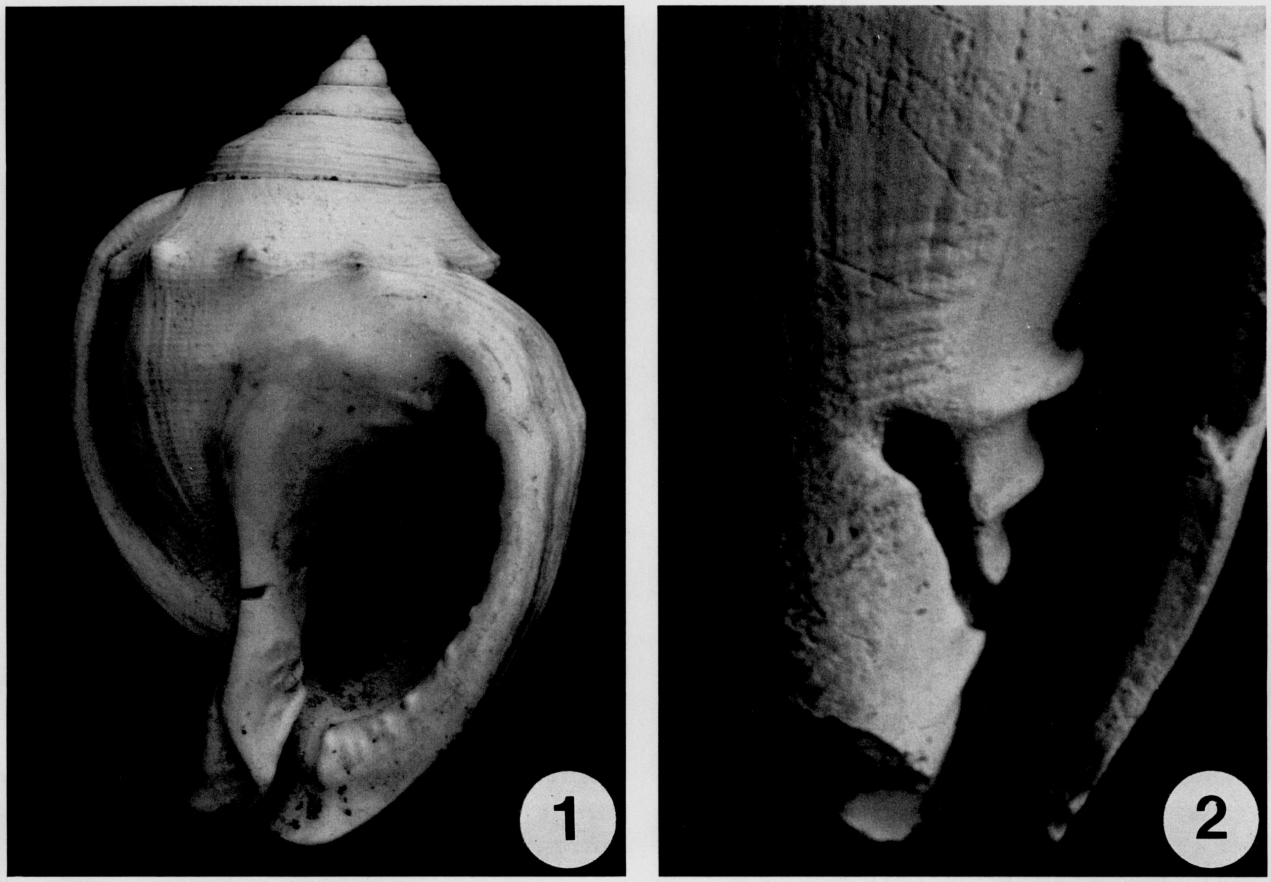

FIGURE 6—Eocene and Oligocene pagurization. *Helicotaphrichnus* bore holes in outer lip of *1, Cassis brevidentata,* Oligocene, USGS 14721, Jackson, Mississippi, shell height, 39.0 mm and *2, Mitra* sp., Eocene, USNM 480359, Hinds Co., Jackson, Mississippi, shell height 35.5 mm (siphonal canal damaged). Specimens are housed at the United States National Museum (USNM).

1969). The dwarf males, which never bore, enter the burrow of the female as a cyprid larva and attach to her. Young are brooded in the female's burrow and released. Small boreholes (assumed to be offspring) are often present around the original individual (Boekschoten, 1966).

The families of boring barnacles can be separated by burrow shape. In Trypetesidae, the aperture which opens toward the interior of the shell, is a tapered slit a few millimeters long and less than a millimeter wide (Tomlinson, 1969b). Some species of trypetesidae may be restricted to thick-shelled gastropods. On thin-shelled gastropods they have two openings: one pinpoint sized hole exiting the exterior of the shell and one slitlike hole exiting the interior of the shell.

Trypetesa lampas (Hancock) was the first boring barnacle to be described (Hancock, 1849). This species is widely distributed in cooler Atlantic and European waters (5–46 m) and inhabits a wide variety of pagurized shells (Table 5). It commonly inhabits pagurized *Buccinum undatum* and is not present on intertidal hermitted shells (White, 1969). This species may indicate deep-water hermitted shells if present in fossil assemblages. *Trypetesa habei,* a boring barnacle associated with hermitted shells in Japan, is also present in deep-water habitats (Tomlinson, 1969b; Utinomi, 1962).

A west coast boring barnacle, *Trypetesa lateralis,* is present only in high intertidal open coast habitats of central California (Tomlinson, 1969b). Because of their restricted geographic distribution and specific depth zonation, boring barnacles may provide important depth and water temperature indicators when present in fossil assemblages.

Encrusting bryozoans (thick encrusters).—Bryozoans are the best known Recent and fossil associates with hermit crabs (Tables 6, 7). Fossil pagurid–bryozoan associations are characterized by the bryozoan's multilayered appearance, characteristic monticulae (bumps), overgrowth of the shell aperture, and growth outward from the surface of the shell (Taylor, 1981). Multilayered bryozoans may be abraded on the bottom of the shell, producing a "pagurid facet" where the hermit crab presumably

TABLE 4—*Helicotaphrichnus* borehole in columellae of *Bullia* (*Bulliopsis*) from the Maryland Miocene. Percentages are calculated from shells with and without boreholes, not from total sample. Localities noted within parentheses. (Data provided by W. and R. Allmon.)

Species	Total sample	With borehole	Without borehole	Indeterminate (damaged shell)
B. (*B.*) *marylandica* (Little Cove Point)	260	88 (59%)	61	111
B. (*B.*) *integra*				
(Deep Point)	18	5 (55%)	4	9
(Windmill Point)	12	7 (77%)	2	3
B. (*B.*) *quadrata*				
(Deep Point)	12	1 (50%)	2	9
(Windmill Point)	63	23 (53%)	20	20
B. (*B.*) *q. bowlerensis* (no locality given)	59	19 (47%)	21	19
Totals	424	143 (56.5%)	110	171