

CANNIBALISM IN AN OPISTHOBRANCH MOLLUSC,
PLEUROBRANCHAEA BROCKII BERGH, 1897
FROM HONG KONG WATERS

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ABSTRACT

Pleurobranchaea brockii Bergh, 1897 is a large opisthobranch mollusc of the order Notaspidea. It occurs commonly in the subtidal of the South China Sea. It appears to be a voracious carnivore. Numerous specimens were collected in shrimp trawls from Hong Kong waters during the Fourth International Workshop on the Marine Flora and Fauna of Hong Kong and Southern China in April 1995. The gut contents of 32 specimens was analysed. Twelve specimens contained more or less dissolved remnants of conspecifics. A total of 18 specimens had remnants of opisthobranchs in the crop. In one specimen a "food chain" of 4 levels of opisthobranchs eating other opisthobranchs could be traced; a large *P. brockii* had eaten a smaller conspecific, which had eaten an aglajid (*Philinopsis* cf. *cyanea* (Martens, 1879)), which had several shells of *Ringicula* cf. *doliaris* Gould, 1860, in its gizzard. Other invertebrates eaten by *P. brockii* include cephalopods, bivalves, ophiuroids, and polychaetes. A few specimens also contained echinoid spines and spicules of gorgonians; these could have originated from the guts of other prey organisms. Eleven specimens had empty crops. Cannibalism has been recorded in other species of *Pleurobranchaea*.

INTRODUCTION

Opisthobranch molluscs sometimes comprise a considerable part of the biomass of benthic marine invertebrates (Taylor & Jensen 1992; Jensen 1994). Opisthobranchs of the order Notaspidea are carnivores, the most primitive ones feeding on sponges, the more advanced ones mostly on Cnidaria (Willan 1984). *Pleurobranchaea brockii* Bergh, 1897 is a large notaspidean opisthobranch with a wide Indo-Pacific distribution; it is found from East Africa to Indonesia (Ambon Island) and Japan (Bergh 1897; Gosliner 1987; Tsubokawa *et al.* 1992). Information on its diet is scarce and highly variable (Willan 1984; Tsubokawa *et al.* 1992).

Benthic molluscs have been surveyed by trawl-sampling during international workshops in Hong Kong (Taylor & Shin 1990; Taylor 1992, 1994). *P. brockii* occurs commonly in these samples. In the present study the contents of the crop of *P. brockii* from Hong Kong has been analysed.

MATERIALS AND METHODS

During the Fourth International Workshop on the Marine Flora and Fauna of Hong Kong and southern China in April 1995 *P. brockii* were collected using a shrimp-trawl for 2 times 5 min. at each station. The trawl stations containing *P. brockii* were located south and east of Hong Kong Island, from Lamma Island to Mirs Bay (Fig. 1). The depth at these stations varied from 8 to 47 m. A total of 32 specimens of *P. brockii* were examined. The animals were cut open dorsally and the crop and pharynx were removed and preserved in 4 % neutral formaldehyde. The crop was then cut open and the contents identified.

RESULTS

P. brockii (Fig. 2) occurred in 30 out of 100 stations. The number of *P. brockii* per station varied from 0 to 12. The specimens examined ranged in size from ca. 60 mm to more than 220 mm. Of the 32 specimens

examined, 11 had empty crops (Tab. 1). Most specimens had 2-3 food items in the crop. Up to 5 different prey species were found in the crop of a single specimen, but more often all food items in one crop were the same species (Tab. 2). Identification of food items showed that smaller specimens of *P. brockii* were the most common prey (Tab. 3). In one case only the penis of a conspecific had been ingested; the size indicated that the "prey" specimen must have been of the same size as the "predator" specimen. Opisthobranchs are evidently the most common prey of *P. brockii*. Eleven of 21 specimens contained only opisthobranch prey. Of these, 4 specimens contained only one prey item, 3 contained more than one specimen of only one species, and 4 contained more than one species. Seven *P. brockii* contained opisthobranchs as well as other prey items, and only 3 specimens contained exclusively non-opisthobranch prey.

A food-chain of 4 levels of opisthobranchs eating other opisthobranchs was identified in one case: a large *P. brockii* had eaten a smaller conspecific, which had eaten a *Philinopsis* cf. *cyanea* (Martens, 1879) (Fig. 3), which again contained several shells of *Ringicula* cf. *doliaris* Gould, 1860 (Fig. 4). In some cases prey items had apparently been eaten by one of the other molluscan prey species, e.g., *Ringicula* cf. *doliaris* had in at least two cases been eaten by *P. cf. cyanea*, and the bivalve had almost certainly been eaten by *Philine orientalis* A. Adams, 1854 (Fig. 5). Cephalopods were only found in one specimen of the 32 specimens studied here. However, cephalopods have been found in 2 other specimens (Jensen 1994), thus may form a regular prey of *P. brockii*. At least 3 different species of polychaetes had been eaten by *P. brockii*, i.e., a phyllodocid, a chaetopterid, and a glycerid.

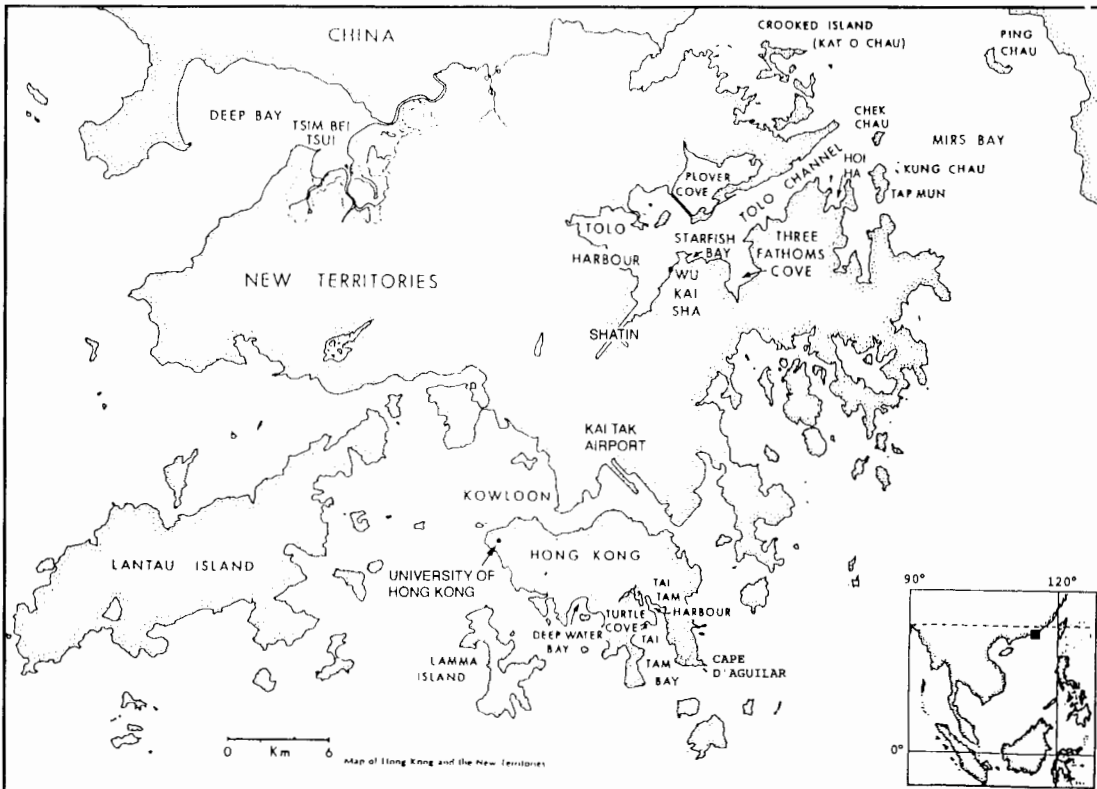


Figure 1. Map of Hong Kong and surrounding waters. Insert: South China Sea. Location of Hong Kong indicated by black square.

Echinoderms, cnidarians, and crustaceans had been eaten by very few *P. brockii*.

DISCUSSION

Species of the genus *Pleurobranchaea* appear to be generalist predators (Willan 1984; Cattaneo-Vietti 1986). Cannibalism has been reported for several species (Willan 1984; Tsubokawa & Okutani 1991). However, it is

not known whether cannibalism is a natural behaviour, or whether they only eat their own conspecifics when other food is scarce. In the present study more than 50% of the specimens with prey in the crop had eaten conspecifics. As two of the three other opisthobranch prey species (*P. cf. cyanea* and *P. orientalis*) were common in the trawl samples, cannibalism was probably not caused

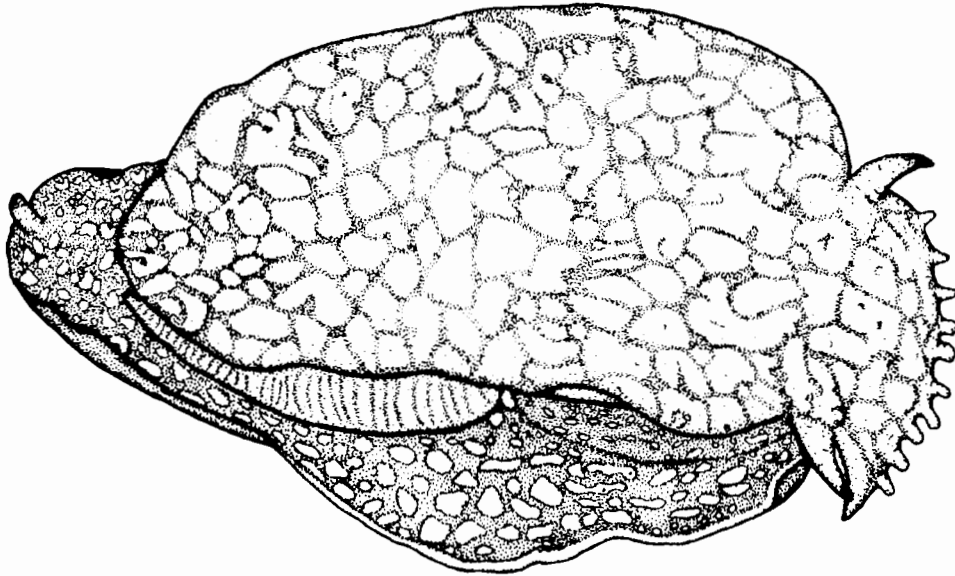


Figure 2. *Pleurobranchaea brockii* Bergh, 1897. Hong Kong, April 1995. Total length 250 mm.

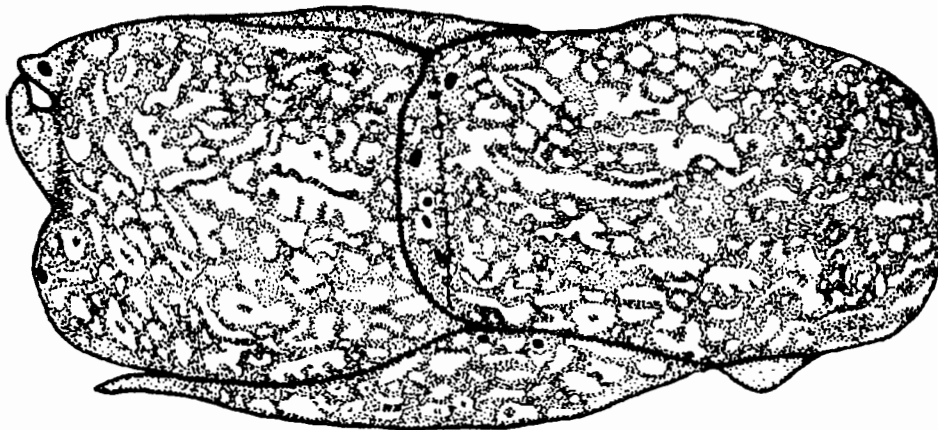


Figure 3. *Philinopsis cf. cyanea* (Martens, 1879). Hong Kong, April 1995. Total length 25 mm.

Table 1. Number of prey items in the crops of 32 specimens of *Pleurobranchaea brockii* from Hong Kong. Average (\pm s.d.) = 2.1 ± 2.6 (N=32).

Number of prey items	0	1	2	3	4	5+
Number of individuals	11	7	3	4	3	4

Table 2. Number of different prey species in individual *Pleurobranchaea brockii* from Hong Kong (N=21). Average (\pm s.d.) = 3.2 ± 2.6 (N=21).

Number of different prey species	1	2	3	4	5
Number of individuals	9	5	4	2	1

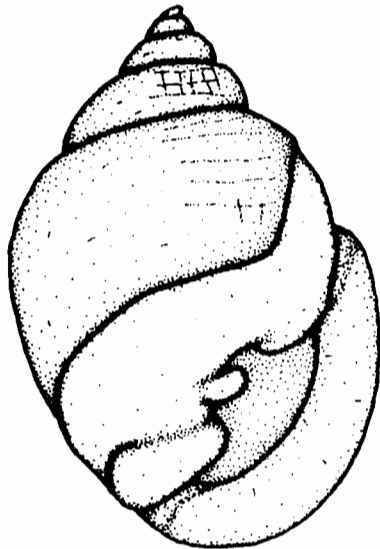
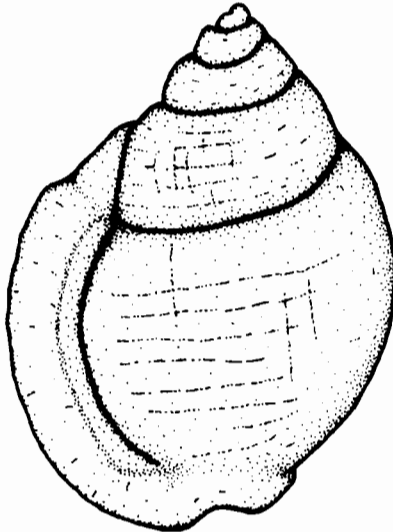


Figure 4. *Ringicula cf. doliaris* Gould, 1860. Hong Kong, April 1995. Shell length 4 mm.

by scarcity of other prey. It could also be noted that species of the nudibranch genus *Armina*, which were also common in the trawl samples (Jensen, in press), were never seen in the crop of *P. brockii*. From an evolutionary standpoint cannibalism would appear to be a poor diet. However, *P. brockii* produces large egg masses with numerous eggs. Also, opisthobranchs are in general considered unpalatable prey, and many notaspideans produce strongly acidic mucus (Thompson 1960, 1969; Avila 1995). Hence it is possible that cannibalism is an important mechanism regulating population density.

Species of *Pleurobranchaea* are often caught in crab pots or fish traps (Willan 1984), and it can be speculated that they eat the

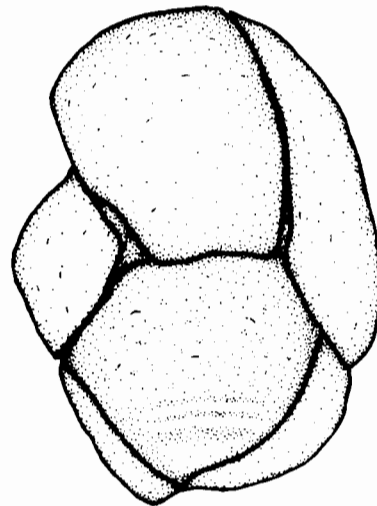


Figure 5. *Philine orientalis* A. Adams. Hong Kong, April 1989. Total length 68 mm.

Table 3. List of prey species and abundance of prey in crops of *Pleurobranchaea brockii* from Hong Kong.

^a - 1 specimen contained a newly bitten off penis of conspecific.

^b - In 2 specimens *Ringicula* was found in the gut of *Philinopsis*.

^c - could have been gut content of other, partly digested prey.

Prey species	Number of <i>P. brockii</i> containing items
<i>Pleurobranchaea brockii</i> , juv.	12 (13) ^a
<i>Philinopsis</i> cf. <i>cyanea</i>	8
<i>Philine orientalis</i>	4
<i>Ringicula</i> cf. <i>doliaris</i>	3 (5) ^b
Other Mollusca	
Bivalvia	1 ^c
Cephalopoda	1
Polychaeta (min. 3 species)	5
Unidentified "worms"	2
Echinodermata	
Fragments of Ophiuroidea	3
Spines of Echinoidea	2 ^c
Cnidaria (fragment of gorgonian)	1 ^c
Crustacea (rostrum of decapod)	1 ^c
Unidentified	1

trapped fish or crabs. The present study indicates that neither fish nor crustaceans form a regular part of the diet of *P. brockii*. It is much more likely that *P. brockii* caught in traps have been attracted to and eat the bait, which in many cases is squid meat. However, it cannot be excluded that the presence of large size *Pleurobranchaea* in fish traps renders them less attractive to fish, especially if the original bait has been consumed by the slugs. It would be interesting to conduct laboratory studies to test the unpalatability of *P. brockii* to fish and crabs.

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