

Morphometric Data and Dimorphism Indices of some Australian Raptors

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Measurements of wing length, exposed culmen length and weight are given for 20 of Australia's 24 diurnal raptors. The degrees of sexual dimorphism exhibited by the raptor species are calculated and discussed.

According to the directives of the Australian Bird-banding Scheme the sexes of five species of Australian diurnal raptor have sufficiently different tarsal circumferences to require different sized bands. While a few experienced banders can sex these strongly dimorphic birds in the hand, there are no published data which distinguish the sexes for the majority of banders. With the measurements of wing length, exposed culmen length and weight in Table 1, all banders can sex strongly dimorphic raptors in the hand, for there is little or no intersexual overlap.

Methods

Wing length was measured as the chord between the carpal joint and the tip of the longest primary when the wing was placed fully extended along a steel ruler; and exposed culmen length as the chord between the anterior tip of the maxilla and the posterior of the cere (see Baldwin *et al.* 1931). Weights were recorded from museum tags or from birds with empty crops that were trapped and weighed with a spring balance accurate to 10 g. These three measurements were chosen because I also wished to compare the dimorphism indices of Australian diurnal raptors with those calculated by Storer (1966) and by Snyder and Wiley (1976) for northern hemisphere raptors. During their calculations they took the cube root of weights so that valid comparisons could be made with linear measurements and used the following formula:

$$\text{dimorphism index} = \frac{\bar{x}(\text{♀♀}) - \bar{x}(\text{♂♂})}{\frac{1}{2}(\bar{x}(\text{♀♀}) + \bar{x}(\text{♂♂}))} \times \frac{100}{1}$$

Their method ignores some potentially important differences which may enable greater

niche separation by the sexes of some species than their mean dimorphism indices would indicate. For example, Marsh Harriers *Circus aeruginosus* are strongly sexually dimorphic for six of eight toe and claw measurements, but only moderately to weakly dimorphic for all other parameters (Baker-Gabb 1982). Snyder and Wiley (1976) considered that raptors with a mean dimorphism index of about 4.5 or less were weakly dimorphic, about 7.0 moderately dimorphic and about 12.0 or greater strongly dimorphic. They also noted that their dimorphism measurements were not equally reliable because for those species in which the sexes overlap in measurements and in which there are no clear colour differences between them, it was not possible to detect mis-sexed museum skins reliably. For those species they used museum tags for sex identification, and consequently the figures they presented were probably slight underestimates of true dimorphism. The same procedure was followed in this study when I measured specimens in the Australian Museum and the Museum of Victoria. If less than ten specimens of a species or less than four specimens of one sex were available for measuring, then they were not included in Table 1. Thus, four Australian diurnal raptors were excluded: the Osprey *Pandion haliaetus*, Square-tailed Kite *Lophoictinia isura*, Black-breasted Buzzard *Hamirostra melanosternon* and Brahminy Kite *Haliastur indus*.

Results and Discussion

Snyder and Wiley (1976) and Newton (1979) have shown that there is a strong positive correlation between the degree of sexual dimorphism of a raptor species and the proportion of

TABLE 1

Morphometric data and dimorphism indices (D.I.) of Australian diurnal raptors. Species are listed in order of descending dimorphism indices.

Species	Wing Chord			Length Exposed Culmen					Weight			MEAN D.I.			
	Mean (mm)	std. dev.	range (mm)	number	D.I.	Mean (mm)	std. dev.	range	number	D.I.	Mean (g)	std. dev.	range (g)	number	D.I.
♂ Grey Goshawk	260	7.3	240-271	25	17.5	27.4	0.8	25.3-29.2	24	17.6	359	61.0	283-450	8	20.9
♀ <i>Accipiter novaehollandiae</i>	310	8.4	291-330	24		32.7	1.1	31.0-34.7	24		674	92.8	530-785	13	
♂ Collared Sparrowhawk	206	4.9	196-218	22	16.1	16.7	0.7	15.6-18.5	22	17.5	125	14.6	110-150	10	21.9
♀ <i>Accipiter cirrhocephalus</i>	242	5.6	230-252	20		19.9	0.7	18.9-21.2	20		242	26.6	180-280	14	
♂ Red Goshawk	357	9.9	347-371	5	14.1	28.4	0.7	27.5-29.2	5	21.7	-	-	-	0	17.9
♀ <i>Erythroriorchis radiatus</i>	411	8.5	400-424	5		35.3	0.6	34.6-36.0	4		-	-	-	0	
♂ Brown Goshawk	264	5.4	255-276	27	13.8	23.1	0.9	20.5-24.5	27	16.7	311	42.9	230-375	19	20.1
♀ <i>Accipiter fuscatus</i>	303	6.6	290-320	32		27.3	1.2	25.4-30.6	32		569	48.9	480-700	27	
♂ Little Eagle	353	24.7	309-400	11	11.5	30.7	1.5	28.4-33.0	10	14.8	600	57.3	530-680	6	20.4
♀ <i>Hieraeetus morphnoides</i>	396	10.9	371-412	19		35.6	1.1	34.1-38.4	19		111.0	111.6	880-1250	18	15.6
♂ Peregrine Falcon	295	6.5	280-306	29	13.3	25.3	0.9	22.6-26.6	17	13.6	588	52.4	505-675	10	13.2
♀ <i>Falco peregrinus</i>	337	6.1	315-355	46		29.0	1.0	27.5-31.1	24		875	63.8	703-950	18	
♂ Spotted Harrier	390	9.3	381-404	10	11.6	28.4	0.8	27.4-29.8	10	14.7	507	42.3	477-537	2	11.6
♀ <i>Circus assimilis</i>	438	11.6	420-462	10		32.9	1.9	30.1-36.7	10		717	24.7	700-745	3	12.6
♂ Australian Hobby	240	5.4	230-250	29	12.1	17.4	0.5	16.4-18.1	23	10.7	213	23.1	177-250	8	11.2
♀ <i>Falco longipennis</i>	271	6.8	260-284	29		19.4	0.8	17.9-20.9	22		293	33.6	201-340	14	
♂ Black Falcon	361	7.4	350-370	10	11.0	25.3	0.5	24.1-26.0	10	9.4	664	32.8	620-710	5	11.6
♀ <i>Falco subniger</i>	403	7.3	392-415	10		27.8	1.0	26.3-29.0	10		940	50.2	879-1000	2	10.7
♂ Brown Falcon	321	9.3	305-337	20	10.3	25.2	0.9	23.8-26.9	19	11.9	474	34.5	417-520	14	9.2
♀ <i>Falco berigora</i>	356	8.5	340-375	23		28.4	1.8	25.9-33.2	22		625	37.3	560-730	24	10.5
♂ Grey Falcon	290	11.1	270-302	11	12.2	22.4	0.8	21.0-23.7	9	8.5	-	-	-	0	10.4
♀ <i>Falco hypoleucos</i>	328	7.0	321-341	7		24.4	1.1	22.7-25.5	6		-	-	-	0	
♂ Wedge-tailed Eagle	611	21.1	576-660	26	6.2	57.4	2.3	54.4-61.6	18	7.2	3137	516.7	2045-4000	10	9.6
♀ <i>Aquila audax</i>	650	16.4	621-680	34		61.7	2.1	59.1-65.1	12		4181	508.9	3180-5300	19	7.7
♂ White-bellied Sea-eagle	577	17.1	547-596	9	5.7	51.0	1.9	48.8-53.3	9	9.2	2875	150.1	2700-3000	4	6.1
♀ <i>Haliaeetus leucogaster</i>	611	27.3	543-634	14		55.9	2.5	52.0-61.3	14		3452	444.5	2695-3900	6	7.0
♂ Marsh Harrier	399	11.8	378-425	31	4.8	32.8	1.3	30.7-35.2	31	9.3	632	49.0	530-740	53	6.9
♀ <i>Circus aeruginosus</i>	419	9.7	400-445	47		36.0	1.2	33.6-38.8	47		847	63.3	740-1080	75	6.7
♂ Australian Kestrel	248	4.8	231-254	23	6.6	17.5	0.6	16.4-18.7	23	6.1	158	13.5	137-195	21	4.3
♀ <i>Falco cenchroides</i>	265	4.0	259-272	20		18.6	0.7	17.3-19.7	19		180	16.8	153-219	16	5.7
♂ Whistling Kite	401	10.6	376-419	32	4.6	33.2	1.4	28.5-35.0	32	6.4	710	39.6	600-750	21	5.2
♀ <i>Haliastur sphenurus</i>	420	10.7	396-446	38		35.8	1.0	33.5-38.0	37		830	34.5	760-900	29	5.4
♂ Pacific Baza	337	10.0	320-349	10	2.6	26.1	0.9	24.5-27.6	8	2.6	296	-	-	1	4.4
♀ <i>Aviceda subaristata</i>	346	9.0	339-360	7		26.8	1.1	25.7-28.7	7		338	-	-	1	3.2
♂ Black-shouldered Kite	294	7.3	274-306	17	0.7	22.3	1.1	20.5-24.0	16	2.6	261	37.3	200-300	11	4.4
♀ <i>Elanus notatus</i>	296	11.6	270-313	23		22.9	1.2	20.9-24.8	22		299	32.7	250-340	9	2.6
♂ Letter-winged Kite	302	6.2	293-313	8	1.6	23.9	1.3	22.3-26.1	8	2.5	259	48.6	217-312	3	2.0
♀ <i>Elanus scriptus</i>	307	5.6	301-316	7		24.7	0.9	23.5-26.0	7		-	-	-	0	
♂ Black Kite	411	17.6	381-431	10	1.0	31.1	0.6	30.1-32.1	9	3.2	574	60.8	505-610	6	1.3
♀ <i>Milvus migrans</i>	415	14.0	402-440	6		32.1	1.5	29.5-33.9	6		592	60.4	529-690	9	1.8

birds in its diet. The dimorphism indices in Table 1, and the detailed diet data of Leopold and Wolfe (1970), Olsen *et al.* (1979), Brooker and Ridpath (1980), Debus (1981), Pruett-Jones *et al.* (1981) and Baker-Gabb (1982), generally support this conclusion. But there are some exceptions, such as the strongly dimorphic Brown Goshawk *Accipiter fasciatus* which ate mainly Rabbits *Oryctolagus cuniculus* near both Werribee, (38°00'S., 144°40'E.) and Mildura (34°20'S., 141°55'E.) in Victoria (Baker-Gabb 1982). However, the dietary predominance of this mammal, which was introduced by Europeans in 1859 (Parer 1982), will as yet have had only a small influence on the morphology of Australia's diurnal raptors. Detailed diet studies are needed in areas north of the Tropic of Capricorn where Rabbits do not occur (Hyett and Shaw 1980).

The Grey Goshawk *A. novaehollandiae* is listed as the most dimorphic of Australia's diurnal raptors. When weight data are available it is likely that this species will be exceeded by the Red Goshawk *Erythrotriorchis radiatus* as Amadon (1977) suggested. That Australia's three goshawks exhibit similar degrees of sexual dimorphism to the smaller Collared Sparrowhawk *A. cirrhocephalus* suggests that they all feed mainly on birds. This runs contrary to northern hemisphere trends where the larger goshawks are considerably less dimorphic and take relatively many more mammals than the sparrowhawks (Newton 1979).

There has been some effort devoted to distinguishing between male Brown Goshawks and female Collared Sparrowhawks in the hand (Disney 1974). The latter species has relatively longer thinner toes and a squarer tail tip. Table 1 shows that male Brown Goshawks are also larger than female Collared Sparrowhawks and there is little overlap between the species for wing and exposed culmen measurements.

The weight data for some species are few (Table 1), and it is possible that the dimorphism indices of some species may change considerably when more data are available. The Osprey is one of four species not included in Table 1 and for which the sexes require different sized bands. It should be a priority among regular banders of this species to publish a comprehensive series of measurements.

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