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Autotomy and regeneration of siphonal tips in Manila clam, *Tapes philippinarum* (Mollusca: Bivalvia)

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Certain vertebrates (Dial & Fitzpatrick, 1983) and invertebrates (Hopkins & Mislan, 1986) possess the capacity to release body parts reflexively at predetermined sites. Such autotomy is used by the animal as an escape response to elude capture by possible predators. Through the use of autotomy the prey manages to escape while the attention of the predator is focussed on the autotomised body part which continues to thrash about for some time after autotomy. The autotomous part is a simple, expendable vulnerable part that has an alternative biological function such as feeding and locomotion. It is usually regenerated following autotomy.

In bivalves, the foot and siphons extend periodically from the shell and thereby become vulnerable to predation. Bivalve siphon tips are nipped and ingested by predatory shrimp and fish such as plaice (*Pleuronecta platessa;* Trevallion et al., 1970), bream (*Acanthopagrus berda;* Day et al., 1981), javlin (*Pomadasys commersonni;* Cyrus & Blaber, 1983), staghorn sculpin (*Leptocottus armatus*), diamond turbot (*Hyposopsetta guttulata;* Peterson & Quammen, 1982) and golden-lined whiting (*Silago analis;* Brewer & Willan, 1985).

Although bivalves with partially regenerated siphons have been collected (Trevallion et al., 1970; Trevallion, 1971), there are no reports of bivalves autotomising their siphonal tips or of time periods required for their regeneration. It has been estimated that nipping off of siphon tips of the bivalve *Protothaca staminea* by predatory fish may result in an energy loss amounting to as much as 60% of the net annual volumetric growth of the bivalve (Peterson & Quammen, 1982). In the Baltic clam, *Macoma balthica,* siphon loss amounted to nearly 50% of the annual mean biomass of its soft tissue (Hopkins & Mislan, 1986).

In the course of an experiment where the respiration of diploid and triploid Manila clams, *Tapes philippinarum,* was being studied (Ekaratne & Davenport, 1993), they were kept in shallow glass vessels containing filtered sea-water

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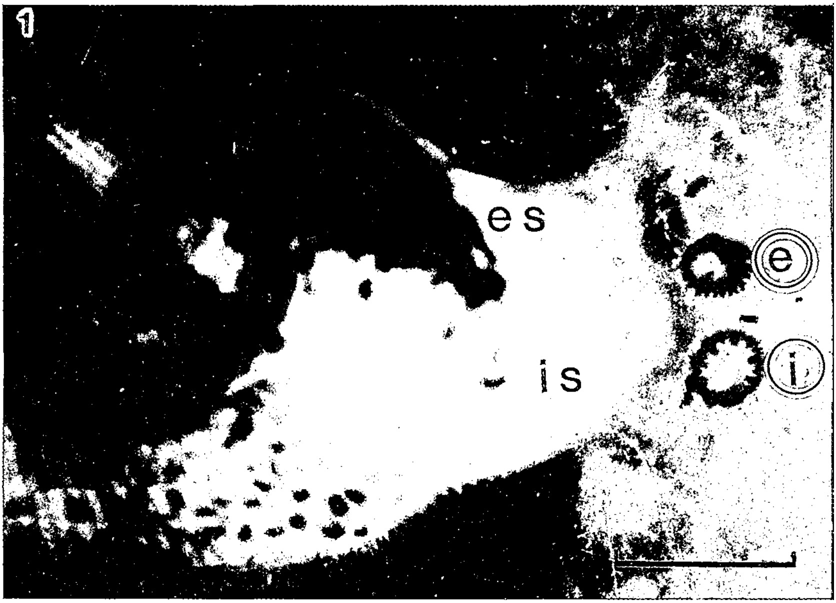

Figure 1. The Manila clam, *Tapes philippinarum*, shown alongside its autotomised siphonal tips. Scale bar = 5mm. Abbreviations: es = exhalent siphon, is = inhalent siphon, e = autotomised tip of exhalant siphon, i = autotomised tip of inhalant siphon.

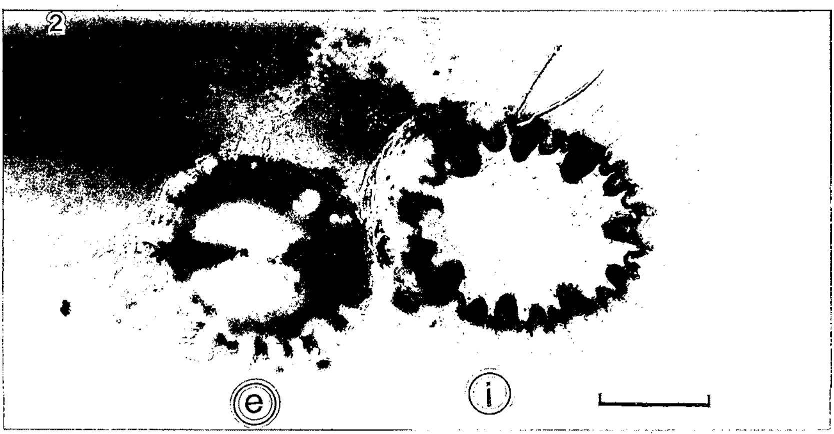

Figure 2. The autotomised siphonal tips. Scale bar = 0.5mm. Abbreviations are as for Figure 1.

(34‰). A triploid Manila clam of 10.7 mm shell breadth was observed to have autotomised both its inhalant and exhalent siphonal tips. The accompanying photographs show the autotomised siphonal tips alongside the triploid clam (Figure 1) and, separately, under higher magnification (Figure 2).

The clam was then transferred to a recirculating sea-water tank at 20°C where it was kept under observation whilst being drip fed with *Tetraselmis suecica*. The clam had regenerated both siphonal tips by the 20th day.

In an attempt to induce other clams to autotomise siphonal tips, both diploid and triploid clams were provided with conditions of salinity, aeration, light and temperature similar to those experienced by the autotomised clam. These attempts were, however, not successful in eliciting siphon tip autotomy.

In other animals such as lizards and geckoes where tail autotomy is commonly employed as a defence tactic against predators, the autotomised part continues to exhibit wriggling movements for sometime in order to hold the attention of the predator (Dial & Fitzpatrick, 1983). No such movements were observed however, in the autotomised siphonal tips. It is therefore questionable whether the autotomy of the siphonal tips reported here could function as an effective predator defense mechanism through diverting attention of the predator, as has been reported for other animals.

Since bivalves live buried in the soft substrate and can quickly retract their siphons into the shell, development of such distractive autotomy does not at first appear to be a pressing need in bivalves. One of us (S.U.K.E.), while working with the tropical estuarine clams *Marcia opima* and *M. hiantina,* that live in soft substrates having sea grasses and large numbers of predatory crabs, had noticed that sudden overhead movements in the laboratory always elicit in these clams an abrupt shell closure response where the siphon tips are sometimes left protruding from the quickly and very tightly closed shell valves. Siphon tips would suffer harm in such instances. Autotomy and regeneration of siphon tips would then become necessary to repair siphon tip damage and may therefore provide a necessary repair mechanism to the bivalve that experiences continued siphon tip damage. Such damage could arise from direct siphon nipping or even from defensive mechanisms (such as rapid shell closure) that have been developed as a safeguard against predation. Further work is necessary to clarify the issue of siphon tip autotomy and a clearer picture will emerge only after further study of the conditions that elicit autotomy and regeneration of bivalve siphon tips.

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