SEXUAL DIMORPHISM OF LARGE GULLS (*LARUS* SPP.)

AGNAR INGOLFSSON

RECENTLY much attention has been paid to sexual dimorphism in birds in relation to niche utilization. Storer (1966) shows that in three species of accipiters the smaller males take smaller prey on the average than do the females, and he suggests intraspecific competition may be partly responsible for maintaining and increasing the dimorphism, although other basic adaptive functions may also be involved. Smith (1966) found for two species of gulls (*Larus glaucoides* and *L. thayeri*) that the difference between the sexes was greatest when the species were allopatric with closely similar species. He suggests (p. 85): "that in the absence of competitors, selection will favor divergence in adaptive features such as bill shape as a means of reducing intraspecific competition."

Similarly Selander (1966) notes that in woodpeckers the greatest degree of sexual dimorphism is found in insular species that have no closely related competitors. He further demonstrates a relationship between degrees of sexual divergence in foraging behavior and in bill size in two species of the woodpecker genus *Centurus*. He believes that sexual divergence is adaptive in alleviating intersexual competition for food and points out that many groups of birds tend to be more sexually dimorphic in bill dimensions than in sizes of other body parts such as wing, tail, or tarsus.

This is not always true, even in cases where differences between the sexes in feeding habits have been demonstrated. Thus the European Goldfinch (*Carduelis carduelis*) is no more dimorphic in bill size than in wing-length, but Newton (1967) shows that the sexes take somewhat different food. Differences in foraging habits have even been demonstrated in the Red-cockaded Woodpecker (*Dendrocopos borealis*) which shows no sexual dimorphism in bill dimensions (Ligon, 1968). For further instances of intersexual differences in feeding habits see Selander (1966).

Obviously more critical information on this subject is needed, and it therefore seems worthwhile to publish the following observations obtained during a study on the feeding habits of several species of large gulls in Iceland (Ingolfsson, 1967). The species studied were the Great Black-backed Gull (*Larus marinus*), the Lesser Black-backed Gull (*L. fuscus*), the Iceland Gull (*L. glaucoides*), the Glaucous Gull (*L. hyperboreus*), and hybrid populations of Herring Gulls (*L. argentatus*) and Glaucous Gulls, referred to here as *L. argentatus/hyperboreus* (a paper describing this hybridization is in preparation). Altogether 1,405 gulls were collected at all times of the year, divided among 78 samples (a sample consists of a number of conspecific birds obtained in one locality within the span

of a few days). The stomach contents of all gulls were analyzed and various body dimensions were measured on most individuals.

All the forms studied showed considerable sexual dimorphism in size, the males being larger. The percentage nonoverlap of the sexes (see Mayr et al., 1953: 146) in body weight (corrected for the weight of crop and stomach contents) ranged from 80 to 98 per cent, averaging around 92. Using the cube root of the body weights (to facilitate comparisons with linear measurements) the males averaged from 1.04 to 1.09 times as large as the females (Table 1). The largest species (*marinus*) is about as dimorphic as the smallest (*fuscus, glaucoides*).

Table 1 compares the sexual dimorphism in culmen length (measured from the bases of the feathers on top of bill), bill depth (at posterior edge of nares), tarsus length, winglength (flattened), and taillength of the various populations examined, and includes some measurements from the literature. The degree of sexual dimorphism is indicated by the ratio of male to female measurements expressed as a percentage of the cube root of male over female weights. Manifestly the sexual dimorphism in bill dimensions is invariably greater than that of other body parts measured, and always greater than the dimorphism in general size (i.e. the percentages are always higher than 100). Furthermore the dimorphism is almost always greater in bill depth than in culmen length. The dimorphism in winglength, on the other hand, is invariably less marked than that of other linear measurements, and is almost always less than the dimorphism in body size (i.e. the percentages are lower than 100).

These results thus agree with those obtained for several other groups of birds, such as woodpeckers. As the sexes of gulls are indistinguishable in the field, we have to rely exclusively on the analysis of stomach contents when comparing the feeding habits of the sexes. Although analysis of stomach contents revealed marked differences among the species, with the exception of *hyperboreus* versus *argentatus/hyperboreus* (Ingolfsson, 1967), no such intersexual differences were indicated. Significant differences between the sexes were seen in 3 of the almost 80 samples (many of them not large enough to make a comparison between the sexes meaningful). Thus barnacles (*Balanus* sp.) were recorded significantly more often in females than in males in *argentatus/hyperboreus* taken at Skrudur, eastern Iceland, on 12 June 1965, but other evidence suggests that barnacles are taken mainly accidentally when the gulls are feeding on other intertidal animals such as mussels (*Mytilus edulis*). In *marinus* taken at Bulandshofdi, western Iceland, on 11 April 1965, fish offal was recorded from a significantly greater number of males than females, and finally in *hyperboreus* collected at Bulandshofdi on 2 March 1965, capelins (*Mallotus villosus*) were more often recorded from males than females.

TABLE 1

SEXUAL DIMORPHISM IN BODY PROPORTIONS IN GULLS (*LARUS* SPP.)[1]

	Sample size[2] (♂♂/♀♀)	Cube root of male over female weights	Degree of dimorphism				
			Culmen	Bill depth	Tarsus	Wing	Tail
L. marinus							
Murman coast[3]	74/59	1.069	103.3	–	–	98.0	–
Norway[4]	18/27	1.087	100.8	103.3	100.4	96.7	99.1
Southwestern England[5]	95/108	1.046	106.2	–	102.2	99.8	100.3
Bulandshofdi, Iceland	27/15	1.077	100.1	104.6	100.0	97.7	98.5
Reykjavik, Iceland	17/22	1.077	101.9	104.2	100.2	98.2	100.0
Hromundarey, Iceland	14/14	1.081	101.6	105.2	100.4	97.2	97.7
L. hyperboreus							
Bulandshofdi, Iceland	40/25	1.063	102.5	105.1	102.3	97.6	99.2
L. argentatus							
Murman coast[3]	162/94	1.054	105.3	–	–	99.4	–
Norway[4]	102/89	1.076	102.1	103.2	100.7	98.1	99.6
Mellum, Germany[6]	80/80	1.067	102.0	103.6	100.9	98.0	–
L. argentatus/hyperboreus							
Skrudur, Iceland	21/19	1.087	104.1	106.2	101.2	96.7	97.2
Hromundarey, Iceland	47/40	1.069	104.2	106.4	101.0	98.0	99.3
Vestmannaeyjar, Iceland	13/13	1.046	104.4	104.7	101.9	99.2	100.0
L. fuscus							
Northern Norway[4]	19/19	1.051	104.6	101.4	102.6	100.0	99.6
Southern Norway[4]	47/53	1.070	102.9	104.2	101.3	98.7	98.5
Southern Iceland	47/30	1.074	103.7	104.7	102.8	98.6	99.3
L. glaucoides							
Southwestern Iceland[7]	63/75	1.064	103.7	102.9	102.0	100.2	100.6

[1] Degree of sexual dimorphism is shown as the ratio of male to female measurements expressed as a percentage of the cube root of male over female weights. Data are my own except where otherwise indicated. Only birds collected during the breeding season (April to July) are included, except for *glaucoides*.

[2] These are minimum figures. The numbers involved in some measurements were sometimes considerably higher.

[3] Belopol'skii, 1961.

[4] Barth, 1966/67. Bill depth is here measured at the angle of the gonys.

[5] Harris, 1964.

[6] Goethe, 1961.

[7] These are wintering birds, collected January to April.

The differences are in all cases barely significant ($0.05 > P > 0.01$), and as numerous significance tests were done on each sample of gulls (one for each kind of food), some "significant" differences due to chance are of course expected. In any case no differences between the sexes are evident when one looks at the whole material for the five species. But the possibility of differences between the sexes too slight for the methods used here to detect cannot, of course, be ruled out.

If sexual dimorphism in size is to some extent the result of intersexual competition for food, one could expect to find the degree of dimorphism to

vary within wide limits, even among closely related species, as somewhat different factors (presence of potential competitors, availability of foods, etc.) can be expected to be involved in every case. Such variations are indeed sometimes observed, and both Storer (1966) and Selander (1966) try to correlate the variations they observed with the habits of the birds.

In gulls the dimorphism is remarkably constant from species to species. This is further substantiated by the measurements Dwight (1925) gives for a large number of gull species of greatly varying sizes. This suggests to me that the sexual dimorphism in gulls is more probably related primarily to some other functions, such as sex recognition or defense of territory, than to feeding habits. Conceivably the increased sexual dimorphism in bill size may be related to such functions, as the bill is important in many displays (e.g. Tinbergen, 1953) as well as in fighting (territories are defended mainly by the males).

As almost all the samples analyzed in Table 1 were taken during the breeding season, the proportionally longer wings of females could possibly be the result of emaciation from egg-production, but samples of *marinus* and *hyperboreus* taken in winter (not included in Table 1) show the proportional wing length differences between the sexes to be just as marked at that season. Of the forms studied in Iceland, *hyperboreus, argentatus/hyperboreus,* and *marinus* appear to be largely residents. Banding results (mostly unpublished records in the files of the Museum of Natural History, Reykjavik) show that some immature *marinus* migrate to the Faroe Islands and Britain in fall, but no adult has been recovered outside Iceland, although the adults do scatter widely within Iceland in winter. Data from Bulandshofdi, western Iceland, show a preponderance of *marinus* females over males in winter, but no such difference for *hyperboreus* (Table 2). While the evidence suggests a differential migration between sexes in *marinus,* the results are the opposite of what would be expected if the proportionally longer wing of females were related to longer migrations. Of the two remaining species, *fuscus* is a wholly migratory summer resident, while *glaucoides* is exclusively a winter visitor. There is no significant difference between the numbers of adult females (79) and males (63) of *glaucoides* collected. Securing food for young will often require much flight, but if anything males are more active in feeding the young than females, at least in *argentatus* (Tinbergen, 1953). In view of the above, reasons for the intrasexual difference in proportional wing length in gulls remain obscure.

ACKNOWLEDGMENTS

This study was conducted while I was a graduate student at The University of Michigan, Ann Arbor. During the period of this study I received financial aid from the Icelandic Science Fund (Visindasjodur Islands), Reykjavik, and the Chapman

TABLE 2

NUMBERS OF ADULT MALE AND FEMALE *LARUS MARINUS* AND *L. HYPERBOREUS* COLLECTED AT BULANDSHOFDI, WESTERN ICELAND

		April–September	October–March
L. marinus	♂♂	60	27
	♀♀	33	46
L. hyperboreus	♂♂	53	37
	♀♀	40	37

Memorial Fund and the Mae P. Smith Gull Fund, American Museum of Natural History, New York, and I was also the recipient of an Edward C. Walker Scholarship and a Rackham Predoctoral Fellowship from The University of Michigan, Ann Arbor. To all of those concerned I am deeply grateful. I am also indebted to Finnur Gudmundsson, Museum of Natural History, Reykjavik, for allowing me access to the files of the museum.

SUMMARY

In gulls sexual dimorphism in size is marked, the males being larger. In several species of large gulls examined (*Larus marinus, L. fuscus, L. glaucoides, L. hyperboreus, L. argentatus,* and *L. argentatus/hyperboreus*) males have proportionally longer and stouter bills than females, but proportionally shorter wings. Analysis of stomach contents of 1,405 gulls from Iceland revealed no difference in feeding habits between the sexes in any species, and it is thought probable that the sexual dimorphism in these birds is related to some such function as sex recognition or defense of territory in which the bill plays an important role, rather than to feeding habits. No explanation can be offered for the difference between sexes in proportional winglength.

LITERATURE CITED

BARTH, E. K. 1966/67. Standard body measurements in *Larus argentatus, L. fuscus, L. canus,* and *L. marinus.* Nytt Mag. Zool., Oslo, Norway, 14: 7–38.

BELOPOL'SKII, L. O. 1961. Ecology of sea colony birds of the Barents Sea. Jerusalem, Israel Program for Scientific Translations.

DWIGHT, J., JR. 1925. The gulls (Laridae) of the world; their plumages, moults, variations, relationships and distribution. Bull. Amer. Mus. Nat. Hist., 52: 63–408.

GOETHE, E. 1961. Zur Taxionomie der Silbermöwe (*Larus argentatus*) im südlichen deutschen Nordseegebiet. Vogelwarte, 21: 1–24.

HARRIS, M. P. 1964. Measurements and weights of Great Black-backed Gulls. Brit. Birds, 57: 71–75.

INGOLFSSON, A. 1967. The feeding ecology of five species of large gulls (*Larus*) in Iceland. Unpublished Ph.D. dissertation, Ann Arbor, Univ. Michigan.

LIGON, J. D. 1968. Sexual differences in foraging behavior in two species of *Dendrocopos* woodpeckers. Auk, 85: 203–215.

MAYR, E., E. G. LINSLEY, AND R. L. USINGER. 1953. Methods and principles of systematic zoology. New York, McGraw-Hill.

NEWTON, I. 1967. The adaptive radiation and feeding ecology of some British finches. Ibis, 109: 33–98.

SELANDER, R. K. 1966. Sexual dimorphism and differential niche utilization in birds. Condor, 68: 113–151.

SMITH, N. G. 1966. Evolution of some arctic gulls (*Larus*): An experimental study of isolating mechanisms. Ornithol. Monogr., 4: 1–99.

STORER, R. W. 1966. Sexual dimorphism and food habits in three North American Accipiters. Auk, 83: 423–436.

TINBERGEN, N. 1953. The Herring Gull's world. London, Collins.

Department of Biology, Southeastern Massachusetts Technological Institute, North Dartmouth, Massachusetts 02747.