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THE INFLUENCE OF SAND PARTICLE SIZE ON NESTING SITE SELECTION OF PAINTED TERRAPIN *(CALLAGUR BORNEOENSIS)* IN KUALA SETIU BARU, PENARIK, TERENGGANU.

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Abstract : Painted terrapin or *Callagur borneoensis* is among Malaysia's most endangered freshwater turtle species that was enlisted as Critically Endangered by the International Union for Conservation of Nature (IUCN) in 1990. In Malaysia, the biggest population of the species can be found in Sungai Setiu, Terengganu. The nesting behavior pattern of Painted terrapin was studied with focus on its relation to the sand particle size in the coastal beach where the terrapins lay their eggs. The findings showed that there was a correlation between distribution of sand particle size and nesting density of the Painted terrapin in this area. Horizontal analysis showed that as sand particle size gets larger further from the river mouth, the number of nest decreases ($r^2 = 0.85$). Vertical analysis showed that as sand particle size gets larger further upward from the shoreline, the number of nest increases ($r^2 = 0.99$). Painted terrapin showed preference to nest and lay their eggs at sand with smaller particle size. The straight-line equation of the analysis is $y = 4.67x - 1.56$ for horizontal analysis and $y = 21.84x - 16.71$ for vertical analysis. Average nest depth is 17.1 cm. Average nest incubation temperature is 29.2° C. Average nest distance from the shoreline is 28.9 m. Average nest distance from the nearest vegetation is 15.4 m. Average size of terrapin eggs is 8.72 cm in length and 5.54 cm in maximum width. The findings suggested the required buffer zone that would be useful for PERHILITAN Department in order to set up a new policy on terrapin conservation and rehabilitation.

KEYWORDS : Painted terrapin, *Callagur borneoensis,* Setiu, sand, nesting

Introduction

Animal interacts with the changes in their environment at all times. Climate, salinity, moisture and soil density are among the factors that influence their behavioral patterns (Byles, 1988). Painted terrapin or scientifically known as *Callagur borneoensis* has no exception. The species that can be found from the southernmost provinces of Thailand, southward through West Malaysia to the islands of Indonesia and Borneo, is enlisted as `critically endangered' by the International Union for Conservation of Nature (IUCN) in 1990. Male species of *Callagur borneoensis* can be identified with single large bright stripe on the top of their eyes, extending from the nostrils (Dioli, 1996), while females are lacking of this characteristic. However, the stripe usually fades during the non-mating season (Moll, 1980). The color of the male's carapace is also intensifying during mating season while the snout turns bluish (Moll, 1990). Although *Callagur borneoensis* is a freshwater turtle, they lay their eggs on the ocean coastal beach. The female will swim through a long distance to the river mouth towards the sea before selecting suitable nesting sites for their eggs. Temperature, salinity and moisture are the major physical factors that affect the phenotype of offspring (Comuzzie, 1987). The incubation temperature will inversely relate to the incubation period. The aim of this study was to find a relationship between the nesting site selections with the sand grain size factor. It is hoped that the findings in this project will benefit terrapin conservation programs in terms of in-situ

incubation site and provide more data for the government and related agencies to justify the need to conserve suitable areas for the nesting site of *Callagur borneoensis*.

Materials and Methods

The study was conducted at the coastal area of Penarik; from Telaga Papan to Kuala Setiu Baru of Kuala Terengganu. This area has been identified as an important nesting area for the Painted terrapin, *Callagur borneoensis* (Sharma, 1977; Moll et al., 1981). Two methods were applied in this study; Beach Survey Method and the Granulometric Method. Beach Survey Method was used to record data on nesting sites of terrapin while the latter was carried out to determine the distribution of sand particle sizes.

Beach Survey Methodology

The nesting site stretches along the 5 km of the sanctuary southward of the river mouth. Point zero (0) at the river mouth was determined by measuring it at 45 m from two point's perpendicular to each other at the water line (Figure 1). A marker was erected at every 100 m to indicate the distance from the river mouth and to establish the 'region'. The 'region' represented by the area at the length of 100 m and width of approximately 50 m. Therefore, 50 regions were established in this study; area of 0 – 100 m as Region 1 and 100 – 200 m as Region 2, 200 to 300 m as Region 3 until Region 50 (Figure 2). Beach walks were done daily during the nesting season from June to September starting from 2100hrs to 0500hrs. The 5 km stretch was divided into two sections and walked upon every two hours, to and fro by separate walkers. Measurement of distance from high tide shoreline and distance from the nearest vegetation were done at each nest encountered. Nesting regions were recorded pertaining to the region established according to the distance of marker from point zero.

Granulometric Analysis : Sand sampling method

Sampling was done in each established sectors at 45, 30 and 15 meters from the high tide shorelines (Figure 3). Three replicates of sand samples were collected using 50mL beaker from each sector at every 25 meters interval. The three samples were then mixed together to form one sample that represents each vertical position. Samples were stored in plastic bags and labeled according to their sectors and vertical positions; e.g. sample from Sector 1 at 45 m from high tide shoreline is labeled as Sample 1A, at 30 m as 1B and at 15 m as 1C. The labeling system was applied to other sectors with the same manner.

Particle size analysis: Dry filtering method

Debris, shells, leaves and other alien particles were removed from sand samples before drying them under direct sunlight for 2 days. Precautions were taken in making sure that no samples were lost during the drying process. Each thoroughly mixed sample was weighed at 200 gm and filtered through 6 meshes arranged on top of each other, beginning with 710μm, 500μm, 355μm, 180μm, 125μm and 63μm. The particle size that represents at least 50% or more weight of each sample was selected to represent the size of that particular sample (Bird, 2000). The unit was then converted to the Φ unit, which has constant intervals to accommodate the statistical procedures according to Wentworth Scale of Particle Diameters (Table 1).

Table 1: Wentworth Scale of Particle Diameters

Wentworth Scale Category	Particle Diameter (μm)	Φ Unit Scale
Boulders	>256 x 10^3	< -8
Cobbles	64 x 10^3 to 256 x 10^3	-6 to -8
Pebbles	4 x 10^3 to 64 x 10^3	-2 to -6
Granules	2 x 10^3 to 4 x 10^3	-1 to -2
Very coarse sand	1 x 10^3 to 2 x 10^3	0 to -1
Coarse sand	500 to 256 x 10^3	1 to 0
Medium sand	250 to 500	2 to 1
Fine sand	125 to 250	3 to 2
Very fine sand	62.5 to 125	4 to 3
Silt	3.9 to 62.5	8 to 4
Clay	<3.9	> 8

The sand sample that was filtered on each mesh size was weighed and the percentage of particle size was tabulated as filtered weight/original weight. The grain size that had the highest percentage in each sample was considered to represent the grain size of the sample.

Results and Discussions

Horizontal analysis

Horizontal statistical analysis were done using data of nesting density and sand particle size obtained from the regions arranged in horizontal array from Point Zero (0) of to the 5 km marking site. Regression analysis showed that there was simple linear regression equation of $y = 4.667x - 1.556$ between nesting density and sand particle size. Strong correlation were noted between sand grain size and nesting distribution of Painted Terrapin ($r^2 = 0.852$).

Vertical analysis

Vertical sorting of sand samples at 45 m (A), 30 m (B), and 15 m (C) showed that at vertical position A, the variance between regions is 0.94 with a standard deviation of 0.97. At vertical position B, variance of particle size between regions is at 1.23 with standard deviation of 1.11. At vertical position C, the variance of sand particle size is at 1.07 with standard deviation of 1.03. The mean of sand particle size at vertical position A was 2.54 Φ, position B was 1.67 Φ while vertical position C was 1.29 Φ. Regression analysis showed an equation relating sand particle size and nest density as $y = 21.84x - 16.71$. Correlation of the two variables was tabulated at 0.99. Average nest depth is 17.1 cm. Average nest incubation temperature is 29.2°C. Average nest distance from the nearest vegetation is 15.4 m. Average size of terrapin eggs in Kuala Setiu Baru is 8.72 cm in length and 7.54cm in maximum width.

The sand grain size distribution at the Turtle & Terrapin Nesting Sanctuary, Penarik, Setiu showed particular pattern both horizontally and vertically. Horizontally, sand nearer to the river mouth has smaller grain size than those further from the river mouth. It must be noted here that the river mouth of Sungai Setiu is gradually shifting northward in time. Therefore there were areas in the coastal beach that was formerly a river mouth. Sorting of sand by waves and wind seemed to

have not taken its full effect on these regions. It was also found that the Painted terrapins tend to lay their eggs in areas with smaller sand grain size. Even though distance from the river mouth might be a major factor in nesting site selection of the terrapins, there was enough statistical evidence to show that sand grain size also affected nesting site selection. For instance, the nesting density in regions 39 to 41 which is approximately 4 km from the river mouth were found to be higher that those in areas nearer to the river mouth but with no nesting at all. Granulometric analyses showed that sand grain size in regions 39 to 41 were smaller than some regions nearer to the river mouth.

Sand particle increases in size in vertical fashion. They were found to be smaller at higher elevation from the shoreline. This can be explained by the action of natural sorting by wind and waves, whereby incoming wind and waves tend to carry smaller sand particle further from the shoreline. This action forms a higher mean of ~ unit for sand at higher elevation than at lower elevation. In general, the sand particle size distribution of Kuala Setiu Baru can be considered as almost fully sorted, horizontally and vertically.

Statistically, there is a linear correlation between the nesting density of Painted Terrapin and sand grain size either horizontally or vertically. This correlation was found to be positive whereby the higher the Φ unit is, the higher number of nest were to be found. However, it must be strongly noted that the Φ unit is a class conversion from the micrometer unit, which indicates bigger number for smaller diameter size.

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