water depth for *Cytheropteron lordi*.

CYTHEROPTERON MIDTHIMBERENSIS new species

Plate 19, figures 8, 10–14; figure 30

Cytheropteron sp. N Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Midthimber Lake, a proglacial lake of Bering Glacier, southeast Alaska.

Diagnosis.—Characterized by subtriangular to subquadrate lateral outline; wide, centrally located caudal process; marked dimorphism; small, ovoid ornament pits in radiating vertical rows; massive, heavily calcified, sinuous, overhanging ventral ridge; two large, oblique ridges from ventral ridge to posterodorsal and anterodorsal cardinal angles.

Description.—Adult valves subtriangular to subquadrate in lateral view. Left valve with highly arched dorsal margin; smoothly curved anterior margin with greatest width ventral of midline; ventral margin broadly sinuous; posterior

margin with wide caudal process at midvalve. Right valve with less arched dorsum. Marked dimorphism: males considerably longer, lower, with more quadrate shape and wider caudal process. Greatest length through caudal process; greatest height through middle of valve.

Valve covered with pitting and ridges. Pits are small, ovoid, occurring primarily along margins and sparsely in median region. Pits arranged as vertical rows radiating from venter. Pits smaller toward margins. Dorsal margin with sulcus and thin marginal ridge. Venter dominated by massive, heavily calcified, sinuous ridge which overhangs margin. Dorsal edge of ventral ridge with deep depression. Two large ridges originate at anterior and posterior end of ventral ridge, proceed toward posterodorsal and anterodorsal corners, respectively. Normal pores simple-type, both within ornament pits and on surface.

Left valve hingement consists of two quadrate anterior sockets; five anteromedian crenulae; smooth median bar; five posteromedian crenulae; and elongate posterior socket.

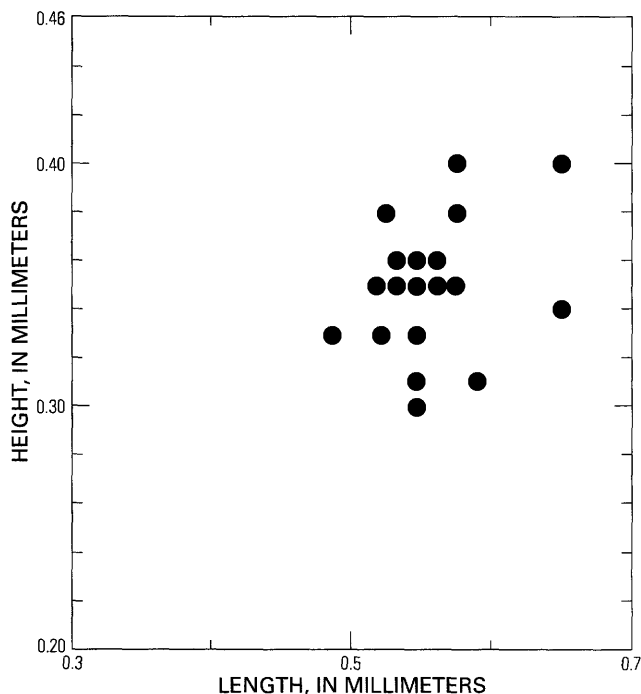


Figure 30. Plot of length versus height for *Cytheropteron midtimberensis*. Dot may represent more than one specimen.

Anteromedian and posteromedian elements are terminal enlargement of median element.

Measurements.—X-Y plot based on 22 specimens (fig. 30).

Comparisons.—*Cytheropteron midtimberensis* n. sp. differs from *C. eremitum* Hanai, 1959 (lower Pleistocene, central Japan) by having a shorter, higher lateral outline; more arched dorsum; strong ventral ridge; two strong oblique ridges at anterior and posterior; and fewer ornament pits. *C. midtimberensis* differs from *C. haydenensis* by having a more arched dorsum, different shape of the ventral ridge, different ornament with fewer pits, and lack of vertical ribs.

Occurrence.—Assemblages II, III, V. Table 2.

Distribution.—Pleistocene through Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf.

Material.—One hundred forty-two adult valves, one hundred thirty-four juvenile valves.

Type specimens.—Holotype: USNM 408575, left valve (pl. 19, figs. 8, 10), locality DC2-80-EG-195, length 0.55 mm, height 0.35 mm.

Paratypes: USNM 408573, left valve, locality DC2-80-EG-195, length 0.64 mm, height 0.34 mm. USNM 408574, right valve, locality DC2-80-EG-195, length 0.64 mm, height 0.40 mm. USNM 408576, right valve (pl. 19, fig. 11), locality DC2-80-EG-195, length 0.55 mm, height 0.36 mm. USNM 408577, left valve (pl. 19, fig. 12), locality DC2-80-EG-195, length 0.56 mm, height 0.35 mm. USNM 408578, left valve (pl. 19, figs. 13, 14), locality DC2-80-EG-195, length 0.59 mm, height 0.31 mm.

CYTHEROPTERON NODOSOALATUM
Neale and Howe, 1973

Plate 11, figure 3; plate 12, figures 2–7; figures 31, 32

Cytheropteron nodosoalatum Neale and Howe, 1973, p. 240–242, pl. 1, figs. 6, 7a, b.

Cytheropteron aff. *C. nodosoalatum* Neale and Howe. Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1982c, p. 2; Brouwers, 1983.

Diagnosis.—Characterized by subtriangular lateral outline; smoothly curved anterior margin; sinuous venter with moderate concavity; concave posterodorsal corner; pronounced dimorphism; strong, overhanging alar ridge terminating at anterior as bifurcating fork; ornament pits aligned vertically in median area and concentrically at margins; secondary fine pits and ridges; shallow arcuate anterior vestibule; and very small, irregular posterior vestibule.

Description.—Adult right valve subtriangular, left valve subquadrate in lateral view. Right valve with broadly arched dorsal margin; smoothly curved anterior margin with concave anterodorsal corner and with maximum width ventral of midline; ventral margin sinuous, with moderately incurved concavity; posterior margin with blunt caudal process; concave posterodorsal corner. Left valve with strong, obtuse, posterodorsal cardinal angle; convex anterodorsal corner; broad, flattened posterior. Pronounced dimorphism: males are more quadrate, lower in height, longer. Greatest height through midline; greatest length through caudal process.

Valve surface covered with pits and ridges. Strong alar ridge overhangs venter, originating at posteroventral corner and terminating at anterior as bifurcating fork. Alar ridge is smooth, heavily calcified, with two dorsal-pointing

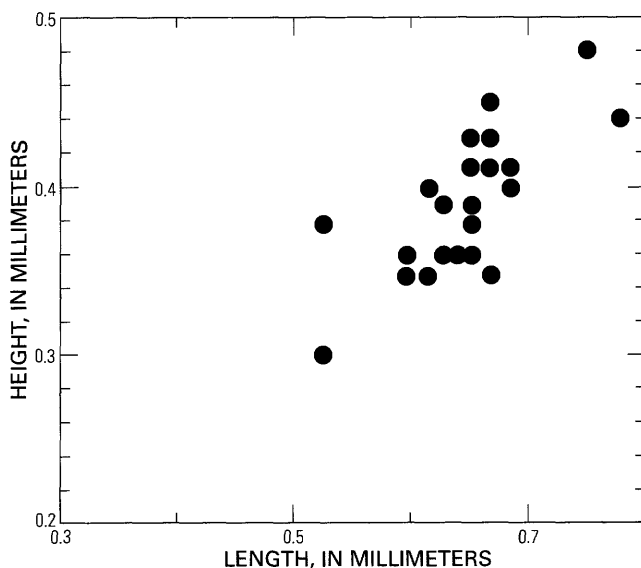


Figure 31. Plot of length versus height for *Cytheropteron nodosoalatum*.

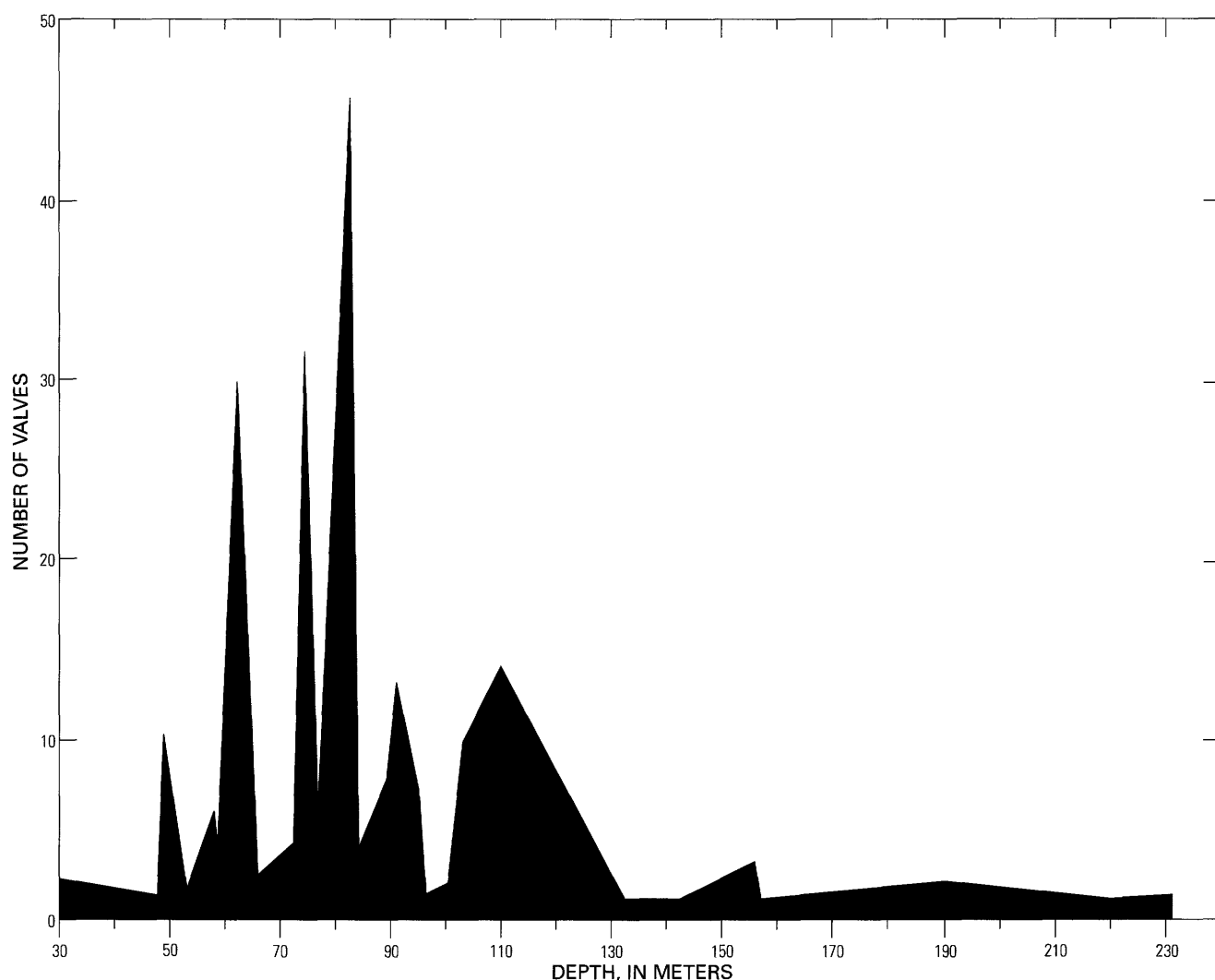


Figure 32. Plot of abundance versus water depth for *Cytheropteron nodosoalatum*.

extensions forming U-shape near middle of ridge. Pits are aligned in vertical rows at median valve, become concentric marginally. Pits are large, ovoid at posteromedian, becoming smaller anteriorly. Dendritic ridges between rows of pits at posteromedian. Secondary fine marginal pits and ridges. Sixty-one simple-type normal pores scattered over valve surface, occurring within pits.

Inner lamella and line of concrescence coincide at posteroventer and venter. Shallow arcuate anterior vestibule; very small, irregular vestibule at caudal process. Fused inner lamella of even width throughout. Strong, well-developed selvage. Seven radial pore canals, one false radial pore canal; most anterior. Radial pores are long, straight, simple.

Hingement in right valve consists of two small, ovoid anterior teeth; finely crenulate median groove; two ellipsoidal posterior teeth. Median groove enlarged terminally, with separated, round crenulate elements. Dorsal edge of right valve enfolded to form accommodation groove for left valve dorsal edge.

Adductor muscle scars form curved row; scars are immediately adjacent. Frontal scar is J-shaped. Scar impressions are weak.

Measurements.—X-Y plot based on 22 specimens (fig. 31).

Comparisons.—*Cytheropteron nodosoalatum* differs from *C. latissimum* (Norman, 1864) (upper Pliocene through Holocene, northeast Atlantic) by having an arched dorsum; strong ventral ridge; pronounced, narrow caudal process; and organized, vertically arranged ornament pits. *C. nodosoalatum* differs from *C. nodosum* Brady, 1868 (Quaternary, northeast Atlantic) by having a less arched dorsum; weak, sinuous ventral ridge; evenly rounded anterior; and lack of dorsal tubercles. *C. nodosoalatum* differs from *C. champlai-num* Cronin, 1981 (Holocene, North Atlantic) by having a strong posterodorsal cardinal angle; massive, sinuous ventral ridge; long, low valve outline; and broad caudal process.

Occurrence.—Assemblages I*, II, III, V. Table 2; figure 32.

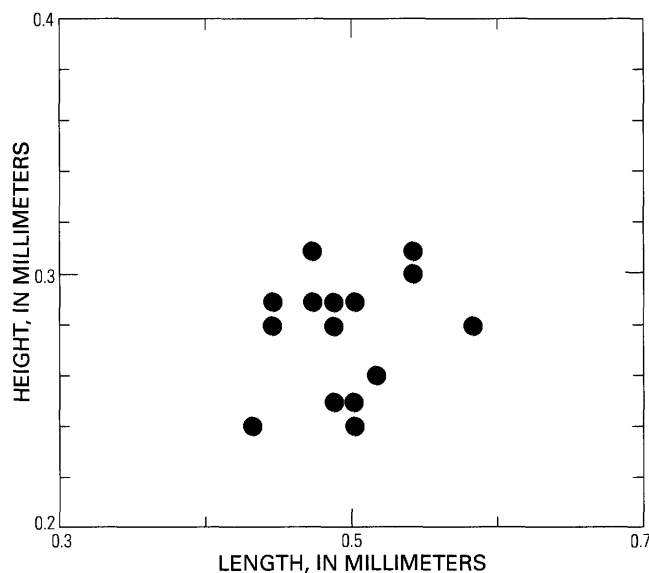


Figure 33. Plot of length versus height for *Cytherofteron squirei*. Dot may represent more than one specimen.

Distribution.—Holocene: Novaya Zemlya, Franz Joseph Land, Barents Sea. Pleistocene through Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf. Sublittoral, upper bathyal.

Material.—One hundred fifteen adult valves, one hundred thirty-three juvenile valves.

Illustrated specimens.—USNM 408505, right valve (pl. 11, fig. 3), locality DC2-80-EG-195, length 0.65 mm, height 0.43 mm. USNM 408506, left valve (pl. 12, figs. 2, 3), locality DC2-80-EG-63, length 0.65 mm, height 0.38 mm. USNM 408507, left valve (pl. 12, fig. 4), locality DC2-80-EG-195, length 0.65 mm, height 0.36 mm. USNM 408508, right valve (pl. 12, fig. 5), locality DC2-80-EG-63, length 0.60 mm, height 0.35 mm. USNM 408509, left valve (pl. 12, fig. 6), locality DC2-80-EG-195, length 0.61 mm, height 0.35 mm. USNM 408510, right valve (pl. 12, fig. 7), locality DC2-80-EG-195, length 0.63 mm, height 0.36 mm.

CYTHEROPTERON SQUIREI new species

Plate 18, figures 7, 8; plate 20, figures 12–18;
plate 22, figures 1–3; figure 33

Cytherofteron sp. 1 Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Cytherofteron sp. 2 Tabuki, 1986, p. 101, pl. 18, figs. 9, 10.

Etymology.—After John Squire, engineering geologist, British Petroleum.

Diagnosis.—Characterized by quadrate lateral outline; straight dorsum; pronounced concavity; broad caudal process; marked dimorphism, males longer, lower; reticulation in vertical rows of elongate to ovoid pits; strong, high, heavily calcified ala with terminal tubercles separated by median depression.

Description.—Adult valves quadrate in lateral view. Left valve with broadly arched dorsum; smoothly rounded anterior margin with greatest width ventral of midline; ventral margin sinuous with pronounced concavity; posterior margin with broad caudal process. Right valve with more arched dorsum; smaller, longer caudal process; more sinuous venter; and concave anterodorsal corner. Marked dimorphism: males considerably longer, lower, with coarse ornament pattern, prolonged caudal process, straight dorsum, and stronger ventral ridge. Greatest length through caudal process; greatest height through anterior hinge element.

Valve covered with reticulation and ridges. Moderately developed reticulation arranged in vertical rows. Pits are elongate to ovoid, arranged with long axis vertical. Ventral margin dominated by strong, high, heavily calcified, overhanging ridge or ala. Anterior and posterior ends of ventral ridge enlarged into tubercles, separated by median depression. Simple-type normal pores scattered over surface; pores with small marginal rim.

Hingement in right valve consists of elongate, narrow anterior tooth; small anteromedian crenulae; finely crenulate median groove; small posteromedian crenulae; and elongate, narrow posterior tooth. Anteromedian and posteromedian crenulae form terminal enlargement of median element.

Four adductor muscle scars form oblique row, inclined posterodorsally. Adductor scars are inflated, subovoid in shape. Frontal scar is J-shaped. Weak, circular fulcral point. Scattered, large, elongate dorsal muscle scars.

Measurements.—X–Y plot based on 18 specimens (fig. 33).

Comparisons.—*Cytherofteron squirei* n. sp. differs from *C. latissimum* (Norman, 1864) (upper Pliocene through Holocene, North Atlantic) by having an elongate, quadrate valve outline; blunt caudal process; pronounced dimorphism; vertical rows of ornament pits; and strong ventral tubercles. *C. squirei* differs from *C. rarum* Hanai, 1957 (upper Pliocene, Japan) by having a weaker ventral ridge; narrow, blunt caudal process; pronounced dimorphism; and small, ovoid, less organized ornament pits.

Occurrence.—Assemblages II, V. Table 2.

Distribution.—Pliocene and Pleistocene: central Japan. Pleistocene, Holocene (?): Gulf of Alaska, Cook Inlet, Kodiak Shelf, Pribilof Islands. Middle sublittoral.

Material.—Fifty-eight adult valves, thirty-four juvenile valves.

Type specimens.—Holotype: USNM 408588, female left valve (pl. 18, fig. 7), locality EGAL-75-KC-52A, length 0.45 mm, height 0.25 mm.

Paratypes: USNM 408589, male left valve (pl. 18, fig. 8), locality DC2-80-EG-195, length 0.50 mm, height 0.29 mm. USNM 408590, male right valve (pl. 20, figs. 12, 17, 18), locality DC2-80-EG-195, length 0.50 mm, height 0.28 mm. USNM 408591, female left valve (pl. 20, fig. 13), locality EGAL-75-KC-32, length 0.49 mm, height 0.29 mm. USNM 408592, female right valve (pl. 20, fig. 14), locality

DC2-80-EG-195, length 0.58 mm, height 0.31 mm. USNM 408593, female left valve (pl. 20, fig. 15), locality DC2-80-EG-195, length 0.45 mm, height 0.29 mm. USNM 408594, male left valve (pl. 20, fig. 16), locality DC2-80-EG-195, length 0.48 mm, height 0.25 mm. USNM 408595, female right valve (pl. 22, fig. 1), locality DC2-80-EG-195, length 0.48 mm, height 0.24 mm. USNM 408596, female left valve (pl. 22, figs. 2, 3), locality DC2-80-EG-195, length 0.49 mm, height 0.29 mm.

CYTHEROPTERON SUZDALSKIYI Lev, 1972

Plate 18, figures 4, 5; plate 20, figures 1–9; figure 34

Cytheropteron suzdalskyi Lev, 1972, p. 19, pl. 1, figs. 1–5.

Cytheropteron sp. Z Brouwers, 1982b, p. 8; Brouwers, 1983.

Diagnosis.—Characterized by quadrate lateral outline; sinuous dorsum; drawn-out anterior and posterior; small concavity; pronounced caudal process; marked dimorphism; fine reticulation with vertical or concentric orientation at margins and chaotic arrangement medially; fine secondary papillae; anterior and posterior flattened marginal rim; large, rounded tubercles at posterodorsal, anterodorsal, anteroventral, and posteroventral corners; weak, sinuous ventral ridge; arcuate anterior vestibule; and four deep internal depressions reflecting external tubercles.

Description.—Adult valves subtriangular in lateral view. Right valve with concave posterodorsum, arched median dorsum, concave anterodorsum; broadly curved anterior margin; sinuous ventral margin with small concavity; posterior margin drawn-out with pronounced caudal process. Caudal process most attenuated dorsal of midline. Left valve with obtuse anterodorsal corner; straight median dorsal margin; broad, blunt caudal process. Pronounced dimorphism: males are longer, lower, with less arched dorsum, broader caudal process, attenuated anterior, and strong posterior convergence of anterior and posterior margins. Greatest length through caudal process; greatest height through anterior hinge element.

Valve covered with fine reticulation network. Ridges vertical or parallel to margin at anterior and posterior, with few oblique connecting cross-ridges. Reticulation more chaotic, ridges heavier in median valve region. Secondary fine papillae cover surface between ridges. Some fine pitting along anterior and posterior margins between reticulation. Anterior and posterior flattened rim. Large rounded tubercle along anterodorsal margin; three weaker tubercles at posterodorsal, posteroventral, and anteroventral corners. Tubercles covered by reticulation and ornament papillae. Weak sinuous ridge parallels ventral margin. Sixty-six to sixty-eight simple-type normal pores evenly distributed over surface, both on and adjacent to ridges. Normal pores with raised marginal rim.

Inner margin and line of concrescence coincide along posterior and venter; arcuate anterior vestibule. Inner margin

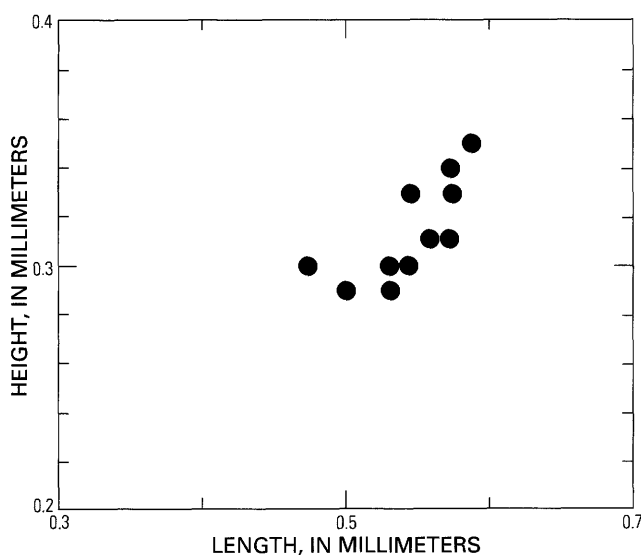


Figure 34. Plot of length versus height for *Cytheropteron suzdalskyi*. Dot may represent more than one specimen.

widest at anterior. Inner margin parallels valve outline. Moderately developed selvage. Ten to twelve radial pores, most anterior; pores are straight, short, simple. Two short false radial pores. Tubercles reflected internally as large, rounded, deep depressions.

Hinge in left valve consists of two anterior rectangular sockets; weakly crenulate median bar which thickens and enlarges terminally into six anteromedian and nine postero-median quadrate teeth; and three posterior quadrate sockets. Median bar formed by dorsal valve edge. Anterior and posterior sockets rimmed dorsally by hinge ears.

Four adductor muscle scars in row, inclined slightly posterodorsally. Dorsal scar trapezoidal; dorsomedian scar an elongate ellipsoid; ventromedian scar elongate, arched; ventral scar ovoid. Few dorsal scars, with rounded to ovoid scars near central scar field, elongate scars along dorsum.

Measurements.—X–Y plot based on 16 specimens (fig. 34).

Comparisons.—*Cytheropteron suzdalskyi* differs from *C. angulatum* Brady and Robertson, 1872 (Quaternary, North Atlantic) by having an elongate, quadrate valve shape; strong tubercles; extended caudal process; weak ventral ridge; ornament ridges.

Occurrence.—Cruise EGAL-75-KC, localities 115, 130, BFM-78-1, G-4.

Distribution.—Pleistocene: Russian Arctic. Holocene: Gulf of Alaska.

Material.—Twenty-one adult valves, twenty-eight juvenile valves.

Illustrated specimens.—USNM 408579, female left valve (pl. 18, fig. 4), locality BFM-78-1, length 0.56 mm, height 0.33 mm. USNM 408580, male left valve (pl. 18, fig. 5), locality BFM-78-1, length 0.53 mm, height 0.29 mm. USNM 408581, female left valve (pl. 20, fig. 1), locality

BFM-78-1, length 0.56 mm, height 0.31 mm. USNM 408582, female right valve (pl. 20, figs. 2, 3), locality BFM-78-1, length 0.54 mm, height 0.33 mm. USNM 408583, male left valve (pl. 20, fig. 4), locality BFM-78-1, length 0.55 mm, height 0.31 mm. USNM 408584, male right valve (pl. 20, figs. 5, 6), locality BFM-78-1, length 0.53 mm, height 0.30 mm. USNM 408585, left valve (pl. 20, figs. 7, 8, 9), locality BFM-78-1, length 0.54 mm, height 0.30 mm.

CYTHOPTERON TARRENSIS new species

Plate 21, figure 1; plate 22, figures 4–10; figure 35

Cytheropteron sp. M Brouwers, 1981, p. 9; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After Tarr Inlet, a fiord of Glacier Bay at the mouth of Grand Plateau Glacier.

Diagnosis.—Characterized by subtriangular lateral outline; moderately arched dorsum; highly convex venter with small concavity; subtle dimorphism; pits in vertical rows; dorsomedian ridges; anterior and posterior smooth, flattened marginal rim; secondary corrugation and papillae on solum floors; strong, sinuous, overhanging ventral ridge, bifurcates at anterior in right valve; and elongate, vertical posteroventral depressions.

Description.—Adult valves subtriangular in lateral view. Dorsal margin arched; anterior margin smoothly rounded with greatest width ventral of midline; ventral margin convex with small concavity; posterior margin with pronounced caudal process. Left valve with less arched dorsum; no concave posterodorsal corner; broad, blunt caudal process. Subtle dimorphism: males slightly shorter, lower; less arched dorsum; broad, weak caudal process. Greatest length through caudal process; greatest height through median hinge element.

Valve covered with ovoid pitting of various sizes arranged in vertical rows. Dorsomedian pit rows separated by low ridges. Pits are large, elongate in middle, smaller at margins. Subdued dorsal marginal sulcus, especially developed in right valve. Anterior and posterior smooth, flattened marginal rim. Secondary fine corrugations and papillae on solum floors. Strong, sinuous ridge overhangs posteroventer; ridge strengthened by heavy calcification. Ventral ridge originates at posteroventer, bifurcates at anterior. Elongate, vertical depressions at posteroventral corner where ventral ridge originates. Fifty-seven simple-type normal pores scattered over surface, both on ridges and in pits. Pores on ridges have raised marginal rim, pores within pits are celate.

Inner margin and line of concrescence coincide at posterior and venter; shallow, arcuate, anterior vestibule. Inner lamella widest at anterior, of even width at posterior and venter. Inner margin parallels valve outline. Moderately developed selvage. Ten radial pores, most anterior; pores are straight, simple, long.

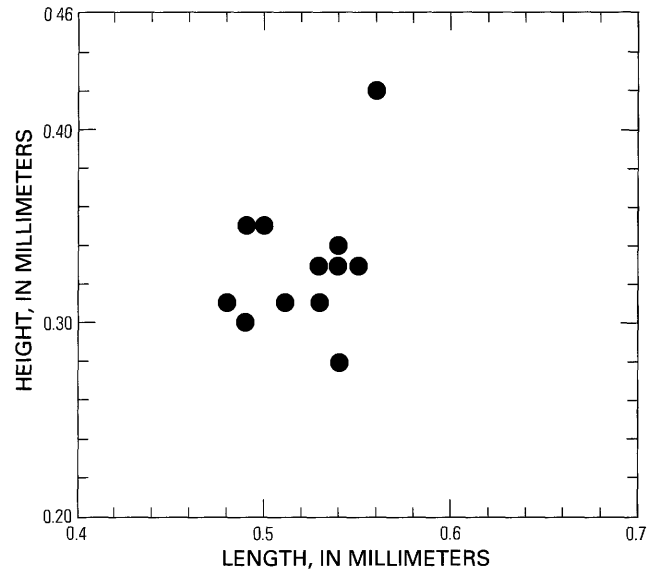


Figure 35. Plot of length versus height for *Cytheropteron tarrensis*. Dot may represent more than one specimen.

Four adductor muscle scars in row, inclined posterodorsally. Dorsal scar is subcylindrical; dorsomedian scar is elongate, I-shaped; ventromedian scar is elongate, with inflated ends; ventral scar is large, subquadrate. V-shaped frontal scar. Two mandibular scars located ventral of frontal scar; anterior scar is circular, posterior scar is elongate, ellipsoidal.

Measurements.—X-Y plot based on 16 specimens (fig. 35).

Comparisons.—*Cytheropteron tarrensis* n. sp. differs from *C. champlainum* Cronin, 1981 (Quaternary, North Atlantic) by having a sinuous, overhanging ventral ridge; broad caudal process; less arched dorsum; large ovoid pits; prolonged anterior; and lack of ridges between pit rows. *C. tarrensis* differs from *C. nodosum* Brady, 1868 (Quaternary, North Atlantic) by its less arched dorsum; long, low valve outline; large, ovoid ornament pits; smooth caudal process.

Occurrence.—Cruise EGAL-75-KC, localities 4, 6, 90, 105, 202, 216. Assemblages II, III, V.

Distribution.—Pleistocene: Gulf of Alaska. Inner-middle sublittoral.

Material.—Twenty-eight adult valves, one juvenile valve.

Type specimens.—Holotype: USNM 408597, left valve (pl. 21, fig. 1), locality EGAL-75-KC-6, length 0.54 mm, height 0.33 mm.

Paratypes: USNM 408598, left valve (pl. 22, fig. 4), locality EGAL-75-KC-6, length 0.56 mm, height 0.41 mm. USNM 408599, right valve (pl. 22, figs. 5, 6), locality EGAL-75-KC-6, length 0.53 mm, height 0.31 mm. USNM 408600, left valve (pl. 22, fig. 7), locality EGAL-75-KC-6, length 0.49 mm, height 0.30 mm. USNM 408601, left valve (pl. 22, figs. 8, 9, 10), locality EGAL-75-KC-6, length 0.54 mm, height 0.28 mm.

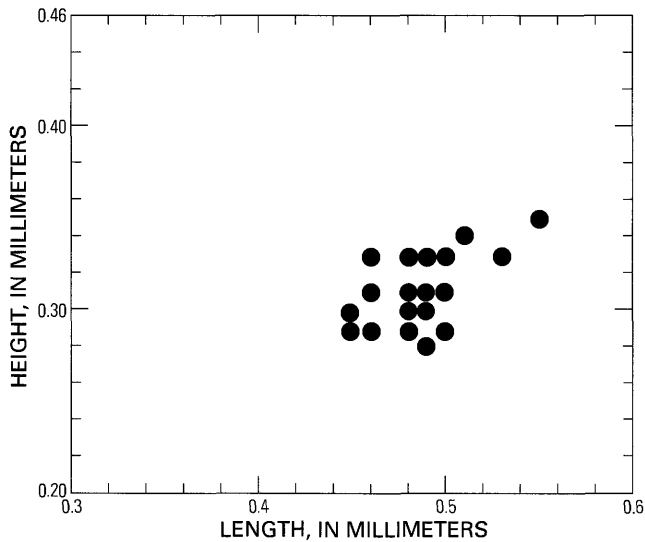


Figure 36. Plot of length versus height for *Cytheropteron tsugaruense*. Dot may represent more than one specimen.

CYTHEROPTERON TSUGARUENSE Tabuki, 1986

Plate 10, figures 8, 14–18; plate 11, figures 1, 2;
plate 12, figure 1; figures 36, 37

Cytheropteron tsugaruense Tabuki, 1986, p. 100–101, pl. 18, figs. 1–6; pl. 20, fig. 8; text-figs. 17–5, 17–6.

Cytheropteron sp. F Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1982c, p. 2; Brouwers, 1983.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched, sinuous dorsal margin; blunt, broad caudal process; strong posterodorsal cardinal angle; moderate dimorphism; strong, sinuous, overhanging ventral ridge ending as posteroventral tubercle; ornament pits arranged vertically and radially; large anterodorsal tubercle.

Description.—Adult valves subtriangular in lateral view. Left valve with highly arched, sinuous dorsal margin; posterior third of dorsal margin highly concave; anterior margin smoothly curved, with greatest width ventral of midline; ventral margin sinuous, with pronounced concavity; posterior margin with blunt, broad caudal process; strong posterodorsal cardinal angle. Right valve with highly arched dorsal margin; pronounced, pointed caudal process; and lack of concave posterodorsal margin. Moderate dimorphism: males are slightly shorter, considerably lower. Greatest length through caudal process; greatest height through median hinge element.

Valve surface covered with ovoid pitting and ridges. Strong sinuous ridge overhangs venter; ridge is strengthened by heavy calcification. Ridge originates at posterodorsal corner as large tubercle, proceeds vertically to posteroventral corner, swings across to form blunt, sinuous, alar structure, and terminates at anteroventral corner. Posteroventral ala

forms large, blunt tubercle; smooth tubercle at median ala. Two large ovoid depressions along ventral alar ridge. Low ridge-reticulation system covers valve, oriented radially and concentrically from ventral ridge. Secondary small pitting along dorsal margin. Caudal process is smooth, flat. Forty-two to fifty-nine simple-type normal pores evenly distributed over surface, occurring within pits and on surface. Normal pores with marginal rim.

Inner margin and line of concrescence coincide along venter; shallow, arcuate anterior vestibule and small, irregularly shaped posterior vestibule. Inner margin parallels valve outline; inner lamella widest at anterior. Strong, well-developed selvage. Twelve to fourteen radial pores, most anterior; radial pores are straight, simple.

Hingement in right valve consists of two rounded anterior teeth; coarsely crenulate median groove; and three rounded posterior teeth. Median element is enlarged terminally to form large crenulae. Dorsal edge of right valve enfolded to form accommodation bar.

Measurements.—X–Y plot based on 29 specimens (fig. 36).

Comparisons.—*Cytheropteron tsugaruense* Tabuki, 1986 differs from *C. angulatum* Brady and Robertson, 1872 (Quaternary, North Atlantic, Arctic) by having an arched dorsum; pointed caudal process; strong posterior vertical ridge; rounded posterior in left valve; vertically arranged ornament pits; and different anterior and posterior hinge elements. *C. tsugaruense* differs from *C. pyramidale* Brady, 1868 (Quaternary, northeast Atlantic) by having a strong posterodorsal cardinal angle; rounded anterior; rounded posterior in left valve; heavily calcified, sinuous ventral ridge; and evenly sized, vertically arranged ornament pits.

Occurrence.—Assemblages II, III, V. Table 2; figure 37.

Distribution.—Pliocene and Pleistocene: central Japan. Pleistocene through Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf, Chukchi Sea. Middle-outer sublittoral.

Material.—One hundred twenty-three adult valves, sixty-one juvenile valves.

Illustrated specimens.—USNM 408498, left valve (pl. 11, fig. 1), locality DC2-80-EG-195, length 0.49 mm, height 0.31 mm. USNM 408499, right valve (pl. 11, fig. 2), locality DC2-80-EG-195, length 0.49 mm, height 0.30 mm. USNM 408500, female left valve (pl. 10, figs. 14, 18), locality DC2-80-EG-195, length 0.50 mm, height 0.29 mm. USNM 408501, female right valve (pl. 10, fig. 15), locality DC2-80-EG-195, length 0.49 mm, height 0.33 mm. USNM 408502, male left valve (pl. 10, fig. 16), locality DC2-80-EG-195, length 0.46 mm, height 0.29 mm. USNM 408503, male right valve (pl. 10, fig. 17), locality DC2-80-EG-195, length 0.46 mm, height 0.31 mm. USNM 408504, male right valve (pl. 10, fig. 8; pl. 12, fig. 1), locality DC2-80-EG-195, length 0.48 mm, height 0.33 mm.

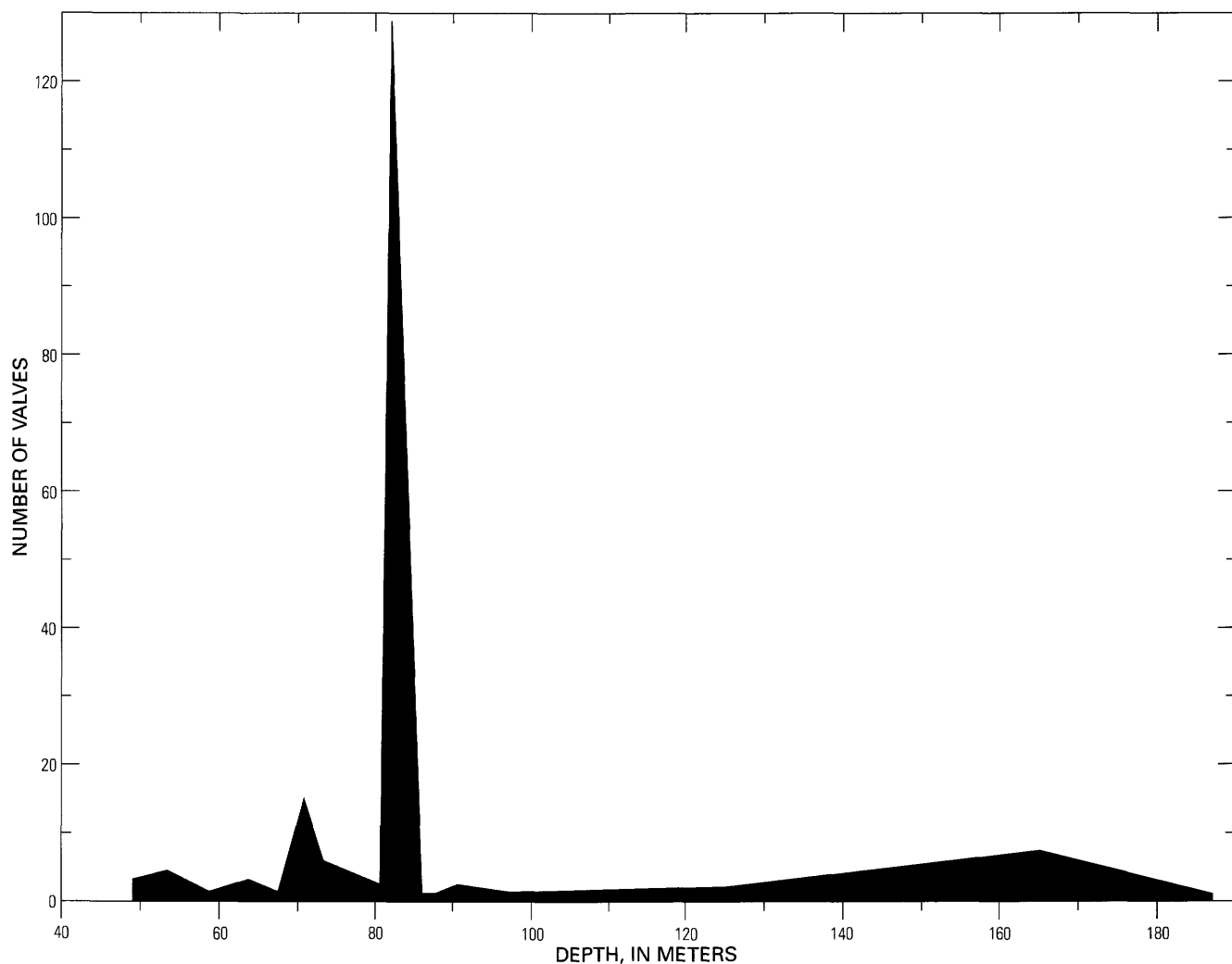


Figure 37. Plot of abundance versus water depth for *Cytherofteron tsugaruense*.

CYTHEROPTERON VERNRITCHIENSIS new species

Plate 21, figure 3; plate 22, figures 14, 15; plate 23, figures 1–6

Cytherofteron sp. P Brouwers, 1981, p. 9; Brouwers, 1982c, p. 2; Brouwers, 1983.

Cytherofteron sp. 1 Tabuki, 1986, p. 101, pl. 18, figs. 7, 8; text-fig. 19–4.

Etymology.—After Vern Ritchie Glacier, originating in the Juneau icefields, southeast Alaska and British Columbia.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; sinuous venter; broad, pronounced caudal process; large ovoid to elongate pits in vertical rows at median and concentric at margins; pitting variable between individuals; low, strong, heavily calcified, overhanging ventral ala.

Description.—Adult valves ellipsoidal to subtriangular in lateral view. In left valve, dorsal margin broadly arched; anterior margin smoothly curved, with maximum width ventral of midline; ventral margin sinuous with concave and

convex parts; broad, pronounced caudal process. Obtuse, rounded posterodorsal corner; broad concave anterodorsal margin. Right valve differs in a high, arched dorsal margin; pointed, drawn-out caudal process; pronounced concave anterodorsal margin; lack of cardinal angle; attenuated anterior margin.

Valve covered with primary and secondary pitting, low ridges, pronounced ventral alar structure. Primary large ovoid to elongate pits oriented in vertical rows near median, radial rows at anterior and posterior margins. Pits largest at median, smaller at margins. Pitting variable between individuals, ranging from large ovoid, elongate pits to smaller, circular to ovoid pits. Low, strong, heavily calcified ala overhangs venter; ala crescentic, originating as bifurcate ridge at anterior and terminating at posteroventral corner. Ventral alar edge is smooth; dorsal alar side with large pits and large polygonal depressions. Low ridge and companion sulcus parallel and adjacent to dorsum. Five to six low, subparallel ridges dominate posterior; ridges originate at posterodorsal corner, proceed obliquely in anteroventral direction

to midline, and follow vertical course to posterodorsal margin. Secondary fine pits and punctae along dorsum. Caudal process and anteroventral margin have broad, smooth, flat region. Sixty-five simple-type normal pores evenly distributed over surface, both in pits and on surface. Normal pores with distinct marginal rim.

Inner margin and line of concrescence coincide at venter and posterior. Deep, arcuate anterior vestibule. Moderately developed selvage, strongest along anterior. Fused inner lamella of even width throughout; inner margin parallels valve outline. Nine radial pore canals, most anterior. Radial pores short, straight, simple. Small ellipsoidal ocular sinus below anterior hinge element.

Hingement in left valve consists of two large, quadrate, anterior sockets; five ovoid anteromedian teeth; smooth median bar; five ovoid posteromedian teeth; and three small, quadrate, posterior sockets. Anteromedian and posteromedian teeth form enlarged terminal portion of median bar. Median element formed by dorsal valve edge. Right valve hingement with dorsal margin enfolded to form accommodation groove.

Four large adductor muscle scars form inclined row; scars are close together. Dorsal scar is wedge-shaped; dorsomedian scar is elongate, subquadrate; ventromedian scar is I-shaped; ventral scar is elongate, subquadrate. Frontal scar irregular in shape, with dumbbell-shaped dorsal end and ovoid ventral end. Some small, ovoid dorsal scars above adductor row; prominent, elongate, dumbbell-shaped dorsal scars below median hinge element.

Comparisons.—*Cytheropteron vernritchiensis* n. sp. differs from *C. angulatum* Brady and Robertson, 1872 (Quaternary, northeast Atlantic) by having a high, short valve shape; narrow, prolonged caudal process; weak ala with weak tubercle; small, numerous ornament pits; posterior vertical ridges; and anterior-bifurcating ala. *C. vernritchiensis* differs from *C. pyramidale* Brady, 1868 (Quaternary, northeast Atlantic) by having a small size; low, short valve outline; posteroventral alar tubercle; large, numerous ornament pits; and oblique posterior ridges. *C. vernritchiensis* differs from *C. nodosum* Brady, 1868 (Quaternary, North Atlantic) by having a long, low valve outline; large, few ornament pits; strong posterodorsal cardinal angle; few, strong posterior ridges; and lack of a median depressed region bounded by two oblique ridges.

Occurrence.—Cruise EGAL-75-KC, localities 39, 46, 141, 204, 263, 283, 289. Assemblages II, III, V.

Distribution.—Pliocene and Pleistocene: central Japan. Pleistocene through Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf, Chukchi Sea, Pribilof Islands. Inner-middle sublittoral.

Material.—Nine adult valves, three juvenile valves.

Type specimens.—Holotype: USNM 408605, right valve (pl. 21, fig. 3), locality EGAL-75-KC-204, length 0.50 mm, height 0.33 mm.

Paratypes: USNM 408606, left valve (pl. 22, fig. 14; pl. 23, fig. 2), locality EGAL-75-KC-263, length 0.45 mm, height 0.29 mm. USNM 408607, right valve (pl. 22, fig. 15; pl. 23, fig. 3), locality EGAL-75-KC-263, length 0.50 mm, height 0.30 mm. USNM 408608, left valve (pl. 23, fig. 1), locality EGAL-75-KC-30, length 0.48 mm, height 0.30 mm. USNM 408609, left valve (pl. 23, figs. 4, 5, 6), locality EGAL-75-KC-141, length 0.45 mm, height 0.28 mm.

CYTHEROPTERON YAJIMAI Tabuki 1986

Plate 9, figures 5, 6; plate 8, figure 15;
plate 10, figures 1–7, 9, 10; figures 38, 39

Cytheropteron yajimai Tabuki, 1986, p. 99–100, pl. 17, figs. 13–18; pl. 20, fig. 7; text-figs. 17–3, 17–4.

Cytheropteron sp. E Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; concave anterodorsal corner; blunt anterior margin; sinuous venter with pronounced concavity; large, attenuated caudal process; prominent overhanging ventral ala; ventral ridge is heavy, broad, strongly calcified; two oblique ridges trend toward posterodorsal and anterodorsal, forming anterior, posterodorsal, and median depressions; scattered small pits aligned in rows, follow ridge orientations.

Description.—Adult valves subtriangular in lateral view. Right valve with highly arched dorsal margin; anterodorsal margin concave; anterior margin smoothly curved, somewhat blunted; ventral margin sinuous, with pronounced concavity; posterior margin with large, attenuated caudal process. Left valve differs in flattened, sinuous dorsum; convex anterodorsal margin; and broad, less pointed caudal process. Greatest length through caudal process; greatest height through middle of dorsal margin.

Valve surface predominantly smooth, with pits and ridges. Prominent ventral ridge overhangs margin; ventral ridge is heavy, broad, strongly calcified. Ridge starts near caudal process, swings down to form arcuate alar structure, and bifurcates anteriorly, terminating at anterior. Strong, narrow dorsal sulcus. Two ridges proceed from posterior and anterior ends of ventral ridge to posterodorsal and anterodorsal corners. Broad depressions between ridges, forming three pronounced depressed regions at anterior, posterodorsum, and median. Caudal process is smooth, flat. Small ovoid pits thinly scattered over surface; number and size of pits may vary among individuals. Pits occur in rows which follow ridge-depression orientation. Forty-six simple-type normal pores evenly distributed over surface, occurring within pits and on surface. Normal pores with light-colored marginal rim.

Inner margin and line of concrescence coincide throughout; inner margin parallels valve outline. Inner lamella widest at anterior. Moderately developed selvage.

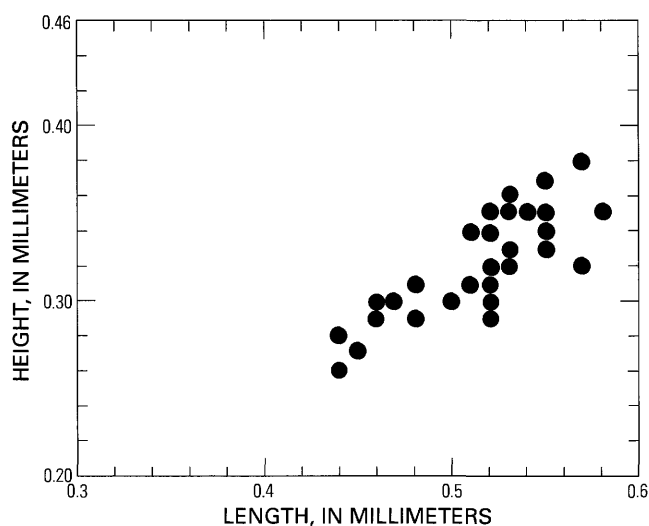


Figure 38. Plot of length versus height for *Cytherofteron yajimai*. Dot may represent more than one specimen.

Six radial pore canals, two false radial pore canals; most anterior. Radial pores straight, simple; radials short at posterior, long at anterior.

Hingement in right valve consists of three rounded quadrate anterior teeth; four elongate quadrate anteromedian sockets; coarsely crenulate median groove; seven quadrate posteromedian sockets; and three rounded quadrate posterior teeth, with bifid posterior tooth. Anteromedian and posteromedian sockets form terminally enlarged portions of median element. Dorsal edge of right valve enfolded to form accommodation bar.

Measurements.—X-Y plot based on 34 specimens (fig. 38).

Comparisons.—*Cytherofteron yajimai* Tabuki, 1986 differs from *C. sawanense* Hanai, 1957 (upper Pliocene, northern Japan) by having a less arched dorsal margin; straight caudal process; lower ventral alar ridge; and ornament pattern with fewer, smaller, weaker pits that are irregularly distributed. *C. yajimai* differs from *C. nodosoalatum* Neale and Howe, 1973 by having a higher dorsal margin, different size, and differences in the size, number, and arrangement of ornament pits.

Occurrence.—Assemblages II, III, V. Table 2; figure 39.

Distribution.—Pliocene and Pleistocene: central Japan. Pleistocene through Holocene: Cook Inlet, Kodiak Shelf, Gulf of Alaska. Middle-outer sublittoral.

Material.—Two hundred forty-eight adult valves, two hundred eleven juvenile valves.

Illustrated specimens.—USNM 408485, left valve (pl. 9, fig. 5), locality DC2-80-EG-195, length 0.52 mm, height 0.34 mm. USNM 408486, right valve (pl. 9, fig. 6), locality DC2-80-EG-195, length 0.58 mm, height 0.35 mm. USNM 408487, left valve (pl. 8, fig. 15), locality DC2-80-EG-195, length 0.57 mm, height 0.38 mm. USNM 408488, right valve

(pl. 10, fig. 1), locality DC2-80-EG-195, length 0.52 mm, height 0.35 mm. USNM 408489, female left valve (pl. 10, figs. 2, 6), locality DC2-80-EG-195, length 0.55 mm, height 0.33 mm. USNM 408490, male right valve (pl. 10, figs. 3, 9), locality DC2-80-EG-195, length 0.50 mm, height 0.30 mm. USNM 408491, male left valve (pl. 10, figs. 4, 10), locality DC2-80-EG-195, length 0.52 mm, height 0.31 mm. USNM 408492, female right valve (pl. 10, fig. 5), locality DC2-80-EG-195, length 0.51 mm, height 0.31 mm. USNM 408493, female right valve (pl. 10, fig. 7), locality DC2-80-EG-195, length 0.53 mm, height 0.32 mm.

***CYTHEROPTERON YAKUTATENSIS* new species**

Plate 21, figure 4; plate 23, figures 7–13; figure 40

Cytherofteron sp. R Brouwers, 1981, p. 9; Brouwers, 1982a, p. 11; Brouwers, 1982b, p. 8; Brouwers, 1983.

Etymology.—After the town of Yakutat, southeast Alaska.

Diagnosis.—Characterized by subovoid lateral outline; arched, sinuous dorsum; sinuous venter with concavity; broad caudal process; oblique posterodorsal cardinal angle; ovoid pits in vertical rows; surface smooth between pits; strong, heavily calcified ventral ala, bifurcates at anteroventer.

Description.—Adult valves subovoid in lateral view. Dorsal margin arched, sinuous; anterior margin smoothly curved, with greatest width ventral of midline; ventral margin sinuous with moderate concavity; posterior margin with broad, moderately developed caudal process. Oblique posterodorsal cardinal angle. Left valve with less arched dorsum, less drawn-out anteroventral margin, and broad, blunt development of caudal process. Greatest length through midline; greatest height through anterior hinge element.

Valve covered with ovoid pitting of various sizes; pits are large, ovoid, in vertical rows. Pitting smaller marginally. Valve surface smooth between pits. Strong, heavily calcified ventral ridge or ala originates at ventral caudal process, overhangs margin, and bifurcates at anteroventral corner. Ridge strongly indented at posteroventral corner. Sixty-two simple-type normal pores evenly distributed over surface, most within pits. Normal pores with raised marginal rim.

Inner margin and line of concrescence coincide throughout. Inner lamella widest at anterior, even width at posterior and venter. Inner margin parallels valve outline. Well-developed selvage. Seven radial pores, three false radial pores, most anterior; pores straight, short, simple.

Hinge in left valve consists of four ovoid anterior sockets; crenulate median bar which thickens, enlarges terminally into five elongate-quadrate anteromedian teeth and nine rectangular posteromedian teeth; three posterior quadrate sockets. Median bar formed by dorsal valve edge. Right valve hingement with dorsal edge enfolded to form accommodation groove.

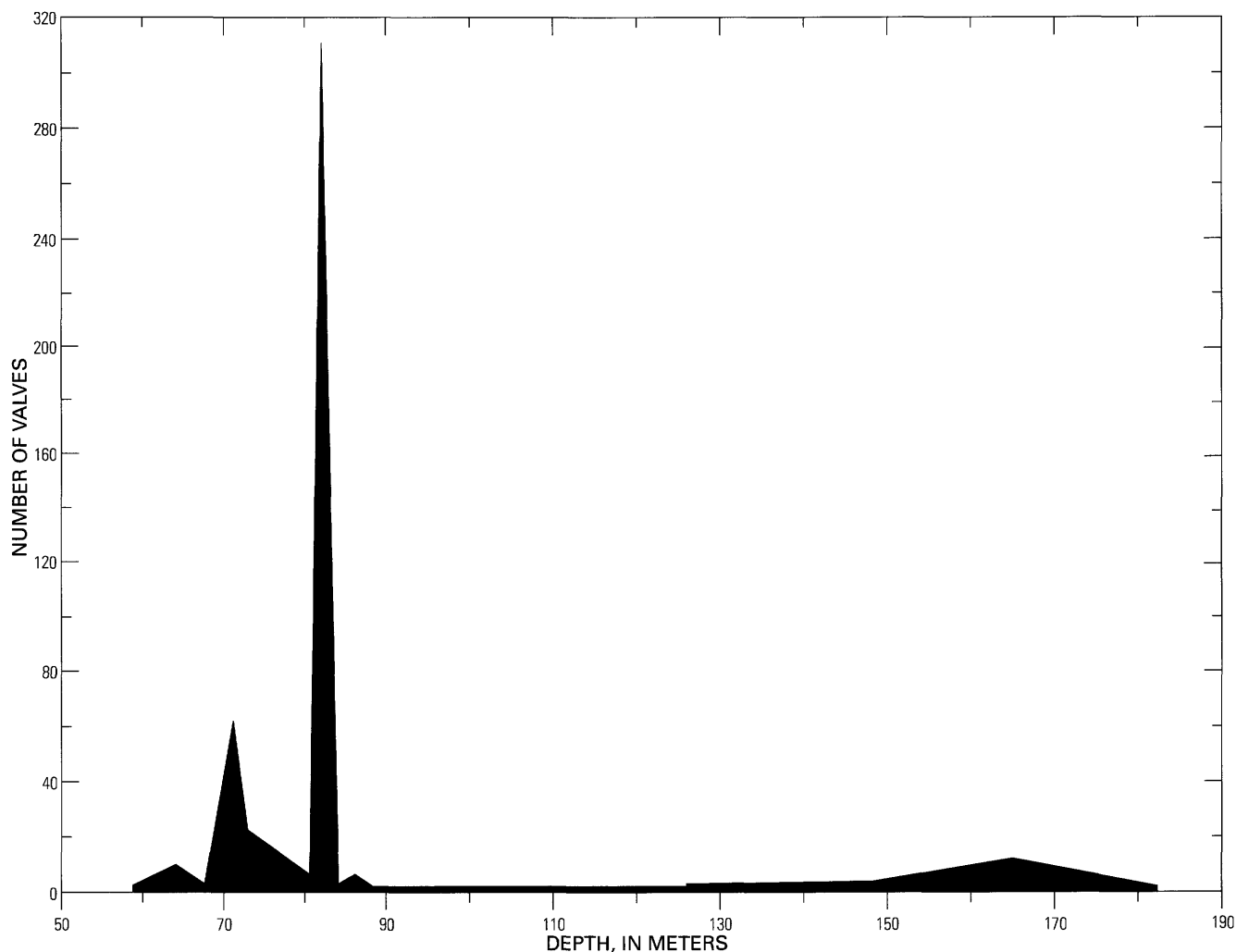


Figure 39. Plot of abundance versus water depth for *Cytheropteron yajimai*.

Four adductor muscle scars in row, inclined posterodorsally. Dorsal scar is semicircular; dorsomedian scar is elongate, with inflated anterior; ventromedian scar is sinuous; ventral scar is ovoid. Frontal scar split into larger, kidney-shaped posterior scar and small, round, anterior scar. Large crescentic fulcral point.

Measurements.—X-Y plot based on 19 specimens (fig. 40).

Comparisons.—*Cytheropteron yakutatensis* n. sp. differs from *C. pararcticum* Whatley and Masson, 1979 (Pleistocene, northeast Atlantic) by having a high, short valve outline; sinuous venter; sinuous ala with posteroventral tubercle; and large, few ornament pits. *C. yakutatensis* differs from *C. angulatum* Brady and Robertson, 1872 (Quaternary, North Atlantic) by having a short, high valve outline; median, wide caudal process; sinuous venter; sinuous, overhanging ala; and small, numerous ornament pits. *C. yakutatensis* differs from *C. nodosoalatum* Neale and Howe, 1973 (Quaternary, North Atlantic) by having a sinuous venter; sinuous ala with strong posteroventral incurving; more

ornament pits; weak, broad median caudal process; and lack of posterior ridges.

Occurrence.—Cruise EGAL-75-KC, localities 58, 86, 87, 157, 174. Cruise DC2-87-EG, locality 195. Assemblages II, III, V.

Distribution.—Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf. Inner-middle sublittoral.

Material.—Fifty-five adult valves, twenty-two juvenile valves.

Type specimens.—Holotype: USNM 408610, right valve (pl. 21, fig. 4), locality EGAL-75-KC-204, length 0.58 mm, height 0.35 mm.

Paratypes: USNM 408611, left valve (pl. 23, figs. 7, 9, 12), locality DC2-80-EG-195, length 0.65 mm, height 0.33 mm. USNM 408612, right valve (pl. 23, fig. 8), locality EGAL-75-KC-32, length 0.51 mm, height 0.29 mm. USNM 408613, left valve (pl. 23, fig. 10), locality DC2-80-EG-195, length 0.58 mm, height 0.33 mm. USNM 408614, left valve (pl. 23, figs. 11, 13), locality DC2-80-EG-195, length 0.59 mm, height 0.30 mm.

CYTHEROPTERON sp. J

Plate 14, figure 1

Cytheropteron sp. J Brouwers, 1982a, p. 11; Brouwers, 1983.

Diagnosis.—Characterized by subtriangular lateral outline; highly arched dorsum; sinuous venter with subtle concavity; wide, short caudal process; smooth valve surface; and broad, arcuate, overhanging ventral ridge.

Occurrence.—Cruise EGAL-75-KC, locality 421. Cruise DC1-79-EG, locality 46. Cruise DC2-80-EG, locality 73.

Distribution.—Holocene: Gulf of Alaska.

Material.—Two adult valves, one juvenile valve.

Illustrated specimen.—USNM 408529, left valve (pl. 14, fig. 1), locality EGAL-75-KC-421, length 0.54 mm, height 0.30 mm.

CYTHEROPTERON sp. V

Plate 11, figure 6

Cytheropteron sp. V Brouwers, 1981, p. 9; Brouwers, 1983.

Diagnosis.—Characterized by subtriangular to semicircular lateral outline; broadly arched dorsum inclined sharply toward posterior; blunt posterior; weak, obtuse posterodorsal cardinal angle; reticulate ornament with polygonal fossae, arranged concentrically at anterior; massive, heavily calcified, overhanging ventral ridge; and shallow, crescentic posterior vestibule.

Occurrence.—Cruise EGAL-75-KC, locality 11.

Distribution.—Pleistocene: Gulf of Alaska.

Material.—Five adult valves, one juvenile valve.

Illustrated specimen.—USNM 408521, left valve (pl. 11, fig. 6), locality EGAL-75-KC-11, length 0.39 mm, height 0.25 mm.

Genus SWAINOCYTHERE Ishizaki, 1981

Type species.—*Swainocythere chejudoensis* Ishizaki, 1981 (Type by original designation).

SWAINOCYTHERE CHEJUDOENSIS Ishizaki, 1981

Plate 21, figure 5; plate 23, figures 14, 15

Swainocythere chejudoensis Ishizaki, 1981, p. 59–60, pl. 12, figs. 12a, 13–15; pl. 13, figs. 17, 18; pl. 15, figs. 12, 13.

Swainocythere chejudoensis Ishizaki. Wang and others, 1988, pl. 54, figs. 11–12.

Cytherura sp. I Brouwers, 1982b, p. 9; Brouwers, 1983.

Description.—Valves elongate, subtriangular in lateral view. Dorsal margin with convex median portion and concave anterior and posterior portions. Rounded, obtuse anterodorsal cardinal angle extends high above dorsum. Smoothly curved anterior margin; ventral margin with subtle

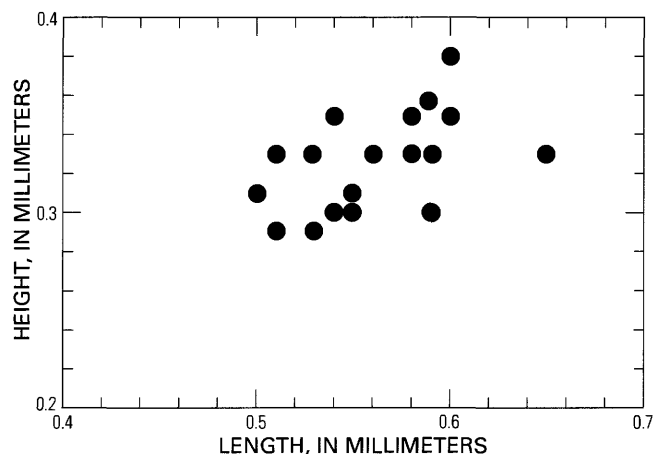


Figure 40. Plot of length versus height for *Cytheropteron yakutatensis*. Dot may represent more than one specimen.

concavity; posterior margin drawn-out, with sharp, pronounced caudal process. Greatest length through caudal process; greatest height through anterior hinge element.

Valve covered with ridges and pitting. Dominant ridge extends from anterodorsal corner, loops parallel to anterior margin, curves around to follow ventral margin, and loops back vertically to posterodorsal corner. Series of discontinuous, horizontal ridges; ridges most pronounced near margins and weaken toward median valve area. Regions between ridges contain ovoid pits, which occur in groups of two to three pits or as rows between ridges. Posterior and anterior margins have wide, flat region lacking primary ornament; marginal regions covered by secondary fine ridges and punctation. Secondary ridges in anterodorsal corner form series of lines parallel to valve outline. Sixteen simple-type normal pores, most anterior. Normal pores with highly visible light-colored marginal rim.

Inner lamella and line of concrescence coincide at posterior; deep, crescentic anterior vestibule and sinuous ventral vestibule. Inner margin parallels valve outline; inner lamella widest along anterior. Moderate selvage, best developed at anterior. Six radial pore canals, two false radial pore canals; most anterior. Radial pores few, straight, simple.

Three adductor muscle scars reflected exteriorly by row of three elongate pits.

Remarks.—*Swainocythere chejudoensis* Ishizaki, 1981 was originally described from the East China Sea; four localities contained the species, at lat 31° N., long 127° E. (east of the Yangtze River and north of Okinawa). Fine sand to mud substrates predominated in water depths of 105–114 m. The East China Sea marks the geographic zone delimiting subtropical southern Japanese faunal elements from the tropical Indo-Pacific realm.

The presence of the warm-water *Swainocythere chejudoensis* was difficult to explain in Quaternary sediments of the Gulf of Alaska because the species did not have a documented range in the temperate realm. One explanation that I

invoked for the presence of this rare taxon was that it was weathering out of Pliocene or older sediments of the Yakataga Formation, reflecting past warmer climates. The four localities in which *Swainocythere* occurs are on Tarr Bank, with exposures of Pleistocene and older lithified sediments of the lower part of the Yakataga Formation.

Until recently, the only known occurrences of *Swainocythere* were the Gulf of Alaska and the East China Sea. I speculated that the taxon either (a) migrated up the Japanese coast to the Kuril Islands and crossed the Bering Sea or moved along the south side of the Aleutian Islands into the Gulf of Alaska or (b) was carried via floating debris across the Pacific Ocean along the Kuroshio Current (Ishizaki, 1981).

W.M. Briggs Jr. has recovered several species of *Swainocythere* in the Arctic Ocean (oral communication, 1993). Even more recently, Corregge and others (1993) illustrated *Swainocythere nanseni* from deep water samples around Australia; *S. nanseni* was originally described as *Cytheropteron nanseni* Joy and Clark from the central Arctic Ocean.

Occurrence.—Cruise EGAL-75-KC, localities 105, 150, 153, 154.

Distribution.—Pliocene (?), Holocene: East China Sea, Gulf of Alaska.

Material.—One adult valve, five juvenile valves.

Illustrated specimens.—USNM 408615, left valve (pl. 21, fig. 5), locality EGAL-75-KC-154, length 0.28 mm, height 0.15 mm. USNM 408616, left valve (pl. 23, figs. 14, 15), locality EGAL-75-KC-105, length 0.28 mm, height 0.14 mm.

FAMILY LOXOCONCHIDAE Swain and Gilby, 1974

Type species.—*Palmoconcha laevimarginata* Swain and Gilby, 1974 (Type by original designation).

PALMOCONCHA KRAUSEI Brouwers, 1993

Plate 1, figure 7; plate 4, figures 1–5; figure 41

Eucytherura sp. B Brouwers, 1981, p. 10; Brouwers, 1983.

Palmoconcha krausei Brouwers, 1993, pl. 13, figs. 5, 6; pl. 14, figs. 13–15; pl. 15, figs. 1–3, 6; text-fig. 33.

Diagnosis.—Characterized by a short, squared, subquadrate lateral outline; truncated, convergent posterior; low reticulation network with large, subovoid pits arranged concentrically at anterior; series of parallel anterior and posterior marginal ridges; large eye tubercle; and anterior and posterior marginal flanges.

Measurements.—X–Y plot based on eight specimens (fig. 41).

Occurrence.—Cruise EGAL-75-KC, localities 17, 421. Cruise DC1-79-EG, locality 46. Cruise DC2-80-EG, locality 195.

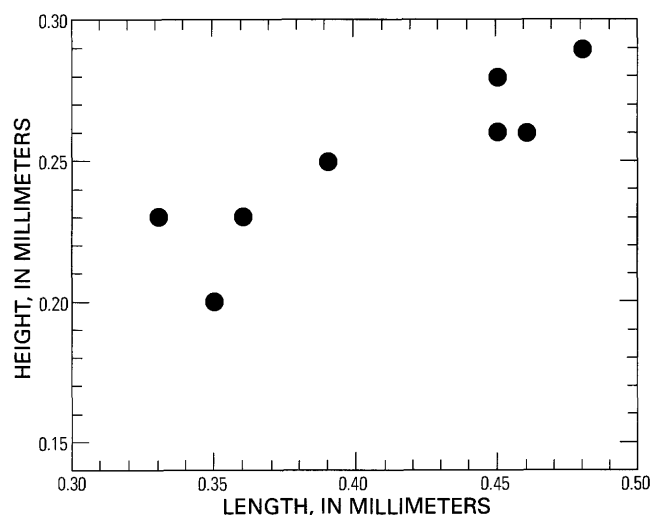


Figure 41. Plot of length versus height for *Palmoconcha krausei*.

Distribution.—Holocene: Gulf of Alaska, Cook Inlet, Kodiak Shelf.

Material.—Nine adult valves, one juvenile valve.

Illustrated specimens.—USNM 408423, female left valve (pl. 1, fig. 7), locality EGAL-75-KC-421, length 0.36 mm, height 0.23 mm. USNM 408424, left valve (pl. 4, figs. 1, 3), locality EGAL-75-KC-17, length 0.39 mm, height 0.25 mm. USNM 408425, right valve (pl. 4, figs. 2, 5), locality DC2-80-EG-195, length 0.33 mm, height 0.23 mm. USNM 408426, right valve (pl. 4, fig. 4), locality DC2-80-EG-195, length 0.35 mm, height 0.20 mm.

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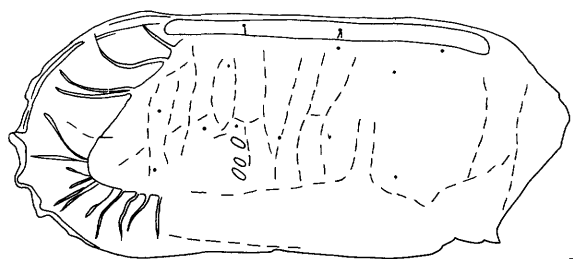
PLATES 1–23

Contact photographs of the plates in this report are available, at cost, from U.S. Geological Survey Library,
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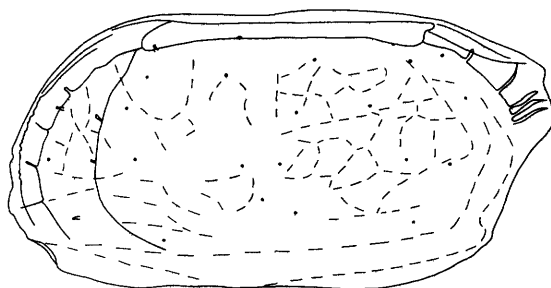
PLATE 1

[All figures are camera lucida drawings]

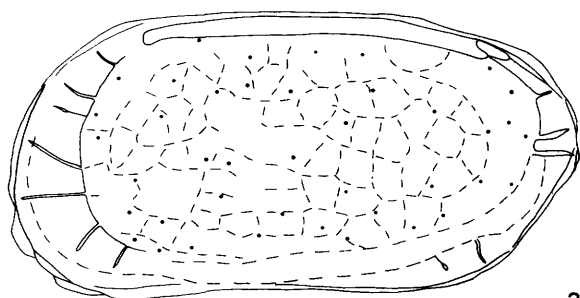
- Figure 1. *Cytherura* sp. H (p. 5).
Exterior left valve, length 0.44 mm, height 0.20 mm. USNM 408412.
Locality EGAL-75-KC-157.
2. *Cytherura burroughsensis* n. sp. (p. 2).
Exterior left valve, length 0.43 mm, height 0.23 mm. USNM 408413, holotype.
Locality EGAL-75-KC-202.
3. *Cytherura* sp. J (p. 5).
Exterior left valve, female, length 0.54 mm, height 0.28 mm. USNM 408416.
Locality EGAL-75-KC-69.
4. *Semicytherura tauronae* n. sp. (p. 14).
Exterior right valve, female, length 0.58 mm, height 0.33 mm. USNM 408419,
holotype. Locality EGAL-75-KC-144U.
5. *Cytherura* sp. G (p. 4).
Exterior left valve, female, length 0.53 mm, height 0.30 mm. USNM 408418.
Locality EGAL-75-KC-39.
6. *Cytherura wachusettensis* n. sp. (p. 4).
Exterior right valve, male, length 0.53 mm, height 0.25 mm. USNM 408422,
holotype. Locality EGAL-75-KC-11.
7. *Palmoconcha krausei* Brouwers, 1993 (p. 43).
Exterior left valve, female, length 0.36 mm, height 0.23 mm. USNM 408423.
Locality EGAL-75-KC-421.
8. *Eucytherura ishizakii* n. sp. (p. 6).
Exterior left valve, female, length 0.40 mm, height 0.28 mm. USNM 408431,
holotype. Locality EGAL-75-KC-284.



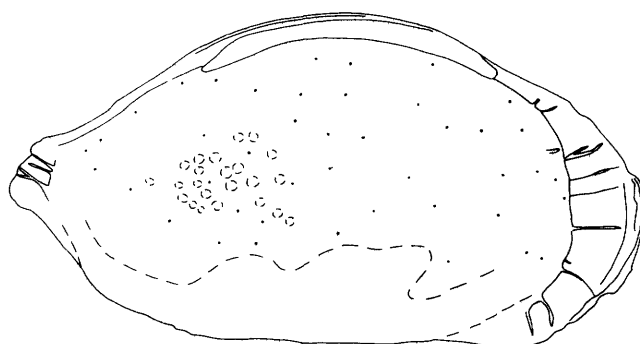
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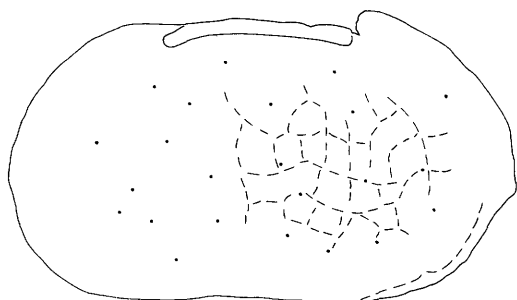
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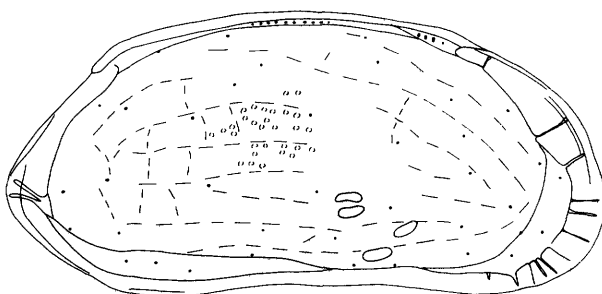
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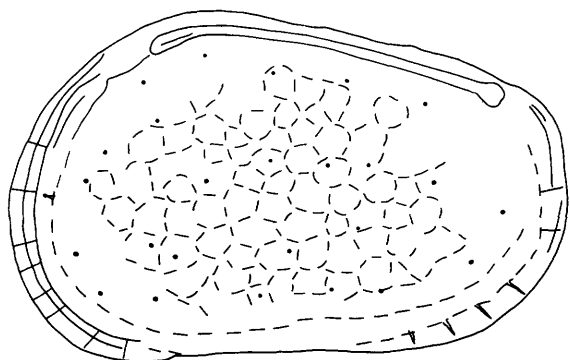
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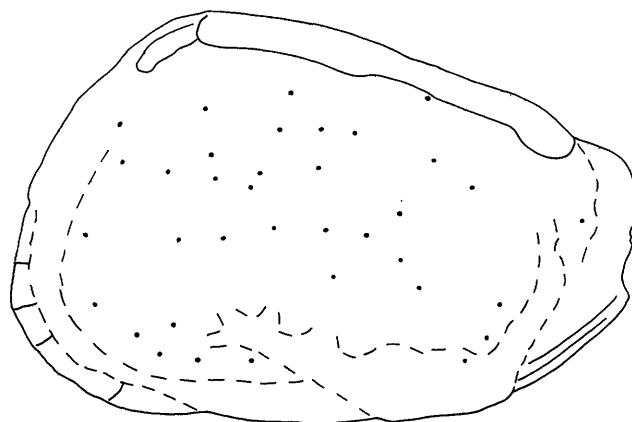
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PLATE 2

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 5–7, 9–10, 13; bar scale equals 10 micrometers for figs. 3, 4, 8, 11, 12, 14]

Figures 1–4. *Cytherura burroughsensis* n. sp. (p. 2).

1. Exterior left valve. USNM 408414, paratype. Locality EGAL-75-KC-6.
2. Exterior right valve. USNM 408415, paratype. Locality EGAL-75-KC-6.
3. Close-up view of secondary ornament. USNM 408414.
4. Close-up view of secondary ornament. USNM 408415.

6. *Semicytherura miurensis* (Hanai, 1957) (p. 12).

Exterior left valve. USNM 408417.

5, 7, 8. *Semicytherura tauronae* n. sp. (p. 14).

5. Interior left valve. USNM 408420, paratype.

Locality EGAL-75-KC-144U.

7. Exterior right valve. USNM 408421, paratype.

Locality EGAL-75-KC-144U.

8. Close-up view of ornament, normal pore. USNM 408421.

9–14. *Eucytherura hazeli* n. sp. (p. 5).

9. Exterior left valve. USNM 408427, holotype. Locality DC2-80-EG-195.

10. Exterior right valve. USNM 408428, paratype.

Locality DC2-80-EG-195.

11. Close-up view of ornament, normal pores. USNM 408429.

12. Close-up view of ornament. USNM 408427.

13. Interior right valve. USNM 408429, paratype. Locality DC2-80-EG-195.

14. Close-up view of central muscle-scar field. USNM 408429.

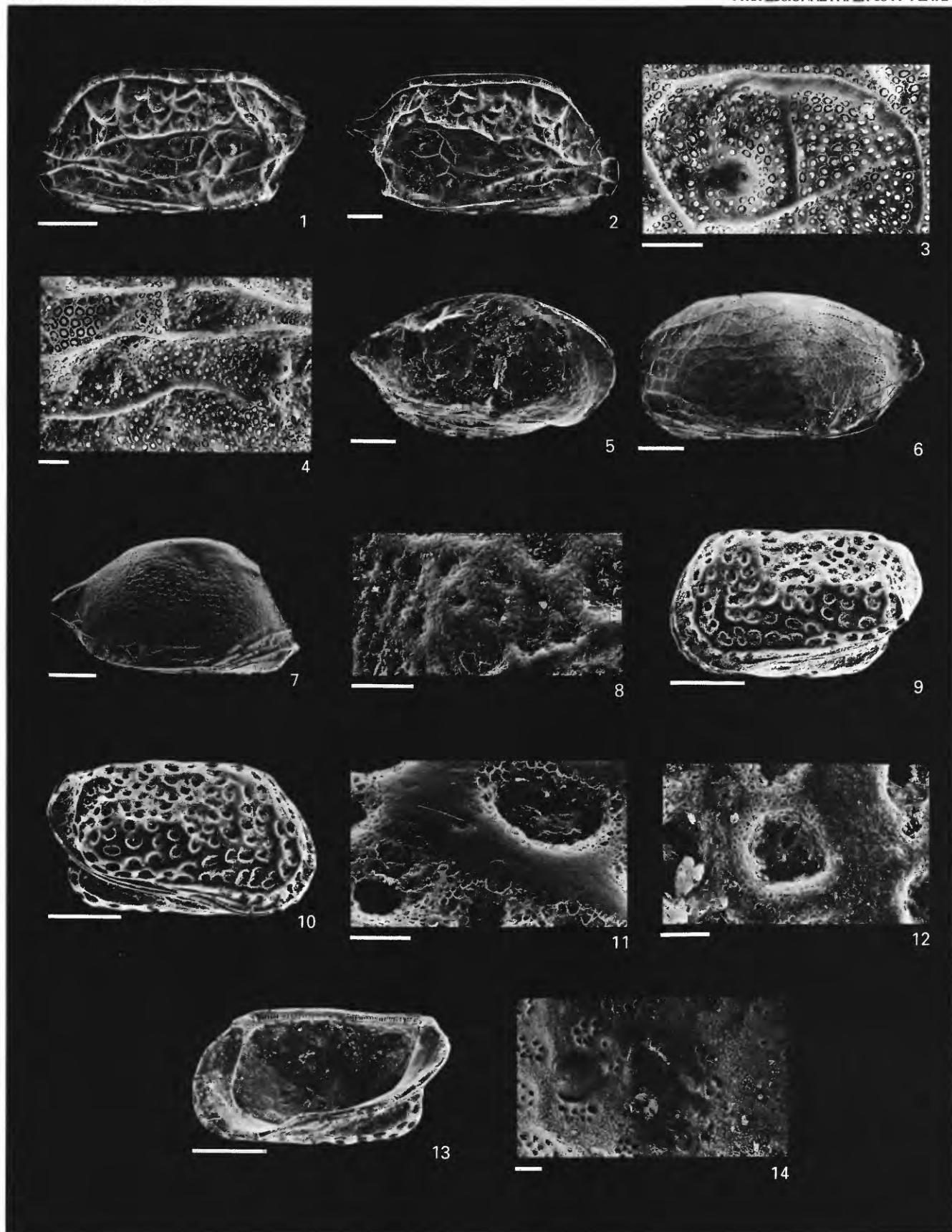
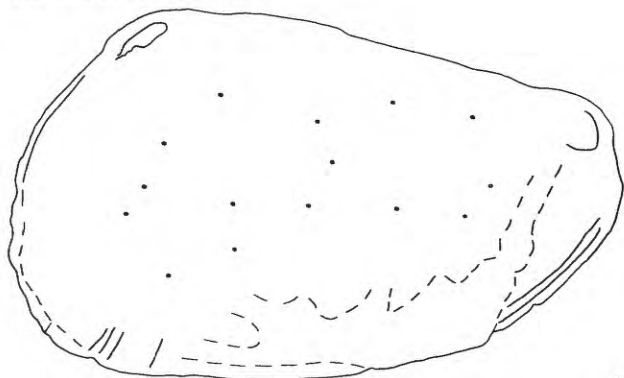


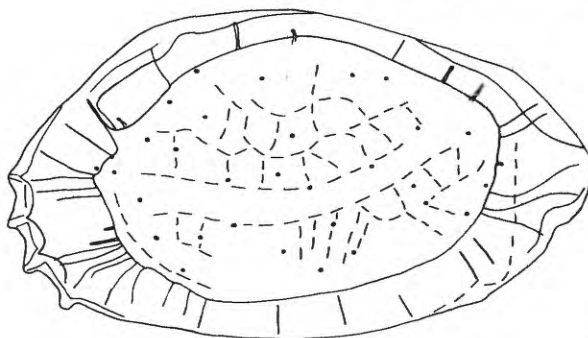
PLATE 3

[All figures are camera lucida drawings]

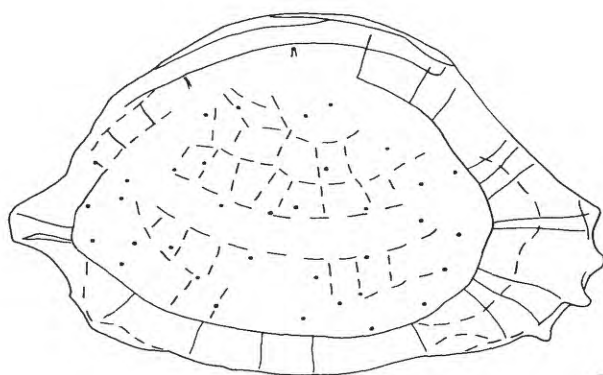
- Figure 1. *Eucytherura ishizakii* n. sp. (p. 6).
Exterior left valve, male, length 0.41 mm, height 0.26 mm. USNM 408432, paratype. Locality EGAL-75-KC-284.
- 2, 3. *Hemicytherura dageletensis* n. sp. (p. 7).
2. Exterior left valve, length 0.40 mm, height 0.24 mm. USNM 408438, holotype. Locality DC2-80-EG-195.
3. Exterior right valve, length 0.41 mm, height 0.26 mm. USNM 408439, paratype. Locality DC2-80-EG-195.
4. *Hemicytherura lemesuriensis* n. sp. (p. 8).
Exterior left valve, length 0.35 mm, height 0.20 mm. USNM 408442, holotype. Locality DC2-80-EG-195.
- 5, 6. *Hemicytherura sitakadayensis* n. sp. (p. 10).
5. Exterior left valve, length 0.46 mm, height 0.23 mm. USNM 408445, holotype. Locality DC2-80-EG-195.
6. Exterior right valve, length 0.47 mm, height 0.27 mm. USNM 408446, paratype. Locality DC2-80-EG-195.
- 7, 8. *Semicytherura* sp. E (p. 14).
7. Exterior left valve, length 0.35 mm, height 0.19 mm. USNM 408458. Locality EGAL-75-KC-11.
8. Exterior right valve, length 0.35 mm, height 0.20 mm. USNM 408459. Locality EGAL-75-KC-11.



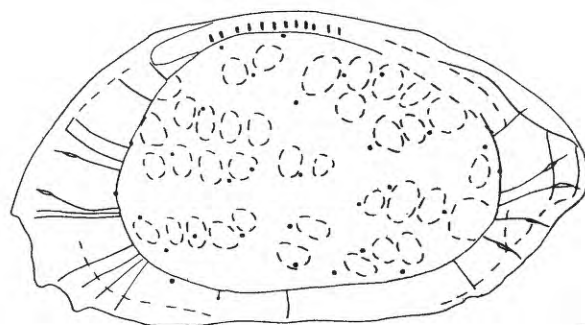
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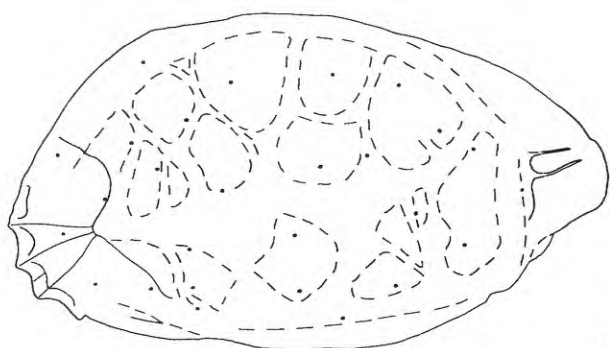
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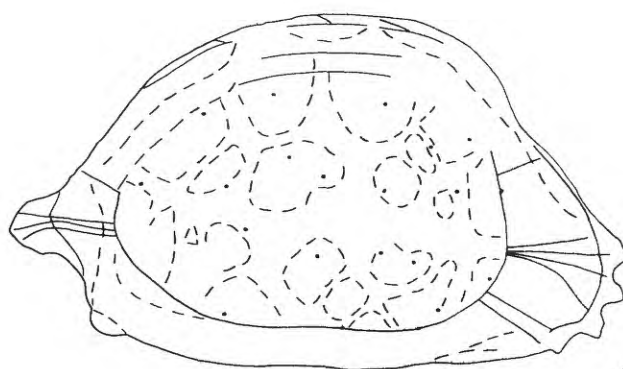
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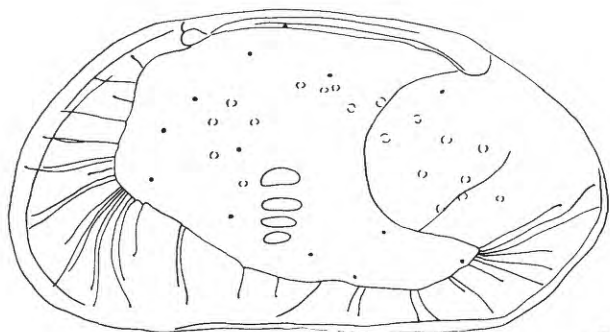
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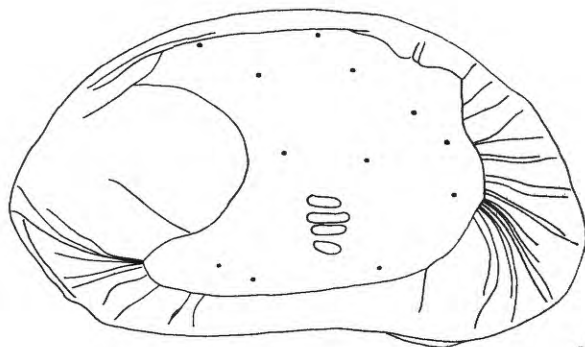
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PLATE 4

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4, 7–8, 10–11, 13; bar scale equals 10 micrometers for figs. 6, 9, 12, 14–15; bar scale equals 1 micrometer for figs. 3, 5]

Figures 1–5. *Palmoconcha krausei* Brouwers, 1993 (p. 43).

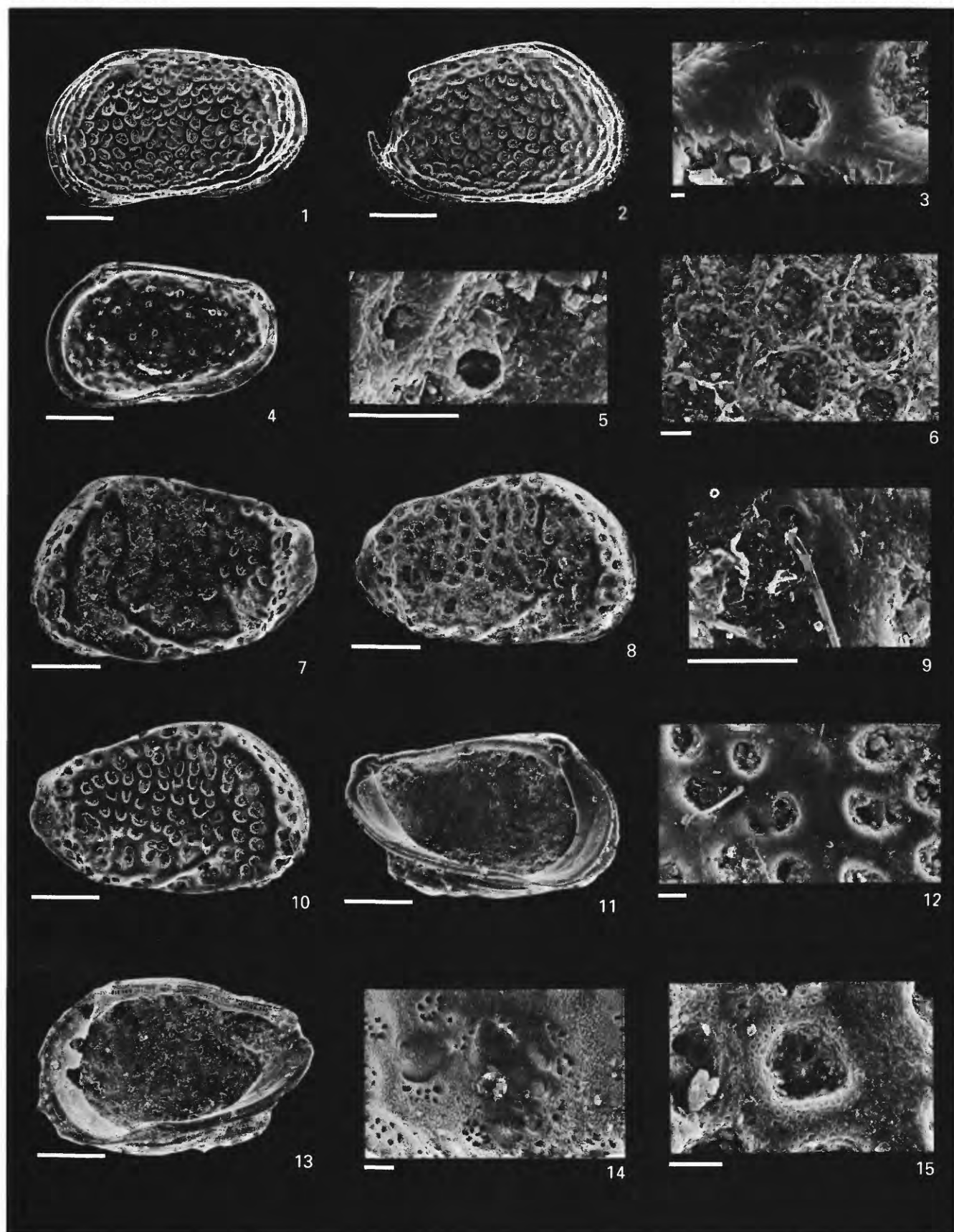
1. Exterior left valve. USNM 408424. Locality EGAL-75-KC-17.
2. Exterior right valve. USNM 408425. Locality DC2-80-EG-195.
3. Close-up view of normal pore. USNM 408424.
Locality EGAL-75-KC-17.
4. Interior right valve. USNM 408426. Locality DC2-80-EG-195.
5. Close-up view of pore. USNM 408425.

6–13. *Eucytherura ishizakii* n. sp. (p. 6).

6. Close-up view of ornament. USNM 408433.
7. Exterior left valve. USNM 408434, paratype.
Locality EGAL-75-KC-268.
8. Exterior right valve. USNM 408433, paratype.
Locality EGAL-75-KC-268.
9. Close-up view of normal pore, seta. USNM 408433.
10. Exterior right valve. USNM 408435, paratype.
Locality EGAL-75-KC-268.
11. Interior left valve. USNM 408436, paratype.
Locality EGAL-75-KC-268.
12. Close-up view of ornament, normal pores with seta. USNM 408435.
13. Interior right valve. USNM 408437, paratype.
Locality EGAL-75-KC-268.

14–15. *Eucytherura hazeli* n. sp. (p. 5).

14. Central muscle-scar field. USNM 408429, paratype.
Locality DC2-80-EG-195.
15. Close-up view of ornament. USNM 408430, paratype.
Locality DC2-80-EG-195.



PALMOCONCHA, EUCYTHERURA

PLATE 5

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4–5, 7–8, 10–11, 13–14, 16, 18; bar scale equals 10 micrometers for figs. 3, 6, 9, 12, 15, 17]

Figures 1–3. *Hemicytherura dageletensis* n. sp. (p. 7).

1. Exterior left valve. USNM 408440, paratype. Locality DC2-80-EG-195.
2. Exterior right valve. USNM 408441, paratype. Locality DC2-80-EG-195.
3. Close-up view of ornament, pore. USNM 408440.

4–6. *Hemicytherura lemesuriensis* n. sp. (p. 8).

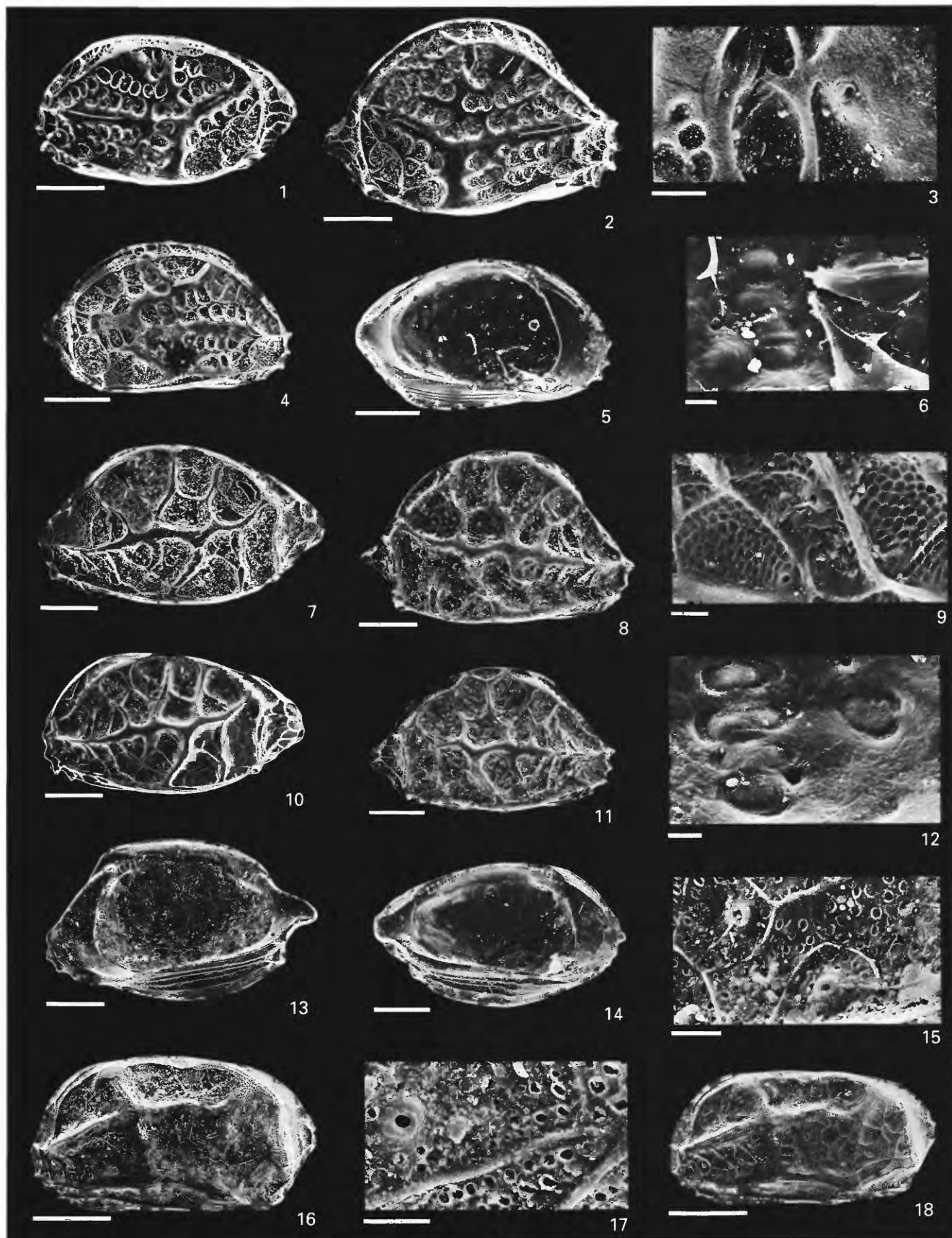
4. Exterior right valve, female. USNM 408443, paratype.
Locality DC2-80-EG-195.
5. Interior left valve, female. USNM 408444, paratype.
Locality DC2-80-EG-195.
6. Close-up view of central muscle-scar field. USNM 408444.

7–14. *Hemicytherura sitakadayensis* n. sp. (p. 10).

7. Exterior left valve, female. USNM 408447, paratype.
Locality DC2-80-EG-195.
8. Exterior right valve, female. USNM 408448, paratype.
Locality DC2-80-EG-195.
9. Close-up view of ornament, pores. USNM 408449.
10. Exterior left valve, male. USNM 408449, paratype.
Locality DC2-80-EG-195.
11. Exterior right valve, male. USNM 408450, paratype.
Locality DC2-80-EG-195.
12. Close-up view of central muscle-scar field. USNM 408451.
13. Interior right valve, female. USNM 408452, paratype.
Locality DC2-80-EG-195.
14. Interior left valve, male. USNM 408451, paratype.
Locality DC2-80-EG-195.

15–18. *Semicytherura balrogi* n. sp. (p. 11).

15. Close-up view of ornament, pores. USNM 408455.
16. Exterior left valve. USNM 408456, paratype. Locality DC2-80-EG-195.
17. Close-up view of ornament, pores. USNM 408456.
18. Exterior left valve. USNM 408455, paratype. Locality DC2-80-EG-195.

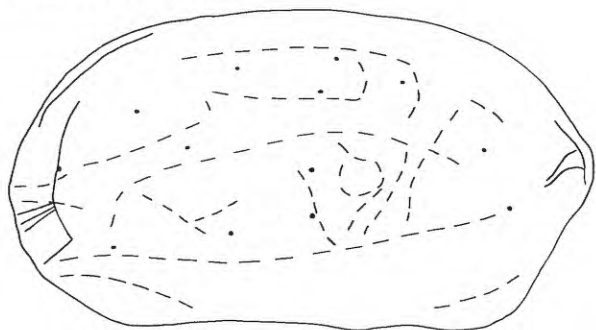


HEMICYTHERURA, SEMICYTHERURA

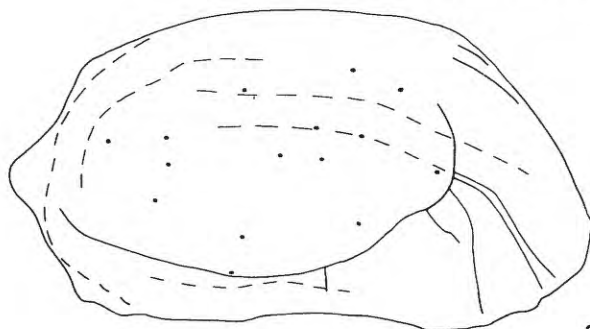
PLATE 6

[All figures are camera lucida drawings]

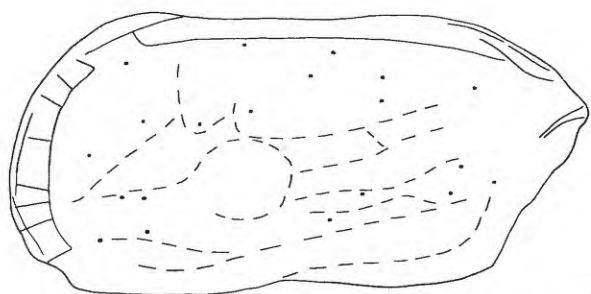
- Figures 1, 2. *Semicytherura balrogi* n. sp. (p. 11).
1. Exterior left valve, female, length 0.35 mm, height 0.20 mm. USNM 408453, holotype. Locality DC2-80-EG-195.
 2. Exterior right valve, female, length 0.35 mm, height 0.20 mm. USNM 408454, paratype. Locality DC2-80-EG-195.
- 3, 4. *Semicytherura henryi* n. sp. (p. 12).
3. Exterior left valve, length 0.36 mm, height 0.18 mm. USNM 408460, holotype. Locality EGAL-75-KC-18.
 4. Exterior right valve, length 0.38 mm, height 0.18 mm. USNM 408461, paratype. Locality EGAL-75-KC-18.
5. *Semicytherura skagwayensis* n. sp. (p. 13).
- Exterior left valve, length 0.65 mm, height 0.32 mm. USNM 408464, holotype. Locality DC2-80-EG-195.
6. *Cytherura* sp. I (p. 5).
- Exterior left valve, female, length 0.41 mm, height 0.25 mm. USNM 408469. Locality G4.
- 7, 8. *Semicytherura* sp. F (p. 14).
7. Exterior left valve, length 0.51 mm, height 0.27 mm. USNM 408470. Locality EGAL-75-KC-11.
 8. Exterior right valve, length 0.51 mm, height 0.26 mm. USNM 408471. Locality EGAL-75-KC-11.



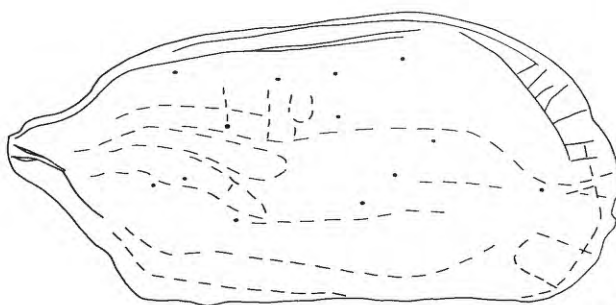
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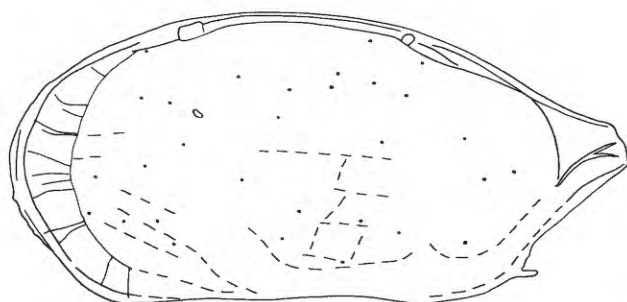
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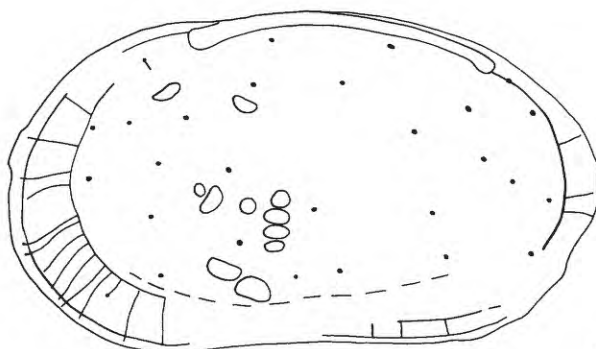
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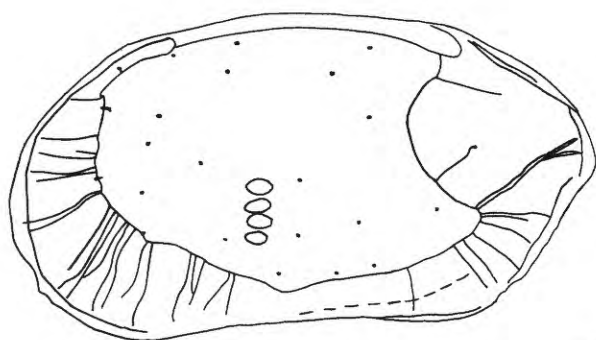
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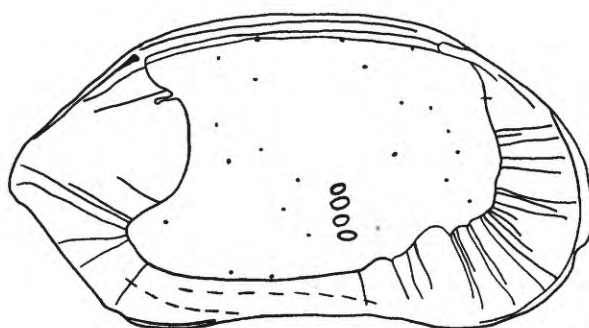
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PLATE 7

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1, 4–5, 7, 9–11, 13–15, 17; bar scale equals 10 micrometers for figs. 2–3, 6, 8, 12; bar scale equals 1 micrometer for figs. 16, 18]

Figures 1–3, 6. *Semicytherura balrogi* n. sp. (p. 11).

1. Exterior right valve. USNM 408457, paratype.
Locality DC2-80-EG-195.
2. Close-up view of ornament. USNM 408457.
3. Close-up view of ornament. USNM 408457.
6. Close-up view of ornament. USNM 408457.

4–5, 7–8. *Semicytherura henryi* n. sp. (p. 12).

4. Exterior left valve. USNM 408462, paratype. Locality EGAL-75-KC-4.
5. Exterior right valve. USNM 408463, paratype. Locality EGAL-75-KC-4.
7. Close-up view of posterior ornament. USNM 408462.
8. Close-up view of ornament. USNM 408463.

9–16. *Semicytherura skagwayensis* n. sp. (p. 13).

9. Exterior left valve. USNM 408465, paratype. Locality DC2-80-EG-195.
10. Exterior left valve. USNM 408466, paratype. Locality DC2-80-EG-195.
11. Exterior right valve. USNM 408467, paratype.
Locality DC2-80-EG-195.
12. Close-up view of pore. USNM 408467.
13. Interior right valve. USNM 408468, paratype. Locality DC2-80-EG-195.
14. Close-up view of right valve hingement. USNM 408468.
15. Close-up view of posterior inner lamella. USNM 408468.
16. Close-up view of pore. USNM 408465.

17–18. *Semicytherura* sp. F (p. 14).

17. Exterior right valve. USNM 408472, paratype.
Locality EGAL-75-KC-11.
18. Close-up view of pore. USNM 408472.

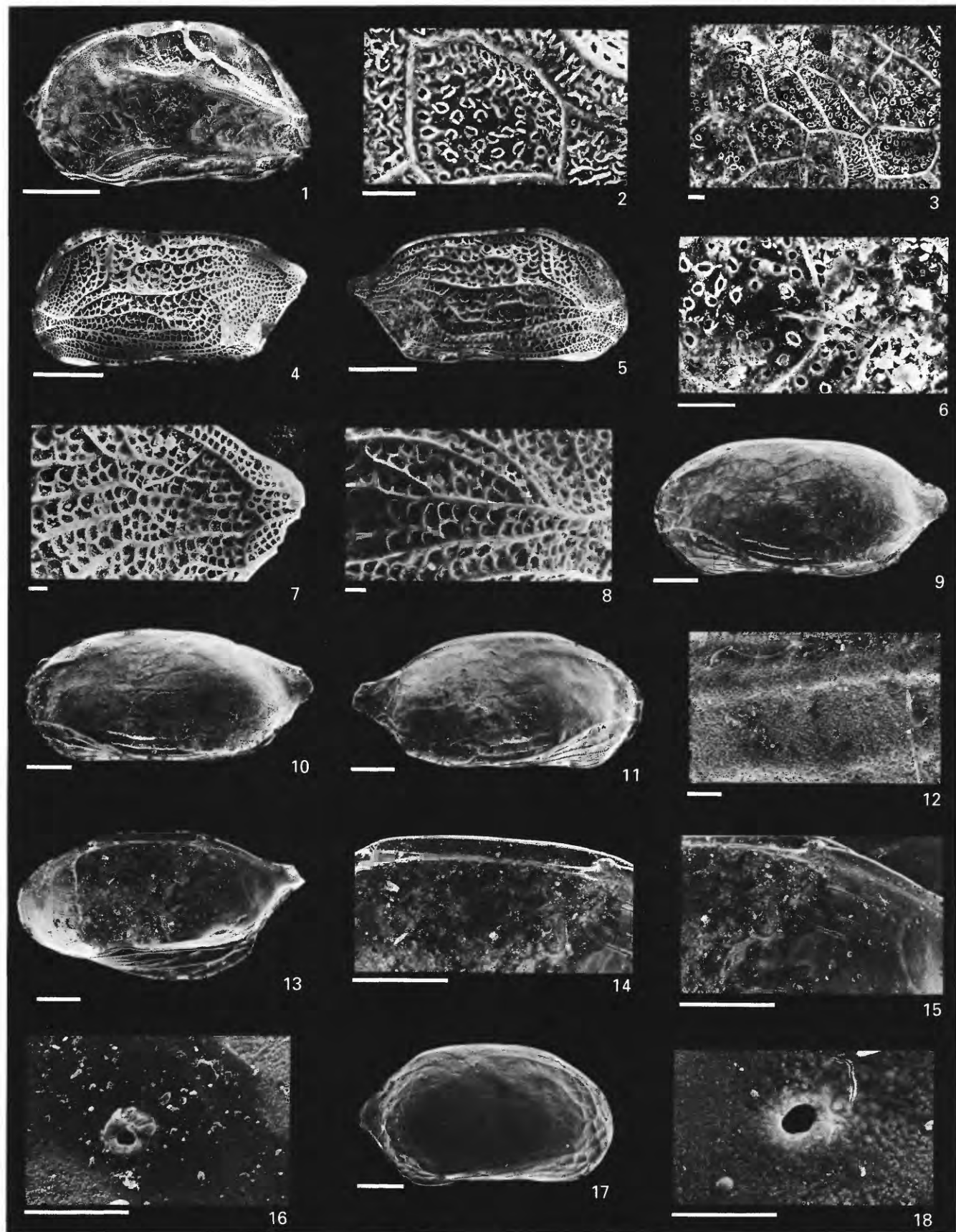


PLATE 8

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4, 7–8, 10, 13–15; bar scale equals 10 micrometers for figs. 3, 5–6, 9, 11–12]

Figures 1–6. *Cytheropteron dimlingtonensis* Neale and Howe, 1973 (p. 19).

1. Exterior left valve. USNM 408474. Locality EGAL-75-KC-123.
2. Exterior right valve. USNM 408475. Locality EGAL-75-KC-123.
3. Close-up view of simple pore. USNM 408474.
4. Interior left valve. USNM 408476. Locality EGAL-75-KC-320.
5. Central muscle-scar field. USNM 408476.
6. Close-up view of pore with seta. USNM 408475.

7–11. *Cytheropteron brokenoarensis* n. sp. (p. 15).

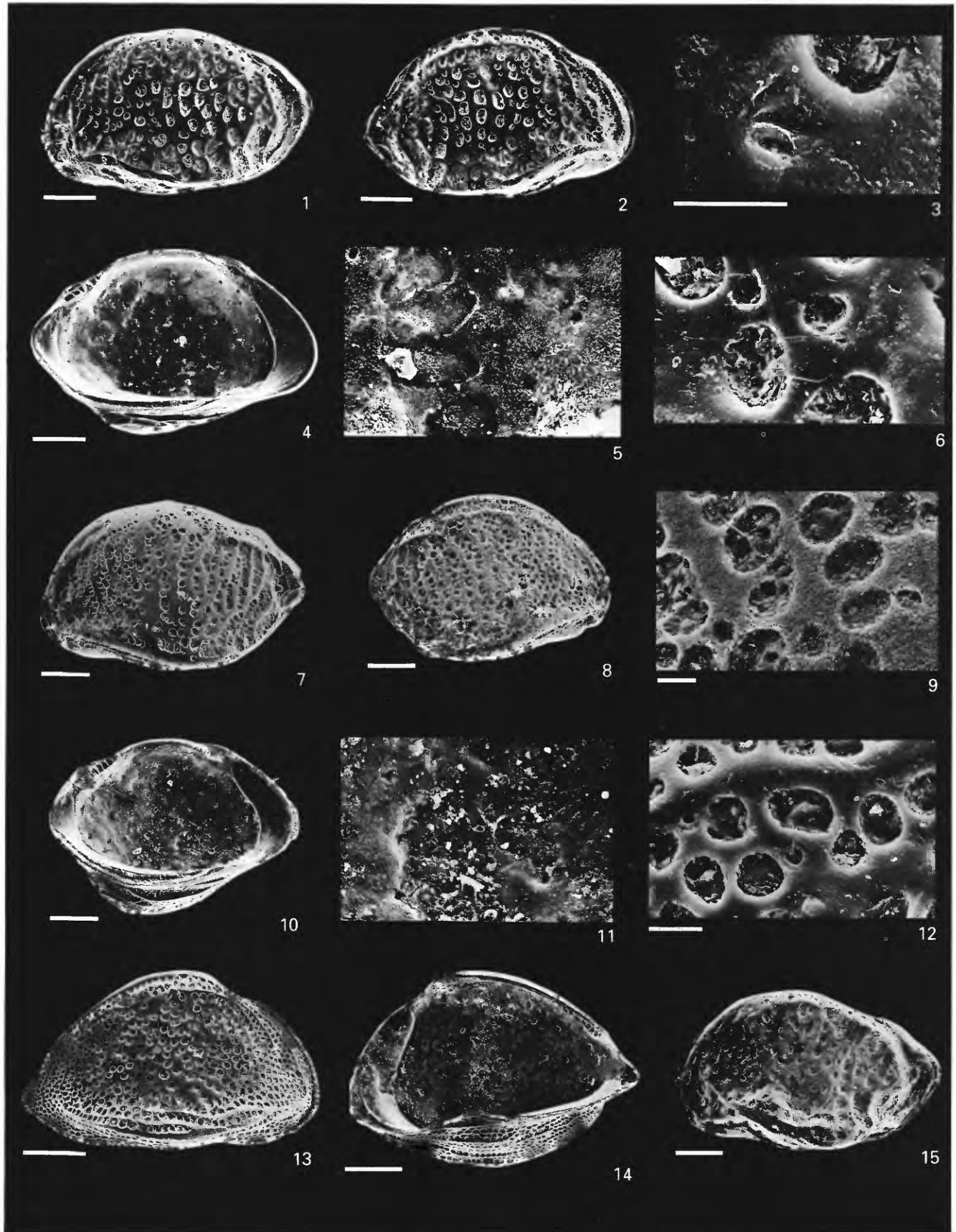
7. Exterior left valve. USNM 408478, paratype.
Locality EGAL-75-KC-52A.
8. Exterior right valve. USNM 408479, paratype.
Locality EGAL-75-KC-52A.
9. Close-up view of ornament pits, simple pores with setae. USNM 408478.
10. Interior left valve. USNM 408480, paratype.
Locality EGAL-75-KC-52A.
11. Central muscle-scar field. USNM 408480.

12–14. *Cytheropteron carolae* n. sp. (p. 17).

12. Close-up view of ornament pits, simple pores. USNM 408483.
13. Exterior right valve. USNM 408483, paratype.
Locality EGAL-75-KC-52A.
14. Interior right valve. USNM 408484, paratype.
Locality EGAL-75-KC-141.

15. *Cytheropteron yajimai* Tabuki, 1986 (p. 39).

15. Exterior left valve. USNM 408487. Locality DC2-80-EG-195.

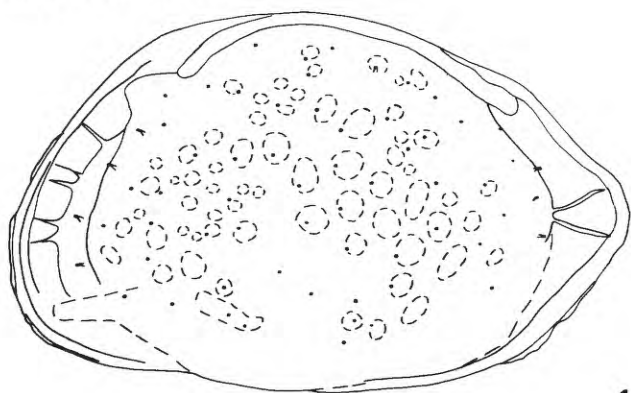


CYTHEROPTERON

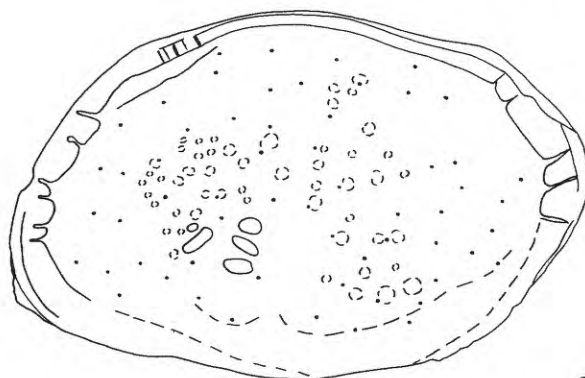
PLATE 9

[All figures are camera lucida drawings]

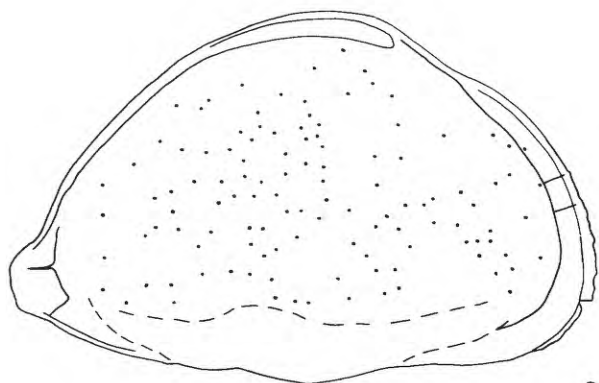
- Figure 1. *Cytheropteron dimlingtonensis* Neale and Howe, 1973 (p. 19).
Exterior left valve, length 0.57 mm, height 0.34 mm. USNM 408473.
Locality EGAL-75-KC-127.
2. *Cytheropteron brokenoarensis* n. sp. (p. 15).
Exterior left valve, length 0.52 mm, height 0.32 mm. USNM 408477, holotype.
Locality EGAL-75-KC-52A.
- 3, 4. *Cytheropteron carolae* n. sp. (p. 17).
3. Exterior right valve, female, length 0.53 mm, height 0.35 mm. USNM 408481, holotype. Locality EGAL-75-KC-68A.
4. Exterior right valve, male, length 0.50 mm, height 0.33 mm. USNM 408482, paratype. Locality EGAL-75-KC-68A.
- 5, 6. *Cytheropteron yajimai* Tabuki, 1986 (p. 39).
5. Exterior left valve, length 0.52 mm, height 0.34 mm. USNM 408485.
Locality DC2-80-EG-195.
6. Exterior right valve, length 0.58 mm, height 0.35 mm. USNM 408486.
Locality DC2-80-EG-195.
- 7, 8. *Cytheropteron chichagofensis* n. sp. (p. 18).
7. Exterior left valve, length 0.58 mm, height 0.35 mm. USNM 408495, holotype. Locality DC2-80-EG-67.
8. Exterior right valve, length 0.55 mm, height 0.35 mm. USNM 408496, paratype. Locality DC2-80-EG-67.



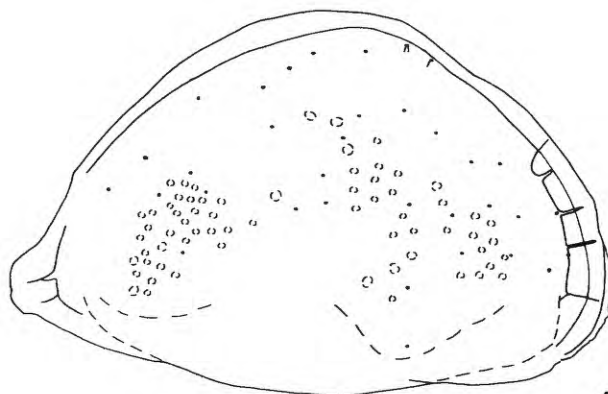
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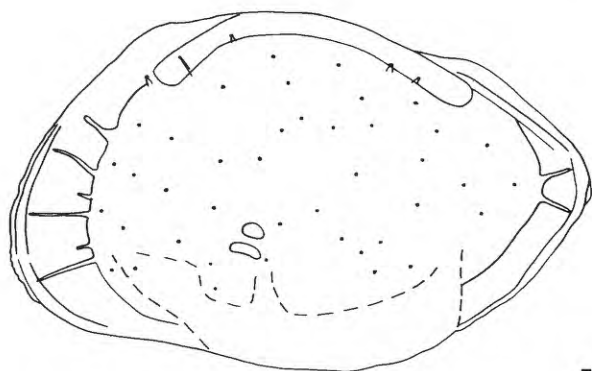
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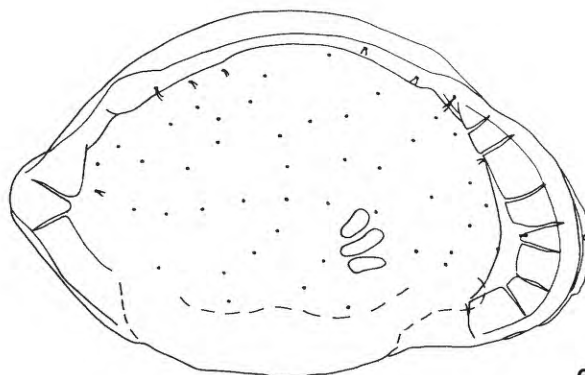
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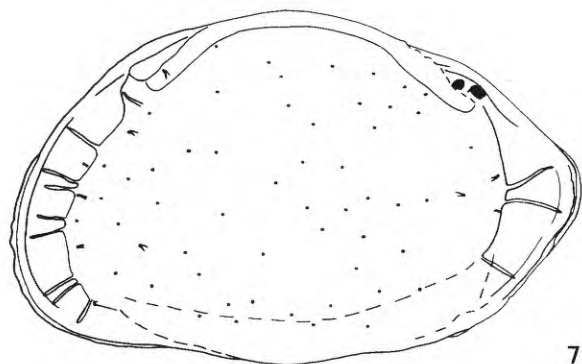
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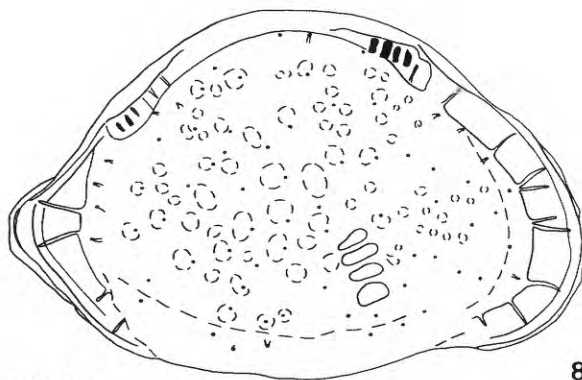
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CYTHEROPTERON

PLATE 10

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–5, 7–8, 11, 14–17; bar scale equals 10 micrometers for figs. 6, 9–10, 12–13]

Figures 1–7, 9–10. *Cytheropteron yajimai* Tabuki, 1986 (p. 39).

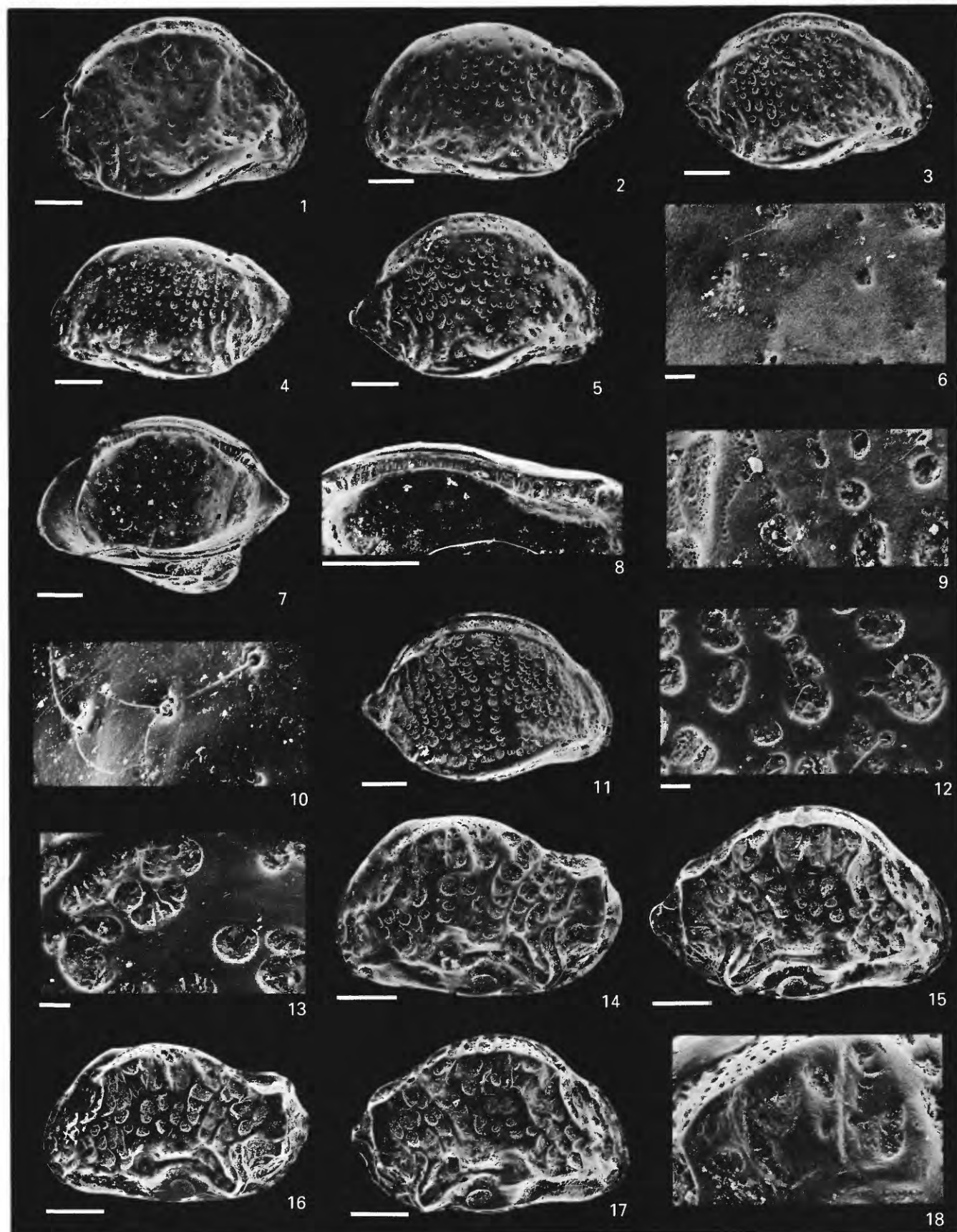
1. Exterior right valve. USNM 408488. Locality DC2-80-EG-195.
2. Exterior left valve, female. USNM 408489.
Locality DC2-80-EG-195.
3. Exterior right valve, male. USNM 408490.
Locality DC2-80-EG-195.
4. Exterior left valve, male. USNM 408491. Locality DC2-80-EG-195.
5. Exterior right valve, female. USNM 408492.
Locality DC2-80-EG-195.
6. Close-up view of ornament pitting, simple pores with setae.
USNM 408489.
7. Interior right valve, female. USNM 408493.
Locality DC2-80-EG-195.
9. Close-up view of secondary ornament, simple pores with setae.
USNM 408490.
10. Close-up view of simple pores with simple bifurcating setae.
USNM 408491.

11–13. *Cytheropteron chichagofensis* n. sp. (p. 18).

11. Exterior right valve. USNM 408497, paratype.
Locality EGAL-75-KC-141.
12. Close-up view of ornament pits, simple pores with setae.
USNM 408497.
13. Close-up view of secondary ornament. USNM 408497.

8, 14–18. *Cytheropteron tsugaruense* Tabuki, 1986 (p. 37).

8. Close-up view of hinge. USNM 408504.
Locality DC2-80-EG-195.
14. Exterior left valve, female. USNM 408500.
Locality DC2-80-EG-195.
15. Exterior right valve, female. USNM 408501.
Locality DC2-80-EG-195.
16. Exterior left valve, male. USNM 408502. Locality DC2-80-EG-195.
17. Exterior right valve, male. USNM 408503.
Locality DC2-80-EG-195.
18. Close-up view of secondary ornament. USNM 408500.

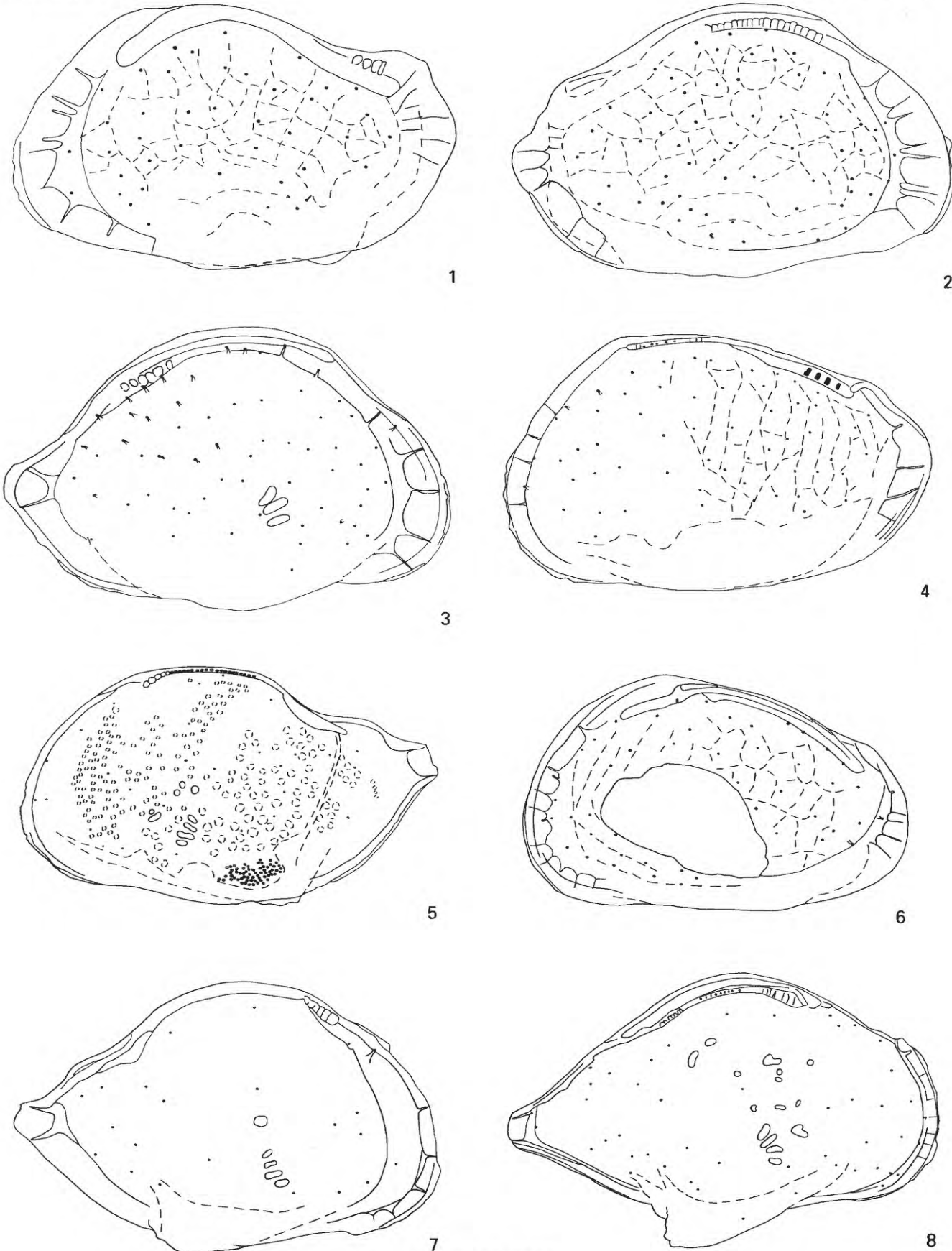


CYTHEROPTERON

PLATE 11

[All figures are camera lucida drawings]

- Figures 1, 2. *Cytheropteron tsugaruense* Tabuki, 1986 (p. 37).
1. Exterior left valve, length 0.49 mm, height 0.31 mm. USNM 408498.
Locality DC2-80-EG-195.
 2. Exterior right valve, length 0.49 mm, height 0.30 mm. USNM 408499.
Locality DC2-80-EG-195.
3. *Cytheropteron nodosolatum* Neale and Howe, 1973 (p. 32).
Exterior right valve, length 0.65 mm, height 0.43 mm. USNM 408505.
Locality DC2-80-EG-195.
4. *Cytheropteron eremitum* Hanai, 1959 (p. 23).
Exterior left valve, length 0.48 mm, height 0.26 mm. USNM 408511.
Locality BFM-78-1.
5. *Cytheropteron discoveria* n. sp. (p. 20).
Exterior left valve, length 0.45 mm, height 0.26 mm. USNM 408516, holotype.
Locality DC2-80-EG-195.
6. *Cytheropteron* sp. V (p. 42).
Exterior left valve, length 0.39 mm, height 0.25 mm. USNM 408521.
Locality EGAL-75-KC-11.
7. *Cytheropteron drybayensis* n. sp. (p. 21).
Exterior right valve, length 0.55 mm, height 0.38 mm. USNM 408522, holotype.
Locality EGAL-75-KC-95.
8. *Cytheropteron eicheri* n. sp. (p. 22).
Exterior right valve, length 0.56 mm, height 0.30 mm. USNM 408526, holotype.
Locality EGAL-75-KC-77.

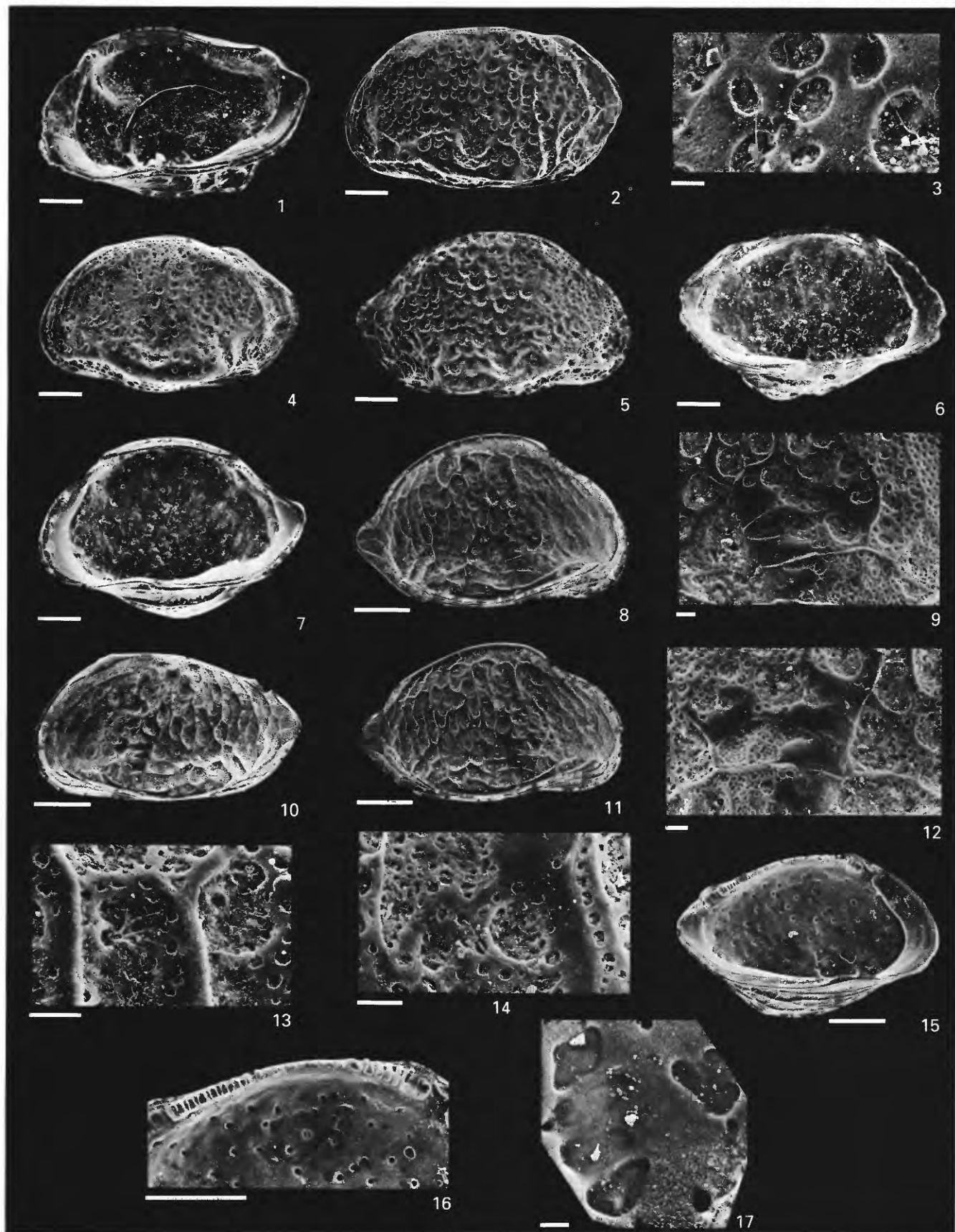


CYTHEROPTERON

PLATE 12

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4–8, 10–11, 15–16; bar scale equals 10 micrometers for figs. 3, 9, 12–14, 17]

- Figure 1. *Cytheropteron tsugaruense* Tabuki, 1986 (p. 37).
Interior right valve. USNM 408504. Locality DC2-80-EG-195.
- 2–7. *Cytheropteron nodosolatum* Neale and Howe, 1973 (p. 32).
2. Exterior left valve. USNM 408506. Locality DC2-80-EG-63.
3. Close-up view of ornament, pores. USNM 408506.
4. Exterior left valve. USNM 408507. Locality DC2-80-EG-195.
5. Exterior right valve. USNM 408508. Locality DC2-80-EG-263.
6. Interior left valve. USNM 408509. Locality DC2-80-EG-195.
7. Interior right valve. USNM 408510. Locality DC2-80-EG-195.
- 8–17. *Cytheropteron eremitum* Hanai, 1959 (p. 23).
8. Exterior right valve, female. USNM 408512. Locality BFM-78-1.
9. Close-up view of ornament, external reflection of central muscle scars. USNM 408512.
10. Exterior left valve, male. USNM 408513. Locality BFM-78-1.
11. Exterior right valve, male. USNM 408514. Locality BFM-78-1.
12. Close-up view of ornament, external reflection of central muscle scars. USNM 408513.
13. Close-up view of normal pore. USNM 408513.
14. Close-up view of ornament, pore. USNM 408512.
15. Interior left valve, male. USNM 408515. Locality BFM-78-1.
16. Close-up view of hingement. USNM 408515.
17. Close-up view of central muscle scars. USNM 408515.



CYTHEROPTERON

PLATE 13

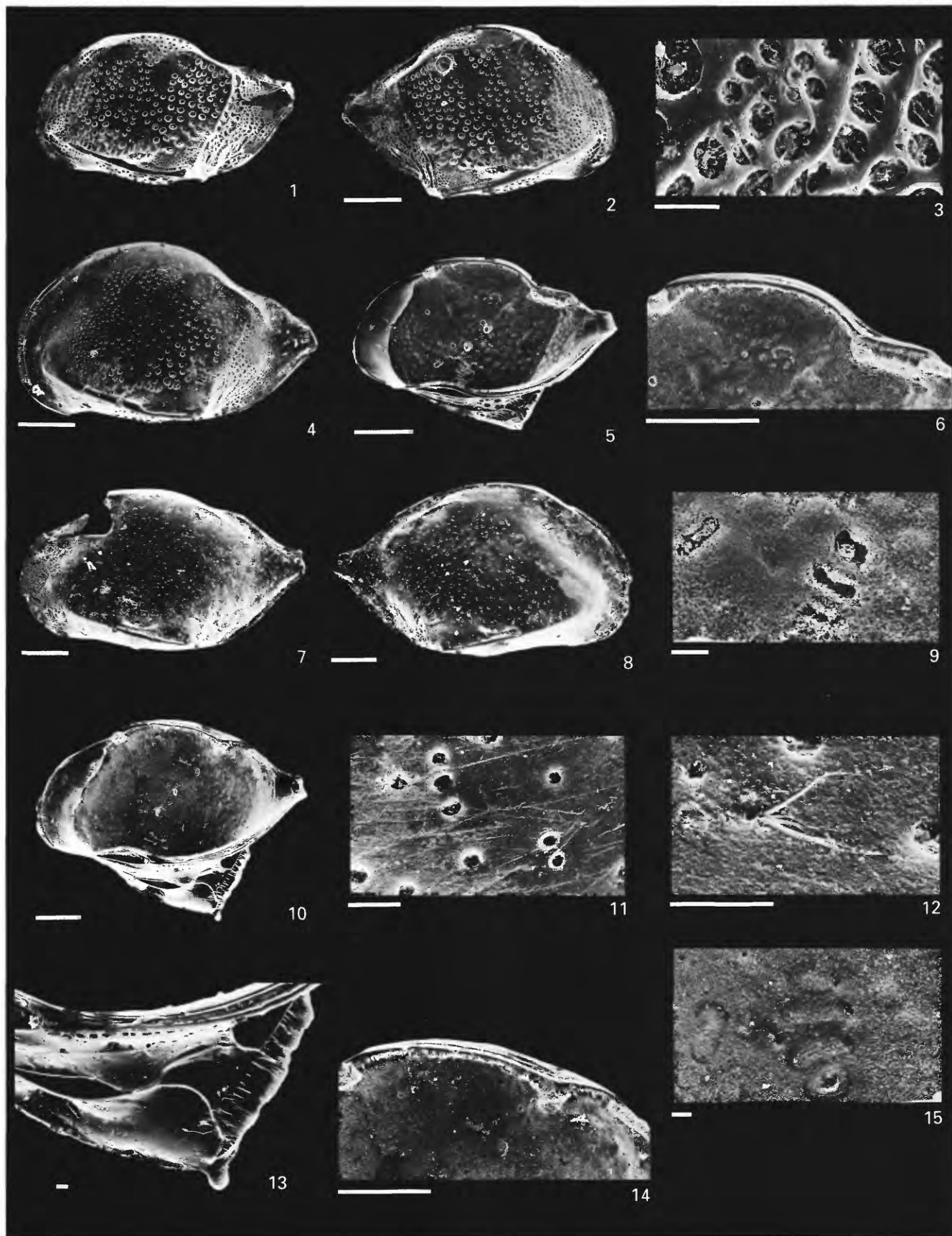
[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 2, 4–8, 10, 14; bar scale equals 10 micrometers for figs. 3, 9, 11–13, 15]

Figures 1–6, 9. *Cytheropteron discoveria* n. sp. (p. 20).

1. Exterior left valve. USNM 408517, paratype. Locality DC2-80-EG-195.
2. Exterior right valve. USNM 408518, paratype.
Locality DC2-80-EG-195.
3. Close-up view of ornament, pore. USNM 408517.
4. Exterior left valve. USNM 408519, paratype.
Locality EGAL-75-KC-150.
5. Interior right valve. USNM 408520, paratype. Locality DC2-80-EG-186.
6. Close-up view of hingement. USNM 408520.
9. Close-up view of central muscle scars. USNM 408520.

7–8, 10–15. *Cytheropteron drybayensis* n. sp. (p. 21).

7. Exterior left valve. USNM 408523, paratype.
Locality EGAL-75-KC-128.
8. Exterior right valve. USNM 408524, paratype.
Locality DC2-80-EG-186.
10. Interior right valve. USNM 408525, paratype.
Locality EGAL-75-KC-128.
11. Close-up view of ornament, pores. USNM 408524.
12. Close-up view of pore. USNM 408524.
13. Close-up view of ala. USNM 408525.
14. Close-up view of hingement. USNM 408525.
15. Close-up view of central muscle scars. USNM 408525.

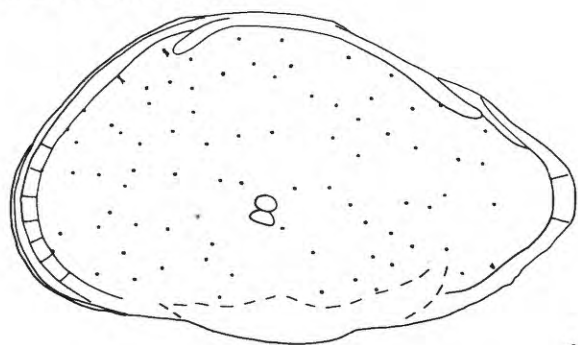


CYTHEROPTERON

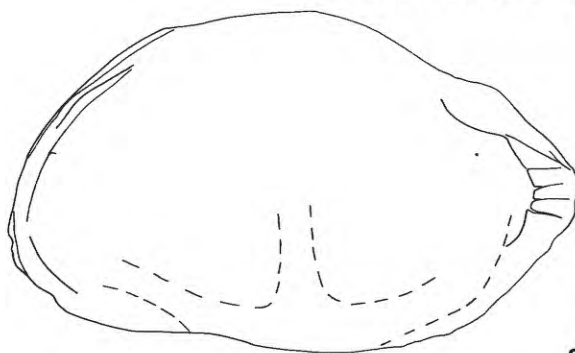
PLATE 14

[All figures are camera lucida drawings]

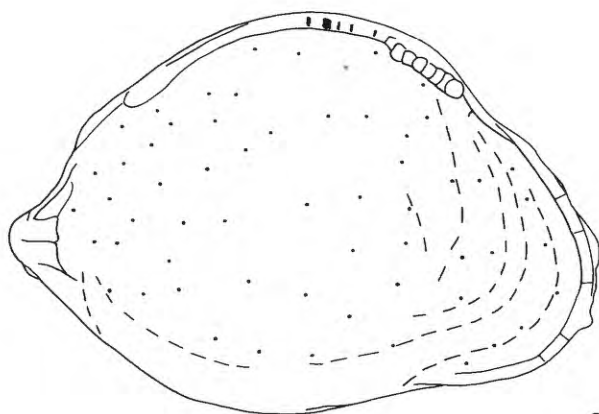
- Figure 1. *Cytheropteron* sp. J (p. 2).
Exterior left valve, length 0.54 mm, height 0.30 mm. USNM 408529.
Locality EGAL-75-KC-421.
- 2, 3. *Cytheropteron haydenensis* n. sp. (p. 25).
2. Exterior left valve, length 0.45 mm, height 0.25 mm. USNM 408530, holotype.
Locality EGAL-75-KC-46.
3. Exterior right valve, length 0.45 mm, height 0.25 mm. USNM 408531, paratype.
Locality EGAL-75-KC-46.
- 4, 5. *Cytheropteron lordi* n. sp. (p. 30).
4. Exterior left valve, length 0.35 mm, height 0.20 mm. USNM 408537, holotype.
Locality DC2-80-EG-195.
5. Exterior right valve, length 0.35 mm, height 0.19 mm. USNM 408538, paratype.
Locality DC2-80-EG-195.
6. *Cytheropteron hopkinsi* n. sp. (p. 27).
Exterior right valve, length 0.53 mm, height 0.33 mm. USNM 408546, holotype.
Locality EGAL-75-KC-11.
7. *Cytheropteron drybayensis* n. sp. (p. 21).
Exterior right valve, length 0.55 mm, height 0.35 mm. USNM 408552, holotype.
Locality EGAL-75-KC-6.
8. *Cytheropteron champlainum* Cronin, 1981 (p. 17).
Exterior left valve, length 0.55 mm, height 0.36 mm. USNM 408553.
Locality EGAL-75-KC-6.



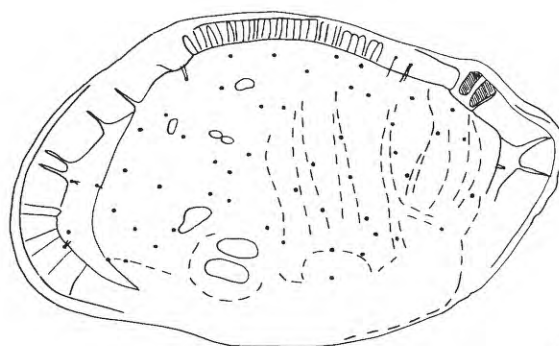
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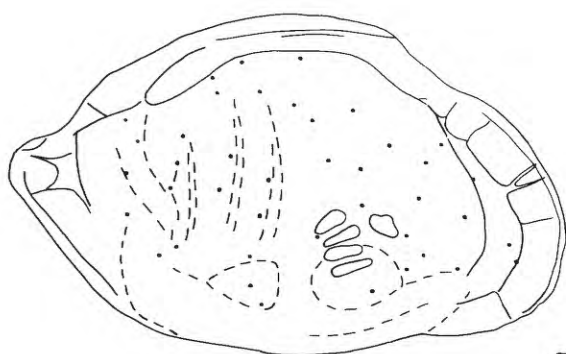
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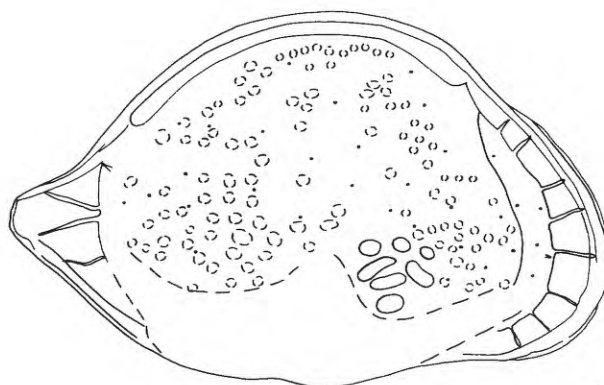
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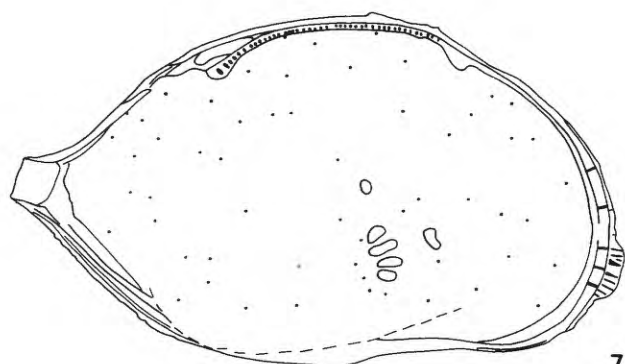
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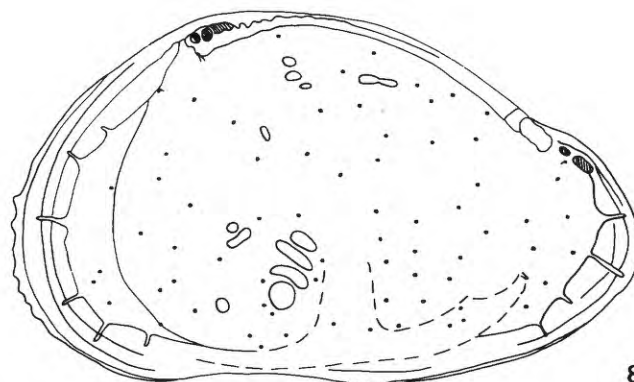
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PLATE 15

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4–5, 7–8, 10, 13–15; bar scale equals 10 micrometers for figs. 3, 6, 9, 11–12]

Figures 1–5. *Cytheropteron eicheri* n. sp. (p. 22).

1. Exterior right valve. USNM 408527, paratype. Locality EGAL-75-KC-30.
2. Close-up view of ala. USNM 408528.
3. Close-up view of pores. USNM 408527.
4. Exterior left valve. USNM 408528, paratype. Locality EGAL-75-KC-30.
5. Close-up view of hingement. USNM 408528.

6–15. *Cytheropteron haydenensis* n. sp. (p. 25).

6. Close-up view of posterior ornament. USNM 408532.
7. Exterior left valve. USNM 408532, paratype. Locality EGAL-75-KC-46.
8. Exterior right valve. USNM 408533, paratype. Locality EGAL-75-KC-46.
9. Close-up view of ornament, pores. USNM 408532.
10. Exterior left valve. USNM 408534, paratype. Locality EGAL-75-KC-46.
11. Close-up view of posterior ornament. USNM 408534.
12. Close-up view of secondary ornament papillae. USNM 408534.
13. Interior right valve. USNM 408535, paratype. Locality EGAL-75-KC-46.
14. Interior left valve. USNM 408536, paratype. Locality EGAL-75-KC-46.
15. Close-up view of hingement. USNM 408535.

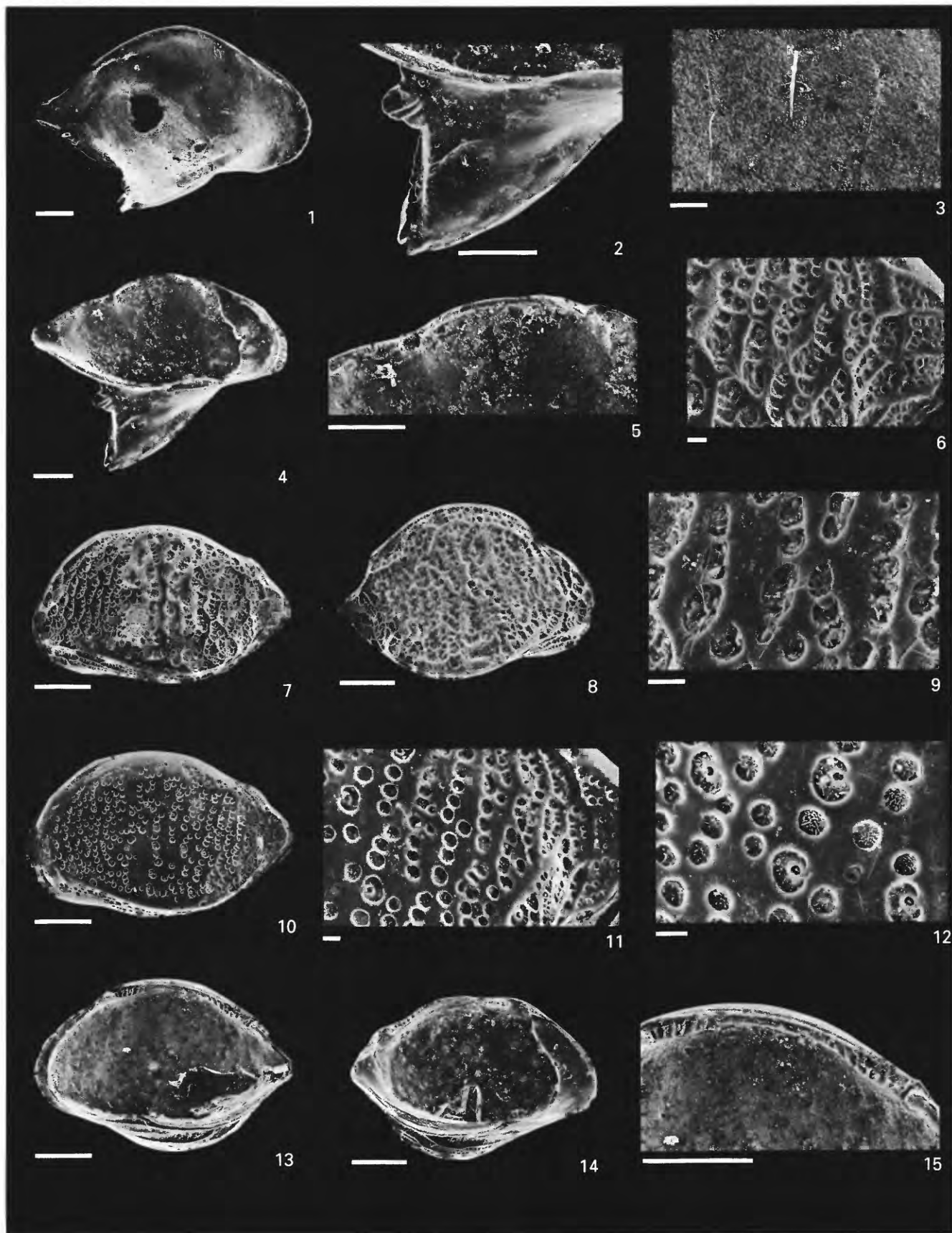


PLATE 16

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4–5, 7–8, 10–11, 13, 16–17; bar scale equals 10 micrometers for figs. 3, 6, 9, 12, 14–15, 18]

Figures 1–9. *Cytheropteron lordi* n. sp. (p. 30).

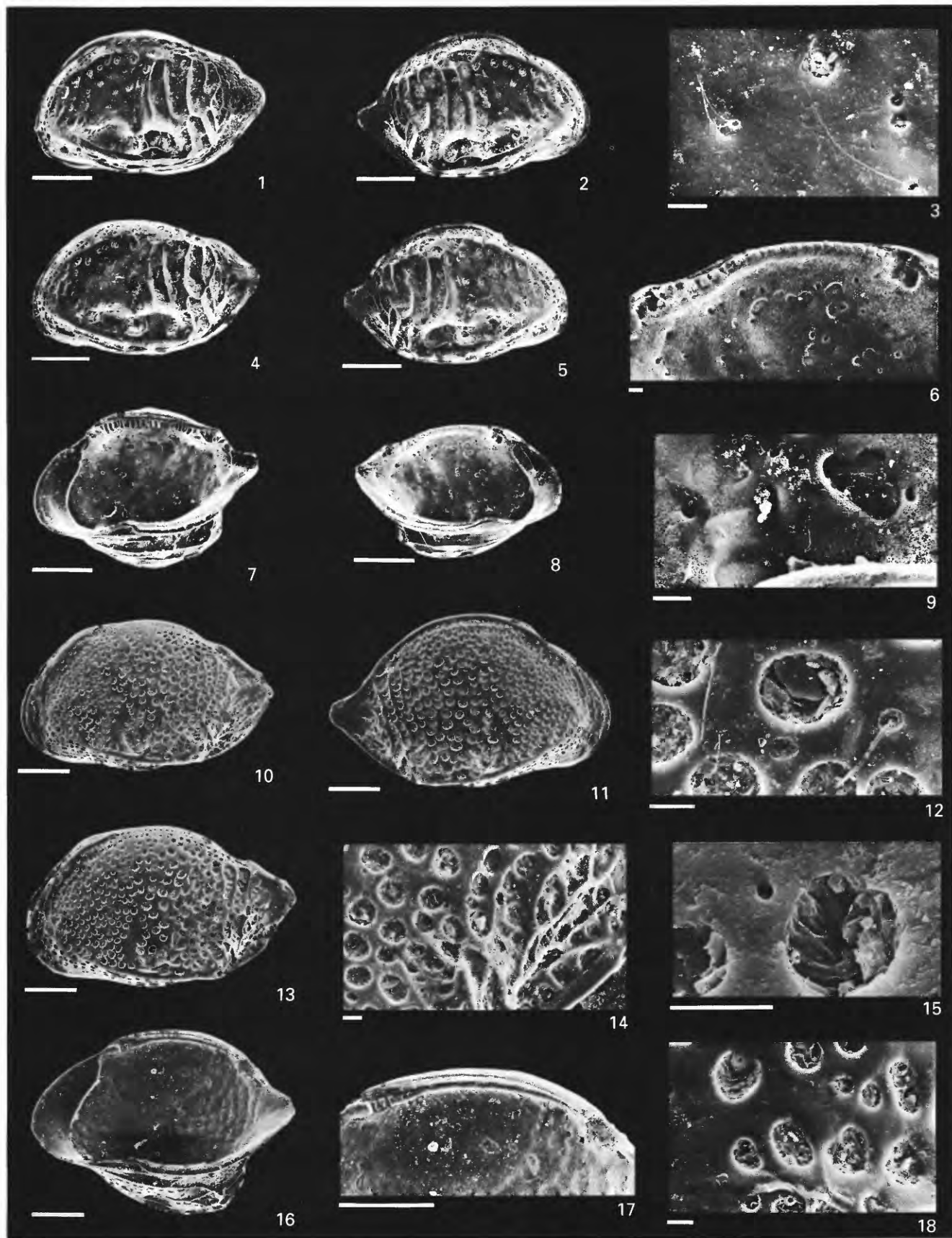
1. Exterior left valve, female. USNM 408539, paratype.
Locality DC2-80-EG-286.
2. Exterior right valve, female. USNM 408540, paratype.
Locality DC2-80-EG-195.
3. Close-up view of pores. USNM 408540.
4. Exterior left valve, male. USNM 408541, paratype.
Locality DC2-80-EG-195.
5. Exterior right valve, male. USNM 408542, paratype.
Locality DC2-80-EG-195.
6. Close-up view of hingement. USNM 408543.
7. Interior right valve. USNM 408544, paratype. Locality DC2-80-EG-286.
8. Interior left valve. USNM 408543, paratype. Locality DC2-80-EG-286.
9. Close-up view of central muscle scars. USNM 408545, paratype.
Locality DC2-80-EG-195.

10–17. *Cytheropteron hopkinsi* n. sp. (p. 27).

10. Exterior left valve, female. USNM 408547, paratype.
Locality EGAL-75-KC-5.
11. Exterior right valve, female. USNM 408548, paratype.
Locality EGAL-75-KC-263.
12. Close-up view of ornament, pores. USNM 408548.
13. Exterior left valve, male. USNM 408549, paratype.
Locality EGAL-75-KC-333.
14. Close-up view of ornament. USNM 408549.
15. Close-up view of secondary ornament and pores. USNM 408547.
16. Interior right valve. USNM 408550, paratype.
Locality EGAL-75-KC-333.
17. Close-up view of hingement. USNM 408551, paratype.
Locality EGAL-75-KC-6.

18. *Cytheropteron champlainum* Cronin, 1981 (p. 17).

- Close-up view of ornament. USNM 408554. Locality EGAL-75-KC-6.



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PLATE 17

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4–5, 7, 10–11, 13–14, 16–17;
bar scale equals 10 micrometers for figs. 3, 6, 8–9, 18]

Figures 1–6. *Cytheropteron champlainum* Cronin, 1981 (p. 17).

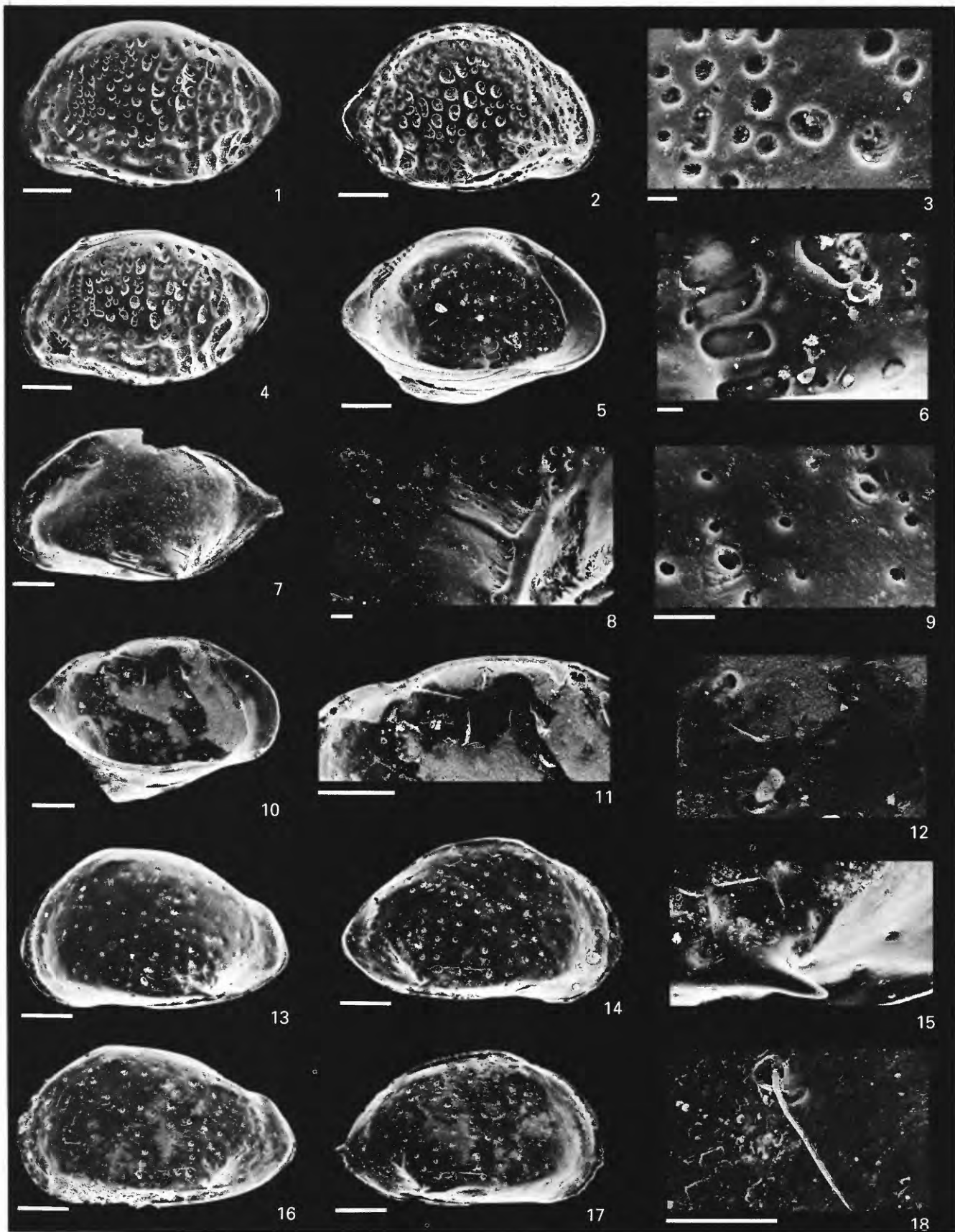
1. Exterior left valve. USNM 408554. Locality EGAL-75-KC-6.
2. Exterior right valve. USNM 408555. Locality EGAL-75-KC-6.
3. Close-up view of ornament, pores. USNM 408554.
4. Exterior left valve. USNM 408556. Locality EGAL-75-KC-6.
5. Interior left valve. USNM 408557. Locality EGAL-75-KC-6.
6. Close-up view of central muscle-scar field. USNM 408557.

7–12. *Cytheropteron drybayensis* n. sp. (p. 21).

7. Exterior left valve. USNM 408559, paratype. Locality EGAL-75-KC-123.
8. Close-up view of ala. USNM 408559.
9. Close-up view of ornament, pores. USNM 408559.
10. Interior left valve. USNM 408560, paratype. Locality EGAL-75-KC-106.
11. Close-up view of hingement. USNM 408560.
12. Close-up view of central muscle-scar field. USNM 408560.

13–18. *Cytheropteron foresteri* n. sp. (p. 24).

13. Exterior left valve, female. USNM 408563, paratype.
Locality EGAL-75-KC-432.
14. Exterior right valve, female. USNM 408564, paratype.
Locality EGAL-75-KC-432.
15. Close-up view of ala. USNM 408563.
16. Exterior left valve, male. USNM 408565, paratype.
Locality EGAL-75-KC-432.
17. Exterior right valve, male. USNM 408566, paratype.
Locality EGAL-75-KC-432.
18. Close-up view of pore. USNM 408564.

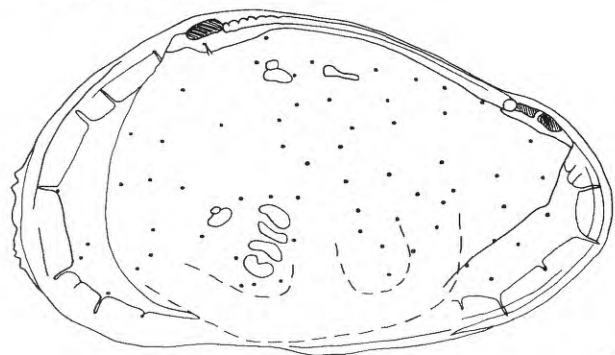


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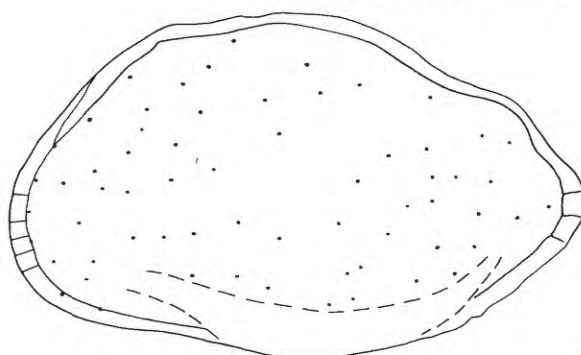
PLATE 18

[All figures are camera lucida drawings]

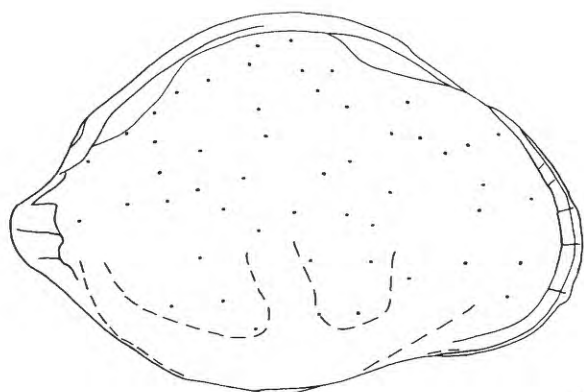
- Figure 1. *Cytheropteron drybayensis* n. sp. (p. 21).
Exterior left valve, length 0.65 mm, height 0.38 mm. USNM 408558, paratype.
Locality EGAL-75-KC-124A.
- 2, 3, 6. *Cytheropteron foresteri* n. sp. (p. 24).
2. Exterior left valve, female, length 0.51 mm, height 0.30 mm. USNM 408561, holotype. Locality EGAL-75-KC-432.
3. Exterior right valve, male, length 0.54 mm, height 0.30 mm. USNM 408562, paratype. Locality EGAL-75-KC-432.
6. Exterior right valve, length 0.50 mm, height 0.31 mm. USNM 408586, paratype. Locality EGAL-75-KC-117.
- 4, 5. *Cytheropteron suzdalskyi* Lev, 1972 (p. 35).
4. Exterior left valve, female, length 0.56 mm, height 0.33 mm. USNM 408579. Locality BFM-78-1.
5. Exterior left valve, male, length 0.53 mm, height 0.29 mm. USNM 408580. Locality BFM-78-1.
- 7, 8. *Cytheropteron squirei* n. sp. (p. 34).
7. Exterior left valve, female, length 0.45 mm, height 0.25 mm. USNM 408588, holotype. Locality EGAL-75-KC-52A.
8. Exterior left valve, male, length 0.50 mm, height 0.29 mm. USNM 408589, paratype. Locality DC2-80-EG-195.



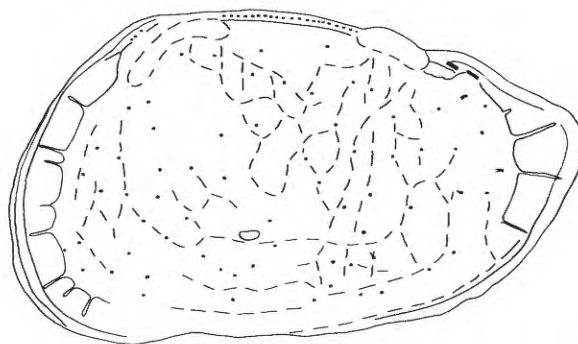
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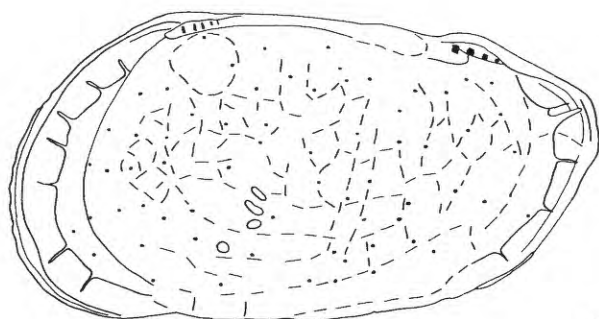
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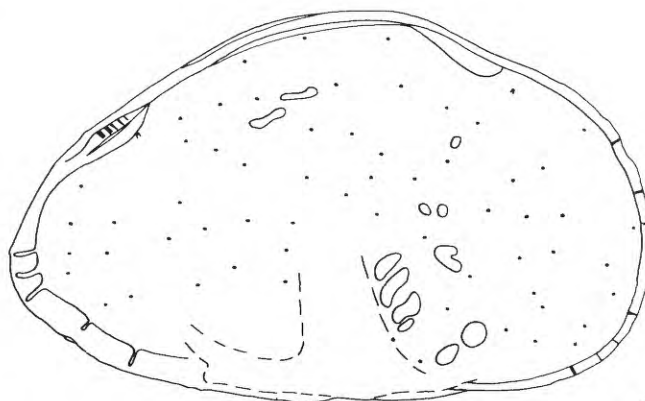
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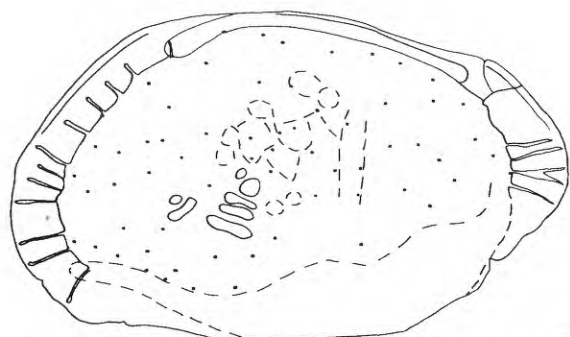
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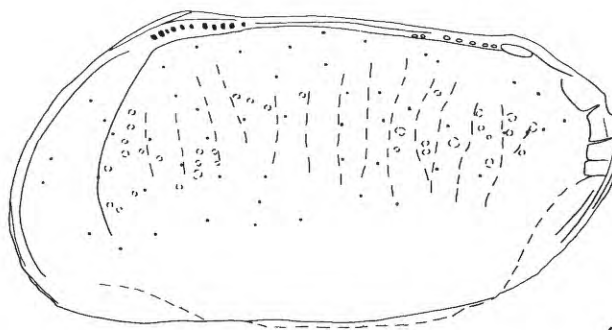
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PLATE 19

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4, 6–7, 9–14; bar scale equals 10 micrometers for figs. 3, 5, 8]

Figures 1–4. *Cytheropteron foresteri* n. sp. (p. 24).

1. Interior right valve, female. USNM 408567, paratype. Locality EGAL-75-KC-432.
2. Interior left valve, female. USNM 408568, paratype. Locality EGAL-75-KC-432.
3. Close-up view of central muscle-scar field. USNM 408568.
4. Close-up view of hingement. USNM 408568.

5–7, 9. *Cytheropteron lituyaensis* n. sp. (p. 28).

5. Close-up view of pore. USNM 408571.
6. Exterior right valve. USNM 408571, holotype. Locality EGAL-75-KC-17.
7. Interior right valve. USNM 408572, paratype. Locality EGAL-75-KC-17.
9. Close-up view of hingement. USNM 408572.

8, 10–14. *Cytheropteron midtimberensis* n. sp. (p. 31).

8. Close-up view of pore. USNM 408575.
10. Exterior left valve. USNM 408575, holotype. Locality DC2-80-EG-195.
11. Exterior right valve. USNM 408576, paratype. Locality DC2-80-EG-195.
12. Exterior left valve. USNM 408577, paratype. Locality DC2-80-EG-195.
13. Interior left valve. USNM 408578, paratype. Locality DC2-80-EG-195.
14. Close-up view of hingement. USNM 408578.

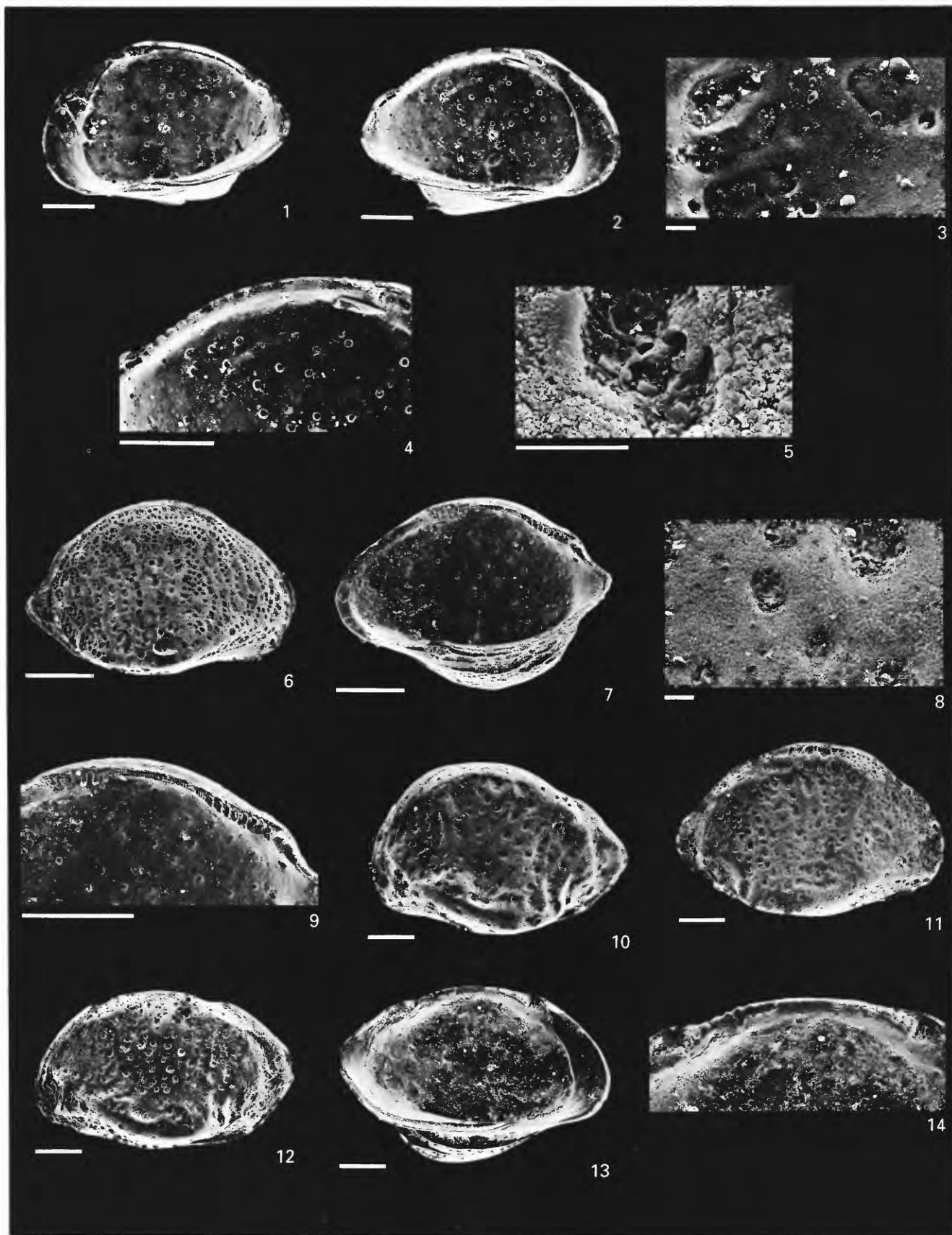


PLATE 20

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4–5, 7–8, 10, 13–14, 16–17;
bar scale equals 10 micrometers for figs. 3, 6, 9, 11]

Figures 1–9. *Cytheropteron suzdalskyi* Lev, 1972 (p. 35).

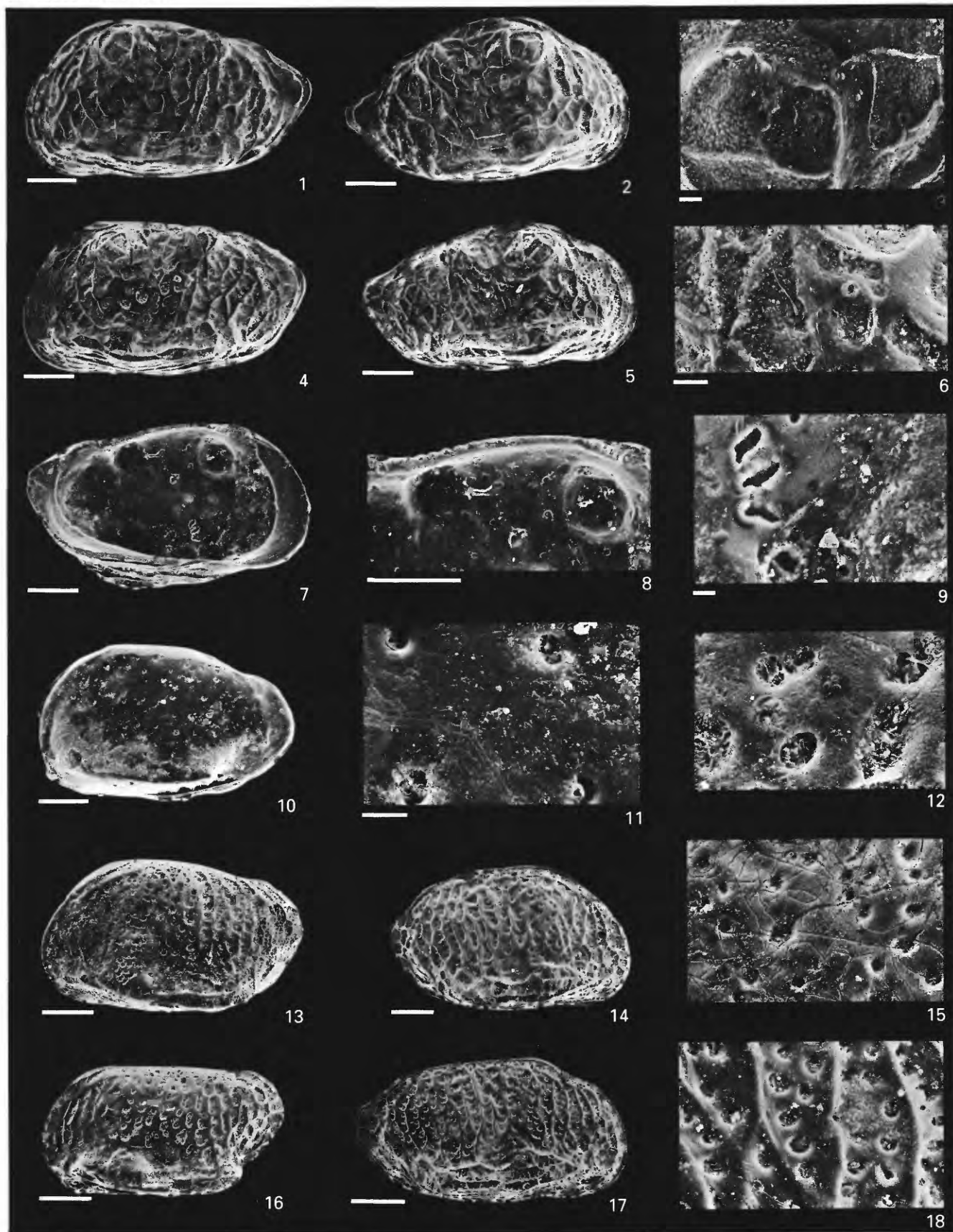
1. Exterior left valve, female. USNM 408581. Locality BFM-78-1.
2. Exterior right valve, female. USNM 408582. Locality BFM-78-1.
3. Close-up view of secondary ornament, pores. USNM 408582.
4. Exterior left valve, male. USNM 408583. Locality BFM-78-1.
5. Exterior right valve, male. USNM 408584. Locality BFM-78-1.
6. Close-up view of secondary ornament, pores. USNM 408584.
7. Interior left valve. USNM 408585. Locality BFM-78-1.
8. Close-up view of hingement. USNM 408585.
9. Close-up view of central muscle-scar field. USNM 408585.

10–11. *Cytheropteron foresteri* n. sp. (p. 24).

10. Exterior left valve. USNM 408587, paratype. Locality DC2-80-EG-195.
11. Close-up view of normal pores. USNM 408587.

12–18. *Cytheropteron squirei* n. sp. (p. 34).

12. Close-up view of normal pores. USNM 408590.
13. Exterior left valve, female. USNM 408591, paratype.
Locality EGAL-75-KC-32.
14. Exterior right valve, female. USNM 408592, paratype.
Locality DC2-80-EG-195.
15. Close-up view of ornament, surface boring. USNM 408593.
16. Exterior left valve, male. USNM 408594, paratype.
Locality DC2-80-EG-195.
17. Exterior right valve, male. USNM 408590, paratype.
Locality DC2-80-EG-195.
18. Close-up view of ornament. USNM 408590.

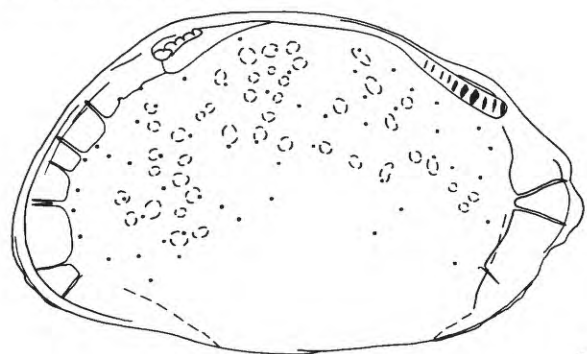


CYTHEROPTERON

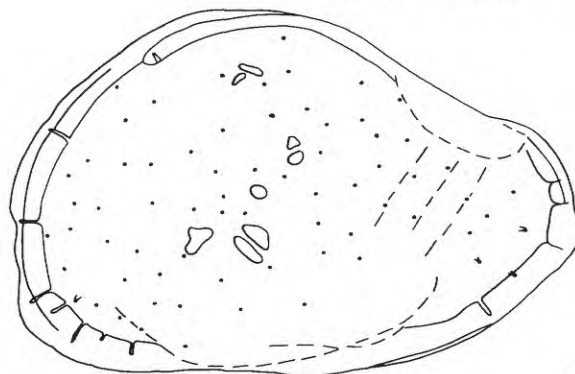
PLATE 21

[All figures are camera lucida drawings]

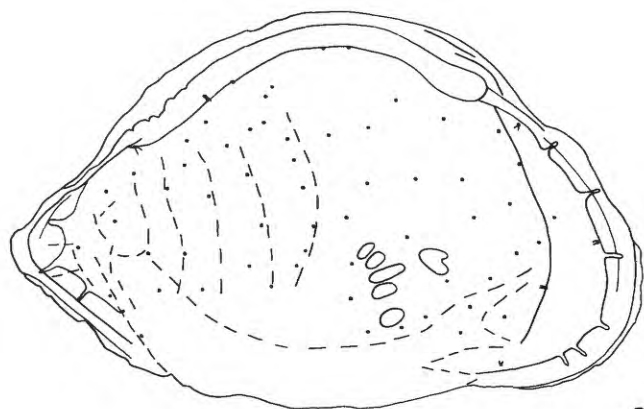
- Figure 1. *Cytheropteron tarrensis* n. sp. (p. 36).
Exterior left valve, length 0.54 mm, height 0.33 mm. USNM 408597, holotype.
Locality EGAL-75-KC-6.
2. *Cytheropteron elaeni* Cronin, 1988 (p. 23).
Exterior left valve, length 0.43 mm, height 0.28 mm. USNM 408602.
Locality EGAL-75-KC-159.
3. *Cytheropteron vernritchiensis* n. sp. (p. 38).
Exterior right valve, length 0.50 mm, height 0.33 mm. USNM 408605, holotype.
Locality EGAL-75-KC-204.
4. *Cytheropteron yakutatensis* n. sp. (p. 40).
Exterior right valve, length 0.58 mm, height 0.35 mm. USNM 408610, holotype.
Locality EGAL-75-KC-204.
5. *Swainocythere chejudoensis* Ishizaki, 1981 (p. 42).
Exterior left valve, length 0.28 mm, height 0.15 mm. USNM 408615.
Locality EGAL-75-KC-154.



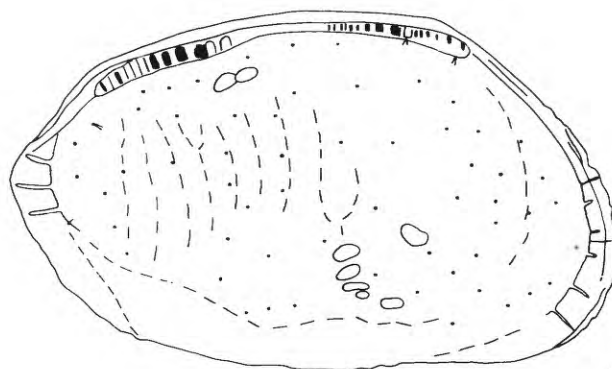
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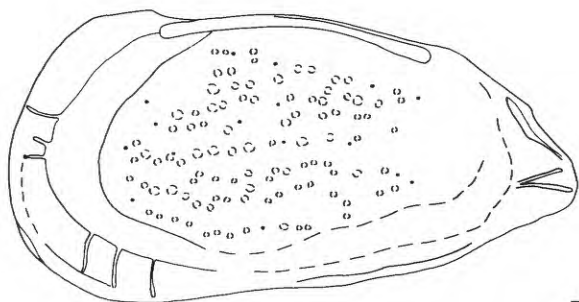
2



3



4

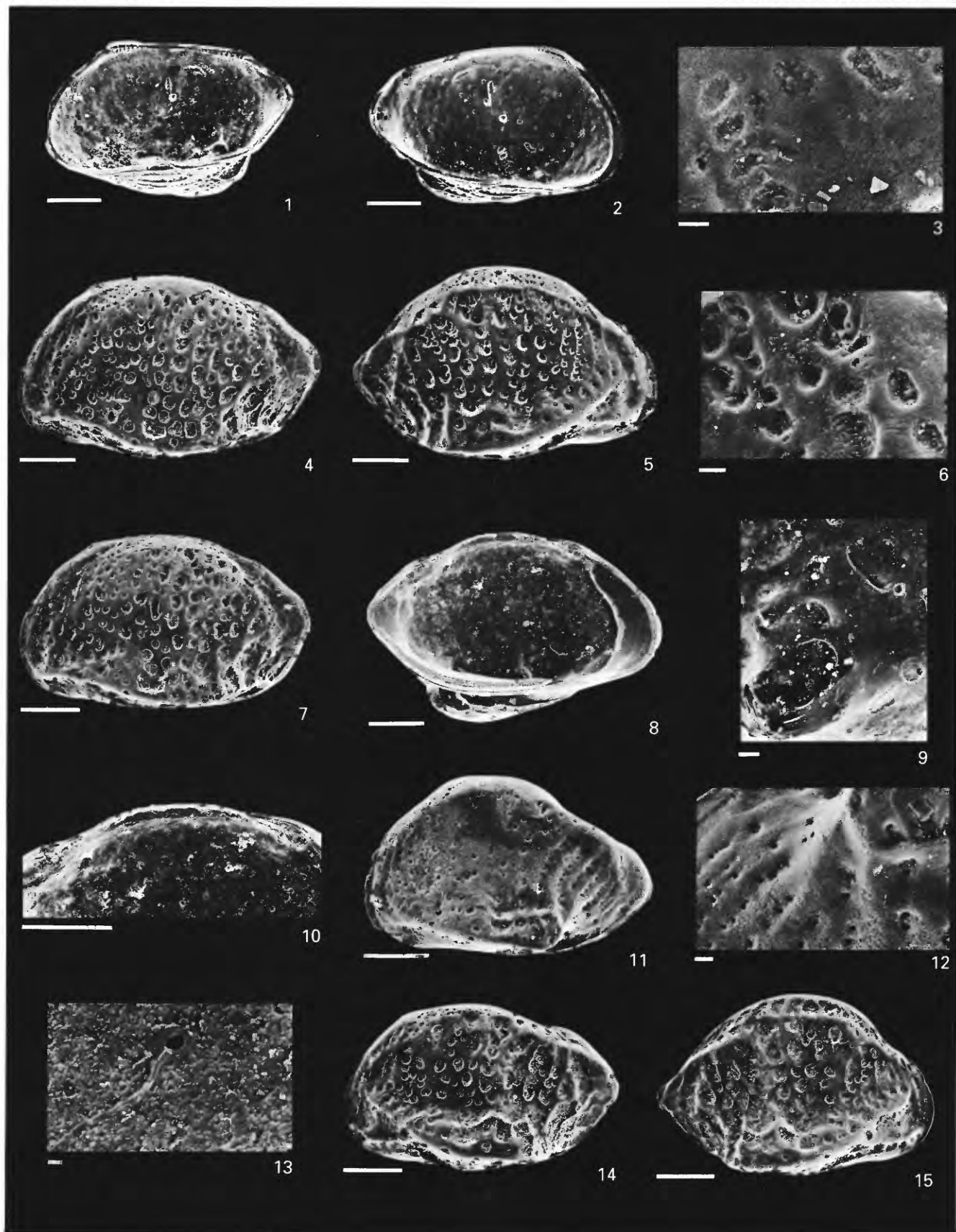


5

PLATE 22

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1–2, 4–5, 7–8, 10–11, 14–15; bar scale equals 10 micrometers for figs. 3, 6, 9, 12; bar scale equals 1 micrometer for fig. 13]

- Figures 1–3. *Cytheropteron squirei* n. sp. (p. 34).
1. Interior right valve. USNM 408595, paratype. Locality DC2-80-EG-195.
 2. Interior left valve. USNM 408596, paratype. Locality DC2-80-EG-195.
 3. Close-up view of central muscle scars. USNM 408596.
- 4–10. *Cytheropteron tarrensis* n. sp. (p. 36).
4. Exterior left valve. USNM 408598, paratype. Locality EGAL-75-KC-6.
 5. Exterior right valve. USNM 408599, paratype. Locality EGAL-75-KC-6.
 6. Close-up view of ornament, pores. USNM 408599.
 7. Exterior left valve. USNM 408600, paratype. Locality EGAL-75-KC-6.
 8. Interior left valve. USNM 408601, paratype. Locality EGAL-75-KC-6.
 9. Close-up view of central muscle-scar field. USNM 408601.
 10. Close-up view of hingement. USNM 408601.
- 11–13. *Cytheropteron elaei* Cronin, 1988 (p. 23).
11. Exterior left valve. USNM 408603. Locality EGAL-75-KC-55.
 12. Close-up view of ornament. USNM 408603.
 13. Close-up view of normal pore. USNM 408603.
- 14–15. *Cytheropteron vernrichtiensis* n. sp. (p. 38).
14. Exterior left valve. USNM 408606, paratype. Locality EGAL-75-KC-263.
 15. Exterior right valve. USNM 408607, paratype.
Locality EGAL-75-KC-263.



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PLATE 23

[All figures are scanning electron photomicrographs. Bar scale equals 100 micrometers for figs. 1, 4–5, 7–8, 10–11, 14; bar scale equals 10 micrometers for figs. 2–3, 9, 12–13; bar scale equals 1 micrometer for fig. 15]

Figures 1–6. *Cytheropteron vernritchiensis* n. sp. (p. 38).

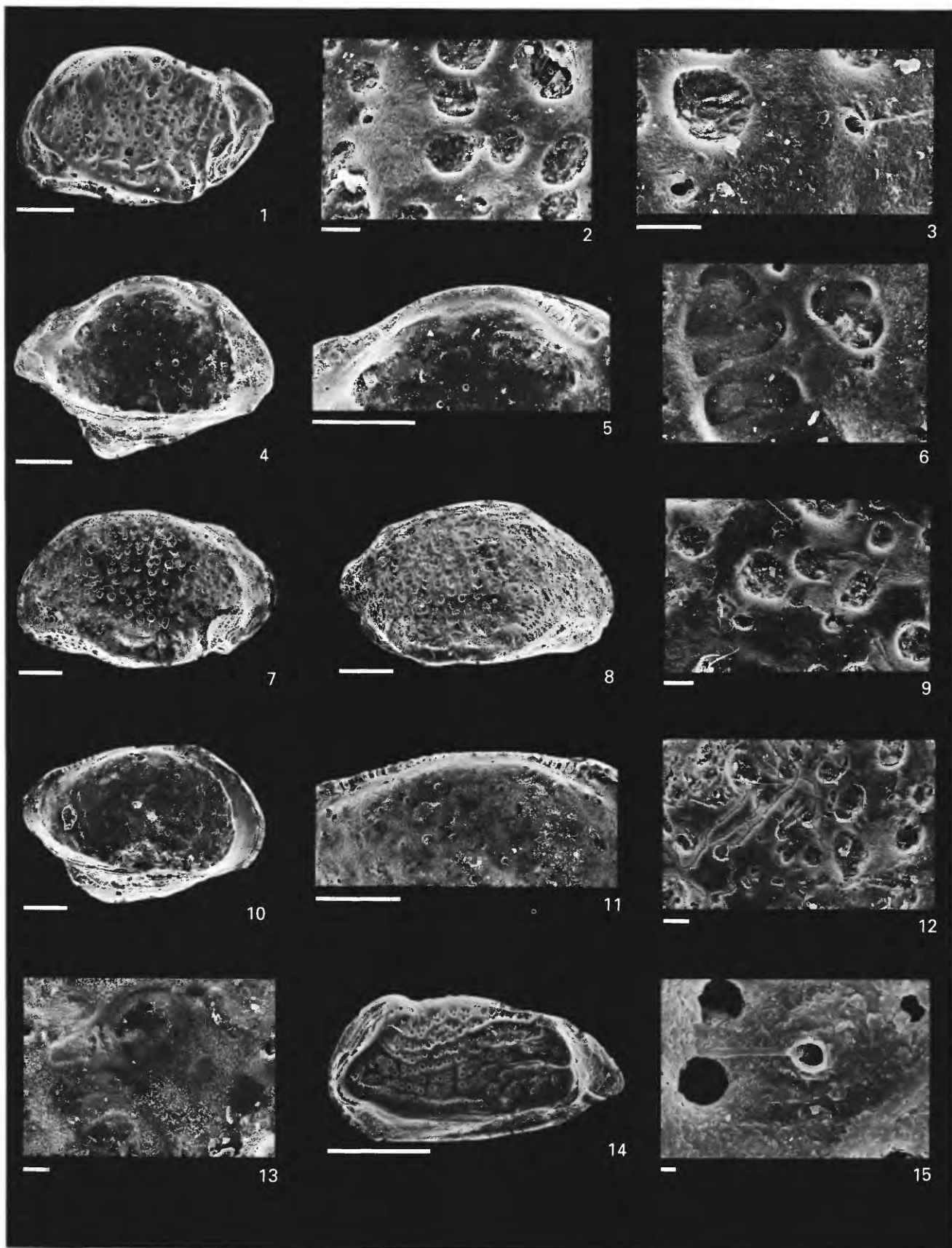
1. Exterior of left valve. USNM 408608, paratype.
Locality EGAL-75-KC-30.
2. Close-up view of ornament and pores. USNM 408606.
3. Close-up view of secondary ornament and pores. USNM 408607.
4. Interior of left valve. USNM 408609, paratype.
Locality EGAL-75-KC-141.
5. Close-up view of hingement. USNM 408609.
6. Close-up view of central muscle-scar field. USNM 408609.

7–13. *Cytheropteron yakutatensis* n. sp. (p. 40).

7. Exterior of left valve. USNM 408611, paratype. Locality DC2-80-EG-195.
8. Exterior of right valve. USNM 408612, paratype.
Locality EGAL-75-KC-32.
9. Close-up view of ornament and pores. USNM 408611.
10. Interior of left valve. USNM 408613, paratype. Locality DC2-80-EG-195.
11. Close-up view of hingement. USNM 408614, paratype.
Locality DC2-80-EG-195.
12. Close-up view of surface borings. USNM 408611.
13. Close-up view of central muscle-scar field.

14–15. *Swainocythere chejudoensis* Ishizaki, 1981 (p. 42).

14. Exterior of left valve. USNM 408616. Locality EGAL-75-KC-105.
15. Close-up view of normal pore. USNM 408616.



CYTHEROPTERON, SWAINOCYTHERE

