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MORPHOMETRIC CRITERIA FOR DISTINGUISHING SPECIES AND AGE-COHORTS OF ERMINE (*MUSTELA ERMINEA*) AND LONG-TAILED WEASEL (*M. FRENATA*)

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Morphologically similar ermine (*Mustela erminea*) and long-tailed weasel (*M. frenata*) were studied to identify diagnostic criteria and confirm the level of certainty with which specimens, both skulls and whole body carcasses, can be classified to species and age classes. Analyses of 9 whole body and 15 skull morphometric measures of 203 specimens revealed that several options for reliable species classification may be employed, ranging from the simultaneous use of several traits as identified within a discriminant function to the use of a single specified trait in cases where pertinent information for the specimen in question may be unavailable. Species identification based on discriminant functions and compliance within range values for selected traits appears possible regardless of gender. Tail vertebrae counts in conjunction with gender information served to successfully distinguish all ermine from long-tailed weasels in the present study. Age-class discrimination was most successful (~75%) with a combination of skull and baculum variables. In terms of practical application, this study provides a solid basis for reliably distinguishing trapper-harvested specimens of either species, including those subjects having sustained extensive trap-inflicted skull damage or tail breakage during the pelting process.

Key words: classification, morphometrics, *Mustela*, species identification, weasel

INTRODUCTION

In North America, the ermine or short-tailed weasel (*Mustela erminea*) occurs from the Canadian Arctic south to Pennsylvania, Ohio, northern Iowa and South Dakota in the eastern United States, and New Mexico and central California in the west (FAGERSTONE 1987) (Fig. 1). The long-tailed weasel (*Mustela frenata*), on the other hand, inhabits southern Canada from the transition zone between aspen parkland and the boreal forest, southward over most of the United States, Mexico and Central America (SHEFFIELD & THOMAS 1997) (Fig. 1). These two species are sympatric in a relatively narrow belt across northern United States and southern Canada (HALL 1951, SIMMS 1979, FAGERSTONE 1987). An inherent problem confronting researchers working on these mustelids in areas where they coexist has been the difficulty in distinguishing and classifying specimens as to their respective species and age cohorts. This dire need for a classification system has been shared by researchers and wildlife managers employing whole animal car-

casses acquired through trapper harvests as well as those involved in studies restricted to the examination of fresh and/or museum-derived skulls. To date, methods for distinguishing between these two mustelids based on hair scale profiles have not been reported within the literature. Molecular approaches to classification such as DNA analyses can require elaborate laboratory facilities, tend to be relatively costly and could not be used in studies using museum-derived skulls.

Substantial variation in morphometric traits has been demonstrated both within and between these two mustelid species (RAYMOND & BERGERON 1986, MEIA & MERMOD 1992), and has provided the basis of most classification attempts. Parameters examined include several whole body measures as well as various skull and baculum measurements – all of which have been examined separately and independently. While this approach has met with varying degrees of success, the need for a more accurate and reliable means of classification remains.

The present study on ermine and long-tailed weasel examines the use of multiple morphometric traits considered simultaneously through the use of discriminant function analyses in the attempt to identify indicator criteria and confirm the level of certainty with which specimens, both skull and whole carcasses, can be classified to species and age class.

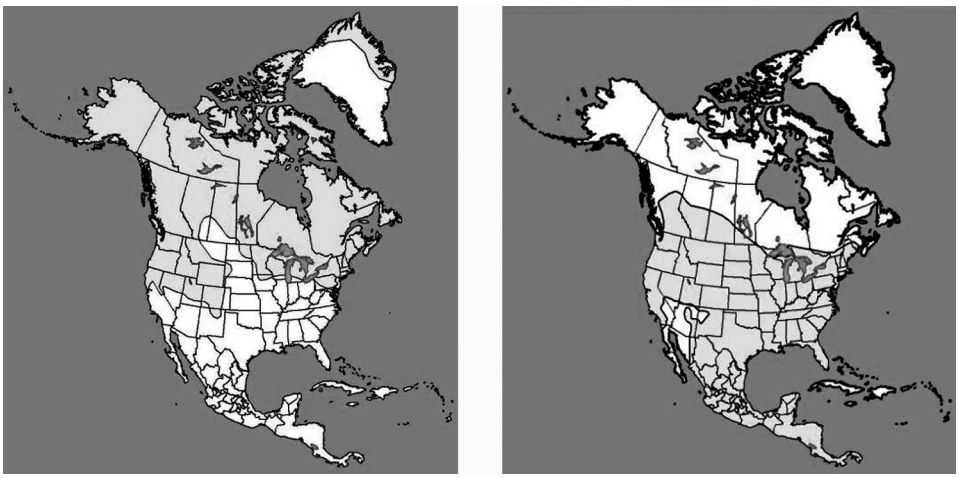

Fig. 1. Distribution of ermine (left) and long-tailed weasel (right) species in North America (adapted from FAGERSTONE 1987). Inset shows long-tailed weasel distribution in Mexico and Central America; range extends south to Venezuela and Bolivia

MATERIAL AND METHODS

Intact carcasses, peltless and frozen (–20°C), were obtained from fur trappers at Rouyn-Noranda (48°15' 0N, 79°1' 0W) in western Quebec, Canada. All animals had been taken within the regular trapping season (October to March) during the winters of 1999 through 2001.

Establishing the species identity of specimens was done according to the well-documented method of determining the ratio of tail length to combined head and body length (KING 1983, FAGERSTONE 1987, SHEFFIELD & THOMAS 1997). A value ≤ 44% was taken as indicative of a short-tailed weasel whereas values > 44% signified a member of the long-tailed species. Validation of this method in establishing species identity has been recently confirmed through genetic (DNA fingerprinting) studies (ST-PIERRE 2003). The gender of the animal was determined by examination of the gonads. Juvenile animals were distinguished from their adult counterparts by the lesser degree of temporal muscle coalescence seen on the dorsal aspect of the cranium, a method commonly used for age determination in mustelids (LECHLEITNER 1954, POOLE *et al*. 1994).

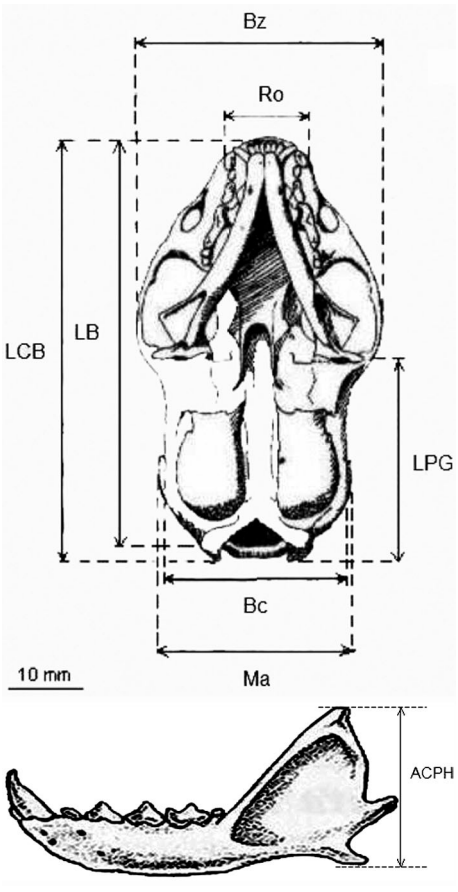

Fig. 2. Skull and mandible measurements (adapted from DEBROT & MERMOD 1978)

A series of morphometric parameters were determined for each individual after carcasses had been thawed to room temperature. Body weight (to nearest 0.01g) as well as total body (nose to tip of tail) length, tail length, and combined head and body length (to 0.01 cm) were recorded. The number of caudal (tail) vertebrae were counted independently on two separate occasions to ensure reliability. Heads were detached from the body, and skulls cleared of soft tissue and placed in a dermestid beetle (*Dermestes vulpinus*) colony. The cleaned skulls were later dried in an oven at 60 °C for 72 hours and standard dry weights (to 0.01 g) recorded for both the skull and mandible. Skull measurements including condylobasal length (LCB), basilar length (LB), postglenoidal length (LPG), mastoid width (Ma), cranial width (Bc), bi-zygomatic width (Bz), muzzle width (Ro), foramen magnum diameter (height and width), palatine to rostrum length, palatine to pterygoid process length, and mandibular angular to coronoid process height (ACPH) were taken with digital calipers to 0.01 mm precision (Fig. 2).

Bacula were removed, cleaned of soft tissue and dried in an oven at 60 °C for 72 hours to establish a standard dry weight (nearest mg). Baculum length and maximum diameter were measured using digital calipers with precision to 0.01 mm.

Statistical analyses

Morphological variables of each species – age cohort were tested for normality with the Kolmogorov-Smirnov procedure (ZAR 1999). Analyses of variance (ANOVA) followed by Scheffé's multiple contrasts were employed to compare variables among species-age cohorts and identify the source of differences noted. Data sets not satisfying the requirements for normality and homogeneity of variance were tested using the Kruskal-Wallis analysis of ranks (ZAR 1999). Forward step-wise discriminant analyses followed by chi-square classification testing were used to identify diagnostic criteria and confirm the level of certainty with which specimens (whole carcasses, carcasses without tail, and skulls only) can be correctly classified as to species and age class. Statistical analyses were performed using SPSS 9.0 for Windows.

RESULTS

A total of 203 specimens were obtained from trapper sources, of which the majority (189) were males. The 14 females obtained were distributed between the two species and the two age classes, resulting in low individual cohort sample sizes (n = 2–6). Because of the paucity of female subjects and the presence of only a single specimen within the juvenile male cohort of long-tailed weasel, statistical analyses were restricted to male specimens and to the following 3 species-age cohorts – juvenile ermine, adult ermine and adult long-tailed weasel. Nevertheless, tabulated data for the female specimens and the single juvenile male long-tailed weasel have been presented for visual comparison.

Comparison of species-age cohorts

Analyses of variances performed to evaluate morphological parameters among the three species-age cohorts indicated that for all 9 whole body parameters and 15 skull measurements significant differences existed among juvenile ermine, adult ermine, and adult long-tailed weasel ($p < 0.001$; eta^2 from 0.42 to 0.92; Table 1). A series of Scheffé's multiple contrasts determined that only the tail to head and body length ratio, number of caudal vertebrae, baculum diameter, postglenoidal to condylobasal length ratio, cranial width, foramen magnum height, foramen magnum width, and palatine to pterygoid process length did not differ significantly between juvenile and adult ermine ($p \geq 0.05$, Table 1). All remaining variables were significantly different between these two age groups ($p < 0.05$, Table 1). All variables differed significantly between the adults of the two species ($p < 0.05$, Table 1) as well as between juvenile ermine and adult long-tailed weasel ($p < 0.05$, Table 1).

Table 1. Morphometric variables for the three species-age cohorts of male weasels examined

Variable	Ermine		Long-tailed weasel	eta^2
	Juvenile (n = 40–55)	Adult (n = 77–103)	Adult (n = 26–29)	
Body weight (g)	85.60^a±16.66 (45.96–120.14)	104.04^b±21.61 (64.93–154.17)	230.41^c±26.69 (172.14–280.85)	0.84
Total body length (cm)	28.4^a±1.8 (22.8–32.7)	29.8^b±1.9 (26.0–33.4)	43.4^c±1.6 (39.3–46.5)	0.89
Head and body length (cm)	20.5^a±1.2 (17.5–23.5)	21.4^b±1.2 (18.9–24.0)	27.7^c±0.9 (26.0–29.5)	0.81
Tail length (cm)	7.9^a±0.8 (5.3–9.4)	8.4^b±0.7 (6.8–9.8)	15.7^c±1.1 (13.3–18.0)	0.92
Tail to head and body length ratio	0.38^a±0.03 (0.30–0.44)	0.39^a±0.02 (0.32–0.43)	0.57^b±0.04 (0.50–0.63)	0.85
Number of caudal vertebrae*	18^a (16–19)	18^a (16–19)	21^b (20–22)	0.74
Baculum weight (g)	0.011^a±0.005 (0.004–0.029)	0.016^b±0.007 (0.005–0.033)	0.040^c±0.002 (0.010–0.100)	0.50
Baculum length (mm)	18.59^a±1.23 (14.28–21.86)	19.69^b±1.54 (14.19–22.84)	22.94^c±1.68 (18.60–26.97)	0.48
Baculum diameter (mm)	1.04^a±0.12 (0.81–1.35)	1.11^a±0.14 (0.79–1.64)	1.59^b±0.25 (1.05–2.14)	0.53
Skull weight (g)	0.99^a±0.18 (0.60–1.53)	1.13^b±0.24 (0.58–1.67)	2.70^c±0.29 (2.22–3.24)	0.86
Mandible weight (g)	0.34^a±0.07 (0.24–0.53)	0.41^b±0.09 (0.23–0.66)	1.00^c±0.12 (0.84–1.27)	0.87
Condylobasal length (mm)	40.14^a±1.56 (37.17–43.85)	41.58^b±1.81 (37.64–45.04)	50.11^c±1.39 (46.77–52.21)	0.82
Basilar length (mm)	37.18^a±1.50 (34.55–40.73)	38.57^b±1.68 (34.75–41.94)	45.99^c±1.25 (42.78–47.90)	0.79
Postglenoidal length (mm)	20.25^a±0.65 (18.90–21.55)	20.81^b±0.88 (16.62–22.50)	23.10^c±0.65 (21.57–23.96)	0.61
Postglenoidal to condylobasal length ratio	0.50^a±0.01 (0.49–0.52)	0.50^a±0.01 (0.43–0.52)	0.46^b±0.01 (0.45–0.48)	0.71
Mastoid width (mm)	18.62^a±0.85 (16.84–20.35)	19.31^b±0.94 (17.39–21.19)	24.01^c±0.82 (22.27–25.69)	0.82
Cranial width (mm)	18.25^a±0.63 (17.10–19.34)	18.43^a±0.78 (16.73–20.67)	21.42^b±0.65 (20.07–23.43)	0.71
Bi-zygomatic width (mm)	20.70^a±1.05 (18.74–22.75)	21.65^b±1.28 (18.87–2.27)	27.32^c±0.95 (25.24–29.12)	0.78
Muzzle width (mm)	9.54^a±0.68 (8.32–11.03)	10.11^b±0.72 (8.26–12.08)	12.01^c±0.66 (10.66–13.28)	0.57
Foramen magnum height (mm)	5.80^a±0.27 (5.24–6.32)	5.82^a±0.31 (5.20–6.60)	6.56^b±0.39 (5.71–7.36)	0.45

Table 1. (continued)

Variable	Ermine		Long-tailed weasel	eta^2
	Juvenile (n = 40–55)	Adult (n = 77–103)	Adult (n = 26–29)	
Foramen magnum width (mm)	7.08^a±0.24 (6.55–7.70)	7.17^a±0.34 (6.21–7.93)	8.27^b±0.36 (7.58–9.26)	0.66
Palatine to rostrum length (mm)	16.10^a±0.80 (14.73–18.31)	16.94^b±0.97 (15.03–19.95)	21.46^c±0.95 (19.63–23.34)	0.79
Palatine to pterygoid process length (mm)	6.60^a±0.39 (5.78–7.48)	6.81^a±0.50 (5.05–7.84)	7.80^b±0.45 (7.05–8.60)	0.42
Angular to coronoid process height (mm)	9.29^a±0.62 (7.48–10.46)	9.87^b±0.69 (8.41–11.31)	13.11^c±0.55 (12.20–14.46)	0.80

Mean ± standard deviation (range in parenthesis)

* indicates median reported (range in parenthesis)

Within each variable-animal combination, group means bearing a common superscript are not significantly different ($p > 0.05$) as indicated by ANOVA followed by Scheffé test; Kruskal-Wallis test employed to compare median values and where assumptions for ANOVA were not met.

Interspecies discrimination

Forward stepwise discriminant analysis on the 7 whole body parameters (total body length variable and tail to head and body length ratio used in species identification excluded in all discriminant analyses undertaken) and 15 skull measurements identified the function: [1.017 × tail length + 0.639 × number of caudal vertebrae + 4.806 × skull weight – 0.692 × postglenoidal length – 1.004 × mastoid length + 0.781 × palatine to pterygoid process length + 0.041] as that which best discriminates between the two species (r^2 = 0.981, Wilks' $\lambda = 0.037$, $\chi^2 = 266.96$, $p < 0.001$). In a reclassification test based on this function, 100% of the 86 animals were correctly assigned as to species. To validate this analysis, the function was applied to a subsample of 11 animals (excluded from the initial analysis because of missing data values); all 11 animals were correctly classified. The mean group centroid for ermine was –3.14±0.96 (n = 72; range = –5.80 to –1.22) compared to 8.13±1.20 (n = 25; range = 5.21 to 9.96) for long-tailed weasel.

A repeat of the above analysis with both tail variables (length and vertebrae count) removed, yielded the function [0.491 × head and body length + 5.221 × skull weight – 0.782 × postglenoidal length – 0.408 × bi-zygomatic width + 6.591] as the best discriminant between the species (r^2 = 0.952, Wilks' $\lambda = 0.093$, $\chi^2 = 211.05$, $p < 0.001$). This function accurately classified 100% of

the original 93 cases, as well as an additional 13 animals used for validation purposes, as to species group. Mean group centroids were –1.87±0.88 (n = 80; range = –3.51 to 0.17) and 5.08±1.23 (n = 26; range = 3.23 to 7.86) for ermine and long-tailed weasel, respectively.

Based on skull variables alone, discriminant analysis showed that [4.946 × skull weight – 0.681 × postglenoidal length + 0.680 × width of foramen magnum + 1.729] was the function that best discriminated between the species ($r^2 = 0.949$, Wilks' $\lambda = 0.099$, $\chi^2 = 220.51$, $p < 0.001$). This combination of variables allowed for correct classification of 100% of the original subjects (n = 99) and likewise for 4 additional cases available for validation testing. Mean group centroids were –1.77±0.86 (n = 77; range = –3.48 to 0.59) for ermine and 4.98±1.28 for long-tailed weasel (n = 26; range = 3.01 to 7.69).

When skull weight was removed from the preceding analysis, the function best discriminating between species was determined to be [11.646 × mandible weight – 0.541 × postglenoidal length + 0.710 × width of foramen magnum – 0.270] ($r^2 = 0.945$, Wilks' $\lambda = 0.108$, $\chi^2 = 212.90$, $p < 0.001$). Of the original 99 cases, 100% were correctly classified, as were the 4 validation cases tested. The mean group centroid for ermine was –1.67±0.89 (n = 77; range = –3.19 to 0.60) compared to long-tailed weasel, which had a mean group centroid of 4.78±1.27 (n = 26; range = 3.08 to 7.94).

Age-class discrimination

Forward stepwise discriminant analysis on the 7 whole body parameters and 15 skull measurements identified the function: [101.438 × baculum weight + 1.090 × mandibular angle to coronoid process height – 11.853] as that which best discriminated between the two age groups in ermine ($r^2 = 0.466$, Wilks' $\lambda = 0.783$, $\chi^2 = 23.042$, $p < 0.001$). For the 97 original subjects used, this combination of variables determined, with 74.2% accuracy, which age group the animal belonged to. Similarly, 72.7% of 31 additional animals used in subsequent validation procedures were correctly classified by this function. Overall, misclassifications tended to be slightly higher among adults (26/89) compared to juveniles (9/39). The mean group centroid for juveniles was –0.71±0.85 (n = 39; range = –2.50 to 1.07), whereas that for adults was 0.50±1.06 (n = 89; range = –1.98 to 3.82).

Based on skull variables only, discriminant analysis showed that the function that contributed most to the separation of age groups was [15.979 × mandible weight – 1.085 × cranial width + 13.795] ($r^2 = 0.437$, Wilks' $\lambda = 0.809$, $\chi^2 = 22.647$, $p < 0.001$). Of the original 110 cases, 72.4% were correctly classified. Application of this function to subjects initially eliminated by incomplete data sets resulted in

Table 2. Morphometric variables for the female weasel specimens and single juvenile male long-tailed weasel

Variable	Ermine		Long-tailed weasel		
	Juvenile female (n = 3)	Adult female (n = 2)	Juvenile female (n = 3)	Adult female (n = 5–6)	Juvenile male (n = 1)
Body weight (g)	55.02±20.97 (40.46–79.06)	38.71, 48.05	105.91±25.79 (88.12–135.49)	98.70±10.80 (80.66–113.95)	176.09
Total body length (cm)	25.3±2.4 (23.2–28.0)	23.3, 24.8	33.3±2.6 (31.5–36.2)	32.9±1.3 (31.6–35.0)	40.4
Head and body length (cm)	18.4±1.3 (17.1–19.6)	17.4, 18.4	21.8±0.9 (21.0–22.8)	21.9±0.6 (21.0–22.7)	26.0
Tail length (cm)	6.9±1.3 (6.1–8.4)	5.9, 6.4	11.5±1.7 (10.5–13.4)	11.0±0.7 (10.4–12.3)	14.4
Tail to head and body length ratio	0.38±0.05 (0.34–0.43)	0.34, 0.35	0.53±0.05 (0.49–0.59)	0.50±0.02 (0.48–0.54)	0.55
Number of caudal vertebrae*	17, 18	17, 18	19 (19–20)	20 (19–21)	21
Baculum weight (g)	–	–	–	–	0.026
Baculum length (mm)	–	–	–	–	21.74
Baculum diameter (mm)	–	–	–	–	1.43
Skull weight (g)	0.66±0.17 (0.50–0.83)	–	1.22, 1.63	1.33±0.11 (1.17–1.46)	–
Mandible weight (g)	0.21±0.05 (0.17–0.26)	–	0.40, 0.54	0.43±0.03 (0.38–0.46)	–
Condylobasal length (mm)	36.28±2.17 (34.17–38.51)	–	40.40, 43.10	41.81±0.94 (40.47–42.94)	–
Basilar length (mm)	33.80±2.03 (31.99–36.00)	–	36.86, 40.47	38.22±0.93 (37.17–39.52)	–
Postglenoidal length (mm)	17.98±1.14 (16.81–19.08)	–	19.71, 21.25	20.69±0.32 (20.31–21.05)	–

Table 2 (continued)

Variable	Ermine		Long-tailed weasel		
	Juvenile female (n = 3)	Adult female (n = 2)	Juvenile female (n = 3)	Adult female (n = 5–6)	Juvenile male (n = 1)
Postglenoidal to condylobasal length ratio	0.50±0.05 (0.44–0.53)	–	0.49, 0.49	0.50±0.01 (0.48–0.50)	–
Mastoid width (mm)	16.59±1.39 (15.40–18.11)	–	18.66, 20.16	18.98±0.57 (18.41–19.90)	–
Cranial width (mm)	16.62±1.23 (15.30–17.73)	–	18.36, 19.39	18.52±0.26 (18.24–18.81)	–
Bi-zygomatic width (mm)	18.11±1.45 (16.58–19.46)	–	21.51, 22.70	21.25±0.39 (20.65–21.57)	–
Muzzle width (mm)	8.64±0.61 (7.95–9.13)	–	8.46, 10.59	9.41±0.31 (9.06–9.79)	–
Foramen magnum height (mm)	5.40±0.11 (5.32–5.52)	–	4.92, 5.84	5.56±0.51 (4.66–5.88)	–
Foramen magnum width (mm)	6.41±0.23 (6.25–6.67)	–	6.21, 7.84	6.98±0.39(6.31–7.30)	–
Palatine to rostrum lenght (mm)	14.27±1.26(13.28–15.69)	–	16.83,17.11	17.38±0.49(16.68–17.80)	–
Palatine to pterygoid process length (mm)	5.97±0.15(5.88–6.14)	–	6.35,7.26	6.57±0.48(5.90–7.12)	–
Angular to coronoid process heigth (mm)	8.13±0.69(7.53–8.88)	–	9.71,11.19	10.14±0.33(9.63–10.48)	–

Mean ± standard deviation (range in parenthesis)

* indicates median reported (range in parenthesis)

67.9% of the additional 24 cases being correctly classified. Misclassifications were slightly higher among adults (33/92) than juveniles (10/42). Mean group centroids were –0.63±0.98 (n = 42; range = –1.90 to 2.14) for juveniles and 0.38±1.06 (n = 92; range of –2.44 to 3.88) for adults.

DISCUSSION

Our results indicate that male ermine and long-tailed weasel can be distinguished with confidence. Each of the discriminant functions derived, including those based on skull parameters alone, allowed for correct species classification of all specimens examined. Furthermore, examination of individual morphometric traits revealed that for more than half of the parameters investigated, the range of values shown by the two species failed to overlap. Accordingly, several options for interspecific separation (other than tail to head and body length ratio) may be employed, ranging from the simultaneous use of several traits as identified within the discriminant function to the use of a single selected trait in cases where pertinent information for the specimen in question may be largely lacking. Of particular relevance in this context, is the fact that during the skinning process the terminal portion of the tail occasionally dissociates and remains adhered to the pelt, thus invalidating use of tail length and tail vertebrae count as variables within discriminant functions as well as disallowing calculation of tail to head and body length ratio. In such cases, correct species assignment can still be confidently made and verified based on skull weight, mandible weight and/or head and body length. Even subjects that have additionally suffered severe trap-induced damage of the skull and mandible should remain classifiable on the basis of head and body length alone.

Visual inspection suggests that many of the morphometric traits useful in distinguishing male ermine from long-tailed weasel may be likewise applicable among female specimens. For 16 of the 24 variables investigated, species ranges for female specimens (juveniles and adults alike) were distinct with no overlap (Table 2); this pattern held true for all 8 parameters employed within both discriminant functions (all variables considered; tail variables excluded) successfully used to distinguish species among male subjects. Although still pending statistical verification, it would thus appear that species identification based on discriminant functions and compliance within range values for selected traits is possible irrespective of the gender of specimens.

In a few instances, traits previously reported as being highly diagnostic in species separation, proved to be less than clearly definitive among animals of the present study. For example, postglenoid to condylobasal length ratios of <0.46 and

>0.47 have been reported for male and female long-tailed weasel respectively, compared to >0.46 in male and >0.48 in female ermine (HALL 1981, KING 1983, SHEFFIELD & THOMAS 1997). While the pattern of greater values in ermine is supported by the significantly higher mean LPG:LBC ratio noted for male ermine compared to long-tailed weasel in the present study (Table 1), application of these critical values to animals, of both sexes and age groups, within the present study would misclassify 10.8% of subjects. Most misclassification errors would result from long-tailed weasel specimens (15/33) being incorrectly classified as ermine and the remaining 2 errors from ermine mistakenly identified as long-tailed weasel. As most of the misclassifications occurred among long-tailed weasel subjects, it is recommended that critical threshold LPG:LBC ratios currently used in distinguishing this species from ermine be re-evaluated, using enhanced sample sizes and considering sympatric populations from various geographic locales, including sites located at the northern limits of distribution for long-tailed weasel.

Total length for all male long-tailed weasel in our study ranged from 39.3 – 46.5 cm (mean 43.3±1.7 cm), resulting in 82.8% (24/29) of specimens exceeding the previously reported range of 33–42 cm (HALL 1981, FAGERSTONE 1987, SHEFFIELD & THOMAS 1997). Similarly, total length for female long-tailed weasel has been reported to range from 28–35 cm, with one female (36.2 cm) in the present study exceeding this range. Values for male and female ermine specimens, on the other hand, generally fell within accepted ranges for the species (HALL 1981). The occurrence of 'over-sized' long-tailed weasel specimens among our collection sample may be linked to the fact that our collection occurred at the very northern-most limit of this species' range where, according to Bergmann's rule, maximum size limits might be expected to prevail. This interpretation stands at odds, however, with previous observations of latitudinal size differences among ermine but not long-tailed weasel populations collected throughout North America (HALL 1951, RALLS & HARVEY 1985). Despite the above noted discrepancies in the range of body length values reported here and by others, ranges for the two species did not overlap, thus endorsing this parameter as a solid morphometric indicator for distinguishing between species.

Species classification based on numbers of caudal vertebrae present proved accurate for the majority of subjects with tails complete. Our results support the findings of HALL (1951) in which ermine were reported to have 15–19 caudal vertebrae compared to 19–23 in long-tailed weasel, with one exception – in the present study, no specimens having 15 or 23 vertebrae were noted. In both studies, overlap in vertebrae counts resulting in unknown-species designation was confined to a small proportion of animals having 19 vertebrae. An interspecies comparison, however, revealed that the range of vertebrae counts for males and like-

wise for females were consistently exclusive; counts ranged from 16–19 vs. 20–22 for male ermine and long-tailed weasel respectively, and from 17–18 vs. 19–21 for respective female cohorts. Accordingly, the use of vertebrae counts on subjects of known gender allows for all specimens, including those falling within the 19-vertebrae class, to be correctly classified as to species.

Gender discrepancies in both the least number and the maximum number of vertebrae present in long-tailed weasel (and likewise apparent in the frequency distribution of specimens across specified vertebrae-count classes) suggest that females tend toward lower vertebrae counts than their male counterparts. Evidence that vertebrae count patterns may be gender-influenced among *Mustela* spp. has not been previously reported. This finding, although tentative until further substantiated, provides incentive for further study and a consideration of the physiological basis for such sexually dimorphic patterns in tail development.

Previous studies have acknowledged that many current methods of age determination in weasels are unreliable, and are based on specimens for which actual ages could not be verified (KING 1980). KING (1991) suggested that due to the substantial degree in error of single-character methods, the recommended approach is to use combinations of skull and baculum measurements. Our results affirm this choice of skull and baculum variables, but indicate that their use in discriminant functions designed to distinguish between juvenile and adult ermine still meet with limited success (<75% of cases). While discrimination between young-of-the-year and adults may be reliable early in the season, it appears that rapid growth and development resulting in early maturation, with the exception of skull and baculum size which continue till 10–11 months of age (WRIGHT 1947, WRIGHT 1950, KING 1980), may render this process less reliable among older fall/winter trapped animals.

The pronounced male bias in specimen collections reported in the present study corroborates the findings of KING (1975) and RALLS and HARVEY (1985) in which sex ratios different from 1:1 in trapped samples of weasels were observed. KING (1975, 1983) reported that although the sex ratio of weasels at birth is equal and there is no evidence of differential mortality, most collections of these mustelids show an excess of males (>60%). The preponderance of male specimens, consistently observed in weasel collections, has mainly been attributed to sampling bias due to sexual dimorphism of home-range sizes (KING 1975, BUSKIRK & LINDSTEDT 1989); males generally have larger home ranges and hunt less often in subnivean tunnels than do females, and would therefore have a greater likelihood of encountering traps. Selective trapping has also been proposed to result in sampling bias; for example, sexual differences in pelt value may motivate trappers to set traps for or discard one sex more than the other (HAMILTON 1933). While the discriminant functions derived in the present study are specific for male

subjects, they nevertheless allow for classification of the majority of animals received during typical trapper-harvested collections of weasels.

Future studies aimed at separating closely-resembling species such as those examined here are likely to concentrate on biomolecular methods. Such approaches clearly hold considerable promise. If to be confidently compared with conventional morphometric methods and validated, such studies will nevertheless require careful design and sample sizes sufficiently large to accurately reflect the inherent genetic, morphologic and geographic variabilities present. For field researchers examining free-ranging subjects, the problem of species and age-cohort identification remains and will require the development of alternative classifying techniques applicable to live specimens.

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