BURSA REGRESSION, GONAD CYCLE AND MOLT OF THE GREAT-HORNED OWL

By Milton W. Weller

Despite the regular and widespread occurrence of the Great-horned Owl (*Bubo virginianus*), many facets of its breeding biology are still unknown. The observations reported here help to clarify some of the uncertainties concerning age at sexual maturity, gonad cycle, and molt patterns. Data were collected mostly from owls killed at game farms in central and northern Iowa during 1957-1962, but five owls were from Minnesota and Manitoba. In addition, a small number of known-age owls were kept in captivity during 1960-1963. I am indebted to Larry Hall, George Kester and others at the State Conservation Commission Research and Exhibit Station at Boone, Iowa for care of the live owls.

METHODS

Owls were collected from various game farms during October through March and often had been frozen for periods of up to 10 days. For this reason, they were not weighed. However, several standard measurements were taken: chord of culmen (excluding cere), middle claw, wing (flattened), and tail length. The depth of the bursa of Fabricius was measured by slitting the ventral portion of the lip of the cloaca and measuring the depth of the bursa from its blind end to its base in the proctodaeum. It later became apparent that the diameter of the opening was of equal significance as depth; diameter was estimated for some specimens by the insertion of probes of several sizes.

Gonads were measured with a vernier caliper and preserved. Preserved gonads later were weighed after rolling them dry on a blotter. The diameter of the largest ovum in each ovary was measured with an ocular micrometer. Molt and general plumage color were noted, and one wing, the tail and one leg were preserved from most owls.

Captive owls were young-of-the-year which were held until various ages at which time they were sacrificed. Such owls were retained mainly for information on bursa regression, but some data were obtained on sequence and chronology of molt.

RESULTS

Subspecies in relation to migration

Despite the fact that the Great-horned Owl is commonly referred to as non-migratory species, considerable movement of northern subspecies occurs. Their regular occurrence in the central United States was summarized by Swenk (1937), and several non-resident subspecies were noted during the present study. Two birds were considered to be of the far northern race *B. v. wapacuthu*, and one

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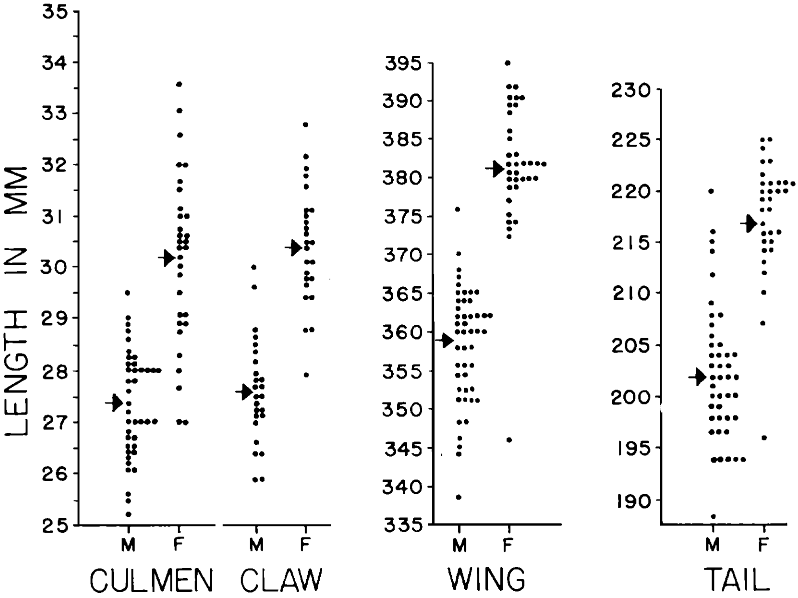
1. A comparison of measurements of male and female *Bubo v. virginianus*. Each dot represents one owl. Arrow indicates the mean.



specimen was considered to be the western *B. v. occidentalis*. The majority of individuals, however, were *B. v. virginianus*, which is the resident subspecies (DuMont, 1934). Nevertheless, some mobility of the latter subspecies is necessary to explain the source of large numbers of birds which often are seen or trapped along wooded stream valleys throughout the eastern deciduous forest. A large percentage of these appear to be young-of-the-year.

Sexual dimorphism

As noted by Oberholser (1904), size seems to be the major external difference in the sexes, and the variation in this sample was great. Data on length of culmen, claw, wing and tail of 85 specimens of *B. v. virginianus* are shown in Figure 1. The overlap may be more extreme in this sample because it probably represents non-breeding individuals from widely separated geographic areas. No single measurement or group of measurements served as a positive indicator of sex. However, it appears that a wing length of 370 millimeters divides all but about 5 per cent of males from females in this sample.

Plumage characters were less reliable. Figures 2 and 3 show the usual plumage characteristics of male and female. The underwing coverts of males tend to be spotted (occasionally a bilobed bar) while females usually are barred. However, this character seems clear-cut on only about 4 out of 5 birds. Exceptions are more commonly males with bars than females with spots. There may be

2. Six month-old male showing spotted underwing coverts, broad and blunt wing bars, and unmarked feet.

3. One year-old (or more) female showing barred underwing coverts, attenuated wing bars, and barred feet.

a tendency for females to have a more rufous underwing lining than males, but it is not commonly as dramatic as shown in Figures 2 and 3. Another plumage character shown in these Figures is the shape of the dark bar in the proximal primaries and in the secondaries. On the inner web, the bar tends to be more narrow and attenuated in females while males often have a broader bar with a blunt end. This character also is quite variable. A third plumage character is the barring of the feet. Feet of males tend to be immaculate; those of females often are barred. Neither remige barring nor foot color was more specific than the underwing barring.

Thus, no single character was found which could serve as a thoroughly reliable criterion of sex. Using a combination of size and plumage characters, an accuracy of approximately 85 to 90 per cent might be attained.

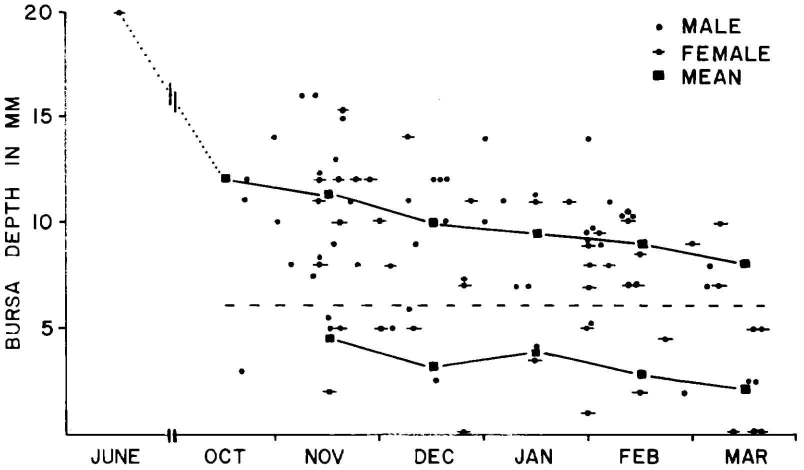
Age criteria

No external character was found which would serve as a means of identifying categories such as young-of-the-year, yearling or adult. Bent (1938) noted that young-of-the-year typically were more rufous than were adults. However, it was noted in this study that young often have light-colored feet and wing linings with a minimal amount of rufous coloring in these areas.

The presence of the bursa of Fabricius commonly has been used as a criterion of age in birds and was employed in this study with the assumption that its atrophy would reflect the approximate age at sexual maturity. Keith (1960) recently used bursa depth as an age criterion in Snowy Owls (*Nyctea scandiaca*) and presented data on the rate of degeneration from which he concluded that the bursa probably regressed completely by April at less than one year of age.

Data on bursa depths of 92 wild-caught Great-horned Owls are plotted in Figure 4. Considerable variation is apparent and immediately suggests the more complex patterns of birds which do not mature in one year, such as the Canada Goose (*Branta canadensis*) (Elder, 1946) or California Gull (*Larus californicus*) (Johnston, 1956). Two curves are suggested and drawn in Figure 4: (1) an upper curve which averages about 12 mm. in October and decreases to an average of about 8 mm. in March, and (2) a lower curve of a smaller number of birds with a bursa of 5 mm. or less during October and which averages only about 2 mm. in March. However, a good deal of variability is suggested. These data suggest that at least two years are necessary for bursa regression. Data from a small number of captive known-age owls are plotted in Figure 5 and strongly support data from wild-caught birds. The bursa does not regress noticeably by mid-winter as is true in most birds which nest when one year old. It is still sizable in early spring when birds are nearly one year old and decreases in depth gradually. It probably does not disappear completely until birds are well beyond two years of age and such regression may be influenced by the same hormones as is breeding activity. Diameter of the bursa opening declined from approximately 5-6 mm. at 3 to 6 months to 2+ mm. at 1 year and −1 mm. in the 2nd fall of life at 1½ years of age (Figure 5).

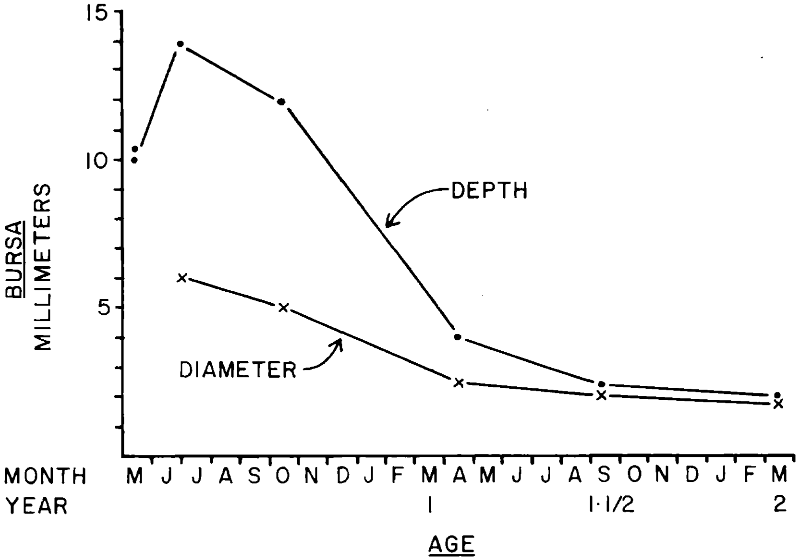
4. Bursa depth of 92 Great-horned Owls. Dotted line suggests possible division of yearling versus adult owls as suggested by data shown in figure 5.



These data suggest that most Great-horned Owls do not mature sexually until at least two years of age. However, the age at first breeding may well vary with time of hatching and with factors such as population density or location of territories. An incubating female collected on the nest had virtually no bursa, but a female, caught with a brood patch, had a bursa 7 mm. deep and over 2 mm. in diameter. Another female collected on March 1 had a bursa of 9 mm. deep and over 2 mm. in diameter yet had an enlarged, convoluted ovary and an open oviduct. There was no evidence of ovulated follicles or a brood patch, but the bird was clearly in a well-developed stage of the cycle despite its large bursa. It is well known that although the Canada Goose normally breeds at three years of age, some breed when only two years old, and Elder (1946) pointed out that the great variability in bursa regression suggested variation in age of first breeding. Moreover, in California Gulls, Johnston (1956) has shown that the bursa normally degenerates at four years of age when the plumage becomes adult, but individuals which breed when only three years old have smaller bursas than do nonbreeding three-year-olds.

Another age criterion is the acquisition of the complete adult plumage. In the Great-horned Owl, there seems to be little color difference in the first winter and adult plumage, but the juvenile remiges and rectrices are not molted until the second summer of life. Thus, any bird with molting wing or tail feathers is a minimum of one year and three months old. However, in the present sample, taken mostly in fall and winter, many owls already would have completed their molt. Thus, the presence of molt indicates age, but its absence is no assurance that the owl has not already completed its molt and may be several years old.

5. Bursa regression in known-age captive Great-horned Owls. Each point represents one owl.



Gonad cycle

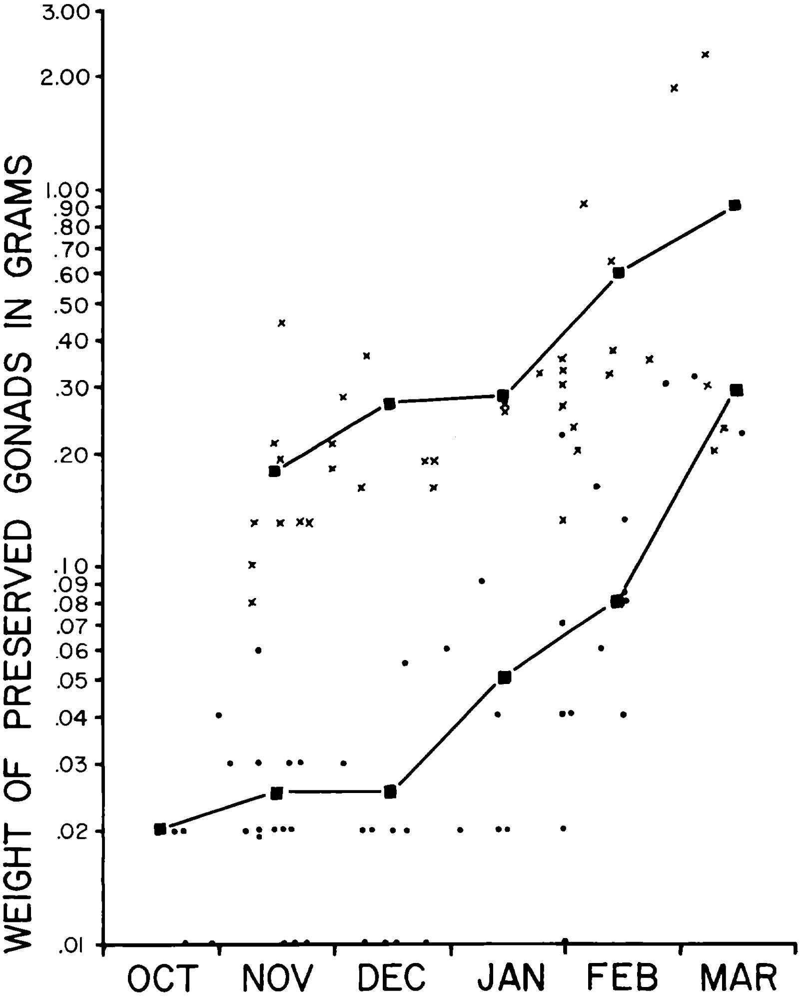
Weights of gonads and maximum size of ova in females are plotted against season in Figures 6 and 7. Despite the obvious mixing of age groups, a general increase in gonad size occurs by February or March when most mid-western owls start to breed. The lack of a higher peak may be because more owls taken probably are non-territorial wanderers and non-breeding yearlings.

Molt

Molt of owls is difficult to study because the softness of the feathers makes it difficult to distinguish old from new generations. Several mistakes in interpretation of age were made during the study and later recognized. It is clear that more questions concerning molting patterns were raised than were answered.

Rectrices. Of 94 wild-caught owls taken mainly during fall and winter, only two showed evidence of recent molt of tail feathers. A female taken in October appeared to have one new center tail feather, and a male taken in November had two new center tail feathers. This suggested that the rectrices were replaced during the summer, a period for which no specimens were available. Subsequently, observations on two captive yearlings proved this hypothesis true. Molt apparently began in one owl in early May since 6 of the 12 rectrices had been shed, and four were well grown by May 20th. However, another owl of the same age still retained all its juvenile feathers at that time. By July 1st both birds had a full set of rectrices but the latest molting bird still had at least three

6. Weights of preserved gonads of 36 female (x's) and 50 male (dots) Great-horned Owls.

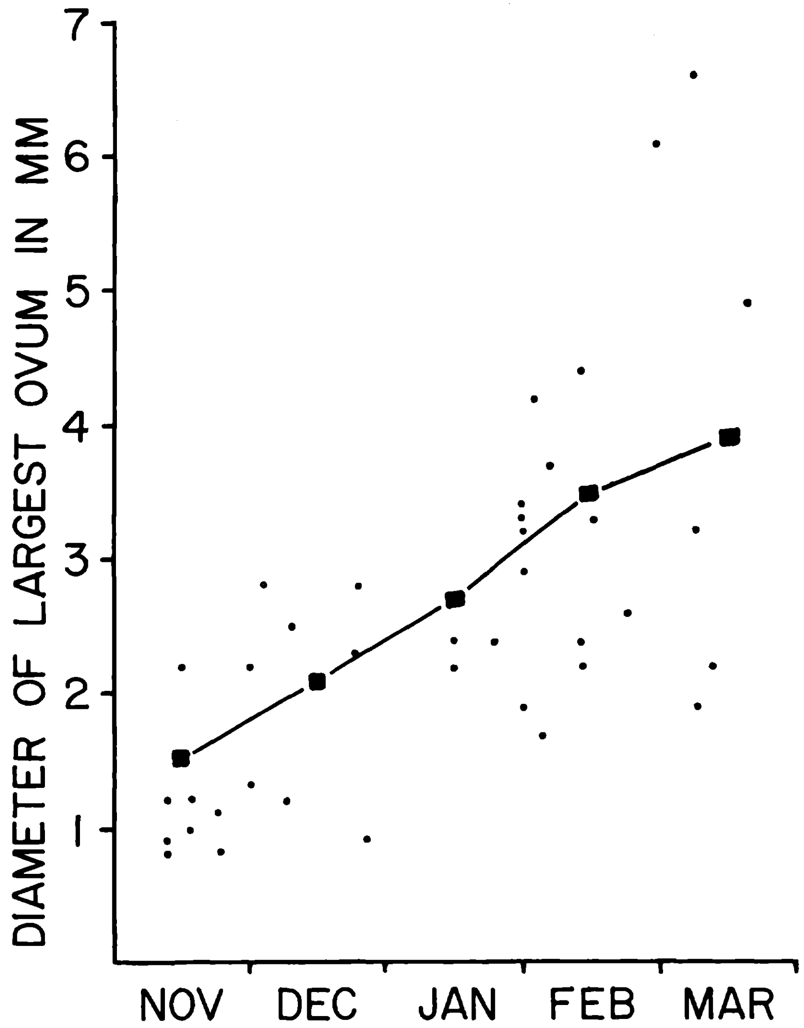


short outer feathers. Thus, it appears that about 50 days are required for the complete molt of the tail and that it occurs during late May and June. However, breeding birds might molt at a later date than non-breeders.

Molt of the tail feathers was gradual in two captive yearlings as seems typical of large owls (Mayr and Mayr, 1954). The molt pattern was centrifugal.

Remiges. The Great-horned Owl has 11 primaries according to Witherby *et al* (1938) and 17 secondaries mounted on ulna and ulna-

7. Diameter of the largest ovum in 38 Great-horned Owls. Squares represent monthly mean.



humeral joint. The 11th primary is minute and, according to Stresemann (1963), may be a covert. The secondaries are diastaxic with secondaries numbers 4 and 5 slightly separated, as is usual, and with numbers 5 and 6 also more widely spaced than are the other secondaries.

Because of variation in color of individual remiges, it appeared that some owls were in wing molt during every month of the year but the remige pattern was unusual in the absence of short, incoming feathers during late fall, winter and spring. After examination of several captives, it appeared that molt was normal in that a single feather dropped after the preceding feather was well developed, thus leaving a shorter remige still conspicuous. Nevertheless, the distinct difference in feather color was apparent. This variation in feather color could be caused by several conditions. First, overlapping feather generations have been noted by Piechocki (1960) in captive Barn Owls (*Tyto alba*). This condition also was observed in one of two captive horned owls, but this bird had an abnormal bill which may have influenced its food intake. Such feather color variation also may be due to variations in the volume or nature of the food supply during the molt. Of 12 owls showing variation in color of feathers (and, therefore, molt), bursa size varied from 0 to 8 mm., and most probably were adults. No evidence of this color variation was found in birds with deeper bursas. Presumably, remige growth is concurrent in juveniles and individual feather variation would not be expected. Another possibility is that age of the feather (i.e. time of replacement) may produce variation in degree of fading.

Whenever possible, notes were made on the molt of two owls which were being held captive for the study of bursa regression. Outer primaries were difficult to observe because of damage in the cages, and some difficulty was encountered in keeping feather numbers clear. Records of number 11 were deleted for this reason. The sequence of molt of remiges of the two captives was complex and differed markedly. Neither proceeded in the direct serial manner described by Mayr and Mayr (1954) for many smaller owls.

Primary molt of one owl started with number 1; then numbers 7 and 8 were replaced, and the outer primaries were the last to be regrown. The second owl apparently never molted primaries 1 through 5 but molted numbers 6 through 8 prior to the regrowth of 9 and 10. Molt centers at either 6 or 7 and at 1 are suggested, but considerable variability may occur.

The secondaries also seem to have several molt centers under the influence of the diastaxic arrangement as in certain falconiforms (Miller, 1941). In general, there seems to be serial and distal molt from number 17 toward number 9, which is followed by the molt of number 4 or 5. The exact time in relation to other secondaries seems to vary among individuals. It appears that there is then some proximal molt from number 1 toward 3. There may be also proximal molt from number 5 and distally from number 9 so that number 6 through 8 are the last secondaries to be renewed. However, more birds need to be followed in captivity to clarify this complex pattern.

Molt was generally bilaterally symmetrical.

Remige coverts and alula. It was of interest that the greater secondary coverts seem to molt completely and somewhat independently of the molt of the secondaries. Yearlings in July had almost all new coverts although fewer than one-half of the secondaries were new. However, their molt is rapid and could not be adequately traced. Molt of these coverts also seemed to begin at number 5 as the early molt pattern showed new coverts numbers 5, 6, and 7.

Greater primary coverts, on the contrary, molted in the order of and concurrently with the primaries.

Molt of the marginal wing coverts followed the molt of greater and secondary coverts but showed no distinct pattern.

The alula feathers appeared to molt from proximal to distal in two captive yearlings. Their molt seemed concurrent with that of the distal primaries and greater primary coverts.

Body molt. Molt of the body feathers was common in wild-caught owls during fall and early winter although no conspicuous absences of feathers were apparent. In two captive yearlings, head and body feathers remained unchanged until the wing molt was nearly complete. There was almost no body molt in June but there was a general increase in new feathers during August. This could explain the preponderance of molting birds found in October through January, after the completion of wing and tail molt.

Timing of molt. The chronological relationship between molt of various feather groups or tracts is suggested by the molt pattern of two captive yearlings. The order was: inner tail feathers, proximal secondaries, secondary coverts, outer tail feathers, middle primaries and their coverts, distal secondaries, proximal primaries, middle secondaries, marginal wing coverts, head and back, ventral body feathers. The entire molt requires from mid or late May to September or October.

SUMMARY

Body weight and other morphological dimensions of males generally exceeded those of females, but there was considerable overlap. A combination of wing measurements and plumage characters can be used to distinguish the sex of most individuals. External measurements and plumage observations demonstrated no simple means of age-determination. The bursa of Fabricius degenerates at approximately two years of age and serves as a fair method of determining age. This rate of disappearance suggests that most individuals do not breed until two years old, although some yearling females may breed.

Weights of gonads and measurements of ova show a general increase from October until March.

The first winter plumage is retained until May to July of the summer following hatching. Molt of the wing and tail feathers in yearlings occurs mainly in mid-May through September. The sequence of molt of the remiges is complex, and several molt centers appear to be present in both primaries and secondaries. Tail molt is gradual and centrifugal. Body molt follows wing molt and is common in late summer and early fall.

LITERATURE CITED

BENT, A. C. 1938. Life histories of North American birds of prey. II. *U.S. Nat. Mus. Bull.* **170**: 1-482.

DUMONT, P. A. 1934. A revised list of the birds of Iowa. *Univ. Iowa Studies in Nat. Hist.* **15**(5): 1-171.

ELDER, W. H. 1946. Age and sex criteria and weights of Canada geese. *J. Wildl. Mgmt.* **10:** 93-111.

JOHNSTON, D. W. 1956. The annual reproductive cycle of the California gull. *Condor.* **58:** 134-162, 206-221.

KEITH, L. B. 1960. Observations on snowy owls at Delta, Manitoba. *Can. Field Nat* **74:** 106-112.

MAYR, E. and M. MAYR. 1954. The tail molt of small owls. *Auk,* **71:** 172-178.

MILLER, A. H. 1941. The significance of molt centers among the secondary remiges in the Falconiformes. *Condor,* **43:** 113-115.

OBERHOLSER, H. C. 1904. A revision of the American great-horned owls. *Proc. U. S. Nat. Mus.* **27:** 177-192.

PIECHOCKI, R. 1961. Über die GroBgefieder-Mauser von Schleiereule und Waldkauz. *J. für Ornith.* **102:** 220-225.

STRESEMANN, Erwin. 1963. Variations in the number of primaries. *Condor,* **65:** 449-459.

SWENK, M. H. 1937. A study of the distribution and migration of the great horned owls in the Missouri Valley region. *Nebr. Bird Rev.* **5:** 79-105.

WITHERBY, H. F., E. C. R. JOURDAIN, N. F. TICEHURST and B. W. TUCKER. 1938. The handbook of British Birds. Vol. II. Witherby, H. F. & G., London. 352 pp.

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GENERAL NOTES

Siberian Recovery of Pectoral Sandpiper.—A Pectoral Sandpiper (*Erolia melanotos*), number 502-86246, was shot on May 28, 1963 near Yanskij (110 km. N of Verkhoyanski), Yakut, U. S. S. R., about 68° 30′ N. and 134° 45′ E. I had banded this bird while mist netting at dawn for Common Snipe (*Capella gallinago*) on Sept. 20, 1961, 18 miles east and 3 miles north of Saskatoon, Saskatchewan. I was assisted on that occasion by J. Bernard Gollop, waterfowl biologist with the Canadian Wildlife Service, and Robert Folker, upland game biologist with the Saskatchewan Department of Natural Resources.

Yanskij is some 1560 miles west of the westernmost tip of Alaska, on the Yana River just north of the Arctic Circle; via the Bering Straits it is about 3800 miles northwest of Saskatoon.

Since the breeding grounds of this species (A. O. U. Check-List. 5th edition) extend across northern Siberia to the Taimyr peninsula, one thousand miles further west, it was quite possibly on its breeding grounds when shot. Its wintering grounds extend from Peru, southern Bolivia, northern Argentina and Uruguay south to Patagonia, whereas it is only casual in Samoa, Australia and New Zealand. It seems possible that Pectoral Sandpipers nesting in Siberia regularly travel up to 2500 miles east before beginning their long southward journey, which may extend another 7200 miles beyond Saskatoon, into South America. The largest migratory movement is east of the Rocky Mountains and the Pectoral is one of the common sandpipers in migration in Saskatchewan each spring and fall. If allowed to indulge in even more speculative theorizing, one could estimate that the total round trip might approach 22,000 miles, rivalling that famous traveller, the Arctic Tern, (*Sterna paradisaea*). Extensive banding on the breeding and wintering grounds might prove fruitful.

Allen J. Duvall, then head of the Bird Banding Laboratory, informs me that 1008 Pectoral Sandpipers were banded up to and including 1960, and that the only two previous recoveries were from the state or province where banded (Illinois and Manitoba).

I have had only one other Siberian recovery—a Pintail (*Anas acuta*) banded