Condor, 82:224–226

REMOVAL OF PRIMARY REMIGES AND ITS EFFECT ON THE FLYING ABILITY OF GLAUCOUS-WINGED GULLS

NICOLAAS A. M. VERBEEK

AND

JOAN L. MORGAN

The Glaucous-winged Gull (*Larus glaucescens*) molts its primary remiges in about 195 days (Verbeek 1979). Ingolfsson (1970) suggested that the long time required to molt the primaries in Glaucous Gulls (*L. hyperboreus*; 205 days) and Great Black-backed Gulls (*L. marinus*; 188 days) keeps the effectiveness of the wing surface at a maximum. He found that the interval between shedding of adjacent primaries was such that "usually two, less commonly one or three" were growing at the same time. The same appears true for Herring Gulls (*L. argentatus*). Thus the gap in the wing caused by growing or missing primaries is never very large.

Wing molt in gulls starts with the first (innermost) primary. When this remex is partly replaced, the second one is shed and so forth. By removing additional primaries from molting birds, producing an artificially large gap in the surface of the remiges, we tried to test certain predictions that can be made from Ingolfsson's hypothesis. If Ingolfsson is correct, one might expect that birds with extra missing primaries: (1) stay away longer on foraging trips; (2) have young who will grow more slowly; and (3) will feed different kinds of food to their young than birds undergoing normal primary molt.

STUDY AREA AND METHODS

The study was conducted on Mandarte Island (48°38'N, 123°17'W), British Columbia, from 1976 to 1978. Adult gulls were caught in a nest-trap when the eggs were pipping. We captured both members of pairs at two nests at the time of hatching but we stopped doing this because it led to temporary inattendance and predation of the eggs. For control birds (N = 30) we recorded the molt score (Ingolfsson 1970) and released the birds. For experimental birds (N = 55) we cut off two or three of the old primaries that were adjacent to the last partially grown or recently shed primaries as follows: primaries 3 and 4 (in one bird); 4 and 5 (17); 5 and 6 (20); 6 and 7 (2); 3, 4 and 5 (1); 4, 5 and 6 (10); 5, 6 and 7 (3); 6, 7 and 8 (1). The decision to cut off two or three old primaries was based on how many new, not yet fully-grown, primaries were present, and the length of these new feathers. The same primaries were cut off, about 1 cm above the skin, from each wing.

The chicks of control and experimental birds were weighed every morning until the fifth day (thereafter every other day) with a Pesola balance. Up to the age of five days all nests had three young; adults that lost young before then were given additional chicks. Each chick was banded with masking tape bearing the nest number and the number of the chick. Vermeer (1963) and Ward (1973) found evidence that growth rates decreased with increasing brood size, so we included in the analysis only the weights of young in nests with three chicks. Because of predation and the fact that large young were often hard to find, the sample size decreased in time.

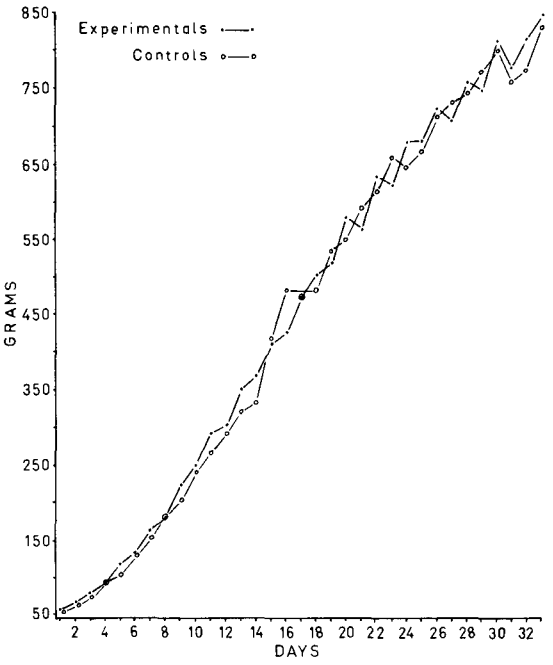

FIGURE 1. Growth curves of Glaucous-winged Gull chicks. Sample sizes of chicks of experimental parents ranged from 59 on day 1 to 17 on day 33. For control parents, sample sizes ranged from 78 to 12, respectively.

In 1978 we timed the foraging absences for 19 pairs in which one bird per pair had had some of its primaries cut off at the time when the eggs were hatching. Control data were taken from the mate of the experimental bird in each pair. The experimental group consisted of 11 males and 8 females, the control group of 8 males and 11 females. The eggs in these 19 nests hatched between 4 and 7 July. On 30 July, one of the 19 nests had one young, four had two young, 12 had three young, and two had four young. The experimental bird in each pair was dyed on the throat and crown for identification. When the dye wore off we identified the members of each pair by individual physical features. The birds were observed continuously from two blinds between 05:00 and 21:45 on 9, 10, 15, 16, 29 and 30 July. We noted all feeding of the young and when possible we identified the food item.

RESULTS

All birds caught were molting primary remiges; molt had not progressed beyond the fifth primary. In a sample of 37 birds, 16 had one, 20 had two, and one had three adjacent primaries in some stage of molt. On the average, 1.6 primaries were growing. These results are similar to those of Ingolfsson (1970) and Verbeek (1977) for other species of gulls. On the average, grow-

TABLE 1. Types of food regurgitated by Glaucous-winged Gull chicks.

Age group (days)	Controls			Experimentals		
	Fish	Garbage	Intertidal[a]	Fish	Garbage	Intertidal
0–7	23	–	3	16	–	–
8–14	11	–	2	16	2	1
15–21	11	2	1	8	2	2
22–28	6	–	–	5	1	2
29–35	5	1	2	4	1	–
36–42	2	–	–	1	–	–
Total[b]	58	3	8	50	6	5

[a] Other than fish.
[b] $\chi^2 = 1.87$, 2 df, $P > 0.50$.

TABLE 3. Types of food fed and total number of feedings by experimental and control birds in 19 pairs of adult Glaucous-winged Gulls.

Food	9–10 July		15–16 July		29–30 July	
	Exp.	Control	Exp.	Control	Exp.	Control
Fish	43	56	89	86	59	49
Garbage	7	11	9	10	19	23
Intertidal	5	5	2	0	2	5
Unknown[a]	—	—	66	71	53	53
Total	55	72	166	167	133	130

[a] Feeding occurred but we could not see what was fed. We did not record this information on 9–10 July.

ing primaries lacked 50.3% (12.8–100.0%) of their combined lengths (compared to when fully grown), or 15.4% (2.5–28.3%) when considering the combined lengths of the first five primaries. As a result of our feather removal, the gap in the wing was enlarged from 15.4% to 37.4% (28.3–48.4%) of the first eight primaries.

The mean growth rate of 39 experimental chicks from the age of 6 to 26 days inclusive (Fig. 1) was 27.52 ± 4.05 g/day. For 39 control chicks this was 27.23 ± 4.83 g/day. To test whether more of the experimental chicks fell into lower growth rate categories than control chicks we used the Mann-Whitney *U*-test. The results showed no significant difference ($P = 0.403$). Furthermore, by grouping the mean growth rates for each chick into four categories (<22.59, 22.60–26.00, 26.01–30.99, and >30.99 g/day) we also found no statistical difference between the individual growth rate of experimental and control chicks ($\chi^2 = 0.137$, 3 df, $P < 0.70$).

In 19 control nests the young were weighed collectively 808 times. During this weighing the chicks regurgitated food 69 times. Similarly, in 21 experimental nests, young were weighed collectively 941 times, and regurgitated food 61 times. The number of times the control and experimental chicks regurgitated fish, garbage, and intertidal food (other than fish) did not differ significantly (Table 1).

The mean duration of the foraging absences of experimental and control birds were significantly different only on 9 and 10 July (Table 2), about one week after the experimental birds were treated. The total number of feedings and the type of food were not different for experimental and control birds (Table 3).

DISCUSSION

As predicted, experimental birds stayed away longer on foraging trips than did control birds, but this prediction held true only for a short period following the removal of remiges (Table 2). Apparently, the experimental birds were affected by the widened gap in their primaries. Because molt proceeded normally, the feathers we cut off were eventually replaced in regular sequence. In about 35 days the enlarged gap in the wing of experimental birds became as large as the (natural) gap in control birds. Even on 15 and 16 July, about 14 days after the average experimental bird was treated, foraging absences of experimental and control birds were no longer significantly different.

The young of experimental birds did not grow more slowly than those of control birds (Fig. 1). Because only one parent per nest was experimentally treated, the other parent could have compensated by contributing more food for the young. This was not the case, however, as both sets of parents fed their young equally often (Table 3). Harris (1971) found that removing primaries of both parents in pairs of Swallow-tailed Gulls (*Creagrus furcatus*) did "not impair the ability of pairs to raise young." Perhaps food was more available in 1976–77 than in other years, thereby masking the effect of removal of some primaries. However, the growth rates of 27.52 g/day and 27.23 g/day for experimental and control chicks, respectively, are similar to those found by others on Mandarte Island (Vermeer 1963, Ward 1973, Hunt and Hunt 1976). The growth rates indicate that in terms of food availability, 1976 and 1977 were average years. Furthermore, the proportion of fish, garbage, and intertidal food regurgitated by the chicks in this study (Table 1) did not differ appreciably from those reported for 1971: 83% fish, 4% garbage and 13% intertidal (calculated from Fig. 9 in Ward 1973).

It might be argued that the fledging weights are important and influence the overall survival of the young. The fledging age of 67 Glaucous-winged Gull chicks varied from 37–53 days ($\bar{x} = 43.8$) and the weights of these birds varied from 566–1,133 g ($\bar{x} = 899$; Vermeer 1963). In our study, 6 of 14 experimental chicks and 6 of 12 control chicks weighed more than 899 g when 36 days old. Thus the control chicks were not significantly heavier than experimental chicks ($\chi^2 = 0.635$, df 1).

Ward (1973) noted that birds feeding larger-than-normal broods tended to use more garbage than birds feeding normal broods. Similarly, we predicted that experimental adults might have changed their feeding habits, for instance, by feeding closer to the colony or by feeding more on garbage than control birds. Our data (Table 3) do not support this prediction. Both ex-

TABLE 2. Mean foraging absences (min) of experimental and control birds in 19 pairs of adult Glaucous-winged Gulls.[a,b]

	9–10 July			15–16 July			29–30 July		
	N	Median	Range	N	Median	Range	N	Median	Range
Experimentals	74	131	39–424	82	112	39–440	100	104	26–411
Controls	80	97	42–420	84	108	29–468	103	118	35–457

[a] Control data were taken from the mate of the experimental bird in each pair.
[b] Statistical significance of difference between experimentals and controls for the three time periods were, respectively, as follows: $\chi^2 = 5.853$; $\chi^2 = 0.024$; $\chi^2 = 1.739$, 1 df (median test, Siegel 1956).

perimental and control adults fed similar proportions of fish, garbage and intertidal food to their young. Although the young of experimental adults gained weight normally, the adults may have lost more weight than control adults and so lessened their own chances of survival. This possibility could not be investigated. However, Ward (1973) noted that no higher mortality occurred among adults raising more than the normal one to three chicks.

ACKNOWLEDGMENTS

We thank Ivor McMahen, Juanita Russell, and Ken Morgan for their assistance in the field. The continued support of Jamie Smith and his field crew are much appreciated. We thank the Tsawout and Tseycum Indian Bands of Saanich, British Columbia, for permission to work on Mandarte Island. Helpful comments on the manuscript were provided by George Hunt. The study was supported by the National Research Council of Canada and a President's Research Grant from Simon Fraser University.

LITERATURE CITED

HARRIS, M. P. 1971. Ecological adaptations of moult in some British gulls. Bird Study 18:113–118.

HUNT, G. L. JR., AND M. W. HUNT. 1976. Gull chick survival: the significance of growth rates, timing of breeding and territory size. Ecology 57:62–75.

INGOLFSSON, A. 1970. The moult of remiges and rectrices in Great Black-backed Gulls *Larus marinus* and Glaucous Gulls *L. hyperboreus* in Iceland. Ibis 112:83–92.

SIEGEL, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill, NJ.

VERBEEK, N. A. M. 1977. Timing of moult in adult Herring Gulls and Lesser Black-backed Gulls. J. Ornithol. 118:87–92.

VERBEEK, N. A. M. 1979. Timing of primary molt and egg-laying in Glaucous-winged Gulls. Wilson Bull. 91:420–425.

VERMEER, K. 1963. The breeding ecology of the Glaucous-winged Gull (*Larus glaucescens*), on Mandarte Island, B.C. Occas. Pap. B.C. Prov. Mus. 13.

WARD, J. G. 1973. Reproductive success, food supply and the evolution of clutch size in the Glaucous-winged Gull. Ph.D. diss. Univ. British Columbia, Vancouver.

Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia V5A 1S6, Canada.
Accepted for publication 22 November 1978.

Condor, 82:226–227

RAPTOR HEMATOCRIT VALUES

SAMUEL R. HUNTER

AND

LEON R. POWERS

Avian hematology has attracted considerable study (Albritton 1952, Lucas and Jamroz 1961, Kaplan 1969, Jones and Johansen 1972, Milsom et al. 1973, Balasch et al. 1974, Carpenter 1975, Sturkie 1975, and Fallaw et al. 1976) yet very few data are available for birds of prey (Bond and Gilbert 1958, Cooper 1972, 1975, Balasch et al. 1976). Hematocrit (defined as the packed cell volume of erythrocytes in the blood expressed as a percentage of the total blood volume) has been shown to be higher in sexually mature male birds than females (Sturkie 1975, Fallaw et al. 1976), perhaps reflecting the influence of gonadal hormones (Sturkie 1975). Seasonal fluctuation also has been recorded in avian erythrocyte numbers (Sturkie 1975). While these may reflect natural fluctuations for avian species, Cooper (1975) has suggested that some reduced hematological values are associated with traumatic injury and disease and as such may be helpful in clinical diagnosis. The objective of this paper is to contribute to the data base of hematocrit values for wild raptors.

Research from 18 December 1975 through 18 December 1976 included five species of raptors: American Kestrel (*Falco sparverius*), Goshawk (*Accipiter gentilis*), Cooper's Hawk (*Accipiter cooperii*), Marsh Hawk (*Circus cyaneus*) and Red-tailed Hawk (*Buteo jamaicensis*). Birds were collected in Canyon Co., Idaho.

We used conventional trapping methods to obtain blood samples from raptors in the wild. Birds were unanesthetized but wrapped in a cloth for restraint while we took blood samples. Blood was drawn from the brachial vein in all species except the kestrel, whose smaller size necessitated sampling from the jugular vein. A 25-gauge unheparinized syringe proved to be most satisfactory for small avian veins. We drew 1 ml (kestrels) to 5 ml (occasionally from larger raptors) without observing any deleterious effects on the birds. Some of the drawn blood was transferred into two heparinized capillary tubes and microcentrifuged for five minutes at 402.5 RCF and the hematocrit recorded. The balance of the blood sample was given to the U.S. Fish and Wildlife Service for other studies. Most of the sampling was done in the field before noon, the capillary samples being stored on ice until analysis. Capillary tubes were always centrifuged within eight hours of drawing the blood. No investigation was made of the possible effects of such storage on hematocrit values.

We obtained few measurements of accipiters, Red-tailed Hawks and the Marsh Hawk and can say little about their comparative hematocrit values (Table 1). Our larger sample size for American Kestrels allows us to examine their hematocrit values by season and sex. During the fall and winter seasons there was no statistically significant difference between male and female American Kestrel hematocrits. A small sample size for spring male values prevents a valid comparison during that season. The fall 1976 mean hematocrit for male kestrels was significantly lower than that of winter 1975 males ($t = 1.843$, $P < .05$). Similarly, spring 1976 female hematocrits were significantly lower than winter 1975 female hematocrits ($t = 2.291$, $P < .05$).

Our data are significant in representing hematocrit values of birds trapped and sampled in the wild, whereas most of the values available in the literature are from captive, domestic, injured or diseased birds. Our kestrel data agree with Sturkie (1975) that hematocrit values fluctuate according to season, but our results do not support the view that hematocrit varies according to sex (Sturkie 1975, Fallaw et al. 1976). In general our raptor hematocrit values appear to be higher than most of those reported by others (Bond and Gilbert 1958, Cooper 1972, 1975, Balasch et al. 1976). This may reflect more normal values of wild birds used in our sampling, or the higher hematocrit values attributed to strong flyers (Carpenter 1975). It is probably