DENSITY, BIOMASS AND DISTRIBUTION OF COCKLE, *POTIARCA PILULA* (REEVE, 1844) IN THE BAY OF MISKAM, WEST JAVA, INDONESIA

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ABSTRACT

A dense population of cockle, *Potiarca pilula* (Reeve, 1844), is found in muddy sediment in the estuary of the Bay of Miskam, Panimbang (Banten), West Java. This population was studied seasonally during 1994: May (transitional season I), July (dry season), September (transitional season II), and December (rainy season). Samples were collected along ten transect stations. The mean densities and biomasses ranged from 0.018 to 0.379 individuals m^{-2} and from 0.179 to 2.378 g m^{-2} respectively. High densities (0.379 and 0.313 individuals m^{-2}) and biomass (1.427 and 2.378 g m^{-2}) were found in July (dry season) and September (second transitional season). The lowest values of both density (0.018 ind. m^{-2}) and biomass (0.179 g m^{-2}) were found in December (west monsoon season/rainy season). The distribution of *Potiarca pilula* is restricted to the muddy sediment in water depths ranging from 0.75 - 3 m (low tide).

INTRODUCTION

The cockle *Potiarca pilula* (Reeve, 1844) inhabits estuaries with muddy sediment and is associated with other species of the genus *Anadara* (*A. granosa* (Linnaeus, 1758), *A. indica* (Gmelin, 1791) and *A. inequivalvis* (Bruguiere, 1784)). *P. pilula* is a commercially important species in Indonesia and in South East Asia as well. However, its biology is poorly known because it is less popular than *A. granosa* which has been studied by Pathansali & Soong (1958), Pathansali (1964) and Broom (1982).

The highest population densities of this cockle in Indonesia are found in the Bay of Miskam (West Java), and Tanjung Balai (North Sumatra). The population in Tanjung Balai has declined drastically due to uncontrolled catching and/or degradation of the environment. The same is also found in Panimbang, West Java. The daily catch of the cockle in Panimbang is only 20-30 kg per boat per day, and the lowest catches occur in the rainy season (December-February). To maintain the population of this cockle, the local government has issued catching regulations: fishermen are allowed to catch cockle only by using traditional boat/sailing boats (pers. comm.). In order to facilitate more decisions regarding management and conservation we have studied population density and distribution of

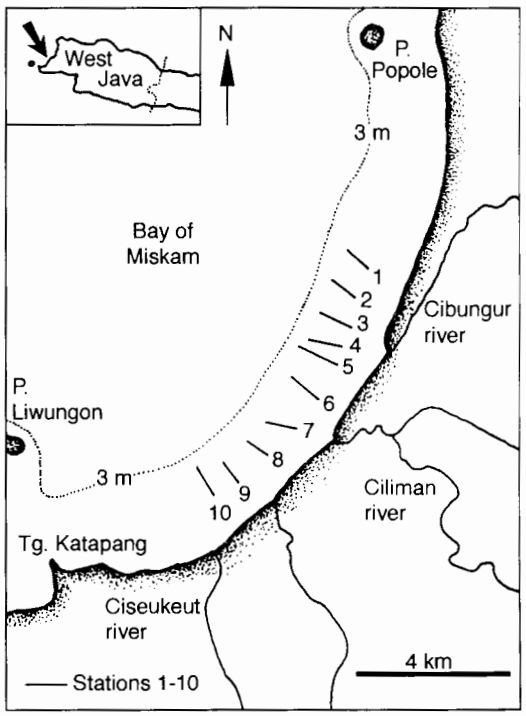

Figure 1. Sampling area and the position of the sampling stations.

Potiarca pilula inhabiting estuarine mud of the Bay of Miskam.

MATERIALS AND METHODS

The *Potiarca pilula* population was studied seasonally in 1994, *i.e.*, May (transitional season I), July (east monsoon season/dry season), September (transitional season II) and December (west monsoon season/rainy season). The study area, 8 km long, is situated from the south-west to the north-east of the Bay of Miskam. Ten transect stations were sampled perpendicular to the shore. The distance between stations was 500 m (Fig. 1). Samples were collected by using a harrow (1.4 m) equipped with a double net with mesh-sizes of 1.0 and 0.5 cm. The harrow was dragged along the sea floor of each transect station from where the cockles occur (500 m from the shore) in the offshore direction over a distance of 800 m. Further offshore the cockles disappeared.

Samples were washed in the laboratory and counted. Biomass was obtained as total fresh weight m^{-2}, and density was calculated as the number of individuals m^{-2}.

Sediment samples were taken from each station for grain size analysis.

RESULTS

Density

Densities obtained in May, July, September and December ranged from 0.018 to 0.379 ind. m^{-2}. The high values (0.379 and 0.313 ind. m^{-2}) were found in July (dry season) and September (second transitional season). In December (rainy season) the density was extremely low (0.018 ind. m^{-2}) (Fig. 2).

Biomass

The biomass values ranged from 0.179 to 2.378 g m^{-2}. The high values (2.378 and 1.427 g m^{-2}) were found in July and September and the lowest (0.179 g m^{-2}) in December (Fig. 2).

Sediment

The sediment of the study area consists of muddy sand and mud. The muddy sand sediment is located from the shore to the offshore over a distance of 500 m (Area I) with the depth of the water ranging from 0.30 to 0.75 m during low tide. This area is dominated by the venerid clam, *Meretrix meretrix* (Linnaeus, 1758). The deeper area (0.75-3.00 m during low tide) has muddy sediment (mean grain size diameter 0.062 mm).

Table 1. Percentage of individuals in three size-classes (mm) of cockle, *Potiarca pilula* collected in May, July, September, and December 1994 in the Bay of Miskam.

	Size classes (mm)		
Month	10.0-19.9	20.0-29.9	30.0-39.9
May	7.63	89.16	3.21
July	5.29	88.05	6.64
September	1.35	85.05	6.64
December	-	69.49	30.50

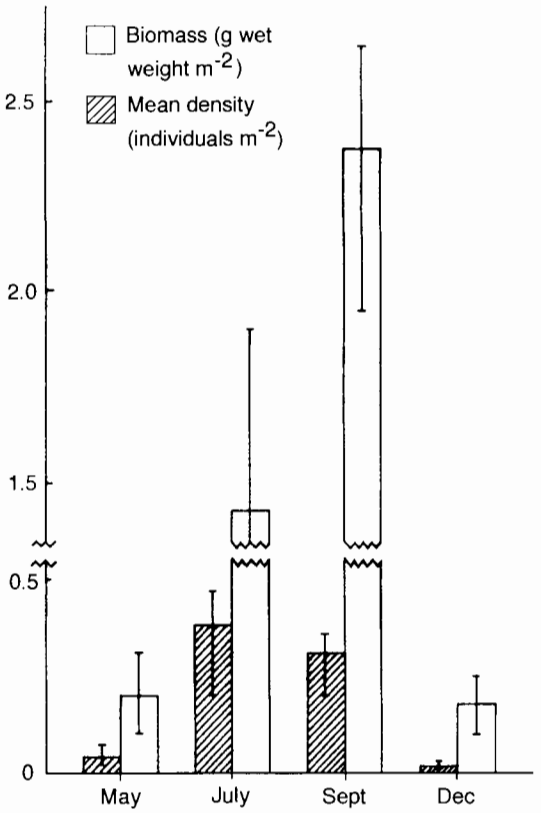

Figure 2. Mean density (ind. m^{-2}) and biomass (g wet weight m^{-2}) of *Potiarca pilula* from the Bay of Miskam.

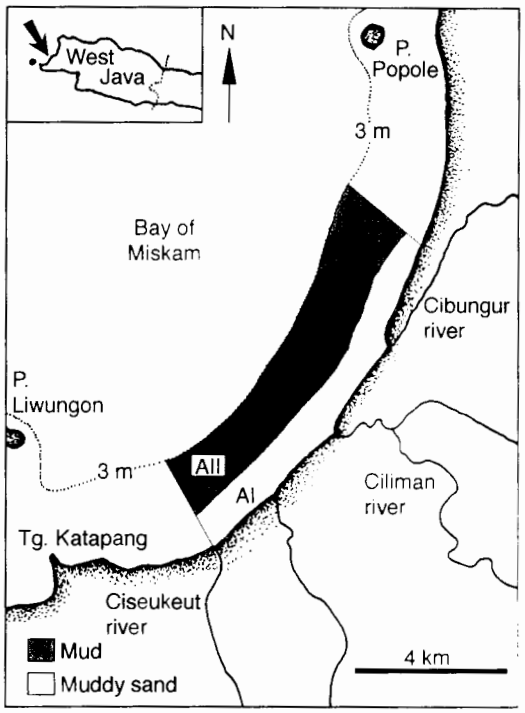

Figure 3. Distribution of *Potiarca pilula* in the Bay of Miskam. AI = area I with *Meretrix meretrix* in muddy sand; AII = area II with *Potiarca pilula* in mud.

Distribution

The distribution of *Potiarca pilula* is restricted to the muddy sediment with a water depth ranging from 0.75 to 3 m during low tide. The cockle bed in the Bay of Miskam is a belt located from the south west to the north east of the bay. This belt lies from Area I in the offshore direction over a distance of 800 m (Area II, Fig. 3).

DISCUSSION

We found a very low mean population density (0.018-0.379 ind. m^{-2}) and biomass (0.179-2.378 g m^{-2}) of the cockle *P. pilula*. *Anadara granosa* belongs to the same subfamily (Anadarinae) and is associated with *P. pilula*. It had a low density (0.014 ind. m^{-2}) and biomass (0.064 g m^{-2}) in the estuarine area of Cirebon (north coast of Java) (Kastoro 1987).

Salinity, dissolved oxygen, type of sediment, availability of food, predators, and pollution affect the density and biomass of benthic animals in shallow waters. Pathansali (1963) found that the optimum salinity range for *A. granosa* in Penang (Malaysia) was between 23.0 and 31.0 ‰ but the salinity of the sea water of natural and culture beds in Panchor Perak (Malaysia) ranged from 14.6 to 30.0 ‰. Lower salinities were tolerated. The salinity of the bed of *P. pilula* in the Bay of Miskam was between 28.6 and 31.1 ‰. This should be within the optimal range for the cockle *P. pilula*.

The amount of dissolved oxygen in sea water varies from 0 to 12.6 mg l^{-1} (Reid & Wood 1976). Clark (1974) found that, in general, a coastal ecosystem needs 6.0 mg l^{-1} of dissolved oxygen as a minimum. Concentrations of dissolved oxygen below 4.0 - 5.0 mg l^{-1} indicate critical conditions. The concentrations of dissolved oxygen of the study area varied from 3.40 to 4.15 ml l^{-1} (Muchtar 1995). It indicates that the study area was approaching oxygen deficiency. This conclusion is supported by black bottom sediment with smell of hydrogen sulphide in stations 4, 5 and 6 (Fig. 1). However, bivalves, especially cockles inhabiting estuarine waters, can tolerate low dissolved oxygen concentrations. Under such conditions, the cockles usually close their valves and survive anaerobically. The anaerobic metabolism causes loss of energy and affects the reproductive activity. The low density and biomass values of *P. pilula* in the Bay of Miskam may be due to such critical condition.

Cockles from the Bay of Miskam consisted of three size classes, *i.e.*, 10-20 mm, 20-30 mm, and 30-40 mm (Tab. 1). The size class of 20-30 mm was dominant and encompassed about 85 to 90 % of the total population. The high density and biomass in July and September were caused by high population densities of the size classes 20-30 mm and 30-40 mm (Tab. 1). This was in accordance with the high amounts of the available food (Fig. 2). The low density and biomass values in December were due to the effect of flooding, caused by the rainy season in the

western part of Indonesia. During the rainy season the north coast of Java is flooded and large amounts of mud are discharged into the estuaries. Based on field observations, it was evident that many cockles died because their gills were clogged with mud.

Kastoro (1995) found that the stomach content of *P. pilula* consisted of bacteria, detritus and pelagic and benthic phytoplankton, and that it was able to obtain food by both deposit and filter feeding. The density of phytoplankton (0.17-1.25 x 106 cells m^{-3}) in the Bay of Miskam was low, twenty times lower than in Jakarta Bay (Arinardi 1995). The same results was also obtained by Thayib (1995). He found that the total number of bacteria from water and sediment samples of the Bay of Miskam were much lower than those from Jakarta Bay. The concentrations of nutrient of this area were also lower compared to the nutrient concentrations in Jakarta Bay (Muchtar 1995).

Among the invertebrates associated with this cockle were crabs (*Leucosia* sp., Crustacea: Brachyura) and sea stars (*Archaster* sp., Echinodermata: Asteroidea) with large numbers of individuals per haul (50-100 ind.). These species prey on juvenile and adult cockles. The density and biomass of *Potiarca pilula* in the Bay of Miskam may be low due to the dense populations of predators. Maurer & Vargas (1984) stated that the density and biomass of benthos in general are low in tropical areas due to the benthic algal production, widely fluctuating salinities, erosion, very high temperatures, and low phytoplankton production.

According to Stanley (1970) *A. granosa* belongs to the group of burrowing bivalves which can penetrate soft substratum by means of pedal locomotion and maintain life completely burrowed (or burrowed in part) in the substratum. The highest density of spat of *A. granosa* in Penang, Malaysia, was recorded in a partially protected part of a shallow bay with a level bottom of fine soft mud. The lowest density was found in the area exposed to wave action where the bottom was undulating with patches of sandy-mud and shells (Pathansali 1963). In addition, Pathansali (1963) found that the areas best suited for culture of cockles are tidal flats with fine soft mud, protected from strong wave action and situated outside river mouths and tidal creeks, with a salinity range between 18 to 30 ‰. *P. pilula* has the same behaviour as *A. granosa*. This cockle burrows to a depth just beneath the mud surface. The estuarine area of the bay of Miskam is a suitable habitat of *P. pilula* because the bottom sediment is an organically rich mud and easy to penetrate.

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