

MESOZOIC OSTRACODA FROM C.O.S.T. ATLANTIC WELLS; ADDITIONS AND EMENDATIONS

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Abstract

In this paper 61 species of Mesozoic Ostracoda are recorded and illustrated from the C.O.S.T. Atlantic offshore wells B-2, G-1 and G-2.

In the B-2 well, Baltimore Canyon area, off New Jersey, Lat. 39 degrees, 22 minutes, 31.972 seconds N., Long. 72 degrees, 44 minutes, 3.871 seconds W., three species had their highest (shallowest) occurrence in the Santonian-Coniacian interval; three species in the Turonian; five species in the Cenomanian; four species in the Albian; and two species in the Aptian.

The G-1 well, Georges Bank area, off Cape Cod, Lat. 40 degrees, 55 minutes, 52.11 seconds N., Long. 68.7 degrees, 18 minutes, 18.92 seconds W., had, based on their highest occurrence, four species from the Campanian and two species from the Santonian.

The G-2 well, slightly more offshore of the G-1, Lat. 40 degrees, 50 minutes, 11.4 seconds N, Long. 67 degrees, 30 minutes 29.8 seconds W, had eight species from the Santonian, eight species from the Coniacian, four species from indeterminate Coniacian or Turonian deposits, one species from indeterminate Turonian or Cenomanian, one species from the Cenomanian, 17 species from The Aptian, one species from indeterminate Aptian or Barremian deposits, two species from the Barremian, nine species from the Hauterivian, three species from the Kimmeridgian, two species from the Oxfordian and two species from the Callovian

Introduction

The Mesozoic Ostracoda from several of the C.O.S.T. (Continental Offshore Stratigraphic Test) Atlantic wells, offshore of the east coast of the United States have been described in part by Swain (1981), Swain and Xie (1991); Ascoli (1976), and their stratigraphic zonation, additionally, by Ascoli (1980, 1981a, 1981b, 1982a, 1982b, 1983), Ascoli and Gradstein (1976), Ascoli et al. (1984) and Poag (1982).

In this brief paper, additional Mesozoic Ostracoda are recorded and illustrated and several emendations are made to the stratigraphic assignments of Swain (1981) and Swain and Xie (1991) made previously in the G-1 and G-2 wells. The stratigraphic tops designated by Ascoli (1988) in the G-1 and G-2 wells have been used to assign ages to the ostracode species.

C.O.S.T. B-2 Well

The C.O.S.T B-2 well (Smith et al., 1976) was drilled off the New Jersey Coast in 298 feet (91 m of water depth, Lat. 39 degrees, 22 minutes, 31.972 seconds N., Long. 72 degrees, 44 minutes, 3.871 seconds W., to a depth of 16,043 feet (4890 m), ending in Late Jurassic? rocks. The ages, sediment types, depth (Smith et al., 1976) and occurrences of some of the Mesozoic Ostracoda (Swain, 1981; Swain and Xie, 1991) were published previously. Those species recorded in the present paper are given below.

Maastrichtian Stage (ca 5000 ft (1524 m)); sandstone

none (see Swain, 1981)

Campanian Stage (ca 5100 ft (1554 m)); sandstone and shale

none (see Swain, 1981)

Late Santonian Stage (ca 5736 ft (1748 m)); sandstone and shale

Early Santonian Stage (ca 6063 ft (1848 m)); sandstone, shale at base

Bairdia alexandrina Blake, *Brachycythere* cf. *sphenoides* (Reuss), *Cythereis simulonuda* Swain

Turonian Stage (7057 ft (2151 m)); shale

Rehacythereis? sp. aff. *R? kosticensis* Pokorny, *Cythereis ornatissima* (Reuss)

Cenomanian Stage, (7610 ft (2319 m)); shale

Cytherella, n. sp. 1, *C.*, n. sp. 2, *C.*, n. sp. 3, *Pontocyprrella* cf. *roundyi* Alexander, *Bairdia* cf. *comanchensis* Alexander, *Rehacythereis* cf. *gatyensis*

Albian Stage, (8130 ft (2478 m)); sandstone, few lignite beds

Brachycythere? sp., *Schuleridea* sp. aff. *S. oliverensis* (Alexander), *Cornicythereis bonnemaioides* Swain and Xie

Aptian Stage (8900 ft (2713 m)); sandstone and lignite

Cytherella austinoides Swain and Xie, *Paracyprideis?* sp. aff. *P. goodlandensis* Alexander

For pre-Aptian ostracodes see Swain (1981)

C.O.S.T G-1 Well

The C.O.S.T G-1 well (Amato and Bebout, 1980) was drilled in 157 feet (48 m) of water depth off Cape Cod, Massachusetts, Lat. 40 degrees, 55 minutes, 52.11 seconds N., Long. 68 degrees, 18 minutes, 18.92 seconds W., to a depth of

16,071 feet (4900 m), ending in early Cambrian? rocks. The ages, sediment types, depths (Ascoli, 1988; Poag, 1982) and occurrences of Ostracoda recorded in this paper are given below.

Maastrichtian and Late Campanian, absent

Early Campanian (1060 ft (314 m)), Ascoli; Absent, Poag, sandstone

Cytherella "ovata" (Roemer), *Brachycythere rhomboides* (Berry), *Opimocythere* gr. *emmae* Deroo, *Sphaeroleberis* cf. *mosaensis* Deroo

Santonian (1226 ft (374 m)), Ascoli; 1030 ft 314 m, Poag, sandstone

Haplocytheridea sp. aff. *H. carolinensis* (Brown), *Phacorhabdotus* cf. *pokorny* Hazel and Paulson

For pre-Santonian Ostracoda see Swain (1981)

C.O.S.T G-2 Well

The C.O.S.T G-2 well (Amato and Simonis, 1980; Ascoli, 1988; Poag, 1982) was drilled in 272 feet (83 m) of water depth, offshore of Cape Cod, Massachusetts, Lat. 40 degrees, 50 minutes, 11.4 seconds N, Long. 67 degrees, 30 minutes, 29.8 seconds W, to a total depth of 21,874 feet (6667 m). ending in early Jurassic or late Triassic rocks. The Mesozoic Ostracoda recorded in the present report are listed below.

Maastrichtian Stage, absent (Poag, 1982)

Campanian Stage, absent (Poag, 1982)

Early Santonian Stage, ca. 1100 feet (335 m), Poag, shale, sandstone

Cytherella "ovata" (Roemer), *Phacorhabdotus* cf. *pokorny* Hazel and Paulson, *Eucythere* cf. *brightseatensis* (Berry), *Clithrocytheridea* sp. aff. *C. pataulensis* (Crane), *C* ? sp. aff. *C. renfroensis* (Crane), *C* ? sp., *Opimocythere* cf. *elongata* Hazel, *Brachycythere* cf. *crenulata* (Crane), *Phacorhabdotus* sp. aff. *P. venodus* Crane. See Swain (1981) for additional Santonian species.

Coniacian Stage, ca. 1600 feet (488 m), Poag, shaly sandstone

Bairdia sp. aff. *B. alexandrina* Blake, *Bairdia* or *Bairdoppilata* sp., *Cytherella* gr. *parallela* (Reuss), *Cytherella* cf. *austinensis* Alexander, *Cytherella* sp. 1, *Bairdoppilata* sp. 1, *Schuleridea*? sp. aff. *S. derooi* Damotte and Grosdidier, *Alatocythere* sp. aff. *A. ponderosana* (Israelsky), *Brachycythere* cf. *taylorensis* (Alexander), *Cythereis* sp. aff. *C. sagena* Crane, *Rehacythereis*? sp. aff. *R. dallasensis rachis* (Crane), *Amphicytherura* sp. See Swain (1981) for additional Coniacian species.

Turonian Stage 2120 feet (646 m) Ascoli; ca. 2100 feet (640 m) Poag, shale

Paracypris cf. "alta" Alexander. See Swain (1981) for additional Turonian species.

Cenomanian Stage 2270 feet (692 m) Ascoli; ca. 2200 feet (671 m) Poag, shale and limestone

Curfsina ? *neali* Swain and Xie. See Swain (1981) for additional Cenomanian species.

Albian Stage absent Ascoli, Poag. See Swain (1981) for species listed in Albian Stage, but belonging in Aptian and Barremian Stages by Ascoli.

Aptian Stage 2420 feet (738 m) Ascoli; ca. 2250 feet (686 m) Poag, limestone and sandy limestone

Cytherella nagaseae Swain and Xie, *C. amatoi* Swain and Xie, *Paracyprideis*? sp. limestone, shale

Schuleridea praethorenensis Bartenstein and Brand, *S. anterofossulata* Swain and Brown, *Asciocythere* cf. *triangularis* Swain, *Paraschuleridea twifordensis* Swain and Brown, *Hutsonia collinsensis* Swain and Brown, *Neocythere* cf. *protovanveeni* Kaye, *Palaeocytheridea*? cf. *insidiosa* Lyubimova, *Protocythere* cf. *triplicata* (Roemer), charophyte oogonia. See Swain (1981) for additional Barremian species and for species listed in Berriasian referred to Hauterivian by Ascoli.

aff. *P. attenuata* (Reuss), *Bairdoppilata* cf. *roemeri* Deroo, *Cytheropteron* sp. aff. *C. eximium* Alexander, *Schuleridea* cf. *rhomboidalis* Neale, *S.* cf. *jonesiana* (Bosquet), *Metacytheropteron*?? sp., *Neocythere* cf. *gottisi* Damotte and Grosdidier, *Rehacythereis*? cf. *dentonensis* (Alexander), *Isocythereis*? sp., *Kingmaina*? sp., *Cythereis paramahonae* Swain and Xie, *Xestoleberis* cf. *ovata* Bonnema. See Albian above.

Barremian Stage 2960 feet (902m) Ascoli; ca. 2600 feet (792 m) Poag, calcareous sandstone and shale.

Cytherella cf. *comanchensis* Alexander, *Centrocythere* cf. *bordeti* Damotte and Grosdidier. See Albian above.

Hauterivian Stage 3919 feet (1194 m) Ascoli; ca. 3900 feet (1189m) Poag, shaly
Valanginian Stage, 5440 feet (1658 m) Ascoli; ca. 4600 feet (1402 m) Poag; sandstone and shale (Ascoli et al, 1984 used 5427 for this top)

None in this paper; see Swain (1981) for ostracode species in this depth interval.

Berriasian Stage, 5530 feet (1686 m) Ascoli; ca. 5500 feet (1676 m) Poag; shale

None in this paper; see Swain (1981) for ostracode species in this depth interval.

Upper Jurassic System

Tithonian Stage, 5856 feet (1785 m) Ascoli; limestone

None in this paper; see Swain (1981) for ostracode species in this depth interval

Kimmeridgian Stage, 6245 feet (1903 m) Ascoli; limestone, shale,
sandstone

Schuleridea acuminoidea Swain and Xie, *Apatocythere* cf. *lanceolata* Swain, Gen. et sp. indet (also see Swain (1981) for additional species in this depth interval.

Oxfordian Stage, 9697 feet (2949 m) Ascoli; ca. 8600 feet (2317 m) Poag; sandstone, limestone

Galliaecytheridea cf. *remota* Grekoff, *Pichottia?* *simonisi* Swain and Xie, *Micropneumatocythere?* sp.

Middle Jurassic System

Callovian Stage, 10060 feet (3006 m) Ascoli; ca. 7600 feet (2317 m) Poag; sandstone, shale

Glyptocythere? sp.,

No ostracodes are recorded in this paper below the Callovian.

Discussion

The discrepancies of age assignments in the Mesozoic rocks of these C.O.S.T wells appear to be the result of incomplete data in the earlier papers. The stratigraphic assignments of Ascoli (1990) are followed in this paper because his data include coordination of a variety of microfossil types.

Most of the C.O.S.T. well Mesozoic ostracodes are open shelf types. A few, such as *Hutsonia* and the cytherurids indicate nearshore, more restricted conditions. The relatively high species diversity in the Santonian and Coniacian Stages in the B-2 and the G-2 wells and in the Campanian of the G-1 well, suggest a relatively slow rate of deposition of these deposits. The same is indicated for the Aptian and Hauterivian deposits in the G-2 well. The units with low species diversity, together with substantial thicknesses suggest more rapid rates of deposition.

There is a striking lack of correspondence among the early Cretaceous and late Jurassic ostracode faunas of the Atlantic border region and those of the Gulf of Mexico region, as noted earlier (Swain, 1981; Swain and Xie, 1991) During the late Cretaceous there was much better ostracode correspondence between

the two regions, pointing to a better marine connection in the late Cretaceous as compared to the early Cretaceous and late Jurassic.

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Plate Descriptions

Mesozoic Ostracoda from C.O.S.T Atlantic Wells

Plate 1

Figures 1, 2. *Cytherella austinoides* Swain and Xie B-2 well, 8820-8830 feet in deposits of Aptian? age. Left side and dorsal view of female, X 60.

Figures 3, 9. *Pontocyprrella?* cf. *roundyi* (Alexander). B-2 well, 7690-7700 feet in deposits cited as Cenomanian. This form occurs in Kiamichi Formation (M. Albian) of Texas. Right side of complete shell, X 68 and ventral view of left valve, X 66.

Figures 4, 5. *Cytherella*, n. sp. 1. B-2 well, 7790-7800 feet in deposits cited as Cenomanian. Ventral view, X 84 and left side of female shell, X 63.

Figures 6, 14. *Cytherella*, n. sp. 2 B-2 well, 7790-7800 feet in deposits of Cenomanian age. Left side of female shell, X 67, dorsal view of right valve, X 64, of same species?

Figures 7, 8. *Cytherella austinoides* Swain and Xie. B-2 well, 7790-7800 feet in deposits of Cenomanian age. Left side and dorsal views of male shell, X 60.

Figures 10, 13. *Bairdia* cf. *alexandrina* Blake. B-2 well 7290-7300 feet in deposits cited as Turonian. Right side, X 46 and dorsal view, X 43, of shell.

Figures 11, 12. *Bairdia comanchensis* Alexander. B-2 well, 8800-8810 feet in deposits of Aptian age. Left side and dorsal views of shell, X 67.

Figures 15, 16. *Bairdia* cf. *alexandrina* Blake. B-2 well 8800-8810 feet in deposits of Aptian age. (may be caving) Dorsal view, X 71 and right side, X 67, of shell.

Figure 17. *Bairdia comanchensis* Alexander. B-2 well, 7790-7800 feet in deposits of Cenomanian age. Exterior of left valve, X 47, broken ventrally.

Figures 18, 20. *Brachycythere* cf. *sphenoides* (Reuss) or *B. taylorensis* (Alexander). B-2 well, 6290-6300 feet in deposits cited as Santonian to Coniacian. Left side and ventral views, X 42.

Figures 19, 23. *Brachycythere* cf. *sphenoides* (Reuss) or *B. taylorensis* (Alexander). B-2 well, 6390-6400 feet in deposits cited as Santonian to Coniacian. Left side and ventral views, X 34.

Figures 21, 22. *Brachycythere?* sp. B-2 well, 8620-8640 feet in deposits cited as Albian. Left side and ventral views of shell, X 40.

Figure 24. *Paracyprideis?* sp. aff. *P.?* *goodlandensis* (Alexander). B-2 well, 8900-8910 feet in deposits of Aptian age. Left side of shell, X 60.

Plate 2

Figures 1, 2. *Schuleridea* sp. aff. *S. oliverensis* (Alexander). B-2 well, 8680-8690 feet in deposits cited as Albian. Right side and dorsal views of shell, X 79.

Figures 3, 4. *Rehacythereis?* sp. aff. *R? kosticensis* Pokorny. B-2 well, 7290-7300 feet in deposits cited as Turonian. Left side and dorsal views of shell, X 60.

Figures 5, 6. *Cythereis? simulonuda* Swain. B-2 well, 5990-6000 feet in deposits cited as Santonian. Right side and dorsal views of shell, imperfect anteriorly, X 42. (Species is typically Coniacian)

Figures 7, 8. *Rehacythereis?* cf. *gatyensis* (Damotte and Grosdidier). B-2 well, 8620-8640 feet in deposits cited as Albian. Dorsal and right side views of shell, X 40.

Figures 9, 10. *Cornicythereis bonnemaoides* Swain and Xie. B-2 well, 8570-8590 feet in deposits cited as Albian. Dorsal and left side views, X 70.

Figures 11, 12. *Cythereis ornatissima* (Reuss). B-2 well, 7290-7300 feet in deposits cited as Turonian. Right side and dorsal views, X 60.

Figures 13, 14. *Cornicythereis bonnemaoides* Swain and Xie. B-2 well, 8870-8880 feet in deposits cited as Aptian. Left side and dorsal views, X 79.

Figures 15, 16. *Rehacythereis?* cf. *gatyensis* (Damotte and Grosdidier). B-2 well, 7790-7800 feet in deposits cited as Cenomanian. Left side and dorsal views of shell, X 45.

Figure 17. *Cytherella "ovata"* (Roemer). G-1 well, 1030-1060 feet in deposits of Campanian age. Exterior of right valve, stereo pair, X 64.

Figure 18. *Cytherella "ovata"* (Roemer). G-1 well, 1240-1270 feet in deposits of Santonian age. Interior of right valve, stereo pair, X 60.

Figure 19. *Cytherella "ovata"* (Roemer). G-1 well, 1240-1270 feet in deposits of Santonian age. Ventral view of right valve, stereo pair, X 66.

Figure 20. *Cytherella "ovata"* (Roemer). G-1 well, 1240-1270 feet in deposits of Santonian age. Ventral view of right valve, stereo pair, X 46.

Plate 3

Figure 1. *Cytherella "ovata"* (Reuss). G-1 well, 1240-1270 feet in deposits of Santonian age. Right side of shell, stereo pair, X 62.

Figure 2. *Brachycythere rhomboidalis* (Berry). G-1 well, 1060-1090 feet in deposits of Campanian age. Right side of shell, stereo pair, X 43.

Figure 3. *Brachycythere rhomboidalis* (Berry). G-1 well, 1060-1090 feet in deposits of Campanian age. Ventral view of shell, stereo pair, X 43.

Figure 4. "*Haplocytheridea*" sp. aff. "*H.*" *carolinensis* (Brown). G-1 well, 1210-1240 feet in deposits of Santonian age. Exterior of left valve, stereo pair, X 86.

Figures 5, 8. "*Haplocytheridea*" sp. aff. "*H.*" *carolinensis* (Brown). G-1 well, 1210-1240 feet in deposits of Santonian age. Interior of right valve, stereo pair, X 86; and detail of muscle scar area, X 315.

Figure 6. "*Haplocythereidea*" sp. aff. "*H.*" *carolinensis* (Brown). G-1 well, 1210-1240 feet in deposits of Santonian age. Ventral view of right valve, stereo pair, X 83.

Figure 7. *Phacorhabdotus* cf. *pokornyi* Hazel and Paulson. G-1 well, 1240-1270 feet in deposits of Santonian age. Exterior of right valve, stereo pair, X 62.

Figures 9, 10. *Phacorhabdotus* cf. *pokornyi* Hazel and Paulson. G-1 well, 1240-1270 feet in deposits of Santonian age. Ventral view of right valve, stereo pair, X 67; detail of adductor muscle scar, X 335.

Figure 11. *Phacorhabdotus* cf. *pokornyi* Hazel and Paulson. G-1 well, 1240-1270 feet in deposits of Santonian age. Ventral view, stereo pair, of right valve, X 67.

Plate 4

Figure 1. *Opimocythere?* sp. gr. *O? emmae* Deroo. G-1 well, 1930-1060 feet in deposits of Campanian age. Right side of shell, stereo pair, X 74.

Figure 2. *Opimocythere?* sp. gr. *O? emmae* Deroo. G-1 well, 1030-1060 feet in deposits of Campanian age. Dorsal view, stereo pair, of shell, X 74.

Figures 3, 6. *Opimocythere?* sp. gr. *O? emmae* Deroo. G-1 well, 1030-1060 feet in deposits of Campanian age. Interior of right valve, stereo pair, X 76; detail of adductor muscle scar.

Figure 4. *Opimocythere?* sp. gr. *O? emmae* Deroo. G-1 well, 1030-1060 feet in deposits of Campanian age. Right side of shell, stereo pair, X 61.

Figure 5. *Opimocythere?* sp. gr. *O? emmae* Deroo. G-1 well, 1030-1060 feet in deposits of Campanian age. Dorsal view of right valve, X 74.

Figure 7. *Sphaeroleberis* cf. *mosaensis* Deroo. G-1 well, 1030-1060 feet in deposits of Campanian age. Right side of shell, X 64.

Figures 8-10. *Sphaeroleberis* cf. *mosaensis* Deroo. G-1 well, 1030-1060 feet in deposits of Campanian age. Interior of left valve, stereo pair, X 43; detail of anterior part of hinge, X 134; detail of adductor muscle scar area, X 134.

Figure 11. *Sphaeroleberis* cf. *mosaensis* Deroo. G-1 well, 1030-1060 feet in deposits of Campanian age. Ventral view of shell, X 64.

Figure 12. *Sphaeroleberis* cf. *mosaensis* Deroo. G-1 well, 1060-1090 feet in deposits of Campanian age. Left side of shell, stereo pair, X 43.

Plate 5

(All figures except 8 and 10 are stereo pairs)

Figure 1. *Cytherella* gr. *parallela* (Reuss). G-2 well, 1700-1730 feet in deposits of Coniacian? age. Left side of female shell, X 67.

Figure 2. *Cytherella* gr. *parallela* (Reuss). G-2 well, 1940-1970 feet in deposits of Coniacian age. Left side of female shell, X 62.

Figure 3. *Cytherella* gr. *parallela* (Reuss). G-2 well, 1940-1970 feet in deposits of Coniacian age. Dorsal view of Female? shell, X 62.

Figure 4. *Cytherella* gr. *ovata* (Roemer). G-2 well, 1850-1880 feet in deposits of Coniacian age. Interior of right valve, X 64.

Figure 5. *Cytherella* gr. *parallela* (Reuss). G-2 well, 1790-1820 feet in deposits of Coniacian age. Left side of male shell, X 67.

Figure 6. *Cytherella* gr. *parallela* (Reuss). G-2 well, 1820-1850 feet in deposits of Coniacian age. Interior of male? left valve, X 67.

Figure 7. *Cytherella* gr. *parallela*? (Reuss). G-2 well, 1829-1850 feet in deposits of Coniacian age. Exterior of right valve showing narrow anterior marginal rim and broad shallow dorsomedian depression, X 67.

Figure 8. *Cytherella* cf. *austinensis* Alexander. G-2 well, 2090-2120 feet in deposits of Coniacian or Turonian age. Exterior of right valve X 71.

Figure 9. *Cytherella* gr. *parallela* (Reuss). G-2 well, 1790-1820 feet in deposits of Coniacian age. Dorsal view of male shell, X 67. (see Figure 5).

Figure 10. *Cytherella* cf. *austinensis* Alexander. G-2 well, 2090-2120 feet in deposits of Coniacian or Turonian age. Interior of right valve, X 73.

Figures 11, 12. *Cytherella* sp. 1. (weakly sulcate) G-2 well, 2090-2120 feet in deposits of Coniacian or Turonian age. Left side and dorsal view of female shell, X 72.

Plate 6

(All figures except 5a, 5b and 12 are stereo pairs)

Figure 1. *Cytherella nagaseae* Swain and Xie. G-2 well, 2900-2930 feet in deposits of Aptian or Barremian age. Exterior of male shell, X 64.

Figure 2. *Cytherella nagaseae* Swain and Xie. G-2 well, 2900-2930 feet in deposits of Aptian or Barremian age. Dorsal view of male shell, X 67.

Figure 3. *Cytherella nagaseae* Swain and Xie. G-2 well, 2540-2570 feet in deposits of Aptian age. Exterior of female right valve, X 70.

Figure 4. *Cytherella nagaseae* Swain and Xie. G-2 well, 2540-2570 feet in deposits of Aptian age. Interior of female right valve, X 70.

Figures 5, 5a, 5b. *Cytherella amatoï* Swain and Xie. G-2 well, 2540-2570 feet in deposits of Aptian age. Right side of male shell, X 64; details of anterodorsal and posterodorsal margins, X 637.

Figure 6. *Cytherella amatoï* Swain and Xie. G-2 well, 2540-2570 feet in deposits of Aptian age. Interior of female right valve, X 70.

Figure 7. *Cytherella cf. comanchensis* Alexander. G-2 well, 3200-3230 feet in deposits of Barremian age. Dorsal view of male? shell, X 77.

Figure 8. *Cytherella amatoï* Swain and Xie. G-2 well, 2540-2570 feet in deposits of Aptian age. Right side of female shell, X 67.

Figure 9. *Cytherella nagaseae* Swain and Xie. G-2 well, 3170-3200 feet in deposits of Barremian age. Ventral view of shell, X 67.

Figure 10. *Cytherella nagaseae* Swain and Xie. G-2 well 3170-3200 feet in deposits of Barremian age. Right side of female? shell, X 72.

Figure 11. *Cytherella cf. comanchensis* Alexander. G-2 well, 3200-3230 feet in deposits of Barremian age. Left side of male shell, X 70.

Figure 12. ?*Cytherella cf. comanchensis* Alexander. G-2 well, 3200-3230 feet in deposits of Barremian age. Right side of female? shell, X 62.

Plate 7

(All figures except 15a are stereo pairs)

Figures 1,2. *Paracypris*, n. sp. cf. "alta" Alexander, 1929 not Zalanyi, 1929. G-2 well 2210-2240 feet in deposits of Turonian or Cenomanian age. Right side of shell, X 44 and ventral view, X 43.

Figures 3, 4. *Paracypris*, n. sp. cf. "alta" Alexander. G-2 well, 2360-2390 feet in deposits of Aptian? age. Left side and dorsal views of shell, X 42.

Figure 5. *Paracyprideis?* sp. aff. *P. attenuata* (Reuss). G-2 well, 2360-2390 feet in deposits of Aptian? age. Right side of a poorly preserved shell, X 42.

Figure 6. *Bairdia* sp. aff. *B. alexandrina* Blake. G-2 well, 2330-2360 feet in deposits of Cenomanian or Aptian age. Right side of shell, X 42.

Figure 7. *Bairdoppilata?* sp. 1. G-2 well, 1790-1820 feet in deposits of Coniacian? age. Right side of shell, X 42.

Figure 8. *Bairdia* sp. aff. *B. alexandrina* Blake. G-2 well, 1640-1670 feet in deposits of Coniacian? age. Right side of shell, X 43.

Figure 9. *Bairdia* sp. aff. *B. alexandrina* Blake. G-2 well, 2330-2360 feet in deposits of Cenomanian or Aptian age. Left side of shell, X 42.

Figure 10. *Bairdian* sp. aff. *B. alexandrina* Blake. G-2 well, 2330-2360 feet in deposits of Cenomanian or Aptian age. Ventral view of shell, X 42.

Figures 11, 12. *Bairdia* or *Bairdoppilata* sp. 2. G-2 well, 2090-2120 feet in deposits of Coniacian or Turonian age. Dorsal view and right side of shell, X 42.

Figure 13. *Bairdian* cf. *alexandrina* Blake. G-2 well, 2270-2300 feet in deposits of Cenomanian age. Right side of shell, X 40.

Figures 14, 15, 15a. *Bairdoppilata* cf. *B. roemeri* Deroo. G-2 well, 2660-2690 feet in deposits of Aptian age. Exterior and interior views of right valve, X 40; and detail of adductor muscle scar, X 168.

Plate 8

(All figures are stereo pairs, except 4a, 6, and 12a)

Figure 1. *Eucythere* cf. *brightseatensis* Berry. G-2 well, 1520-1550 feet in deposits of Santonian age. Right side of shell, X 83.

Figures 2,3. *Cytheropteron* sp. aff. *C. eximium* Alexander. G-2 well, 2330-2360 feet in deposits of Aptian age. Right side, X 120, and dorsal views, X 77.

Figures 4, 4a. *Clithrocytheridea?* sp. aff. *C.? pataulensis* (Crane). G-2 well, 1430-1460 feet in deposits of Santonian age. Right side of poorly preserved shell, X 74, and enlargement of a normal pore and associated sieve plate, X 3685.

Figure 5. *Clithrocytheridea?* sp. aff. *C? renfroensis* (Crane). G-2 well, 1460-1490 feet, in deposits of Aptian age. Ventral view of shell, X 64.

Figure 6. *Schuleridea?* sp. aff. *S. derooi* Damotte and Grosdidier. G-2 well, 2420-2450 feet in deposits of Aptian age. Ventral view of shell, X 45

Figures 7, 8. *Schuleridea* sp. aff. *S. derooi* Damotte and Grosdidier. G-2 well, 1850-1880 feet in deposits of Coniacian age. Dorsal view, X 87 and right side of shell, X 84.

Figure 9. *Clithrocytheridea?* sp. G-2 well, 1730-1760 feet in deposits of Santonian age. Exterior of right valve, X 44.

Figures 10, 11. *Schuleridea* cf. *rhomboidalis* Neale. G-2 well, 2420-2450 feet in deposits of Aptian age. Right side, X 70 and dorsal view, X 66 of shell.

Figures 12, 12a. *Clithrocytheridea?* sp. G-2 well, 1730-1760 feet in deposits of Santonian age. Interior of right valve, X 44 and detail of adductor muscle scar, X 137.

Plate 9

(All figures are stereo pairs except 1a and 6a)

Figures 1, 1a. *Schuleridea* cf. *jonesiana* (Bosquet). G-2 well, 2450-2480 feet in deposits of Aptian age. Right side, X 64, and detail of normal pore, X 3149, showing sieve plate pores surrounding normal pore.

Figures 2, 3. *Schuleridea* cf. *jonesiana* (Bosquet) G-2 well, 2450-2470 feet in deposits of Aptian age. Right side, X 54 and dorsal view, X 66, of shell.

Figure 4. *Schuleridea* cf. *jonesiana* (Bosquet). G-2 well, 2570-2600 feet in deposits of Aptian age. Left side of shell, X 70.

Figure 5. *Schuleridea* cf. *jonesiana* (Bosquet). G-2 well, 2540-2570 feet in deposits of Aptian age. Left side of shell, X 63.

Figures 6, 6a. *Schmuleridea* cf. *jonesiana* (Bosquet). G-2 well, 2540-2570 feet in deposits of Aptian age. Left side of shell, X 66 and detail of normal pore, X 3183, showing rows of sieve plate pores around normal pore.

Figure 7. *Schuleridea* cf. *jonesiana* (Bosquet). G-2 well, 2570-2600 feet in deposits of Aptian age. Ventral view of shell, X 68.

Figures 8, 9. *Paracyprideis* sp. aff. *P. attenuata* (Reuss). G-2 well, 2660-2690 feet, in deposits of Aptian age. Right side, X 60 and dorsal view, X 65.

Plate 10

(All figures are stereo pairs)

Figures 1, 2. *Alatacythere* sp. aff. *A. ponderosana* (Israelsky) or *A. robusta langi* Kaye. G-2 well, 1700-1730 feet in deposits of Coniacian age. Left side and ventral views, X 42 of specimen with broken alar process.

Figure 3. *Opimocythere* cf. *elongata* Hazel. G-2 well, 1400-1430 feet in deposits of Santonian? age. Left side of shell, X 44.

Figure 4. *Brachyocythere* cf. *crenulata* (Crane). G-2 well, 1610-1640 feet in deposits of Santonian? age. Ventral view of shell, X 42.

Figure 5. *Brachyocythere* cf. *taylorensis* (Alexander). G-2 well, 1790-1820 feet, in deposits of Coniacian age. Right side of shell, X 42.

Figure 6. *Brachyocythere* cf. *crenulata* Crane. G-2 well, 2900-2930 feet in deposits of Aptian age, but specimen may have caved from a higher level. Left side of shell, X 64.

Figure 7. *Brachyocythere* cf. *taylorensis* (Alexander). G-2 well, 1940-1970 feet in deposits of Coniacian age. Exterior of right valve, X 62.

Figure 8. *Brachyocythere* cf. *crenulata* Crane. G-2 well, 2810-2840 feet in deposits of Aptian age (caving?). Left side of shell, X 46.

Figures 9, 12. *Metacytheropteron?* sp. G-2 well, 2840-2870 feet in deposits of Aptian age. Dorsal view and left side of shell, X 78.

Figure 10. *Brachyocythere* cf. *taylorensis* (Alexander). G-2 well, 1760-1790 feet in deposits of Coniacian age. Left side of shell, X 46.

Figure 11. *Centrocythere* cf. *bordeti* Damotte and Grosdidier. G-2 well, 3260-3290 feet in deposits of Barremian age. Right side of shell, X 78.

Plate 11

(All figures are stereo pairs except 1a, 2a, 5a, 7a, 9a)

Figures 1, 1a. *Neocythere* cf. *gottisi* (Damotte and Grosdidier). G-2 well, 2750-2780 feet in deposits of Aptian age. Right valve exterior, X 68, and detail of a normal pore and associated sieve plate, X 3350.

Figures 2, 2a. *Neocythere* cf. *gottisi* (Damotte and Grosdidier). G-2 well, 2750-2780 feet in deposits of Aptian age. Right valve interior, X 67, and detail of adductor muscle scar area, X 295.

Figure 3. *Metacytheropteron bicostatum* Swain and Broan. G-2 well, 2480-2510 feet in deposits of Aptian age. Exterior of right valve, X 80.

Figure 4. *Metacytheropteron bicostatum* Swain and Brown. G-2 well, 2480-2510 feet in deposits of Aptian age.. Right valve interior, X 80.

Figures 5, 5a. *Metacytheropteron bicostatum* Swain and Brown. G-2 well, 3110-3140 feet in deposits of Barremian age. Interior of left valve, X 75 and detail of adductor muscle scar area, X 335.

Figures 6, 8. *Cythereis* cf. *sagena* Crane. G-2 well, 1820-1850 feet in deposits of Coniacian age. Left side of shell, X 67, and ventral view of shell, X 84.

Figures 7, 7a, 9, 9a. *Amphicytherura* sp. G-2 well, 2060-2090 feet in deposits of Coniacian or Turonian age. Right side of shell, X 121, detail of sieve plates, X 596; ventral view of shell, A 122, and detail of sieve plate, X 1219.

Plate 12

(All figures are stereo pairs except 4a)

Figures 1-3. *Rehacythereis?* cf. *dallasensis rachis* (Crane). G-2 well, 1850-1880 feet and 2330-2360 feet in deposits of Coniacian and Cenomanian age, respectively (the latter caving?). Interior of right valve, X 62, ventral view of shell, X43; and right side of shell, X 42.

Figures 4, 4a. *Phacorhabdotus* sp. aff. *P. venodus* Crane. G-2 well, 1700-1730 feet in deposits of Santonian? age. Exterior of male? left valve, X 68; and detail of a sieve plate area, X 3149.

Figures 5, 7. *Phacorhabdotus* sp. aff. *P. venodus* Crane. G-2 well, 1730-1760 feet in deposits of Santonian? age. Left side and ventral view of female? shell, X 40.

Figures 6, 8. *Phacorhabdotus* sp. aff. *P. venodus* Crane. G-2 well, 2270-2300 feet in deposits of early Cenomanian age (caved from higher level?). Left side and dorsal view of male? shell, X 74.

Figure 9. *Phacorhabdotus* sp. aff. *P. venodus* Crane. G-2 well, 2750-2780 feet in deposits of Aptian age (maybe caving) Exterior of right valve, X 84.

Figure 10. *Phacorhabdotus* sp. aff. *P. venodus* Crane. G-2 well, 2480-2510 feet in deposits of Aptian age (may be caving). Interior of left valve, X 44.

Figure 11. *Phacorhabdotus* sp. aff. *P. venodus* Crane. G-2 well, 2480-2510 feet in deposits of Aptian age (caving?) Interior of right valve, A 43.

Figure 12. *Phacorhabdotus* sp. aff. *P. venodus* Crane. G-2 well, 2750-2780 feet in deposits of Aptian age (caving?).

Plate 13.

(All figures are stereo pairs except 1a, 1b, 8a, and 10a)

Figures 1, 1a, 1b. *Curfsina? neali* Swain and Xie. G-2 well, 2270-2300 feet in deposits of Cenomanian age. Right side of shell, X 69, detail of part of surface, X 677, showing normal pores, fine surface ornamentation and enlargement of a normal pore and a sieve plate, X 3384.

Figures 2, 3. *Rehacythereis? cf. dentonensis* (Alexander). G-2 well, 2480-2510 feet in deposits of Aptian age. Dorsal view, X 68, and left side of shell, X 67.

Figure 4. *Curfsina? neali* Swain and Xie. G-2 well, 2270-2300 feet, in deposits of Cenomanian age. Interior of left valve, X 66.

Figures 5,7. *Isocythereis? sp.* G-2 well, 2510-2540 feet, in deposits of Aptian age. Exterior and interior of left valve, X 68.

Figure 6. *Cythereis? sp.* G-2 well, 2840-2870 feet, in deposits of Aptian age. Exterior of left valve, X 67.

Figures 8, 8a. *Cythereis? sp.* G-2 well, 2570-2600 feet, in deposits of Aptian age. Exterior of left valve, X 94 and enlargement of a surface node, X 402.

Figure 9. *Rehacythereis? cf. dentonensis* (Alexander). G-2 well, 2720-2750 feet, in deposits of Aptian age. Exterior of right valve, X 72.

Figures 10, 10a. *Cythereis? sp.* G-2 well, 2570-2600 feet in deposits of Aptian age. Interior of left valve, X 42, and enlargement of adductor muscle scar area, X 335.

Plate 14

(All figures are stereo pairs except 6a, 7a, 9a, 11a, 11b)

Figure 1. *Cythereis simulonuda* Swain. G-2 well, 2600-2630 feet in deposits of Aptian age. Right side of shell, X 43.(May be caving)

Figures 2,3. *Cythereis simulonuda* Swain. G-2 well, 2660-2690 feet in deposits of Aptian age. Right side and dorsal views of shell, X 42.(May be caving)

Figure 4. *Cythereis simulonuda* Swain. G-2 well, 1880-1890 feet in deposits of Coniacian age. Left side of shell, X 45.

Figure 5. *Cythereis simulonuda* Swain. G-2 well, 2900-2930 feet in deposits of Aptian age. Dorsal view of shell, X 43.(May be caving)

Figures 6, 6a. *Cythereis simulonuda* Swain. G-2 well, 2540-2570 feet in deposits of Aptian age. Right side of shell and enlargement of anterior part of shell, X 43 and X 82, respectively.(May be caving)

Figures 7, 7a. *Cythereis simulonuda* Swain. G-2 well, 1880-1890 feet in deposits of Coniacian age. Interior of right valve and enlargement of adductor muscle scar area, X 45 and X 302, respectively.

Figures 8, 8a, 8b, 9. *Curfsina? nealei* Swain and Xie. G-2 well, 2750-2780 feet in deposits of Aptian age. Left side, X 68; details of shell surface, X 1213; and dorsal view, X 70 of shell.

Figures 10, 11, 11a, 11b. *Kingmaina? sp.* G-2 well, 2420-2450 feet in deposits of Aptian age. Exterior of left valve, X 66; interior of left valve, X 67; enlargement of adductor muscle scar, X 302; and enlargement of anterior end of hinge, X 302.

Plate 15

(All figures are stereo pairs except 3a,3b,7a,10a)

Figure 1. *Phacorhabdotus pokornyi* Hazel and Paulson. G-2 well, 1550-1580 feet in deposits of Santonian age. Exterior of left valve, X 70.

Figures 2, 3,3a,3b. *Cythereis paramahonae* Swain and Xie. G-2 well, 2600-2630 feet in deposits of Aptian age. Exterior of left valve, X 45; interior of left valve, X 44; enlargement of part of anterior margin, X 169; and detail of traces of radial canals in that same area, X 817.

Figures 4, 5. *Cythereis paramahonae* Swain and Xie. G-2 well, 2660-2690 feet in deposits of Aptian age. Exterior view, X 43; and interior view of right valve, X 42.

Figure 6. *Rehacythereis?* sp. aff. *R.? dallasensis rachis* (Crane).G-2 well, 2810-2840 feet in deposits of Aptian age. Exterior of left valve, X 43.

Figures 7, 7a. *Protocythere* cf. *alexanderi* Howe and Laurencich. G-2 well, 2840-2870 feet in deposits of Aptian age. Right side of shell, X 80; and detail of anterior shell surface, X 419.

Figures 9,10,10a. *Xestoleberis* cf. *ovata* Bonnema. G-2 well, 2810-2840 feet in deposits of Aptian age. Dorsal view, X 88; Right side, X 88; and enlargement of a normal pore, X 4422.

Plate 16.

(All figures are stereo pairs except 7, 13, 15)

Figure 1. *Schuleridea acuminoidea* Swain and Xie. G-2 well, 6400-6430 feet in deposits of Kimmeridgian (late Jurassic) age. Right side of shell, X 91.

Figure 2. *Schuleridea acuminoidea* Swain and Xie. G-2 well, 6400-6430 feet in deposits of Kimmeridgian age. Dorsal view of shell, X 102.

Figure 3. *Schuleridea acuminoidea* Swain and Xie. G-2 well, 6400-6430 feet in deposits of Kimmeridgian age. Right side of shell, X 72.

Figures 4, 7. *Schuleridea acuminoidea* Swain and Xie. G-2 well, 6340-6370 feet in deposits of Kimmeridgian age, Right side and dorsal views of shell, X 90.

Figure 5. *Schuleridea acuminoidea* Swain and Xie. G-2 well, 6370-6400 feet in deposits of Kimmeridgian age. Right side of shell, X 90.

Figures 6, 10. *Schuleridea praethorenensis* Bartenstein and Brand. G-2 well, 4390-4420 feet in deposits of Hauterivian (early Cretaceous) age. Right side, X 117 and dorsal view, X 135, of shell.

Figures 8, 14. *Schuleridea acuminoidea* Swain and Xie. G-2 well, 6370-6400 feet in deposits of Kimmeridgian age. Right side, X 90 and dorsal view X 106 of shell.

Figures 9, 13. *Schuleridea anterofossulata* Swain and Brown. G-2 well, 4480-4510 feet in deposits of Hauterivian age. Right side, X 84 and dorsal view, X 98, of shell.

Figures 11, 15. *Schuleridea anterofossulata* Swain and Brown. G-2 well, 4480-4510 feet in deposits of Hauterivian age. Right side, X 122 and dorsal view, X 113, of shell.

Figures 12, 16. *Sculeridea acuminoidea* Swain and Xie. G-2 well, 6370-6400 feet in deposits of Kimmeridgian age, Right side, X 100, and dorsal view, X 113, of shell.

Plate 17

(All figures are stereo pairs except 12a and 13)

Figures 1, 2. *Schuleridea praethorenensis* Bartenstein and Brand. G-2 well, 4160-4190 feet in deposits of Hauterivian age. Right side, X 120 and dorsal view, X 126, of shell.

Figure 3. *Schuleridea anterofossulata* Swain and Brown. G-2 well, 4750-4780 feet in deposits of Hauterivian age. Right side of shell, X 117.

Figure 4. *Galliaecytheridea?* cf. *remota* Grekoff. G-2 well, 10,870-10,900 feet in deposits of Oxfordian age. Left side of shell, X 135.

Figure 5. *Pichottia?* *simonisi* Swain and Xie. G-2 well, 11,330-11,360 feet in deposits of Callovian age. Right side of shell, X 135.

Figure 6. *Pichottia?* *simonisi* Swain and Xie. G-2 well, 11,330-11,360 feet in deposits of Callovian age. Right side of shell, X 135.

Figure 7. *Apatocythere?* *lanceolata* (Swain). G-2 well, 6550-6580 feet in deposits of Kimmeridgian age. Right side of female shell, X 162.

Figure 8. *Apatocythere?* *lanceolata* (Swain). G-2 well, 6550-6580 feet, in deposits of Kimmeridgian age. Right side of male shell, X 171.

Figures 9, 10. *Pichottia?* *simonisi* Swain and Xie. G-2 well, 10,870-10,900 feet in deposits of Oxfordian age. Left side, X 117 and dorsal view, X 100, of shell.

Figure 11. *Micropneumatocythere?* sp. G-2 well, 10,330-10,360 feet in deposits of Oxfordian age. Right side of shell, X 153.

Figure 12, 12a. *Asciocythere triangularis* Swain. G-2 well, 4750-4780 feet in deposits of Hauterivian age. Right side of shell, X 90 and enlargement of a sieve plate and normal pore, X 3600.

Figures 13, 14. *Galliaecytheridea* cf. *remota* Grekoff. G-2 well, 11,240-11,270 feet in deposits of Callovian age. Right side, X 100 and dorsal view, X 120, of shell.

Figure 15. Gen. et sp. indet. G-2 well, 6400-6430 feet in deposits of Kimmeridgian age. X 153.

Plate 18

(All figures are stereo pairs except 7a and 14)

Figure 1. *Paraschuleridea twifordensis* Swain and Brown. G-2 well, 4750-4780 feet in deposits of Hauterivian age. Right side of shell, X 166.

Figure 2. *Glyptocythere?* sp. G-2 well, 11,240-11,270 feet in deposits of Callovian age. Left side of shell, X 100 (May be caving from Upper Jurassic)

Figure 3. *Hutsonia collinsensis* Swain and Brown. G-2 well, 4390-4420 feet in deposits of Hauterivian age. Right side of female? shell, X 117.

Figure 4. *Neocythere* cf. *protovanveeni* Kaye. G-2 well, 4750-4780 feet in deposits of Hauterivian age. Left side of shell, X 144.

Figures 5, 6. *Hutsonia collinsensis* Swain and Brown. G-2 well, 4480-4510 feet in deposits of Hauterivian age. Left side, X 126 and dorsal view, X 130 of female? shell.

Figures 7, 7a, 8. *Hutsonia collinsensis* Swain and Brown. G-2 well, 4480-4510 feet in deposits of Hauterivian age. Right side of male? shell, X 127, enlargement of normal pore, X 5100, and dorsal view, X 126.

Figure 9. *Palaeocytheridea?* cf. *insidiosa* Lyubimova. G-2 well, 4750-4780 feet in deposits of Hauterivian age. Right side of shell, X 106.

Figures 10, 11. *Neocythere* cf. *protovanveeni* Kaye. G-2 well, 4390-4420 feet in deposits of Hauterivian age. Dorsal view, X 115, and left side, X 117, of shell.

Figure 12. *Neocythere* cf. *protovanveeni* Kaye. G-2 well, 4390-4420 feet in deposits of Hauterivian age. Right side of shell, X 104.

Figure 13. Charophyte oogonium. G-2 well, 4390-4420 feet in deposits of Hauterivian age. Lateral view, X 77. Indicates non-marine conditions within interval.

Figure 14. Charophyte oogonium. G-2 well, 4390-4420 feet in deposits of Hauterivian age. Lateral view, X 70.

Figure 15. *Protocythere cf. triplicata* (Roemer). G-2 well, 4750-4780 feet in deposits of Hauterivian age. Left side of shell, X 106.

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