

HOLOCENE ASTRANGIA (SCLERACTINIA)
IN FORESHORE SHELL ACCUMULATIONS, BOGUE BANKS, NORTH CAROLINA

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ABSTRACT

Shell accumulations in the foreshore zone at Pine Knoll Shores, near the eastern end of Bogue Banks, contain a complex environmental and temporal mixture of molluscs, including Pleistocene estuarine species, subfossil marine Holocene material, and modern shells derived mostly from the adjacent shoreface. Mixed with these shells are the coralla of *Astrangia danae*, also mostly derived from the modern shoreface. The coral colonized mollusc shells from a variety of sources during varied intervals of exposure at the seafloor. Occurrence of the coral facilitates identification of pathways of shell transport and shell exposure intervals in modern nearshore environments. *Astrangia danae* is interesting in its own right because it is one of the only shallow-water scleractinians now living in the Cape Lookout area.

INTRODUCTION

Shell accumulations on the ocean beach of Bogue Banks, located at the southern terminus of the North Carolina Outer Banks, consist of complex mixtures of Holocene, Pleistocene, and occasionally older skeletal remains. Fragments and whole valves of gastropod and bivalve molluscs make up the bulk of these localized concentrations. At some locations scleractinian coralla, either attached to molluscs or occurring as unattached bioclasts, can be found in the shell accumulations.

In the latitude of Cape Lookout, scleractinians make their last strong showing in the faunal inventories of late Pliocene-early Pleistocene formations (Tuomey and Holmes, 1857; Vaughan, 1904; DuBar, Solliday, and Howard, 1974; DuBar, Johnson, Thom, and Hatchell, 1974; Bailey and Tedesco, 1986; Carter *et al.*, 1988). By comparison, only *Astrangia* is usually listed as a minor component of the shallow marine fauna from younger units (Clark, 1906; Richards, 1950; DuBar, Solliday, and Howard, 1974; Spencer and Campbell, 1987). *Astrangia* and *Oculina* appear to be the only scleractinians still living in modern shallow marine environments of the region

(Verrill, 1872; McDougall, 1943; Field, 1949; Stephenson and Stephenson, 1952; Wass, 1963; Gosner, 1971, 1978). A slightly richer coral assemblage occurs today in offshore Onslow Bay, at depths of 20-30 meters on rock outcrops (MacIntyre and Pilkey, 1969). Other than entries in species lists, often with little explanation or additional data, *Astrangia* has not been studied in nearshore settings of the central coast of North Carolina.

In this report, I describe *Astrangia* coralla from shell accumulations sampled at Pine Knoll Shores (Fig. 1), approximately 13-17 km west of Beaufort Inlet. Specimens were collected by simply picking through the shelly concentrations during low tides in the early summers of 1992-1994. Because there is confusion in the literature concerning species determinations, I will evaluate taxonomic status of the corals from Pine Knoll Shores. The corals encrust modern, subfossil and Pleistocene mollusc shells at this collecting site, and it appears that they can be used as "taphonomic tracers" to map generalized redistribution pathways of shells moving through coastal depositional environments. All specimens used in this study are stored in the Geology Department collection, Humboldt State University.

GEOLOGIC AND ENVIRONMENTAL
CONTEXTS

Shell accumulations at Pine Knoll Shores cover areas in the order of 1-10 m², and are spaced at intervals of 10's- to 100's-of-meters in the foreshore zone. The accumulations are ephemeral in the sense that tidal cycles result in periodic reworking of shells and relocation of shelly patches on a time scale of days to months. Shells and other skeletal material include freshly killed specimens that may have soft tissues still attached, "brown shells" from Holocene and Pleistocene sources, and "black shells" of mostly estuarine molluscs reworked from Pleistocene outcrops at the seafloor (see Pilkey *et al.*, 1969). Preservation of individual mollusc specimens ranged from pristine articulated shells and disarticulated valves to unidentifiable

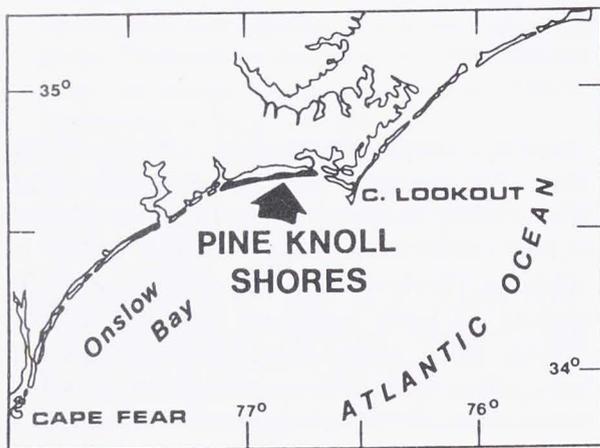


Figure 1. Map showing location of collecting site on Bogue Banks.

scraps. There were no clear trends in source or preservation quality of shells along the approximately 4 km stretch of beach examined. All *Astrangia* specimens appear to be recently killed or subfossil Holocene material.

Bogue Banks is a wave-dominated, microtidal barrier island having well-developed, multiple dune ridges and few washover fans. The island is oriented east-west, unlike most of the barrier segments of the Outer Banks, and encloses a narrow, shallow lagoon (Cleary and Hosier, 1979). Although cottages and hotels cover much of the dune topography, jetties and other sand-conserving structures are mostly absent from the ocean beach. Sand replenishment of the beach appears to be derived from the nearshore zone. An attempt was made in this study to avoid shell accumulations reworked from these replenishment deposits. "Natural" foreshore deposits at Pine Knoll Shores consist of very light tan, fine to coarse, mostly well-sorted, quartz sand containing shell fragments.

Pleistocene-Holocene stratigraphy of Bogue Banks has been described by Moslow and Heron (1986). They recorded 15-20 meters of dune/overwash and foreshore/shoreface sands overlying discontinuous pockets of inlet and backbarrier deposits that were < 5 meters thick, all of Holocene age. The Pleistocene basement occurs at depths from roughly 10 to 20 meters below mean sea level. The Pleistocene units represent a variety of nearshore marine and

estuarine facies comparable to modern depositional environments in the area (Mixon and Pilkey, 1976), and their seaward equivalents appear to be the sources for some of the oldest shells at Pine Knoll Shores. Relict Holocene deposits also contribute shells to the beach.

TAXONOMIC STATUS

Astrangia specimens collected from the Beaufort area have been referred to both *A. danae* (e.g., McDougall, 1943; Field, 1949) and to *A. astraeiformis* (e.g., Stephenson and Stephenson, 1952; MacIntyre and Pilkey, 1969)*. The chief differences between these species seem to be (1) corallite packing (the former is plocoid, the latter cerioid) and (2) geographic distribution (*A. danae* is usually regarded as a Virginian Province species; *A. astraeiformis* is supposed to belong to the Carolinian Province). A cerioid corallum collected south of Cape Hatteras, according to these criteria, should be referred to *A. astraeiformis*. Viewed in this way the western Atlantic *Astrangia* comprise a morphocline in corallum organization, possibly related to the inter-regional thermal gradient.

On the other hand, Verrill (1872, p. 436-437) noted that the two species may occur together in the same collecting area, with the plocoid form being more common at higher (cooler) latitudes (see Gosner, 1971, 1978). Verrill regarded *A. astraeiformis* as a junior synonym of *A. danae*. Interestingly, Richards (1950, fig. 75k) illustrated a

*The correct author and date for these two species is subject to some confusion. Certain workers cite *Astrangia danae* as of Agassiz, 1847, but I have been unable to locate this reference. According to Sherborn (*Index Animalium*), Agassiz did not describe *A. danae* until 1850 (Proc. Amer. Assoc. Advanc. Sci., v. 2, p. 69), wherein he states "I propose to dedicate the species to the able describer and illustrator ... and call it in future *Astrangia Danae*." However, also according to Sherborn, in 1849 (Ann. Sci. Nat., [3] Zool., p. xii; Sept., 1849 *vide* Sherborn) Milne-Edwards and Haime described both *A. danae* (p. 180) and *A. astraeiformis* (p. 181). Unless the Agassiz, 1847, reference can be discovered, *A. danae* Milne-Edwards and Haime, 1849, is the older name and would have one page priority over *A. astraeiformis*, if the two species prove to be synonymous.

specimen identified as *A. danae*, from Pleistocene deposits in Hyde County, North Carolina, that featured both plocoid and cerioid organization *in the same corallum*. Biologic properties of *A. danae* have been described in detail by Field (1949) and Waterman (1950).

Specimens from Pine Knoll Shores are intermediate between typical *A. danae* and *astraeiformis*. I will follow Verrill (1872) and use *A. danae* as the appropriate species name, and consider the grades of corallite packing to be morphs. Some specimens were clearly cerioid (Fig. 3A), but others have raised corallites that could be described as subplocoid (Fig. 3B). In all

cases, septa are dentate and axial parts of unabraded corallites feature a distinctly papillary columella (see Wells, 1956, p. F408-F409). The intermediate morph from Pine Knoll Shores might represent the geographic transition between dominantly plocoid forms of the Virginian Province and the dominantly cerioid forms of the Carolinian Province. Alternatively, plocoid and cerioid morphs could occur in the same area, and possibly reflect corallum response to short-term climate cycles or fluctuation in other environmental factors. These possibilities need to be tested through a comprehensive autecologic evaluation of *A. danae* from different localities within both provinces.

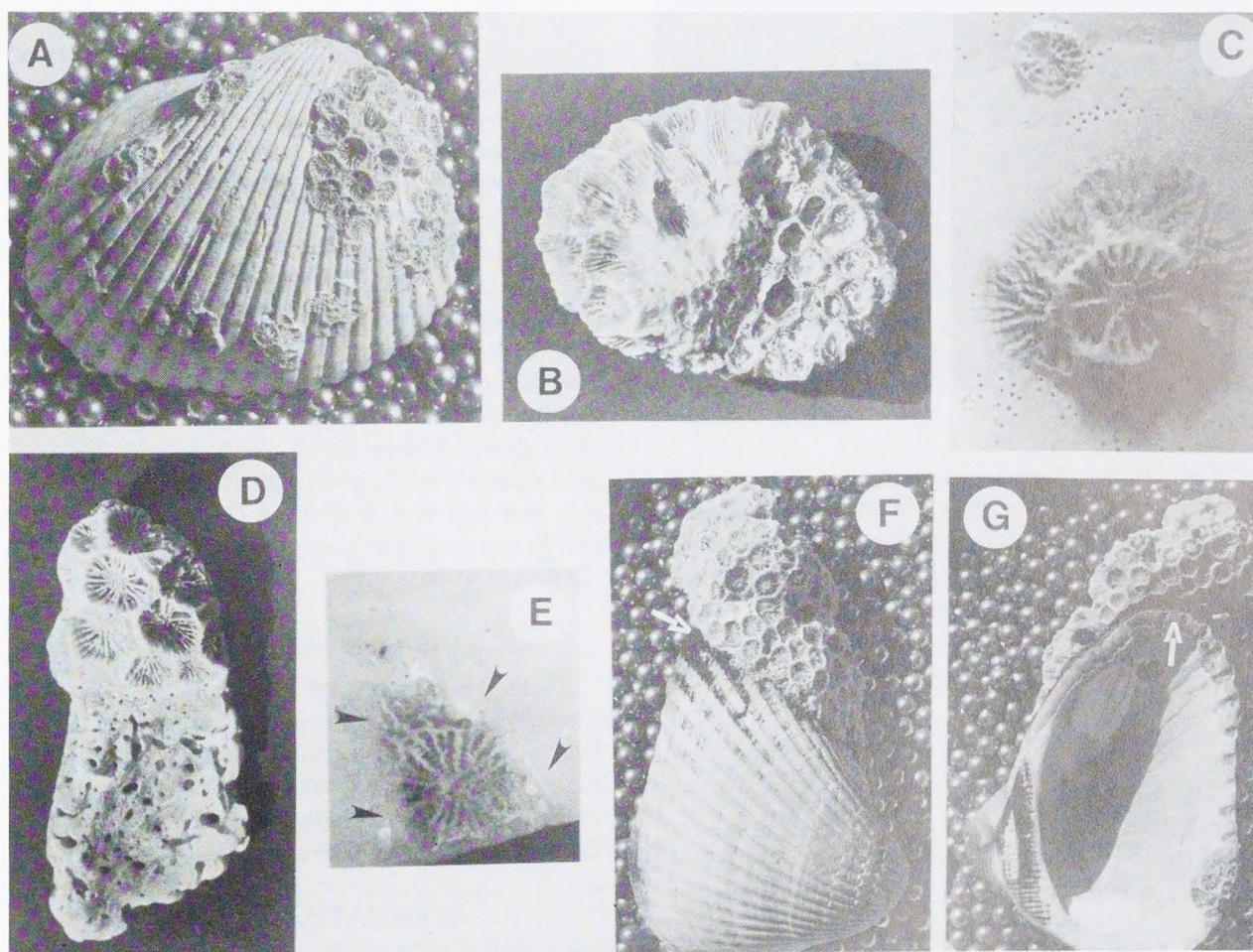


Figure 2. *Astrangia danae* from Pine Knoll Shores. A, Several small coralla on subfossil Holocene *Anadara* (shell is 59 mm in length). B, Corallum covering a patch of *Balanus* (specimen 36 mm across). C, Nascent colonies on interior of possible subfossil *Dinocardium* (largest corallite is 2.6 mm in diameter). D, Reworked Pleistocene shell fragment having a small, wrap-around colony (fragment 33 mm in longest dimension). E, Nascent colony in depression (arrows) on inside margin of *Anadara* (corallite 1.5 mm in diameter). F and G, Relatively large corallum on modern *Noetia*, overgrowing periostracum layer (arrows) (shell 66 mm in length).

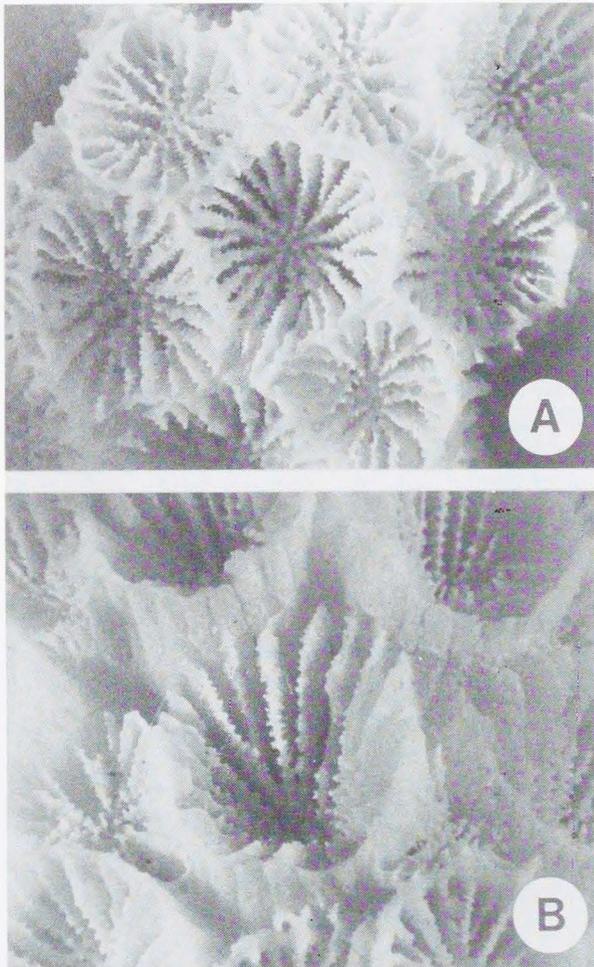


Figure 3. Morphologic variation in *Astrangia danae*. A, Closely-packed corallites (essentially cerioid organization). B, Corallites having raised margins (subplocoid organization). (Corallites in both photographs are 4 to 5 mm in diameter.)

TAPHONOMIC SIGNIFICANCE

A conspicuous feature of *A. danae* from Pine Knoll Shores is the excellent preservation of skeletal anatomy in many specimens, in contrast to the range of preservation quality exhibited by the more abundant molluscs. Other rare corals in the shell accumulations (?*Septastrea* sp.) are badly damaged and barely identifiable. This suggests that specimens of *A. danae*, at least at this particular site, probably are no older than Holocene and that most are derived from the modern nearshore zone.

Coralla of *A. danae* encrust a variety of shells, including Pleistocene estuarine

shell fragments (Fig. 2D), Holocene subfossil marine shells (Fig. 2A), and modern marine shells with the periostracum still attached (Fig. 2F, G). All stages in corallum development are represented, from small incipient colonies (Fig. 2C) to large "columnar" colonies (Fig. 2F). Both inner and outer surfaces of mollusc shells are colonized; some nascent colonies are located in small cavities and depressions on the host shells (Fig. 2E). Colonies typically overgrow bored surfaces and epibiont patches (Fig. 2B, C and D), but are seldom overgrown or bored. Only a few coralla have been penetrated by clionid sponges and juvenile boring clams.

Substrata used by *A. danae* were not only derived from multiple sources, but also appear to have resided for varied time intervals at the seafloor. Some shells may have been buried and exhumed repeatedly (as in the "Jeram Model" of Seilacher, 1985). Occurrence of *A. danae* coralla representing all growth stages indicates that host shells were exposed from weeks to perhaps years at the continental shelf surface before being buried or transported to the foreshore. This demonstrates a complex interaction of a living sedentary, colonial organism with a variety of dead organisms over variable time spans. Although individual shell movement patterns and exact coral colonization environments are not known, Figure 4 depicts the most likely general pathways and environments involved.

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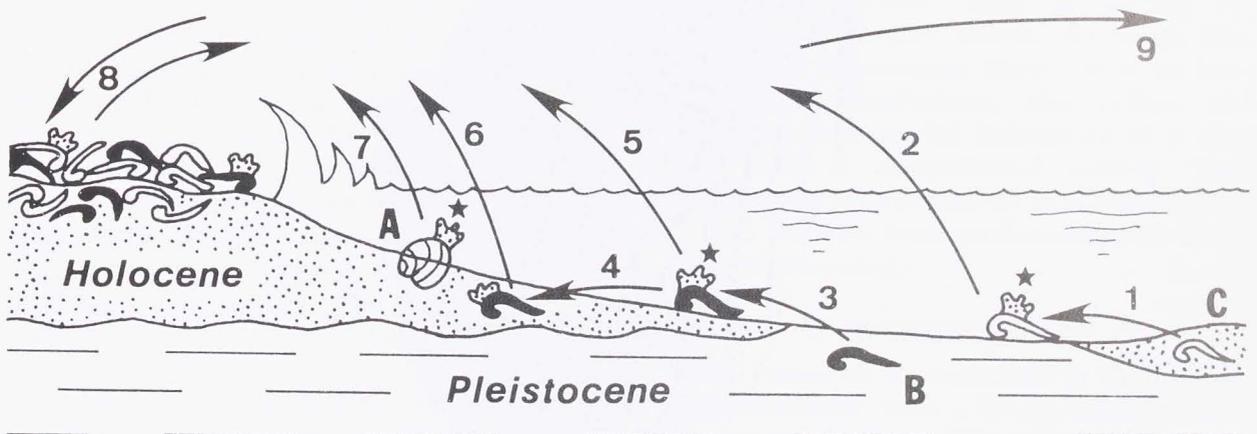


Figure 4. Possible transport pathways and colonization environments involving modern (A) and relict (B) host shells. 1, Exhumation of subfossil Holocene shells; 2, Holocene shells delivered to foreshore; 3, exhumation of Pleistocene shells; 4, reburial in Holocene shelf deposits; 5, Pleistocene shells delivered to foreshore; 6, Pleistocene shells undergo repeated burial and exhumation before being delivered to foreshore; 7, modern shells delivered to foreshore; 8, tidal cycles and storms move shells into and out of foreshore zone, probably many times; 9, export to deeper shoreface and offshore zones; and, ★, shells reside at seafloor long enough to be colonized or overgrown by *Astrangia danae*. (Not drawn to scale.)

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