NOTES

Caudal fin branding fish for individual recognition in behavior studies

RICHARD E. McNICOL and DAVID L. NOAKES

Department of Zoology, University of Guelph
Guelph, Ontario N1G 2W1, Canada

Caudal fin branding is an inexpensive technique for marking and identifying small, fragile fish. A modified tip on a hand-held soldering pencil is used to cauterize small holes in the caudal fin membrane. The technique is simple to use, appears to cause little trauma to the fish, and lasts for at least several weeks.

Identifying fish in behavioral studies often presents a special problem. The collars, leg bands, or colored dyes that can be used so readily on terrestrial vertebrates are virtually useless on fish. A variety of external tags are commercially available, and are widely used for ecological studies. However, these, although convenient, have serious limitations. They are relatively expensive and are usually intended for large (e.g., greater than 10-cm length) individuals. They almost invariably cause obvious discomfort and/or impairment to the tagged animal, attract attention from conspecifics, and affect the health of the tagged fish (Roberts, McQueen, Shearer, & Young, 1973).

Several investigators have reported alternative identification techniques. These include subcutaneous injection of colored latex pigment, freeze branding, hot branding, and fin clipping (e.g., Arnold, 1966; Laird, Roberts, Shearer, & McArdle, 1975; Lotrich & Meredith, 1974; Raleigh, McLaren, & Graff, 1973; Thresher & Gronell, 1978). To be useful in behavioral observations, any mark must be readily visible and unambiguous, often from some distance, whatever the orientation of the fish and the observer.

From preliminary efforts at marking fish by some of the previously mentioned techniques, the caudal fin membrane was identified as the best location. On larger fish (ca. 10-cm length), a system of punching small holes (2-mm diam) at specified locations in the caudal fin has been used to individually identify fish (Noakes & Leatherland, 1977). However, many of our observations

are on small (3-5 cm), more fragile fish, and these punches tear the subjects' fins. Conventional techniques for small fish (e.g., Heugel, Joswiak, & Moore, 1977; Leary & Murphy, 1975) are simply not applicable for behavioral observations.

This simple and inexpensive form of heat branding works well. The method has been tested on several species (Table 1), with similar results.

APPARATUS

The apparatus (Figure 1) is a modified soldering pencil, with the brass tip filed down by hand to a small (.5-mm) square end. The iron is heated by an internal electrical resistance using an ac power source outlet (the model we use, "Crafterite," Eldon Industries, Canada, Inc., costs about \$5). The ac power supply is not critical; a battery-powered iron can be used if the situation requires it.

The fish are anesthetized by immersing them in a dilute (approximately 1:10000) solution of MS-222 (tricaine methane sulfonate), until the righting reflex is lost, and swimming motions cease. They are then taken from the water and the caudal fin lightly blotted on a paper towel. The fish is laid on a clean, flat glass plate for the operation. A thin film of oil on the small area of the plate where the actual cauterization takes place helps to prevent the fin from sticking to the plate.

The small tip of the hot iron is pressed lightly against the desired spot on the fin membrane. Only a brief touch is necessary to destroy a small area of cells.

Table 1
Fishes Marked by Caudal Fin Branding

Species	Size*
Yellow Perch (<i>Perca flavescens</i>)	6-7
Pigmy Sunfish (<i>Elassoma</i> spp.)	3-4
Bluegill Sunfish (<i>Lepomis macrochirus</i>)	6-9
Pumpkinseed Sunfish (<i>L. gibbosus</i>)	4-6
Warmouth (<i>Chaenobryttus gulosus</i>)	4-6
Flagfish (<i>Jordanella floridae</i>)	3-4
Golden Shiner (<i>Notemigonus chryssoleucas</i>)	5-7
Common Shiner (<i>Notropis cornutus</i>)	3-6
Rosyface Shiner (<i>N. rubellus</i>)	4-5
Redbelly Dace (<i>Chromosus eos</i>)	4-5
Tiger Barb (<i>Capoeta tetrazona</i>)	2-4
Zebra Danio (<i>Brachydanio rerio</i>)	2-3
Orange-Finned Loach (<i>Botia</i> spp.)	7-8
Convict Cichlid (<i>Cichlasoma nigrofasciatum</i>)	1-6
Rainbow Trout (<i>Salmo gairdneri</i>)	3-6
Brook Charr (<i>Salvelinus fontinalis</i>)	3-7
Lake Charr (<i>S. namaycush</i>)	3-6
Arctic Charr (<i>S. alpinus</i>)	5-8

*Total length in centimeters.

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Figure 1. Modified tip on pencil-type soldering iron, used for caudal fin branding.

This often results in a visible mark. Holding the iron in place slightly longer allows it to burn through the fin membrane to the underlying glass plate. This is readily detected by the solid feel of the tip as it touches the glass plate.

Depending on the size of the fish (and therefore, the area of the caudal fin), the fin can be reliably marked in six different locations, three proximally and three distally. The proximal marks are discrete holes in the fin membrane (Figure 2), the distal marks are divots removed from the distal edge of the fin membrane (Figure 3). With a smaller fin, adjacent holes and/or divots merge, either at the time of marking or soon afterward. Consequently, smaller fish can only be marked in two or three different locations. The number of different marks possible is a function of the number of different locations that can be marked (2^n , where n is the number of different locations). In most cases, this number should be sufficient for the number of fish used in behavioral observations. If necessary, marks can be made in other locations (e.g., dorsal and/or anal fins), as each additional location doubles the number of possible combinations.

DISCUSSION

This technique was developed with young salmonid fishes (trout and charr), but it is satisfactory for marking young cichlids as small as 1 cm, for example. The

marks persist and are readily visible for at least 8 weeks (in salmonids). We have not systematically followed fish longer than this, but the marks would likely remain visible for some time.

An anesthetic is used, but no disinfectant or medication is generally necessary. We have found no indication of secondary infections resulting from the brand. In some larger fish, with thicker fin membranes, fins sometimes tear distal to the brand area. The technique seems best suited, at least for the size of burning rod tip used, for small fish. Tips of other sizes have not been tried. Care must be taken when marking small fish that the branding tip is not held too long against the fins, since this results in a large hole that makes the fin more susceptible to tearing.

Some species (sunfish, cichlids) may at times bite each other and cause fin damage in the normal course of events. Caudal fin brands do not seem to attract the attention of these fish to further injure the fins, but it may add to such damage. These injuries typically heal as the fin regenerates. If fish are handled roughly after marking, or placed in tanks with abrasive substrate (e.g., screen cages), the marked caudal fins seem more prone to tearing. It is best to let anesthetized fish recover individually in a container of clean water.

In most fish, the marks are accentuated by changes in the chromatophores in the immediate vicinity of the mark and/or more distal portions of the fin membrane. It has long been known (Parker, 1948) that a localized section of the caudal fin membrane has this effect on melanophores. Localized damage to chromatophores

Figure 2. Young brook charr (*Salvelinus fontinalis*) preserved 8 weeks after caudal fin branding. Brands (arrows) on caudal fin membrane.

Figure 3. Brand (divot, arrow) on distal edge of caudal fin membrane (millimeter scale divisions).

and subsequent healing are also known to cause color changes in the affected area (Laird et al., 1975).

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