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Sexual dimorphism of four owl species in South Africa

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Sexual dimorphism was studied in four South African owl species (African Grass-Owl *Tyto capensis*, Barn Owl *T. alba*, Marsh Owl *Asio capensis* and Spotted Eagle-Owl *Bubo africanus*) by examining specimens of intact owl carcasses found killed by vehicles along a national road in Gauteng Province, South Africa. Females were significantly heavier and larger than males for most species. The body mass and length of *T. capensis* and body mass and tail length of *A. capensis* were significantly different, with females being larger than males. Body, wing, tail and tarsus length for *T. alba* males were significantly different to females. For *B. africanus*, only tarsus length was found to be significantly different among genders. These findings were reiterated further when applying a Dimorphism Index to the same morphometric measurements. This study contributes to morphometrics distinguishing the sexes the of four southern African owl species, especially *T. capensis*, which has a Vulnerable IUCN status.

Introduction

Morphometric studies are of ecological and taxonomic importance amongst raptors as they can be used to predict and understand the habitat selection, hunting methods, time budgets and systematic relationships of different species (Norberg 1986). Biggs *et al.* (1979), Mendelsohn *et al*. (1989), Harrison *et al*. (1997), Urban *et al*. (1997) and Hockey *et al*. (2005) provide information regarding morphometrics of South African owls, but sample sizes are small and gender differences are not always presented.

Males are generally larger than females in most vertebrate species (Andersson 1994), but in the Strigiformes and most Falconiformes females are typically larger (Massemin *et al.* 2000). In the field it is often important to be able to sex individuals reliably and rapidly (Ropert-Coudert *et al*. 2005). This is most often achieved by considering dimorphic and dichromatic differences among genders. A more detailed study involving *post mortem* examination of owls is presented here to determine if any dimorphic relationships in the four South African owl species (African Grass-Owl *Tyto capensis*, Barn Owl *T. alba*, Marsh Owl *Asio capensis* and Spotted Eagle-Owl *Bubo africanus*) exists. In this paper, eight morphometric measurements are described for these species collected from the Gauteng Province, South Africa. The main aim of this study is to present further morphometric measurements of four southern African owl species with particular emphasis on *T. capensis*, which has a Vulnerable IUCN status.

Methods

Owl samples were collected as intact road carcasses found along the N17 national road in the south-eastern parts of Gauteng Province, South Africa (26°15’–26°27’ S, 28°30’–28°48’ E) from January 2002 to December 2003. Eight standard morphometric measurements, namely body mass (using a spring scale), total length of body, wingspan (both extended wings in a straight line), flattened wing length (distance from the carpometacarpal joint to the tip of the longest primary feather), tail length (distance from base of central feather to tip of longest feather), bill (from distal edge of the cere to the tip of the bill), total tarsus (tibiotarsus to the tarsometatarsus) and talon (average claw) lengths were measured prior to dissection (Dzubin and Cooch 1992, Proctor and Lynch 1993).

The condition of the carcasses was determined using the methods adapted from Wolfson (1954), Zaletaev (1956) and Proctor and Lynch (1993). If the pectoral muscle was well rounded and the keel mostly unnoticeable, a positive index value for good condition was applied. If the distinct convexity of the pectoral muscle in birds in good condition was replaced by a flattening of the muscle between the area bounded by the keel of the sternum and the arc of the thorax, an index value of zero was applied. If the pectoral muscles were concave and the keel protruded sharply, then a very poor condition, characteristic of heavy parasitic infestations or starvation was applied. Severe muscle dystrophy, which has a waterlogged appearance, would be an indication of this type of condition. Specimens of this nature were assigned a negative value.

The dimorphism index (DI) adapted from Storer (1966) was applied as follows:

$$DI = \frac{100 \times (parameter\ of\ female - parameter\ of\ male)}{0.5 \times (parameter\ of\ female + parameter\ of\ male)}$$

The cube root of each body mass was used to make the resulting value comparable to the indices of the linear measurements as suggested by Blanco and De La Puente

(2002). This DI is widely used and permits comparisons (Marti 1990). A positive value would result if reversed sexual dimorphism occurred, i.e. if females were larger than males. The same was true for all other linear measurements studied.

Statistical analysis

Descriptive statistical analyses, including the mean, standard deviation and range, were determined for all owl measurements. All statistics were performed with SPSS software (SPSS, Inc., Chicago, USA). Normality and homogeneity of variance were tested using Kolmogorov-Smirnoff and Levene's tests, respectively. Comparisons between means were carried out using one-way analysis of variance (ANOVA) followed by Scheffe's (for normally distributed homogenous data) or Dunnet's-T3 (for non-homogenous data) *post hoc* multiple comparison tests if significant differences were found. Significance was assessed at a level of $p \leq 0.05$. Non-parametric Spearman's rank correlation (two-tailed) analysis was used to determine the relationships between measured variables.

Results

In total, 83 intact owl carcasses were collected and examined. All specimens were scored positive following *post-mortem* examination, indicating that the specimens were in good condition. The mean morphometrics with their corresponding standard deviations, sample sizes and ranges for all species and corresponding genders are shown in Table 1. *Bubo africanus* (610.9 ± 74.7 g, n = 7) had the largest mean body mass of the species examined, followed by *T. capensis* (432.4 ± 61.9 g, n = 20), *A. capensis* (310.1 ± 37.9 g, n = 43) and *T. alba* (297.8 ± 27.4 g, n = 13). Comparisons of the means of the measured morphometrics between the genders of individual species using ANOVA indicated that body mass (p = 0.003, F =12.119, df = 16) and body length (p = 0.048, F = 4.571, df = 16) in *T. capensis* were significantly different. For *A. capensis*, body mass (p = 0.018, F = 6.212, df = 30) and tail length (p = 0.01, F = 7.539, df = 30) differed significantly, whereas body (p = 0.044, F = 4.219, df = 11), wing (p = 0.023, F = 5.402, df = 11), tail (p = 0.036, F = 4.549, df = 11) and tarsus lengths (p = 0.017, F = 5.984, df = 11) in *T. alba* differed significantly between male and female individuals. Only the tarsus length (p = 0.015, F = 14.286, df = 4) differed significantly between male and female *B. africanus*. With the exception of *B. africanus* tarsus length and *T. alba* tail and tarsus lengths, all other measurements indicated that females were significantly larger than the males.

The dimorphism indices are presented in Table 2. *Tyto capensis* females (mean = 469.1 g, n = 9), which weighed significantly more than males (mean = 412.1 g. n = 9), had a positive DI value of 4.34. This is similar for all other morphometric DI calculations for this species. The significant differences in body length in this species gave the largest DI value (6.62). *Tyto capensis* had the highest degree of sexual dimorphism amongst the four owl species in this study, followed by *A. capensis* and *B. africanus*. *Asio capensis* showed the highest degree of sexual dimorphism in tail length (DI = 4.92). *Tyto alba* displayed negative DI values for two variables (tail and tarsus lengths), indicating that the males are significantly larger than the females for these measurements. The significant differences in body and wing lengths showed *T. alba* females to be larger than the males. The largest degree of sexual dimorphism found in *B. africanus* was indicated in wing length (DI = 16.14) but was not statistically significant. Males, however, had significantly longer tarsus lengths for this species. It was also observed during examination of *T. capensis*, *A. capensis* and *T. alba* specimens that males and females could not be distinguished according to dichromatic differences.

Discussion

All specimens were found to have been in good condition prior to death. The intervals between time of death and collection were relatively small, as most specimens were collected early on a daily basis, and were weighed and dissected immediately. It was therefore unlikely that desiccation had a significant effect in reducing the mass of the carcasses and was thus considered to be representative. Contents of the stomach were removed and were excluded in the measurement of body mass, eliminating any discrepancies in gender differences due to ingestion of food. This reiterates the usefulness of carcasses as a source of biological information.

Earhart and Johnson (1970), Newton (1979), Andersson and Norberg (1981), Andersson (1994), Taylor (1994) and Newton *et al.* (1997) discuss differences in morphometrics found between genders and species being mostly attributed to hunting techniques employed (including type of prey) and brooding efficiency. *Tyto capensis* and *A. capensis* are grassland species that would be expected to be structurally adapted for functionality within such a habitat. A proportionally smaller bill length and tail length in *A. capensis* in relation to other intraspecific variables is potentially an indication of their preferred smaller prey (mainly insects) (Ansara, 2004). Wing length, wingspan and body mass in relation to bill length in *B. africanus* would be better suited to its predominant flight-hunting of smaller prey (mainly insects), and the long wings and longer bodies would suit the cosmopolitan and diverse hunting habits of *T. alba.* The lower overall dimorphism in body mass exhibited by *A. capensis* and *B. africanus* could be due to their high dietary intake of insects as opposed to the rodents and birds taken by *T. capensis* (Armstrong, 1991; Mendelsohn, 1989). It should, however, be noted that sample sizes for *B. africanus* (n = 7) and *T. alba* (n = 13) were relatively small and could have influenced the DI values for *T. alba* bill length and *B. africanus* wing length given in Table 2.

It can be concluded from morphometrical analyses of the owl specimens examined in this study that there is a definite correlation between certain morphometrical variables and gender. Dichromatic differences among genders of *T. capensis, A. capensis* and *T. alba* need to be studied to determine if this characteristic can be used as a tool for distinguishing genders of these owl species. It is recommended that further studies look at age-related differences.

Table 1: Morphometrics of four owl species, *Asio capensis, Tyto capensis, T. alba* and *Bubo africanus*. Measurements were taken from carcasses found along a national road and are presented as the mean ± standard deviation. The sample size and range are given in brackets. All measurements are presented in (mm) and mass in (g)

Species	Body mass	Body length	Wing length	Wingspan	Tail length	Tarsus length	Talon length	Bill length
Asio capensis	310.08 ± 37.93	340.8 ± 1.84	396.1 ± 1.92	939.7 ± 4.24	150.6 ± 1.06	48.1 ± 0.41	18.5 ± 0.23	32.9 ± 0.22
(n = 43)	(221.0–392.8)	(310.0–380.0)	(350.0–440.0)	(820.0–1020.0)	(130.0–170.0)	(40.0–55.0)	(12.0–23.0)	(28.0–38.0)
Male	297.59 ± 34.51	337.1 ± 1.71	398.1 ± 1.94	944.8 ± 3.92	148.8 ± 0.82	47.7 ± 0.37	18.5 ± 0.25	32.8 ± 0.19
(n = 21)	(230.6–351.5)	(310.0–370.0)	(350.0–440.0)	(830.0–1000.0)	(130.0–160.0)	(40.0–50.0)	(12.0–20.0)	(30.0–35.0)
Female	329.07 ± 32.76	348.2 ± 2.09	398.2 ± 1.99	947.3 ± 3.50	156.3 ± 1.15	48.4 ± 0.32	19.3 ± 0.18	33.4 ± 0.24
(n = 11)	(283.4–392.8)	(310.0–380.0)	(370.0–440.0)	(910.0–1020)	(140.0–170.0)	(45.0–53.0)	(15.0–22.0)	(30.0–38.0)
Bubo africanus	610.9 ± 74.74	414.3 ± 3.26	414.3 ± 8.56	1001.0 ± 10.41	186.0 ± 1.93	66.4 ± 0.48	23.1 ± 0.23	16.3 ± 0.21
(n = 7)	(491.2–723.0)	(360.0–470.0)	(240.0–510.0)	(800.0–1130.0)	(150.0–200.0)	(60.0–70.0)	(20.0–25.0)	(13.0–19.0)
Male	593.87 ± 95.23	400.0 ± 3.46	380.0 ± 12.49	970.0 ± 16.52	178.3 ± 2.47	70.0 ± 0.00	22.7 ± 0.25	16.3 ± 0.31
(n = 3)	(491.2–679.3)	(360.0–420.0)	(240.0–480.0)	(800.0–1130.0)	(150.0–195.0)	(70.0–70.0)	(20.0–25.0)	(13.0–19.0)
Female	627.87 ± 82.59	430.0 ± 3.61	446.7 ± 5.51	1026.7 ± 5.13	190.0 ± 1.73	61.7 ± 0.29	23.0 ± 0.26	16.0 ± 0.17
(n = 3)	(574.5–723)	(400.0–470.0)	(420.0–510.0)	(970.0–1070.0)	(170.0–200.0)	(60.0–65.0)	(20.0–25.0)	(15.0–18.0)
Tyto alba	297.83 ± 27.36	348.8 ± 2.22	403.8 ± 2.16	950.0 ± 4.05	131.3 ± 0.72	59.8 ± 0.41	21.3 ± 0.34	17.3 ± 0.91
(n = 13)	(238.4–332.4)	(310.0–380.0)	(370.0–440.0)	(860.0–1030.0)	(120.0–140.0)	(50.0–68.0)	(15.0–28.0)	(7.0–35.0)
Male	302.27 ± 13.81	326.7 ± 2.08	390.0 ± 1.0	940.0 ± 3.61	136.7 ± 0.58	65.3 ± 0.25	22.0 ± 0.35	14.3 ± 0.31
(n = 3)	(293.8–318.2)	(310.0–350.0)	(380.0–400.0)	(910.0–980.0)	(130.0–140.0)	(63.0–68.0)	(20.0–26.0)	(11.0–17.0)
Female	299.92 ± 34.48	351.1 ± 1.69	416.7 ± 1.87	964.4 ± 3.61	132.2 ± 0.67	57.8 ± 0.36	21.2 ± 0.41	20.4 ± 1.13
(n = 9)	(238.4–332.4)	(330.0–380.0)	(390.0–440.0)	(910.0–1030.0)	(120.0–140.0)	(55.0–60.0)	(15.0–28.0)	(7.0–35.0)
Tyto capensis	432.9 ± 61.94	399.0 ± 3.08	453.5 ± 3.39	1051.0 ± 4.42	134.0 ± 0.94	73.9 ± 0.66	25.4 ± 0.23	17.8 ± 0.30
(n = 20)	(277.1–535.5)	(350.0–450.0)	(370.0–490.0)	(980.0–1120.0)	(120.0–150.0)	(60.0–80.0)	(20.0–28.0)	(11.0–20.0)
Male	412.59 ± 46.74	390.0 ± 2.83	451.1 ± 3.59	1038.9 ± 4.57	132.2 ± 0.97	74.4 ± 0.53	25.3 ± 0.20	17.8 ± 0.22
(n = 9)	(370.3–488.2)	(360.0–450.0)	(400.0–490.0)	(980.0–1120.0)	(120.0–150.0)	(70.0–80.0)	(22.0–28.0)	(14.0–20.0)
Female	469.05 ± 39.03	416.7 ± 2.45	465.6 ± 2.01	1072.2 ± 3.53	137.8 ± 0.83	75.3 ± 0.69	26.1 ± 0.20	18.2 ± 0.31
(n = 9)	(431.5–535.5)	(370.0–440.0)	(440.0–490.0)	(1020.0–1110.0)	(130.0–150.0)	(60.0–80.0)	(18.0–22.0)	(12.0–20.0)

Table 2: Dimorphism indices based on body mass (cube root), total length, wing length, wingspan, tail, tarsus, talon and bill length in four South African owls

Variable	*Asio capensis*	*Bubo africanus*	*Tyto alba*	*Tyto capensis*
Body mass	3.35	1.77	-0.3	4.34
Body length	3.24	7.23	10.00	6.62
Wing length	0.03	16.14	6.62	3.16
Wingspan	0.26	5.68	2.56	3.16
Tail length	4.92	6.35	-3.35	4.15
Tarsus length	1.46	-1.26	-12.19	1.20
Talon length	4.23	1.31	-3.70	3.11
Bill length	1.81	-1.86	35.16	2.22

It is hoped from this that further research into this elusive group of birds will continue, especially on *T. capensis,* which is a species easily and readily studied.

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