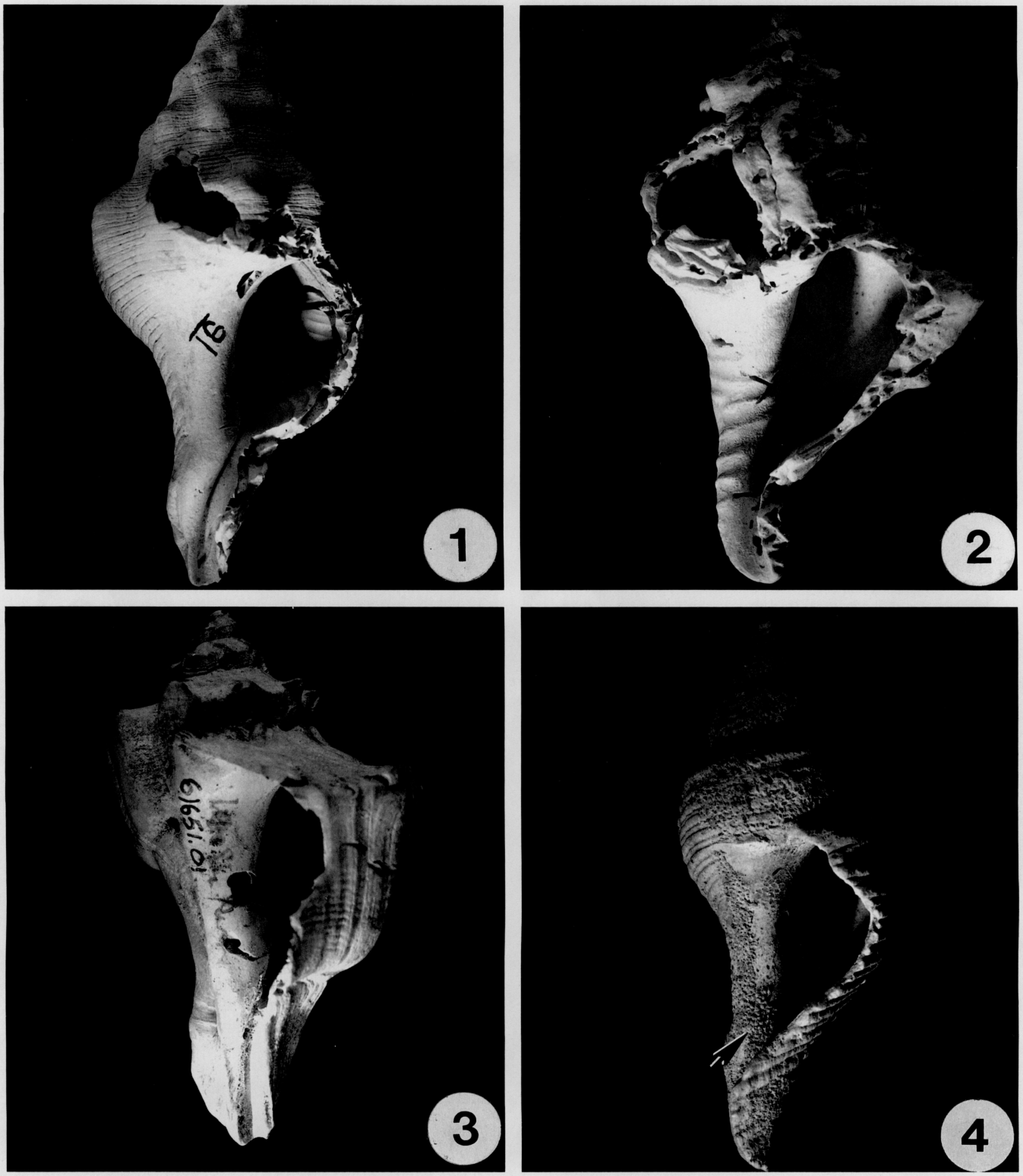

FIGURE 7—Spionid polychaete trace fossils in apertural notch and columella of subtidal Pleistocene gastropods (pagurized) from southern California. *1, Kelletia kelletii* (Forbes) with pencil-thin spionid trace fossil on columella and anastomosing spionid tunnels on apertural notch and outer lip, Palos Verdes Sand, Los Angeles Co., California, CAS Loc. 91.01, shell height, 68.0 mm; *2, Bursa californica* (Hinds) with bifurcating spionid trace fossils in columella and a tunnel on columella near siphonal canal, with other spionid trace fossils on apertural notch, Orange Co., California, UCLA Loc. 3195, LACMIP No. 11493, shell height, 68.5 mm; *3, Forreria belcheri* (Hinds) with multiple boreholes in columella, Palos Verdes Sand, Newport Beach, Orange Co., California, CAS Loc. 61651.01, shell height, 63.2 mm; *4, Fusinus barbarensis* (Trask) with enlarged borehole in columella, encrusting bryozoans also present on columella (arrow), Dead Man Island, Los Angeles, California, CAS Loc. 61652.01, shell height, 41.5 mm.

TABLE 5—Boring and encrusting barnacles associated with hermit crabs.

Barnacles	Hermit crab	Gastropod shell	Locality	Reference
Encrusting barnacles				
Balanus sp. *Balanus eburneus* *Chthamalus* sp.	*Clibanarius vittatus*	unidentified	Galveston, Texas St. Joseph's Bay, Florida	Fotheringham, 1976 McLean, 1983
Balanus crenatus	*Pagurus granosimanus*	*Olivella biplicata*	Bodega Bay, California	Walker, 1988b
Boring barnacles				
Trypetesa lampas (*Alcippe lampas*)	*Pagurus bernhardus* *Pagurus prideauxi* *Pagurus cuanensis*	*Buccinum undatum* *Colus gracilis* *Neptunea antiqua* *Natica alderi*	North Sea, Helgoland; NE Britain; English channel; Sweden; Isle of Man; Denmark; Mediterranean; Woods Hole, Massachusetts; Beaufort, North Carolina; North Wales	White, 1969
Trypetesa lampas	—	*Buccinum undatum* *Littorina littorea* *Natica catena* *Natica poliana* *Turritella communis* *Trochids*		Turquier, 1967
Trypetesa lampas	—	*Fusus antiguus* *Buccinum undatum*	Durham (Britain)	Hancock, 1849
Trypetesa lampas	—	*Buccinum undatum*	North Sea; E. Coast of United States	Boekschoten, 1966
Trypetesa lateralis	*Pagurus samuelis*	*Tegula*	Central California	Tomlinson, 1955
Trypetesa lateralis	—	*Strombus*	Puerto Rico Japan	Seilacher, 1969
Trypetesa nassaroides	*Anapagurus hyndmanni* *Pagarus bernhardus* *Pagurus cuanensis*	*Nassarius* sp. *Trophon* sp. *Mangelia* sp.	Roscoff, France	Tomlinson, 1969b after Turquier, 1967
Trypetesa habei		*Tectus conus* *Chlorostoma nigerrium* *Monilea* sp. *Tegula rustica*	Japan	Tomlinson, 1969b
Encrusting fossil barnacles				
Balanids	—	*Thais lapillus*	Pleistocene, Red Crag, Suffolk	Boekschoten, 1967
Balanus sp.	—	*Olivella biplicata*	Pleistocene, Moonstone Beach	Walker, 1988b
Boring fossil barnacles				
Trypetesa-like borings (unnamed)	—	*Pyrula*	Hungary	Seilacher, 1969
Unidentified burrows	—	*Pyrula cornuta* *Fasciolaria tarbelliana* *Triton nodiferum*	Varpolata and Grund	Tomlinson, 1969b after Zapfe, 1936

dragged the shell (Palmer and Hancock, 1973). These abraded areas represent discontinuities in bryozoan growth.

Multilaminar associations are reported from the middle Jurassic of France (Buge and Fischer, 1970; Palmer and Hancock, 1973). The amount of encrustation varies on these shells from large, multilaminar crusts that completely engulf the snail shell (Figure 2.5, 2.6) to thinner crusts with the snail shape still visible (Figure 2.7). It was once thought that these bryozoans dissolved the shell underneath, but this is not the case (Taylor and Cook, 1981). The shell may be difficult to find under 30–50 layers of zooecia (see Cook, 1964), but is is invariably present.

Amazingly, multilaminar bryozoans appear to mimic the gastropod spiral. For example, the encrusting bryozoan *Hippoporidra edax* grows helically and apparently uses the hermit crab as a template for making a coiled shell (Taylor and Cook, 1981). This globular growth form can be seen in fossils from the Pliocene of England (Coralline Crag, Suffolk; Taylor and Cook, 1981) (Figure 2.8, 2.9). *Hippoporidra edax* are found on gastropod fossils dating from the Miocene and are extant in offshore habitats of the southeastern United States (Table 6). *Hippoporidra* may also have two color and growth forms, which appear to mimic cnidarians (McKinney and Jackson, 1989).

Conopeum commensale is another encrusting bryozoan that produces a ball-shaped form (Kirkpatrick and Metzelaar, 1922). Ball-forming bryozoans on gastropod shells are reported from fossil deposits from the west coast of the United States (Miocene, Santa Margarita Formation, San Luis Obispo County, Adegoke, 1967; Astoria Formation, Moore, 1963; and Pliocene, Imperial Formation, Gyllenhaal and Kidwell, 1989) (Table 7).

Encrusting bryozoans may also have elongated projections radiating out from a multilaminar colony. *Hippoporidra,* a round encrusting form, is also noted for its unusual growth, called "Texas longhorns," when associated with hermit crabs (Deichmann, 1954; Smith, 1966) (Figure 2.10). The zooecia grow out from the shell in the form of long "arms" that resemble horns (Smith, 1966; Glaessner, 1969). This growth form is not restricted to *Hippoporidra* in the Gulf of Mexico, but is also present in *Hippoporidra* species off the coast of Africa (Cook, 1964).

Longhorn bryozoans are associated with deep-water pagurids. Interestingly, these longhorns are very similar to staghorns of