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Received: 19 September 1997
Reviewed: 26 April 1998
Revised and Accepted: 15 May 1998

Chelonian Conservation and Biology, 1998, 3(1):102–104

Use of Passive Integrated Transponder (PIT) Tags for Marking Small Freshwater Turtles

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Internally injected passive integrated transponder (PIT) tags have been used in recent studies on a wide variety of animal species, including salmonid fishes (Prentice et al., 1990; McCutcheon et al., 1994; Peterson et al., 1994), crustaceans (Pengilly and Watson, 1994), birds (Elbin and Burger, 1994), and mammals (Thomas et al., 1987; Barnard, 1989; Ball et al., 1991). In amphibian and reptile studies, PIT tags have been used on salamanders (J.A. Ott and D.E. Scott, *pers. comm.*), snakes (Keck, 1994; Jemison et al., 1995), lizards (Germano and Williams, 1993), crocodilians (Dixon and Yanosky, 1993), freshwater turtles (Camper and Dixon, 1988), and sea turtles (Fontaine et al., 1987; McDonald and Dutton, 1996; Steyermark et al., 1996). Loss incidence of internally injected PIT tags appears to be low. Reported tag loss has been attributed to inability to detect the tag in large animals (Steyermark et al., 1996) or to faulty implantation (Freeland and Fry, 1995). PIT tag retention of 100% has been reported in pine snakes (*Pituophis melanoleucus*) by Elbin and Burger (1994) and in leatherback turtles (*Dermochelys coriacea*) by McDonald and Dutton (1996).

Internal injection of PIT tags has been successfully implemented with large sea turtles but has not yet received popular application with small freshwater turtles. Although hard-shelled turtles are easily marked for long-term studies by notching carapacial marginal scutes (Cagle, 1939; Gibbons, 1986), the use of PIT tags might have several valuable applications and advantages. Scute notching is remarkably reliable and permanent when used on adult and subadult turtles, but PIT-tagged juveniles could be positively identified upon recapture when the interval in years is large and scute notches difficult or impossible to identify.

Also, if PIT tags could be injected into the body cavity without adverse effects, species that are difficult to mark, such as soft-shelled turtles (Trionychidae), could be better studied. Movement patterns of PIT-tagged turtles could be monitored with remote scanners over frequently used or established routes, such as openings in drift fences or entrances to tortoise (*Gopherus* spp.) burrows, where a scanner could be positioned within close range of a passing turtle. This technique was employed to study the use of highway culverts by desert tortoises (W. Boarman, *pers. comm.*) and has been successfully used with other taxa such as fish and mammals (Prentice et al., 1990; McCutcheon et al., 1994; Harper and Batzli, 1996). PIT tags are very useful for long-term marking of captive animals, particularly where physical disfigurement caused by carapacial notching is undesirable (B. Tryon, *pers. comm.*). Also, there is potential use for PIT tags in wildlife law enforcement and in detecting illegal trafficking of endangered species. Our goal was to determine if PIT tags are suitable for individual identification of small turtles, specifically freshwater emydids.

Methods. — We injected PIT tags (American Veterinary Identification Devices [AVID], Norco, CA) (12 x 2 mm, 0.096 g) into 7 *Trachemys scripta elegans* ranging in size from 86 to 131 mm plastron length (PL). We chose three injection sites into the inguinal region of the body cavity: A) anteriorly and parallel to the bridge of the shell ($n = 3$ turtles), B) anteriorly and perpendicular to the spine ($n = 2$), and C) posteriorly and parallel to the carapace edge ($n = 2$) (Fig. 1). Due to the small size of our turtles, we did not inject PIT tags into the legs to avoid damage to neurovascular structures and impairment of muscle movement. After cleansing the skin with 70% isopropyl alcohol, we inserted the 12-gauge injection needle swabbed with antibiotic ointment into the body cavity only far enough to puncture the skin and all muscle layers. Following implantation we covered the insertion wound with New Skin Liquid Bandage (Medtech Laboratories, Inc., Jackson, WY). We measured PL to the nearest mm and X-rayed each turtle (Gibbons and Greene, 1978) immediately following implantation on 26 July 1995 (time = T1).

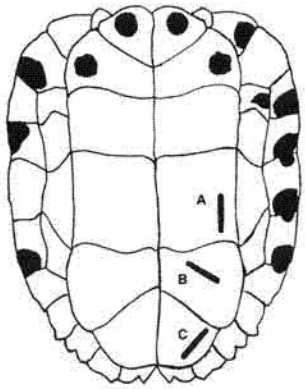

Figure 1. Sites chosen for injection of PIT tags into the body cavity of *Trachemys scripta elegans*: A) anterior inguinal region parallel to the bridge of the shell; B) anterior inguinal region perpendicular to the spine; and C) posterior inguinal region parallel to the carapace edge.

Turtles were released after a 24-hr observation period. We also X-rayed and measured the turtles we later recaptured at 11 months (30 May 1996; time = T2), 16 months (2 October 1996; T3), and 24 months (16 July 1997; T4). At the time of recapture we compared current and previous X-rays for tag loss and described any observed movement of each PIT tag within the body cavity.

Results. — Of the 7 turtles PIT-tagged, one was never recaptured, one was found dead six months later from causes unrelated to PIT tag implantation, five were recaptured at T2, and three at both T3 and T4. PIT tags were always readable by placing the scanner flush against the plastron. X-rays at T2 of three turtles showed little detectable change in tag location from their positions at T1, but slight changes of tag angle (29, 11, and 3°) were measured. The same three recaptured turtles displayed changes in tag angle between T2 and T3 of 11, 12, and 13° and between T3 and T4 of 4, 22, and 2°, respectively. For illustrative purposes, we depict one of these turtles X-rayed at T1, T2, and T3 (Fig. 2). We believe the slight changes in tag angle are due to differences in amount of leg retraction. X-rays of two turtles injected with PIT tags at site C showed no movement of the tag within the body between T1 and T2, other than a slight change of angle (5 and 17°).

Of the five turtles recaptured at T2, all exhibited some PL growth (range = 2–4 mm) and appeared healthy; three were recaptured again at T3 and displayed an additional 3–11 mm PL growth. We dissected the one dead turtle and found no sign of infection associated with the tag. In no instance did we observe a PIT tag to move across to the opposite side of the body from the injection point. However, X-rays indicated that tags injected at sites A and B ultimately resided in the same relative position in the body cavity. Of the six recaptured turtles (1 dead, 5 live), all had retained their PIT tags. Three of these turtles were known to have retained tags for a minimum of 24 months.

Discussion. — We have no reason to suspect that PIT tags injected into the body cavity of small turtles would interfere with body functioning if properly placed in a specimen of adequate size. We would not recommend use of tags in hatchling turtles.

The PIT tags we injected did not migrate within the turtles' bodies and probably became attached to coelomic membranes and mesenteries, as was seen during dissection of the dead turtle. Therefore, we suggest that observed changes in PIT tag angle among subsequent X-rays of the same turtle are attributable to withdrawal or extension of the hind legs. Although our sample size was too small to make recommendation regarding a standardized PIT tag injection location, many zoos use site A as the injection point (B. Tryon, *pers. comm.*) and we see no reason to alter this protocol. When inserted in the manner we describe, we doubt PIT tags would interfere with egg development in females, but additional study is probably warranted.

We suggest that the use of PIT tags for individually marking small turtles may have valuable application in monitoring and curtailing illegal trafficking of turtles for the pet trade. For example, bog turtles (*Clemmys muhlenbergii*) are listed as Threatened or Endangered in every state within their range and the northern populations were recently listed as Federally Threatened (Anonymous, 1997). Illegal collection from wild populations for the pet trade is a major conservation concern. If biologists working with populations of rare turtles were using PIT tags to mark animals,

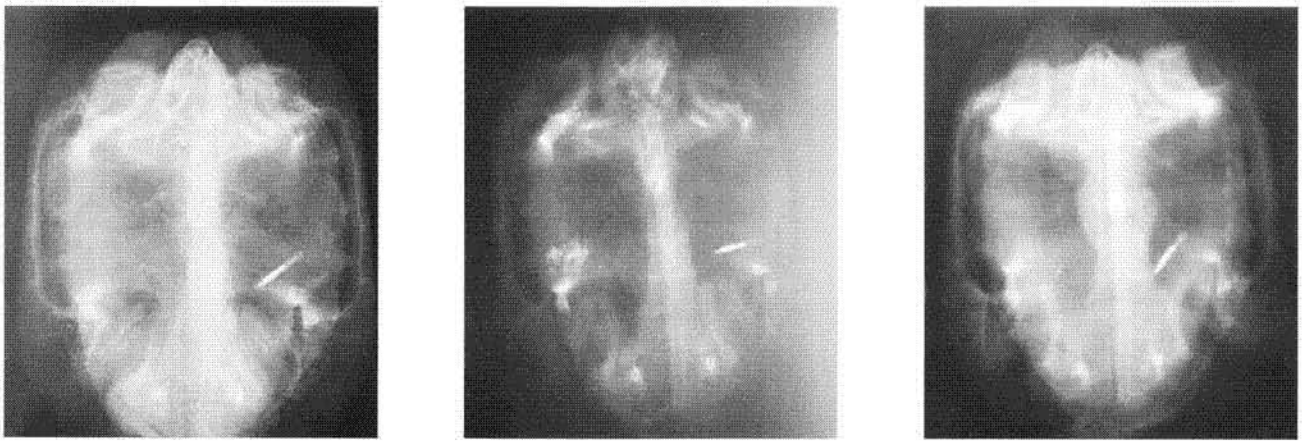

Figure 2. X-rays of the same specimen of *Trachemys scripta elegans* illustrating PIT tag location within the body cavity at the time of injection and during two subsequent recaptures. **Left:** 26 July 1995, T1. **Center:** 30 May 1996, T2. **Right:** 2 Oct 1996, T3. The PIT tag was injected at site A (see Fig. 1).

illegal collectors would risk being apprehended with marked turtles. Therefore, PIT tags may act as deterrents and would provide concrete evidence that specimens were illegally collected from wild populations, making prosecution and conviction more likely. Freeland and Fry (1995) suggested that PIT tags would be suitable for monitoring trade only where animals are individually handled — large numbers of animals could not be easily scanned. We suspect that most shipments of rare turtles would be in small quantities, allowing for individual inspection.

Other benefits of PIT-tagging rare turtles include the ability to individually identify each animal and to know its origin. This information would make repatriation of confiscated animals theoretically possible, although concerns such as introduction of disease would need to be addressed.

Coordination among researchers and state agencies is the primary problem in need of attention before a PIT tag system could be implemented to counteract illegal wildlife trade. Law enforcement personnel (i.e., USFWS and Customs officers in the United States) with PIT tag readers would need to be available to scan shipments of turtles. In addition, one PIT-tagging system would need to be selected. A previous report has recommended a global standard (IUCN Working Group on Permanent Animal Identification, 1991) but multiple systems are available and some researchers began using other systems prior to the recommendation. Finally, a centralized database for PIT tag codes and collection information would need to be created and maintained. A PIT tag central data registry was previously operated for sea turtle research (Manzella, 1988) but has not been maintained.

The costs and benefits of establishing a central data registry, determining responsibility for the database, obtaining funding for PIT-tagging equipment, and facilitating cooperation among researchers committed to freshwater turtle conservation should be an agenda item at a future gathering of herpetologists and conservation biologists.

Acknowledgments. — We thank W. Eure for discussions on anatomy; J.W. Gibbons, D. Dutton, B. Tryon, A. Rhodin, and P. Pritchard reviewed the manuscript. This study was supported by Financial Assistance Award Number DE-FC09-96SR18546 from the U.S. Department of Energy to the University of Georgia Research Foundation.

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Received: 2 October 1997
Reviewed: 26 April 1998
Revised and Accepted: 5 June 1998