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THE EFFECT OF SHADING ON THE LENGTH OF INCUBATION AND HATCHING SUCCESS OF GREEN TURTLE (*Chelonia mydas*) EGGS IN PANGUMBAHAN, SUKABUMI, WEST JAVA

Pengaruh Naungan Terhadap Lama Masa Inkubasi Dan Keberhasilan Tetas Telur Penyu Hijau (*Chelonia mydas*) Di Pangumbahan, Sukabumi, Jawa Barat

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ABSTRACK

The condition of the nest greatly determines the success of turtle egg hatching. The success of turtle egg hatching, both naturally and artificially, is influenced by several factors such as the location of the nest, the depth of the nest, vegetation conditions, environmental temperature, humidity and the surrounding environment. This study aims to determine the effect of protection on the incubation period and hatching success of green turtle (Chelonia mydas) eggs in semi-natural nests in the Pangumbahan turtle conservation area, Sukabumi, West Java. The method used was an experiment by placing eggs in two different environmental conditions: exposed to direct sunlight and shaded, with variations in nest depth of 30, 50, 70, 90 cm, and control (68 cm). The parameters observed included temperature, nest humidity, incubation period, and percentage of hatching success. The results showed that the nest temperature in the exposed area tended to be higher (29–31°C) than in the shaded area (28–30°C), while the humidity was higher in the shaded area (up to 98.07%). In the exposed area, the hatching success rate reached 96.67% with an incubation period of 61 days at a depth of 30 cm. Meanwhile, in the sheltered area, the highest hatching rate of 89.60% was recorded at a depth of 90 cm with the fastest incubation period. Statistical analysis showed that there was no significant effect between nest depth and incubation period in exposed areas ($p>0.05$), but there was a significant effect in sheltered areas ($p<0.05$). These results indicate that shade conditions and nest depth affect temperature, humidity, and hatching success of turtle eggs. This study contributes to turtle conservation practices through optimization of semi-natural hatching based on shade management and nest depth.

Key words: *incubation period, the green turtle, the success of hatching.*

ABSTRAK

Kondisi sarang sangat menentukan keberhasilan tetas telur penyu. Keberhasilan penetasan telur penyu baik secara alami maupun buatan dipengaruhi oleh beberapa faktor seperti letak sarang, kedalaman sarang, kondisi vegetasi, suhu lingkungan, kelembaban dan lingkungan sekitar. Penelitian ini bertujuan untuk mengetahui pengaruh naungan terhadap lama masa inkubasi dan keberhasilan penetasan telur penyu hijau (*Chelonia mydas*) pada sarang semi alami di kawasan konservasi penyu Pangumbahan, Sukabumi, Jawa Barat. Metode yang digunakan adalah eksperimen dengan menempatkan telur pada dua kondisi lingkungan berbeda: terekspos sinar matahari langsung dan ternaung, dengan variasi kedalaman sarang 30, 50, 70, 90 cm, dan kontrol (68 cm). Parameter yang diamati meliputi suhu, kelembaban sarang, lama inkubasi, dan persentase keberhasilan penetasan. Hasil menunjukkan bahwa suhu sarang pada daerah terekspos cenderung lebih tinggi (29–31°C) dibandingkan daerah ternaung (28–30°C), sedangkan kelembaban lebih tinggi di area ternaung (hingga 98,07%). Pada daerah terekspos, tingkat keberhasilan penetasan mencapai 96,67% dengan masa inkubasi 61 hari pada kedalaman 30 cm. Sementara itu, di daerah ternaung, tingkat penetasan tertinggi sebesar 89,60% tercatat pada kedalaman 90 cm dengan masa inkubasi tercepat. Analisis statistik menunjukkan tidak terdapat pengaruh yang signifikan antara kedalaman sarang terhadap lama masa inkubasi pada daerah terekspos ($p > 0,05$), namun terdapat pengaruh yang signifikan pada daerah ternaung ($p < 0,05$). Hasil ini mengindikasikan bahwa kondisi naungan dan kedalaman sarang berpengaruh terhadap suhu, kelembaban, dan keberhasilan penetasan telur penyu. Studi ini memberikan kontribusi terhadap praktik konservasi penyu melalui optimalisasi penetasan semi alami berdasarkan pengelolaan naungan dan kedalaman sarang.

Kata Kunci: keberhasilan tetas, masa inkubasi, penyu hijau

INTRODUCTION

Sea turtles are marine reptiles that breathe with lungs, but spend their entire lives in sea waters. Turtles can be found in all oceans in the world and are known to be able to migrate long distances of up to thousands of kilometers. Currently, there are only seven species of turtles that still survive, namely the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbracata*), olive ridley turtle (Lepidochelys olivacea), tampayan turtle (*Caretta caretta*), flatback turtle (*Natator depressus*), leatherback turtle (*Dermochelys coriacea*), and Kemp's ridley turtle (*Lepidochelys kempi*). Six of the seven species can be found in Indonesian waters, showing the importance of Indonesia as an important habitat for the survival of the world's turtles. However, the world's turtle population continues to experience a significant decline. One of the main causes of this decline is human activity that disrupts the natural habitat of turtles, especially in coastal areas where they lay their eggs. Various studies have shown that uncontrolled human interactions contribute to habitat degradation and low hatching success rates for turtle eggs (Irwandi and Winarti, 2018; Marlian *et al*., 2021; Rachman *et al*., 2022; Habiburrahman and Merdeka, 2023). Conservation efforts are also important steps that must be taken to protect and preserve turtle populations, especially in nesting areas such as those in Pangumbahan, Sukabumi, West Java.

One of the important conservation areas in Indonesia is the Pangumbahan Turtle Coastal Park, located on the south coast of Sukabumi Regency, West Java. This area is known as a green turtle (*Chelonia mydas*) nesting habitat and has great potential as a conservation-based ecotourism destination. Based on this potential, the local government designated this area as a conservation area which was inaugurated on December 22, 2009 through the Decree of the Regent of Sukabumi No. 523/Kep.639-Dislutkan/2008. Along with the increasing human activity in this area, one of the protection efforts made is the transfer of turtle eggs from natural

nests to semi-natural nests as a form of mitigation against environmental disturbances (Samosir *et al*., 2018). Semi-natural hatching of turtle eggs is a conservation method that aims to maintain the sustainability of the turtle's life cycle without ignoring its natural conditions. According to Fitri and Herawati (2023), this method is expected to increase the chances of successful hatching and maintain the turtle population which continues to decline. Meanwhile, Kushartono and Hartati (2016) emphasized the importance of adjusting semi-natural nest conditions to natural nests, especially in terms of depth and microhabitat conditions, to support optimal turtle embryo development.

The success of turtle egg hatching in semi-natural nests is influenced by various environmental factors, including temperature, humidity, nest depth, vegetation conditions, and especially the availability of shade. Shade is thought to play an important role in regulating the temperature of the nest microhabitat which has a direct impact on the incubation period and hatching success rate of turtle eggs. Therefore, further studies are needed to determine the extent to which shade affects the length of the incubation period and hatching success of green turtle eggs in semi-natural nests.

The purpose of this study was to analyze the effect of shade on the incubation period and hatching success of green turtle eggs (*Chelonia mydas*) in semi-natural nests in the Pangumbahan Turtle Coastal Park conservation area, Sukabumi Regency. The results of this study are expected to provide useful scientific information in supporting turtle conservation efforts based on a microhabitat ecology approach.

RESEARCH METHODS

Time and Place

This research was conducted from November 2014 to January 2015 in the UPTD turtle conservation area of Pangumbahan, Pangumbahan Turtle Coastal Park, Pangumbahan Village, Ciracap District, Sukabumi Regency, West Java Province (Figure 1). Turtle observations were conducted by observing the turtle landing locations which were divided into 6 landing posts. This research was divided into 2 areas, namely exposed areas and sheltered areas.

Research Design

The method used in this study is an experimental method by treating semi-natural nests placed in two different areas, namely in exposed areas or areas exposed to direct sunlight and shaded areas or areas protected from direct sunlight with different nest depths, namely a depth of 68 cm (control), 30 cm, 50 cm, 70 cm and 90 cm. The nest is made by digging a hole with a diameter of 25 cm nest depth and the number of eggs ± 533 grains.

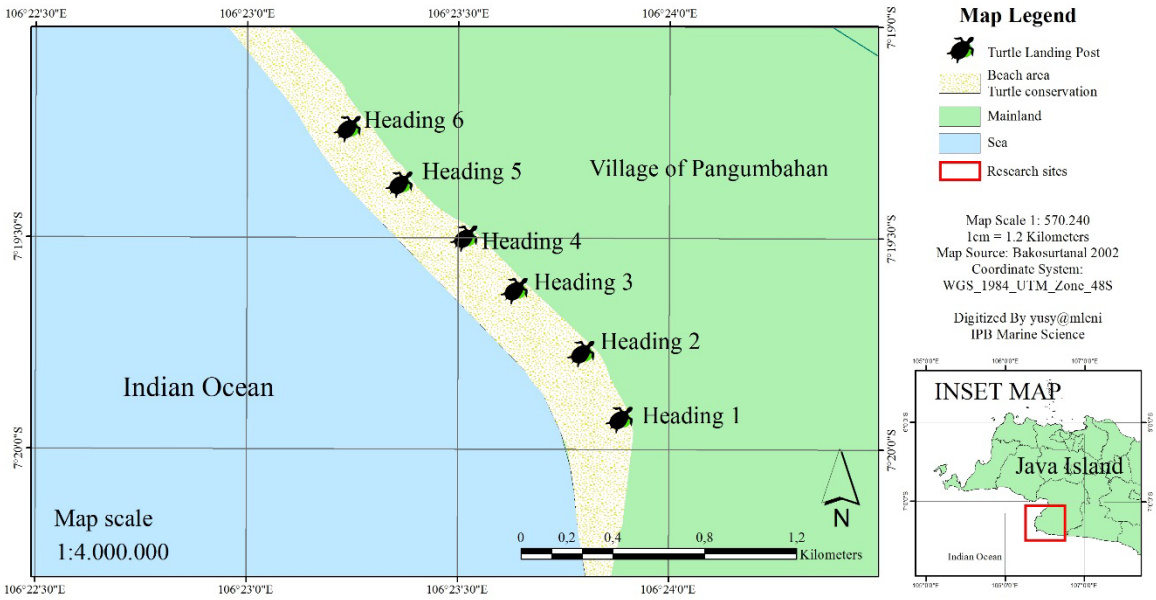


Figure 1. Map of turtle landing location

a. Measurement of environmental factors

Environmental factors measured such as nest temperature, outside nest temperature and nest humidity using a Thermo-hygrometer. The tool is inserted into the nest that has been given a PVC pipe before being planted until it touches the top surface of the egg pile (Figure 2). Measurements are carried out 4 times a day, namely morning, afternoon, evening and night with 3 repetitions.

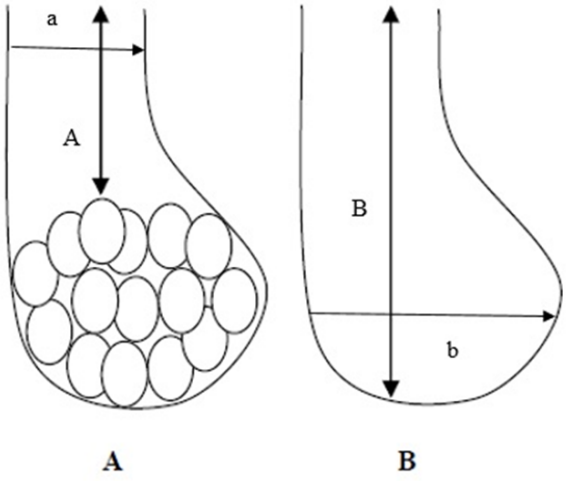


Figure 2. Measurement of the nest (A), surface diameter of the nest (a), depth of the nest (B), and inner diameter of the nest (b)

b. Percentage of green turtle hatching

The percentage of successful hatching of green turtle eggs is calculated based on the comparison between the number of eggs that hatch and the total number of eggs incubated in the nest (Dobbs *et al*., 1999), as follows :

$$HSs = \frac{JS}{TM} \times 100\ \%$$

Information :
HSs = hatching success rate
JS = number of eggs hatched
TM = number of eggs incubated

c. Egg collection

Turtle eggs were taken from the nesting beach in the Pangumbahan conservation area of Sukabumi, West Java. Egg planting was carried out in two places, namely the first in an open place or an area exposed to direct sunlight, the second egg planting was carried out in a place protected from the sun, namely a shady area or under a tree canopy.

d. Incubation period

The incubation period is the length of time it takes for an egg to hatch into a baby turtle (hatchling). In its natural habitat, the hatchlings that hatch come out onto the surface of the nest and go straight into the sea, while in a semi-natural hatching location, the baby turtles (hatchlings) that hatch and come out of the semi-natural nest will be moved to a large container until 1 or 2 days before the hatchlings are released into the ocean. The incubation period is calculated from the time the egg is planted in the semi-natural nest until the first hatchling emerges from the surface of the nest.

Pada When hatching, the hatchlings will experience an inprinting phase, which is the phase before entering the sea, the hatchlings will record and enter the location, conditions and characteristics of the hatching beach so that after entering the sea to migrate to the sea to find food and mate and during the egg-laying season the turtles will return to the beach where the turtles were hatched. The hatchlings will not eat anything for two to three days at sea because the hatchlings rely on the remaining yolk (food) in the hatchlings' bodies. During this phase the hatchlings learn to recognize food such as small invertebrates and seaweed (Nope *et al*., 2014).

Data analysis

The data obtained will be analyzed descriptively and presented in the form of graphs and images. The effect of nest depth on the hatching time and the percentage of successful hatching of green turtle eggs will be carried out using Oneway ANOVA using the SPSS Statistics 18 program.

RESULTS

Environmental Factors

Nest temperature conditions

The results of nest temperature measurements in exposed areas ranged from 29 - 31 oC while in sheltered areas ranged from 28 - 30 oC. The outside temperature of the nest in exposed areas ranged from 26 -36 oC, while in sheltered areas ranged from 25 - 35 oC (Figure 3). According to Nutija (1992) the optimum temperature for hatching green turtle eggs is between 24 - 32 oC. The higher the sand temperature, the faster the eggs will hatch (Benni *et al*., 2017).

Humidity (RH) of the nest The condition of the nest greatly determines the success of turtle egg hatching. Based on the results of the study, the humidity (RH) of the nest in exposed areas ranges from 65.40 - 95.73% and in sheltered areas ranges from 69.07 - 98.07% where the

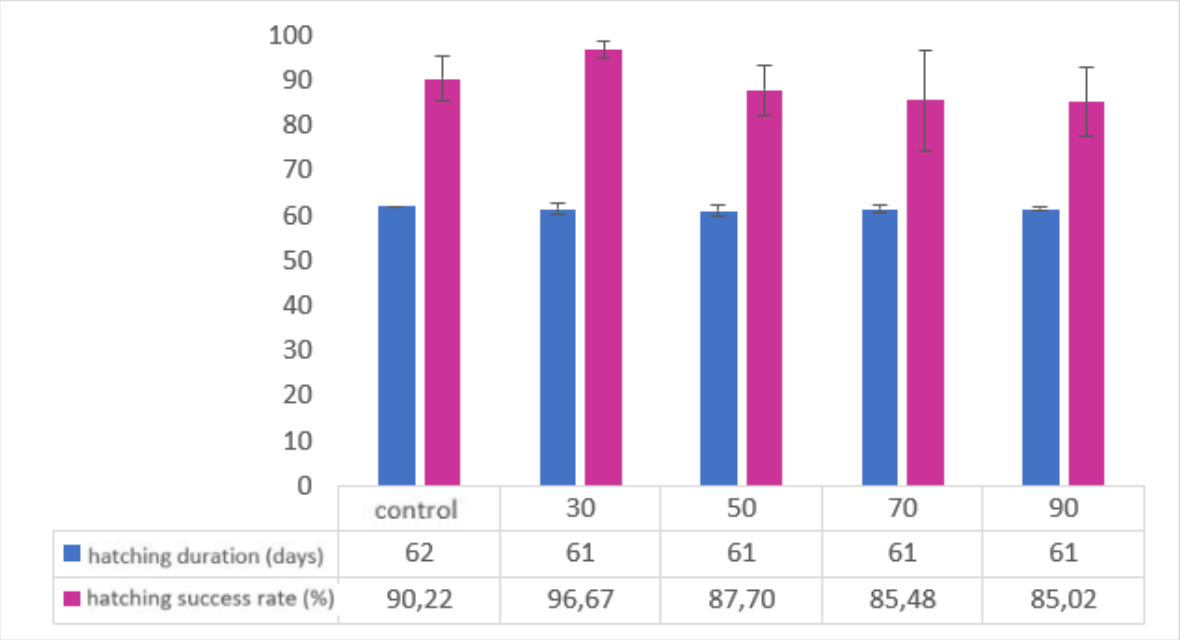
lowest humidity occurs during the day, this occurs when the sun's heat is at its peak and the highest humidity occurs at night, this is also found in the research of Kushartono et. al (2014) which was conducted on semi-natural nests.

Table 1 Average nest temperature (SS), outside nest temperature (SL) and humidity (RM)

Depth	Exposed			Sheltered		
	SS	SL	RM	SS	SL	RM
Morning						
Control	30,33	31,21	90,20	29,95	34,83	76,33
30	30,21	34,24	76,40	29,79	35,47	73,93
50	30,66	32,84	80,67	29,97	34,99	76,40
70	30,07	34,65	78,07	30,01	37,52	73,80
90	30,63	34,81	74,93	29,86	35,17	75,07
Afternoon						
Control	31,35	35,84	65,40	30,17	35,61	69,07
30	29,75	36,83	67,27	30,02	34,85	72,33
50	31,06	36,55	69,33	30,13	35,42	71,53
70	31,01	36,75	68,80	30,18	34,99	71,07
90	30,62	36,53	70,27	30,07	35,30	71,33
Evening						
Control	30,45	30,01	90,87	29,27	29,40	88,40
30	30,44	29,64	88,93	29,87	29,44	88,27
50	31,16	29,88	88,87	29,45	29,41	88,87
70	29,46	29,45	87,87	29,22	29,25	89,80
90	29,87	29,86	88,60	29,35	29,31	89,87
Night						
Control	30,33	27,29	90,93	29,42	25,97	97,07
30	29,75	26,50	95,27	29,32	25,83	97,67
50	30,13	27,22	92,40	29,37	25,62	97,07
70	29,67	26,40	95,73	28,71	25,53	98,07
90	30,12	26,88	94,00	29,09	25,56	97,80

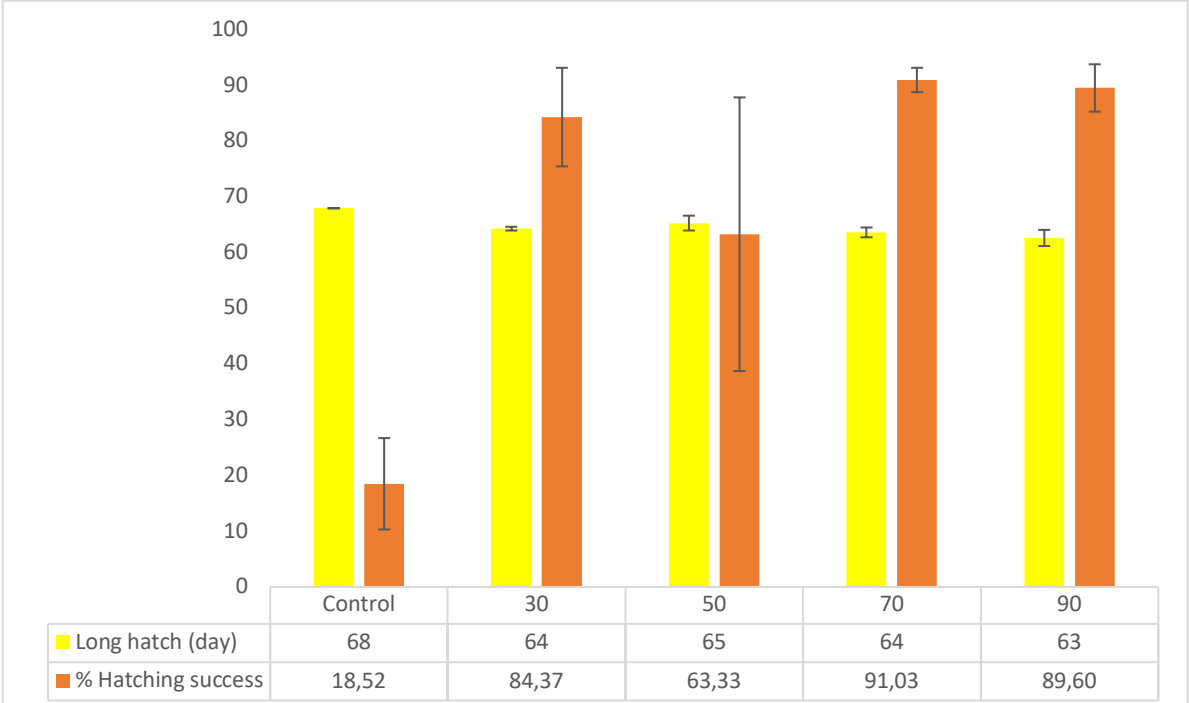
Length of incubation period and hatching percentage of green turtle eggs

The results of the study showed that the success rate of green turtle egg hatching in exposed locations ranged between 85.02%-96.67% (Figure 3), while in sheltered locations it ranged between 18.52%-89.60% (Figure 4).



	control	30	50	70	90
hatching duration (days)	62	61	61	61	61
hatching success rate (%)	90,22	96,67	87,70	85,48	85,02

Figure 3 Comparison of egg hatching time with percentage of hatching success in exposed areas



	Control	30	50	70	90
Long hatch (day)	68	64	65	64	63
% Hatching success	18,52	84,37	63,33	91,03	89,60

Figure 4 Comparison of egg hatching time with percentage of hatching success in shaded areas

DISCUSSION

The results of the study on the nest temperature in the morning in the exposed area were at a depth of 50 cm with a temperature of 30.66 oC while in the sheltered area at a depth of 70 cm with a temperature of 30.01 oC. The temperature during the day in the exposed area that had the highest temperature was at a depth of K (Control) with a temperature of 31.35 oC, while in the sheltered area it was at a depth of 70 cm with a temperature of 30.18 oC. The nest temperature in the afternoon in the highest area was at a depth of 50 cm with a temperature of 31.16 oC, while in the sheltered area the highest was at a depth of 30 cm with a temperature of 29.37 oC. At night the highest temperature in the exposed area was at a depth of K (Control) with a temperature of 30.33 oC, while in the sheltered area the highest nest temperature was at a depth of K (Control) with a temperature of 29.42 oC. Rofiah *et al*. 2012 explained that the temperature difference in each nest is influenced by the intensity of light received on the surface of the nest because some of the heat will be absorbed and propagated on the deeper soil surface and some will be reflected. Setiawan (2015) stated that the higher the temperature, the faster the incubation period will be, while the lower the temperature, the longer the incubation period will be. Temperature can also affect the difference in incubation period, such as research by Sheavtiyan *et al*., (2016) stating that eggs hatched on Sebubus Beach have an incubation period of between 52 and 75 days with an average temperature of 28.27°C.

Humidity (RH) measurements of the nest ranged from 65.40 to 95.73 percent in exposed areas and 69.07 to 98.07 percent in shaded areas. During the day, the highest humidity occurs when the sun's heat is at its peak, and the lowest humidity occurs at night. According to Desi *et al*., (2018) and Putera *et al*., (2015), the humidity of turtle nests is influenced by the water content in the sand substrate, the depth of the nest, rainfall, and the distance and slope of the nest to the beach. The water content of the nest environment is important for the survival of the embryo. Excessive water content causes high humidity. High humidity in the nest environment increases the growth of fungi and bacteria so that it can cover the pores of the egg shell. This closure interferes with the egg respiration process, further inhibiting embryo growth and can even result in death (Baran *et al*., 2001 in Rianda *et al*., 2017). Humidity is also closely correlated with shade, the wider the shade of the nest, the more it can increase the humidity of the nest, because shade will reduce evaporation (Benni *et al*., 2017).

Hasil The results of the study in the exposed area at a depth of 30 cm showed high hatching success with a percentage of success rate of 96.67% with an incubation period of 61 days. While in the sheltered area, the fastest incubation period was at a depth of 90 cm with a percentage of success rate of 89.60%. The lowest percentage of success rate in the exposed area was at a depth of 70 cm with a percentage of 85.48% with an incubation period of 61 days, while in the sheltered area the lowest percentage of hatching was at the control depth (68 cm) of 18.52% with an incubation period of 68 days. Priyono (1994) explained that the longer the incubation period, the lower the percentage of successful hatching of turtle eggs in the nest and the turtle incubation period is shorter if the nest is located in an area that does not have shade or in an area directly exposed to sunlight. According to Dewi *et al*., (2016) and Manurung *et al*., (2016), turtles tend to choose nests near certain vegetation to protect eggs from direct exposure to sunlight, avoid natural predators, and maintain environmental stability around the nest. Figures 4 and 5 show the fastest hatching incubation rate in exposed areas with nest depths of 30,50, 70, and 90 cm, while the fastest hatching incubation rate in sheltered areas occurs at nest depths of 70 cm and 90 cm. The results of this study differ from the results of Rianda *et al*., (2017) the hatching rate of eggs in closed areas or not exposed to direct sunlight is higher than the hatching rate of eggs planted in open places, in addition, hatching is also influenced by nest sand, where nest sand will affect temperature and water content.

The results of statistical analysis conducted on the incubation period in exposed areas and sheltered blood at different depths showed that in exposed areas there was no significant difference in the effect of each level of treatment on the incubation period as seen from the sig. value of 0.532, greater than 0.05 which means H0 is accepted, while in sheltered or protected areas there was at least one difference in the level of treatment given to the incubation period as seen from the sig. value of 0.027, less than 0.05 which means H0 was rejected, when H0 was rejected, a Duncan test was carried out which gave the result that at the control depth (68 cm) it was significantly different from the treatment depths of 30 cm, 70 cm and 90 cm but at a depth of 50 cm it was not significantly different for all treatment levels.

CONCLUSION

Based on the results of this study, it can be concluded that there is no effect of depth on the length of the incubation period in exposed areas, while in sheltered areas there is an effect of depth on the length of the incubation period. At depths of 30, 50, and 90 cm in exposed areas, the incubation time tends to be shorter with a higher percentage of hatching and nest temperature compared to sheltered areas. The longer the incubation time in the nest, the lower the percentage of hatching.

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