A female green turtle at Huyong Island rests at the drop off

TOHYA YASUDA[1], NOBUAKI ARAI[1], KONGKIAT KITTIWATTANAWONG[2], WINAI KLOM-IN[3]
[1]*Graduate School of Informatics, Kyoto University, Kyoto 606-8501, Japan*
Email: tohya@bre.soc.i.kyoto-u.ac.jp
[2]*Phuket Marine Biological Center, P.O.BOX Phuket 83000,Thailand*
[3] *Naval Special Warfare Group, Royal Thai Navy, P.O. Box 21 Sattahip,Cholburi 20180. Thailand*

ABSTRACT
This paper gives preliminary results of diving behavior for one female green turtle during an inter-nesting period at Huyong Island in Thailand. A depth/temperature logger was used to examine the habitat utilization of the female green turtle during an inter-nesting period at Huyong Island in Thailand. In general, it has been believed that female turtles during this period rest at shallow water (typically less than 20 m) because they save energy for the nesting activities. However, time-series of depth for the female turtles at Huyong Island indicated that she sometime dived into the deep area (more than 20 m) although she tried to save energy by performing U-shape diving. A relationship between dive depth and dive duration suggests the deep dives were not resting dives. Previous satellite tracking study indicated that they stayed near the Huyong Island during this period. According to these results, female turtle used a reef edge or a drop-off, as their habitat during inter-nesting period.

KEYWORDS: green turtles, diving behavior, Huyong Island, inter-nesting period

INTRODUCTION

Huyong Island is one of main rookeries of green turtles (*Chelonia mydas*) in Thailand. Year-round nesting of the green turtles is observed in this Island (Kittiwattanawong, 2004; Yasuda et al., submitted). Previous satellite tracking studies showed that female turtles stayed around Huyong Island during the inter-nesting period and they subsequently moved to Andaman Island, India and Phura Thong Island, Thailand after nesting (Kittiwattanawong, 2004; Yasuda et al.). However, our knowledge of underwater behavior of them during both the inter-nesting period and post-nesting period is still rudimentary. Therefore, we used depth/temperature loggers to understand the underwater behavior of female green turtles during the inter-nesting period. This work gives preliminary results of diving behavior for one female green turtle during an inter-nesting period in Huyong Island, Thailand.

MATERIALS AND METHODS

A field experiment was conducted on the nesting beach at the Huyong Island of Similan Islands (8.28°N, 97.38 °E) in Thailand. Night patrols were conducted from 8:00 PM to 4:00 AM to find female green turtles landed on the beach for nesting. A time-depth-temperature logger (UME-190 DT; Little Leonardo Co. Ltd., Tokyo, Japan) with a 12 bit resolution and 64 MB memory was used to record the diving behavior of a female green turtle. Sampling intervals of the logger were 1 second for depth and 10 seconds for temperature, respectively. The logger was attached on a carapace of the female turtle (CCL: 98.0 cm) with epoxy resin after her nesting. The female with the logger returned to the nesting beach for subsequent nesting, and the logger was recovered from the females after subsequent nesting. The data were retrieved from the logger and analyzed using PC and the Igor Pro version 4.0 programs (WaveMatrics, Co. Ltd., USA).

All dives (both periods of activity and inactivity) were defined as starting when the turtle dived below 3 m. A single dive was registered when the turtle was below 3 m for at least 30 s continuously. A dive cycle was defined as an individual dive and the accompanying pre-dive surface time. A surfacing event was defined as when a turtle either reached a depth of 0.5 m or was shallower than 3 m for more than 30 s. Dive depth was defined as the maximum depth attained during the dive.

RESULTS AND DISCUSSION

We found characteristic behavior of the female green turtles from time-series of depth data. The female turtle continuously dived 777 times during an inter-nesting period for 15 days (Fig. 1). Mean dive duration was 22.66 ± 17.77 (S.D.) min and mean dive depth was 23.13 ± 17.77 (S.D.) m. Frequencies of dive duration for different depth categories are shown in Figure 2. At the dive depth of less than 30 m, frequencies of dive duration showed a unimodal distribution. In these depths, dive durations were longer when the turtle dived deeper (Fig. 3). In contrast, from 30 m to 60 m, the frequencies showed bimodal distribution. In the depth of more than 60 m, the frequencies showed unimodal distribution again. However, dive durations were shorter when the turtle dived deeper in these depths (Fig. 3).

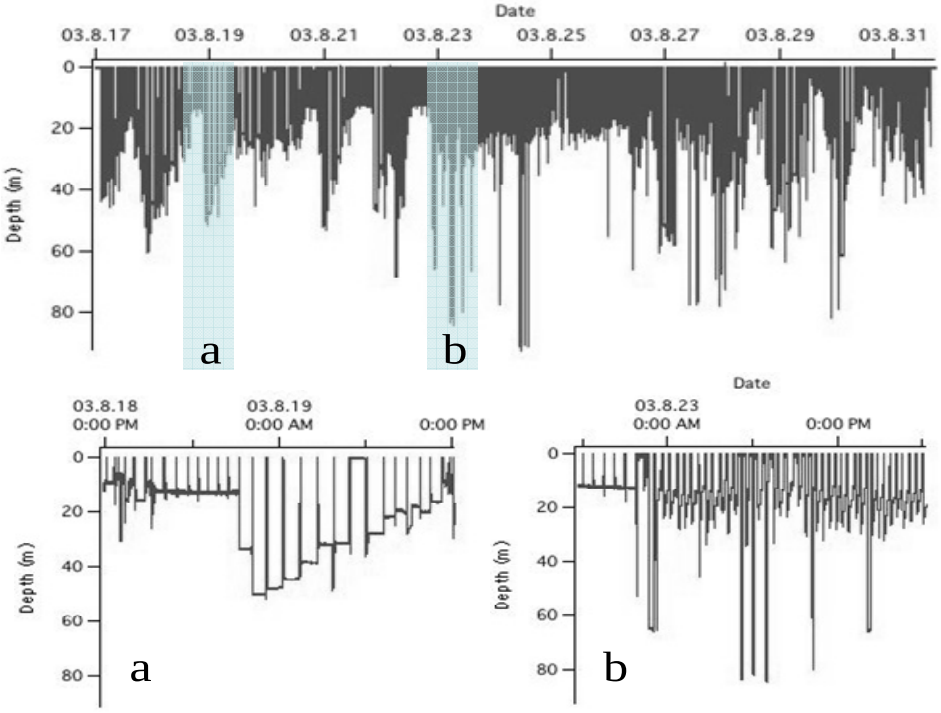

Fig.1. Time series of depth for turtle during inter-nesting period. (a) Enlarged section of a, from 12:00 on August 18 to 12:00 on August 19. (b) Enlarged section of b, from 18:00 on August 22 to 18:00 on August 23.

In general, female green turtles during inter-nesting periods performed resting dives at shallow water (typically less than 20 m) to save their energy for subsequent nesting (Hays et al., 1999). For resting dives, dive durations are longer when animals dived deeper (Minamikawa et al., 2000; Hays et al., 2001). These facts and the results of this study suggest that the female turtles in Huyong Island also performed resting dives at the depth of less than 30 m (Fig. 1 and Fig. 2). Although the female turtle during inter-nesting periods try to save energy in shallow water, she sometime dived into a deep area. For deep diving, dive durations were shorter when the turtle dived into deep area (Fig. 2). This suggests that the deep dives are not resting dives. From 30 to 60 m, frequencies showed the bimodal distribution (Fig. 2). The turtles might perform several types of dive in these areas (Fig. 2). Kittiwattanawong (2004) estimated that home ranges of the female green turtles during an inter-nesting period distributed around the Huyong Island. To perform both the deep dives and shallow dives, female turtles may use the drop-off, such as a reef edge, as their habitat during inter-nesting period.

Why did the turtle dive into deep area? We note the fertile males as the factor which caused deep dives of the female. Courtship and mating behavior occurs around nesting sites (Limpus, 1993; Miller, 1997). Males mate with several females and females mate with several males (Miller, 1997). Certainly, courtship and mating are not gentle processes. Females receive damage to her flippers, neck, head, and carapace from the males (Miller, 1997). Probably, the female dived into deep areas to escape from males. However, further studies are needed to understand the ecology of green turtles in Huyong Island.

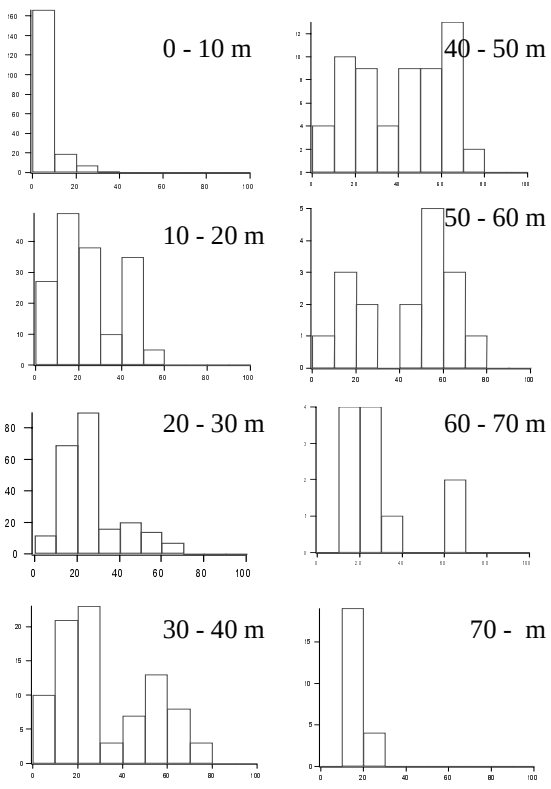

Fig.2. Frequencies of dive duration for the different depth categories.

For example, in time-series of depth data, dive profile of the green turtle exhibits several shapes. To understand ecology of female turtles from diving behavior, we have to examine the roles of these dive profiles. However, it may be difficult using only conventional data correcting systems. Then, new techniques play an important role in analyzing the function of the several dive shapes (e.g. Yasuda and Arai, 2005; Yasuda et al., 2004).

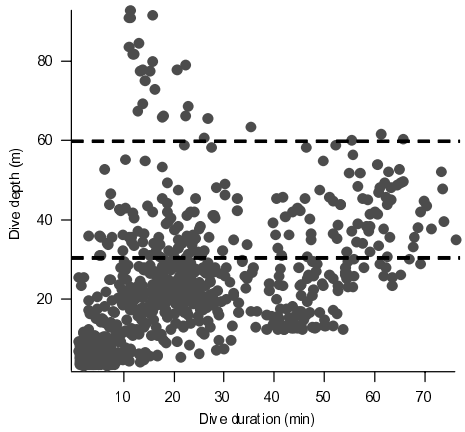

Fig.3. A relationship between dive depths and dive durations for a female green turtle during inter-nesting period.

ACKNOWLEDGEMENTS

We gratefully thank all members of Royal Thai Navy and Phuket Marine Biological Center. This work was conducted under the permission of the National Research Council in Thailand (NRCT).

REFERENCES

Kittiwattanawong, K. (2004). Biology and conservation of green turtles Chelonia mydas in Thailand. PhD thesis, Kyoto University.

Hays, G. C. *et al*., (2000). The diving behavior of green turtles at Ascension Island. 59. 577-586

Limpus, C. J. (1993). The green turtle, *Chelonia mydas*, in Queensland: breeding males in the southern Great Barrier Reef. *Wildl. Res*. **20**: 513-523.

Miller, J. D. (1997). Reproduction in Sea turtles. In: *The biology of sea turtles*: pp. 51-82. Lutz, P. L. & Musick, J. A. (Ed.). Boca Raton, FL: CRC press.

Minamikawa S. *et al.*, (2000). Maintain of neutral buoyancy by depth selection in the loggerhead turtle *Caretta caretta*. *J Exp Biol*. **203**. 2967-2985.

Yasuda, T. *et al*., (2004). Reconstruction of three-dimensional moving paths of green turtles by means of magneto resistive data loggers. *Proceedings of 4th SEASTAR2000 workshop*. 5-8.

Yasuda, T. and Arai, N., (2005)**.** Fine-scale tracking of marine turtles using a GPS-Argos PTTs. *Zool. Sci.* **22**. 547-553.

Yasuda, T. *et al*., Do female green turtles exhibit the reproductive seasonality in a year-round nesting rookery? (submitted)