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LITERATURE CITED

- BRUCE, R. C., AND J. CASTANET. 2006. Application of skeletochronology in aging larvae of the salamanders *Gyrinophilus porphyriticus* and *Pseudotriton ruber*. *J. Herpetol.* 40:85–90.
- CRABILL, T. L. 2007. Are roadside ditches viable wetland habitats for aquatic salamanders? Unpublished M.S. thesis, Towson University, Towson, Maryland.
- DONNELLY, M. A., AND C. GUYER. 1994. Estimating population size. In W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. A. C. Hayek, and M. S. Foster (eds.), *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*, pp. 183–205. Smithsonian Institution Press, Washington, DC.
- , J. E. JUTERBOCK, AND R. A. ALFORD. 1994. Techniques for marking amphibians. In W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. A. C. Hayek, and M. S. Foster (eds.), *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*, pp. 277–284. Smithsonian Institution Press, Washington, DC.
- FERNER, J. W. 1979. A Review of Marking Techniques for Amphibians and Reptiles. *SSAR Herpetological Circular* 9.
- FRESE, P. W. 2000. Spatial activity, growth, and population characteristics of *Siren intermedia* in an intensively managed wetland. Unpublished M.S. thesis, Southwest Missouri State University, Springfield, Missouri.
- GAMBLE, L., S. RAVELA, AND K. MCGARIGAL. 2008. Multi-scale features for identifying individuals in large biological databases: an application of pattern recognition technology to the marbled salamander *Ambystoma opacum*. *J. Appl. Ecol.* 45:170–180.
- GEHLBACH, F. R. AND S. E. KENNEDY. 1978. Population ecology of a highly productive aquatic salamander (*Siren intermedia*). *SW Nat.* 23:423–430.
- HALLIDAY, T. R., AND P. A. VERRELL. 1988. Body size and age in amphibians and reptiles. *J. Herpetol.* 22:253–265.
- LUHRING, T. M. 2008. Population ecology of greater siren, *Siren lacertina*. Unpublished M.S. thesis, University of Georgia, Athens, Georgia.
- . *In press*. Trashcan traps. In G. J. Graeter, K. A. Buhlmann, L. R. Wilkinson, and J. W. Gibbons (eds.), *Inventory and Monitoring: Recommended Techniques for Amphibians and Reptiles*. Partners in Amphibian and Reptile Conservation Technical Publication Series. Aiken, South Carolina.
- , AND C. A. JENNISON. 2008. A new stratified aquatic sampling technique for aquatic vertebrates. *J. Fresh. Ecol.* 23:445–450.
- RAYMOND, L. R. 1991. Seasonal activity of *Siren intermedia* in northwestern Louisiana (Amphibia:Sirenidae). *SW Nat.* 36:144–147.
- SORENSEN, K. 2003. Trapping success and population analysis of *Siren lacertina* and *Amphiuma means*. Unpublished M.S. thesis, University of Florida, Gainesville, Florida.
- TURNER, F. B. 1960. Population structure and dynamics of the western spotted frog, *Rana p. pretiosa* Baird and Girard, in Yellowstone Park, Wyoming. *Ecol. Monogr.* 30:251–278.

Marking Lizards by Heat Branding

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During a mark-recapture study on island populations of the lacertid lizard *Podarcis sicula* (Rafinesque-Schmaltz 1810), we needed to provide large numbers of lizards with individual, permanent marks. Toe clipping was not an option, because of the high incidence of natural toe loss in our study populations (see e.g., Schoener and Schoener 1980; Vervust et al., unpubl.). In addition, preliminary observations suggested that toe clipping may influence locomotor abilities and thereby reduce survival in this saxicolous species (Vervust et al., unpubl.). Techniques involving color banding or painting were discarded because they are insufficiently durable and/or might affect the lizards' visibility to predators. Passive integrated transponders (PIT tags) could not be used due to the small size of the lizards, especially the juveniles and subadults. Decimal coded wire tags (Northwest Marine Technology, Inc.) and visible implant elastomers (Northwest Marine Technology, Inc.) are not clearly visible in lizards and/or require sedation and later sometimes euthanization of the study animals.

Heat branding has been used to mark anurans (Taber et al. 1975; Thomas 1975; Daugherty 1976), salamanders (Taber et al. 1975; Bull et al. 1983; Woolley 1962), turtles (Woodbury and Hardy 1948; Clark 1971), lizards (Clark 1971) and snakes (Clark 1971; Lewke and Stroud 1974; Winne et al. 2006). Typically, marking-irons in the shape of numerals or alphabetic characters are combined to obtain different recognition codes. However, the total number of individuals that can be given a distinct code this way is limited by the number of shapes and is more cumbersome than necessary, especially in small animals. We decided to use a heat branding method and coding technique employed by Winne et al. (2006) to successfully mark snakes. The technique consists of marking specific combinations of ventral scales with disposable medical cautery units (Aaron Medical Change-A-Tip cautery high power units; Aaron Medical, St. Petersburg, Florida 33710, USA; www.aaronmed.com). We modified the coding system slightly for use in our study species. A first mark (R0) was burned on one of the first ventral scales on the right side of each individual, to act as a reference point. Second, third and fourth marks were then burned into other ventral scales. Each of these marks was given a name reflecting its position with regard to the reference point (Figs. 1, 2). For instance, a mark at the right side of the body, 5 scale rows below R0 would be called R5; a mark at the left side of the body, 3 scale rows below R0, would be L3. These marks were made on the outer ventral scale rows. These names could then be combined into an individual lizard's code (R5L3). The number of unique combinations that can be produced in this way is:

$$\sum_{k(0 \rightarrow 3)} \frac{n!}{k!(n-k)!}$$

with k = the number of dots applied, exclusive of R0 and n = the number of ventralia available, exclusive of R0. In our study species, 24 rows of ventralia could be used for burning; the ventralia adjacent to the collaria and preanalia were often too small to allow proper marking. Hence, 48 lizards could be coded individually with one dot; 1,129 with two dot combinations, 17,344 with three dot combinations and 195,709 with four dot combinations (plus the reference dot). Since our study populations have estimated population sizes between 3000 and 9000 lizards (Vervust et al. 2007), we used a maximum of four dots per lizard (inclusive of R0).

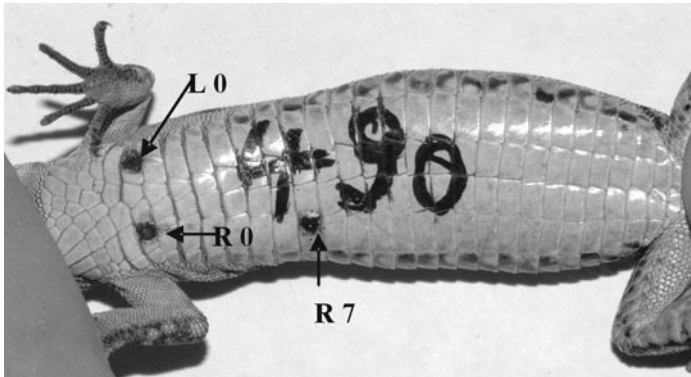


FIG. 1. Lizard from the islet Pod Kopište, with burn mark R7L0, after 48 h.

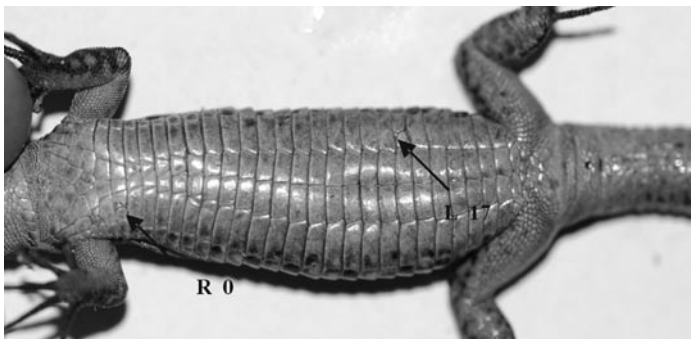


FIG. 2. Lizard from the islet Pod Mrčaru, with burn mark L17, after 465 days.

To date we have marked over 1000 lizards, including juveniles, with this technique. All lizards were kept and observed in captivity for 48 hours after marking. None showed any obvious negative effects and all lizards resumed their normal activities within minutes after the treatment. Not a single lizard died during this period. The markings remained clearly visible over a period of at least 485 days during which the lizards resided in their natural habitat (Fig. 2) and could be readily distinguished from natural scars.

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- BULL, E. L., R. WALLACE, AND D. H. BENNETT. 1983. Freeze-branding: a long term marking technique on long-toed salamanders. *Herpetol. Rev.* 14:81–82.
- CLARK, D. R. 1971. Branding as a marking technique for amphibians and reptiles. *Copeia* 1971:148–151.
- DAUGHERTY, C. H. 1976. Freeze branding as a technique for marking anurans. *Copeia* 1976:836–838.
- LEWKE, R. R., AND R. K. STROUD. 1974. Freeze branding as a method of marking snakes. *Copeia* 1974:997–1000.
- SCHOENER, T. W., AND A. SCHOENER. 1980. Ecological and demographic correlates of injury rates in some Bahamian *Anolis* lizards. *Copeia* 1980:839–850.
- TABER, C. A., R. F. WILKINSON, AND M. S. TOPPING. 1975. Age and growth of hellbenders in the Niangua River, Missouri. *Copeia* 1975:633–639.
- THOMAS, A. E. 1975. Marking anurans with silver nitrate. *Herpetol. Rev.* 6:12.
- VERVUST, B., I. GRBAC, AND R. VAN DAMME. 2007. Differences in morphology, performance and behaviour between recently diverged populations of *Podarcis sicula* mirror differences in predation pressure. *Oikos* 116:1343–1352.
- WINNE, C. T., J. D. WILLSON, K. M. ANDREWS, AND R. N. REED. 2006. Efficacy of marking snakes with disposable medical cautery units. *Herpetol. Rev.* 37:52–54.
- WOODBURY, A. M., AND R. HARDY. 1948. Studies of the desert tortoise, *Gopherus agassizii*. *Ecol. Monogr.* 18:145–200.
- WOOLLEY, P. 1962. A method of marking salamanders. *Miss. Speleol.* 4:69–70.

AMPHIBIAN DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian pathogens, especially the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses. *Bd* is an emerging pathogen linked to mass mortality and declines of amphibians worldwide, yet *Bd* has also been detected in amphibians without disease. Ranaviruses also cause mass mortality, but have not yet been linked to large-scale declines. We know relatively little about their global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling¹, reports of non-detections.

We ask authors to: 1) restrict the Introduction of their paper to a **maximum** of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map might also be useful, and limited text; and 4) have a short discussion of a **maximum** of three paragraphs to touch upon key findings. Please include the following information in submissions as appropriate: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); species name(s) and life history stages examined, as well as other species present; whether samples were collected randomly or just from dead or moribund animals; date of specimen collection; evidence of unusual mortality; numbers of positive and negative samples; disposition of voucher specimens; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We encourage researchers to conduct post-mortem examinations when possible to identify the cause of death when reporting mortalities. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us.