GUT CONTENT OF BLOOD COCKLE, *ANADARA GRANOSA* (L.), WITH EMPHASIS ON DIATOMS, TRA VINH, SOUTH VIETNAM

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ABSTRACT

Gut contents of a total of 137 *Anadara granosa* were examined shortly after collection in two biotopes in the Mekong River delta. Detritus was the main component. Plankton organisms made up an estimated 7 % of the gut content. Diatoms were dominant with 102 species present. A check list of these species is presented. The percentages of detritus and phytoplankton changed with spatial and temporal differences of the two biotopes. It was reflected in the gut content index (I %). The index was highest in small cockles.

INTRODUCTION

Blood cockles are widely distributed in Vietnam, both in marine and brackish water (estuaries) where the substratum is mud or sandy mud. Coastal areas of the Mekong River delta in Tra Vinh province, have high population densities of *A. granosa* L., 1758. These bivalves constitute an important resource, and cockle farming has started in Tra Vinh province, and neighbouring areas. *A. granosa* provide a sustainable crop and improve the local economy. Cockle farming has already developed in many other South East Asian countries: Malaysia, Thailand, the Philippines (Tandanavanitj 1996).

Knowledge of environmental conditions and food potential is basic in sea farming of blood cockles. Estuaries are preferred biotopes for culture, but estuaries are complex environments with marked seasonal variations. Shifting monsoons cause dry and rainy seasons characteristic of South East Asia thereby influencing the levels of primary productivity (Sundstrom *et al.* 1987), as well as the species composition. *A. granosa* is a so-called detritus-feeder. Detritus constitutes the bulk of the stomach content, but detritus in itself is generally a poor source of food (Hylleberg & Riis-Vestergaard 1984). We therefore speculate that phytoplankton and resuspended benthic microalgae may constitute main food sources of *A. granosa*. Accordingly, our aim has been to study po-

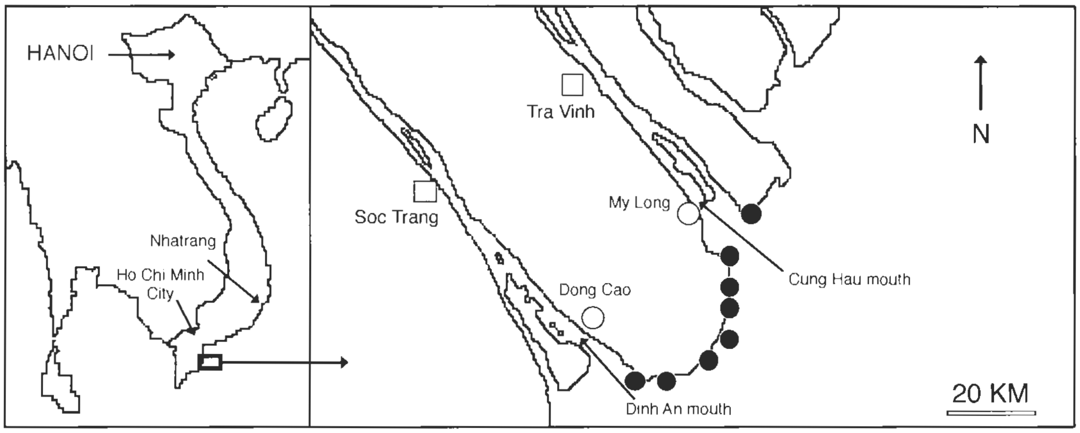

Figure 1. *Anadara granosa* (L.) sampling sites, the south eastern part of South Vietnam.

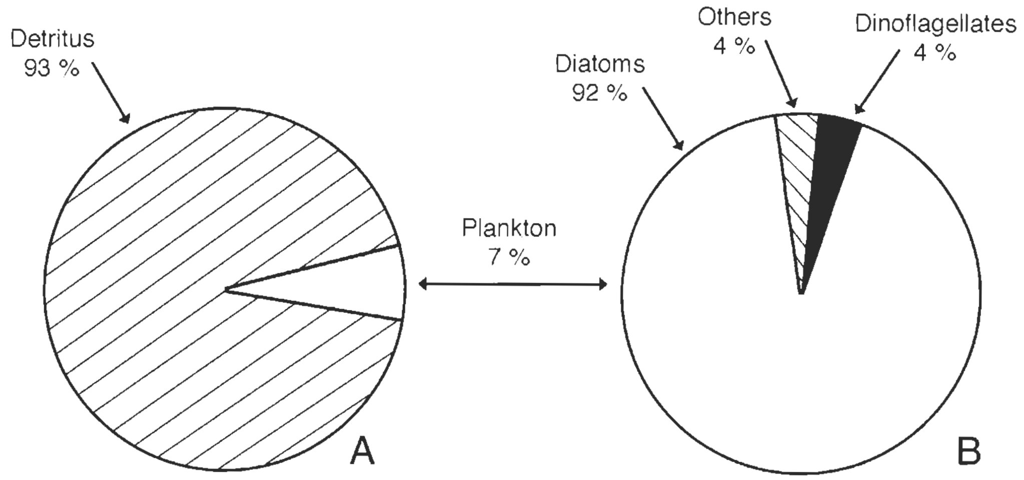

Figure 2. *Anadara granosa*. (A) ratio between detritus and plankton; (B) phytoplankton composition in guts.

tential food based on identification of phytoplankton extracted from the stomach content of the bivalves. We hypothesize that seasonal variation of primary productivity should influence the feeding activity of *A. granosa*.

MATERIALS AND METHODS

A. granosa samples of different sizes were collected in 1995-96 at two sites of two river mouths of the Mekong River (Fig. 1): My Long bank is located at the Cung Hau river mouth (106°31'30" E and 9°45' - 9°47' N). Sampling in May, July, September, and October. Dong Cao bank is located at Dinh An river mouth (106°25' - 106°27' E and 9°32' N). Sampling in May, July, September, October, December, February, March, and April.

Salinity was measured on each sampling occasion by refractometer (Atago, Japan) with an accuracy of ± 1 ‰.

A total of 92 and 45 *A. granosa* samples were collected from My Long and Dong Cao respectively, and immediately fixed in 10 % formalin. The soft parts were weighed (Sartorius-Portable, PT-210, accuracy ± 0.01 g). The contents of *A. granosa* guts were weighed with an accuracy of ± 0.1 mg.

The ratio between detritus and phytoplankton in the food was calculated according to the 'points method' (Swynnerton & Woryhington 1940). The intestine was separated from the flesh, and the gut content index (I %) was calculated by the formula I (%) = $100 \cdot W_f \cdot W_s^{-1}$, where W_f is the food weight in the gut and W_s is flesh weight with intestine.

Phytoplankton identification was based on Ricard (1987), Hendey (1964), Crosby *et al.* (1958), and Wood *et al.* (1959, 1961).

RESULTS

Food composition of blood clams

Detritus was the main component constituting an estimated average of 93 % of the gut content. But the amount of detritus showed considerable variation with sampling time and location. Plankton organisms constituted the rest of the gut contents. Diatoms were dominant with 102 species (Figs. 2A-B).

A total of 104 and 53 plankton species were recorded in the guts of *A. granosa* from Dong Cao and My Long banks respectively (Tab. 1). The species composition of phytoplankton changed with time and location. On the Dong Cao sandy mud banks, diatoms occupied about 90 % of the plankton (93 spe-

Table 1. Plankton species recorded in gut of *Anadara granosa*. From Dong Cao (DC) and My Long (ML) banks.

Taxon	DC	ML	Taxon	DC	ML
I. BACILLARIOPHYCEAE			I. BACILLARIOPHYCEAE (cont.)		
Achnanthes sp.	+	+	*Navicula* sp.	+	
Actinocyclus crassus	+	+	*Nitzschia amphibia*	+	+
Amphora nacilenta	+		*Nitzschia closterium*	+	+
Amphora ostreana	+		*Nitzschia compressa*	+	
Amphora ovalis	+		*Nitzschia frustulum*		+
Amphora perpusilla	+	+	*Nitzschia granulata*	+	
Anomoneis sp.	+		*Nitzschia gracilis*	+	+
Biddulphia dubia	+		*Nitzschia hungarica*	+	+
Biddulphia heteroceros	+		*Nitzschia longissima*	+	+
Caloneis westii	+	+	*Nitzschia lorenziana*	+	
Caloneis sp.	+		*Nitzschia majuscula*		+
Campylodiscus echeneis	+		*Nitzschia navicularis*	+	+
Campyloneis grevillei	+	+	*Nitzschia panduriformis*	+	
Chaetoceros messanensis	+		*Nitzschia punctata*	+	
Coscinodiscus argus	+		*Nitzschia sigma*	+	
Coscinodiscus asteromphalus	+		*Nitzschia* sp.	+	+
Coscinodiscus bipartitus	+	+	*Odontella mobiliensis*	+	
Coscinodiscus concavus	+	+	*Oestrupia* sp.	+	
Coscinodiscus curvatilus	+	+	*Paralia sulcata*	+	+
Coscinodiscus diversus	+	+	*Pinularia viridis*	+	
Coscinodiscus excentricus	+	+	*Pinularia* sp.	+	
Coscinodiscus gigas	+	+	*Plagiotropis lepidoptera*		+
Coscinodiscus jonesianus	+	+	*Planktoniella sol*		+
Coscinodiscus lineatus	+		*Pleurosigma angulatum*	+	+
Coscinodiscus marginatus	+	+	*Pleurosigma elongatum*	+	+
Coscinodiscus perforatus	+	+	*Pleurosigma formosum*	+	
Coscinodiscus radiatus	+	+	*Pleurosigma naviculaceum*	+	
Coscinodiscus subtilus.	+	+	*Pleurosigma normanii*	+	+
Coscinodiscus sp.	+	+	*Rhizosolenia bergonii*	+	
Cyclotella bodanica	+		*Rhizosolenia crassispina*	+	
Cyclotella comta	+	+	*Rhizosolenia setigera*	+	
Cyclotella kuetzingiana	+	+	*Skeletonema costatum*	+	
Cyclotella meneghiana	+		*Suriella ovalis*	+	
Cyclotella striata	+	+	*Suriella ovata* var. *pinnata*	+	
Cyclotella stylorum	+	+	*Suriella robusta*	+	+
Cymbella cistula	+		*Suriella robusta* var. *splendida*	+	+
Cymbella parva var. *hungarica*	+		*Suriella striatula*	+	
Cymbella ventricosa	+		*Synedra ulna*	+	+
Cymbella sp.	+		*Synedra* sp.	+	+
Diploneis bombus	+	+	*Synedra tabulata*	+	+
Diploneis fusca	+		*Thalassionema nitzschioides*	+	
Diploneis litoralis	+	+	*Thalassiosira subtilis*	+	
Diploneis smithii	+	+	*Trachyneis aspera*	+	
Diploneis smithii var. *rhombica*	+		*Triceratium favus*	+	
Ditylum brightwellii	+	+	II. DICTYOCHOPHYCEAE		
Ditylum sol	+		*Dictyocha fibula*	+	
Ethmodiscus roperii		+	III. DINOPHYCEAE		
Eunotia lunarus	+		*Dinophysis caudata*	+	+
Eunotia sp.	+		*Diplosalis lenticula*	+	
Gyrosigma attenuatum	+		*Prorocentrum micans*	+	
Gyrosigma sp.	+		*Protoperidinium brevipes*	+	
Hantschia amphioxus	+		IV. CHLOROPHYCEAE		
Hyalodiscus stelliger	+		*Pediastrum simplex*	+	+
Melosira granulata	+	+	V. PROTOZOA		
Navicula flanatica	+		*Coxliella* sp.		+
Navicula humerosa	+		*Tintinnopsis nucula*		+
Navicula tuscula	+	+	*Tintinnopsis* sp.	+	+
Navicula weisslogii	+		TOTAL NO. OF SPECIES	104	53

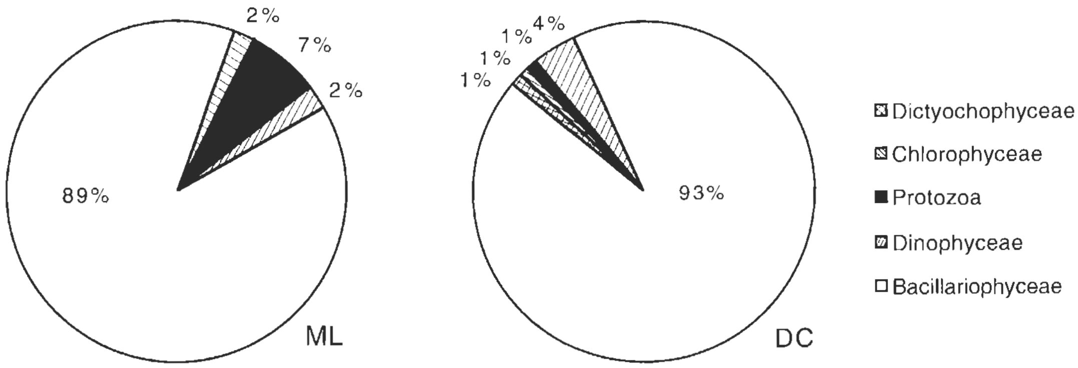

Figure 3. *Anadara granosa*. Plankton composition in guts of specimens from the Dong Cao (DC) and My Long (ML) banks.

cies, Fig. 3). On the My Long banks, phytoplankton species richness was comparatively low with forty species of Bacillariophyceae (diatoms), one species of Chlorophyceae (green algae), and three species of Protozoa (Fig. 3).

Phytoplankton in guts was more abundant in the dry season but the diversity of species was higher in the rainy season. In Dong Cao, the highest diversity of phytoplankton species was found in December, February and March (>40 species, and the lowest in September-October (<20 species). In My Long, more than 30 species were recorded in the guts. The highest diversity of phytoplankton was in February-March.

Species of Protozoa (*Coxliella* sp. and *Tintinnopsis* spp.) were found in guts at My Long but with low frequency. Some diatoms (*Coscinodiscus bipartitus*, *C. divisus*, *Paralia sulcata*, *Cyclotella striata*, *C. stylorum*, *Synedra ulna*, and *Nitzschia navicularis*) dominated and accounted for more than 80 %. Dinoflagellates were few, among them *Prorocentrum micans* was more common in the Dong Cao than in the My Long area (Tab. 1).

Gut content index of blood clams

Fig. 4 shows that the gut content index did not vary much during the study period of 8 months. In particular, the index displayed little variation at Dong Cao in the dry season. Unfortunately, samples were not col-

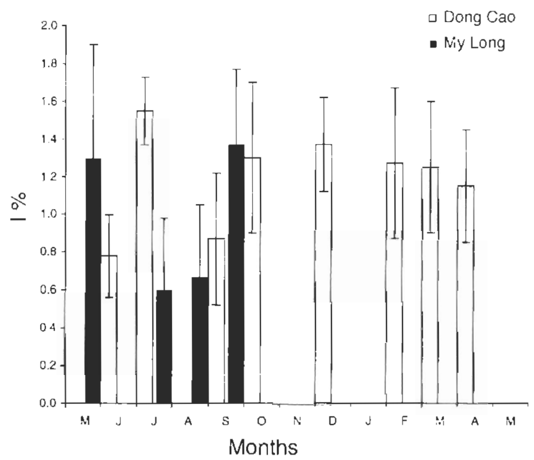

Figure 4. *Anadara granosa*. Gut content index (± 1 S.D.) of specimens collected at the Dong Cao and My Long banks.

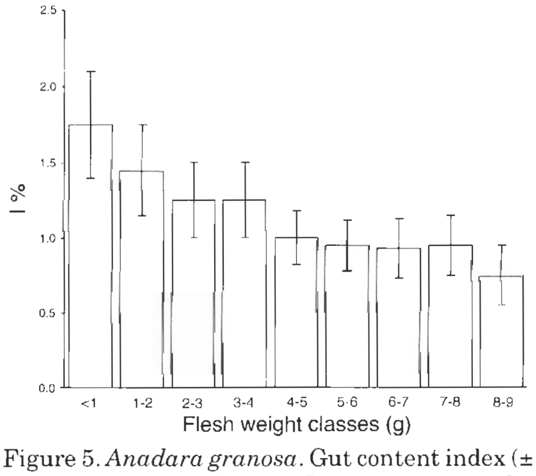

Figure 5. *Anadara granosa*. Gut content index (± 1 S.D.) of weight classes. Specimens from the Dong Cao bank.

lected in the dry season at My Long.

Fig. 5 shows that the gut content index decreased with increasing weights of *A. granosa*. This trend was also observed in specimens from the My Long banks. In the same weight group (<2 g), I % of the Dong Cao cockles reached a value of >1.5, which was higher than that of the My Long cockles.

DISCUSSION

A. granosa are suspension-feeders ingesting a mixture of mineral particles, detritus and plankton. The spectrum of particle sizes is important because the bivalves will discard potential food particles that are too big. Therefore, plankton such as *Cladocera* sp. and *Coscinodiscus gigas*, were rarely recorded in the clam guts. However, some protozoans (*Tintinnopsis* spp. and *Coxliella* sp.) were found.

In this study we recorded a total of 111 plankton species, dominated by 102 species of diatoms. This species composition reflects the plankton composition in the water which again is related to environmental conditions, primarily variation of salinity. The water was very brackish at the My Long bank (ca. 5-20 ‰) resulting in phytoplankton with low diversity (53 species). In comparison, 103 species of plankton were found at the Dong Cao bank characterized by higher salinity. This finding confirms our hypothesis that seasonal variation of primary productivity will influence the feeding activity of *A. granosa*. Sea farming should be more successful in areas with higher salinity.

It is not possible to give data on the weight of individual food items, using the 'points method' to quantify the gut content. The plankton is always mixed with quantities of detritus making it impossible to isolate phytoplankton from the general gut content. Therefore, we only refer to the amount of phytoplankton in estimated percentages.

Altogether, 137 samples of gut content were analyzed. The highest gut content index was about 1.6. In comparison, this value reached 4.0 in the clam *Meretrix lyrata* (Nguyen & Doan 1994). The higher gut content index of *M. lyrata*, studied in the same period and same area as *A. granosa*, is possibly related to *M. lyrata* being more mobile and able to tolerate lower salinity than *A. granosa*. Broom (1985) showed that *A. granosa* will reduce the physiological activity in low salinity. They stop feeding by closing the shells. In addition, *A. granosa* do not move because they are attached with byssus to particles in the soft bottom.

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