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A Biological Determination of the Taxonomic Status of *Conus elisae* Kiener in Hawaii[1]

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ABSTRACT: A population of *Conus pennaceus* Born was examined at Hauula, Oahu, and was found to include darkly pigmented specimens referable to *C. elisae* Kiener. The larvae from an egg mass laid by one of the darkly pigmented cones were reared in the laboratory. Of seven surviving larvae, six developed the *C. pennaceus* color pattern, while one developed the *C. elisae* pattern. It was concluded that Hawaiian cone shells which have in the past been referred to *C. elisae* are simply rare color forms of *C. pennaceus*.

OF THE THIRTY OR SO species of the neogastropod genus *Conus* known to maintain permanent populations in the Hawaiian Archipelago (Kohn 1959), *Conus pennaceus* Born, 1780 is the most variable both in shell shape and pattern. Although striking differences between local populations of *C. pennaceus* have long been known to professional malacologists and amateur collectors alike, Ostergaard (1950) was the first to relate this polytypy to the limited dispersal potential of *C. pennaceus* larvae. In contrast to most Hawaiian species of *Conus* whose larvae remain in the plankton from 10 days to several weeks, the larvae of *C. pennaceus* metamorphose within 1 day of emergence from the egg capsule (Kohn 1961, Ostergaard 1950). Shells resembling those of *C. pennaceus* but differing in possessing dark color patterns have been referred to *C. elisae* Kiener, 1845 (Kohn 1959, Weinkauff 1874). I propose to show that these shells are merely variants of *C. pennaceus*.

Kiener's original description of *Conus elisae* does not include a type locality, so it is unclear whether the specimen he described and figured was from Hawaii or East Africa where specimens fitting the description are also known to occur. According to Kohn (1959), *C. elisae* was first definitely reported from Hawaii by Weinkauff in 1874. Although Sowerby (1858) considered *C. elisae* to be a synonym of *C. pennaceus*, the status of the Hawaiian *C. elisae* has remained controversial up to the present. Kohn (1959) listed *C. elisae* as a possibly valid species on the basis of reported differences in microhabitat between *C. elisae* and *C. pennaceus* and the lack of intermediates between the two cones. However, Kay (1979) includes *C. elisae* from Hawaii as a synonym of *C. pennaceus*.

Although I will comment below on the taxonomic status of the Hawaiian cone shell which is called *Conus elisae* Kiener, nothing that I say here should be extended to the East African *C. elisae* about which I have no first-hand information.

In the course of an ongoing ecological study of *Conus pennaceus* at Hauula, Oahu, I have made observations on a mixed population of *C. pennaceus* and the so-called *C. elisae*. Of 1066 cones examined to date, 30 conform to Kiener's description of *C. elisae*, while the remainder conform to our interpretation of *C. pennaceus*. The shells referable to *C. elisae* ranged in length from 7.4 to 41.2 mm ($\bar{x} = 19.8$). No obvious intermediates between shells attributed to *C. elisae* and those of *C. pennaceus* were observed. The habitat at the Hauula study site ranges from piled boulders to boulders resting directly on sand. No differences in microhabitat were

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apparent, with shells of both color patterns being found either infaunal in sand under rocks or epifaunal in the crevices between boulders.

In April 1978, a 33.1-mm female of the *Conus elisae* color pattern was brought into the Kewalo Marine Laboratory of the Pacific Biomedical Research Center and was segregated in a seawater tank. Several days later, this animal deposited an egg mass comprised of 45 capsules identical to those of *C. pennaceus*. Some of these capsules were dissected or preserved, while the remainder were kept in flowing seawater so that the embryos would develop. The uncleaved ova averaged 490 μm in diameter, similar to those of the *C. pennaceus* pattern.

Between 3 and 4 weeks after oviposition, larvae began hatching from the egg capsules. These larvae measured 1.3 mm in shell length and appeared identical to *Conus pennaceus* larvae observed by the author and those figured by Ostergaard (1950) and by Kohn (1961). Some of the hatching larval shells were orange, while the others were white. This polymorphism is also characteristic of *C. pennaceus* larvae.

The larvae of the purported *Conus elisae* metamorphosed within a day of hatching and 20 of these juvenile cones were placed in a seawater tank that contained large numbers of the microgastropod *Bittium* sp. Within a few days the young cones began feeding on the prey provided for them. The *Conus* juveniles grew at a rate of about 2 mm/month and reached an average shell length of 14 mm by December 1978. By this time, mortality had reduced the original cohort to seven surviving animals. One of these juveniles was consistent with Kiener's description of *C. elisae*, while the other six had color patterns of the *C. pennaceus* type (Figure 1). The observed ratio of one *C. elisae* pattern to six *C. pennaceus* patterns is not particularly instructive because the color form of the male parent is not known.

These results lead to the conclusion that Hawaiian cone shells referred to *Conus elisae* Kiener are simply color forms of *C. pennaceus*. Kohn's (1959) provisional acceptance of these shells as representing a species distinct from *C. pennaceus* was based partially on the absence of specimens intermediate in character. However, absence of intermediates is only indicative of specific differences when continuously varying traits are considered. The shell pigmentation of *C. pennaceus* may be controlled by only a few alleles at a single locus with a particularly rare allele coding for the "elisae form." If shell pigmentation is, in fact, a discontinuous trait similar to human eye color, then intermediates between *C. pennaceus* and the "elisae form" would not be expected.

FIGURE 1. Juveniles that developed from an egg mass of the so-called *Conus elisae*. The darkly pigmented shell conforms to Kiener's description of *C. elisae*, while the other six have the typical *C. pennaceus* pattern.

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