Morphometric Data and Dimorphism Indices of some Australian Raptors

D. J. BAKER-GABB

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:

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

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	18.7
Accipiter novaehollandiae	♀	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	18.5
Accipiter cirrhocephalus	♀	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
Erythrotriorchis radiatus	♀	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	16.9
Accipiter fasciatus	♀	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	15.6
Hieraaetus morphnoides	♀	396	10.9	371–412	19		35.6	1.1	34.1–38.4	19		111.0	111.6	880–1250	18		
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	13.4
Falco peregrinus	♀	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	12.6
Circus assimilis	♀	438	11.6	420–462	10		32.9	1.9	30.1–36.7	10		717	24.7	700–745	3		
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	10.8	11.2
Falco longipennis	♀	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	10.7
Falco subniger	♀	403	7.3	392–415	10		27.8	1.0	26.3–29.0	10		940	50.2	879–1000	2		
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	10.5
Falco berigora	♀	356	8.5	340–375	23		28.4	1.8	25.9–33.2	22		625	37.3	560–730	24		
Grey Falcon	♂	290	11.1	270–302	11	12.2	22.4	0.8	21.0–23.7	9	8.5	–			0	–	10.4
Falco hypoleucos	♀	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	7.7
Aquila audax	♀	650	16.4	621–680	34		61.7	2.1	59.1–65.1	12		4181	508.9	3180–5300	19		
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	7.0
Haliaeetus leucogaster	♀	611	27.3	543–634	14		55.9	2.5	52.0–61.3	14		3452	444.5	2695–3900	6		
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	6.7	6.9
Circus aeruginosus	♀	419	9.7	400–445	47		36.0	1.2	33.6–38.8	47		847	63.3	740–1080	75		
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	5.7
Falco cenchroides	♀	265	4.0	259–272	20		18.6	0.7	17.3–19.7	19		180	16.8	153–219	16		
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	5.4
Haliastur sphenurus	♀	420	10.7	396–446	38		35.8	1.0	33.5–38.0	37		830	34.5	760–900	29		
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	3.2
Aviceda subcristata	♀	346	9.0	339–360	7		26.8	1.1	25.7–28.7	7		338	–	–	1		
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	2.6
Elanus notatus	♀	296	11.6	270–313	23		22.9	1.2	20.9–24.8	22		299	32.7	250–340	9		
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
Elanus scriptus	♀	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	1.8
Milvus migrans	♀	415	14.0	402–440	6		32.1	1.5	29.5–33.9	6		592	60.4	529–690	9		

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.

Acknowledgements

I thank the staff of several Australian museums who provided ready access to the collections in their keeping and in some cases supplied me with raptor weight data. These people included Walter Boles, Greg Czechura, Belinda Gillies, Wayne Longmore, Alan McEvey and Shane Parker. Tom Aumann, Stephen Debus, Jerry Klapste, Nick Mooney and Penny Olsen generously provided weight data from their own records and local collections.

References

Amadon, D. (1977). 'Further comments on sexual size dimorphism in birds', *Wilson Bull.* 89:619-620.

Baker-Gabb, D. J. (1982), Comparative ecology and behaviour of Swamp Harriers *Circus approximans*, Spotted Harriers *C. assimilis* and other raptors in Australia and New Zealand. Ph.D. Thesis, Monash University.

Baldwin, S. P., H. C. Oberholser and L. G. Worley (1931), 'Measurements of birds'. *Sci. Publ. Cleveland Mus. Nat. Hist.* 2:1-65.

Brooker, M. G. and M. G. Ridpath (1980), 'The diet of the Wedge-tailed Eagle *Aquila audax*, in Western Australia', *Aust. Wildl. Res.* 7:433-452.

Debus, S. J. S. (1981), Biology of the Little Eagle *Hieraaetus morphnoides* on the New England Tablelands, New South Wales, Dip. Nat. Res. thesis, University of New England.

Disney, H. J. (1974), Bird in the Hand. (Ed. S. G. Lane). Bird Banders Assoc. Aust., Sydney.

Hyett, J. and N. Shaw (1980), Australian Mammals. Thomas Nelson, Australia.

Leopold, A. S. and T. O. Wolfe (1970). 'Food habits of nesting Wedge-tailed Eagles *Aquila audax* in southeastern Australia'. *CSIRO Wildl. Res.* 15:1-17.

Newton, I. (1979), Population Ecology of Raptors. Buteo Books, Vermillion.

Olsen, P., W. J. M. Vestjens and J. Olsen (1979). 'Observations on the diet of the Australian Kestrel *Falco cenchroides*'. *Emu* 79:133-138.

Parer, I. (1982), 'Dispersal of the wild Rabbit *Oryctolagus cuniculus*, at Urana in New South Wales', *Aust. Wildl. Res.* 9:427-441.

Pruett-Jones, S. G., C. M. White and W. R. Devine (1981), 'Breeding of the Peregrine Falcon in Victoria, Australia', *Emu* 80:253-269.

Snyder, N. R. and J. W. Wiley (1976), 'Sexual size dimorphism in hawks and owls of North America', *Orn. Monogr.* 20:1-96.

Storer, R. W. (1966), 'Sexual dimorphism and food habits in three North American Accipiters', *Auk* 83:423-436.

D. J. Baker-Gabb,
Department of Zoology,
Monash University,
Clayton, Victoria 3168.

Present Address:
Royal Australasian Ornithologists Union,
21 Gladstone Street,
Moonee Ponds, Victoria 3039.