

NOTES ON THE *TEREBRALIA PALUSTRIS*
(GASTROPODA) FROM THE CORAL
ISLANDS IN THE JAKARTA BAY AREA

by

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ABSTRACT

A dense population of *Terebralia palustris* occurs in many coral islands in the Jakarta Bay area, living usually in association with mangrove communities. A preliminary study on this gastropod has been carried out in two islands, Pulau Rambut and Pulau Burung, which concerned with population density and structure, length-weight relationship, rate of growth, and the effect of prolonged desiccation and starvation. Analyses were made on the properties of the substrate including soil component, organic matter content, pH, salinity, and daily temperature fluctuation at the soil's surface.

No less than 130 specimens per square meter were counted in the most densely populated place in Pulau Rambut. The length frequency distribution showed a bimodal histogram, and the length-weight relationship was represented by the following equation:

$$W = 0.00024 L^{2.5534}$$

where : W = dry weight in gram; L = length in millimeter.

A number of young individuals were confined in a fenced area for growth study. During the first four-month they gained an average additional length of 10 mm. Out of water and starved this gastropod may survive for three months.

INTRODUCTION

The mud dwelling gastropod *Terebralia palustris* is widely distributed in the Indo-Pacific region from East Africa to India, Malaysia, Indonesia, the Philippines, and North Australia (BENTHEM JUTTING 1956). It occurs usually in association with mangrove swamps. Some aspects of its biology have been studied by a number of workers (SEWELL 1924, ANNANDALE 1924, RAO 1938).

A dense population of *Terebralia palustris* exists in many coral islands in the Jakarta Bay area. They serve as a cheap source of animal protein for the local population.

A preliminary study on this gastropod mollusc has been carried out in two islands, namely Pulau Burung and Pulau Rambut. The study includes:

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ecological condition, population density and structure, local distribution, rate of growth, and the effect of starvation and desiccation on the weight and mortality of the animal.

METHODS

Experimental works were carried out on samples obtained from Pulau Burung. A few hundred specimens of all sizes were collected, cleaned, and wrapped up in aluminum foil, and then oven-dried at 100°C for about 48 hours. By this time the dry weight was more or less constant. Each specimen was weighed on a top-loading balance to the nearest hundredth of a gram. The length of the shell was measured with a pair of vernier caliper to the nearest hundredth of a millimeter. A log-scale regression of dry weight on length was then computed.

A number of young specimens measuring between 10 mm and 40 mm were confined in a fenced area and had their length measured after 4, 8, and 11 months for growth study. Analyses were made on the condition of the substrate, namely : soil fraction, organic matter content, pH, and salinity. Daily temperature fluctuation at the mud surface were recorded once a month at 3-hour interval for 24 hours.

Three batches of *Terebralia palustris* were subjected to starvation and desiccation. The first batch (360 specimens) was placed in a wire basket, kept in the field station on the island, and checked monthly for dead animals. The second batch (90 specimens) was placed in plastic containers in the laboratory and checked monthly. The third batch (21 specimens) was numbered, placed individually in a carton box, weighed every week to record the rate of loss of weight.

A rough estimate on the population density was made by counting all specimens found in a known area. The area selected was part of a wider area that showed a more or less homogenous distribution. No attempt was made to analyse it statistically. To obtain an idea on the local distribution across the swamp, a transect belt was established on each island extending from the edge of the dryland to the end of the mangrove stand.

RESULTS

Ecological Condition

Pulau Burung constitutes one of the five small islands that make up Pulau Pari complex, situated about 35 km northwest of Jakarta (Figs. 1 & 2). A reef rampart develops around the complex, enclosing a wide intertidal

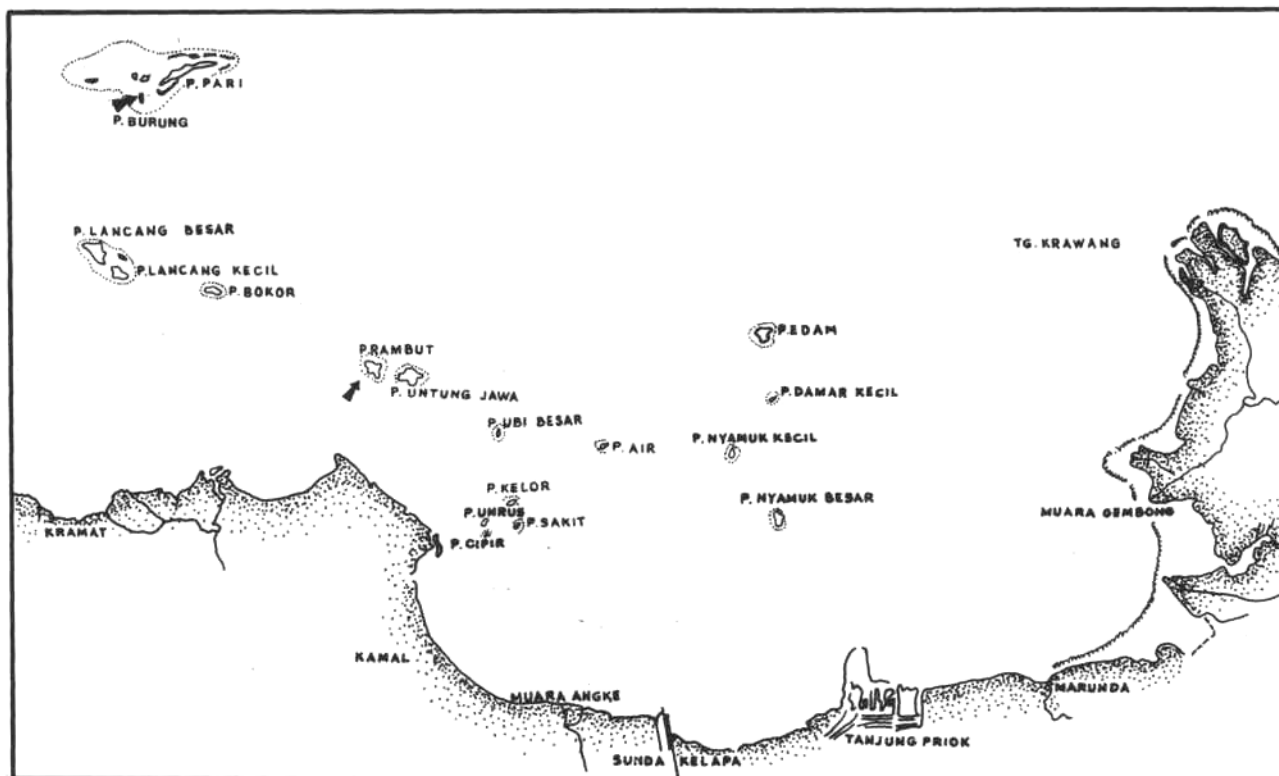


Figure 1. Map of Jakarta Bay showing the locations of Pulau Rambut and Pulau Burung (see arrows).

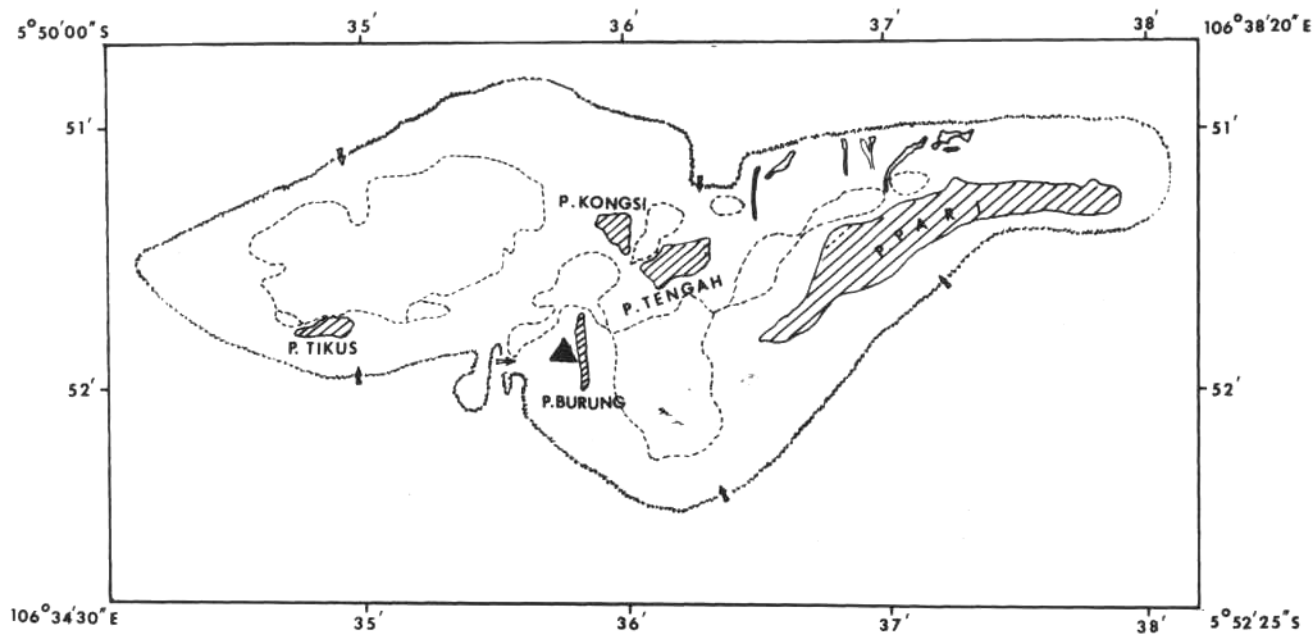


Figure 2. Chart showing Pulau Burung within Pulau Pari complex. Solid triangle represents the area in which *Terebralia palustris* occurred.

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flat, some lagoons, and the islands *per se*. A large portion of the reef rampart is exposed above water at low tide, leaving behind shallow pools on the lee side which are abound with various species of algae, corals, echinoderms, molluscs, and other invertebrates.

Being derived from coral formations, the islands are all flat, less than one meter above mean sea water. Pulau Burung is one of two minor islands in the complex. It forms an elongated piece of land-not exceeding 100 m in length and 3 m in width —, extending in the north-south direction. The soil consists essentially of sand, amounting to 90% and over (Table I). Samples Nos. 2, 3, 4, and 5 were obtained respectively from the north, west, south, and east sides of the island; whereas sample No. 1 was taken from an area close to the coastline on the west side where it showed thicker mud deposit. No significant difference in the nature of the soil represented by the samples was apparent, except for sample No. 1 which, apart from having low pH value and lower percentage of sand, it also showed higher organic matter content.

Table I. Some physical and chemical properties of the soil of Pulau Burung.

Sample	Texture (%)			pH	Organic Matter (%)	
	Sand	Silt	Clay		C	N
1	90	7	3	7.5	3.15	0.15
2	96	2	2	8.4	0.35	0.04
3	94	4	2	8.1	0.28	0.03
4	95	4	1	8.2	0.35	0.03
5	94	4	2	8.1	0.95	0.05

Figure 3 shows the daily fluctuation of bottom temperature at the place where soil sample No. 1 was taken. During the period of observation the temperature ranged from 25.3°C to 38.6°C. The hour and state of the day, and the state of tide at that particular hour, determined the magnitude of fluctuation. At low tide in a bright noon the temperature reached the highest level, *e.g.* on midday 25 March 1976. The reverse was true at low tide early in the morning, where temperature dropped down to the lowest level, *e.g.* in October 25 and November 26, 1975.

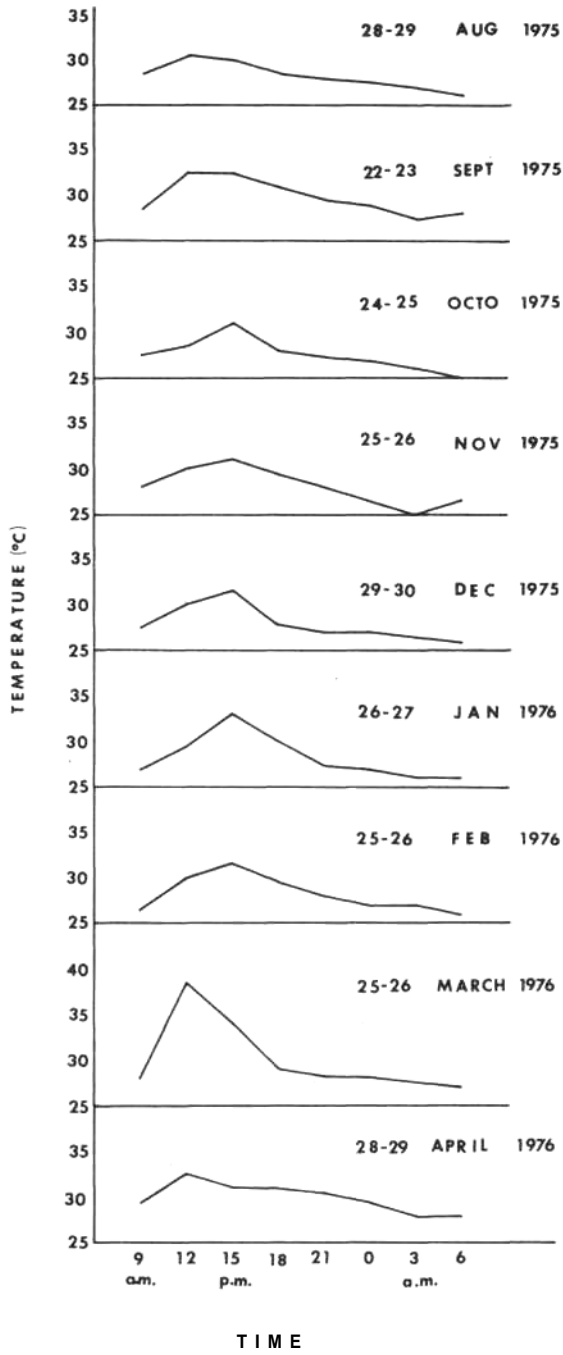


Figure 3. Daily bottom temperature fluctuation in Pulau Burung.

The salinity of the water in the area, however, was more or less stable. It ranged between 31.22% and 33.26%.

A few trees and shrubs grew on the available small piece of land, namely *Casuarina equisetifolia*, *Pandanus* sp., *Hibiscus tiliaceus*, *Caesalpinia crista*, *Canavalia maritima*, *Cyperus javanicus*, *Ipomoea pes-caprae*, and *Ipomoea tuba*. The coastal area was grown by mangrove vegetation, dominated by *Rhizophora stylosa*. Other species were only found sparsely, namely *Sonneratia alba*, *Rhizophora apiculata*, and *Avicennia marina*. Sea grass communities, *Thalassia hemphricii*, *Halophila ovalis*, *Halodule tridentata*, *Enhalus acoroides*, occupy the seaward fringe of the mangrove formation (SOEMO - DIHARDJO *et al* in press).

Pulau Rambut is officially recorded to have an area of 25 hectares, but KARTAWINATA & WALUJO (personal communication) estimated it to be about 56 hectares. It lies approximately 20 km northwest of Jakarta (Figs. 1 & 4). Like the other islands in this area, it also developed from a coral formation, hence is low and flat. A dryland coastal forest occurs in the middle of the island. Big trees such as *Sterculia foetida*, *Disoxylum caulistichyum*, *Chisocheton pentandrus*, and *Adenanthera pavonina* were commonplace here. Surrounding the dryland coastal forest was the mangrove swamp. In the north and west sides, the swamp extended up to the coastline. In the south and east sides, however, it was cut off from the open sea by dry sand flat, on which developed the familiar pes-caprae formation with *Ipomoea pes-caprae*, *Spinifex littoreus*, *Sesuvium portulacastrum*, and *Canavalia maritima* as the main vegetations.

KARTAWINATA & WALUJO (personal communication) recognized three mangrove communities across the swamp, *i.e.* *Scyphiphora hydrophyllacea* — *Lumnitzera racemosa* community, *Rhizophora mucronata* community, and *Rhizophora mucronata-Rhizophora stylosa* community. They believed the zonation was related to the habitat conditions. The *Scyphiphora hydrophyllacea-L. racemosa* community occurred on firm muddy sand overlaying old coral formation. It was located in the inland part of the swamp bordering the dryland coastal forest and was rarely inundated by tidal water. *Rhizophora mucronata* community occurred on muddy soil rich with organic matter and it was affected by daily tide. *Rhizophora mucronata-R. stylosa* community developed on the coral flat in the intertidal area where the substrate was made up largely of sand and coral fragments with very low organic matter content.

The mangrove stand in the *Scyphiphora hydrophyllacea-Lumnitzera racemosa* community was not dense, and numerous isolated water patches occurred on depressed grounds among the trees. Daily temperature fluctua-

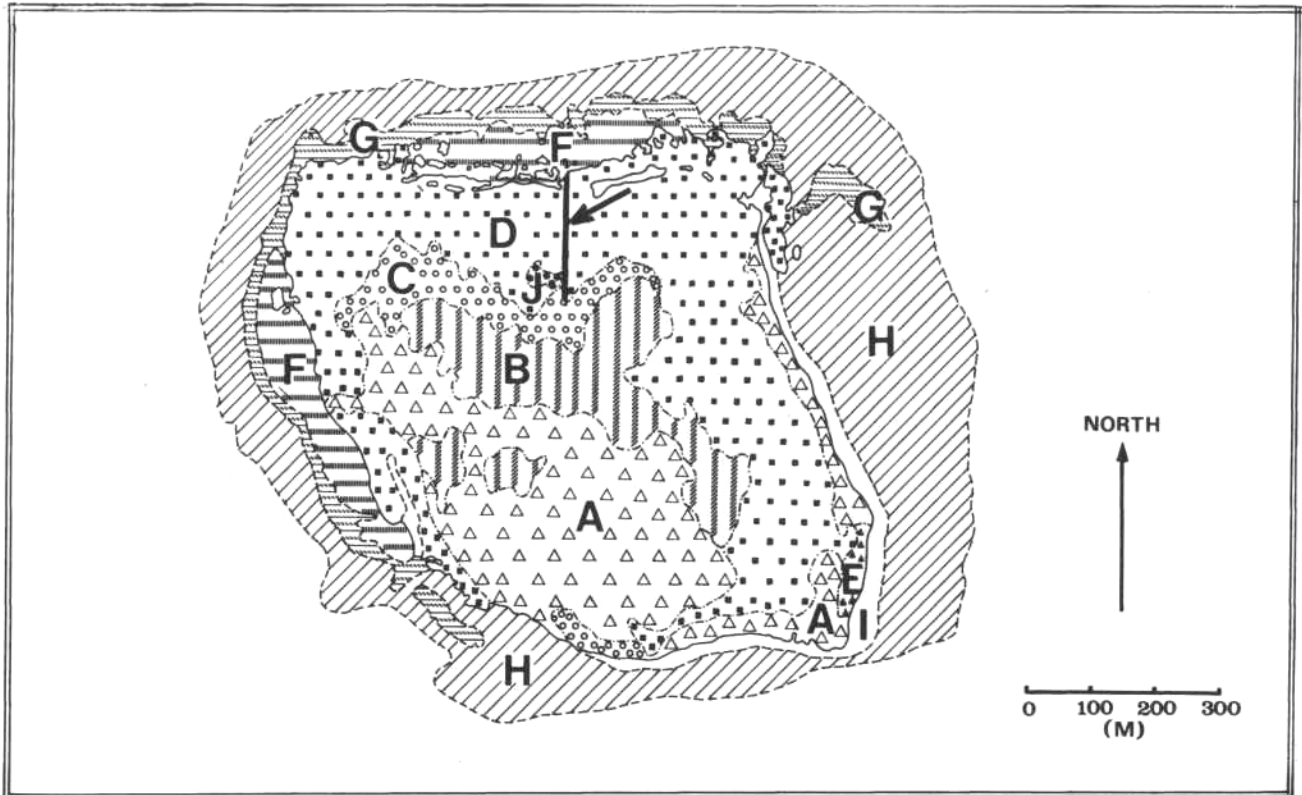


Figure 4. Diagrammatic representation of Pulau Rambut showing its vegetation and surroundings (Modified - after KARTAWINATA and WALUJO). The transect is indicated by the solid straight line (see arrow)

A = dryland forest, B = dryland secondary forest, C = *Scyphiphora Pempis* community, D = mangrove forest, E = *Ipomoea pes-caprae*, F = *Thalassia - Enhalus* community, G = lagoon, H = coral reef, I = sandy beach, and J = Clear-out mangrove forest.

tion at the soil surface ranged from 25°C to 42°C. The salinity of the water patches varied from 36‰ near the dryland coastal forest to 30‰ nearer the coast. Analyses of soil samples from 4 localities along the north-south transect indicated an appreciably higher percentage of silt, clay, and organic matter; a lower percentage of sand, and a lower pH value as compared to those of Pulau Burung (Table II).

Table II. Some physical and chemical properties of the soil of Pulau Rambut

Sample	Texture (%)			pH	Organic Matter (%)	
	Sand	Silt	Clay		C	N
1	6	53	41	6.5	38.47	1.39
2	79	9	12	7.7	1.60	0.13
3	64	26	10	7.4	1.49	0.43
4	90	6	4	7.6	1.15	0.10

Population Structure and Local Distribution

In Pulau Burung *Terebralia palustris* lived in a restricted area on the west side of the island under the shade of a pure stand of *Rhizophora stylosa*. Figure 5 shows the kite diagram of population structure of the gastropod found living in a 2 x 30 m transect belt across the mangrove stand. The transect was sub-divided consecutively into three portions of 10 m length, and each kite diagram represents the number and length frequency distribution of the gastropod from each portion in the order indicated.

Several information may be drawn from the above kite diagrams. For one thing, the diagram shows that the population consisted largely of small individuals, ranging in size between 10 mm and 85 mm. For the other, the greater part of the gastropods occupy the 0 — 10 m zone. Also in this zone did most of the young individuals exist. Toward the sea the density gradually diminished. On a limited space in the vicinity of the 0 — 10 m zone of the transect, a large concentration of young specimens was noted. At least 120 individuals have been counted from a unit area of 0.25 m². No adult specimen was seen in that particular area, nor in the places adjacent to it. The area showed a much thicker mud deposit in comparison with any other part of the island.

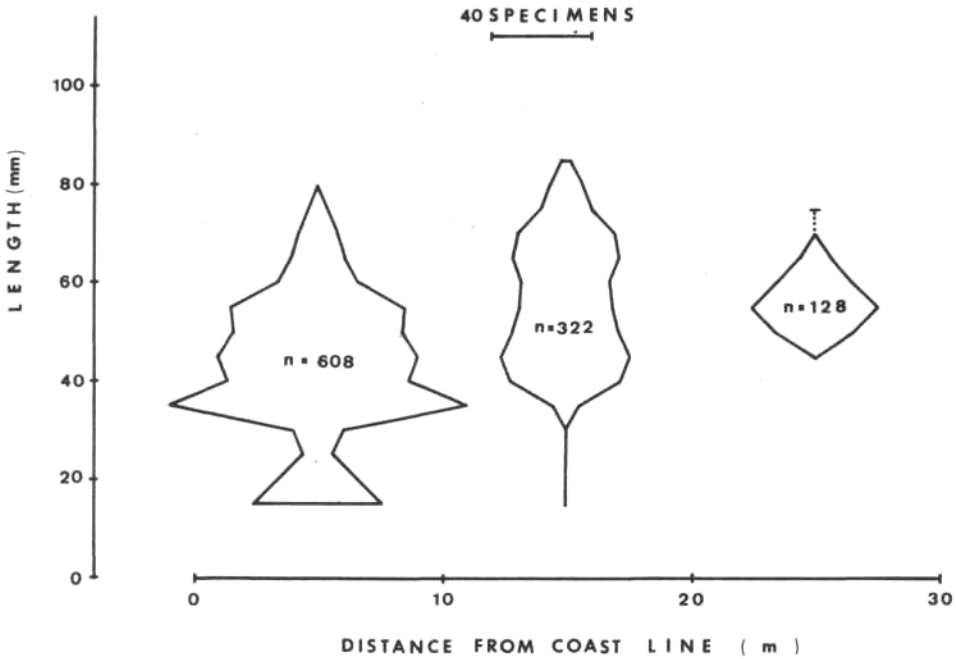


Figure 5. Population structure of *Terebralia palustris* from Pulau Burung.

Computation of the length-weight relationship gave result to the following equation :

$$\text{Log } W = -3.6149 + 2.5534 \log L$$

or in its original measurements

$$W = 0.000243 L^{2.5534}$$

where : W = dry weight in gram; L = shell length in milimeter.

The correlation coefficient for the relationship is given by 0.9799 which, for a sample of 300 specimens, is highly significant (Fig. 6). Also calculated was the relationship between shell weight and fresh meat weight. For the range of 10 — 30 gram shell weight, the relationship is linear and may be represented by the equation :

$$Y = 5.29 + 0.266 X$$

Where : Y = shell weight in gram; X = fresh meat weight in gram.

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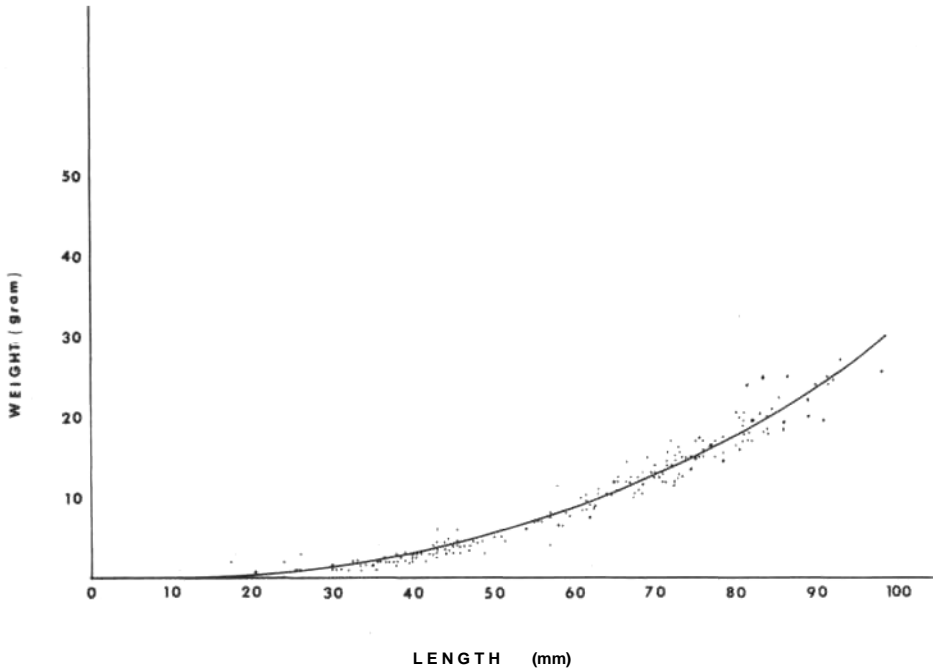


Figure 6. Length - weight relationship of *Terebralia palustris* from Pulau Burung.

The correlation coefficient for the relationship is 0.54, which is significant at 1% level for a sample of 21 specimens (Fig. 7).

The *Terebralia palustris* in Pulau Rambut were distributed all over the mangrove swamps. In the *Scyphiphora hydrophyllacea-Lumnitzera racemosa* community these gastropods occurred in the isolated water patches as well as on the dry places which were inundated by sea water only during the high spring tide. However, they seemed to like the water patches better, as was apparent from the greater number of individuals per unit area in the water patches than in the dry places. The substrate in this community was composed of coral fragments with insignificant mud deposit, except in the water patches where a thin layer of mud deposit usually covered the depressed bottom.

After crossing the *Scyphiphora hydrophyllacea-L. racemosa* community the transect passed through a relatively wide pool. This pool, besides being shallow and muddy, was devoid of mangrove trees. A large concentration of *T. palustris* occurred on the periphery of the pool where mangrove trees were available. The open space of the pool was only sparsely populated

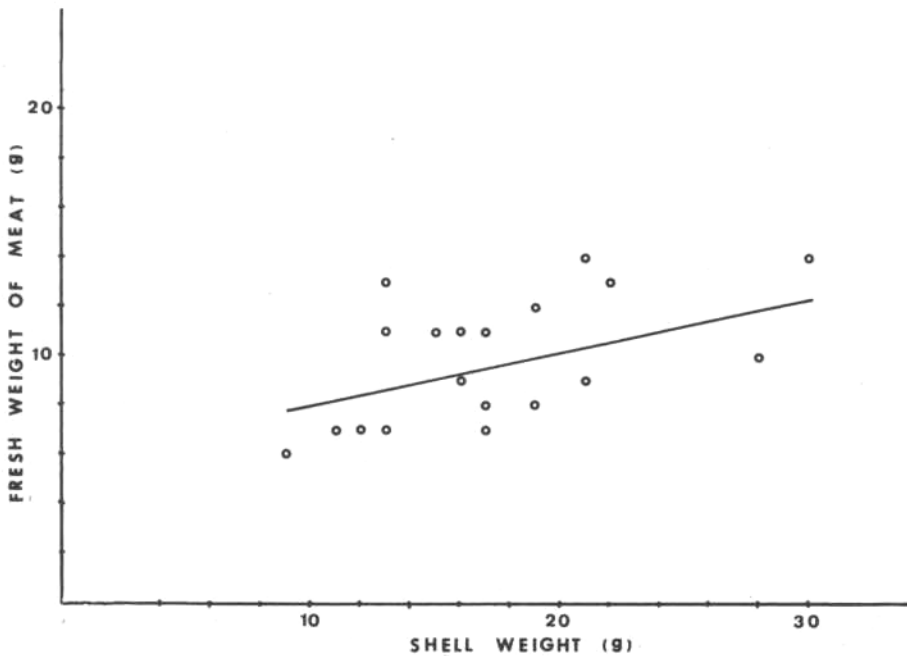


Figure 7. Fresh weight of meat plotted against shell weight for *Terebralia palustris* from Pulau Burung.

by this species of gastropod, but was heavily infested with other potamidid species, *Telescopium telescopium*.

An average of 130 specimens per square meter was counted from the most densely populated area. The shell ranged from 40 to 130 mm in length and showed a bimodal distribution (Fig. 8). The modes lay successively in the 77.5 and 122.5 mm classes.

After the pool, the transect belt traversed the *Rhizophora mucronata* community. The mangrove stand in this community was so dense that it was difficult to pass through. *Terebralia palustris* occupied the space between the mass of stilt roots on the black muddy substrate. They were distributed all over the zone but were less dense in the mid section.

The last portion traversed by the transect was the *R. mucronata-R. stylosa* community. It formed the outermost zone of the mangrove swamp and thus was in direct contact with the open sea. No live *Terebralia palustris* was found in this zone.

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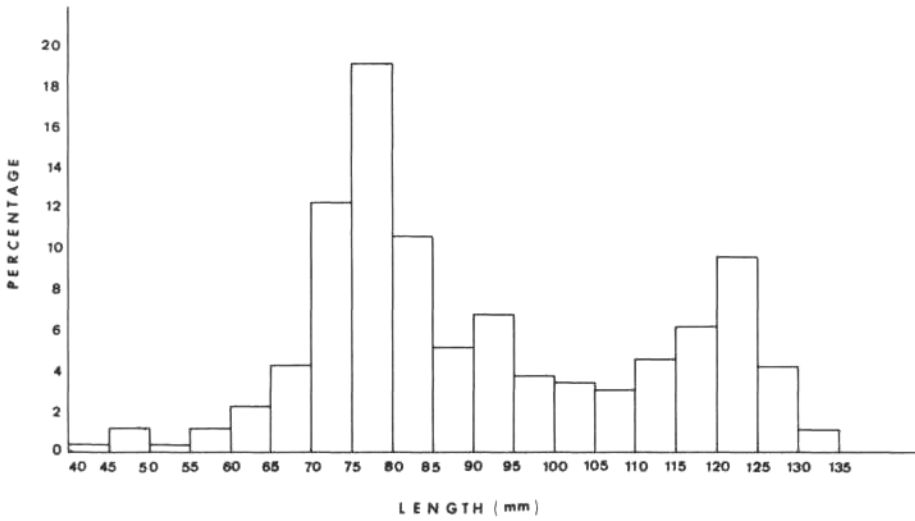


Figure 8. Length – frequency histogram of *Terebralia palustris* from Pulau Rambut.

Rate of Growth

The graphs in Fig. 9 show the length frequency distribution of the confined specimens for the indicated months. The first graph (August 1976) represents the length frequency distribution at the start of the confinement; while the second, third, and fourth represent those after 4, 8, and 11 months respectively. The shift of the graph's mode is taken to indicate the growth in length during the particular period (RAO 1938).

It is apparent from the graphs that during the first 4-month period in the fenced area the gastropod attained an average additional length of about 10 mm. During the second 4-month and the last 3-month periods, the additional length gained was 5 mm each.

Effects of Desiccation and Starvation

Figure 10 shows the rate of mortality of two batches of *Terebralia palustris*, starved and kept out of water. Graph A represents the mortality rate of the batch placed in plastic containers in the laboratory, and graph B represents the mortality rate of the other batch kept in a wire basket in the field station. It appeared that the mortality rate between the two batches was substantially different. In the laboratory the gastropods survived up to the second month. In the third month mortality began to occur and went

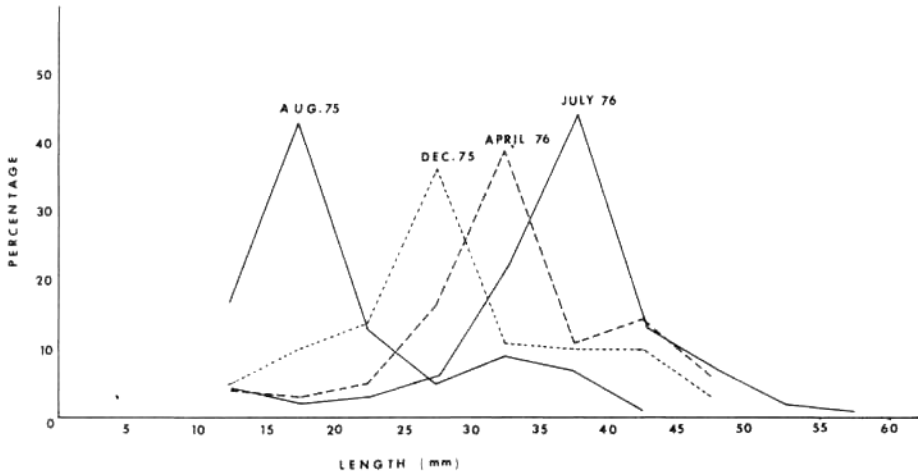


Figure 9. Length - frequency distributions of confined *Terebralia palustris* for the month indicated.

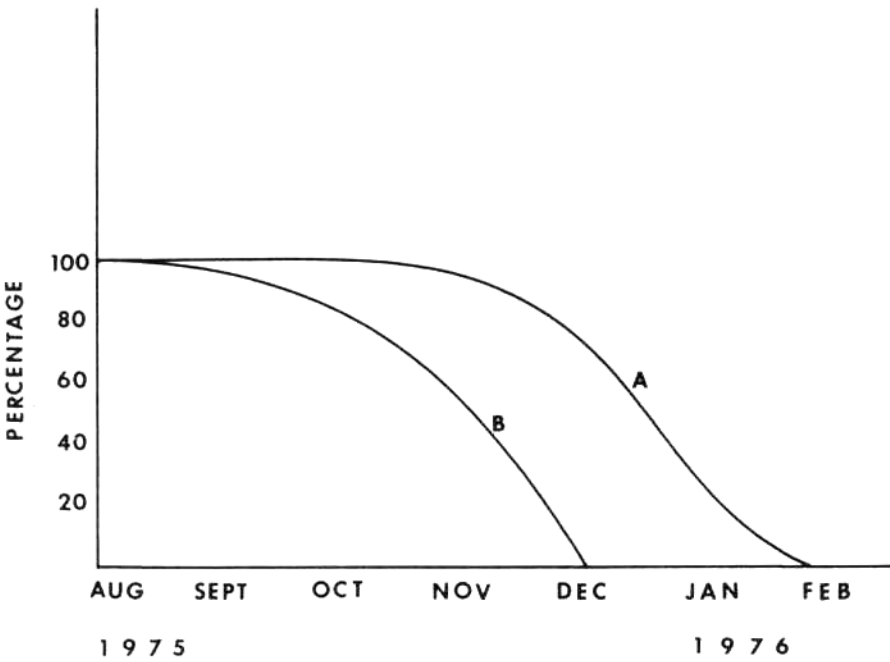


Figure 10. Effects of desiccation and starvation on the mortality of *Terebralia palustris*; A - in the laboratory; B - on the island.

on at an increasing rate. About five and a half months later all specimens were found dead. As for the other batch, mortality began to take place at the beginning of the second month. After 4 months all the animals died. Determining whether or not an individual being dead proved to be an uneasy matter in this experiment. The shyness of the animals had kept them to remain inside the shell throughout the experiment. Therefore, the way to do it was to make use of the characteristic smell of a decaying animal. It is admittedly not very satisfactory but is considered to suffice the present purpose.

The rate of loss of weight for a number of animals is shown in Fig. 11. It is expressed in percent of fresh weight of the soft part. The experimental

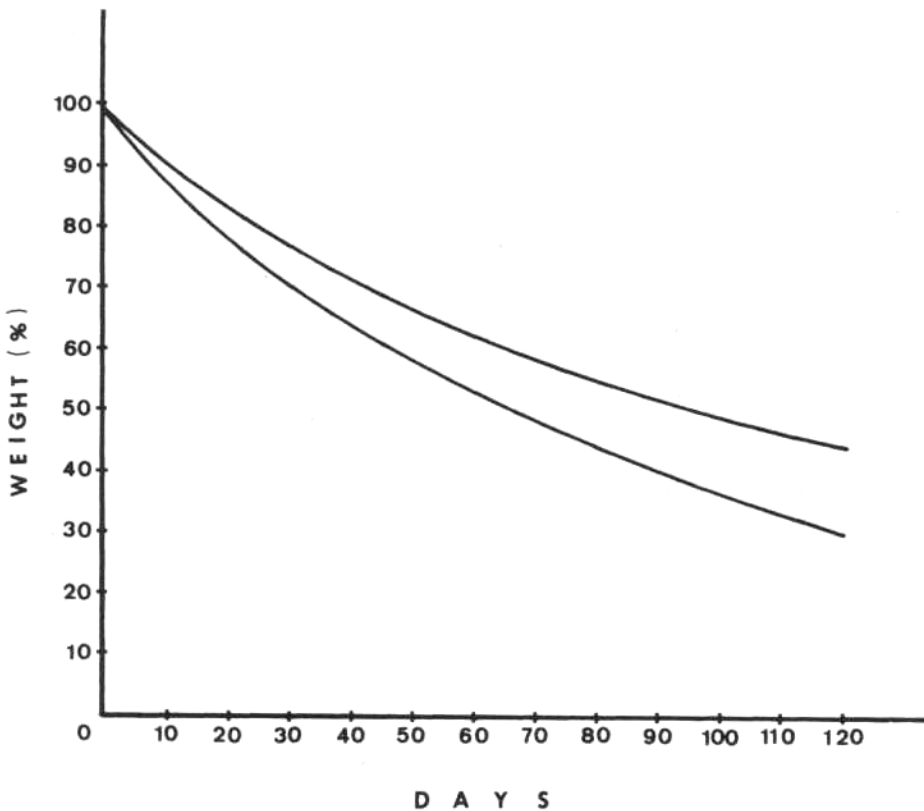


Figure 11. Effects of desiccation and starvation on the weight of *Terebralia palustris* (shell weight excluded). The area within the two lines indicates the extent of variation of the percentage values from 21 experimental animals.

animals were kept in a cartoon box in the laboratory. The two lines were fitted by eye passing the points of highest and lowest values, thus indicating the range of the percentage values. During the first 10 days the loss of weight was high, about 15%. The rate of loss decreased with time. At the end of the 4-month period the animals weighed about 25% of the original weight.

DISCUSSION

Three potamidid gastropods, *Terebralia palustris*, *T. sulcata*, and *Telescopium telescopium*, dominate the mangrove swamp of Pulau Rambut. They are obviously well adapted for this type of habitat, where severe physical factor fluctuation is a daily routine. The simple experiment has shown *T. palustris* to survive at least one month desiccation and starvation. Against starvation alone this gastropod can stay alive for 4 months (RAO 1938). Compared to what they have to endure in the above experiment, the environmental stress occurring in their natural habitat is really mild.

There were noticeable differences between the population in Pulau Burung and Pulau Rambut. In the former the population was composed of young and small individuals, measuring from 8.0 mm to 85.0 mm, whereas in the latter it was composed of larger individuals, measuring between 40.0 mm to 130.0 mm. One possible cause for this size difference is man's intervention. From time to time the local people come to Pulau Burung to collect these gastropods for food. Other factors such as substrate type or food supply may also play a part. As shown in Table 1 and Table 2, the sand component and the organic matter contents of the two islands differed significantly. The *T. palustris* of Pulau Rambut never have to undergo any human intervention, due to the island's status as sea bird sanctuary; this being so these gastropods have the chance to grow to their maximum size. Another contrasting fact was the lack of individuals smaller than 40 mm in Pulau Rambut, the group that formed the most abundant component in Pulau Burung (Fig. 5). It would appear that, by one reason or other, recruitment must have failed during the past few years in Pulau Rambut.

It is interesting to note that the distribution of *T. palustris* in Pulau Burung was restricted to a small area on the west side of the island. This is in a way peculiar since no appreciable ecological difference occurred between the east and west coasts of the island. Furthermore the island is only very small. The only physical barrier noticeable in the island is the sand flat in the north and south sides. However, a sand flat should not be too hard for *T. palustris* or its offsprings to pass through.

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During the work it was noticed that *T. palustris* seemed to prefer living under the canopy of the mangroves. This was more apparent in Pulau Rambut where the open shallow pool was hardly populated by this species. Instead, the pool was densely colonized by *Telescopium telescopium*. It could be that *T. palustris* avoids direct sun rays, while *Telescopium telescopium* is able to tolerate it. Thus each of them enjoys a special territory of its own, a necessary condition for these two sympatric species to thrive.

Toward the open sea the population density declined. Neither *Terebralia palustris* nor *Telescopium telescopium* were found living at the swamp bordering the sea. The reason might be constant water stirring by the surf and wave keeps the organic matter in suspension, thus making it unavailable for the gastropods as food.

In the Andamans *T. palustris*, RAO (1938) recorded a 2 mm growth in 6 weeks for young specimens ranging from 2 mm to 14 mm in length. This figure is about the same compared to that obtained from the Pulau Burung specimens. By the age group method, RAO (1938) estimated an average yearly growth of 20 mm for the Andamans *T. palustris*. One thing to be noted in Fig. 9 is the presence of individuals belonging to the 10 — 15 mm size class in each graph. The likely explanation for it would be the entry of some tiny individuals into the fenced space through small holes in the fence structure.

The differing mortality rate between the specimens kept in the laboratory and those kept in the field station is possibly due to the relatively slower rate of loss of water and body liquid in the specimens kept in the laboratory. In any case, it is evident that *T. palustris* is endowed with a great capacity to withstand severe environmental stresses. This special property undoubtedly is the key factor for the success of this species in colonizing the mangrove swamps.

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