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INCUBATION AND HATCHING RATE IN THE TURTLE *CHELONIA MYDAS* LINNAEUS

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ABSTRACT

This paper embodies the results of experiments conducted to find out the role of temperature on the development, hatching and survival of turtle eggs. The experiments were conducted in the laboratoary at Bogor Agriculture University as well as in the Citirem Beach. Temperature from the surface, 15 cm, 30 cm 45 cm and 60 cm below the surface were reecorded at 0600, 1200, 1800 and 2400 Hrs WIT. The turtle eggs were incubated in groups in boxes at the University laboratory. 25 W and 40 W electrical bulbs were lighted over the surface of the nests to heat the incubating eggs. The temperature was found to vary with time and depth. The temperature variation was vide at 9 cm and 15 cm levels. The best result achieved in the semi-natural nests was at the Citirem Beach where the hatching rate was 98 to 100% in group I. The hatching rate was O in Group III.

INTRODUCTION

THE SEA TURTLES lay eggs more than once during breeding season (Carr, 1952; Bustard. 1973 and Schulz, 1975). However the breeding season in different species of turtles varies and depends on the region. The number of eggs laid also varies from species to species and depends on the age of the turtle. The edible turtle lays between 106 and 143 eggs (Hendrickson, 1958; Carr and Hirth, 1962; Pritchard, 1969 and Hirth and Carr, 1970), while in Australia Bustard (1973) observed that the turtle produces an average of 110 eggs in Heron Island, while the same species found to lay between 98 and 120 and between 90 and 118 eggs in the Ai-Ketapang Beach and Citirem Beach respectively.

The young sea turtles pass through several critical phases from egg through hatching, emergance as juveniles and their migration to sea. Temperature variations, tidal waters, rainfall, andpredation by ants and wild pigs also cause considerable mortality of turtle eggs. Dodge *et al.* (1977) studying the incubation temperature, showed a positive correlation between the temperature and period of incubation. According to Ehrenfeld (1974), the survival of sea turtles from egg to adult stage is only 1%

This paper aims at studying the role of temperature on development, hatching and survival of turtle eggs. The information presented in the paper would also be useful in the artificial hatching for sea turtle eggs and their culture in the endeavour of enhancing their production as well as conservation of this resource.

MATERIAL AND METHODS

The experiments were conducted in the laboratory at Bogor Agriculture University as well as in the Citirem Beach. In the laboratory experiments incubators were used as hatching devices. Nine wooden incubators of 40 cm long, 40 cm wide and 85 cm high were fabricated and they were divided into 3 groups, each group consisting of 3 boxes. The electrical light was used to heat the incubators. One group of incubator was not provided with the electrical current. In the second group of incubator, each box was equipped with an electrical bulb of 25 watts, and in group three with 40 watts. The sand collected from the natural nest site where turtles lay eggs, was provided as bed of 6 or 7 cm thick. The turtle eggs taken from Citirem Beach were transported in shock

absorber boxes. On reaching the laboratory, each box was filled with 60 eggs as in the nature. Care was taken to avoid any friction while keeping the eggs in the incubator. The eggs were kept burried and an electrical bulb was hung over each surface in group two and group three incubators. A hole of 28 mm in diameter was provided in each incubator to allow air circulation. Once in two weeks, a glass of freshwater was sprinkled on to the surface sand in the incubators.

The field experiment was conducted at the Citirem Beach. The experiment was divided into three groups. The incubator bed of group I experiment consisted of natural sand, of group II - 75% natural sand and 25% coastal soil, and of group III - 50% natural sand and 50% coastal soil. The heat obtained was directly from sunlight. The arrangement of eggs in the beds was done as that of the initial experiment. The selection of soil and sand in the experiment was based on the fact that the edible turtles generally select sites for their nests rather in the upper regions of the beach towards the land where the sand is mixed with soil. Data were also collected from four nests which were located free from natural disturbances, either from tidal sea water or from coastal trees or wild animals in the Sukomade Beach.

As the turtles normally lay their eggs at an average depth of 60 cm (Nuitja, 1973), the temperature was measured at four depths, namely at 15 cm, 30 cm, 45 cm, 60 cm below the surface in all the field experiments as well as in the natural nests at the Sukomade Beach. The temperature was noted at 0600; 1200; 1800 and 2400 hrs WESTERN INDONESIAN TIME (WIT), by using Grant thermometer of 60 cm long. This device had 0.1 accuracy. The temperatures of the semi natural nests on the Citirem Beach and four nests on Sukomade Beach was recorded for a week after several days of replantation of the eggs. However, in the laboratory, the temperature was noted from the beginning of the experiments till the juveniles emerged. To' study the effect of depth, time and temperature on the nesting behaviour of the turtle, a factorial analysis of 4 x 4 was performed.

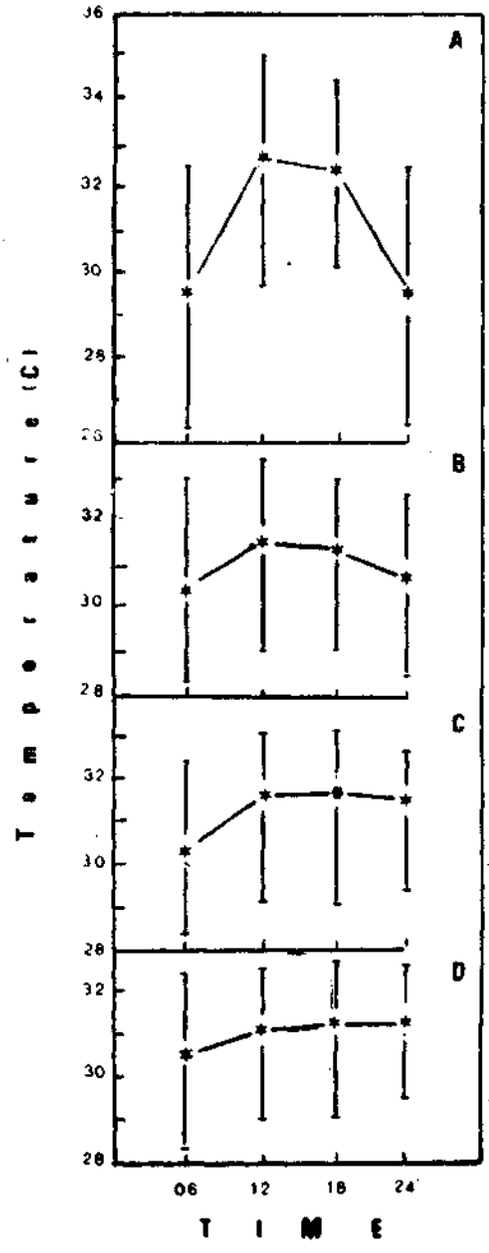

Fig.1 The fluctuation on different time of natural nest temperature for green turtle egg on Sukomade Beach. a. 15cm in depth; b. 30cm in depth; c. 45cm in depth and d. 60cm in depth.

RESULTS

Nest temperature condition

Temperature of the turtle nests at the Sukomade Beach was recorded for a week in December 1981. The temperature on the intertidal nest was not measured, but the hatching success was noted. In the intertidal zone single nest was found. Fig. 1 shows the average value of temperature at the selected depths at 0600; 1200; 1800 and 2400 hrs (WIT). It was observed that the range of temperature at 45 cm and 60 cm depth was relatively narrow as compared to the other depths, indicating that the difference in depth caused temperature fluctuation especially in the upper layer at different time. Table 1 gives results of analysis of variance between the depth and time and it was observed that the interaction between depth and time was higly significant.

TABLE 1. *An analysis of variance of factorial* 4x4 *experiment, on time and measurement of depth in the natural nests of Green turtle* C. mydas *on the Sukomade Beach in December* 1981

Source of variance	Degree of freedom	Square number	Variance	F
Treatment	15	38.670		
Depth	3	0.848	0.282	5.366*
Time	3	14.726	4.908	92.790**
Interaction	9	23.096	2.566	48.510**
Error	64	3.370	0.053	
Total	79	42.060	0.532	

* Significant difference

** Highly significant difference

In semi natural hatchery at the Citirem Beach, the temperature at the surface to a depth of 15 cm showed wide variation except at 1800 hrs WIT. At deeper layers, the variation in temperature was smaller (Fig. 2). At 15 cm depth, in group I nests, the temperature at 0600 hrs (WIT) was 28.5 + 0.9°C while in that of group II and III 27.2+0.3°C and 25.3 + 1.0°C respectively. Although temperature variation was observed at all the depth and time, the variation was not sharp in layers below 15 cm depth from surface. Temperature fluctuation at different layers in group I, II and III in the laboratory experiments is shown in the Fig. 3. Significant variation of temperature was observed in the layer at 15 cm below the surface. In the layer at 30 cm and 45 cm deep in group 1, the range of temperature was also significant, but at 60 cm depth, the fluctuation was relatively smaller. In group II and III, the temperature was not significant, although appreciable temperature range was noticed.

Incubation time and hatching rate

Table 2 shows the incubation period and hatching rates recorded in the green turtle nests at various locations in the Sukomade Beach.

It was observed that the hatching rate of green turtle eggs which were located in the nests in the open beach above the high tide mark, varied between 92.4 to 98.3 %. On the other hand, the hatching rates of eggs in the nests located under trees of *Pandanus tectorius* above the high tide mark varied between 76.6 and 78.9%. The hatching rate of eggs in single nest found in the interdialt zone was only 8.9%. The green turtle rarely nests in the intertidal zone.

TABLE 2. *Incubation period and hatching rate of Green turtle eggs on the Sukomade Beach in December* 1981.

Nest number	Incubation period	Number of eggs Initial	Hatched	Hatching rate
1	48	122	120	98.3
2	47	92	85	92.4
3	49*	136	116	78.9
4	48*	123	98	77.2
5	54*	99	81	76.4
6	48	119	117	98.3
7	49	115	112	97.4
8	52*	106	96	79.3
9	55*	109	76	69.7
10	54**	101	9	8.9

* Nests located under trees, mostly of *Pandanus*

** Nests located in the intertidal zone

Table 3 shows the hatching rate of eggs and incubation period in the experiments conducted at the semi natural nests in the Citirem Beach. The group I which was provided with the natural sand, showed a between 70.0% and 78.3%, but no eggs hatched out in group III. Stable temperature in group I gave a good hatching rate (Fig. 2). It was noted that here the natural soil might have contributed to maintain a more stable

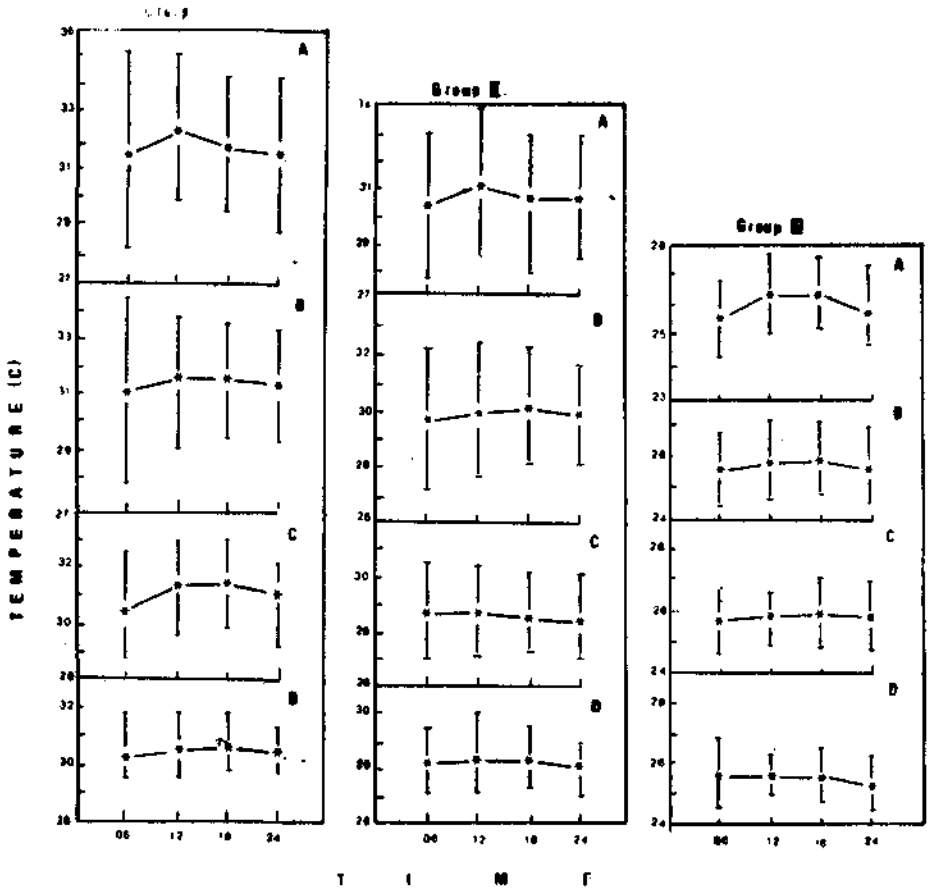

Fig. 2. The fluctuation of nest temgerature on different time in semi natural for Green turtle egg on Citirem Beach. a. 15 cm in depth; b. 30cm in depth; c. 45cm in depth and d. 60cm in depth.

satisfactory hatching rate of 98.0% upto 100%.

However, group II and III showed varying results. In group II, the hatching rate was temperature, whereas in group II and group III, mixed soil and the adherance of wet soil on the egg shell which perhaps caused the lower temperature conditions, contributed to the poor hatching rates.

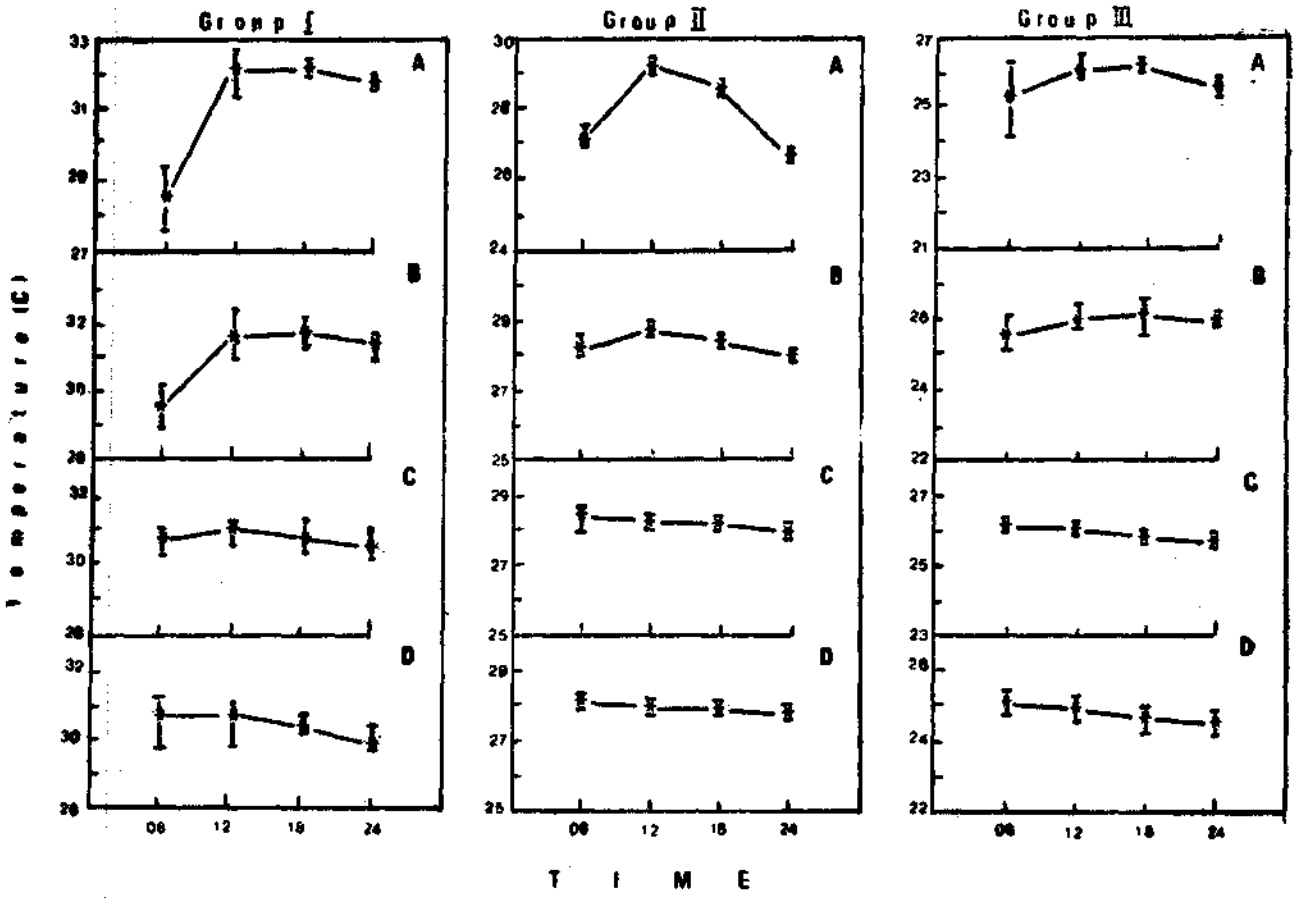

Fig. 3. The fluctuation on different time in full laboratory of nest temperature for Green turtle egg. a. 15cm in depth; b. 30cm in depth; c. 45 cm in depth and d. 60cm in depth.

TABLE 3. *Incubation period and hatching rate of turtle eggs in the experiments conducted at the Citirem Beach*

Group and medium	Hole	Incubation period	Hatching rate	Number of eggs	
				Initial	Hatched
I	1	52	100	60	60
Natural	2	54	100	60	60
Sand	3	55	98	60	58
II	1	60	70	60	42
Nat. sand 75%	2	58	76.6	60	46
plus soil 25%	3	55	78.3	60	60
III	1	62	0	60	0*
Nat. sand 50%	2	62	0	60	0*
plus soil 50%	3	62	0	60	0*

*All eggs in group III were rotten.

TABLE 4. *Incubation period and hatching rate of turtle eggs in the laboratory experiments*

Group and heat	Incubator	Incubation period (days)	Hatching rate (%)	Number of eggs	
				Initial	Hatched
I	1	68	3.3	60	2
Without	2	69	0	60	0
light	3	66	5.0	60	3
II	1	56	65.0	60	39
With light	2	59	61.6	60	37
of 25 watt	3	60	51.6	60	31
III	1	54	95.0	60	57
with light	2	55	90.0	60	54
of 40 watt	3	52	90.0	60	54

The incubation period and hatching performance of turtle eggs in the laboratory experiments at Bogor Agriculture University are shown in Table 4 and Fig. 3.

In these experiments the best hatching success was recorded in group III (90.0 to 95.0%). Here incubation period was also shortest as compared to the other groups, although the temperature was high at the nest surface and more stable at 45 cm and 60 cm deep.

DISCUSSION

The temperature in the turtle nests was found to vary with the time and depth. At 0600 and 2400 hrs (WIT), the temperature variation was wide particularly at 0 cm to 15 cm. The heat from the sunlight was effectively transferred in three zones through radiation, convection and conduction process. Fig. 2 a showed the nest temperature at 15 cm deep as ranging from 26.6 to 35.2°C. However, smaller temperature range (28.2 to 33.8°C) was found in 30 cm deep; while in 45 cm deep it was between 28.5 to 33.3°C and in 60 cm deep, 28.6 to 32.9°C. This clearly indicated more stable temperature in deeper layer and this temperature stability allowed a good embryonic development as shown by the hatching rates (Table 2). The laboratory experiment also showed almost similar results. The range of temperature from 29.4 to 32.0°C was the best temperature in the laboratory hatchery. The results achieved were 90.00 to 95.0% of hatching. In group III, the temperature at 60 cm deep was from 24.3 to 26.7°C. As this was relatively lower, eggs failed to hatch out. The young turtles were found dead in their shells, as the temperature was found to be inadequate for complete development. In group II where the temperature in 60 cm deep, was between 26.7 to 29.7°C, the hatching rate was 51.6 to 65.0%.

The best result achieved in the semi natural nest was at the Citirem Beach where the hatching rate was 98.0 to 100% in group I. The temperature in the nests was from 29.9 to 31.3°C in 60 cm deep. In group III, the hatching rate was 0 as all eggs were found in notten condition. This was due to adhering soil on egg shell, so that it inhibited the proper development of eggs, or possibly, the soil contained bacteria which damaged the egg shell. Thus in the incubation bed containing more soil than coastal sand recorded increased mortality of eggs indicating that the nests located away from the beach are not congenial for turtle nesting.

Satisfactory incubation of green turtle eggs was observed in the nests located in the supratidal zone which was free from all disturbances and directly obtain heat from the sunlight.

In the nests located in the terrestrial zone where the bed is a mixture of sand and soil or under dense trees or on intertidal zone, the hatching rate was found adversely affected. To obtain better survival rates such nests should be transferred to supratidal zone or to semi artificial nests where environmental condition could be adjusted. Although the laboratory experiments produced high hatching rate by electrical heating of 40 watt in wet season from November to December the system would not be of economical value because of high cost.

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