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First report of shell boring predation by a member of the Nassariidae (Gastropoda)

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Shell boring predation occurs in a range of animal groups1, but is most well-studied in the prosobranch gastropods, notably representatives of the Naticidae and Muricidae2. In both families, a wide range of species engage in such predation activities and characteristic boreholes in their even more diverse prey are evidence of this and provide further evidence in the fossil record for the origins of such activities3. Muricid boreholes are generally straight-sided and such borers are characterized by the presence of an accessory boring organ in the foot4. The naticid borehole is countersunk, or bevelled, at the edges and there is also an accessory boring organ, but this time on the ventral surface of the proboscis5. In representatives of both families, therefore, boring is by chemical dissolution using secretions from an accessory boring organ. The boring organs, independently evolved in both groups, are assisted by mechanical abrasion using the radula. There is also a suggestion that species of Cominella (Buccinidae) from Western Australia bore their bivalve prey6. A fourth, less well-studied, family, some of which, e.g., Austroginella sp., are shell borers, is the Marginellidae7. The Cassidae (Neotaenioglossa) are specialist, hole-making (but not boring), echinoderm predators5.

Representatives of the Nassariidae are herbivorous, carnivorous or scavenging members of the Neogastropoda. There is an extensive literature on scavenging in the numerous species of the Nassariidae much of which has been reviewed and they are generally assumed to be ‘the closest attempt of an obligate scavenging life style6, along with the amphipod Lysianassidae. The spatial and temporal ephemerality of carrion in the sea, however, it is argued8, can only sustain facultative scavengers. Yet, in the Nassariidae, only Bulila digitalis9 and Ilyanassa obsoleta10 are known to eat live prey, but not by boring. Bulila digitalis is also known to consume algae11.

Three reports mention12-14, in passing, that nassariids are shell borers, but there is no confirmatory evidence of this and, hitherto, to the contrary, it has been generally assumed that species of this family are incapable of such activity. This study provides the first evidence of shell boring in a member of the Nassariidae and was obtained in a wholly accidental manner. Nassarius festivus (Powys, 1835) is the most common and widely distributed nassariid on Hong Kong’s soft shores and is, undoubtedly, a scavenger15. Where in Hong Kong, for example, either pollution creates a stressed biota on beaches or where trash fish discarded by fishermen float ashore, numbers of N. festivus are elevated enormously and they readily and
descend speedily on such food to consume it rapidly and in large quantities\textsuperscript{15}. The present authors are studying \textit{N. festivus} with a view to understanding the effects of organic and metal pollution upon its life history strategy and the research involves the rearing of larvae to examine the phenomenon of imposex induced by, specifically, tributyltin from anti-fouling paints. In Hong Kong, the species reproduces from November to April and, following hatching, the larvae can be sustained on an algal diet (\textit{Chorella} sp.) and remain in the plankton for between 33 to 41 days\textsuperscript{16}. One batch of reared larvae had just settled but were left for a period of five days over an extended public holiday (February 17–21 inclusive). Upon re-examination, most were crawling normally on the bottom of the culture dishes but others (eight of thirty) were dead. Examination of the eight individuals, with a mean shell length of 1.33 mm, showed them to be devoid of flesh and to have been bored. All eight had one borehole always on the ventral surface of the main body whorl. Three examples of the borehole are shown in Figure 1. The first (A) shows a newly settled larva and a mechanically abraded, elongate, ventral borehole. The second (B) shows a rather elongate, irregular, borehole some 145 \(\mu\)m in diameter also created by mechanical rasping while the third (C and D) shows an almost spherical, countersunk, borehole some 250 \(\mu\)m in diameter, mainly smooth and with the organic matrix standing slightly proud at the edges, indicating chemical dissolution. The only animals capable of making such boreholes in the culture dishes were surviving conspecifics. This is, therefore, first, an example of post-larval cannibalism but, second, the first evidence of boring by a nassariid in which there is clearly mechanical radula rasping and chemical dissolution. The post-larvae had been, again presumably, reduced to cannibalism by hunger.

In all the experiments on adult nassariids, there has never been any evidence of shell boring, rarely even of predation and \textit{Nassarius festivus}, a well-studied species, has never been seen attempting to bore either in the field or the laboratory. It is unknown, therefore, if this observation is evidence of the potential to bore in adults or is a post-larval ability only,
perhaps, for example, allowing them to survive in the natural environment where they would be unable to compete with conspecific adults in obtaining carrion. Possibly, adults can also bore but rarely do so if carrion is readily available and is, thereby, less energy-consuming to obtain. If adults do not or cannot bore then this observation on post-larval *N. festivus* is even more intriguing than at first glance. If boring, at least in this species, is a post-larval feature only (and steps are being taken to test this possibility), then it is also possible that the first emergence of shell boring in the post Palaeozoic, i.e., the Cretaceous, as a part of the Mesozoic Marine Revolution, might have been derived from the retention of a larval adaptation, that is, prey boring was achieved by neotenous, or paedomorphic, ancestors of the present Muricidae (and Nassariidae) and which is still seen in the post-larval state of, for example, this representative of the Nassariidae. The Nassariidae are, however, a relatively recent (Cenozoic) family, probably derived from a buccinid ancestor, so that the presently described boring ability may also be independently evolved from that seen in the Muricidae. The observations reported upon here, however, do raise another question of whether the interpretation of borings in more Recent fossil assemblages may relate only to the currently known families of borers?

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