

Toxin Secretion and Tail Autotomy by Irritated *Oxyhoe panamensis* (Opisthobranchiata; Sacoglossa)¹

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ABSTRACT: The green sacoglossan gastropod *Oxyhoe panamensis* occurs in mangrove swamps on the coasts of Baja California, Mexico, apparently feeding exclusively on the green siphonaceous alga *Caulerpa sertularioides*. When irritated, it secretes an astringent, milky mucus, which contains a toxin lethal to fish. Continued molestation may induce autotomy of the tail.

THE ORIGINAL DESCRIPTION of *Oxyhoe panamensis* (Mollusca: Opisthobranchiata) by Pilsbry and Olsson (1942) was based on empty shells collected in Panama. Living animals identified as this species were first reported by Smith (1961), who collected specimens near La Paz, Baja California, Mexico. The sluglike animals may reach 3 cm in length. They have paired tentacles (rhizophores) and paired eyes; a visceral hump enclosed in a lightly calcified, globular shell, partly covered by pallial folds; and a relatively long, muscular tail (Figs. 1-4).

We found them in the same area in 1967 and 1969, usually in mangrove swamps, and always associated with mats of *Caulerpa sertularioides* (Gmelin) Howe (Chlorophyceae; Siphonales). In May 1969, these animals were relatively abundant (about one individual found per square meter) in a dense mat of *C. sertularioides* overlying calcareous ooze, at depths of less than 1 meter, in a shallow bay at the south end of Isla Partida. They are green, with white papillae, and are particularly well camouflaged among the fronds of *Caulerpa*, on which they feed by puncturing the wall and sucking up cytoplasm, including whole chloroplasts. *Oxyhoe antillarum* was reported to feed almost exclusively on *Caulerpa* (Warmke and Almodóvar, 1963). Certain other sacoglossans are generally found living on species of siphonaceous algae such as *Caulerpa*, *Bryopsis*, *Codium* (Kay, 1964; Burn, 1966; Doty, 1966; Taylor, 1968).

O. panamensis copulated readily in our

aquaria, and laid coils of yellow eggs which hatched as veligers within 13 days (at 21° C). Their subsequent development was not followed.

TOXIN SECRETION

When the animal is molested or irritated mechanically or chemically, for example, with alcohol, it begins within a few seconds to secrete a mucoid, milky exudate from its skin. Several hours after such a discharge, further secretion can be produced if the animal is again irritated. This can be attributed to biosynthesis of fresh exudate, since animals incubated for a day in the presence of C¹⁴O₂ secrete a milky exudate labeled with C¹⁴. The mucus is initially tasteless, but within a few seconds it tastes caustic and astringent to the tongue. This secretion is presumably a defence mechanism, since it is not only irritant but also poisonous to fish (and, probably, to other animals).

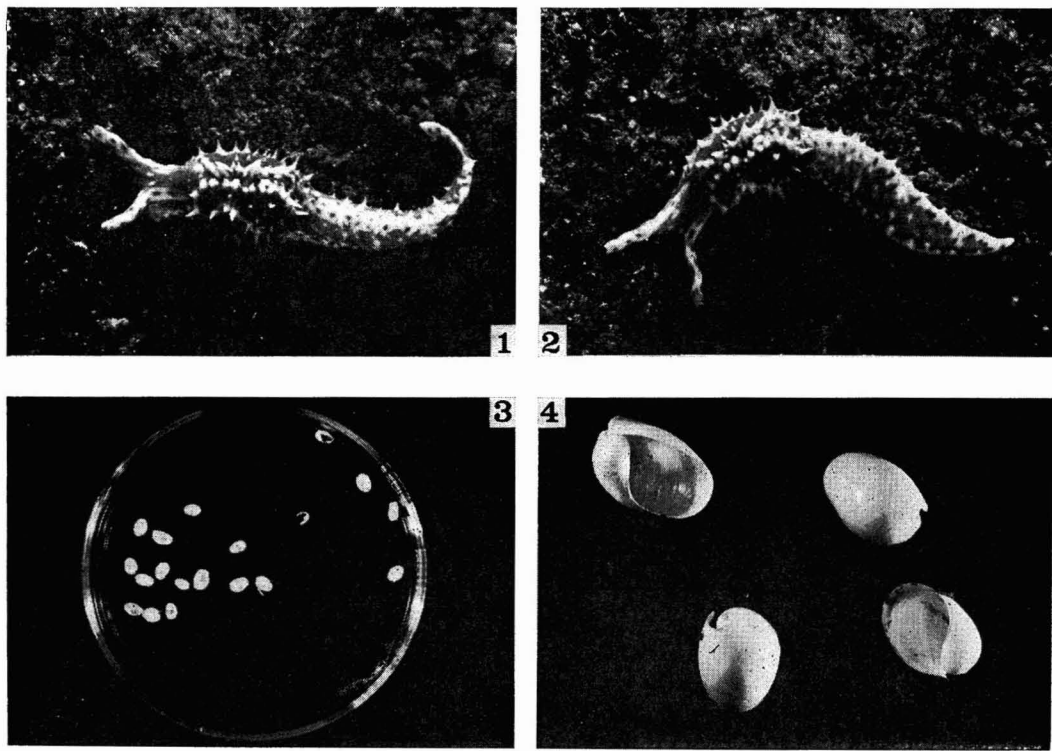
ACTION AND NATURE OF THE TOXIN

One-quarter of the discharge from a single adult, mixed in 100 ml of seawater, is sufficient to kill a 5-gm specimen of the herring *Harengula thryssina* (Clupeidae) within 15 minutes. One-fiftieth of a discharge dispersed in 2 ml of pond water is sufficient to kill a 40-mg guppy, *Lebistes reticulatus* (Cyprinodontidae), within 30 minutes. The symptoms exhibited by these fishes include convulsive movements of the body, irregular activity of the gill opercula, paroxysms, and a few seconds of tremor leading to death.

The exudate from *Oxyhoe* may contain a neurotoxin, perhaps ultimately of pharmaceutical interest. The toxic factor passes through dialysis

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FIGS. 1-4. *Oxynoe panamensis*. 1 and 2, Living animal, extended and moving, $\times 2$. (Photographs by Walter E. Harvey.) 3, Thin, calcified shells, $\times 0.45$. 4, Same, $\times 2.7$. (Photographs by James E. Rupert.)

membranes. It is thermostable, remaining active after boiling in seawater for 5 minutes. It is not precipitated by 80 percent ethanol, which precipitates only the mucous moiety of the exudate. The alcohol-soluble portion from the discharge of one animal has been calculated to contain less than 1.0 mg of organic carbon.

Poisonous milky exudates are produced on irritation by other opisthobranchs, such as species of *Acteon*, *Phyllidia*, *Aplysia*, etc. (Fretter and Graham, 1954; Johannes, 1963; Thompson, 1960; Halstead, 1965), but the toxic components have not yet been sufficiently well characterized for useful comparisons.

AUTOTOMY OF THE TAIL

When *Oxynoe panamensis* is persistently irritated mechanically, it responds by strong lateral movements of the tail, which is eventually detached at its anterior junction, just behind the visceral hump. Autotomy is presumably mediated by a circular muscle in that region. The

detached tail continues to twitch sporadically for several minutes. Similar autotomous reactions to molestation have been reported in other opisthobranchs, for example, *Lobiger* (Gonor, 1961).

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