Deepwater Tube Worms (Polychaeta, Serpulidae) from the Hawaiian Islands[1]

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THREE SERPULID TUBE WORMS have been discovered on shells and coral fragments taken in dredges from around the Hawaiian Islands. The two serpulines *Spirobranchus latiscapus* Marenzeller and *Vermiliopsis infundibulum* Philippi are new records for the islands. However, the small spirorbid *Pileolaria* (*Duplicaria*) *dalestraughanae* Vine has been described previously from within diving depths (Vine, 1972), but it is absent from shoal waters and intertidal regions.[3] The occurrence of this species in the dredged collections indicates an extensive depth range in the Hawaiian Islands.

The tube worms were obtained from collections taken during two separate oceanographic investigations in Hawaiian waters. Material consisting mostly of the pink serpuline *Spirobranchus latiscapus* was loaned by Dr. E. C. Jones of the National Marine Fisheries Service (N.M.F.S.) and was taken from an average depth of 200 meters (lat 21°9.6′ N, long 157° 25.1′ W). Examination of these samples, which consisted of both living and preserved specimens, proved very interesting. The other collection contained all three serpulid species attached to the branches of the precious pink coral *Corallium secundum* and on the solitary coral *Cyatheras* sp., both of which were collected by V. E. Brock during the 1966 *Sange Pele* survey for locating areas of precious coral on Penguin Banks off Molokai (lat 20°51.6′ N, long 157° 19.3′ W; depth, 220–600 meters).

Previous literature on Hawaiian polychaetes consists of a few important listings from cruises. The polychaetes dredged from around the islands during the cruise of the steamer U.S.S. *Albatross* in 1902 was reported by Treadwell (1906), but no serpulids were found. Hartman (1966*a*) reviewed the literature in an extensive analysis of the Hawaiian polychaete fauna. Straughan (1969), presented a more recent survey of the littoral and upper sublittoral Serpulidae. Other works by Vine (1972) and Vine, Bailey-Brock, and Straughan (1972) include ecological data collected from settlement plates and by diving, but no records extend below 28 meters. Serpulids have been described from deepwater collections in other parts of the world. Southward (1963) found 14 species of calcareous tube worms on hard substrata dredged from depths as great as 1,755 meters along the continental shelf off southwestern Britain. Antarctic collections yielded 14 genera and more than 23 species from depths ranging from the littoral zone down to 4,930–4,963 meters in the South Sandwich Trench (Hartman, 1966*b*, 1967).

DESCRIPTIONS OF SPECIES

Spirobranchus latiscapus has been included in the genus *Pomatostegus* by von Marenzeller (1885) and other authors, secondly in the genus *Spirobranchus* by Imajima and Hartman (1964) and other earlier authors, and possibly identified as *Pomatocerus strigiceps* by McIntosh (1885). H. A. ten Hove (1970) reviewed the literature on this species and retained the generic status, *Spirobranchus*. The specimens of *S. latiscapus* from the N.M.F.S. were mainly associated with the shells of the gastropod *Xenophora tenuis*, a carrier shell, and to a lesser extent with *Terebra* spp. Living specimens were kept in an aquarium in an air-conditioned office for approximately 2 months and observed at leisure. The following description includes the characteristic morphological features and the colors of the living worms.

The tubes of *Spirobranchus latiscapus* are from 22 to 33 mm in length, sinuous, and vary

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[3] Species listed in Vine, 1972, and Vine, Bailey-Brock, and Straughan, 1972, as *Pileolaria* (*Duplicaria*) *dalestraughani*.

in color from pale pink to a deep salmon orange. There is an obvious median, longitudinal ridge with blunt, triangular to rectangular teeth, which are most well developed toward the mouth (Fig. 1*a*). Where the tube has grown up off the substratum, as seen in a few specimens, there are three or more finely toothed ridges on either side of the median ridge (Fig. 1*a*). Erect portions of tube are circular in cross section; attached portions are typically triangular in section.

The opercula are composed of 1 to 7 calcareous tiers, which get smaller toward the apex (Fig. 1*b*). These tiers comprising the operculum can be dislodged and some of the largest specimens were lacking one or more of the older tiers. The opercular stalk has broad lateral wings. There is an incomplete collar, seven thoracic segments, and a large abdomen with as many as 48 setigerous segments.

The color of living specimens is an overall pink-red. The opercular stalk has red patches extending over the wings; the opercular plates vary from shades of orange to yellow. The radioles are red at the bases and have red bands on an orange background extending to the tips. My observations agree with those of Takahasi (1938), who described this serpulid from Japan as *Pomatostegus latiscapus.*

The Hawaiian specimens of *Vermiliopsis infundibulum* Philippi agree with the descriptions by Fauvel (1927), Zibrowius (1968), and Hartman (1969: 779–780). The whitish tubes have a characteristic fluted appearance with an expanded flute forming the mouth (Fig. 1*c*). The operculum is a ringed, chitinous dome, golden brown in color, and the stalk lacks lateral wings (Fig. 1*d*).

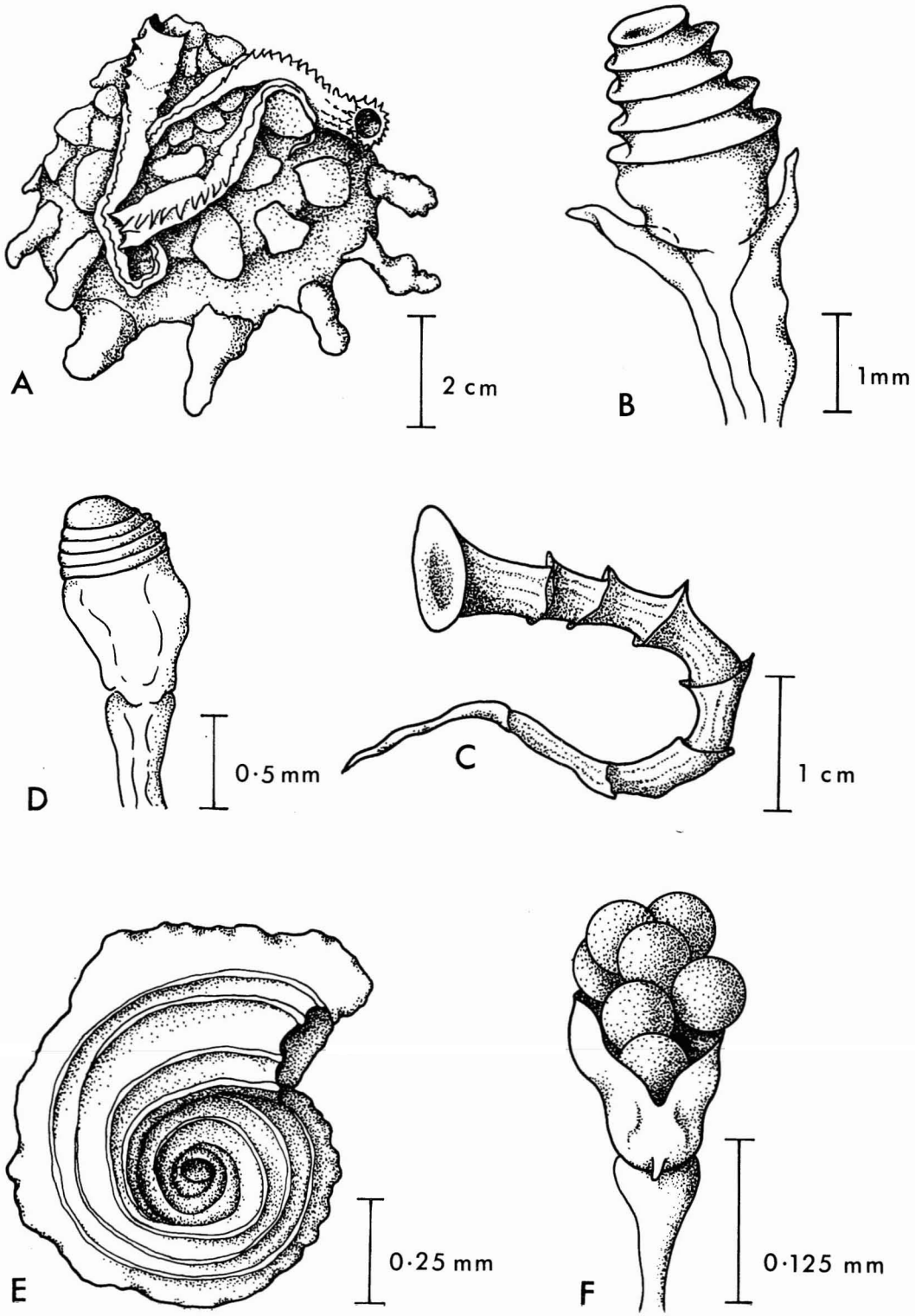
Pileolaria (*Duplicaria*) *dalestraughanae,* an opercular-brooding spirorbid, occurred in both *Sange Pele* and N.M.F.S. collections. This species was recently described by Vine (1972) from Maili Point and Pokai Bay, Oahu, from depths of 8 and 15 meters, respectively. The tube coils sinistrally (clockwise) in a flat spiral and has four distinct longitudinal ridges which extend to the tube opening (Fig. 1*e*). Among seven specimens from the *Sange Pele* dredge haul (depth between 220–600 meters), both adult and juvenile stages were found. Hollow, cup-shaped, calcareous brood chambers develop prior to breeding and one specimen was incubating two embryos. This is perhaps the most open type of brood chamber that has been described in the Spirorbinae literature. Vine (1972) said that one of the specimens he found had six developing embryos, but only two could fit in the confines of the opercular chamber (Fig. 1*f*). This would seem to be a hazardous method for incubating the developing trochophore larvae, except under the most ideal circumstances.

DEPTH AND ZOOGEOGRAPHICAL RANGE

H. A. ten Hove (1970) reviewed the geographical range of *Spirobranchus latiscapus,* a range which extends throughout the Indo-West Pacific. Station records from Moore and Bush (1904) and Takahasi (1938) showed that this serpulid occurs between 80–150 meters. Hawaii represents the most easterly record of this species in the Pacific.

The type locality of *Vermiliopsis infundibulum* is the Mediterranean Sea, but it is found in the Atlantic, Indian, and Pacific oceans (Zibrowius, 1968). The shallowest record is by Hartman (1969), who found the species from within diving depths off Santa Catalina Island, California. Southward (1963) found three species of *Vermiliopsis,* including *V. infundibulum,* taken from depths between 205–1,430 meters on the continental shelf. This cosmopolitan distribution may be a result of water temperature and current systems, as well as available substrata for larval settlement. The vertical range of *Pileolaria* (*Duplicaria*) *dalestraughanae* is extensive. The species has a known distribution in Hawaii from 8 meters (Vine, 1972) to between 220–600 meters off Penguin Banks. The upper limit of this considerable range may be determined by the degree of water movement and possibly by the amount of suspended ma-

FIG. 1. *Spirobranchus latiscapus*: (*a*), three tubes attached to a carrier shell; (*b*) tiered operculum with winged stalk. *Vermiliopsis infundibulum*: (*c*), tube; (*d*), ringed operculum. *Pileolaria* (*Duplicaria*) *dalestraughanae*: (*e*), sinistral tube; (*f*), adult operculum containing eggs.
NOTE: *e* and *f* after Vine (1972).


A
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B
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D
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C
1 cm
E
0·25 mm
F
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terial that could obstruct the adult brood chamber. As the operculum is merely a modified radiole it is extruded from the protection of the tube every time the animal extends the branchial crown during feeding. Spirorbinae that brood within the confines of the tube in an egg string or thoracic pouch are not so vulnerable to loss of embryos (Bailey, 1969). The relatively calm water off Oahu's leeward coast appears to permit an unusually shallow distribution of this spirorbid. *P.* (*D.*) *dalestraughanae* has been recorded from 20–27 meters off southern Africa and is tentatively identified in collections from the Cape Verde Islands by Phyllis Knight-Jones (personal communication). These records give some idea of the geographical range of this species.

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