STUDIES IN THE SEA TURTLES — II

The Nesting Site Characteristics of the Hawksbill and the Green Turtles

by

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RINGKASAN

Tempat peneluran dua jenis penyu Indonesia dipelajari. Dalam penelitian ini, garis tengah dan keseragaman butir pasir tempat peneluran dihitung. Warna pasir dan profil pantai diidentifikasi. Bahan dasar tempat peneluran ini berupa pasir koral dan kadang-kadang tercampur dengan cangkang dan akar. Bahan-bahan inilah yang mungkin menjadi faktor penentu bagi penyu untuk memilih tempat yang tepat untuk bertelur. Bagi penyu hijau topografi yang berupa pantai landai juga menentukan pemilihan tempat bertelur.

SUMMARY

The nesting sites of hawksbill and green turtles from Indonesia were examined. Effective diameter and coefficient uniformity of their sand nest were calculated. Color of sand nest and profiles of beaches were identified. The main materials were composed mostly of coral sand and sometime mixed with shells or roots. These were probably the influencing factors for these species in choosing suitable place for spawning. Although green turtle had nearly the same requirement for heteregenous material composition for their nesting sites as it was for the hawksbill, the topography of flat beaches has been known to be required by the green sea turtles nesting in Indonesia.

INTRODUCTION

There are five genera with seven species of sea turtles living in the world. The sea turtles are endangered species, and a few detailed studies have been made on the ecology of nesting site selection. Some authors have noted that the sea turtles nest on sand beaches over banks (Bustard and Greenham, 1969), while the logger head prefer sands of finer texture than leatherback (Hughes *et al.*, 1967). Carr *et al.* (1966) reported that for the hawksbill, nesting takes place periodically or sporadically on all undisturbed Carribean shores, both insular and mainland, where ever there is suitable sand beach. Stancyk and Ross (1978) concluded that in the absence of disturbance or competition, green turtles have a wide tolerance of physical conditions on their nesting beaches. With regard to behavior, Pearse (1926) denoted that

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all of the animals resort to particular breeding places. By their behavior the animals tend to find the environment that is best suited for their peculiar types of activities. Breeding is one activity of sea turtles, which choose suitable sand beach. The objective of this studies is the identification of the characteristics of sea turtle nesting sites. These will cover the profiles of beaches, color, diameter and type of sand nest, coefficient uniformity of sea turtles nesting site and a few quantitative studies under natural environment.

MATERIALS AND METHODS

Field work was conducted during the period of September 6 to 30, 1980. The islands of the main nesting grounds of hawksbill turtle *(Eretmochelys imbricata)* and green turtle *(Chelonia mydas)* were visited by means of air plane and speed boat. These two species of turtles nest mostly on several island groups (Fig. 1). On Gosong Batang Lompo, there was only one nest found. A large number of nests of hawksbill turtles was found on the beaches of Semut Kecil, Panjang Kecil and Sepa Kecil islands. Among the nesting grounds visited, Beland, Tukung and Kalonambang island beaches were the most productive. As many as 15 new nests were found. However, the largest concentration of nesting ground was found on Penyun Island, West Sumatra.

From each nest visited, two samples were collected. Sands were collected from the surface and the bottom of egg chambre, which was 30-35 cm deep for the hawksbill and 40-50 cm for the green turtle. Samples of sands were bagged in polyethelene containers, together with all data required (Table 1).

Twenty two samples were collected and analyzed in the laboratorium. Data analyses were based on methods by Baiby (1959/and Croxton (1953).

Water content of the sands was determined through several steps. First step was by drying the sands under the sun for two days. Two samples were used as control. After sun drying process, the samples were dried in an oven at $80^{\circ}C$ for two hours. The weight loss after drying is considered as the water content of the sands.

Particle size was determined by passing 415 — 543 grams of sands through a series of sieve with the following sizes of meshes : 4.00 mm; 2.83 mm; 2.00 mm; 1.68 mm; 1.19 mm; 1.00 mm; 0.84 mm; 0.59 mm; 0.42 mm; 0.35 mm; 0.21 mm; and 0.149 mm. Sieving was done for 36 minutes. The fraction of sands retained on each sieve were weighed in gram

Table 1. Effective diameter (D_{10}) and coefficient uniformity ($D_{60} : D_{10}$) of hawksbill and green sea turtles nesting sites.

Species	Position	Value	abundance of nests		
			$\leqslant 2$	3 — 9	$\geqslant 10$
E. imbricata	On the surface	D_{10}	0.56	0.287 0.274 0.26 ± 0.08 0.224	0.350 0.310 0.385 0.30 ± 0.10 0.183 0.249
	In the bottom	D_{10}	0.58	0.195 0.316 0.27 ± 0.17 0.301	0.360 0.284 0.365 0.30 ± 0.07 0.226 0.270
	On the surface	$\frac{D_{60}}{D_{10}}$	1.55	1.578 1.751 1.73 ± 0.34 1.852	1.860 2.448 2.877 2.27 ± 0.51 2.191 1.947
	In the bottom	$\frac{D_{60}}{D_{10}}$	1.90	1.815 1.930 1.82 ± 0.26 1.723	2.033 2.271 2.677 2.51 ± 0.86 3.889 1.685
C. mydas	On the surface	D_{10}	—	—	0.28
	In the bottom	D_{10}	—	—	0.31
	On the surface	$\frac{D_{60}}{D_{10}}$	—	—	—
	In the surface	$\frac{D_{60}}{D_{10}}$	—	—	1.90

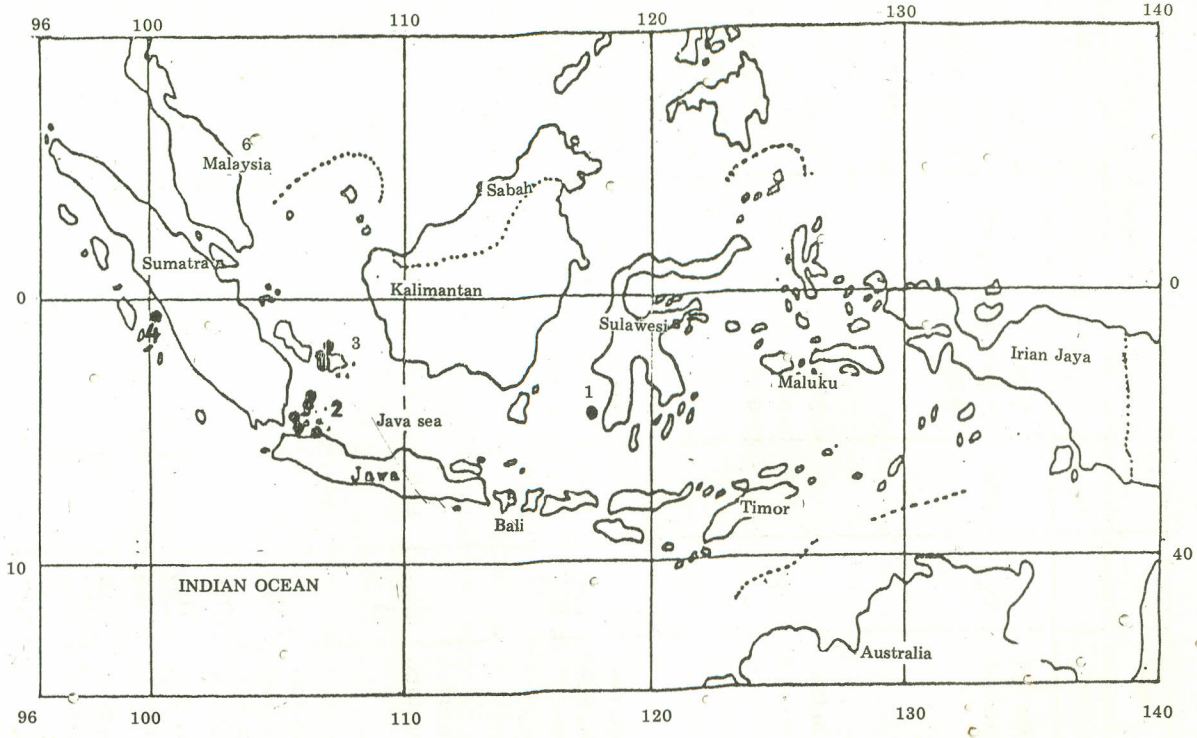

Fig. 1 Map of Indonesian Archipelago and Malaysia : 1. Spermode islands; 2. Seribu islands; 3. Belitung islands; 4. Penyu island; . = sampling localities.

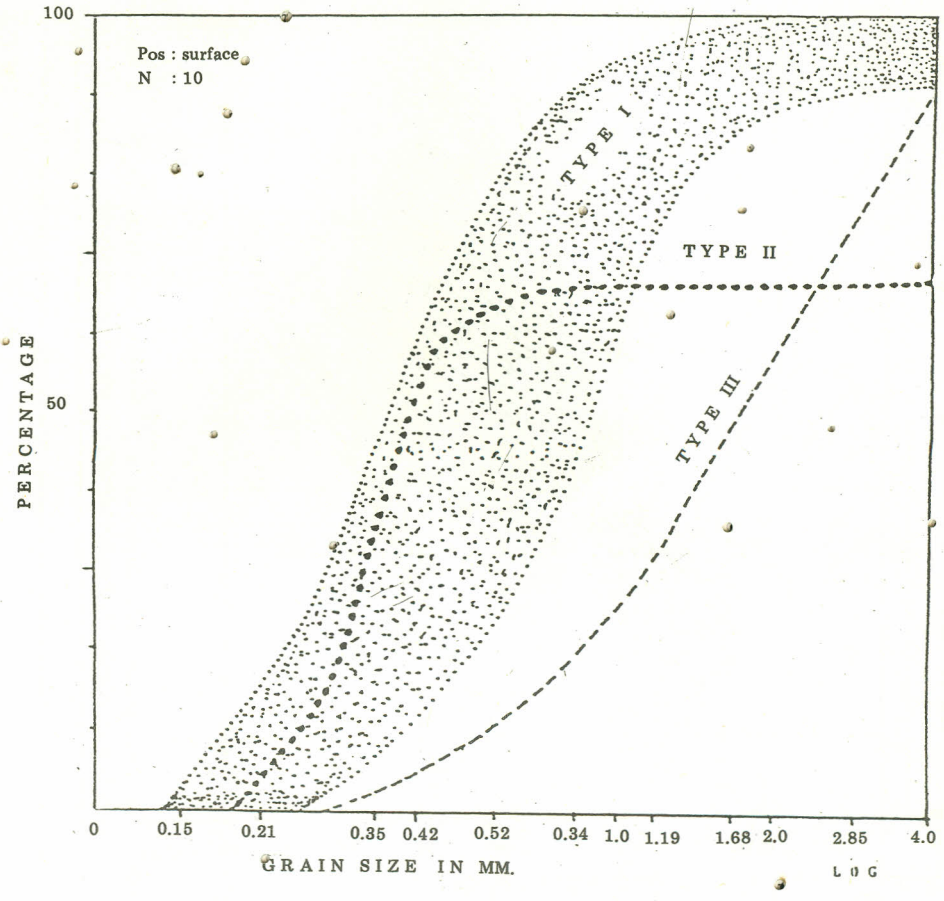

Fig. 2a. Type I, consisted of samples from surface taken from the islands of Semut Kecil, Panjang Kecil, Sepa Kecil and Belanda (Seribu Islands), Tukung and Kalmambang islands (Belitung Islands). Type II consisted of a single sample from Kalmambang Island. Type III from Gosong Batang Lompo Island.

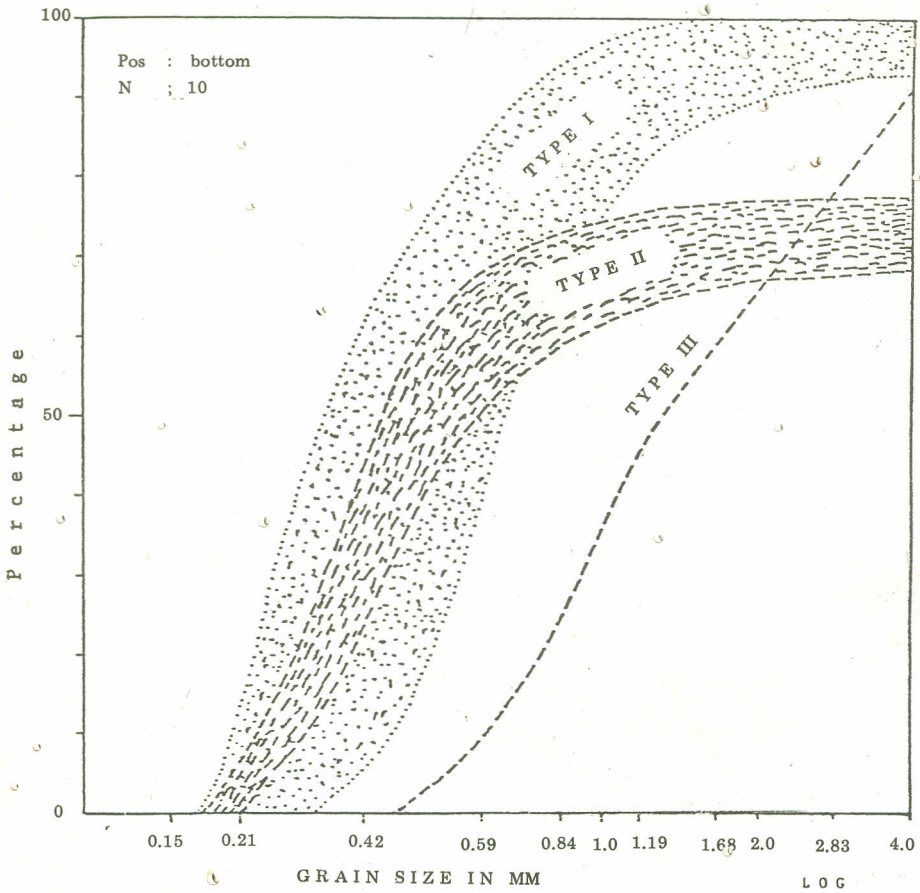

Fig. 2b. Type I consisted of samples from bottom, taken from Islands of Semut Kecil, Panjang Kecil, Sepa Kecil (Seribu Islands). Type II composed of samples of Belanda, Tukung and Kalmambang islands (Belitung and Seribu Islands). Type III consisted of sample of Batang Lompo Island.

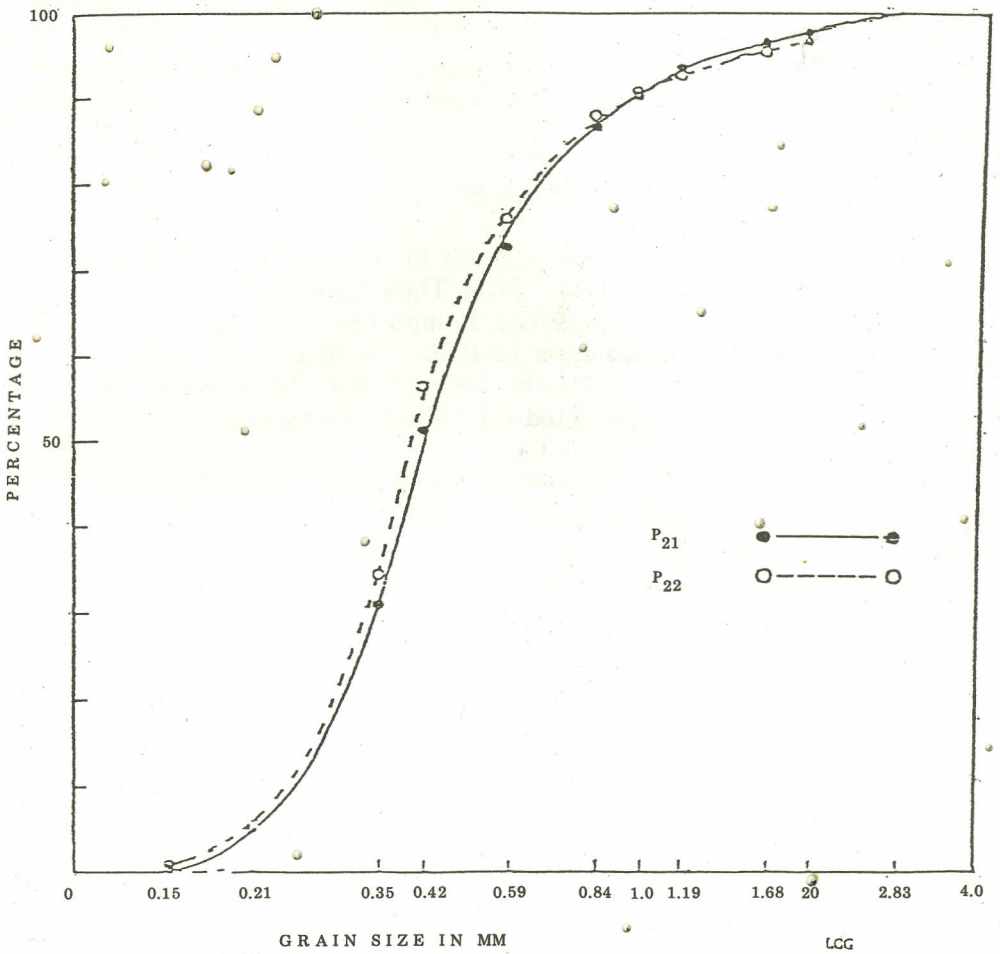

FIG. 3. P_{21} sample collected on the surface of Penyu Is.
P_{22} sample collected in the bottom of Penyu Is.

and compared in percent. The values were plotted in logarithmic curves. The coefficient uniformity was calculated from the results of the comparative value between $D_{60} : D_{10}$. From this calculation the materials were expressed as heterogenous or homogenous.

The identification of sand colour was based on International Standard of Color, by means of Jacol Color Card 220 number which is produced by Japan Color Research Institute. In addition to all of these analyses, records were made on the general Composition of the sands, including coral particles, roots and shells.

RESULTS

There were four types of sand grains in the nesting grounds studied, based on the classification of King (1961). These types have been plotted on Figs. 2 and 3. The sands from Batang Lompo beach belonged to type III (Fig. 2, a and b), having diameter of 0.56 — 0.58 mm. In Semut Kecil, Panjang Kecil and Sepa Kecil Islands, the nests were composed of medium sands. The sample of sands collected from Kalmambang beach belonged to type II.

The types of sand grains and nests of hawksbill and green turtles were varied (Fig. 4). There were 4 types recorded :

1. Type A, composed of coral sands, roots and small and broken shells; sometimes mixed with egg shells. This type was mostly found in Kalmambang beach, belonging to type II;
2. Type B, consists of coarser coral sands, as found in Gosong Batang Lompo;
3. Type C, composed of coarser coral sands, small or pieces of roots and shells; this type was found in Tukung Island.
4. Type D, composed of mixed coral sands, roots and sometimes mixed with shells.

Data on effective diameter and coefficient uniformity of sea turtle nesting sites have been available (Table 2). These two aspects were varied. On the surface, for hawksbill turtle, the effective diameter showed the following variation. On the beach of Batang Lompo, the diameter was 0.56 mm. Along the coast of Islands of Panjang Kecil, Sepa Kecil, Belanda and Semut Kecil, the diameter ranged from 0.18 to 0.34 mm. The range of 0.20 — 0.40 mm was found in Tukung and Kalmambang Islands, and also Belanda Island. The variation on the bottom samples was similar to those on the surface. For the green turtles the effective diameter ranged from 0.28 to 0.31 mm. The coefficient uniformity showed differences in the position of the nest. For hawksbill turtles, the range on the surface was 1.39 — 2.05 and on the bottom it was 1.76 — 2.77 (Fig. 5).

Table 2. The material composition and sand color for sea turtle nesting sites.

No.	Name of islands	Material composition			Sand Color					
		Cs	Sh	Others	LYB	YWW	PB	BW	GW	BG
1.	Sepa Kecil (SK 1)	+	0	0	0	0	0	+	0	0
2.	Sepa Kecil (SK 2)	+	0	+	0	0	0	+	0	0
3.	Sepa Kecil (SK 3)	+	0	0	0	0	0	+	0	0
4.	Sepa Kecil (SK 4)	+	0	+	0	0	0	+	0	0
5.	Belanda (BL 5)	+	+	0	0	0	0	+	0	0
6.	Belanda (BL 6)	+	+	+	0	0	0	+	0	0
7.	Belanda (BL 7)	+	+	0	0	0	0	+	0	0
8.	Belanda (BL 8)	+	+	+	0	0	0	+	0	0
9.	Semut Kecil (SK 9)	+	0	0	0	+	0	0	0	0
10.	Semut Kecil (SK 10)	+	0	+	0	+	0	0	0	0
11.	Panjang K. (PK 11)	+	+	0	0	0	0	+	0	0
12.	Panjang K. (PK 12)	+	+	0	0	0	0	+	0	0
13.	Gs. Bt. Lompo (GT 13)	+	0	0	0	0	0	+	0	0
14.	Gs. Bt. Lompo (GT 14)	+	0	0	0	0	0	+	0	0
15.	Kalmambang (KL 15)	+	+	0	0	0	+	0	0	0
16.	Kalmambang (KL 16)	+	+	+	0	0	+	0	0	0
17.	Kalmambang (KL 17)	+	+	0	0	0	+	0	0	0
18.	Kalmambang (KL 18)	+	+	+	0	0	+	0	0	0
19.	Tukung (TK 19)	+	+	0	0	0	0	+	0	0
20.	Tukung (TK 20)	+	+	+	0	0	0	+	0	0
21.	Penyu (P 21)	+	+	+	0	0	0	+	0	0
22.	Penyu (P 22)	+	+	+	0	0	0	+	0	0

Explanation : + means the samples consist of the related materials, or color.
Cs : coral sand.
Sh : shells.
Others mean root or big coral.
LYB : Light Yellowih Brown 9 YR 6.5/5.
YWW : Yellowih White 2.5 Y 9/0.5.
PB : Pale Beige 9 YR 9/2.
BW : Brownish White 5 YR 9/0.5.
GW : Grayish White 5 G 9/0.5.
BG : Brownish Gold 9 YR 5.5/8.

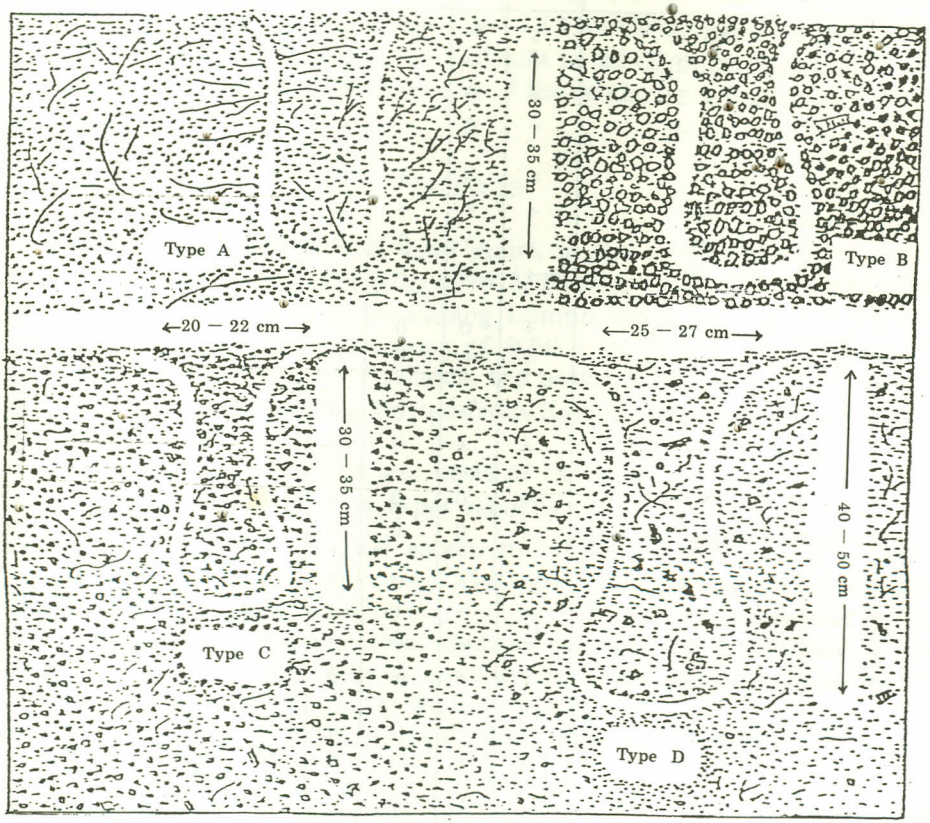

Fig. 4. Types of sand grains and nests of hawksbill and green turtles. Type A : mixture of coral sands, many roots and a little shells. Type B : coarser coral sands. Type C : coaser coral sands, a little roots and shells. Type D : coral sands, roots and sometimes mix with shells.

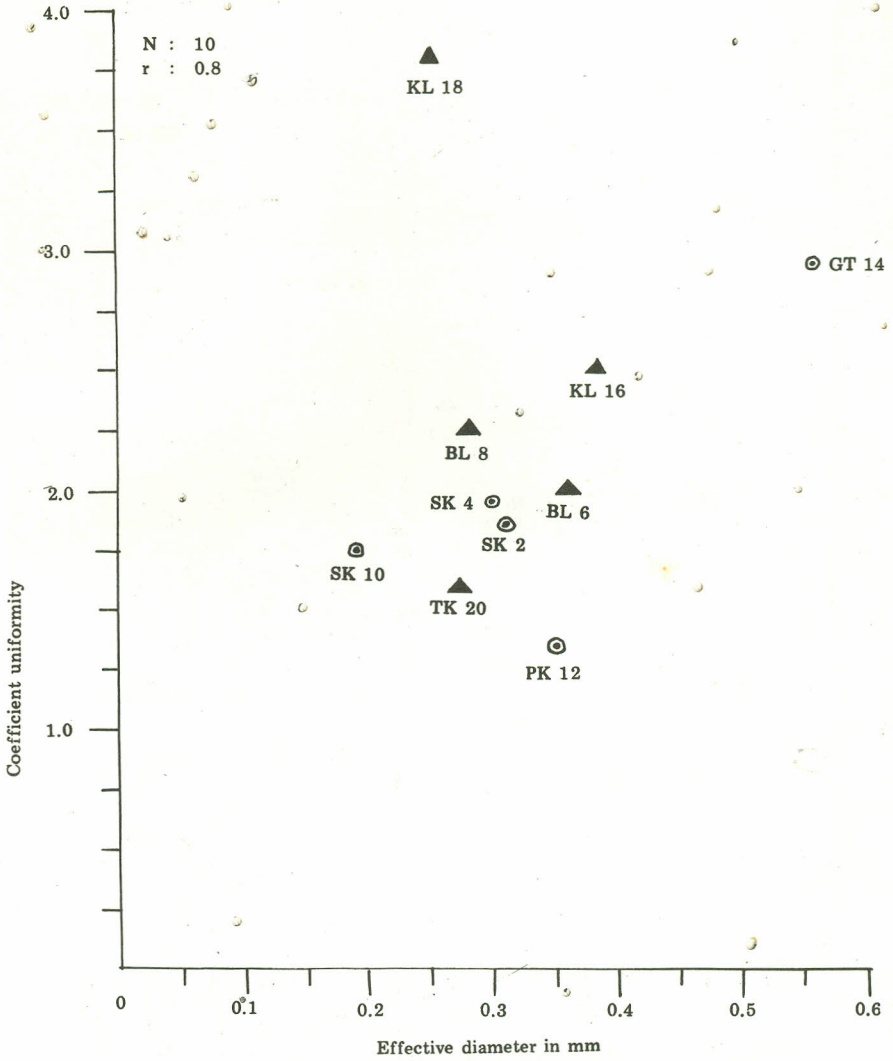

Fig. 5a. Relationships between coefficient uniformity and effective diameter of hawksbill nesting sites in the bottom.

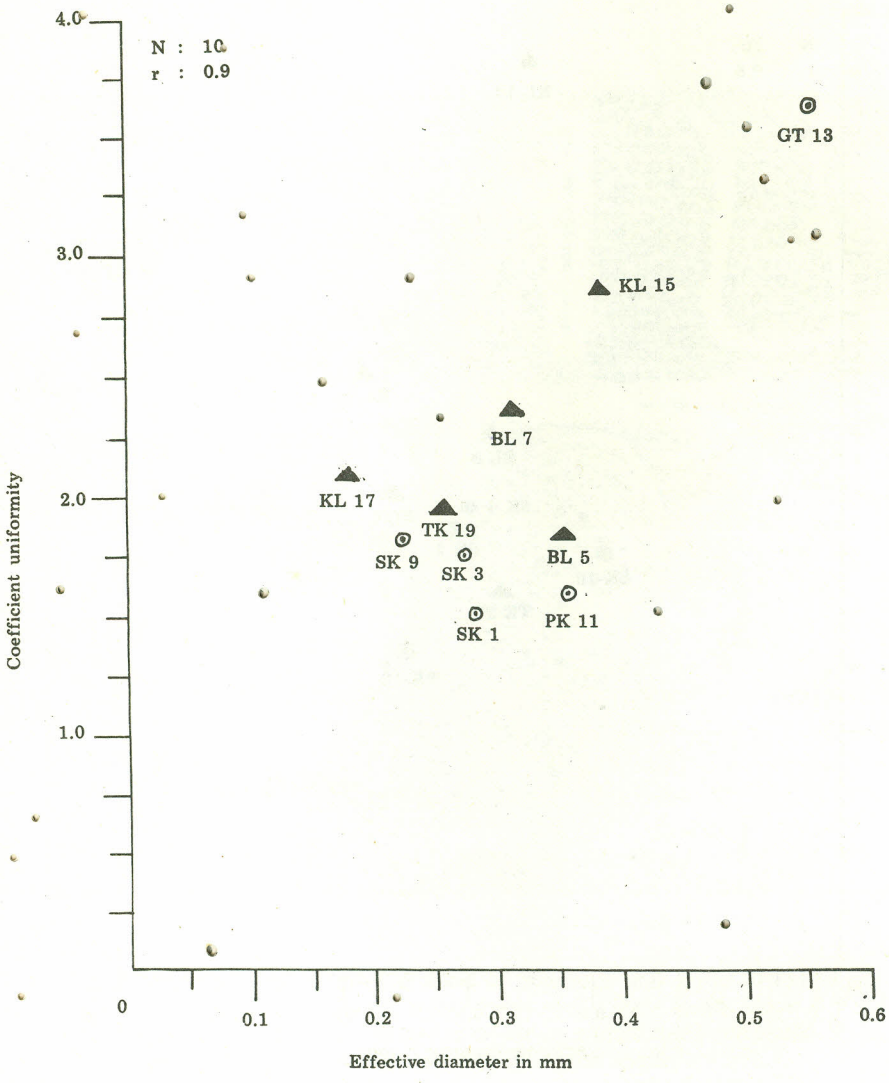

Fig. 5b. Relationships between coefficient uniformity and effective diameter of hawksbill nesting sites on the surface.

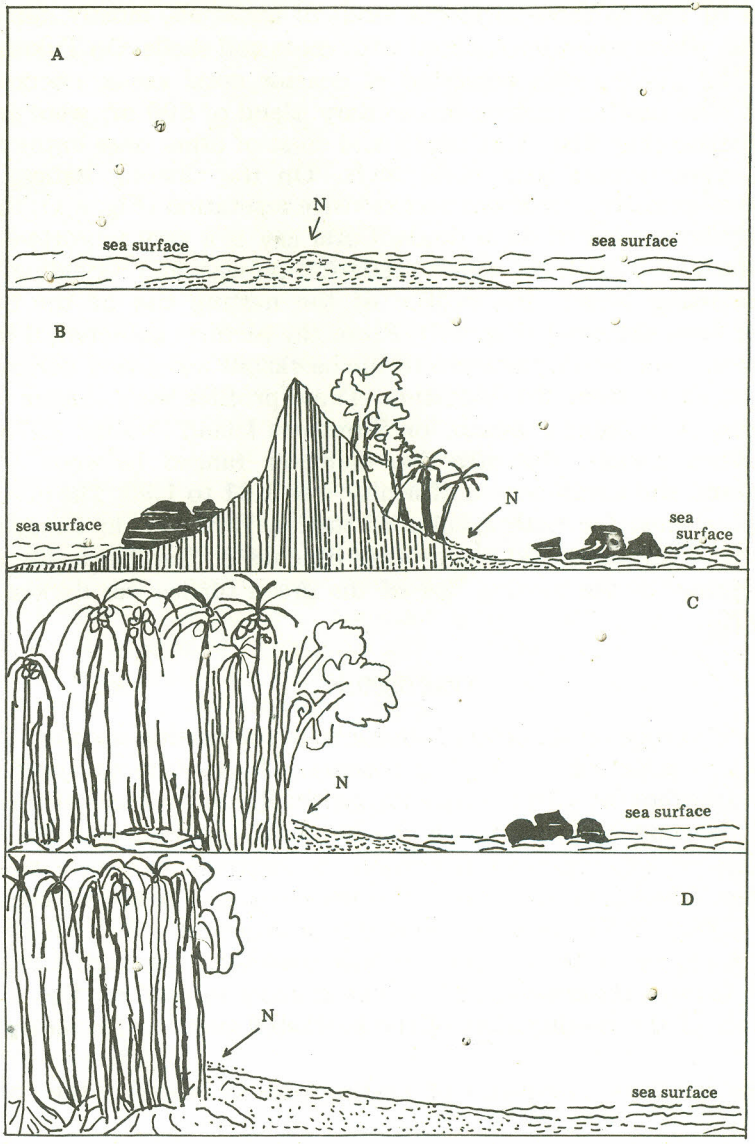

Fig. 6. Beach profiles of hawksbill (A, B, and C) and green turtles (D) nesting sites; A. Gosong Batanglompo; B. Tukung Is.; C. Kalmambang Is.; D. Penyu Is.; N. nesting site.

In general, the nesting sites of the hawksbill and the green turtles were composed of one to three different kinds of materials, mostly consisted of coral sands, which sometimes mixed with roots and shells. On Tukung for an example, the nesting sites consisted of coarser coral sands, coconut roots and shells. The nesting sites on this solitary island of 600 m^2 were protected by rock barrier (Fig. 6B). This island and most of other ones in the Strait of Karimata were dotted with coral reefs. On the Gosong Batang Lompo which was a coral cay, there was no extensive vegetation (Fig. 6A); the beach was mostly composed of coral sands. Coral cay is a very important nesting ground (Bustard, 1976), on which predation on eggs and hatchlings is low. On Kalmambang Island, the profile of the nesting site of the hawksbill turtles has been sketched (Fig. 6C). From the pictures gathered, it might be concluded that the nesting beaches of the hawksbill was a very narrow stripe, about 7 to 10 m from the high tide. These profiles were similar to those found along Ai-Ketapang Beach, on Sumbawa Island (Nuitja, 1975). Here for the green turtles, the effective diameter ranged between 0.28 and 0.31 mm, and the coefficient uniformity was 1.61 to 1.90. The color of the sands was whitish for both species of turtles. However, in Pangumbahan, Sukamandi (West Java) and some other beaches on Sumbawa, the color of the sand grains in the nesting site of the green turtles was darker (Nuitja, 1975; 1976).

DISCUSSION

The difference on the sizes of the sands in the nesting site may influence the turtles in selecting the nesting beaches. The nesting site preference is noticably different for different species, especially on the basis of the composition of the materials. Although the hawksbill population nests only on the beaches of heterogenous materials, its settlements are distributed on stable range. Therefore, to support the spawning, the hawksbill requires the range of 1.76 — 2.77 for coefficient uniformity and 0.20 — 0.40 mm. in effective diameter of the surface. In this condition, the turtles respond to structural feature (Heatwole, 1977). The triangle symbol on Fig. 5 showed the position of the nesting sites of the hawksbill turtles with more than 10 nests.

There are three categories of nesting sites as based on the composing materilas :

1. Of one kind of material, *i.e.* coarse coral sands; Gosong Batang Lompo. The coarseness of the sands and slopes of the beach are increased by strong wave action (McConnaughey, 1974).
2. Of two kinds of materials : coral sands and roots or coral sands with shells; Sepa Kecil, Semut Kecil and Panjang Kecil. A sufficient number

of hawksbill nest on these islands, in the group of Seribu Islands in the Jakarta Bay.

3. Of three or more kinds of materials, *i.e.* coral sands roots and shells. The roots or shells may have determining influence for the hawksbill to choose the suitable place for spawning.

There has been speculation on how the hawksbill choose the surface layer which is readily broken. The hawksbill, which is the smallest among sea turtles, has a limited power for digging. The choice of broken layer is to make easier for the hawksbill in digging the sands. The fore feet of sea turtles are used to scratch, scrape or throw the dirts backward or to the side, but not best developed in the hawksbill (Ehrenfeld, 1979). Pritchard (1966) found so many kinds of materials, consisting of broken shells, bones and skulls which were referable to the following species : Pacific riedly hawksbill, green and leatherback turtles in British Guiana.

The green turtles will not nest in the absence of tall vegetation (Bustard, 1976); the hawksbill may tend to nest abundantly when the materials on nesting sites are heterogenous. The abundant nests of the hawksbill are found on three islands, namely Tukung, Kalmambang and Belanda. On the former two islands, the nesting sites consist of coral sands and fine roots of coconuts. On Belanda the coconut does not grow. The vegetation is a mixture of grasses, *Ipomoea* sp, *Pandanus* sp. and sometimes *Casuarina.*

Although the coefficient uniformity for the green and the hawksbill turtles is the same, *i.e.* heterogenous, there may be some other factors influencing the behaviours of the turtles. They may be topography (Pianka, 1977) and the abundance of vegetation (Bustard, 1976). Penyu Island has a high beach platform. The nesting sites of the hawksbill are differentiated as a narrow stripe, 7 — 10 m from the high tide. Barrier on the front part of the hawksbill nesting site sometimes occurs. For Penyu Island, the heterogenous types of materials on the surface and in the bottom, and the effective diameter are similar (Table 1). This is an indication that flat waves move the materials land-ward and build up the profile as mentioned by King (1961). The distribution of the nesting sites of the hawksbill population was determined by the heterogenous materials. In the solitary areas, there is no dominant wave action.

CONCLUSIONS

Certain types of sand grains as the components of the nests have been chosen as a preference or suitable places for sea turtles. In general, the green and the hawksbill turtles are responsive to medium sized grains of sands for the nests. The detailed compositions for these two species of turtles are rather different.

Nearly similar effective diameter and heterogenous materials compose the nesting sites of both hawksbill and green turtles. Consequently, these two species of turtles sometimes spawn in one nesting place, as it was found in Penyu Island. The habitat shows similarity, *i.e.* rocky places.

The hawksbill prefers the sites where the materials for the nests are composed of many kinds. There is a tendency, that the hawksbill will prefer to nest in the sites with abundant coral sands, fine roots, pieces of shells, that are already broken in the surface layer. The abundance of vegetation does not seem to be important for the green turtle nesting sites, but the sites may need at least strands of grasses. However, the green turtles require extended high beach platform, which is the opposite of the hawksbill. The latter species tends to prefer nesting individually on solitary islands.

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