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NOTES AND NEWS

EVALUATION OF INTERNAL ELASTOMER TAGS FOR SMALL, MATURE CRABS

BY

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Tagging is an important tool in tracking movement, monitoring mortality, and estimating population size, all of which are critical to understanding population dynamics of ecologically and commercially important species. Tagging small crustaceans for long-term monitoring is problematic because they shed their exoskeletons during molting. Tags must be durable enough to last over multiple molts, yet small enough to not interfere with the molting process. The purpose of this paper is to determine the usefulness of an internal tag for identifying small crabs over multiple molts.

A number of methods including branding, rostrum ablation, and anchor tags have been used to identify crustaceans over multiple molts with varying success (Abrahamsson, 1965; Taylor & Hoening, 1991; Linnane & Mercer, 1998; Davis et al., 2004). Brands are difficult to discern after multiple molts and cause mortalities by forming holes in the carapace (Abrahamsson, 1965; Cooper, 1970; Linnane & Mercer, 1998). Rostrum ablation has limited utility because limbs and other protrusions regenerate during molting (Linnane & Mercer, 1998). Anchor tags have had mixed results, being successful in tagging some large crustaceans (Cooper, 1970; Taylor & Hoening, 1991; McPherson, 2002), but causing high mortalities when tagging juvenile blue crabs and adult tanner crabs (Miller, 1981; Stevens, 2002). PIT (Passive Integrated Transponder) tags and microwire tags have been successfully maintained through multiple molts in adult green crabs (E. D. Grosholz, pers. comm.), although tag size limits the use in smaller crabs and cost per tag is high. Microwire tags have been shown to be effective in tagging small crustaceans (Linnane & Mercer, 1998; Jerry et al., 2001; Davis et al., 2004) but the equipment cost is prohibitive for most small-scale tagging projects.

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In addition to these techniques, Visible Implant Elastomer (VIE) from Northwest Marine Technologies, recently has been shown to be effective in tagging juvenile shrimp (Godin et al., 1996; Brown et al., 2003), juvenile lobsters (Uglen et al., 1996; Linnane & Mercer, 1998) juvenile crayfish (Jerry et al., 2001). However, the utility of VIE for tagging blue crabs was limited (Davis et al., 2004). Tag loss was as high as 65% in 35-day experiments that were conducted in the laboratory at high densities, probably because of autotomy during interactions (Davis et al., 2004). Furthermore, as crabs grew over 60 mm in carapace width, their exoskeletons became calcified and obscured the elastomer tag (Davis et al., 2004). Tag migration within the body also presented a problem in maintaining tag visibility in blue crabs and juvenile lobsters (Linnane & Mercer, 1998; Davis et al., 2004). While studies of VIE tagging in crustaceans have generally focused on tagging juveniles that molt and grow rapidly, little work has examined the use of VIE in small, mature crustaceans that molt less frequently, and have fully calcified exoskeletons. This study was conducted to determine whether VIE is an effective tool for identifying small, adult shore crabs, *Pachygrapsus crassipes* (Randall, 1840) over an extended timeframe.

Twenty-five *P. crassipes* (20.2–41.5 mm carapace width, 12 female and 13 male) were captured from Bodega Harbor, California, and were held individually in marked containers at the Bodega Marine Laboratory. The study began in September, in order to correspond with the peak of molting between August and October (Hiatt, 1942), and lasted four months (September 26, 2004 to January 26, 2005). Crabs were placed in a flow-through seawater table with minimal water exchange to increase water temperature. The containers were partially submerged, allowing these semi-terrestrial crabs to climb out of the water. Crabs were fed weekly an unlimited supply of macroalgae (*Ulva* spp.) and three grass shrimp (*Heptacarpus* spp.) that were collected from Bodega Harbor.

Crabs were partitioned into 3 treatment groups: (1) seven bearing external and internal tags, (2) 14 with internal tags, and (3) four with no tags serving as controls. Treatment 1 was designed to assess whether a combination of external tags and internal tags could be used to mark individuals over a short period and follow movements of cohorts over long periods of time, and treatment 3 served as a control to understand natural intermolt periods and mortality. External tags (Hallprint shellfish tags 8 × 4 mm, Victor Harbor, Australia) were glued to the carapace with cyanoacrylic gel. From the ventral side, elastomer was injected into the coxa-basis joint on the 4th pereopod on the crab's right side, and the 2nd pereopod on the crab's left side. The VIE was injected using steady pressure on a 0.3 ml syringe until a 1 mm mark was visible (fig. 1). Elastomer colors (green, yellow, or orange) were partitioned evenly among crabs with internal tags. The condition of elastomer tags was evaluated for each crab after each molt and at the end of the experiment on

Fig. 1. Tagging *Pachygrapsus crassipes* (Randall, 1839) with visible implant elastomer (VIE) on the ventral side of the coxa-basis joint of pereiopod 3.

a scale from 0 to 3: 0 = tag not visible, 1 = tag barely visible, 2 = tag moderately visible, and 3 = tag clearly visible.

Nine of the 11 crabs that molted during the study were smaller than 28 mm and the other two were 31.1 and 31.9 mm, respectively. Six of the 14 crabs that were tagged internally molted (29%), 3 of 7 crabs that were tagged internally and externally molted (43%), and two of the four crabs that were not tagged molted (50%). Overall, nine of the 21 crabs that were tagged internally molted and two crabs died. Both of these were tagged internally and were preparing to molt, as indicated by the formation of a new epicuticle.

The visibility of the three colors of internal tags was similar among the 19 tagged crabs that survived. Orange VIE tags were visible clearly to moderately in 15 of 16 limbs (93.8%), yellow in eight of 12 (66.7%), and green in 8 of 10 (80.0%) of limbs (table IA). Visibility of tags was also similar on the two limbs, where 58.9% for the second pereiopod and 63.2% for the fourth pereiopod were visible clearly, and 5.3% were not visible on each limb (table IB). Internal tags remained visible in all seven crabs that molted: 50% were visible clearly, 36%

TABLE I

Number of *Pachygrapsus crassipes* (Randall), grouped by crabs that molted and those that did not molt, with VIE tags clearly, moderately, barely, or not visible after four months; A, grouped by color of VIE tag; B, grouped by limb tagged (2nd or 4th pereopod)

A

		Visibility			
		Clearly	Moderately	Barely	Not
Molted	Green	3	0	1	0
	Yellow	0	1	1	0
	Orange	4	4	0	0
No molt	Green	5	0	0	1
	Yellow	4	3	2	1
	Orange	7	0	1	0

B

		Visibility			
		Clearly	Moderately	Barely	Not
Molted	2nd	3	3	1	0
	4th	3	2	2	0
No molt	2nd	8	2	1	1
	4th	8	1	2	1

moderately visible, and 14% barely visible. For the 12 crabs that did not molt, 66.7% were visible clearly, 12.5% moderately, 12.5% barely, and 8.3% were not visible. Overall, 60.5% of tags were visible clearly, 21.1% moderately, 13.2% barely, and 5.3% were not visible at the end of the 4-month study. All external tags remained on crabs that did not molt.

Visible implant elastomer did not impede molting success and remained visible through a molt cycle, making it an effective and inexpensive (<\$ 0.30 per tag) method of tagging small crab species. All three colors of internal tags remained visible (94.5% overall, 83.3% with clear to moderate visibility) enabling investigators to use multiple color combinations and injection locations to identify many individuals or batches of individuals. Also, tags in crabs that molted during the study were visible in similar proportions to those that did not molt, indicating that molting did not obscure the VIE tags. Although tags with moderate to clear visibility are easily recognized, a barely visible tag might be missed in a field experiment. A barely visible tag could be more easily viewed with an ultraviolet light that enhances the visibility of tags (Linnane & Mercer, 1998).

The molting rate (44% of crabs molted once) was lower than expected. The longer intermolt period was likely due to a combined affect of keeping crabs in

laboratory conditions, which substantially elongates the intermolt period, and less frequent molting in the winter than in the summer or fall (Hiatt, 1942). Post-tagging survival (91.5%) and tag retention were similar to four other studies of VIE tagging in juvenile or adult decapod crustaceans (Godin et al., 1996; Linnane & Mercer, 1998; Jerry et al., 2001; Davis et al., 2004). This level of mortality would be acceptable when determining movement patterns but would tend to overestimate population size and density.

Tag retention for *P. crassipes* in this study was higher than was found in juvenile blue crabs with VIE injected into the basal segment of their swimming limb (Davis et al., 2004). Most (64%) of the blue crabs that lost their VIE tags had autotomized a limb, and autotomy occurred more often at high crab densities in laboratory tanks. Although no autotomy of a tagged limb was observed in this study, it is possible that autotomy rates would be higher in a natural setting. Tags disappeared as the juvenile blue crabs grew and their exoskeletons calcified (Davis et al., 2004), but for *P. crassipes* in this study, the tags remained visible, especially for newly molted crabs. No crabs over 32 mm molted during the four-month period, and so we cannot assess the results for larger crabs. However, because the tag was in a joint rather than under the exoskeleton, no calcification occurred over the mark, and it is unlikely that results would differ for larger crabs. Tags also migrated over time within the bodies of blue crabs (Davis et al., 2004), as also was observed in lobsters (Linnane & Mercer, 1998). Tag migration was evident during our preliminary studies when elastomer was noted in the gills of post-mortem crabs. Thereafter, tag migration was minimized by a shallow injection localized in the coxa-basis joint (fig. 1). Given the high tag retention in this study, tag migration was not a likely barrier to detection.

We recommend that tags be placed in the coxa-basis joint rather than under the exoskeleton. If done so, VIE tagging at the coxa-basis joint is an effective and inexpensive means of identifying individuals or cohorts over an extended time-period, especially in cooler waters where molting frequency is low.

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