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SPECIMEN SHRINKAGE IN TENNESSEE WARBLERS AND "TRAILL'S" FLYCATCHERS

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Abstract.—Guidelines for morphometric sexing of monochromatic species are frequently based on museum specimens. These specimens tend to shrink when they dry, introducing a potential source of error that is typically ignored when sexing guidelines are applied to living birds. Shrinkage can amount to as much as 4% of the length of living body components, and investigators should correct their field data before applying museum-derived sexing criteria. Studies in the literature and data from Tennessee Warblers (*Vermivora peregrina*) and "Traill's" flycatchers (*Empidonax "traillii"*) suggest that suitable correction factors will vary with taxon and body component.

SE ENCOJEN ESPECÍMENES DE *VERMIVORA PEREGRINA* Y *EMPIDONAX TRAILLII*

Sinopsis.—Las guías para el sexado morfométrico de especies monocromáticas se basan frecuentemente en especímenes de museo. Estos especímenes tienden a encogerse cuando se secan, introduciendo una fuente potencial de error que es típicamente ignorada cuando se aplican las guías de sexado a individuos vivos. Las pieles pueden encogerse hasta un 4% del largo de sus componentes en un organismo vivo por lo que los investigadores deben hacer las correcciones pertinentes en sus datos de campo antes de aplicar los mismos a los criterios de sexado con pieles de museos. Estudios en la literatura y datos tomados en especímenes frescos y luego de secarse de las especies *Vermivora peregrina* y *Empidonax traillii* sugieren que los factores de corrección pueden variar de un taxón a otro al igual que en los componentes corporales.

Guidelines for determining the sex of birds of monochromatic species on the basis of their measurements are frequently developed using museum specimens. Despite the fact that these specimens tend to shrink when they dry, this shrinkage is typically ignored and the results of museum-based studies are applied directly to living birds (e.g., Pyle et al. 1987). Given that shrinkage can amount to an average of as much as 4% of the living length of various body components (e.g., Fjeldså 1980), ignoring it seems unwise. When the sexes are mensurally similar, the difference in length between a fresh and dried body component can represent a large portion of the difference between the sexual means. For example, Mueller (1990) noted that shrinkage of 1.72% represented about 34% of the difference between the mean wing lengths of male and female Saw-whet Owls (*Aegolius acadicus*). In an attempt to estimate correction values to apply to field data before the application of museum-derived sexing guidelines, I examined the literature and measured "Traill's" flycatchers (*Empidonax traillii* and *E. alnorum*) and Tennessee Warblers (*Vermivora peregrina*) before and after drying.

PRIOR INVESTIGATIONS

The degree of shrinkage occurring in specimens varies on an individual basis, and wing shrinkage can vary between studies and species (Greenwood 1979, Harris 1980). Correction factors, however, can be obtained from reasonable samples (Harris 1980). At present, only shrinkage in wing length has been widely addressed, primarily for non-passerines.

In addition to the references offered in Greenwood (1979), who found an average wing length shrinkage in Dunlin (*Calidris alpina*) of 1%, an average shrinkage of 1.1% was found in Puffins (*Fratercula arctica*; Harris 1980), 1.2% in Rooks (*Corvus frugilegus*; Knox 1980), 2% in Black Guillemots (*Cepphus grylle*; Ewins 1985), 2.7% and 2.2% in Ringed Plovers (*Charadrius hiaticula*) and Dunlin, respectively (Green 1980), approximately 3% in grebes of various species (Fjeldså 1980), 0.5–1% in House Sparrows (*Passer domesticus*; Bjordal 1983), 0.5% in a sample of two *Hypsipetes* species (Herremans 1985), and Figure 6 in Jenni and Winkler (1989) implies an approximately 4% shrinkage in many species of passerine (regardless of wing length). Average percent shrinkage values do not seem to reflect wing measuring techniques (flattened versus chord), although most of the studies cited measured flattened wings. Jenni and Winkler (1989) found virtually no shrinkage in primary feather lengths, thus these would appear to be superior wing measurements. In some species, however, chord is found to be a better predictor of sex, and both measurements can be useful (Winker, unpubl.).

Measurements of tail, bill and tarsus lengths might be less prone to shrinkage than wings, because they do not (typically) include bone joints. Tarsus shrinkage was found to be insignificant in Dunlin (Greenwood 1979) and various grebe species (Fjeldså 1980), but Bjordal (1983) found significant tarsus length shrinkage in House Sparrows (1.1–1.3%) and Herremans (1985) found that tarsus length increased significantly in a sample of two *Hypsipetes* species (0.9%). Tail length shrinkage in Dunlin was found to be 2.4% (Greenwood 1979), probably as a result of pressing the measuring device into live (soft) versus dead (hard) flesh. West et al. (1968) found tail lengths of Willow Ptarmigan (*Lagopus lagopus*) to shrink when dried by 0.69%. Both Bjordal (1983) and Herremans (1985), however, found that tail lengths increased following drying in House Sparrows (0.4–1.5%) and *Hypsipetes* (1.1%), respectively. Both authors thought this increase was due to a retraction of the intercalamal skin during drying.

Shrinkage in bill length will vary with bill morphology: Fjeldså (1980) found shrinkage of approximately 4% in grebe bills, whereas Greenwood (1979) and Harris (1980) found virtually no change in the lengths of Dunlin and Puffin bills, respectively. Bjordal (1983) found shrinkage of 1.6% in the bills of House Sparrows, but Herremans (1985) found shrinkage to be insignificant in the culmen lengths of his sample of *Hypsipetes*.

Haftorn (1982) found 0.5% shrinkage in wing length and 1.1–1.2% shrinkage in tail lengths of Willow Tits (*Parus montanus*). Although he did not find this shrinkage significant, the statistical test used was inappropriate.

TABLE 1. The effects of shrinkage on various body components in Tennessee Warblers (top) and Alder and Willow flycatchers (combined; bottom).

		Mean length (mm)				
	n	Fresh (SD)	Dry (SD)	*t*[a]	*P*	% shrinkage
Wing chord	68	62.34 (2.13)	61.44 (2.04)	9.77	<0.0005	1.44
Tail	67	42.09 (1.60)	41.63 (1.82)	3.34	0.001	1.09
Bill	67	7.60 (0.34)	7.68 (0.34)	−3.45	0.001	−0.96
Tarsus	68	16.53 (0.56)	15.92 (0.52)	16.17	<0.0005	3.73
Wing chord	29	71.60 (1.87)	71.19 (2.05)	2.29	0.03	0.57[b]
Tail	29	58.22 (1.79)	56.60 (1.66)	8.54	<0.0005	2.77
Bill	29	8.69 (0.44)	8.63 (0.41)	2.73	0.01	0.61

[a] *t*-value from paired sample *t*-test.
[b] This very low value is probably the result of a novel preparation procedure; see text.

METHODS

Sixty-eight Tennessee Warblers were salvaged from a communications tower-kill in St. Louis County, Minnesota on 27 Aug. 1990. These birds were received in very fresh condition and kept triple-bagged (in plastic) and frozen until measured. The sample was composed entirely of first-year (HY) birds. Molt was rare and restricted to the body, and hence did not affect measurements. Lengths of wing chord, tail, tarsus and bill (from anterior edge of nostril) were taken to the nearest 0.1 mm with vernier calipers (after Baldwin et al. 1931, using calipers rather than dividers for all but tarsus). Specimens were subsequently dried at approximately 50 C in a drying oven until dried body mass revealed no more water loss (5–6 d). Three months later they were re-measured.

Twenty-nine adult Alder and Willow flycatchers (*Empidonax alnorum* and *E. traillii*) were collected in June and early July 1991 in central Minnesota. These birds were also kept triple-bagged and frozen until measurement and preparation as museum specimens. For this study the two *Empidonax* species are lumped into one sample; these sibling species are mensurally very similar (see Seutin 1991). Wing chord, tail and bill lengths were taken prior to preparation, and 3–5 mo later these components were re-measured. None of the frozen specimens of either species revealed signs of desiccation that can appear in birds frozen improperly or for a long time. I performed all of the measurements and used the same set of calipers throughout the study. The same wing and tarsus on each individual was measured each time (the left if not broken). Tarsus shrinkage in the *Empidonax* flycatchers was not examined.

RESULTS

All of the measured components showed significant change following drying (Table 1). All components showed a decrease in length except for Tennessee Warbler bills, which showed an increase. This increase seems to be due to shrinking and hardening of the skin that forms the anterior

edge of the nasal fossae. Hardening of this skin prevents the calipers from resting more anteriorly within the "greater" nares (as delimited by the underlying rhinotheca and premaxillae). Tyrannid flycatchers do not have skin on this part of the mandible, and the bills of the *Empidonax* flycatchers showed slight shrinkage (Table 1). Shrinkage in wing chord, tail and bill lengths were compared between the warblers and flycatchers by comparing individual changes (percent shrinkage) between the two groups. This comparison showed significant differences between the two taxa in the shrinkage of these components (Mann-Whitney U-test corrected for ties, wing chord $Z = 2.93$, $P = 0.003$; tail $Z = 3.21$, $P = 0.001$; and bill $Z = 3.71$, $P = 0.0002$).

DISCUSSION

Significant changes were found in both warblers and flycatchers for all characters measured. Also, the degree of change for bill, wing chord and tarsus lengths differed significantly between the two taxa. Differences in wing shrinkage between the warblers and flycatchers may have been caused by differences in preparation of specimens. The flycatchers were prepared as skins and almost-complete skeletons; the radius and ulna were removed from each wing and the carpometacarpi tied together. It became apparent during remeasuring that the wrist area was usually not completely everted. As a consequence, extra layers of dried skin and feathers were usually included in the measurement taken after drying. Differences between the flycatchers and warblers in tail measurement may also have been a factor of preservation technique. Skin preparations leave only skin and feathers in the tail, and as a result the tail retains some flexibility, flexing rather than cracking when pressure is applied. In the dried warblers the tails were quite fragile and subject to breakage. Tennessee Warbler tails may show less shrinkage because cracks form upon insertion of calipers, allowing the calipers to rest deeper within the intercalamal region.

Significant tarsus shrinkage was not found by Fjeldså (1980) in grebes, nor by Greenwood (1979) in Dunlin. Significant change was found in House Sparrows (Bjordal 1983) and *Hypsipetes* (Herremans 1985), however. These different results may be a factor of morphology. In passerines, the reference point for the distal end of the tarsometatarsus is the most distal undivided scute (Baldwin et al. 1931:107). Contraction of the skin covering the tarsometatarsus may cause this scute to move proximally, resulting in a shorter dried tarsus measurement. Bjordal (1983) reached this same conclusion. Thinning of the tissue at the proximal end of the tarsus during drying might also be a contributing factor. Herremans (1985) found tarsus lengths to increase in his sample of *Hypsipetes*, and felt that this was a result of being unable to apply the same measuring procedure on fresh versus dried legs.

Shrinkage is a general phenomenon that probably affects most sexing guidelines developed from museum specimens. Contra Herremans (1985), researchers should take into account measurement differences between

live birds and specimens. Herremans' (1985) opposite conclusions seem to be based on an inappropriate use and interpretation of statistics (see Sokal and Rohlf 1981:356–359). Evidence suggests that taxon-based morphological characteristics and methods of preparation affect shrinkage. As a consequence, shrinkage values obtained from one taxon may have limited applicability outside that group. Nevertheless, prior to applying museum-derived sexing guidelines to living or recently dead birds, investigators should correct their data for specimen shrinkage. To do this, measurements of live or freshly dead birds should be multiplied by some value less than 1.0. Correction values ranging from 0.960 to 0.996 (depending on species and body component) are suggested by the studies cited here and in Greenwood (1979). A general correction factor for wing shrinkage that might be applied to species or groups where shrinkage has not yet been investigated can be obtained by averaging values from all of the species and studies considered here and in Greenwood (1979; 17 total). This yields an average shrinkage of about 1.7%, suggesting a correction factor of 0.983. This correction factor is crude, but nothing better can be done for taxa that have not yet been examined. More data on shrinkage in other avian taxa would be very useful.

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