Summer foraging by spruce grouse: implications for galliform food habits

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Observations of foraging birds showed that the summer diet of adult and juvenile spruce grouse (*Dendaragapus canadensis*) in southwestern Alberta included 31 taxa of fungi, vascular plants, and animals. The genus *Vaccinium* was confirmed as the major food source for these grouse during summer. For the first time, however, conifer needles and fungi were recorded as important components of the diet at this time of the year. The latter observations raised questions about the potential for bias, particularly in terms of the type of the food ingested and the time of day when it was consumed, in studies of the food habits of galliforms that are based only on analyses of crop contents.

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Des observations d'oiseaux à la recherche de leur nourriture ont permis d'établir que le régime alimentaire d'été des Tétras du Canada (*Dendragapus canadensis*) du sud-ouest de l'Alberta se compose de 31 taxons de champignons, plantes et animaux. Le genre *Vaccinium* constitue la principale source alimentaire de ces oiseaux durant l'été, comme il a été signalé auparavant. Cependant, c'est la première fois que l'on constate que ces oiseaux mangent aussi beaucoup d'aiguilles de conifères et de champignons à ce moment de l'année. Ces résultats soulèvent le problème des erreurs d'interprétation possibles lorsque les résultats des études sur la nourriture des galliformes sont basés seulement sur l'analyse des contenus stomacaux, particulièrement lorsqu'il s'agit d'études sur le type de nourriture ingérée et le moment de la journée où les aliments sont consommés.

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Introduction

Most studies of galliform food habits have been based upon items retrieved from the upper gastrointestinal tract, particularly the crop (Korschgen 1980). The collection of such samples requires that birds be killed. Moreover, that the contents of the crop truly reflect the diet rests on two assumptions: (*i*) ingested foods do not differentially enter the crop before moving to the stomach, and (*ii*) the time of day when the food was collected (i.e., the relative fullness of the gut) does not influence the type of the food consumed shortly before collection.

In this paper we document the summer diet of Franklin's spruce grouse (*Dendragapus canadensis franklinii*) in southwestern Alberta by using a nondestructive method of studying food habits which involved observing the foraging birds (Savory 1977). We compare our observations with published information on the summer diet of Canada spruce grouse (*Dendragapus canadensis canadensis*) that is based on analyses of crop contents of shot birds, and discuss the possible reasons for differences noted.

Methods

This study was conducted in a block of forest dominated by pine (*Pinus contorta*) in southwestern Alberta, 32 km west of the town of Turner Valley (Boag et al. 1979). A total of 39 days was spent searching for and observing spruce grouse during July and August, 1987.

Food habits of these birds were determined by recording what they consumed while observing them at close range (3–10 m). This technique was usable because the birds were sufficiently confiding to permit close approach without showing any evidence of an overt fleeing response. At such distances birds continued to forage, apparently naturally, and one could observe in most cases (>80%) what was being consumed, particularly with the aid of binoculars. When we found spruce grouse (lone birds or females accompanied by chicks), we followed them quietly and carefully as they either meandered slowly through the pine stands or stopped in small clearings to rest, dust bathe, and forage. In so doing, we recorded all pecks made and what was pecked. When necessary, we confirmed the species fed upon by subsequent inspection of the plant. Only those pecks for which we knew the nature of the object consumed (object disappeared and bird was seen to swallow) were included in the analysis; occasionally pecks appeared to be directed at forest litter, possibly in an attempt to expose what lay beneath it, or as a form of displacement behaviour.

When we found a female with a brood, we observed the foraging of each individual in the group for 5 min in a rotational sequence. This pattern was continued until the end of the observation period (one to five rotations). When all birds fed together at a central foraging location, such as an ant hill, the total number of pecks by all birds involved was recorded.

Results

A total of 2009 min was spent observing foraging spruce grouse (Fig. 1). All grouse observed were in pine-dominated forest. Although grouse were observed foraging during most daylight hours (Fig. 1), the number of grouse observed and the amount of time spent observing foraging birds peaked in midmorning and midafternoon. This was because searches began in the early morning and birds were usually not encountered immediately. Once encountered, birds were watched for up to 3.5 h before a search was made for others, hence the second peak during the afternoon.

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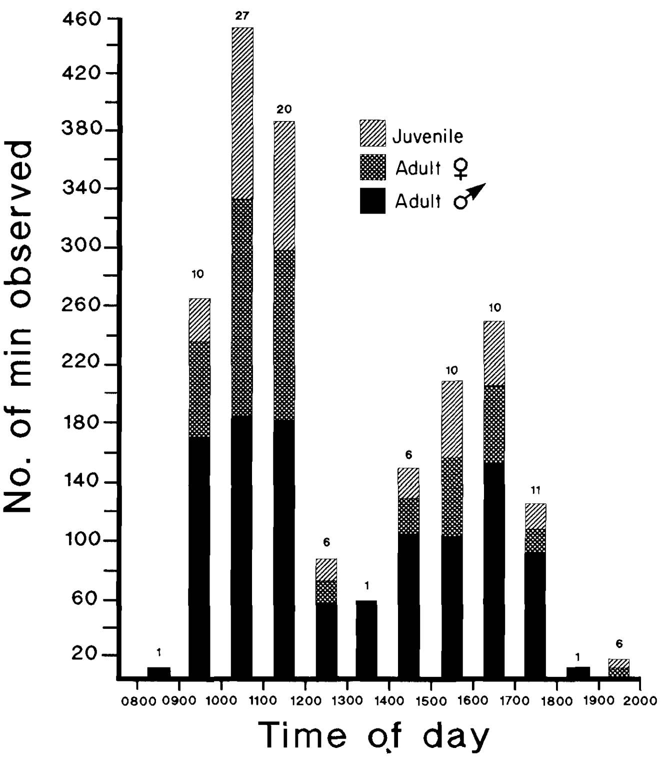

FIG. 1. The number of minutes during which spruce grouse were observed foraging between 08:30 and 19:30 in July and August, 1987. The numbers above the columns indicate the number of grouse observed foraging during each time block.

The species composition of the diet during July and August (Table 1) included a minimum of 31 taxa of vascular plants, animals, and fungi. Adult spruce grouse were observed to forage on nothing but vascular plant and fungal material, whereas juveniles consumed arthropods as well (almost exclusively ants). The plant material taken included stem tips, leaves, flowers, and fruits. In addition, the lamellae of basidiomycete fungi formed an important component of the diet of both age groups of grouse. However, the proportions contributed by these various items to the diet varied significantly between the sexes of adults and between the two age categories (Table 2). The vegetative parts of vascular plants (leaves, stems, and flowers) composed the major part of the diet of all birds, regardless of sex or age (Table 2). Adult females and chicks, however, made heavy use of the fruits as well. Only juveniles were recorded taking arthropods. Fungi formed a major part of the diet of adult males and, to a lesser extent, of juveniles, which began using them only at the beginning of August. Fungi were more likely to be consumed in the morning (391 of 733 pecks) than in the afternoon (151 of 466 pecks) ($\chi^2 = 4.62$, $P < 0.05$).

Of the plants used, only three major taxa were heavily used by both sex and age groups: conifers (*Picea* and *Pinus*), legumes (*Hedysarum, Vicia, Lathyrus, Oxtropis,* and *Trifolium*), and heaths of the genus *Vaccinium* (Table 1). Although the proportion of grouse observed taking conifer needles was only 39%, needles formed a large proportion of the total pecks recorded for these particular birds: adult males 28%, adult females 17%, and juveniles 18%. Juveniles, however, were recorded taking conifer needles only in late August. Conifer needles were consumed throughout the day but the fraction of pecks directed at them was significantly smaller in the morning (184 of 1406 pecks) than in the afternoon (240 of 1075 pecks) ($\chi^2 = 36.91$, $P < 0.001$). About 46% of individuals were observed taking legumes, and the proportion of the total pecks directed at them was considerable: adult males 12%; adult females 19%; and juveniles 9%. *Vaccinium* spp., including all plant parts, were observed to be taken by the greatest proportion of individuals (64%) and were also the recipients of the highest proportion of the total pecks directed at food items: adult males 18%; adult females 41%; and juveniles 35% (Table 1). The remaining vascular plant taxa were consumed in much smaller amounts, either generally or by only one class of birds (Table 1).

Discussion

The use of the nondestructive sampling procedure described herein, which is perhaps possible only with such confiding species as the spruce grouse, enabled us to document fully the qualitative aspects of the diet and to a lesser extent the quantitative aspects. It was not possible to record the exact volume consumed with each peck without killing the bird observed foraging. When this is known, it will be possible to estimate more accurately the volume consumed, as was done by Savory (1978) when using this technique to document the diet of red grouse (*Lagopus lagopus*) in Scotland.

The number of taxa recorded as taken by spruce grouse in this study considerably exceeded that recorded in the summer diet of this species elsewhere: a minimum of 31 taxa of vascular plants, animals, and fungi was taken during July and August (Table 1) compared with 23 taxa from the crops of 35 spruce grouse (age not specified) collected over the same months in Alaska (Ellison 1966), 19 taxa from the crops of 33 adults in June, July, and August, and 12 taxa from the crops of 16 juveniles collected in July and August in central Alberta (Pendergast and Boag 1970). Some taxa, apparently important to spruce grouse in this study, were virtually unused in other studies (e.g., conifer needles and fungi). There are a number of possible reasons for these differences: (*i*) the community of organisms from which food items can be chosen may vary with the location sampled; (*ii*) conditions during the period when sampling was carried out may have varied among locations; (*iii*) without access to the plants actually fed upon, recognition of the species or even the genus may be impossible (for example, if only parts of leaves are recovered), leading to the combining of items under one taxon; (*iv*) crop samples may not reflect what is actually ingested.

Our observations indicate that conifer needles continue to be a major food item for adult spruce grouse, even during the summer; juveniles begin to consume them in August, earlier than has previously been recorded. Ellison (1966) reported that conifer needles (spruce) made up less than 1% of food volume at this time of year and that their presence in a few crops was probably the result of displacement feeding actuated by the collector. We do not believe that this explanation is correct, based on our observations of foraging birds and the fact that Pendergast and Boag (1970) also reported a few conifer needles taken in these months. The greater proportion of conifer needles in the summer diet of spruce grouse in our study may reflect the timing of our observations relative to the time of collection of birds in other studies. If there were tendency for grouse to concentrate their foraging on conifer needles later in the day (in preparation for the night fast), as our data suggest, and most grouse collected for the purpose of obtaining crop samples were taken earlier in the day, this would explain the difference noted.

Our observations suggest heavy summer reliance by spruce grouse on *Vaccinium* spp., from which the stem tips, leaves, flowers, and fruits were used (Table 1). These observations

TABLE 1. Diet of spruce grouse, based on observations of 49 birds foraging between 08:30 and 19:30 in pine forests of southwestern Alberta during July and August, 1987

	Adult males			Adult females			Juveniles		
Food items	No. of pecks	%	Freq.	No. of pecks	%	Freq.	No. of pecks	%	Freq.
Basidiomycetes (*Russula* spp.) (spore cap)	403	36.6	38	139	9.8	11	424	16.3	42
Lichen (thallus)	7	0.5	11						
Moss (spore capsule)				6	0.2	6			
Equisetum (spore capsule and leaves)	2	0.1	11	3	0.1	6			
Picea glauca (needles)	75	6.8	25	160	11.5	44	144	5.5	6
Pinus contorta (needles)	233	21.3	88	87	6.1	33	344	12.8	13
Graminaceae (leaves and flowers)	10	0.9	25	5	0.4	11			
Habenaria hyperborea (fruit)							36	1.4	6
Fragaria glauca									
Leaves				32	2.3	11	20	0.8	25
Fruit				27	1.9	33	50	1.9	31
Rosa woodsii									
Leaves	4	0.4	13						
Fruit	1	0.1	13						
Spiraea lucida (leaves)				6	0.4	22			
Hedysarum sulfurescans (leaves and flowers)	41	3.7	25	46	3.2	22	29	1.1	19
Vicia americana and Lathyrus ochroleucus (leaves and flowers)	94	8.5	38	119	8.4	22	123	4.7	50
Oxytropis sericea (leaves)							15	1.1	11
Trifolium repens (leaves and flowers				95	6.7	44	75	2.9	19
Sheperdia canadensis (fruit)				16	1.1	11	3	0.1	6
Cornus canadensis (fruit)							7	0.3	13
Arctostaphylos uva-ursi (leaves)	4	0.4	13	22	1.6	11			
Rhododendron albiflorum (leaves)				22	1.6	11			
Vaccinium caespitosum									
Leaves and flowers	193	17.5	63	154	10.9	44	165	6.3	75
Fruit				16	1.1	22	82	3.2	19
Vaccinium scoparium									
Leaves and flowers				179	12.6	11	72	2.8	19
Stems				17	1.2	11	40	1.5	13
Fruit				86	6.1	11	62	2.4	13
Vaccinium vitis-idaea									
Leaves				11	0.8	11			
Fruit				118	8.3	11	500	19.2	25
Castilleja miniata (leaves and stems)				6	0.4	22			
Pedicularis groenlandica (stems and fruit)	27	2.5	13				4	0.2	6
Galium boreale (leaves, flowers, and stems)				12	0.9	11	3	0.1	6
Linnaea borealis (leaves)	2	0.2	13						
Taraxacum officinale (leaves)				15	1.1	11	3	0.1	6
Unknown (leaves)	7	0.6	25						
Grit	5	0.5	13						
Orthoptera (grasshopper)							2	0.1	6
Lepidoptera (butterfly)							1	0.0	6
Hymenoptera (ants)							416	16.0	75
Total	1101	100		1418	100		2604	100	

NOTE: The total numbers of observations of adult males, adult females, and juveniles were 11, 10, and 28, respectively; the total numbers of birds involved were 8, 9, and 16, respectively. Adults were identified by means of a combination of coloured leg bands. The number of pecks indicates the number directed at a specific food item. The percentage represents the number of pecks at a given food item/total pecks for a given sex and age ×100. Frequency (freq.) is the number of individual grouse of a given sex and age observed feeding on a specific food item/total birds observed of given sex and age ×100.

TABLE 2. The percentage of pecks at items in the major subdivisions in the diet of adult male, adult female, and juvenile spruce grouse during July and August (based on the data in Table 1)

	Adult males	Adult females	Juveniles
Vascular plant material			
Leaves, flowers, and stems	60.3	70.8	38.7
Fruits	2.6	18.5	28.7
Fungi (lamellae)	36.6	9.8	16.3
Other (arthropods and grit)	0.5	0.9	16.3

NOTE: Based on a χ^2 contingency table, using original number of pecks for all four categories (Table 1), adult males were significantly different from adult females (χ^2 = 355.2), and juveniles were significantly different from adult males and adult females combined (χ^2 = 798.7) at $p < 0.001$.

agree with analyses of crop contents obtained elsewhere: 72.7% of the total volume consumed in Alaska was *Vaccinium* (Ellison 1966), whereas in central Alberta the proportion was 52.4% by adults and 38.5% by juveniles over the same period (Pendergast and Boag 1970).

The inclusion of basidiomycete fungi in the summer diet of spruce grouse has been recorded in Alaska, though only one crop was found to contain a very small amount (Ellison 1966). Likewise, Pendergast and Boag (1970) reported these fungi in small amounts (0.7% of total volume) in two crops of adults taken in central Alberta; they reported no fungi taken by juveniles until autumn (September and October), when the volume was still low (0.8% of total volume) but the frequency rose to 18.1% of crops sampled.

Our observations suggest a heavier use of fungi than elsewhere, particularly by adult males (Table 1). The reason(s) for this difference may be the relative availability of fungi at the time when sampling occurred at various locations throughout the range of spruce grouse. If, as is possible with conifer needles, time of day has an effect, one would predict that fewer fungi would be recorded in the crops of birds collected in the morning, since the probability of finding needles in the crop at that time of day is lower. However, this was not the case, as fungi were more frequently fed upon in the morning than in the afternoon. This difference in the use of fungi at different locations may also reflect the destination of items ingested; they may either enter the crop or bypass it entirely to enter the proventriculus. Ziswiler and Farner (1972, p. 357) suggest that the sphincter surrounding the opening into the crop, an outpouching of the esophagus, is "controlled reflexly by the degree of fullness of the remainder of the digestive tract." Thus, after fasting, the first food items ingested are swept directly into the proventriculus and only later does the crop sphincter relax, admitting food into its lumen. They state that "further food taken in is then stored largely [within the crop]," implying that some may bypass it. Soft material, such as fungal tissue, may tend to bypass the crop and enter the proventriculus directly. This would explain its rarity in crop samples. In the proventriculus, such soft material would be rapidly rendered unrecognizable.

Crichton (1963. p. 597) stated that "fungi were not eaten fresh but only when dead and black." Such was not the case with the fungi (*Russula* spp.) consumed in this study. All sporocarps used were mature, with the lamellae exposed, but not black or "dead." Once consumed, the fungal parts probably soon became black, which may have led Crichton (1963) to the above conclusion. Spruce grouse feeding on these fungi may also consume insects associated with the fungal tissue (staphylinid beetles and dipterous larvae). This was suggested by rapid rates of packing during which the sporocarp was overturned and the lamellae and overlying tissue were consumed.

In summary, this study confirmed the importance of *Vaccinium* spp. in the summer diet of spruce grouse, and supports the suggestion of Penderast and Boag (1970) that conifer needles may be untilized year-round, at least among adult spruce grouse in southwestern Alberta. It also raises the possibility that this species makes much heavier use of fungi than was previously believed. Finally, the results of this study raise the possibility that the summer food habits of grouse, based on crop analysis alone, could be biased against (*i*) soft material, such as fungal tissue, because these foods may bypass the crop entirely, and (*ii*) very fibrous food items, such as conifer needles, because the timing of collection may influence the probability of their presence in the crop. We hope to address these possibilities through a comparative study of food habits, using both types of sampling on the same birds over the same time period.

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