RESEARCH NOTES

Holothurian feeding by *Nassarius dorsatus* on a beach in Western Australia

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The species-rich caenogastropod Nassariidae occupy intertidal and subtidal sands and muds worldwide.[1] Feeding behaviour and food resources for members of the family vary considerably. Some species, e.g. *Ilyanassa obsoleta*[2] and the juveniles of others, e.g. *Nassarius reticulatus*,[3] are believed to be deposit feeders. *Bullia digitalis*, *Ilyanassa obsoleta*, and perhaps others graze algae growing upon their shells.[4,5] There are three reports[6–8] suggesting some nassariids are shell drillers, but without confirmatory evidence, it has been widely assumed that most members of the family are incapable of such an activity.[9] Juvenile *Nassarius festivus* have been shown, however, to cannibalize smaller conspecifics by drilling them.[9]

Many nassariids are known scavengers. *Bullia digitalis*, for example, 'surfs' up and down wave washed beaches of South Africa to feed on stranded jellyfish and *Physalia*.[10] We have, in fact, postulated a scavenging life mode as characteristic of the majority of nassariids, especially intertidal ones occupying broad, gently sloping beaches onto which constructive waves deliver carrion.[11] The smell of carrion, concentrated in the drying film of water as the tide recedes stimulates most nassariids to emerge from subterranean repose and seek out its source.[12] On Australian shores, *Nassarius dorsatus* is one of the few species that emerges at low tide to actively forage and to retreat into repose with the returning sea.[13] Because of the ephemeral and serendipitous nature of carrion, there are probably few obligate scavengers, although the Nassariidae comes close to being such.[11] Members of this family have come to dominate either polluted or fishery-impacted shores and subtidal seabeds receiving regular discarded windfalls of by-catch.[14] In Hong Kong, for example, these are represented by the intertidal *N. festivus* and subtidal *N. siquijorensis*. Nassariids have a suite of characters that facilitate successful utilization of carrion, most appropriately and collectively termed opportunism.

This paper reports a second incidence of hole-making by a nassariid and the utilization of a potential food source rarely exploited by the Gastropoda. On 26 July 2000, the beach at Watering Cove, Dampier Archipelago, northwestern Western Australia, was reconnoitred as part of a study of the behaviour of its resident nassariids and other scavengers. No clusters of feeding nassariids were observed. That evening, a tropical depression passed over the coast, creating high winds and waves. During a repeat visit to the beach on 27 July, we observed moribund holothurians, *Acaudina leucoprocta* (Clark, 1938) lying upon the tidally-exposed sand. This species is a beach resident living as U-shaped individuals in the surface sands. The storm had washed the holothurians out of the sand and they were attracting the attention of resident scavengers. On the 27 July, nine holothurians were surrounded by clusters of gastropod scavengers, including the large *Nassarius dorsatus* (Röding, 1798) (up to 28 mm shell height) and with six of them also being attracted to by the smaller columbellid *Mitrella essingtonensis* (Reeve, 1859) (up to 10 mm shell height), the latter, hitherto, not known to be a scavenger (Table 1 and Figure 1). The snails appeared to be feeding on the surface film of mucus the distressed holothurians had produced.

On the 28 July, 26 holothurians were found surrounded by gastropods. In addition to *Nassarius dorsatus*, *Mitrella essingtonensis* (12 of the holothurians) and *Nassarius albinus* (Thiele, 1930) (up to 16 mm shell height; five of the holothurians) also contributed to the feeding clusters. Feeding, however, was now well underway especially by groups of the larger *N. dorsatus*. Of the 26 feeding assemblages, 13 of them (50%) consisted of either *N. dorsatus* individuals or groups with proboscises inside the anus of their prey and feeding internally. One group of four *N. dorsatus* was also feeding at the oral end of one of the holothurians. Furthermore, four holothurians had been penetrated laterally, again by *N. dorsatus* individuals, there being in the body wall a perfectly circular opening into each of which one animal had its proboscis.

On the 29 July, eight holothurians were observed attended by clusters of scavengers. Of these, five (60%) were being fed on by groups of *Nassarius dorsatus* at the anus and one other was penetrated laterally and being fed on internally by another *N. dorsatus*. On this day, five of the eight holothurians had also attracted *Mitrella essingtonensis*, and one each of *Nassarius albinus* and *Cominella acutinodosa* (Reeve, 1846) (Buccinoidea: 30 mm shell height) were among the feeding clusters of gastropods. On the 30 July, no holothurians were recorded and, thus, all carrion-feeding clusters had dispersed.

These observations are important in a number of respects. First, the resident scavenging gastropods, notably *Nassarius dorsatus*, recognized distressed, disinterred holothurians as a source of nutrition. On the first day, however, they seemed unsure of how to tackle it, perhaps because the skin and oral tentacles of holothurians contain saponins, holothurin A and B, which are both toxic[15] and block sodium ion transport in predator chemoreceptors.[16] This may also be true for *Acaudina leucoprocta* because no gastropod scavenger was observed feeding on the body wall itself, only the mucous covering. By the second day, however, many *N. dorsatus* (with *Mitrella essingtonensis* sometimes joining them) had discovered the anus and their long proboscises were inside the distressed holothurians feeding on the presumably non-toxic intestines and gonads.

Secondly, single individuals of *Nassarius dorsatus* had created circular holes in the body walls of *Acaudina leucoprocta* and were also feeding on the internal organs. It is unknown if a salivary gland secretion acting in concert with the radula is needed to penetrate the body wall of a holothurian, but regardless, this observation constitutes only the second authenticated record of a nassariid attacking prey in such a way,[9] and the first for an adult.

We also observed *Nassarius dorsatus* at Watering Cove attacking and overpowering other prey, including polychaetes that we had possibly inadvertently damaged simply by walking on the beach. Among such damaged, but living prey was the predatory crab *Matuta* sp., which was surprising. We both have much experience in observing nassariids in the field and have never seen such active (and aggressive) animals being attacked by nassariids. This record of *N. dorsatus* making a hole in an holothurian must not, however, be construed as evidence of a more general ability to drill holes in prey with a hard exoskeleton, as we have not seen this. Nevertheless, it shows that *N. dorsatus* can create holes with its radula, and this raises the question as to whether or not it can tackle other prey in such a manner.

Thirdly, our fortuitous presence on a beach following a rela-

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Table 1. Records of scavengers feeding on moribund holothurians (*Acaudina leucoprocta*) at Watering Cove, Dampier Archipelago, Western Australia, 27–29 July 2000 following a storm.

	N	*a*	*s*	*s*	*a*
	d	*o*	*r*	*s*	*a*
27 July 2000					
Numbers of holothurians attacked	9	6	0	0	
Mean number of scavengers per holothurian (±SD)	6.7 (4.1)	1.2 (0.4)	–	–	
Maximum numbers per holothurian	13	2	–	–	
Minimum numbers per holothurian	2	1	–	–	
Total numbers on holothurians for day	60	7	–	–	
Total anal feeding, oral feeding, and drilling body wall	0, 0, 0	0, 0, 0	–	–	
28 July 2000					
Numbers of holothurians attacked	26	12	5	0	
Mean number of scavengers per holothurian (±SD)	5.5 (3.1)	1.6 (0.9)	1.4 (0.5)	–	
Maximum numbers per holothurian	12	4	2	–	
Minimum numbers per holothurian	1	1	1	–	
Total numbers on holothurians for day	142	19	7	–	
Total anal feeding, oral feeding, and drilling body wall	26, 4, 4	0, 0, 0	0, 0, 0	–	
29 July 2000					
Numbers of holothurians attacked	8	5	1	1	
Mean number of scavengers per holothurian (±SD)	3.1 (2.0)	2.8 (2.0)	–	–	
Maximum numbers per holothurian	6	5	–	–	
Minimum numbers per holothurian	1	1	–	–	
Total numbers on holothurians for day	25	14	1	1	
Total anal feeding, oral feeding, and drilling body wall	13, 0, 1	0, 0, 0	0, 0, 0	0, 0, 0	

tively mild natural perturbation has shown that nassariids are efficient scavengers of the resulting disinterred and moribund casualties. This may be the first record of nassariids cleaning up a beach after a natural perturbation, as opposed to the now well known phenomenon of doing it after human-induced ones.[11,14]

Only a few nassariids are known to feed on living prey, i.e. *Bullia digitalis*[4] and *Ilyanassa obsoleta*,[5] but not by making holes. Similarly, holothurians are the prey of few predators, mostly fishes, starfish, and crustaceans.[17] They are, however, the exclusive prey of species of *Tonna* (Gastropoda: Tonnidae),[18,19] which do not drill, but rather ingest their prey whole.[20] The columbellid *Amphissa columbiana* was observed scavenging either dead or damaged holothurians (*Psolus chitonoides*) in the field, as with *Mitrella essingtonesis* at Watering Cove, but when offered the same species in the laboratory it would not feed, even after several days without food.[21] *Charonia variegata* was also cited as a holothurian predator in Jamaica,[22] and in Trinidad and Tobago it feeds on species of *Synapta* and *Cucumaria*.[23] Similarly, a high frequency of holothurian (*Trochodota maculata*) spicules have been identified in the gut contents of *Oliva tigridella* on shores in Queensland, Australia, and a single whole animal identified from one olive's foot pouch.[24] This study, therefore, is the only record of a holothurian being attacked by a nassariid making holes in the body wall, and one of only a few related to sea-cucumbers being attacked by a non-tonnid gastropod.

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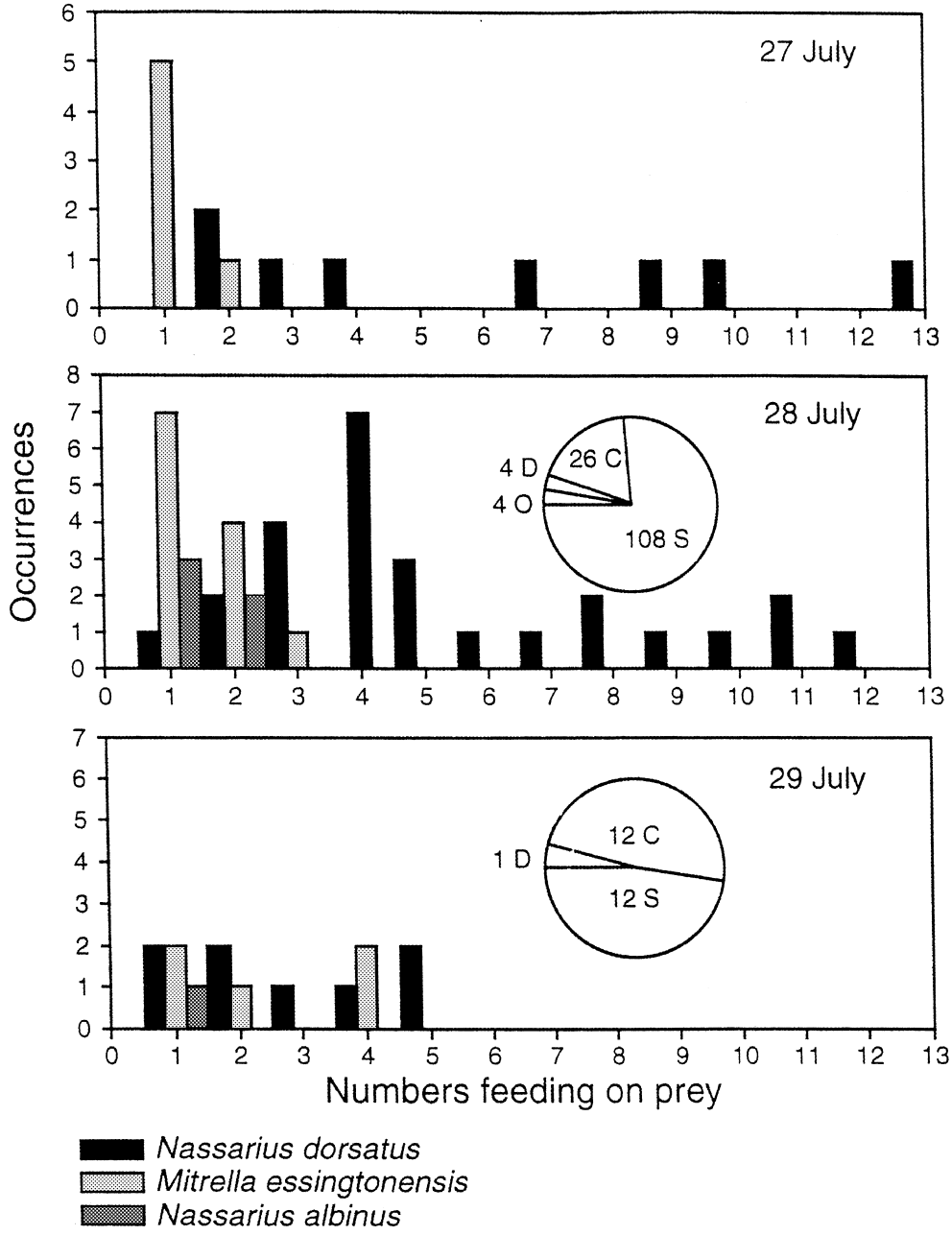

Figure 1. Numbers and feeding patterns of scavengers feeding on moribund holothurians (*Acaudina leucoprocta*) at Watering Cove, Dampier Archipelago, Western Australia, 27–29 July 2000, following a storm. S, feeding at holothurian body wall; C, feeding at holothurian anus; O, feeding at holothurian buccal cavity; D, feeding at a hole in the holothurian's body wall.

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