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Factors Affecting the Retention of Metal Tags on Sea Turtles

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The identification of individuals with easy-to-read tags that remain in place for many years is the most fundamental tool that can be utilized to study sea turtles in the wild. Self-piercing Monel alloy flipper tags manufactured by the National Band and Tag Company (NBTC) of Newport, Kentucky USA have been extensively used for this purpose over the past 25 years. Although tag loss is known to occur, some impressive successes have been achieved in gathering data for certain populations. A reliance on these tags can therefore be expected to continue during the coming years. In view of this anticipated usage, it will be helpful to summarize the various interrelated problems, and offer suggestions for enhancing tag retention.

Locking-Mechanism Failure. There are two styles of locking mechanisms in the tags produced by NBTC. One consists of a "tamper-proof" design in which the piercing point bends over a bridge on the inside surface of the tag. In the other, the piercing point passes directly through a hole in the tag and bends over on the outside surface. The tamper-proof lock was originally designed for domestic livestock and is sold in NBTC tag sizes 49, 62, and 4 (Table 1). Size 49 has been the most popular tag for adult sea turtles.

Table 1. Specifications of NBTC's self-piercing Monel flipper tags.

Style 4-1005 size No.	Length (mm)	Width (mm)	Mean width of gap (mm)	Locking mechanism
49	40	10	11	Bridge
19	40	10	11	Hole
62	35	10	10	Bridge
681	25	8	9	Hole
4	18	5	5	Semi-bridge
3	13	4	4	Hole
1	8	2.5	2.5	Hole

Until this past year, the through-the-hole lock has only been available in size 681 and the very small

sizes 3 and 1. However, due to the greater strength of this lock, and periodic breakage of the bridge of the tamper-proof design, NBTC now manufactures size 49 tags with an optional through-the-hole lock. This improved version has been designated as size 19.

A disadvantage of the through-the-hole lock is that when the piercing point is not fully bent over, the tag may be more prone to snagging and loss should the turtle encounter nets. This problem can be avoided by making certain that the point has locked fully into place with the special applicators. If a complete bend of the point has not occurred, this should be carried out using standard pliers. Even if entanglement is not a concern to the researcher, tags with the through-the-hole lock should still he routinely inspected and the lock corrected as needed. In contrast, it is impossible to correct an improperly locked tag with the tamper-proof design. In such cases, the tag should be removed and replaced with a new one.

A spring-action effect that exists in the tag after attachment places stress on the locking mechanism. Tags that have been on for many years may still retain this property and pop open 5 mm or more if the lock fails. Such tension contributes to the failure of the lock, particularly when corrosion of the metal develops in this region. The spring action can be easily eliminated after attachment by using pliers to squeeze the two sides of the tag slightly together at a point about one-third from the folding end. Only a minimum of pressure is needed. When carried out properly, there will be no visible evidence that the tag sides were momentarily bent inward. It should be noted that even if the lock fails and the tag springs open, tag loss will not always result.

Tissue Necrosis. Attachment of the tag in a manner that compresses tissue to the point of blocking vascular circulation can result in necrosis. To avoid this situation, the distance from the piercing site to the trailing edge of the flipper should be the same, or slightly less, than the length, of the tag when locked. If the distance on the flipper exceeds the tag length, the tissue will be gathered together and constricted after the tag is attached. Necrosis can also develop when the two sides of the tag are crushed together after being attached to the turtle. Tags damaged in this manner have been seen in Hawaii, Australia and Nancite, Costa Rica. This problem is almost certainly the result of turtles nipping at each other, or at their own tags. It may also be caused by certain fish, such as common and spiny puffers (Tetradontidae and Diodontidae) biting at tags while the turtles are resting underwater. The shiny appearance of Monel tags may stimulate biting. However, certain algae and invertebrates often grow on the tag and mask this brilliance. Tags that corrode are less apt to host encrusting growth due to the antifouling toxic properties of copper and nickel released in the corrosion process. A method for possibly reducing biting would be to render the tag less noticeable by using the smallest tag practical. For example, the size 681 tag is less conspicuous and more appropriate for adults of several if not all sea turtle species. A further disadvantage of larger tags is that when they are applied to their full length, piercing can take place through thick and potentially important musculature. This is more likely to occur in the smaller species. For researchers contemplating a change to the 681 tag, it should be noted that an inscription of up to 35 letters can be accommodated. This is less than the 55 letters possible on the size 49 and 19 tag, but is adequate for most addresses. Necrosis can also be caused by the release of chemicals that result from Monel corroding in contact with the piercing site.

Tearing. Tags can be torn out of the flipper by biting, snagging in nets and other objects, or by the slapping against the carapace that occurs during nesting. A tag is more likely to be torn out if it hangs loosely on the flipper. While prevention of tissue necrosis requires that the distance from the piercing site to the flipper's trailing edge be equal to or slightly less than the tag length, too short of a distance will make it liable to tear. For subadult turtles, some risk must be taken in order to ensure adequate space inside the tag to accommodate growth.

The location where the tag is attached can also influence tearing. A survey by the author of the exact location where various researchers attach flipper tags revealed a wide range of sites currently in use.

Tags that pierce directly through keratinized scales on the flippers should be more resistant to being torn out than tags placed in the webbing between these scales, or in the flap of soft tissue where the front flipper joins the body. However, working of the tag back and forth due to swimming movements of the flippers, and slapping on the carapace during nesting, increases as the tagging site becomes more distal. Also, in the tagging of adult males, especially green turtles, a greater proportion of the nipping during mating activity is directed at the distal edges of the flipper.

Abrasion. Abrasion of tags can result from contact with substrate when turtles are feeding and resting underwater, and nesting. This action produces scratches on the tag and, over an extended period, may cause loss of metal and contribute to tag loss. However, unlike plastic tags, where the effects of abrasion (and susceptibility to breakage) can be severe, metal tags appear to be very resistant to this form of damage.

Corrosion. Corrosion of Monel tags appears to be common, but its degree varies significantly, even within the same population of turtles. In many instances, corrosion is responsible either directly, or indirectly, for tag loss. The appearance of corroded tags can range from only a greenish surface discoloration to one that is pitted and deteriorated with certain areas paper thin. The rate of corrosion is not always correlated with the time that the tag is attached. No clear reasons exist to account for these differences. Some possible factors may include the composition and temperature of the seawater, diet of the turtle, serum chemistry, and small but conceivably important differences in the composition of the alloy used and the manner in which the tags were manufactured. In captivity, corrosion may be accelerated by electrolysis created between metals present in the facility and the tag. Corrosion is often more severe around the locking mechanism and in the letters stamped on the tag. The metal in these areas is subjected to greater stress during the manufacturing process, a factor that reduces corrosion resistance. Accelerated corrosion is also frequently found in the tag area that passes through the piercing site and rests in direct contact with internal tissue. In such cases, the incision will not heal but rather show necrosis and fluid drainage. The area of the tag in contact with this wound will not necessarily be the piercing end because rotation can occur after attachment.

The basic problem of corrosion in Monel tags is the inability of this particular alloy to withstand extremely corrosive conditions. This was not realized when Monel was selected for tags. Some of the desirable attributes that contributed to the selection of Monel, and are responsible for its continued use, include availability, relative low cost, metallurgical properties that make it easy to fashion into tags, and successful use on some sea turtles.

Investigations undertaken, at the author's request, by NBTC and Huntington Alloys, Inc. (Huntington, West Virginia, USA) have resulted in the special production of size 681 tags made from the highly corrosion-resistant alloy, Inconel 625 (see Marine Turtle Newsletter 1976, 1:3-4 and 1977, 2:7-8). Although attached to Hawaiian green turtles for up to 5 years, tags have shown no evidence of the corrosion previously found in this population with Monel tags. Inconel tags are not commercially available at present, however, their production could be initiated if financial support was made available to NBTC.

Other Tagging Considerations. The use of two or more tags on each turtle is a simple method for promoting longer-term recognition and measuring tag loss. On adult Hawaiian green turtles, two size 681 tags can be attached to each front flipper without appearing to burden the animal. Another worthwhile practice is to replace all old tags that are not adequately attached or show signs of corrosion. The value of a turtle to a research program increases each time it is recovered. Every effort should therefore be made to improve an individual's chances for continued recognition. The cost of tags in most research programs constitutes only a small percentage of the total expenditures. If tag problems are thought to exist, both the researcher and the funding agency should be willing to spend more to rectify

this critical deficiency.