8. CENOZOIC OSTRACODES FROM HOLE 628A, ODP LEG 101, BAHAMAS

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ABSTRACT

The Oligocene to Pleiocene section from Hole 628A supplied about 100 species of Tertiary ostracodes. Deep-sea psychrospheric species (Bradleya cf. dictyon, Agrenocythere cf. gosnoldia, Cardobairdia spp., Henryhowella sp., Cytheropteron spp., etc.) are present throughout the section. Starting in the Miocene, neritic species (Hulingsina sp., Puriana spp., Caudites spp., Loxoconcha fischeri, Cytherelloidea sp., etc.) dominate. Redeposition of these species from the continental shelf seems to be penecontemporaneous with sedimentation. Variations in the assemblages indicate biostratigraphic position. Species having an ecologic or stratigraphic importance are discussed and illustrated.

INTRODUCTION

Five of the sites drilled during Leg 101 penetrated Oligocene (or older) sediments. However, only a small part of the Tertiary series was recovered at two sites (Holes 634A and 635A). Two other Leg 101 holes were difficult to interpret. Hole 627B was difficult because downhole contamination occurred during drilling; Hole 626D, because of downslope contamination by neritic sediments. Therefore, we present only results from Tertiary ostracodes of Hole 628A.

Hole 628A was located in a water depth of 966 m north of Little Bahama Bank (latitude 27°31.85'N; longitude, 78°18.95'N), about 15 km from the neritic platform (Fig. 1). Today, this platform belongs to the epibathyal zone. Drilling penetrated 298 m of unconsolidated or slightly lithified sediments and reached the upper Paleocene or the lower Eocene. Ostracodes occur above the base of the lower Oligocene. The lower and middle Miocene are missing from two sections (Austin, Schlager, et al., 1986).

PALEOENVIRONMENTAL INTERPRETATION

We identified about 100 ostracode species. Those species that occur in at least three samples and are represented by more than five specimens (having carapaces or single valves) are noted in Table 1. Most specimens cannot be assigned precisely to known species because many belong to faunas from deeper-water environments that have not been studied much. However, the specimens can be divided into three ecological groups:

1. Species of genera exclusively or mainly occurring in the modern neritic environment, such as Cytherelloidea, Hulingsina, Jugosocythereis, Puriana, Loxoconcha, and species of other genera with well-developed eye tubercles.

2. Species of genera exclusively or mainly occurring in the modern deep-sea environment (i.e., for some genera this is as shallow as the lower limit of the photic zone). These species include Cardobairdia, Henryhowella, Krithe, Trachyleberidea, Agrenocythere, Pseudonaiadopsis, Bythoceratina, and Pseudocythere.

3. Species belonging to common genera that occur at nearly all depths from the infralittoral or medilittoral range to the abyssal or bathyal zone, such as Cytherella, numerous Bairdiidea, Echinocythereis, Pterygocythereis.

Species of the first two groups are the most interesting for paleobathymetric reconstructions. However, note that (to the limits of our current knowledge of ostracode ecology) it is difficult to discriminate between the infraneritic (circalittoral) zone and the epibathyal one. In fact, below the lower limit of the infralittoral (50-100 m water depth, in clear, well-lighted water), the main zone of biological turnover is the thermocline separating the thermosphere from the psychrosphere. The depth of the thermocline varies geographically, especially according to latitude, and probably changed during Cenozoic time. Around the Florida-Hatteras slope (the Straits of Florida and the Blake Plateau), the thermocline is a major barrier between shallow- and deep-water species, as shown by Cronin (1983).

In spite of these constraints, this change in ostracode assemblages from Oligocene to late Pleiocene (Table 1) allows us to conclude the following:

1. The Oligocene from Hole 628A yielded rare ostracodes (60 specimens), which belong almost exclusively to common or deep-sea genera, including Cytherella, Krithe, Agrenocythere, Henryhowella, Cardobairdia and "Bairdia," the most typical elements. We interpreted the occurrence of occasional abraded or broken valves of neritic genera (Jugosocythereis, Pokornyella, and Pterygocythereis) as transportation of sediment from the continental shelf. This conclusion is also supported by the presence of lepidocycline foraminifers in our samples (Fourcade and Butterlin, this volume).

2. From the middle Miocene (N1 part/N13 part) to the upper Pleiocene (the Pleistocene is represented in only one sample, by a single valve of Cytherella), ostracode assemblages contain many specimens and species of genera usually considered neritic, such as Cytherelloidea, Hulingsina, and Puriana (Hazel, 1970; Valentine, 1971; and others). These genera indicate temperate to subtropical marine climates. However, deep-sea genera (such as Agrenocythere, Bradleya, and Bythoceratina) are observed throughout the section. Although not indicated by the specimens that are well preserved and have asimilar sedimentary filling, logic suggests that the valves of neritic taxa were transported from the continental shelf. Since the Miocene, a small part of the infraneritic ostracode population could possibly have colonized the upper part of the continental slope. However, the concomitant presence of bathyal with neritic ostracodes may be attributed to the turbidites that occur in lithologic Unit II of Hole 628A (Austin, Schlager, et al., 1986).
Therefore, it appears that important events took place between the late Oligocene and the late middle Miocene; these events are responsible for the faunal break and the resedimentation of neritic ostracodes on the continental slope. These ostracodes suggest that most of the observed turbidites came from the infralittoral zone. Only those turbidites associated with large benthic foraminifers (Cores 101-628A-11H and 101-628A-12H) probably came from the shallow zones of the ancestral carbonate platform.

The change in specific composition of the ostracode assemblages through time is probably of biostratigraphic importance. The possible redeposition of the continental shelf seems to be penecontemporaneous with specimens indicating off-bank sedimentation. Note that with regard to the Eocene ostracode faunas from DSDP Site 390 (Guernet, 1982) and from Barbados (Steineck et al., 1984) species renewal is complete between the Eocene and the Oligocene, while at the generic level assemblages bear the same psychrospheric features. In contrast, the Oligocene–Miocene transition, despite the early and middle Miocene hiatus at Site 628, is characterized by the appearance of new species, rather than by extinctions. This “enrichment” continued during the late Miocene and the Pliocene. However, only further studies will enable us to determine if some appearances, such as Hulingsina sp. 1 (Core 101-628A-13H), Gangamocytheridea cf. dictyon, Puriana sp. 1 and Cytherelloidea sp. during the late Miocene (Cores 101-628A-11H and 101-628A-12H), Semicythere sp. 1, Hulingsina cf. tuberculata, and Ornatoeleberis sp. during the Pliocene (Cores 101-628A-8H through 101-628A-4H), which are well-represented in our samples, are biostratigraphically significant.

**SYSTEMATIC PALEONTOLOGY**

Among the 100 species observed, many occur as having only one or two valves. Their genetic significance (e.g., reworked specimen or downhole contamination) is particularly suspect. Consequently, these species are neither plotted in Table 1 nor illustrated in Plates 1 through 6. Species having easily identifiable features and ecologic or stratigraphic importance are discussed next. The systematics used here follow Hartmann and Puri (1974).

Order PODOCOPIDA Muller, 1894
Suborder PODOCOPA Sars, 1866
Superfamily CYTHERACEA Baird, 1850
Family CYTHERIDAE Baird, 1850
Genus GANGAMOCYTHERIDEA van den Bold, 1963
Gangamocythereidae cf. dictyon van den Bold, 1963
Pl. 5, Figs. 14 and 15

Remarks. The valves assigned to this species are abundant throughout the Neogene (Table 1) but seem to differ from those described by van den Bold (1963) by their more complex reticulation. *G. dictyon*, known in the Caribbean in the late Miocene, still lives “on the continental shelf north and east of Trinidad. The maximum depth at which the species has been observed is 30 fathoms” (van den Bold, 1963b). A closely related species, *G. reticulata* (van den Bold, 1957), occurs in the Miocene of Trinidad.
Table 1. Range chart for Tertiary ostracodes from Hole 628A.

<table>
<thead>
<tr>
<th>Epoch</th>
<th>Conts</th>
<th>Intervals (cm)</th>
<th>Taxa (incl. Morphotypes)</th>
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<td>Oligocene</td>
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<td>Pliocene</td>
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Note: * = bathyal species; ** = neritic species.
Family CUSHMANIDEIDAE Puri, 1973

Remarks. The Cushmanidae are absent in our Oligocene samples but do occur often in the Neogene samples. They are represented by Cushmanidea sp. (Pl. 4, Fig. 8) and particularly by three species assigned to the genus Huilingina Puri, 1958: H. cf. tuberculata Puri, 1958 (Pl. 4, Fig. 9), H. sp. 1 (Pl. 4, Figs. 4 and 6), and H. sp. 2. This last species is coarsely punctate and related to H. wilberti (Puri, 1952). It occurs sporadically in the Pliocene samples. The known species of the genera Cushmanidea and Huilingina are all neritic, and the genus Huilingina seems to indicate warm temperate to subtropical climates (Hazel, 1970; Valentine, 1971).

Description. Huilingina has a contraction of the posterior end of the carapace and an individualization (on one of the valves) of a kind of caudal process, which corresponds internally to a notch. The species may be a useful criterion for distinguishing Huilingina from Cushmanidea and related genera (see Athersuch, 1982).

Family KRITHIDAE Mandelstam, 1960

Genus KRITHE Brady, Crosskey and Robertson, 1874

The genus Krithe is represented in all Cenozoic sediments from Hole 628A by at least two species.

Krithe cf. trinidadiensis van den Bold, 1958

Description. Valves from Hole 628A present the following features, described by van den Bold for Oligocene and Miocene Krithe from Trinidad, that is, strong sexual dimorphism, anterodorsal inflection, posterior dorsal margin bent, and narrow vestibulum; however, Hole 628A specimens are more elongated (for size of the valves see Pl. 1, R. V. Q. , LI = 0.9 mm, h = 0.5 mm; R. V. S, LI = 1.1 mm, h = 0.49 mm).

Remarks. K. trinidadiensis is a common species in deep-sea, middle Eocene and Oligocene deposits on Barbados (Steineck et al., 1984). It is probably pro parte conspecific of Krithe sp. D of Peypouquet (1979) and particularly of Krithe sp. D12 of the Pliocene-Quaternary of DSDP Site 517 (Benson and Peypouquet, 1983). K. trinidadiensis is similar to K. morkhoveni van den Bold, 1960, from the Miocene of Trinidad, but this latter species has a less sinusous inner lamella.

Krithe cf. hiwanneensis Howe and Law 1936

(Pl. 1, Figs. 14-15)

Remarks. The valves of this species are less common than those of the one previously described. They are tentatively assigned to K. hiwanneensis, which occurs in deep-sea Paleogene deposits from Barbados. Those found in Hole 628A, however, do not have a large vestibulum like the specimen illustrated by Steineck et al. (1984). Indeed, all the Krithe found in the Cenozoic of Hole 628A as well as those from the Oceanic Formation of Barbados have a constricted vestibulum. According to Peypouquet (1979), this feature corresponds to well-oxygenated waters. In general, the relative abundance of Krithe in our samples, particularly those from the Oligocene section, signifies deep-water environments (Neale, 1985).

Families TRACHYLEBERIDIDAE Sylvester-Bradley, 1958 and HEMICYTHERIDAE Puri, 1953

Remarks. These families were not distinguished because of our difficulty in observing the internal features of the valves from Hole 628A.

Genus PURIANA Coryell and Fields, 1937

Remarks. Species attributed to Puriana are present in all Neogene sediments from Hole 628A. Two to five valves were recovered in most of the samples. Currently, the genus Puriana is represented by neritic and probably thermophilic species. However, Valentine (1971) reported the genus from modern assemblages occurring as deep as ~ 140 m offshore southern Virginia.

Puriana? cf. fissispinata Benson and Coleman, 1963

(Pl. 5, Figs. 1 and 2)

Description. The crests of these valves are narrower than those of P. convoluta Teeter, 1975 (see figure in Cronin and Hazel, 1979; Hazel, 1977, 1983). Their arrangement is also slightly different, and their valves are slimmer. They are probably instars of P. fissispinata, species that must perhaps be assigned to Corruguiuma Ohmeri, 1968 (after T. M. Cronin, pers. comm., 1987). Puriana? cf. fissispinata is present in Core 101-628A-12H (i.e., as young as the late Miocene).

Genus AGRENOCYTHEIRE Benson, 1972

Arenocythere cf. gosnoldia Benson, 1972

(Pl. 2, Figs. 3 and 4)

Remarks. Specimens from Hole 628A were differentiated from the Eocene species described by Benson (1972) by their elongated shape and details of their ornamentation. Valves of different instars and of different sexes were compared because each sample contains only one to three valves (except Sample 101-628A-26X, from which we extracted 10 or 11 valves corresponding to at least four molts).

Arenocythere cf. haezelae (van den Bold), 1946

(Pl. 2, Fig. 7)

Description. Valves from Hole 628A are represented by early instars and are characterized by the division of their pore-conuli (especially on the ocular ridge and on the dorsal spines). The caudal process is short and may be a larval feature.

Remarks. A. haezelae was described first from the lower Miocene of Cuba. The species still lives in the Carribean area and in the eastern Pacific (Benson, 1972). We observed it only in the Neogene of Hole 628A.

Genus BRADLEYA Hornibrook, 1952

Bradleya diction (Brady, 1880)

(Pl. 2, Fig. 6)

Remarks. This species is known in the Atlantic and the Southern Hemisphere from the lower Miocene to Holocene. It occurs sporadically in the Neogene from Hole 628A (Table 1). The Oligocene at this site contains several valves belonging to a new subspecies, or possibly a different species, that is similar, in its coarser reticulation, to Bradleya johnsoni Benson (in Benson and Peypouquet, 1983) of the lower Miocene from the South Atlantic. The genus Arenocythere, Bradleya, Poseidonamicus (P. pintoi, Pl. 3, Fig. 13), and Trachyleberidea are among the more characteristic of deep-water taxa. They are associated with widespread genera (Krithe and Cytherella) in the Oligocene from Hole 628A and are less numerous in the middle Miocene with respect to neritic genera.

Genus ECHINOCYTHEIREIS Puri, 1952

Three species are described to this genus. Only one bears eye tubercles.

Echinocythereis margaritifera (Brady, 1870)

(Pl. 6, Fig. 3)

Description. In a lateral view, the valves appear subquadrangular, with large pore-conuli and well-developed eye tubercles (perhaps an adaptation to a life in a shaded environment).

Remarks. Today, this tropical to cold temperate species is known from the shelf and upper slope of the Gulf of Mexico and Florida and from off Cape Hatteras down to a depth of 2000 m (Hazel, 1970).

Echinocythereis echinata (Sars, 1866)

(Pl. 6, Fig. 1)

Remarks. Valves from Hole 628A can be identified with Sars' species as illustrated by Benson et al. (1983). Today E. echinata seems to be a blind species, living in the cold, deep water of the Atlantic Ocean. Its valves and carapaces occur at depths greater than 3000 m. Its occurrence with E. margaritifera in the Pliocene from Hole 628A (unless it results from postmortem reworking) points out an epi- or mesobathyal environment and a temperature of about 10°C.

Echinocythereis sp. 1

(Pl. 2, Fig. 2)

Description. This species also lacks well-developed eye tubercles and is similar to E. echinata in the pore-conuli arrangement, although these specimens are much larger, except in the anterior, where they disappear. Their valves are more quadrangular than those of E. echinata, of which E. sp. 1 might be an ancestral form. They occur in only one of the Oligocene samples (Table 1) from Hole 628A.
CENOZOIC OSTRACODES FROM HOLE 628A

1. During the Oligocene (Cores 101-628A-27X through 101-628A-16H) deep-sea or common species prevail, whereas from the middle Miocene onward (unfortunately, the lower Miocene is absent in Hole 628A), neritic species that were transported downslope from the continental shelf are more numerous. This change perhaps is the result of a late Oligocene–early Miocene eustatic event and/or of the progradation of the carbonate platform (Austin, Schlager, et al., 1986).

2. During the Neogene (Cores 101-628A-15H through 101-628A-2H), specific diversity increases. Most likely this change has biostatigraphic significance; however, it must be confirmed and documented by future investigations.

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APPENDIX

Systematic Listing of Cenozoic Species

Hole 628A

Cytherella sp. 1

Cytherella sp. 2 gr. consueta Deltel, 1961 (see Ducasse, 1981)

Cytherella sp. 3

Cytherelloidea sp.

Cardohia


C. gr. asymetrica (van den Bold, 1946); Section 101-628A-26X-1.

Paranesidea? sp. 1 and sp. 2.

Parunesidea cf. cassida (van den Bold, 1946) (see also Steineck, 1981); Section 101-628A-23X-5.

Neonesidea? sp.

Trebellina coronata (Brady, 1870); Section 101-628A-2H-4.

Rhynchocypris sp.

Gangamocytheridea cf. dictyon van den Bold, 1963a.


Cushmanidae sp.

Hulingsina sp. 1

Hulingsina sp. 2; Sections 101-628A-6H-6, 101-628A-5H-3, and 101-628A-2H-2.

Krithe cf. trinidadensis van den Bold, 1958.

Krithe cf. hiwannnesius Howe and Law, 1936 (see also Steineck et al., 1984).

Parakrithe sp.; Section 101-628A-1H-3.

Puriana sp. convoluta Teeter, 1975 (see also Hazel, 1983).

Puriana sp. costispinata Benson and Coleman, 1963.

Trachyleberidea cf. biapipea Howe and Law, 1936.


Echinocythereis margaritifera sp. 1, 1957; Benson, 1972.

Pterygocythereis sp.


Hulingsina sp. 1

Pterygocythereis sp. 2.

Krithe cf. trinidadensis van den Bold, 1958.


Krithe cf. hiwannnesius Howe and Law, 1936 (see also Steineck et al., 1984).

Parakrithe sp.; Section 101-628A-1H-3.

Puriana sp. convoluta Teeter, 1975 (see also Hazel, 1983).

Puriana sp. costispinata Benson and Coleman, 1963.

Trachyleberidea cf. biapipea Howe and Law, 1936.


Pterygocythereis sp. 2 = P. sp. 2 Howe and van den Bold, 1975; Sections 101-628A-6H-2 and 101-628A-3H-4.

Pterygocythereis sp.

Brachycythere sp.

Echinocythereis echinata (Sars, 1866).

Echinocythereis sp. 1 gr. echinata

Echinocythereis margaritifera (Brady, 1870) (see also Hazel, 1967, 1970).

Henryhewella sp.

Ambocythere sp.

Radimella sp. 1.

Radimella sp. 2.

Malzella sp.

Bradleya dictyon (Brady, 1880).

Poseidonamicus pintoi Benson, 1972.

Jugosocythereis spp. gr. pannonia (Brady, 1869).

Orionina sp.; Sections 101-628A-1H-3 and 101-628A-6H-1.

Cauldites sp. 1; Sections 101-628A-1H-3 and 101-628A-8H-2.

Occuldocythereis sp. 1

Neocladocyclid aff. maconaci (Ciampo, 1971) (see also Bonaduce et al., 1970).

Loxocorina sp. 1

Laxocorina fisheri (Brady, 1869).


Paracytheridea aff. byrampus Howe and Law, 1936 (see also Hazel et al., 1980).
Paracytheridea sp. 1; Sections 101-628A-26X-2 and 101-628A-8H-6.

Paracytherides sp. 2.


Cytherura cf. hermesi van den Bold, 1946; Sections 101-628A-8H-3 and 101-628A-6H-CC.

Hemicytherura sp.; Sections 101-628A-4H-4 and 101-628A-6H,CC.

Kangarina abyssicola (Müller, 1894) (see also Breman, 1976, van den Bold, 1963a, etc.)

Semicytherura sp. 1.

Cytheropteron trinidadensis van den Bold, 1960 = Pelecocythere trinidadensis (Pl. 1, Fig. 13).

Cytheropteron spp.

Xestoleberis sp.

Uroleberis sp.

Ornatoleberis sp.

Bythoceratina spp.

Pseudocythere sp.

Pellicistoma aff. spurium van den Bold, 1963a; Section 101-628A-11H-3.

Macrocypris sp.

Paracypris sp.

Argilloeia spp.
All the illustrated valves or carapaces come from Hole 628A and, except for Pl. 2, Figs. 2 and 4, from intervals 50-52 cm; sections only are then indicated.