WINTER FEEDING PROGRAM OF ALASKA WILLOW PTARMIGAN SHOWN BY CROP CONTENTS

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In winter large numbers of Willow Ptarmigan (*Lagopus lagopus*) move through Anaktuvuk Pass (68° 9′ N lat, 151° 46′ W long) in the central part of the Brooks Range in arctic Alaska. The movement is southward in autumn and northward in spring with regular sequences that indicate a population making an annual migration. We believe that ptarmigan move southward from their extensive breeding area north of the Brooks Range through Anaktuvuk Pass and about 100 miles southward into the Koyukuk Valley (Irving, 1960; Irving, West, Peyton, and Paneak, 1966). The view that a single population is involved is supported by the dimensions of wings, tails, and weight which are normally distributed within limits characteristic of morphological homogeneity.

In the Colville Valley at Umiat (69° 24′ N lat, 152° 7′ W long), Anaktuvuk, and the vicinity of Bettles Air Field (66° 55′ N lat, 151° 28′ W long) in the Koyukuk Valley the winter distribution of these ptarmigan varies with sex and age in patterns consistent with a population organized in respect to these categories according to locality and date (Irving, West, Peyton, and Paneak, 1966).

Although we have been recording observations of winter migration of Willow Ptarmigan at Anaktuvuk since 1948 with the help of the Eskimos in that small village, our observations have been hampered by the limitation imposed by arctic winter weather on human sight and movement. In midwinter the frequent overcast days are dark and on cloudless days visibility is limited (or brief). Winds and blowing snow often confine even Eskimos to shelter, and unless preparations of food and fuel have failed, arctic people use midwinter for indoor work and sociability. In order to supplement direct observation we have utilized the indirect evidence of tracks in snow and sounds of calls for indications of the pattern of midwinter activity of the ptarmigan.

Crops of ptarmigan in winter from Anaktuvuk and Umiat contain almost exclusively buds and twig tips of the few species of willow (*Salix*) that are accessible above the snow, but in the wooded Koyukuk Valley some birch (*Betula*) catkins and poplar (*Populus*) buds are included (West and Meng, 1966). The food is easily identifiable and shows no appearance of digestive alteration by the thin membranous crop.

In 1960 we noticed that the amount of food in the ptarmigans' crops in midwinter increased from small quantities in morning to as much as 15 per cent of a bird's weight toward evening. West and Meng (1966) remarked that average dry weights of crops increased from autumn to winter and decreased to lowest weights in summer. It appeared that the accumulation in crops might provide an index of the daily feeding program of the birds that would avoid the irregularity in observation imposed by arctic winter conditions.

METHODS

Ptarmigan collected by shooting were weighed. Juvenile birds could be distinguished by the pigmentation of the 9th primary feathers. Sex was determined by dissection, and crops were removed and weighed.

The average weight of the membranous tissues of the crop was only 3.1 g.

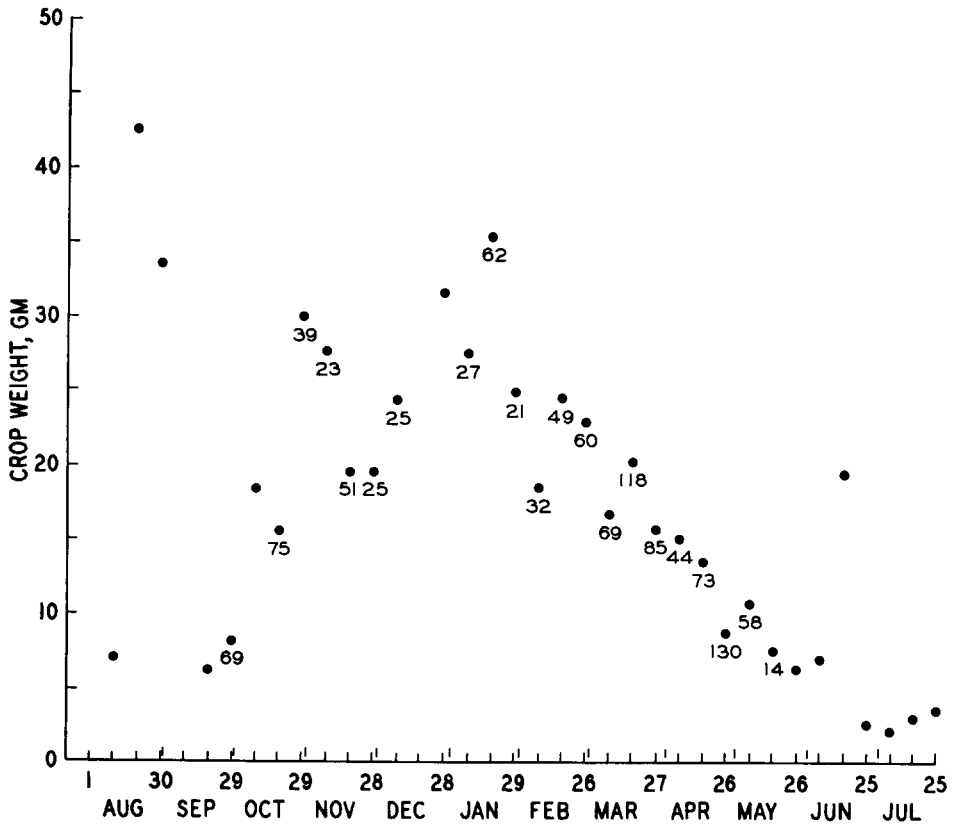

Figure 1. Average weight of crops of Willow Ptarmigan in each 10-day interval. Number of crops weighed is shown by numeral under point. Points without figures represented fewer than 10 birds. Total = 1192 birds from localities collected between the Koyukuk River and Umiat.

Therefore it made little difference whether the crop was weighed intact with its contents, or whether the contents were removed and weighed separately.

RESULTS

Distribution of Crop Weights during the Seasons

The recorded weights of 1192 crops of Willow Ptarmigan summarized by 10-day periods clearly show a maximum in midwinter (fig. 1), with lower values in summer. Samples in summer are too few for meaningful statistical comparison, but the limited data that we have and the long experience of the Eskimos indicate that during the long summer days with varied green food available, ptarmigan crops usually contain little material.

Variation in Weights of Crops at Anaktuvuk during the Day

We had earlier remarked that at Anaktuvuk, crops collected in the afternoon in midwinter were often filled (Irving, 1960). Figures 2 to 8 display the weights of crops in relation to the time of day when the birds were collected in the months

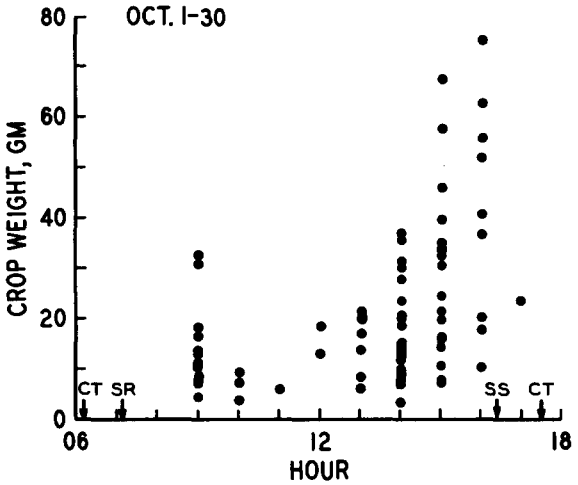

Figure 2. Weight of crops of Willow Ptarmigan from Anaktuvuk during day. SR sunrise, SS sunset, CT beginning and end of civil twilight.

from October to May. For this purpose we have utilized only the collections made at Anaktuvuk.

It is apparent that from October through March afternoon crops are usually heavier and forenoon crops are lighter. In April and May there is no certain diurnal trend.

December observations are statistically insufficient for comparison. We do not believe that this represents absence of ptarmigan, but that in December bad weather and darkness kept prudent people indoors and reduced their effective observation when outside.

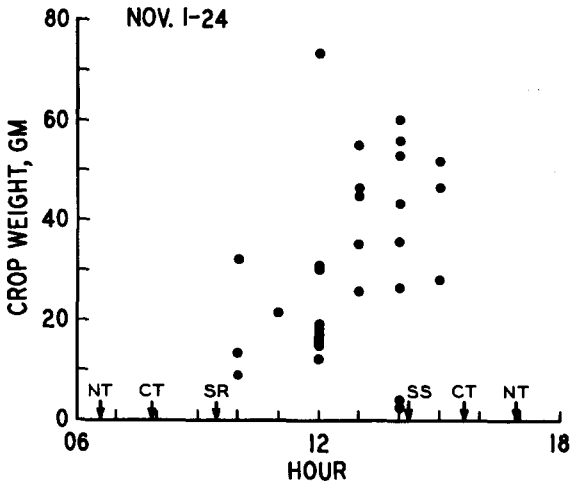

Figure 3. Weight of crops of Willow Ptarmigan from Anaktuvuk during day. SR sunrise, SS sunset, CT beginning and end of civil twilight, NT beginning and end of nautical twilight.

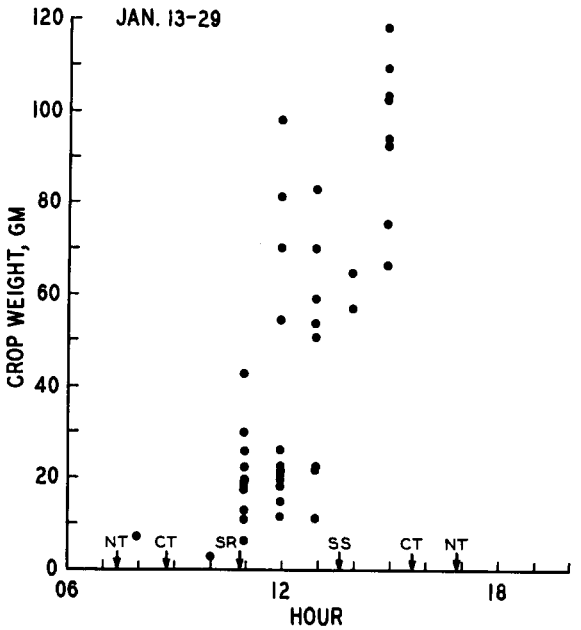

Figure 4. Weight of crops of Willow Ptarmigan from Anaktuvuk during day. Time designations as in figure 3.

Records near sunset exceeded those near sunrise as a result of the reluctance of hunters to start in the morning before the day's conditions could be estimated and operations planned.

Observed Daily Program of Willow Ptarmigan

Our own program of observation in midwinter began later in the morning than did the activities of the ptarmigan. While we were still indoors, calls could occa-

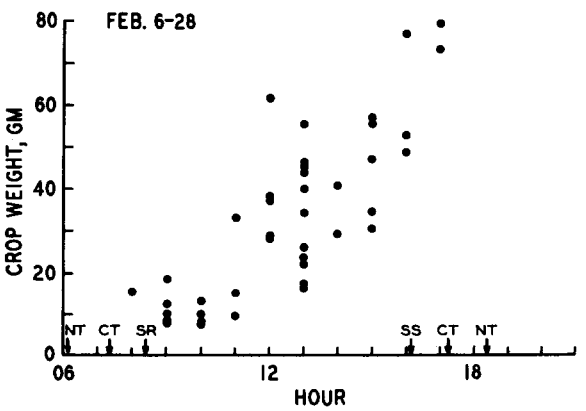

Figure 5. Weight of crops of Willow Ptarmigan from Anaktuvuk during day. Time designations as in figure 3.

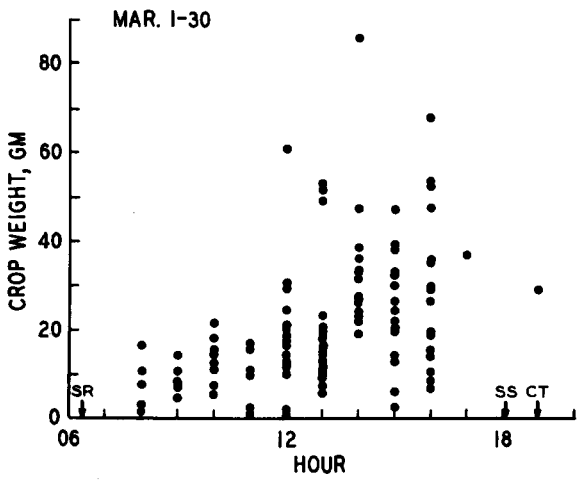

Figure 6. Weight of crops of Willow Ptarmigan from Anaktuvuk during day. Time designations as in figure 2.

sionally be heard in the dim light of dawn, and tracks in fresh snow showed early activity. When we could see the birds, they were moving and feeding before noon but appeared sedentary at midday.

After midday, feeding was resumed but appeared to diminish at dusk. Occasional observations of their retirement to roost at dusk showed flocks settling from flight into their roosting places in snow. Lack of tracks around roosting places indicated that they were usually entered from flight and that the birds flew out, as Sandys and Van Dyke (1904) remarked was their habit and as Nelson (1887) observed on the shores of Norton Sound; individuals roost separately.

In shallow or wind-packed hard snow, ptarmigan roost in open depressions in the snow. When soft snow is deep enough they burrow a foot downward and one or two feet horizontally. There, in a chamber large enough for a ptarmigan to turn around, they remain for the night. The accumulation of droppings, sometimes amounting to more than 100 g, indicated that the birds had remained for a considerable period of digestion and had discharged residues weighing as much as the evening crops. Occasionally in early morning, we have startled them to fly from their burrows, and rarely have we found tracks to indicate that they take a few steps from the burrow before flight.

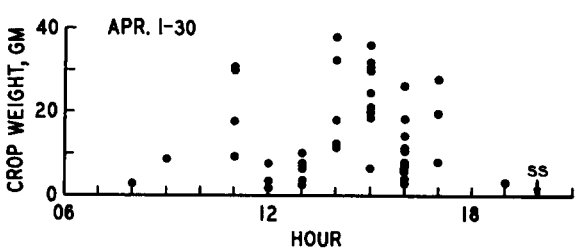

Figure 7. Weight of crops of Willow Ptarmigan from Anaktuvuk during day. Time designations as in figure 2.

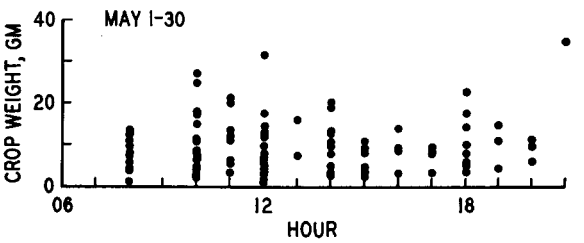

Figure 8. Weight of crops of Willow Ptarmigan from Anaktuvuk during day. Time designations as in figure 2.

We have seen no evidence that ptarmigan are active before or after twilight in midwinter; but as daylight rapidly lengthens in April their calling becomes more frequently heard after sunset and before sunrise. In late April and early May, during the final accelerated northward migration (Irving, West, Peyton, and Paneak, 1966), flying flocks are frequently heard in late-evening twilight and early before dawn. After mid-May, arctic nights are no longer dark. The ptarmigan may then be active during nearly any part of each 24 hours.

DISCUSSION

We have not seen any evidence that digestion occurs in crops. Caloric equivalents determined by combustion and fat analyses of willow species from crops indicated that they had not changed from the natural condition of the food species (West and Meng, 1966).

The population of ptarmigan at Anaktuvuk changes month by month during winter in the proportions of male and female adult and juvenile birds (Irving, West, Peyton, and Paneak, 1966), and these categories differ in size (table 1).

If we suspected that crops weighed in proportion to the size of the birds, the crops of lighter juvenile females might be 618/512 or 121 per cent nearer to filled capacity than the crops of the larger males (table 1). The possibility of significant bias in the seasonal variation in crop weights was reduced, however, by the predominance of male ptarmigan at Anaktuvuk in winter. Of our collections at Anaktuvuk (Irving, West, Peyton, and Paneak, 1966), male birds (adults and juveniles combined) constituted the following percentages: Oct., 47%; Nov., 54%; Dec., 80%; Jan., 94%; Feb., 87%; Mar., 90%; Apr., 81%; May, 59%. The difference in size of birds accordingly could not appreciably alter the seasonal maximum weight of crops in winter (fig. 1) or the time of afternoon maximum in midwinter (figs. 2 to 8).

The size of crop is related seasonally to the duration of sunlight at Anaktuvuk (fig. 9). On clear days in December and January with reflection from snow, one

TABLE 1

WEIGHTS (WITHOUT CROP) OF WILLOW PTARMIGAN FROM BROOKS RANGE IN WINTER

Number	Category	Mean ± SE
446	Adult males	618 ± 41 g
174	Adult females	534 ± 39
337	Juvenile males	590 ± 47
233	Juvenile females	512 ± 40

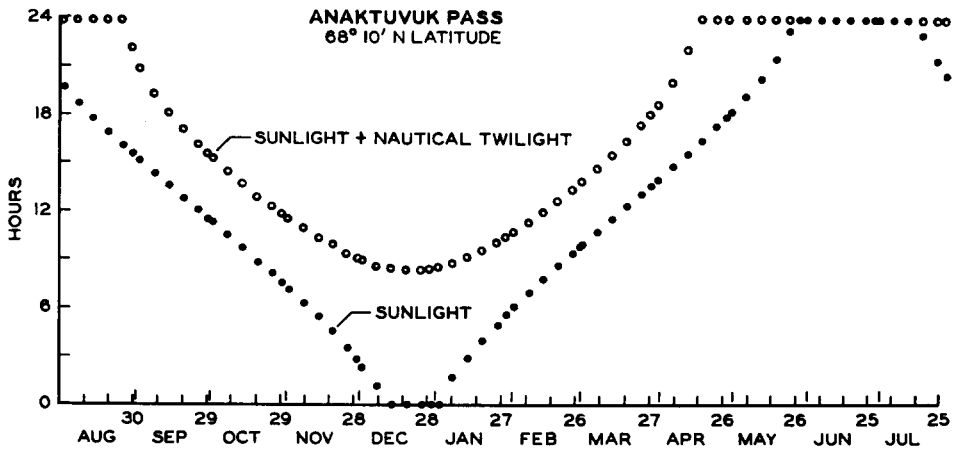

Figure 9. Duration of sunlight and nautical twilight (2 hours before and after sunrise and sunset) at Anaktuvuk, 69° 24′ N lat, 152° 7′ W long (U. S. Naval Observatory, 1945).

can see ptarmigan as they move and can shoot them with a shotgun for three or four hours around noon. Occasionally birds could be heard calling at 0900 and might be flushed after 1500. We believe that in midwinter their feeding day does not extend for eight hours and that more than 16 hours are spent in the roost. This agrees with the indication from midwinter crop weights, which rose to their maximum of around 100 g three hours after noon (fig 4). Ptarmigan appear to be active on clear midwinter days during the hours of sunlight and nautical twilight, which extends for two hours before and after sunrise and sunset.

Dark overcast and stormy days precluded collections. Our examples represent the feeding schedule in good weather, but we lack information in the worst weather. Occasional glimpses of ptarmigan in stormy weather showed them not feeding but only seeking shelter from the wind in the lee of a bank. We suspect that occasionally in midwinter storms, the ptarmigan can scarcely feed for one or two days. So the maximum accumulation in crops on clear days represents restitution for food missed in previous bad weather and provision for building reserves.

Maximum filling of crops coincides with the shortest days of winter in January and, by interpolation, in December. November crops corresponded with those of February, and October crops corresponded with those of March. The autumn period of southward migration is compressed within October and November, but northward movements beginning late in January extend through five months into May (Irving, 1960; Irving, West, Peyton, and Paneak, 1966). Thus the migratory periods are not symmetrical with changing daylength, for although they start with the September equinox, they continue for two months after the March equinox. They rather resemble the annual course of cooling and warming weather (fig. 10) in which October and May correspond. Snow usually continues to accumulate into March and only clears from the ground during May.

It appears that maximum accumulations in the crops of ptarmigan are related to the short duration of light for feeding. Maximum accumulation in crops occurs when daylight is least, and it is also about at this date when migratory activity is least evident. Before midwinter the trend of movements is southward, and afterward

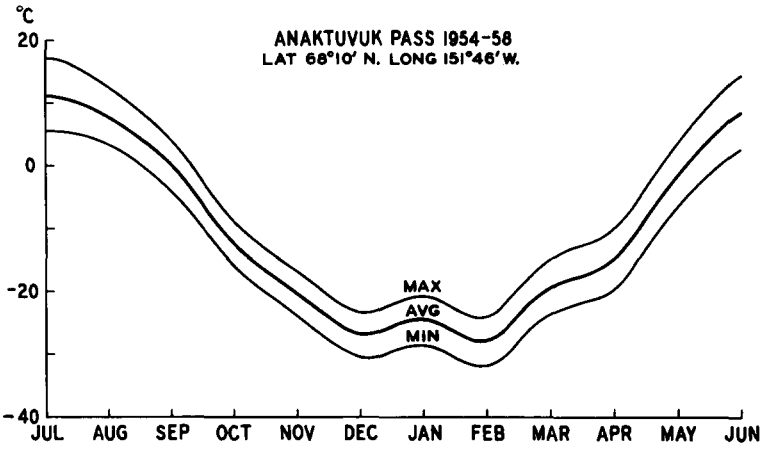

Figure 10. Monthly average temperatures at Anaktuvuk (U. S. Weather Bureau, 1965).

it becomes northward. In view of the prolongation of northward migratory activity, we can see no reason for ascribing the period of maximum crop size to the cycle of migration.

More cold weather follows than precedes the time of maximum accumulation by crops in midwinter. It would now be idle to speculate upon the effect of cold on the requirement for food to preserve body heat, but the accumulations in crops are in phase with the changing duration of illumination rather than with the winter cycle of temperature.

SUMMARY

Crops of 1192 Willow Ptarmigan (*Lagopus lagopus*) from the Brooks Range of Alaska progressively increased in weight from October to December and January and diminished in weight monthly until April. In October and November migration of this population is southward; from January to May migration is northward.

In January the weight of crops increased during the few hours of light and attained weights of around 100 g (15 per cent of the weight of ptarmigan without crop) three hours after noon. November and February accumulations in crops were less and later in the day, and in October and March the accumulation diminished further and occurred later. In April and May there were no clear times of maximal accumulation. These records are related to the duration of light (sunlight plus nautical twilight) and indicate that feeding extends for less than eight hours on clear midwinter days to provide for a resting time of 16 hours. In autumn the increasing accumulations in crops are related to shortening days. After midwinter in lengthening days, the diminishing accumulations in crops represent the results of prolonged feeding and activity that in May brings about migratory activity during much of the 24 hours that are then continually light. The concentration of feeding is related to shortening of daylight, and prolongation of feeding is related to lengthening day. Cold and snow cover continue after midwinter into May, so that accumulation in crops is not in phase with the prolongation of arctic winter into spring, or with the cycle of migratory activity.

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