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A Long Term Internal Tag for Sea Turtles

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A LONG TERM INTERNAL TAG FOR SEA TURTLES

Sea turtles are rare and endangered reptiles that are of concern by states (Schwartz, 1977a,b), nation (Anonymous, 1973; Henderson, 1978; Christman and Lippencot, 1978), and world (ICUN, 1969). Although various aspects of their biology have been studied we lack basic information concerning their life span or how they migrate long distances to and from a nesting beach, perhaps even to their beach of origin. These gaps in our knowledge stem from the inability to tag and follow a sea turtle throughout its life.

External tags such as Peterson Disk or plastic Roto tags pull out or deteriorate through sand abrasion. Only Monel tags exhibit long-term retention or resistance to sea water or the elements (Carr, Carr and Meylan, 1978). Recent use of tag telemetry has proven costly, time consuming, and of limited tracking potential (Timko, 1980).

Carr *et al.* (1978) aptly noted, "Because of the difficulty of developing a tag for the hatchling that will remain in place when the turtle bearing it grows from a weight of 25 grams to 575 kilograms or more, it has not been possible to prove that homing turtles return to the place at which they hatched." Thus, to meet such a formidable task a tag has to be of light weight and size, inert, retained by the sea turtle throughout its life span (regardless of age or size), should not induce sores or shedding, and not impair the swimming activites of the turtle. A tag that met these requirements was the internal wire coded tag developed on the west coast of the United States for salmon (Jefferts *et al.*, 1963; Bergman *et al.*, 1968; Ebel, 1974; Hager, 1975; Moring and Moring, 1976) and recently used in the spot prawn *Pandalus platyceros* (Prentise and Rensel, 1977).

Binary or color coded wire tags, either of round or flat stainless steel design are available in one or two millimeter lengths. Insertion is via an expensive sophisticated injector or a modified manually operated hypodermic syringe. I chose the latter less expensive method. Tag retention rates above 90% have been achieved for fishes and prawns (Moring and Moring, 1976; Opdycke and Zajac, 1981). While Ebel (1974), Lesh and Rowell (1981), Smith (1980), and Zirges (1976) have devised special equipment for tag holding prior to decoding or retrieval (Hager, 1975), no such devices were necessary in this study. Cost/turtle, other than a one time syringe cost, has remained the same from 1977 to 1981 at 06¢/tag/turtle or $30-60/1000 tags (cost is dependent on 1 or 2 mm length tags.)

Other than that mentioned in the text, 390 hatchling green sea turtles have been released in 1980 with internal tags in their front flipper into the Atlantic Ocean at Camp Lejeune and Ft. Macon, N.C. These resulted from the first documented multiple nesting in North Carolina (Schwartz *et al.*, 1981). Likewise, 3037 internal tagged loggerhead hatchlings, hatched from other nests, were released at the same sites in 1979 and 1980.

STORAGE FACILITIES

Between April and December all tagged and control sea turtles were kept in large outdoor 9.1 x 18.2 meter rectangular concrete tanks of 1.2 mil liter capacity. Continuous flow through water was pumped from nearby Bogue Sound (salinity range 10-34 ppt.). All specimens were transferred indoors for the winter once water temperatures dropped to 10°C and held in round 1.5 m metal tanks of 900 liter capacity. Indoor tank water was changed every 2-3 days from reservoirs where the incoming water was stored and warmed to ambient room tem-

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peratures above 10°C. Food, during the test period 1977-1980, consisted of a variety of fresh or frozen fishes and invertebrates.

TAGS AND TAG SITES

Initially, in 1977, a standard, binary-coded, grooved, type 302, stainless steel, rod tag 0.254 mm diameter x 2.0 mm long was inserted into hatchling or subadult Atlantic loggerhead and green sea turtles. A fault of this tag design was that the round configuration of the rod tag permitted a maximum of only 16,384 consecutively different identification numbers. Because of this numerical limitation, a flat binary-coded, stainless steel, grooved tag 1.067 mm wide x 0.406 mm deep x 2 mm long was devised for the 1978 tagging studies. The flat surfaces of that tag permitted greater combinations of available tag numbers and, more importtantly, made the tag code number easier to read by eye or from radiographs.

Rod tags were inserted into the neck (midway between the skull and shell) and dorsal surface of the flippers of each hatchling or subadult sea turtle tagged in 1977. Flat rectangular tags were similarly inserted in the surviving hatchlings tagged in 1978. Neither tag was injected into the body cavity. Some test specimens received multiple tags per appendage. Tags were inserted via a modified metal syringe fitted with a 24-gauge hypodermic needle. Initially the tagging time to insert 50 tags varied from 6 to 22 min but with experience 225-250 turtles/hr were tagged. Insertion was accomplished by approaching the insertion site at about a 20° angle to the flipper or body surface (Fig. 1). Periodically radiographs were taken of all specimens, to note if the tags were shed or had moved as a result of the turtle's body movements. Tags were readily visible on the radiographs and tag number was read directly without magnification over fluorescent lights or through a dissecting microscope (Fig. 2a).

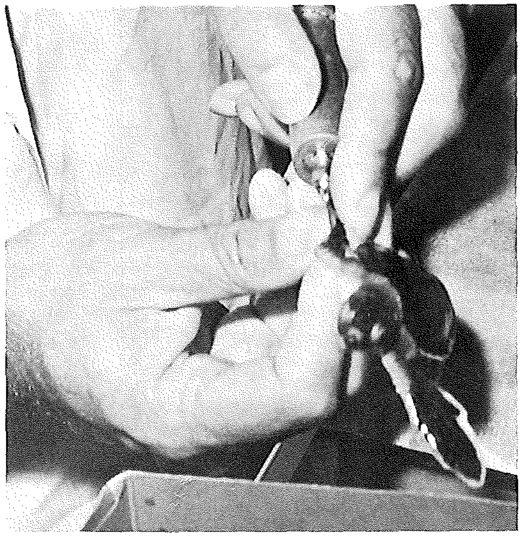

Figure 1. Tagging hatchling green sea turtle illustrating hand held injector syringe and angle of tag insertion.

RADIOGRAPH METHODS AND VALUE

Radiographs of any tagged sea turtle can be easily achieved with permanent laboratory or portable field units. Field detection of the tag site is by noting a white scar on the front flipper (the best tag site is near the distal end of the humerus of the front flipper). Tags need not be removed from the turtle, as is done for fishes (Hager, 1975; Smith, 1980) once implanted.

The utility of the wire coded tagging method will be best realized in areas, such as Tortugero, Costa Rica, etc. where large nestings by adult sea turtles occur or where mass hatching and release from turtle hatcheries (Mexico, Texas, Florida, North Carolina) exist. While the wire coded tag method is best suited for areas of mass nesting or hatchling production the low costs involved per tagged turtle make it an attractive alternative to present external tagging methods. The ability of the tag to be retained by a sea turtle throughout its hatchling to adult life now resolves one of the long-term retention problems noted by Carr, Carr and Meylan (1978). Further, periodic recaptures of tagged sea turtles will permit a continuous monitoring of their activities and will shed light on their age and growth, possible return to original beach of release, subpopulation status, and a host of other aspects now unresolved.

OBSERVATIONS AND RESULTS

Green Turtles

Twelve of sixteen (10 hatchling and 2, 2-yr old) green turtles, *Chelonia mydas*, obtained from the state of Florida, were tagged in each limb and neck area with the rod tag in 1977 (Figure 2b). Six tagged turtles survived the three-year study. Four (3 hatchlings and 1, 2-yr old turtle) tagged and two untagged control turtles succumbed during the 1977-78 winter to an eye fungus to which green sea turtles are susceptible (Witham, 1973), although all turtles were treated several times per week to baths of $KMnO_4$ and boric acid solutions in efforts to control the infection. Two additional tagged small green sea turtles and the remaining two controls succumbed to the eye fungus during the winter of 1978-79. These deaths were also attributable to the fungus and not to the tags as no sores were evident in relation to the tag site(s). Turtle behavior was normal in that feeding or swimming was also not impaired by the tag.

All green turtles that died within the first six months of tagging retained the internal tags. Of the 60 rod tags implanted in 1977 in the six turtles that survived one year of tagging, only three tags, which had been inserted into the right rear, left front and left rear flipper of three separate turtles, were lost. Rod tags were retained best (80%) in the neck and right front flipper during the year 1977-78.

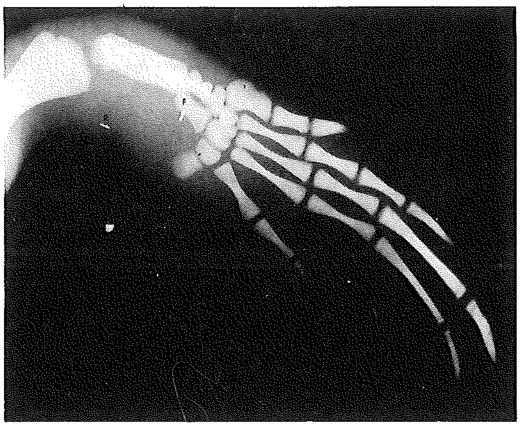

Figure 2a. Enlargement of right flipper of two year old green sea turtle illustrating binary coded wire tags (x 5.88). F = flat tag, R = rod tag.

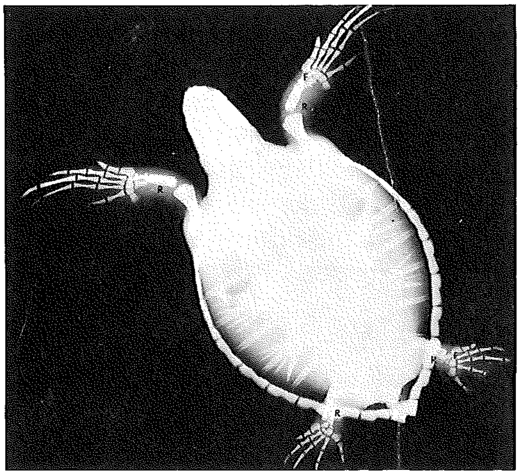

Figure 2b. Two year old Atlantic green sea turtle illustrating internal tags in each flipper. Both rod (R) and flat (F) tags visible in the right rear flipper (x 1.79).

The same six green turtles tagged in 1977 were retagged with flat tags in 1978 and retained all flat tags in the right forelimb during 1978-1979 but lost one neck and one left forelimb tag to yield an overall (2-year) flat tag retention of 73%. No further round or flat tag loss was evident during the 1979-80 year. The five largest specimens were released into the wild 18 September 1980 at Ft. Macon, N.C. following additional external tagging with Monel strap tags. One was subsequently recaptured a month later in the nearby Newport River, North Carolina. Growth of all surviving tagged green turtles was not impaired by the internal tag as substantial individual length and weight increases were achieved each year (Table 1).

Atlantic Loggerhead

Thirty hatchling and four subadult Atlantic loggerhead (3 female, 1 male, weight 43-81 kg) turtles *Caretta c. caretta* from three geographic areas were tagged in 1977 with rod tags (Table 2) in each limb and in the neck, similar to that of the green turtles. The 14 survivors were also retagged with flat internal tags in 1978. The flat tag was harder to insert as the rectangular flat end offered more resistance than did the circular end of the rod tag used in 1977. The tagging site was checked visually immediately to ascertain that the flat tag had not backed out. Round tag retention for the hatchling turtles, after one year, varied between 73 and 90%, with the right forelimb exhibiting best retention. No further loss of round tags was evident in 1978-1980. After two years 70-90% of the flat tags had been retained by 10 surviving turtles (Table 2). Right forelimb tag retention was the best. Overall, forelimb and neck areas, regardless of type of tag, seemed to be better retention areas than were the hind limbs (Table 2).

Only 10 tagged hatchling loggerhead turtles survived for more than two years. Death was attributed to an eye fungus, which affected or killed tagged and 14 control turtles during the 1977-78 winter, and not to either type of tag. The subadults having developed no eye infection retained all inserted tags, survived the three year study and achieved substantial growth.

Growth of the small loggerheads (Table 2) was not impaired by tagging but size and growth-rate differences were evident in the hatchlings, which were offspring from eggs obtained from three different geographic areas (Table 2). The

Table 1. Growth of Atlantic loggerhead sea turtles from three geographic localities and six (five hatchling and one 2-yr old) green sea turtles from Florida tagged with internal wire tags during study period 1977 through 1980.

Geographic Area	Original Hatchling 1977 $\bar{x}$ (c)Carapace Length* (w)Weight** C	N			September 1978 $\bar{x}$ (c)Carapace Length (w)Weight C	N			September 1979 $\bar{x}$ (c)Carapace Length (w)Weight C	N			September 1980 $\bar{x}$ (c)Carapace Length (w)Weight C	N		
Atlantic Loggerhead																
Melbourne, Fla.	5	11	(c)	55.7	0	6	(c)	175.5	0	2	(c)	280.0	0	2	(c)	339.0
			(w)	40.9			(w)	904.5			(w)	2975.5			(w)	5999.0
Pea Island, N.C.	5	15	(c)	52.9	0	5	(c)	166.8	0	5	(c)	260.6	0	5	(c)	283.0
			(w)	30.5			(w)	733.9			(w)	2343.5			(w)	3410.0
Onslow Beach, N.C.	4	4	(c)	51.6	0	3	(c)	133.7	0	3	(c)	253.0	0	3	(c)	315.0
			(w)	28.4			(w)	743.0			(w)	2581.0			(w)	4845.0
Green																
Florida	4	10	(c)	71.4	2	7	(c)	189.8	0	5	(c)	281.0	0	5	(c)	311.8
			(w)	55.6			(w)	954.2			(w)	2837.0			(w)	3575.0
	0	2	(c)	129.7	0	1	(c)	265.0	0	1	(c)	330.0	0	1	(c)	353.0
			(w)	279.5			(w)	2368.4			(w)	4163.0			(w)	4930.0

$\bar{x}$ = mean
* = millimeters
** = grams
C = controls
N = number tagged

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Table 2. Number of tagged Atlantic loggerhead hatchlings obtained from three geographic sources retaining internal tags inserted in five body locations during the test years 1977 through 1980.*

Geographic Area	Number Tagged	RF T	RF R	RR T	RR R	N T	N R	LF T	LF R	LR T	LR R	Overall Percent
1977-1978												
Melbourne, Fla.	11	11	11	10	8	12	5	13	8	10	7	70
Pea Island, N.C.	15	15	12	12	9	14	13	10	9	14	14	88
Onslow Beach, N.C.	4	4	4	3	3	4	4	3	3	4	4	100
Total Retention	30	30	27	25	20	30	22	26	20	28	25	
		90%		80%		73%		77%		82%		81
1978-1979												
Melbourne, Fla.	2	2	2	2	2	2	2	2	2	2	1	90
Pea Island, N.C.	5	5	4	5	4	5	4	5	3	5	3	72
Onslow Beach, N.C.	3	3	2	3	3	3	2	3	3	3	3	80
Total Retention	10	10	7	10	9	10	9	10	8	10	7	78
		70%		90%		80%		80%		70%		

RF = Right front flipper
RR = Right rear flipper
N = Neck
LF = Left front flipper
LR = Left rear flipper
T = Total number tags inserted
R = Total number tags retained
*No further tag loss occurred during 1979-1980.

largest and heaviest loggerhead hatchlings were from Melbourne, Florida. Pea Island, North Carolina, hatchlings (from eggs transferred from Cape Romain, South Carolina) were next largest, while those from Onslow Beach, Camp Lejeune, North Carolina, were the smallest (Table 2). These size differences persisted after three years growth when the Melbourne turtles were the heaviest, by weight, followed by Onslow Beach and Pea Island turtles (Table 2). All but three of the tagged turtles were fed the same whole natural food diet. The three Onslow Beach specimens had been held at a nearby aquarium facility and fed a fish meal diet. This apparently accounted for their size differences in 1978 rather than any impairment resulting from the tagging. Florida (Melbourne) loggerhead turtles were more susceptible to the eye fungus than those from northern egg clutches. Growth and swimming abilities of all survivors were not impaired by tagging. The five Pea Island test specimens were released in 1980 into the Atlantic Ocean at Pea Island.

An additional internal tag study was performed in 1978 using 35 loggerhead hatchlings from Surf City, N.C. eggs. Fifteen specimens were maintained as controls in the same holding tank as the tagged turtles. Ten of the 20 tagged specimens were tagged in the neck, right fore and hind flipper, while 10 were tagged in the neck, left fore and hind flipper. No noticeable effects of the tags were evident other than a white mark developed at each injection site. Tags inserted within the flippers were better retained than those within the neck. Tag loss during the 1978-79 year, per 20 turtles, was: right flipper - l, left flipper - 1, rear flipper - none, as opposed to 7 of 20 neck tags were lost. Neck tag loss resulted if the tag was sluffed when the turtle retracted its neck. Tag retention, after one year, was 85% regardless of side tagged. All the controls as well as 18 tagged turtles succumbed to eye fungus by February (control) or April (tagged) 1979. The two survivors were released into the sea following the one year observation.

CONCLUSIONS

Thus, the internal binary-coded wire

tag proved to be a potentially long-term, efficient, and harmless tag for sea turtles. It can be magnetized to permit field detection of a previously tagged sea turtle prior to field X-ray detection of the tag. The recent availability of portable X-ray units, with daylight development of the film, also permits quick identity of a previously internally tagged turtle. When one is hesitant in using the internal tag alone, turtles one year or older can be doubly tagged with the standard Monel external tag. Thus, use of the internal tag permits more reliable data to be accumulated on hatchling sea turtle survival per nesting site, frequency of beach use by subsequently mature females, as well as data on the longevity and movement patterns of adult turtles on land or sea without fear of tag loss. This tag breakthrough also enhances our long-term understanding of these endangered animals.

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