Establishment of biologging approach to sea turtle in the neritic environment

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ABSTRACT
Data loggers are emerging as a powerful tool for quantifying behavioral parameters of aquatic animals. However, in the history of the study about sea turtles, this approach has been applied only into gravid female turtles which land on the same beach several times within a nesting season because data loggers require physical recovery for data retrieval. Therefore, our knowledge of ecology on sea turtles in the neritic and oceanic environment is still rudimentary. We, in this study, developed an automatic time scheduled release system that allows the loggers to be located and retrieved using VHF radio and ultrasonic signals without recapturing sea turtles. The data logger-recovery experiment was conducted on sea turtles in the neritic environment of the Yaeyama Islands, Okinawa, Japan. We recovered four data loggers and two time scheduled operated release systems at the time we programmed without the data loggers falling out. We demonstrated a high collection rate of data loggers by the recovery system, which means there is viability for the use of various data loggers in the study of ecology of sea turtles.

KEYWORDS: Data logger recovery system, Time scheduled release system, Radio tracking system

INTRODUCTION

The recent development of data loggers has dramatically changed the environment in which to conduct research of aquatic animals. Data loggers can record behavioral parameters like swimming speed and depth experienced. Data loggers made breakthroughs (Sato et al., 1994) in the area of ecology of aquatic animals.

Sea turtles are large turtles that inhabit warm waters of oceans, bays and estuaries. All sea turtles have a similar life history. They are basically creatures that spend their entire lives in marine or estuarine habitats, and only adult female turtles land on the beach for their nesting (Musick & Limpus., 1997). Sea turtles clutches usually contain between 50 and 170 eggs (Ehrhart., 1982) and develop in nests buried beneath the sand of oceanic beaches (Lohman et al., 1997). After hatching, hatchlings emerge *en masse* from the nest, and then enter the sea and swim away from land (Lohmann et al., 1997). After two to three years they move into coastal waters in their northern range, where they spend their juvenile life. Then after maturing, only females return to the nesting beach to lay up to 10 clutches of eggs in a season.

Therefore, the only behavioral data we obtained by data loggers for sea turtles was from gravid females landing on the beach, because of their life history as mentioned above and data loggers required physical recovery for data retrieval. Therefore, our knowledge of ecology of sea turtles in the neritic environment is still rudimentary.

It is only recently that the time scheduled release system to retrieve data loggers was developed. In this system the data loggers are separated from aquatic animals after recording and at a programmed time, so it is not necessary to recapture the aquatic animal. As a result, previous studies have provided new insights on Mekong Giant Cat fish (Mitamura et al., 2005) and Baikal seal (Watanabe et al., 2006).

MATERIALS AND METHODS

Study area

This study was conducted on the north part of Ishigaki Island which is one of the Yaeyama Islands. The Yaeyama Islands have several small nesting sites of hawksbill turtles (Kamezaki,1986; 1989). Also, Kamezaki & Hirate (1992) reported that there were some immature hawksbill turtles, in which the Straight Carapace Length (SCL) of their captured samples was between 393mm and 631mm that had wide distributions with highest peak in the class size 440-460mm.

Experimental animals

Four juvenile hawksbill turtles and one green turtle were used for this experiment (Table.1).

Attachment of the recovery system of data loggers

Recovery system of data loggers in the neritic environment for sea turtles consisted of two systems,

time scheduled release system and radio tracking system. The time scheduled release system consisted of a data logger (DST-milli, Star-Oddi, USA), a time scheduled releaser (Little Leonardo Co., Tokyo, Japan), a very high frequency (VHF) radio transmitter (MM340B, ATS, USA), and an ultrasonic transmitter (V16-5H continuous, Vemco, USA).

Table1 Summary of the physical traits

ID (species)	SCL (cm)	SCW (cm)	BW (kg)
1 (hawksbill)	47.7	40.1	12.0
2 (hawksbill)	49.5	38.5	11.5
3 (green)	65.9	51.6	32.0
4 (hawksbill)	45.4	38.7	8.1
5 (hawksbill)	52.2	40.4	14.0

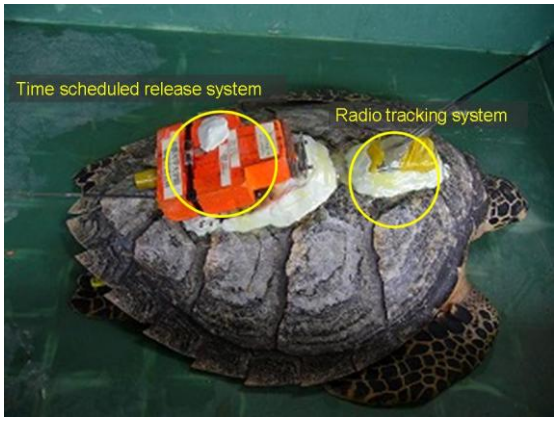

Fig.1. The recovery system of data loggers

In this study, dummy data loggers were used because this study was conducted only with the aim of confirming the probability of data logger recovery. At the programmed time, the releaser explodes and breaks a band which fixes a float to a turtle's body. These components were packaged in a T-shaped housing (length: 13cm; width: 9cm; height: 4cm) composed of incompressible polystyrene foam (Nichiyu Giken Kogyo Co., Saitama, Japan). For recovery, the very high frequency (VHF) radio transmitter was equipped to retrieve the data logger after operating the time scheduled releaser. The ultrasonic transmitter was incorporated to find the data logger in case the logger was entangled in something under the sea after separating from turtles' body. The units of individuals were slightly positively buoyant. Therefore, after the time scheduled releasers operated, the units came up to the water surface. We attached the units on the carapace. The units were also fitted with fairings made with quick-set putty.

The radio tracking system consisted of another very high frequency (VHF) radio transmitter (MM130B, ATS, USA). The radio tracking system was designed to confirm the positions of sea turtles before the release system operated. We attached the units to rear of the carapace and bonded them with quick-set putty as well as the time scheduled release system.

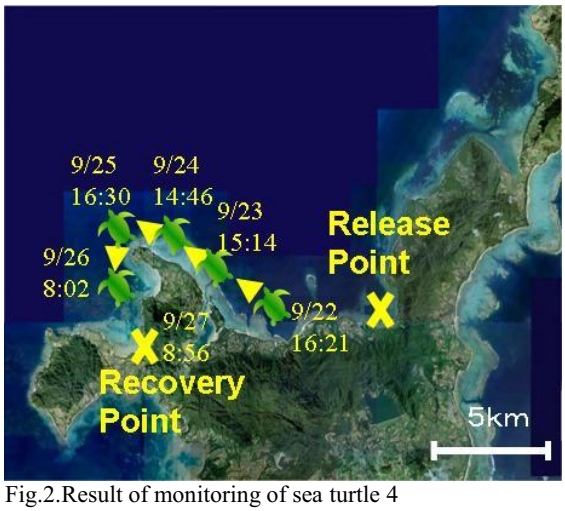

Fig.2.Result of monitoring of sea turtle 4

Tracking

Tracking was conducted from land like hills or mountains. We could detect radio signals when the turtles came up to the surface to breath and the antennas emerged above sea level. We then recorded the direction of the turtles. We monitored at several locations on Ishigaki Island and we then located the turtles by triangulation.

RESULTS

We recovered four data loggers and two time scheduled operated release systems at the time we programmed without the data loggers falling out.

Turtle 1, Turtle 2 and Turtle 3 were released in June. Turtle 1 moved out of the area we could access by boat, so we couldn't recover the logger. The data logger of Turtle 2 was accidentally uncoupled before the time scheduled release system operated, but an anonymous diver found it entangled in a coral reef. The time scheduled release system of turtle 3 worked very well. However, the data logger was entangled in something under the sea. We tried to look for it by ultrasonic receiver but unfortunately we were not able to take a boat out because of the weather. However, after three months, the float was found on the beach by a resident.

The other turtles were released in September. For turtle 4 after 5 days monitoring and operation of a time scheduled release system at the time we programmed, we found a float on the beach in the western part of the island. The result of turtle No5 was similar to the result of turtle No2. The float was accidentally uncoupled before the time scheduled release system operated, but we found it on the beach near the releasing point by radio tracking.

Some data loggers were found easily by using the tracking data obtained by the radio tracking system. A little before the time scheduled releaser operated, we were able to determine the exact position of surfacing and retrieve the data loggers.

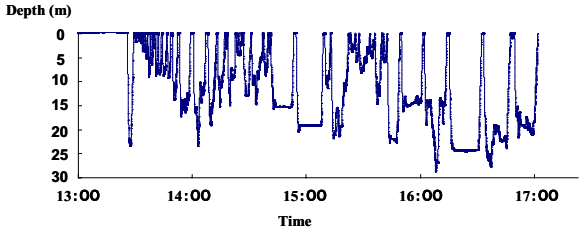

Fig.3.Time-series of depth of Turtle 5 obtained from the recovery system

We used dummy loggers whose batteries run out of power, but fortunately the data logger of turtle 3 was still working. Therefore we also got diving depth profiles and plotted depth data. All vertical movements of ≥3.0m depth were considered dives. We characterized each dive visually by the general shapes of descent, bottom, and ascent phases of time-depth plots. We also calculated depth (m) and duration (min) for each dive. Depth was defined as the deepest point on the dive profile.

DISCUSSION

We demonstrated of high collection rate by the recovery system of data loggers, which means there is viability for use of various data loggers in the study of ecology of sea turtles. Here were the two keys to success. Firstly, we increased the discovery rate of the data loggers by separating them from turtle's body. When the data loggers emerged from the deep, local people or outsiders might find them even if we failed to locate them. The data loggers are easily washed up on the shores where we could retrieve them. Secondly, the radio tracking system also helped us find the data loggers, because we understood the exact position of surfacing of the data loggers. Without this system, the data loggers would have been swept away by currents before we got to the recovery location.

As to requirements for system in general, if you will use this recovery system in other study sites, you have to attach the data loggers to turtle's body strongly such that they do not become uncoupled before the system operates. Then, to recovery data loggers. In the neritic environment, we should understand currents in study sites and consider weather and tide conditions to avoid data loggers from being swept away.

When we estimate the position of sea turtles by radio tracking systems, we need data obtained at several monitoring points. Therefore it is desirable to have a lot of monitoring points on land like high mountains and hills with easy access.

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Table 2. Summary of dive data on turtle 3

N. of the dives	Max depth(m)	Mean duration of the dives(min)
41	12.3±7.6	6.9±4.48

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