Wing areas and other dimensions of Greater and Lesser Flamingos

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Wing areas and other dimensions for seven Greater and eight Lesser Flamingos are presented. Indices of aspect ratio and wing loading and estimates of the costs of flapping flight (Masman & Klaassen 1987) were calculated for each bird. Greater Flamingos apparently incur higher costs in flight than Lesser Flamingos, while flight costs for males of both species are probably lower than for females.

INTRODUCTION

There are no published data, as far as we know, on the wing areas of Greater *Phoenicopterus ruber* and Lesser Flamingos *P. minor.* This paper presents these and other measurements recorded on seven Greater Flamingos and eight Lesser Flamingos collected on the Ekuma River (18° 35'S; 16° 03'E) in the Etosha National Park, South West Africa/Namibia. The specimens are now preserved in the State Museum, Windhoek.

METHODS

The following measurements were recorded: (a) Body Mass (g) recorded using a Pesola scale accurate to about 1%. (b) Wing Area (cm^2) measured from tracings of one extended wing and doubled for the area of both wings. The wing was flattened onto paper and extended so that the leading edge formed as straight a line as possible. Our wing areas exclude the area of the body and tail. (c) Wing Span (cm), the maximum distance between the tips of the extended wings. (d) Wing Length (mm), the standard measurement of the flattened wing from the wrist (carpometacarpal joint) to the tip of the longest primary feather. (e) Secondary Length (mm), the length of the most distal secondary remex, flattened and measured from the wrist to the tip of the feather. (f) Ulnar Length (mm) from the folded wrist to the inner side of the elbow joint, actually to the inner side of the distal humerus and thus an index of the length of the ulnar. (g) Tail Length (mm) from the tip of the longest rectrix to the posterior base of the uropygial gland. (h) Tarsus (tarsometatarsus) Length (mm) from the posterior centre of the tibiotarsal-tarsometatarsal joint to the base of the hind toe. (i) Culmen Length (mm) from the tip of the culmen to the suture at the skull-bill junction. (j) Total Body Length (cm) from the tip of the culmen to the tip of the longest claw, the body being fully extended. Sex was determined by inspection of the gonads.

The following ratios and indices were calculated for each bird: (a) Aspect Ratio (wing span^2/wing area), (b) Mass Loading (body mass/wing area, i.e. g/cm^2) and (c) Linear Loading (cube root of mass/square root of wing area, $g^{0.33}$/cm) (see Jaksić & Carothers 1985). We also estimated the costs of flapping flight for each bird from a multiple regression of body mass, wing area and wing span to predict the cost (in Watts) of flight (Masman & Klaassen 1987).

RESULTS & DISCUSSION

The Appendix lists the original measurements for each individual bird. Table 1 compares the dimensions of the two species by combining data for both sexes. Greater Flamingos were larger in all measurements. The costs of flapping flight for Greater Flamingos were probably about 39% greater than those for Lesser Flamingos, perhaps in relation to the higher absolute wing loading (see Mass Loading) of Greater Flamingos. However, they carry relatively lighter loads (Linear Loading) and their aspect ratios were similar to those of Lesser Flamingos.

Males were significantly larger than females in both species, except for body mass and length in Lesser Flamingos and culmen length in Greater Flamingos (Table 1). Although their wing

TABLE 1. Means, standard deviations and sample sizes of various measurements and indices (see text) of Greater and Lesser Flamingos. The first section compares the two species while males and females of each species are compared in the second and third sections. Students t–tests: NS–not significant, * – p<0.05, ** – p<0.025, *** – p<0.01, **** – p<0.005.

SPECIES		BODY MASS (g)	WING AREA (cm²)	WING SPAN (cm)	WING LENGTH (mm)	SECOND-ARY LENGTH (mm)	ULNAR LENGTH (mm)	TAIL LENGTH (mm)	TARSUS LENGTH (mm)	CULMEN LENGTH (mm)	BODY LENGTH (cm)	ASPECT RATIO	FLIGHT COST (Watts)	MASS LOADING	LINEAR LOADING
Greater Flamingo	AVERAGE	2734.29	2661.00	161.11	409.14	220.00	229.71	150.00	289.29	123.57	12.36	9.98	92.75	1.059	0.274
	SD	220.77	171.98	9.69	16.90	9.77	13.86	11.34	19.98	3.29	0.33	0.96	16.18	0.086	0.010
	NUMBER	7	6	7	7	7	7	7	7	7	7	6	5	6	6
		****	****	****	****	****	****	****	****	****	****	NS	***	***	*
Lesser Flamingo	AVERAGE	1592.50	1685.71	122.29	333.50	184.13	180.75	103.38	191.38	97.50	9.75	9.31	66.63	0.944	0.284
	SD	118.19	119.30	11.93	14.64	12.18	10.54	6.28	15.91	6.10	0.61	0.92	14.65	0.063	0.008
	NUMBER	8	7	8	8	8	8	8	8	8	8	7	7	7	7
Greater Flamingo Males	AVERAGE	2855.00	2751.00	169.17	419.75	227.75	239.75	157.50	303.75	125.25	12.53	10.67	81.94	1.043	0.271
	SD	152.40	140.15	4.29	12.95	2.86	5.72	9.01	11.10	1.48	0.15	0.88	12.01	0.102	0.011
	NUMBER	4	4	3	4	4	4	4	4	4	4	3	3	4	4
		*	*	****	**	****	****	**	***	NS	****	*	*	NS	NS
Females	AVERAGE	2573.33	2481.00	150.43	395.00	209.67	216.33	140.00	270.00	121.33	12.13	9.07	108.96	1.092	0.280
	SD	193.45	29.00	1.02	9.63	4.99	9.57	4.08	10.80	3.68	0.37	0.01	0.22	0.009	0.001
	NUMBER	3	2	3	3	3	3	3	3	3	3	2	2	2	2
Lesser Flamingos Males	AVERAGE	1690.00	1853.00	139.20	353.00	196.00	195.00	110.00	217.00	107.00	10.70	10.47	52.69	0.915	0.277
	SD	90.00	69.00	0.80	4.00	14.00	0.00	4.00	7.00	1.00	0.10	0.27	0.35	0.083	0.010
	NUMBER	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		NS	****	****	***	*	***	*	****	****	NS	***	NS	NS	*
Females	AVERAGE	1560.00	1618.80	116.65	327.00	180.17	176.00	101.17	182.83	94.33	9.43	8.84	72.21	0.955	0.287
	SD	109.17	48.49	7.90	10.55	8.35	7.62	5.27	5.43	3.04	0.30	0.63	13.84	0.048	0.004
	NUMBER	6	5	6	6	6	6	6	6	6	6	5	5	5	5

proportions were similar, males have higher aspect ratios (i.e. relatively narrower wings than females). This might explain the apparent lower costs of flight for males (the difference was almost significant for Lesser Flamingos [$P<0.1$]) since their wing loadings were similar. Female Lesser Flamingos, however, carry relatively heavier loads than males.

Our measurements from Etosha were similar to most of those published by Gallet (1950), Cramp & Simmons (1977) and Brown *et al.* (1982). Small differences in linear measurements were perhaps because of differences in measuring techniques. The only substantial difference was in body mass of male Greater Flamingos. Gallet's figures ($\bar{x} = 3579$, SD = 340, n = 13) were much higher ($p<0.005$). Fat reserves carried by flamingos probably vary markedly during the year and body mass would change as a result. Such changes will affect their flight costs. For example, if Gallet's (1950) flamingos had similar wing areas and spans to those from Etosha (as the measurements suggest), their flight costs would have been 26% greater. Flamingos are known to move very great distances and it remains to be seen how the timing of these flights may relate to changes in body mass and flight costs.

ACKNOWLEDGEMENTS

We are grateful to John Lawson, Tony Williams, Malan Lindeque and Terry Archibald for their help in the field.

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Manuscript received August 1988; accepted September 1988.

APPENDIX: Measurements of seven Greater and eight Lesser Flamingos collected in the Etosha National Park, S.W.A./Namibia.

SEX	BODY MASS (g)	WING AREA (cm)	WING SPAN (cm)	WING LENGTH (mm)	SECONDARY LENGTH (mm)	ULNA LENGTH (mm)	TAIL LENGTH (mm)	TARSUS LENGTH (mm)	CULMEN LENGTH (mm)	BODY LENGTH (cm)
Greater Flamingo										
M	2800	2932	–	430	230	235	170	289	123	161
M	2630	2820	169	405	223	240	145	298	127	166
M	2990	2696	164	435	230	235	160	310	125	165
M	3000	2556	175	409	228	249	155	318	126	172
F	2700	2452	149	382	203	221	145	255	121	144
F	2720	2510	151	405	215	225	135	275	126	158
F	2300	–	151	398	211	203	140	280	117	136
Lesser Flamingo										
M	1600	1922	140	349	210	195	106	210	90	122
M	1780	1784	138	357	182	195	114	224	95	121
F	1480	1644	126	345	187	177	100	181	93	110
F	1600	1628	112	328	166	189	107	185	95	126
F	1470	1580	119	316	172	178	106	185	100	123
F	1440	1552	117	328	182	169	105	182	93	106
F	1750	1690	124	332	189	178	96	191	108	108
F	1620	–	102	313	185	165	93	173	106	104