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Ecology of Sandy Beach Bivalves of Pari Island off the Coast of Jakarta Bay, Indonesia

By

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Abstract The following five species of bivalves were recorded from the intertidal sandy beach of Pari Island, northwestern Java, Indonesia: *Atactodea striata*, *Davila plana*, *Latona faba*, *Asaphis violascens* and *Gafrarium tumidum*. The first two species were relatively common, and they were found living in the intertidal zone where the substrate was made up of loose sand grains. They were not found subtidally. The other three species were substantially less frequent or even rare, but they may be found subtidally as well.

On the basis of population density and the frequency of occurrence, *Atactodea striata* was the dominant species. It was found in all transects that were made and one transect even showed a pure population of this species. *Davila plana* was second in abundance. The lateral distribution of *A. striata* displayed a more extended distribution than *D. plana* which showed the tendency of occupying the lower tidal level. As regard the vertical distribution within the substrate, *A. striata* occupied the surface layer, *D. plana* the upper mid-layer and *Asaphis violascens* the bottom layer. The length frequency distribution of *A. striata* took the form of normal, unimodal curve, suggesting that there was no definite spawning seasonality in this species.

Introduction

The intertidal sandy beach of a coral island can be a suitable habitat for some species of bivalves. By intertidal sandy beach in this context is meant the narrow belt of sandy area around a coral island which is uncovered by seawater during low tide. An outstanding character of these bivalves is their ability to cope with desiccation and high temperature that prevail during the low tide. In this period, the habitat is exposed to air and can become very dry and hot, particularly in the mid-sunny day. Despite this seemingly unfavourable condition, some of these bivalves appear to like the habitat better.

In Pari Island, a coral island located several nautical miles north of Jakarta, two species of bivalves, *Atactodea striata* and *Davila plana*, were found very common in the intertidal sandy beach. Most likely the two species are widely distributed all over the tropical islands in the Indo-Pacific region, however, they seem to have escaped the attention of the world malacologists. Information of these bivalves is very limited (e.g. OYAMA, 1977; ZHUANG, 1978; HABE *et al.*, 1982; ROBERTS *et al.*, 1982; MATSUKUMA, 1984; ANSELL, 1985).

Extensive reports on sandy beach bivalves are presently available elsewhere, however, most of them concern primarily with species of the genus *Donax* and almost no mention is made on *Atactodea striata* and/or *Davila plana*. To name a few of these works: COE (1953, 1955), TURNER and BELDING (1957), ALAGARSWAMI (1966), JOHNSON (1966), WADE (1967), TIFFANY (1972), ANSELL and LARGARDER (1980), ANSELL and MCLACHLAN (1980), MIKKELSEN (1981) and DONN *et al.* (1986). In most cases the reports provide some indication that *Donax* have been the dominant component of the bivalve community of the sandy beach concerned.

This paper is an attempt to complement the existing information on sandy beach bivalves, with special reference to *Atactodea striata*, *Davila plana* and *Asaphis violascens*, from Pari Island, Indonesia. The study was focused on three main aspects, i.e. species composition, community structure and spatial distribution.

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Material and Methods

Field works were done by the first author in the months of June, September, December 1986 and February 1987. Each trip lasted for a few days. To obtain appropriate representation, sampling activities were carried out during low tide in the day time.

Transect belts of 0.5 m wide and 0.3 to 0.5 m deep were carefully dug out perpendicular to the coast line. All living bivalves found along the transect belts were collected. Their relative position to the sand surface and the low water line, as well as their shell width and length were recorded.

Environmental parameters studied included: width and slope of the beach, air and sand temperatures, interstitial water and sand grain size. Samples of beach sand were taken from two points at each transect, i.e. at the edge of low water line and at a point on the landward side where the last specimens of living bivalve in each transect was found.

In the laboratory, the sand samples were weighed and then oven-dried at 70°C until the weights were constant. The difference in weight between the wet and dry samples revealed the amount of interstitial water in each sample. The water content is expressed in percentage of dry weight of the sand. After weighing, the dried sand was passed through a series of 8 sieves with mesh sizes of successively 8.0, 4.0, 2.0, 1.0, 0.5, 0.25 and 0.125 mm.

Systematic Notes

Family Mesodesmatidae GRAY, 1840

Subfamily Mesodesmatinae GRAY, 1840

Genus ***Atactodea*** DALL, 1895

Type-species: *Mactra glabrata* GMELIN, 1791 [=*Mactra striata* GMELIN, 1791], by original designation.

Diagnosis: Shell subtrigonal, thick, smooth or sculptured by weak concentric ribs. Submarginal ligament amphidetic, weak; resilium located between strong cardinals on thick hinge-plate. Pallial sinus small.

Remarks: *Atactodea* DALL, 1895, is a new name for *Paphia* LAMARCK, 1799, non ROEDING, 1798.

Atactodea striata (Gmelin, 1791)

(Fig. 6 A–B)

Synonyms: *Mactra striata* GMELIN, 1791, p. 3257; *Mactra glabrata* GMELIN, 1791, p. 3258.

Description: Shell subtrigonal, small, thick. Beak small, opisthogyrous. Outer surface ornamented with weak concentric ribs. Outer and inner colorations white. Amphidetic submarginal ligament weak; resilium small, located just below the beak. Hinge-plate thick with strong cardinals. Anterior and posterior adductor scars nearly equal in size. Pallial sinus small, subtrigonal.

Distribution: Wakayama Prefecture (NSMT=National Science Museum, Tokyo), Amami Islands (NSMT), Okinawa Island (NSMT), Iriomote Island (NSMT) Japan; Saipan (NSMT); Palau Islands (NSMT); Truk Island (MATSUKUMA, 1984); Ponape Island (NSMT); Majuro Island (MATSUKUMA, 1984), Marshall Islands; Zamboanga (NSMT), Philippines; Gulf of Tonkin (DAUTZENBERG & FISCHER, 1905); Gulf of Thailand (LYNGE, 1909); Singapore (LYNGE, 1909); Pari Island (LON= Research and Development Centre for Oceanology, NSMT), Indonesia; Green Island (NSMT), Queensland, Australia; Mergui Islands, Burma (LYNGE, 1909); Sri Lanka

(LYNGE, 1909); Maldive (NSMT); Oman (BOSCH & BOSCH, 1982); Red Sea (LYNGE, 1909; BOUCHET & DANRIGAL, 1982); Mozambique (LYNGE, 1909); Madagascar (OYAMA, 1977); Amirante Islands (MARTENS, 1880), Seychelles (MARTENS, 1880); Reunion (DESHAYES, 1863).

Remarks: For detailed synonym list, see LYNGE (1909) and ZHUANG (1978).

Subfamily Davilinae DALL, 1895

Genus *Davila* GRAY, 1853

Type-species: *Davila polita* GRAY, 1853 [=*Mesodesma planum* HANLEY, 1843], by monotypy.

Diagnosis: Shell smooth, oval. Submarginal ligament amphidetic; resilium weak. Pallial line nearly entire.

Davila plana (HANLEY, 1843)

(Fig. 6 C–D)

Synonyms: *Mesodesma planum* HANLEY, 1843, p. 102; *Mesodesma munda* GOULD, 1851, p. 217; *Davila polita* GRAY, 1853, p. 44; *Mesodesma crassula* (sic) REEVE, 1854, sp. 26, pl. 4, fig. 26.

Description: Shell oval, compressed bilaterally, smooth, thick. Beak small, pointed, opisthogyrous. Outer surface creamy white in color, smooth without fine growth lines. Obscure radial rays umbonally. Submarginal ligament amphidetic, weak; resilium narrow. Anterior adductor scar elongated oval; posterior scar oval. Pallial line nearly entire.

Distribution: Amami Islands (SAKURAI & HABE, 1973), Miyako Island (NSMT), Japan; Hainan Island (ZHUANG, 1978), China; Zamboanga (NSMT), Philippines; Pari Island (LON, NSMT), Indonesia.

Family Donacidae FLEMING, 1828

Genus *Latona* SCHUMACHER, 1817

Type-species: *Latona variabilis* SCHUMACHER, 1817 [=*Donax cuneatus* LINNAEUS, 1758] (ICZN Op. 1057), by monotypy.

Diagnosis: Radials reduced to fine thread-like striae except on posterior slope, which may be rugose. Interior margin smooth or with minute radial wrinkles.

Latona faba (GMELIN, 1791)

(Fig. 6 E–G)

Synonyms: *Donax faba* GMELIN, 1791, p. 3264; *Donax radians* LAMARCK, 1818,

p. 547.

Description: Shell trigonal, thick, bilaterally compressed. Beak small, pointed, opisthogyrous. Outer surface ornamented with weak radial threads and concentric ridges which are rather distinct in posterior slope. Ligament opisthodetic with thin marginal ligament along the antero-dorsal margin. Anterior adductor scar oval; posterior scar subcircular. Pallial sinus deep, rounded.

Distribution: Okinawa Island (NSMT), Iriomote Island (NSMT), Japan; Hainan Island (NSMT), China; Malaysia (NSMT); Pari Island (LON, NSMT), Sorong (BERTIN, 1881), Irian Jaya (BERTIN, 1881), Indonesia; North Coast (NSMT), Queensland, Australia; New Caledonia (BERTIN, 1881); Sri Lanka (OYAMA, 1977); Malabar Coast (BERTIN, 1881), India; Mauritius (MARTENS, 1880; BERTIN, 1881); Madagascar (OYAMA, 1977).

Remarks: For detailed synonym list, see SCARLATO (1965).

Family Psammobiidae FLEMING, 1828

Genus *Asaphis* MODEER, 1793

Type-species: *Venus deflorata* LINNAEUS, 1758, by monotypy.

Diagnosis: Shell elongate oval, slightly gaping behind, with numerous irregular radial threads. Two prominent cardinal teeth in each valve. Parivincular ligament on nymph. Pallial sinus deep, rounded.

Asaphis violascens (FORSSKÅL, 1775)

(Fig. 6 J–K)

Synonyms: *Venus violascens* FORSSKÅL, 1775, p. xxxi, no. 28 (fide YARON *et al*., 1986); *Sanguinolaria dichotoma* ANTON, 1838, p. 4.

Description: Shell medium in size, elongated oval, inflated. Outer surface ornamented with irregular radial ridges, which are nodose in posterior slope. Beak low, orthogyrous. Parivincular ligament located on small nymph. Outer coloration variable, e.g. purple, red, yellow or creamy white. Inner coloration orange umbonally. Posterior cardinal in the right valve and anterior cardinal in the left valve bifurcated. Anterior adductor scar elongated oval; posterior scar subcircular. Pallial sinus deep, widely rounded.

Distribution: Kii Peninsula (Habe, 1977), Amami Island (NSMT), Okinoerabu Island (NSMT), Okinawa Island (NSMT), Ishigaki Island (NSMT), Japan; Penghu Island (NSMT), Hungt'ou Island (NSMT), Taiwan; Palau Islands (NSMT); Truk Island (MATSUKUMA, 1984;) Majuro Island (MATSUKUMA, 1984); Fiji Islands (CERNOHORSKY, 1972); Tonga Islands (NSMT); Tahiti Island (OYAMA, 1977); Hainan Island (SCARLATO, 1965), China; Basilan Island (NSMT), Philippines; Gulf of Tonkin (DAUTZENBERG & FISCHER, 1905); Pari Island (LON, NSMT), Indonesia; Torres

Strait (OYAMA, 1977); Oman (BOSCH & BOSCH, 1982); Trucial Coast (BIGGS, 1973), Persian Gulf; Red Sea (FORSSKÅL, 1775; YARON *et al.*, 1986); Amirante Islands (MARTENS, 1880), Seychelles (MARTENS, 1880; ROST & SOOT-RYEN, 1955); Reunion (DESHAYES, 1863).

Remarks: For detailed synonym list, see Scarlato (1965). ABBOTT (1974) considered that this species is conspecific with *Asaphis deflorata* (LINNAEUS, 1758) from the tropical western Atlantic, but the Indo-Pacific species differs from the Atlantic species by the possession of more irregular and stronger radial ribs.

Family Veneridae RAFINESQUE, 1815

Genus ***Gafrarium*** [ROEDING, 1798]

Type-species; *Gafrarium pectinatum* [ROEDING, 1798], subsequently designated by DALL (1902).

Diagnosis: Shell thick and oval. Outer surface ornamented with nodose radial ribs antero-medially; posterior area with weak oblique ribs. Pallial sinus extremely shallow.

Gafrarium tumidum [ROEDING, 1798]

(Fig. 6 H–I)

Synonyms: *Gafrarium tumidum* [ROEDING, 1798]; *Cytherea gibbia* LAMARCK, 1818, p. 577 (587).

Description: Shell thick, oval, well-inflated; posterior end obliquely truncated. Anterior and middle parts of outer shell surface ornamented with strong, nodose, radial ribs which are bifurcated and intercalated with growth; posterior part with weaker, oblique ribs.

Distribution: Amami Islands (NSMT), Iriomote Island (NSMT), Japan; Taiwan (NSMT); Truk Island (MATSUKUMA, 1984); Negros Oriental (NSMT), Zamboanga (NSMT), Philippines; Pari Island (LON, NSMT), Indonesia; Sri Lanka (NSMT); Amirante Islands (MARTENS, 1880), Seychelles (NSMT).

Remarks: Although SOTTO & COSEL (1982) considered *Gafrarium tumidum* [ROEDING] is one of junior synonyms of *G. pectinatum* (LINNAEUS, 1758), we consider that they are two distinct species. The shell of *G. tumidum* is more inflated and higher than an oval shell of *G. pectinatum*. Outer coloration of *G. tumidum* is whitish with indistinct dark-brown blotches around umbonal area and postero-dorsal margin, while *G. pectinatum* has blotches all over the shell.

Results and Discussion

Habitat condition: Pari Island is the largest of the five coral islands that form

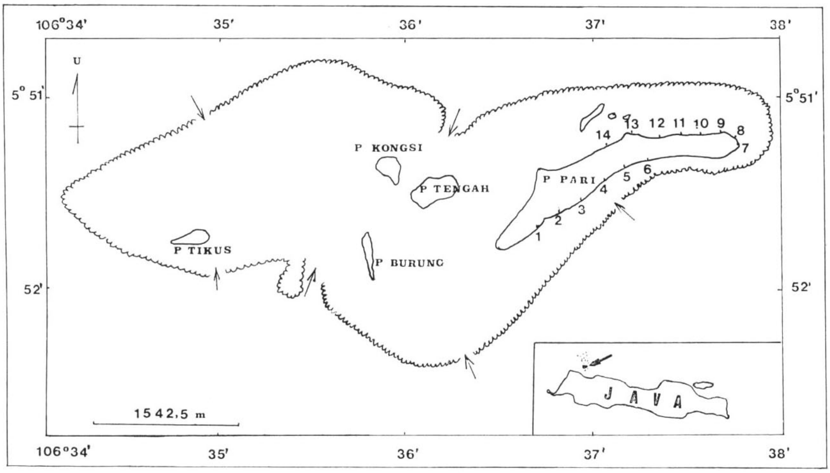


Fig. 1. Pari Island Complex and its associated coral islands. The biggest island in the upper right corner is Pari Island s.s. after which the complex is named. Arabic numbers represent transect belts made during the work.

the Pari Island complex. This complex is encircled by a wall of coral reef which emerges above seawater during low tide, giving it an atoll-like impression (Fig. 1). For the above reason the complex is sometime referred to as "pseudo-atoll." The area between the reef wall and the island proper is made up of shallow sand flat, some small lagoons, sea grass beds, coral patches and a limited community of coral-associated mangroves. The field works have been restricted to Pari Island (s.s.).

The largest propotion of the beach of Pari Island was composed of coral sand; a small portion was made up of coralline boulder and a small other was composed of a muddy sand. Being completely surrounded by a reef wall, the beach was practically sheltered from wave action, hence was categorically a low energy sandy beach.

Fourteen transect belts distributed along the sandy beach were worked out (Fig. 1). From this figure it becomes apparent that the distances between transect 1 and transect 14, as well as between transect 7 and transect 6 (clockwise) are much larger in comparison to those between other successive transects. This is due to the differing physical condition of the two beach sections. In the former, the substrate was muddy sand grown by a limited mangrove community, whereas in the latter it was made up of coralline boulders. Both types of habitat were not favourable for the sandy beach clams, hence no transect was made in these particular sections of the beach.

The intertidal sandy beach around Pari Island ranged between 5 and 8 m wide, with a slope of between 5° and 7°. The bigger the slope, the narrower will the sandy beach be. During a hot sunny day the sand surface temperature may reach 34°C. Water temperature ranged from 27°C to 30°C, while water salinity fluctuated between

Table 1. Grain size composition of the beach sand at the saturated points near low water line (A) and that at the upper tidal level where the bivalves were still found to exist (B).

Transect No.	Water content (%)	Percentage dry weight of grain size (mm diameter)							
		8	4	2	1	0.5	0.25	0.125	R
7A.	23.50	0.12	0.43	2.63	38.00	45.90	1.63	0.70	0.60
B.	12.10	0.29	0.51	5.80	54.10	37.00	2.00	0.20	0.10
8A.	26.10	0.70	7.16	20.00	41.00	24.60	3.26	1.81	1.43
B.	10.10	0.74	1.81	11.00	48.45	25.45	8.90	3.12	0.60
9A.	21.80	3.61	4.80	12.65	29.38	21.49	14.35	10.85	2.86
B.	13.70	2.48	2.10	6.12	38.80	41.31	9.22	4.95	1.00
10A.	20.10	1.62	2.48	13.78	50.75	14.00	7.00	6.97	3.33
B.	7.50	0	0.47	2.57	46.57	47.83	1.35	0.65	0.21
11A.	21.80	0.50	1.72	6.30	19.18	27.63	20.00	19.21	4.78
B.	7.60	0	0.18	1.60	33.58	57.67	5.10	1.49	0.35
12A.	20.30	4.19	2.71	8.82	3.12	37.55	15.19	22.67	5.72
B.	13.80	0.58	0.69	2.87	28.00	21.20	8.00	6.84	1.67
13A.	16.70	0	0.50	5.27	27.40	54.70	9.00	2.10	1.00
B.	5.05	0.35	0.30	2.80	24.90	59.00	5.50	4.00	2.90
14A.	26.06	0.05	1.20	3.30	2.40	60.30	10.00	3.20	1.30
B.	11.94	0.80	1.80	4.40	17.70	58.00	10.40	3.70	3.10
Mean: A	22.05	1.35	2.63	9.09	27.65	35.77	10.05	8.44	2.62
B	11.50	0.65	0.98	4.65	36.51	43.41	6.30	3.12	1.24

Note: R=residual

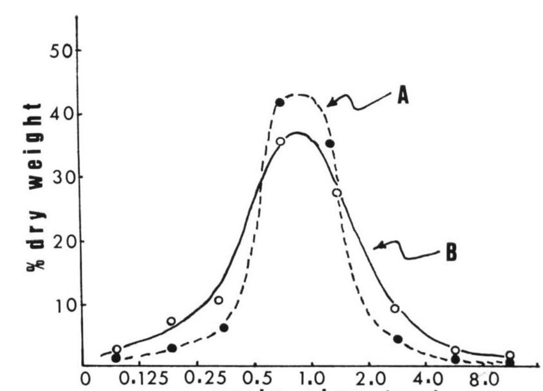


Fig. 2. Mean grain size composition of the Pari Island beach sand at the saturated point (A) and at the unsaturated point (B). Lines were fitted by eye.

27.0 and 30.0‰.

Table 1 and Fig. 2 represent the grain size distribution of the beach sand, sampled from the well populated transect belts, i.e. transect 7 to transect 14, The graph suggests that the beach sand was composed predominantly of sand grains which were retained by 0.5 and 1.0 mm mesh size. Jointly they accounted for approximately 63.4% at the saturated point (A: near water edge) and 79.9% at the unsaturated point (B: at the landward side where the last living bivalve was found in the transect). Meanwhile the water content ranged from 26% in the former to as low as 5% in the latter.

Species composition: The extreme condition of the intertidal sandy beaches limits the number of marine species inhabitants. Dryness, high temperature, physical disturbance and sometime also extreme salinity fluctuation are among the natural hazards these animals have to cope with. Thus only those well adapted for the situation will survive. In the intertidal sandy beach of Pari Island, five species of bivalve have been identified, i.e. *Atactodea striata* (GMELIN), *Davila plana* (HANLEY), *Latona faba* (GMELIN), *Asaphis violascens* (ANTON) and *Gafrarium tumidum* [ROEDING]. Of these five species, only *Atactodea striata* and *Davila plana* may be categorized as true intertidal sandy beach dwellers, for the reason that they were not found in the subtidal area. What prevent them from occupying the subtidal area, is an interesting topic to be studied.

Community structure: Table 2 summarizes the community structure of the bivalves of the sandy beach of Pari Island. It appears from the table that none of the 14 transect belts harboured all the five species recorded. For instance, transect 6, the richest of all transects, contained only three species.

Among the species collected, *Atactodea striata* constituted the dominant species. Not only was it the most abundant, it was also found in all the 14 transects made. Out of 145 specimens of bivalves collected from transect 4, no less than 131 specimens were *Atactodea striata*. The rest were *Davila plana* (10) and *Gafrarium tumidum* (4). Transect 1 even showed a purely *A. striata* population.

Davila plana was second in abundance. However, compared with *A. striata* the population density was much smaller. Nonetheless, in one of the 14 transects made (transect 10, Table 2) there were more *D. plana* than there were *A. striata*. In the case of *Asaphis violascens*, it was relatively widely distributed. In terms of population density, on the other hand, the population was small. *Latona faba* and *Gafrarium tumidum*, by contrast, were relatively rare. The former was found in two transects (numbering 1 and 2 specimens), and the latter was in three transects (numbering 1, 3 and 4 specimens respectively).

On the basis of shell length, *Atactodea striata*, *Davila plana* and *Asaphis violascens* were represented by various age classes. The shell length ranged 6.55–24.15 mm, 10.25–39.40 mm and 7.90–54.85 mm, respectively. The most well represented population was *A. striata* from transect 4 (Fig. 3). The histogram shows a normal distribution with the mode at length class 16–18 mm. This form of distribution suggests two possibilities, i.e. (1) the population is a mixture of different age classes and (2) the bivalve spawns all year round, resulting in a population of varying ages. In the tropical waters the possibility of the latter is usually the general rule. Such character

Table 2. Distribution, percentage of occurrence and population density (indiv./m^2) of sandy beach bivalves of Pari Island.

Transect No	*Atactodea striata*	*Davila plana*	*Latona faba*	*Asaphis violascens*	*Gafrarium tumidum*
1.	10.4	—	—	—	—
2.	10.5	—	—	3.5	—
3.	14.8	—	—	0.8	—
4.	37.4	2.9	—	—	1.1
5.	13.1	0.4	1.8	—	—
6.	37.1	5.6	—	1.6	—
7.	6.8	1.1	—	—	—
8.	1.8	3.8	—	3.0	0.5
9.	3.5	0.9	—	1.7	—
10.	1.8	10.3	0.2	0.2	—
11.	1.1	—	—	0.6	0.2
12.	5.4	1.1	—	1.5	—
13.	4.5	7.8	—	0.3	—
14.	4.9	4.9	0.4	—	—
Percentage occurrence (%)	100	71.43	21.33	64.29	21.42
Mean density (indiv. per m^2)	10.93	2.75	0.17	0.94	0.13

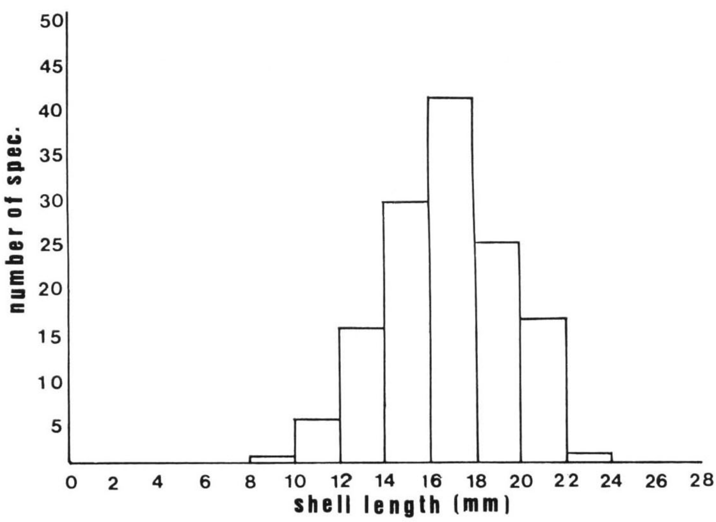


Fig. 3. Size frequency distribution of *Atactodea striata* from the sandy beach of Pari Island (transect 4).

is found not only in mollusks, but also in many other invertebrates.

Spatial distribution: The pattern of spatial distribution of sandy beach bivalves is basically three dimensional, i.e. horizontal, lateral and vertical. The first term, horizontal distribution, is used to denote distribution along the shore line, the second,

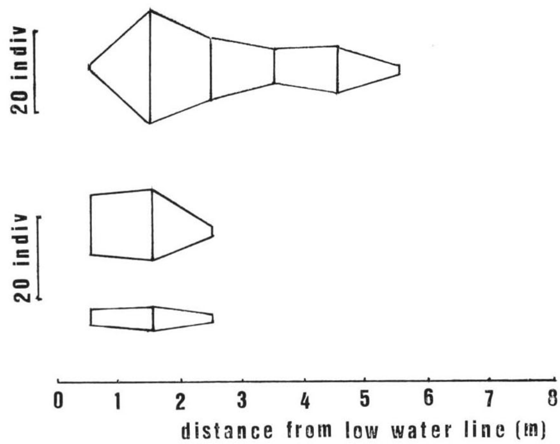


Fig. 4. Kite diagrams of the lateral distribution of three species of sandy beach bivalves from Pari Island. *Atactodea striata* (top); *Davila plana* (center); *Asaphis violascens* (bottom).

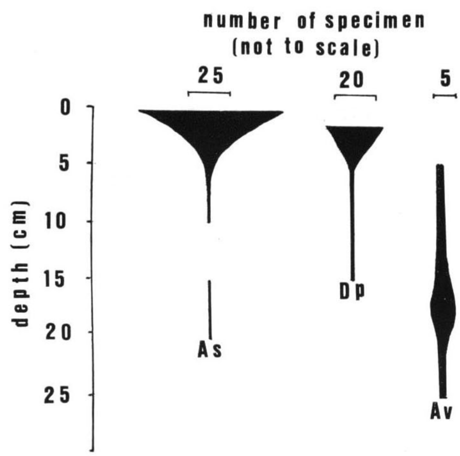


Fig. 5. Diagramatic representations on the vertical distribution of three species of sandy beach bivalves from Pari Island. As, *Atactodea striata*; Dp, *Davila plana*; Av, *Asaphis violascens*.

lateral distribution, to indicate distribution across the beach, i.e. the land-sea direction, and the third, vertical distribution, is to show the distribution in term of depth in which the animal burry themselves in the sandy substrates. This study approach is considered applicable bearing in mind that none of the bivalves collected, is a tidal migrant.

One way to measure the extent of horizontal distribution is by looking at the percentage of occurrence index. The greater the index, the more extensive is the distribution of the species concerned. The maximum value of the index being 100%, meaning the species is found in all samples. However, this index suggests only the areal coverage of the distribution. It does not say anything about the quantitative parameter which will throw some light on the abundance of the species. For this purpose another type of population index may be used, namely index of abundance or density, which is expressed as number of specimens per unit area. Table 2 summarizes the percentage of occurrence and the population density of sandy beach bivalves of Pari Island.

It is evidence from Table 2 that *Atactodea striata*, *Davila plana* and *Asaphis violascens* constituted the important components of the intertidal sandy beach bivalves in this island. This is clearly suggested by the high value of the percentage of occurrence, i.e. 100%, 71.43% and 64.29%, respectively.

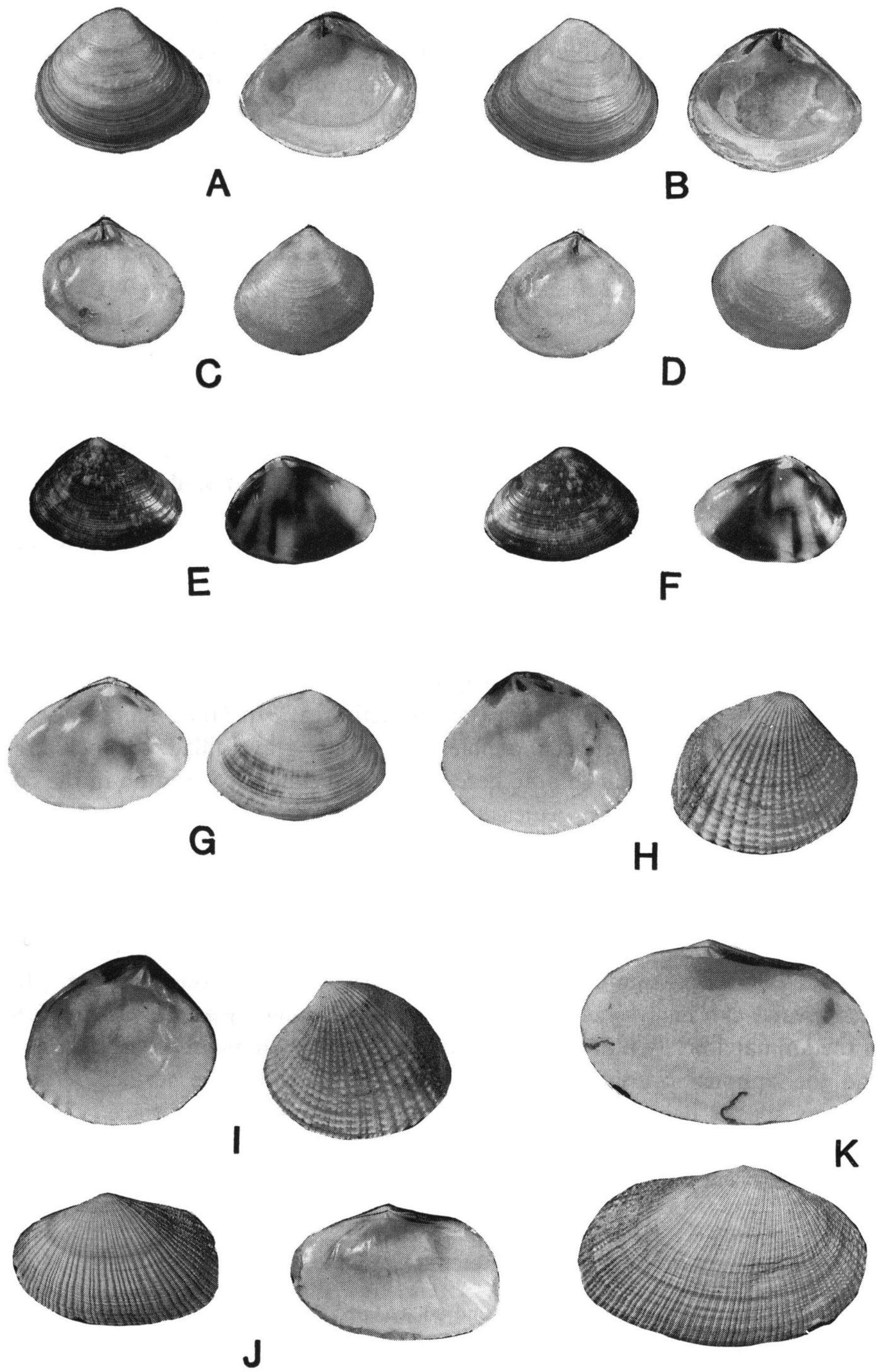
Figure 4 shows the kite-diagrams of the lateral distribution of *A. striata*, *D. plana* and *A. violascens*. The diagrams provide some information on the characteristic of the population. Firstly, the population of *A. striata* substantially outnumbered the other two species. Secondly, *A. striata* suggested a more extended distribution landward as compared to the other two. Thirdly, *D. plana* and *A. violascens* were distributed at the lower tidal level. The highest concentration of *A. striata* was found between one to two meters from the low water line landward. Naturally, the amount of interstitial water in the sand constitutes one factor that plays a role in determining the lateral distribution of the bivalves. This water makes the sand beach damp, cool and humid, a pra-condition for the bivalve to survive. The minimal value of the interstitial water at the unsaturated point was 5%.

The results of the vertical distribution analysis revealed that *A. striata* was distributed at depths ranging from 0 to 4 cm, *D. plana* between 3 and 8 cm, while *A. violascens* were found at the deeper layer, i.e. between 13 and 20 cm. Thus in terms of vertical distribution in the substrate, *A. striata* was concentrated more or less at the surface layer, *D. plana* at the upper middle layer, while *A. violascens* at the lower middle to the bottom layer. As for *Gafrarium tumidum*, the four specimens were collected from the sand surface down to 10 cm deep. The distance from the low water line landward ranged between 30 and 160 cm. Meanwhile, the three specimens of *Latona faba* were collected several cm below the surface at the lower tidal level.

Concluding Remarks

In Hong Kong ANSELL (1985) reported *Atactodea striata* to inhabit sheltered

Fig. 6. Sandy beach bivalves of Pari Islands off Jakarta Bay, Indonesia. A–B, *Atactodea striata* (GMELIN, 1971), length 21.0 mm; C–D, *Davila plana* (HANLEY, 1843), length 18.2 mm; E–F, *Latona faba* (GMELIN, 1791), length 18.3 mm; G, *Latona faba* (GMELIN, 1791), length 21.5 mm; H–I, *Gafrarium tumidum* (ROEDING, 1798). length 40.0 mm; J. *Asaphis violascens* (FORSSKÅL, 1775), length 29.8 mm; K, *Asaphis violascens* (FORSSKÅL, 1775), length 51.0 mm.


A
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sandy beaches in association with *Latona faba*. The interesting thing to note here is that the association was found to be restricted with *L. faba* and not with other donacids. PICHON (1967, in ANSELL, 1985) recorded an abundant of *Atactodea glabrata* (=*A. striata*?) sharing a sheltered sandy beach with *L. faba* in the Malagasy Republic. ALAGARSWAMI (1966) noted a dominant *L. faba* on the beach of Mandapan, Gulf of Manaar, India.

From the reports cited above, it may be inferred that very likely *L. faba* is a common species in the Indo-Pacific region. So far as Pari Island is concerned, however, this generalization may have to be taken with some reserve. Only three specimens of *L. faba* have been collected throughout the whole exercise. This is very rare indeed in comparison with the population of *L. faba* in Mandapan, which reached a density of between 89 to 217 clams per square meter (ALAGARSWAMI, 1966).

One possible explanation for the extraordinarily low population of *L. faba* could be the occurrence of severe population fluctuation in this species. COE (1955) reported that *Donax gouldi* on the California coast undergoes population resurgents at varying interval from two to fourteen years. During resurgent period a density of up to 20,000 clams per square meter may be recorded, and then in the next period the whole population may disappear. Whether or not such fluctuation of *L. faba* occurs on the sandy beach of Pari Island, it requires a long series of specific study.

Asaphis violascens was well distributed in Pari Island, notwithstanding the low density. However, this bivalve is not a specific intertidal sandy beach dweller, bearing in mind that it is also found living in the subtidal area. In Hong Kong this species was found burried deep between cobbles or within gravel-filled bedrock crevices (BRITTON, 1985). One point to note here is the occurrence of variation in the coloration of the shell in this species. At least three colorations were noted during this work, i.e. white, reddish brown and violet.

The occurrence of *Gafrarium tumidum* in the intertidal sandy beach poses an interesting question. Normally this species lives burried in a semi-compact muddy sand. It positions itself just below the substrate surface so that the siphonal opening and the shell margins around it are levelled with the surface of the substrate. In this way the bivalve can easily filter the water from the surrounding area. During feeding, when the animal actively pumping the water in and out, the mantle and shell margins around the siphonal opening are readily seen on the substrate surface. In other words, this species habitually lives immediately below the sand surface. Therefore, the finding of this species in the deeper layer of the intertidal area seems contradictory to their life habit and hence merits further study.

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