OLIGOHALINE FOSSILS FROM THE PLEISTOCENE FLANNER BEACH FORMATION, NORTH CAROLINA

WILLIAM MILLER, III

DEPARTMENT OF GEOLOGY
HUMBOLDT STATE UNIVERSITY
ARCATA, CALIFORNIA

ABSTRACT

Oligohaline fossils occur at two localities within the middle Pleistocene Flanner Beach Formation: at the type section on the Neuse River and near Hills Point on the Pamlico River. At the type section, *Rangia cuneata* (Gray) valves form pods and lenses at the base of the formation, show signs of prolonged exposure on the seafloor prior to burial, and are mixed with mesohaline to polyhaline mollusks. At Hills Point a sparse association of *Rangia* and polychaete worm burrows occurs in a thick mud bed also located at the base of the Flanner Beach. Analysis of the first locality indicates conditions of winnowing or sediment starvation and mixing of shells from several original benthic communities during initial stages of inundation of the Flanner Beach estuarine basin. In contrast, the second locality contains an essentially undisturbed oligohaline fossil association derived from a single original community that inhabited the margin of this basin.

The Flanner Beach Formation in eastern North Carolina is notable for its richly fossiliferous estuarine deposits. At two locations within the formation (Figure 1) the lowest stratigraphic levels contain an oligohaline fauna consisting largely of the mactrid bivalve *Rangia cuneata* (Gray), which commonly occurs today in the upper parts of estuaries from northern Chesapeake Bay to Veracruz, Mexico (Abbott, 1974; Andrews, 1977). The purpose of this paper is to describe the fossils from these two interesting localities and comment on their significance in the interpretation of Flanner Beach paleoenvironments. Lithostratigraphy of both exposures has been described in detail by Miller (1985, Figs. 6, 7, p. 119-121).

Locality 1. Type Locality of Flanner Beach Formation. – DuBar and Solliday (1963) established the type section of the Flanner Beach Formation at Flanner Beach Recreation Area, south shore of Neuse River, Craven County (Figure 1). As originally defined, the lowest shelly bed in the formation (Unit 2 at their Station 32; DuBar *et al.*, 1974, p. 121) contains abundant *Rangia* valves. This bed is succeeded by shelly layers containing more diverse associations of mollusks indicative of mesohaline to polyhaline environments. As reinterpreted by Miller (1985), the *Rangia* bed delineates the base of the formation (Figure 2a). The "cypress stump bed" beneath this layer of shells is a separate lithostratigraphic unit (see Mixon and Pilkey, 1976). The type section is now deeply weathered and partially obscured by vegetation, but the *Rangia*-rich interval remains clearly visible.

The *Rangia* bed varies greatly in thickness with irregular upper and lower contacts; it pinches out completely in places. *Rangia* shells are abundant and approximately 5-10% are still articulated. None, however, were seen in living positions

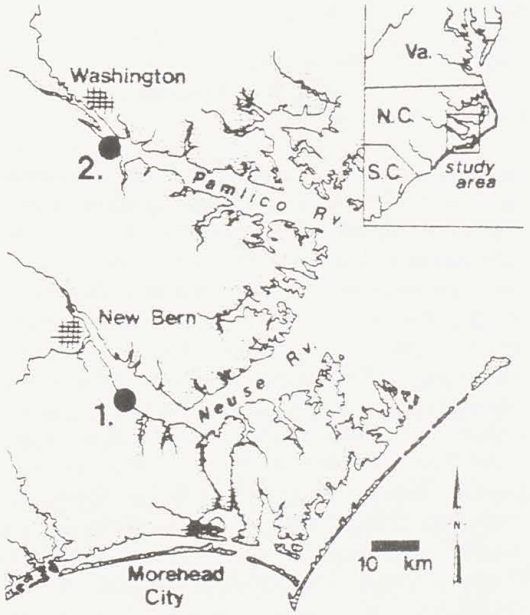

Figure 1. Locality map: *1*, Flanner Beach Recreation Area; *2*, Hills Point on Blounts Bay.

Figure 2. Locality 1 – Flanner Beach study site: *a*, base of Flanner Beach Formation with *Rangia* shell lenses located directly above pre-Flanner Beach fluvial deposits (unconformable contact shown with arrows at right); *b*, close-up view of shell lens showing *Rangia* shells mixed with *Mulinia*, *Ensis*, and other typical Flanner Beach mollusks (note nested and stacked valves in varied orientations).

(Figure 2b). Surrounding sediment is olive gray (5 Y 4/1), shelly medium sand containing sand and mud clasts. Intermixed with *Rangia* are abundant shells of typical Flanner Beach mollusks: *Mulinia lateralis* (Say); *Ensis directus* (Conrad); *Dinocardium robustum* (Lightfoot); *Nuculana acuta* (Conrad); *Nassarius* spp.; *Acteocina canaliculata* (Say); and *Polinices duplicatus* (Say). This mixture of taxa is ecologically incompatible as most of the species prefer higher average salinity than *R. cuneata*. The fossil deposit, then, is a mixed assemblage containing elements from several different benthic communities.

Of the 170 *Rangia* valves collected at random, 95 (55.9%) were encrusted with the cheilostome bryozoan *Electra*, 28 (16.5%) had been bored by the endolithic demosponge *Cliona*, and 48 (28.2%) had conical to curvilinear dissolution pits and trenches that predated final entombment (as shown by epibionts occurring within the pits). A few valves were bored by ctenostome bryozoans and algae. This pattern of shell utilization and damage suggests a long period of exposure on the seafloor or repeated exhumation prior to burial. Ratio of left to right valves in the sample is 91:79, but smallest valves are typically larger than 1 cm in length. Biofabric of shells in the sediment consists of all orientations from concordant with bedding to oblique, with both stacking and nesting of valves in lenticular to pod-shaped accumulations (Figure 2b).

The *Rangia* bed at Locality 1 is either a Type III or IV shell bed in the genetic classification proposed by Kidwell (1986, p. 10), in which a shelly concentration occurs directly above either an omission or erosion surface and grades upward into comparatively less shelly sediments. Such concentrations may result from return of net sediment accumulation to a sediment-starved site (Type III), or from a change from erosional processes to conditions of sediment accumulation (Type IV).

Locality 2. Type Locality of Hills Point Member. – Miller (1985) proposed the name Hills Point Member for the basal mud unit of the Flanner Beach Formation in the Blounts Bay area, Beaufort County. The bottom meter of this member contains a sparse oligohaline fossil deposit consisting of *Rangia cuneata*, small branching burrows, larger unbranched burrows, fossil driftwood, and borings in the wood (Figure 3). Fossils occur in a sticky, medium dark gray (N 4) mud averaging 2.5 m thick. The lowest 2 to 3 cm is cemented by limonite, forming a moderate to light brown (5 YR 3/4-5/6) mudstone ledge (Figure 3a). Most of the fossils are in limonitic mudstone slabs that have weathered out of this layer.

Rangia specimens are found in the slabs as casts and external molds of valves (Figure 3c) and articulated shells (Figure 3d). Based on counts of molds preserved on four large slabs, the average density of clams is 38.5/m^2, with at least 14% being the molds of articulated shells. No unequivocal examples of broken or epibiont-encrusted

valves were observed and some articulated individuals were in living positions (Figure 3d). All specimens are mature individuals larger than 1 cm in length.

Thin sand interlaminations within the mudstone are burrow-mottled and occasionally contain discrete branching, cylindrical burrow systems (Figure 3e) resembling miniature *Thalassinoides* (Häntzschel, 1975, Fig. 70, 2b). These biogenic structures are comparable to the smaller versions of polychaete burrows described from Georgia estuaries by Howard and Frey (1980, Figs. 27, 34). Tenore (1972) has documented the regular co-occurrence of *R. cuneata* with the eurytopic polychaete worm *Nereis succinea* in oligohaline areas of the modern Pamlico River. Thus, these small burrows and burrow-mottled fabrics in the Hills Point Member may have resulted from nereid bioturbation.

In soft mud located above the limonite-cemented base larger, unbranched burrows, approximately 1 cm in average diameter and filled with sand, are rarely found. These structures are referable to the ubiquitous ichnogenus *Planolites* (Häntzschel, 1975, p. W95), and may have been produced by crustaceans or large polychaetes.

Small phytoclasts are fairly common in the Hills Point (Miller, 1985), but wood fragments larger than 5 mm in longest dimension are rare. One large piece of wood, apparently fossil driftwood, contained several rounded, cylindrical borings averaging about 5 mm in diameter and filled with mud matrix (Figure 3b). No woodground organisms were found within the borings. The structures are questionably referred to the ichnogenus *Teredolites* (Bromley *et al.*, 1984). The driftwood probably floated to its entombment site from an area of higher average salinity where wood-boring bivalves, such as the pholadid *Martesia*, were common.

This co-occurrence of *Rangia* with small, branching burrows constitutes an essentially undisturbed oligohaline fossil association. Low density of *Rangia* and fine-grained sediments point to deposition in a deep, quiet-water estuarine environment. By comparison, *Rangia* densities in shallow estuarine margin settings can exceed 200 individuals/m^2 (Tenore, 1972, p. 59). The thin bioturbated sand interlaminations could record storm-related transport of coarser sediments into channel areas from the margins.

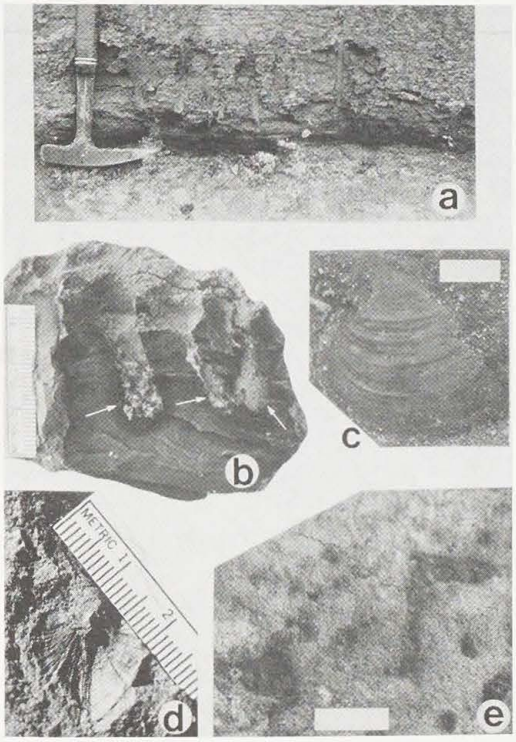

Figure 3. Locality 2 – Hills Point study site: *a*, base of Flanner Beach Formation and Hills Point Member marked by limonitic mudstone (dark band) unconformably above pre-Flanner Beach fluvial deposits; *b*, bored fragment of fossil driftwood (scale in cm's and mm's; arrows point to individual ?*Teredolites* borings); *c*, cast of *Rangia cuneata* left valve (bar represents 1 cm); *d*, external mold of an articulated *R. cuneata* shell (scale as in *b*); *e*, polychaete worm burrows highlighted by limonite in sand interlamination from the basal limonitic mudstone shown in *a* (bar scale represents 1 cm).

Significance. – The two localities reveal that initiation of estuarine conditions at Flanner Beach Recreation Area and Blounts Bay proceeded in sharply different ways. Locality 1 shows signs of shell concentration resulting from winnowing or sediment starvation, with mesohaline and polyhaline fossils mixed with *Rangia* shells

that were exposed on the seafloor for a prolonged interval of time. By comparison, Locality 2 appears to have formed by continuous accumulation of fine-grained sediments and organic remains in the upper portion of an estuary. Higher salinity did not rapidly succeed early oligohaline conditions at this site. Interlayered sand, mud, and burrow-mottled beds of the Mauls Point Member conformably overly the Hills Point Member at Locality 2, and may signal the gradual initiation of a more open lagoonal, higher salinity environment in the Blounts Bay area (Miller, 1985, p.108). Although the Locality 1 area became the center of a large lagoon during the Flanner Beach depositional cycle, Locality 2 seems to have been always on the landward periphery of this extensive estuarine basin.

REFERENCES

ABBOTT, R. T., 1974, American Seashells (2nd Ed.) Van Nostrand Reinhold, New York, 663 p.

ANDREWS, J., 1977, Shells and Shores of Texas. Univ. Texas Press, Austin, 365 p.

BROMLEY, R. G., S. G. PEMBERTON, and R. A. RAHMANI, 1984, A Cretaceous woodground: the *Teredolites* ichnofacies: Jour. Paleont., v. 58, p. 448-498.

DUBAR, J. R., and J. R. SOLLIDAY, 1963, Stratigraphy of the Neogene deposits, lower Neuse Estuary, North Carolina: Southeast. Geol., v. 4, p. 213-233.

DUBAR, J. R., J. R. SOLLIDAY, and J. F. HOWARD, 1974, Stratigraphy and morphology of Neogene deposits, Neuse River estuary, North Carolina, *in* R. Q. OAKS, Jr. and J. R. DUBAR (eds.), Post-Miocene Stratigraphy, Central and Southern Atlantic Coastal Plain. Utah State Univ. Press, Logan, p. 103-122.

HÄNTZSCHEL, W., 1975, Trace Fossils and Problematica (2nd. Ed.), Treatise on Invertebrate Paleontology, Part W. Geol. Soc. Amer. and Univ. Kansas, 269 p.

HOWARD, J. D., and R. W. FREY, 1980, Holocene depositional environments of the Georgia coast and continental shelf, *in* J. D. HOWARD, C. B. DEPRATTER, and R. W. FREY, Excursions in Southeastern Geology, the Archaeology-Geology of the Georgia Coast: Guidebook 20, Geol. Soc. Amer., p. 66-134.

KIDWELL, S. M., 1986, Models for fossil concentrations: paleobiologic implications: Paleobiology, v. 12, p. 6-24.

KIDWELL, S. M., F. T. FÜRSICH, and T. AIGNER, 1986, Conceptual framework for the analysis and classification of fossil concentrations: Palaios, v. 1, p. 228-238.

MILLER, W., III, 1985, The Flanner Beach Formation (middle Pleistocene) in eastern North Carolina: Tulane Stud. Geol. Paleont., v. 18, p. 93-122.

MIXON, R. B., and O. H. PILKEY, 1976, Reconnaissance geology of the submerged and emerged Coastal Plain Province, Cape Lookout area, North Carolina: U. S. Geol. Survey, Prof. Pap. 859, 45 p.

TENORE, K. R., 1972, Macrobenthos of the Pamlico River estuary: North Carolina: Ecol. Monogr., v. 42, p. 51-69.

APPENDIX

Locality Register

Locality 1. Shell pods and lenses 1.4 to 1.7 m above beach level in bluffs at Flanner Beach Recreation Area, Croatan National Forest, south shore of Neuse River, Craven County, North Carolina; Havelock 7.5' quadrangle.

Locality 2. Basal 1 m of mud bed located 1.7 to 4.2 m above beach level in bluffs 0.2 km upstream from Camp Hardee and 1.2 km west of Hills Point, south shore of Pamlico River, Beaufort County, North Carolina; Blounts Bay 7.5' quadrangle.

July 20, 1988