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KENT A. PRIOR, *Dept. of Biology, Trent Univ., Peterborough, Ontario K9J 7B8.* (Present address: *Dept. of Biology, Carleton Univ., Ottawa, Ontario K1S 5B6.*) *Received 9 Nov. 1989, accepted 22 Feb. 1990.*

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Marking passerine tail feathers with colored tape.—Numerous techniques have been used to mark small birds, thus enabling them to be recognized at a distance when resighted (for a review see Marion and Shamis 1977). These methods have included colored leg bands, colored streamers, patagial tags, and coloring or marking plumage. Among the latter group are various schemes to mark the tail feathers (rectrices) of birds.

Colored leg bands have been used widely to mark birds, particularly for studies in open habitats with relatively short and/or sparse vegetation. Leg bands work best for species that can be approached closely and that do not conceal their legs when perched (Samuel 1970, pers. obs.). In "closed" habitats with dense tree and shrub cover, and for species often only sighted in flight or whose legs are not easily seen when the bird is perched, other, more visible markers (streamers, patagial tags, marking plumage, etc.) have been developed. Generally, more handling time and greater skill are required when these markers are applied to birds than when colored leg bands are used. Also, there may be a greater risk of a bird being injured either during the marking process or after its release (e.g., Hewitt and Austin-Smith 1966, pers. obs.).

In the past, tail-marking techniques have included painting or dyeing the rectrices (e.g., Swank 1952, Samuel 1970), imping feathers to the tail (e.g., Heydweiller 1934, Wright 1939), notching the rectrices (e.g., Lovell 1948), and applying tape to the tail (e.g., Dickson et al. 1982). In general, tail-marking techniques are less appropriate for species with relatively short tails or for species that use their tails in behavioral displays. Dyeing the tail of species with dark rectrices is not effective unless the feathers are first bleached. Such a procedure is cumbersome and generally not used. Painting the rectrices may require prolonged handling time to dry the paint before the bird is released, and the marker visibility is relatively short-lived because birds can preen the paint from the tail (Dickson et al. 1982, pers. obs.). Imping feathers to the tail is time consuming for passerine-sized birds (Hester 1963) and has been used mostly for game birds and raptors.

An alternative procedure for marking birds' tails involves using colored, plastic tape. This was attempted on Northern Cardinals (*Cardinalis cardinalis*) by Dickson et al. (1982). They cut the barbs from the rachis on the distal portion of a single rectrix and applied colored tape face-to-face on both sides of the rectrix. The tape was then trimmed to the same shape as the other rectrices. The technique was considered unsuccessful, however, because the birds bit off the taped portion of the rectrix.

In this report, I describe a procedure, not previously reported, for marking the rectrices of passerine-sized birds with tape. This marking technique is relatively quick and easy, requires inexpensive and readily available materials, is adaptable to birds of different sizes, and produces a highly visible marker that may persist until the tail feathers are molted. Furthermore, the marker is concealed from above when the bird is perched or sitting on a nest, and the taped rectrices do not seem to interfere with normal behavior. The method is particularly suited for marking birds to be studied during the breeding season. Details of this procedure and a discussion of its relative merits are the subject of this report.

Description of marking procedure.—This procedure consists of marking the rectrices with Scotch brand 471 vinyl plastic tape manufactured by 3M (see also Frankhauser 1964). The tape is sold in rolls ¾ inch (1.9 cm) wide and 36 yards (33 m) long, and is available in 10 colors (white, yellow, orange, red-orange, red, purple, blue, green, brown, and black). The tape is commonly found in stores that sell office supplies. The only other equipment required is a small pair of scissors and some means of holding the captured birds. The method has been used successfully to mark Northern Cardinals, Brown Thrashers (*Toxostoma rufum*), and Northern Mockingbirds (*Mimus polyglottos*).

Birds to be marked were mist netted and transferred to nylon holding socks during the marking operation. Each holding sock was made so that it fit over the bird's head and body, but allowed the legs and tail to protrude. The two or three outermost rectrices on each side of the tail were selected for marking, and the following procedure was used to mark first one side of the tail and then the other. (The procedure for two rectrices will be used as an example.)

The two outermost feathers on one side of the tail are separated from the other rectrices and positioned such that their rachises are lying side-by-side, with the outermost rectrix most ventral (Fig. 1A). This is the normal spatial relationship of the two feathers when the tail is folded. Placing the rachises side-by-side rather than superimposing one on the other adds lateral stability to the tape marker. A rectangular notch is then cut from the feather vanes on each side of the rachises about midway along the feather shaft (Fig. 1B). The length of the notches should be twice the width of the plastic tape (1.5 inches [3.8 cm]), and the notch on each side should extend from the edge of the feather vane to within 1–3 mm of the nearest rachis. The distance of the cut from the rachis depends upon the width of the vane; enough of the vane must be cut to assure adequate tape-to-tape contact (see below). This is particularly true for the outer, narrow vane of the rectrices.

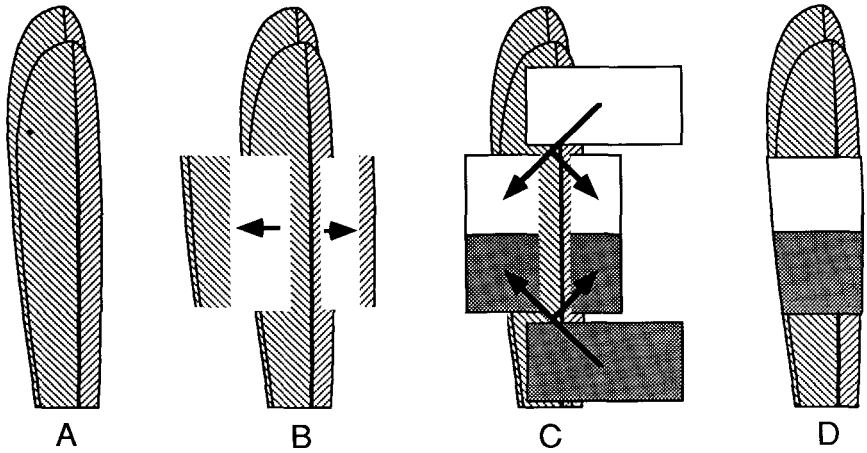

FIG. 1. Procedure used to mark birds' tails with colored, plastic tape. (A) Position feathers to be marked, (B) Notch vanes on both sides of rachises, (C) Attach tape strips to rachises in notched area, and (D) trim tape to feather contour. The ventral view of the right side of the tail is illustrated.

With the notches cut out, two strips of tape are attached (one anterior to the other) to the dorsal surface of the two rectrices and within the notched area (Fig. 1C). The strips of tape are applied one at a time, and they can be of different colors to provide a bicolor identification code. The tape should be cut in strips long enough to extend beyond the margins of the feather vanes. Two additional strips of tape are placed on the ventral side of the rectrices, directly over the two strips previously attached. Colors of the ventral strips of tape should match those of the dorsal strips. The strips of tape are then pressed firmly together to provide secure attachment to the rachises and assure good tape-to-tape contact in the notched areas of the vanes. Care must be taken at all times when handling a bird, and particularly when applying the tape, not to pull on the rectrices in a direction away from the bird's body, because that may cause the feathers to be shed during the marking operation or shortly after the bird is released.

The final step consists of trimming the strips of tape to conform to the contour of the edges of the two rectrices being marked (Fig. 1D). When marking is finished, the feather vanes and the tape should lie in the same plane, and the marked feathers should rest in a natural position when the tail is folded. Also, the bird should be able to fan its tail without restriction.

Evaluation of marking procedure.—The outermost rectrices were selected for marking because they are positioned beneath the innermost rectrices when the bird's tail is closed. This conceals the markers from above when the bird is perched or sitting on a nest—a highly vulnerable position to visually searching predators. The tail markers are visible from the side when the bird is perched, particularly when it flicks its tail. Although in the bird's shadow, the markers also can be seen from below when the tail is closed. Thus taping tails might be particularly useful in identifying birds, such as warblers, that spend most of their time in the upper canopy of trees. In general, the bands on the tail are much more easily seen and their colors more readily identified than those of the relatively small, colored leg

bands. When the birds are in flight, they sometimes fan their tail, making the colored tail markings highly visible. This is especially true when a bird is about to land. It is possible to recognize individual birds observed only in flight, and often only a fleeting glimpse is necessary to sight the colored markers, particularly the brighter colors.

Although the plastic tape is available in 10 colors, some colors work better than others. Light, bright colors (e.g., white, yellow, orange, red) are more easily identified than darker colors (e.g., black, green). This is particularly true when the birds are sighted only briefly (e.g., when vegetation is dense) or when light conditions are poor.

The number of rectrices selected to be taped on each side of the tail depends upon several considerations. At least two feathers are needed to provide lateral stability to the tape so that it does not rotate around the feather rachises, thus maintaining a flat and continuous surface between the feather vane and the tape. Taping more than one feather also increases the structural support for the tape and reduces the likelihood that the feather will pull loose during handling or after the bird is released. Also, there is a risk that the bird will remove the tape marker if only one rectrix is used (see Dickson et al. 1982). Taping more than three rectrices on each side of the tail probably would not add appreciably to the tape's stability, but it might increase retention of the marked feathers (see below). Taping more than three rectrices would, however, make the tape more visible from above when the bird is perched and would restrict the bird's ability to fan its tail during flight or other behaviors.

Tail taping is most appropriate for species with relatively long tails. For such species, two strips of colored tape can be seen easily from a distance, and possibly even a third strip of colored tape could be added and used effectively. Using colored tape to mark rectrices may not be a useful technique for birds with short tails, such as meadowlarks (*Sturnella* spp.) and European Starlings (*Sturnus vulgaris*), but the method has not been evaluated for such species. One advantage that marking the tail has over use of colored streamers is that the spatial order of the colors is maintained (i.e., one color is anterior to the other) thus doubling the number of bicolored identification codes that can be produced from a fixed set of colors.

Marking rectrices with tape does not seem to adversely affect birds' behavior. Passerines normally have 12 rectrices (Welty and Baptista 1988:23), thus the marking procedure reduces 12 separate feather "units" to 10 or eight depending upon whether two or three rectrices are taped on each side of the tail. Marked birds can fly normally and fan their tails, and the taped feathers fold in nicely with the other rectrices when the tail is closed. Marking rectrices may not be appropriate for birds that use their tail in courtship displays (e.g., Rufous-sided Towhees [*Pipilo erythrophthalmus*]; Dickinson 1968), but this needs to be evaluated.

The tape persists on the marked feathers because the birds evidently cannot pull it free from the rachises. This is probably attributable to the care taken to assure tape-to-tape contact on the outer edges of the tape strips. Northern Cardinals, with their strong beaks, are notorious for removing markers (e.g., Lovell 1948, Dickson et al. 1982, pers. obs.), but this was recorded in only one of seven cardinals marked with tail tape. In this instance, a male cardinal, recaptured 30 days after he was marked, was found to have removed all but one strip of tape from his tail. (The same bird also had removed one of two colored leg bands.) Most passerine-size birds have weaker beaks than cardinals, thus tape removal by these birds would be less likely.

Feather retention is the most important factor influencing duration of the taped-tail markers. (This probably is true for other tail-marking techniques as well.) Care must be taken not to pull on the rectrices during the marking operation, thus lessening the likelihood that the feathers will be dropped. Mitigating this loss, however, is the fact that the two sides of the tail are marked separately, thus rectrices must be lost from both sides of the tail before the marker is completely gone. It is possible that the birds themselves may remove some of the marked rectrices after their release when they attempt to pull the tape from the

tail. This would be most likely with species that have strong beaks, such as Northern Cardinals. To date, the taped-tail markers have been attempted on a relatively small sample of birds (14 Brown Thrashers, seven Northern Cardinals, and one Northern Mockingbird), thus further study evaluating the retention of marked feathers in these and other species would be desirable.

Marking rectrices with tape is a relatively easy technique to master, and for a cardinal-sized bird, it takes less than 5 min to complete. The technique would be appropriate for studies conducted during the breeding season or for other short-term studies where marker loss during molt would not interfere with research objectives. That the marker is lost at the end of the study period could be an advantage. This would reduce the likelihood of injury to the bird or of increased vulnerability to predators after the study period—hazards that may occur with other more permanent markers (e.g., streamers, patagial tags).

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LOUIS B. BEST, *Dept. Animal Ecology, Iowa State Univ., Ames, Iowa 50011.* *Received 20 Nov. 1989, accepted 1 Feb. 1990.*