

# Protein and Calcium in Diets of Wild Pheasants Feeding Ecology as a Nutritional Tool

Christine Sheppard, Ellen Dierenfeld and Martin Burnett

Department of Ornithology

Wildlife Conservation Society, 2300 Southern Blvd., Bronx, NY 10460

## Abstract

Pheasant nutrition is not well studied despite its potential impacts on management of both captive and wild populations. This study looks at the differential diets of 42 species of pheasant. Data on diets were collected from literature searches and tags from specimens held at the American Museum of Natural History. Diets were categorized into five food categories: INSECTS (insects/spiders; high protein, low calcium), SEEDS (seeds/nuts; moderate protein, low calcium), LEAVES (leaves/grass/shoots/moss; moderate to high protein, high calcium), FRUIT (fruits/berries; low protein, low calcium) and MOLLUSKS (mollusks, crustaceans, worms: high protein, high calcium). Primary and secondary food items were determined for each species. Based on the estimated nutrient content of the diets reviewed here we found that the diets across the pheasant group are more diverse than previously considered and that current dietary recommendations maybe inappropriate for some species.

## Key Words

Pheasant, nutrition, protein, calcium, diet

## Introduction

Although knowledge of nutrition in pheasants is important for management of both wild and captive populations, it has been little studied. This is especially ironic, as the group includes two extremely well studied species, the chicken, *Gallus gallus*, foundation of the domestic poultry industry, and the Ring-necked pheasant, *Phasianus colchicus*, introduced widely in Europe and North America as a game bird. Of 51 pheasant species (Sibley and Monroe, 1990), 29 are listed in The World List of Threatened Birds (Collar et al., 1994). Efforts to preserve wild populations and to develop self-sustained captive populations of some species have been hindered by lack of information on habitat use, social organization, nutrition, and seasonal activity patterns (McGowan and Garson, 1995).

Within a single group of birds, even a relatively homogeneous one, diets can vary significantly. However, there is a tendency for managers to think of a single diet as appropriate for the entire group. Hornbills, for example, range from highly carnivorous to highly frugivorous (Kemp, 1980; Leighton 1982; Poonswad et al, 1983), but discussions of captive diets usually refer to 'the Hornbill diet.' The same could be true for Pheasants. While extensive studies have defined

comparative nutrient requirements in mammalian groups like the ruminants (Cheeke, 1991), little analogous work has been completed for avian taxa.

Nutrient standards for virtually all captive avian diets are based on controlled studies of the requirements domestic poultry (see, for example, Ullrey et al, 1991). Some field research has been conducted on diet of the Ring-necked pheasant (Dalke, 1937; McAtee, 1945; Edminster, 1954) but specific requirements for nutrients have not been determined. Requirements for chickens and turkeys were the primary resources used to establish dietary guidelines for the pheasants as a group (National Research Council, 1994; Woodard et al, 1993). It should be noted that these guidelines are intended for birds managed for commercial production of eggs or meat.

Species like the Golden Pheasant (*Chrysolophus pictus*) and the Mikado (*Syrnaticus mikado*) have bred well in captivity. Others, like the Bulwer's (*Lophura bulweri*) breed poorly. Diet could well be a factor, if the pheasants are, in fact, diverse in nutritional requirements. The goal of our study was to determine whether there is a range of nutrients consumed by adult pheasants of different species and if so, to identify hypotheses for development and testing of optimal captive diets. Animals require many nutrients and requirements vary with physiological state (growth, reproduction) and environmental factors (temperature, migration). Diets must supply a proper balance of essential nutrients, over an

adequate time frame, to successfully meet the needs of an individual animal (Murphy, 1996). A major objective of our analysis was to ascertain evidence for broad differences in dietary nutrient levels, based on dietary habits of free-ranging pheasants. Because protein and calcium are among the most commonly evaluated nutrients in avian diets, we focused on these, as indicators of general diet diversity.

## Methods

It was our hope to extract information that could be analyzed semi-quantitatively from both historical and contemporary reports (references are listed in Appendix I.) In addition to published sources, we examined tags from specimens in the skin collection at the American Museum of Natural History, for lists of crop contents. We compiled data on food sources and feeding behavior, to elucidate the range of foods and nutrients consumed by adult pheasants. Using the software program Square-note (SQN Inc., 1996), we created a database of specific mentions of pheasant food sources, habitats and behaviors. This database is available on request from the senior author.

Information was compiled for 42 species, although the number of references and the amount of information per species varied considerably. Some references were detailed and specific, others very general. For each pheasant species, all items consumed were scored as primary (P) or secondary (S) (tables 1 - 4).

Primary sources comprise items eaten regularly, throughout the year, by adult birds; a single species can have more than one primary food type. Secondary sources are those consumed either seasonally or only occasionally. Of necessity, scoring was subjective. Obviously, these categories can only be used as an indication of the importance of each item in the diet; the actual proportion of each item cannot be calculated. Chick diets were not included.

We next rated all food types according to their general levels of important nutrients and we grouped items with similar macro-nutrient composition (table 5). For analyses of actual foods consumed by free-ranging pheasants, we used some data from the field (Peoples et al, 1994; Robel et al, 1995; Ramos-Elorduy et al, 1997) plus extrapolation from similar foods analyzed for human (Watt and Merrill, 1975) and agricultural uses (National Research Council, 1982), as well as an extensive database of natural foods (WCS Department of Nutrition, unpublished data). Food categories included INSECTS (insects/spiders; high protein, low calcium), SEEDS (seeds/nuts; moderate protein, low calcium), LEAVES (leaves/grass/shoots/moss; moderate to high protein, high calcium), FRUIT (fruits/berries; low protein, low calcium), MOLLUSKS (mollusks, crustaceans, worms: high protein, high calcium). If any item within a group was a primary source for a pheasant species, that group was scored as primary.

## Results

LEAVES was the most frequent primary food type, occurring for 27 pheasant species. This was followed by SEEDS and FRUIT, scored as primary for 25 and 24 species respectively and INSECTS, primary for 21 species. All other food sources were scored as primary for 9 or fewer species (Tables 1 - 4). We sorted species into two groups, according to whether or not INSECTS (high protein) were a primary food source. Twenty-one species had insects as a primary diet component. This group of species could be divided into two sub-groups. The first sub-group, which we termed 'omnivores,' (table 1) comprised eight species which included LEAVES and SEEDS, in addition to insects, as primary food sources. Each species in this sub-group had, on average, a higher diversity of primary food sources than the 13 highly insectivorous species ('insectivores', table 2) which apparently depend more exclusively on insects. Of the twenty-one pheasant species that did not have INSECTS as a primary food source, 20 had LEAVES as a primary food source. Of these, eleven species, which we termed 'vegetarians,' (table3) also had SEEDS and FRUITS as primary food sources. Of the remaining ten species, which we termed 'folivores,' (table4) nine depend extensively on LEAVES.

Dietary information is sparse for several species. In most cases, however, the information available was sufficient to conduct our analysis. In four instances, however, where species did not fit the general pattern, it was difficult to determine

whether this was an artifact of the available information or whether these species were genuinely different in food consumption patterns and nutrient requirements. We consulted aviculturists familiar with these species and people who had worked with them in the wild, for additional insight. The genus *Crossoptilon* comprises three very closely related species. Most dietary information is available for the Blue Eared-Pheasant (*Crossoptilon auritum*). This species has been reported to consume leaves and it is generally supposed that all three species do. We have used this assumption in this analysis and scored the Brown and White Eared-Pheasants, *Crossoptilon mantchuricum* and *C. crossoptilon* as having leaves as a primary food source. Similarly, Sclater's Monal (*Lophophorus sclateri*) is thought to be similar in diet to the Himalayan Monal (*Lophophorus impejanus*) and on this basis, Sclater's Monal has been included with the insectivores. Data for the Reeves's Pheasant (*Syrnaticus reevesi*), does not indicate that LEAVES are a primary food source for this species. However, both congeners do have LEAVES as a primary source and aviculturists have reported that Reeves do use this food source. Therefore this species has been included with the herbivores. It is worthy of note that all four hard-to-categorize species are specialists on roots.

## Discussion

There is essentially no literature on the subject of whether nutrient levels in wild diets predict nutrient requirements of animals, wild or domestic. However, it is

unlikely that this relationship is random. We do know that different species have different requirements for protein and other nutrients and that improper levels of nutrients can impair health. Proteins are composed of amino acids, which must be available in appropriate ratios for efficient use (Scott, et al, 1982). Studies evaluating the amino acid composition of insects (Finke et al, 1985; Oyarzun, et al, 1996, Ramos-Elorduy, 1997) suggest that insects are a high quality protein source and are not amino acid limiting for poultry. As insect proteins can be used efficiently, we estimate that adult pheasants of highly insectivorous species may require up to 40% protein for good health. Protein levels recommended for growth in domestic poultry range from 24% for ducks and geese to 33% for pheasants. For breeding, the range is 16%, for chickens and turkeys, to 27%, for Japanese Quail (National Research Council, 1984). Diets containing 20% crude protein (with balanced amino acids) have been suggested as adequate for breeding pheasants (National Research Council, 1984). Woodard et al, (1993) recommend 18% protein for breeding pheasants and 16% for growth. It seems likely that these levels are marginal for some species. From the evidence presented, we conclude that the four groups of pheasants described represent a spectrum of protein requirement, increasing from about 20% to about 40% (Table 6).

Dietary calcium recommended for pheasants is 2.5% of diet, on a dry matter basis (Woodard et al, 1993). However, these recommendations are for birds



laying multiple clutches. A more realistic estimate of adequate dietary calcium, for wild birds, is 0.5% to 1.5% (Chambers, 1966). Pheasants consuming primarily leaves and green plant materials (vegetarians) should have adequate calcium in the diet. For folivores and omnivores, LEAVES may be an important source of calcium, supplementing low levels found in SEEDS, FRUIT and INSECTS.

Primary food types for insectivores do not appear to supply adequate calcium. While INSECTS are a very poor source of calcium, mollusks, crustaceans and worms can be excellent sources of this mineral (WCS Department of Nutrition, unpublished data.) All of the species reported to consume MOLLUSKS as a primary food source were in the insectivorous groups. Closer observation of wild birds may show that more insectivorous pheasants consume MOLLUSKS. Additionally, pheasants as a group ingest grit and it has been demonstrated that they can absorb calcium from this source (Dale, 1955).

INSECTS and LEAVES differ not only in protein and calcium levels, but also, potentially, in digestibility. Insect meals have been shown to be highly digestible, (Ramos-Elorduy, et al, 1997). The fibrous constituents of green plants, however, may require extensive microbial fermentation in the gastrointestinal tract. The Galliformes in general have large intestinal caecae, compared to other orders. These organs are sites of microbial digestion and protein absorption (Welty, 1963), as well as intestinal reflux (Robbins, 1993). Pheasant species with plant-

based diets may have a more developed gut architecture, compared to those with insect-based diets, although there is some plasticity of intestinal morphology with diet composition (Leopold, 1953; Karasov, 1996).

Pheasants from different diet groups are often fed identical pelleted rations. Protein sources in pellets vary, but are largely plant based in the US, mixed with vertebrate by-products in Europe. Differences in digestive efficiency may be important to explore, especially if insect specialists are inefficient at digesting plant materials. The distinction between insectivorous species and herbivores correlates strongly with ecological parameters like minimum temperature and seasonality (Johnsgard, 1986; del Hoyo et al, 1994). The species in the insect dependent group tend to be tropical forest species and many have proven to be difficult to breed in captivity. For insectivores, availability of live food could also be important, as a psychological trigger. Ecological parameters such as temperature, light levels and photoperiod may also be significant here. While this analysis shows that existing literature can provide us with significant and useful information, it also confirms the need for aggressive work, both in the field and in captive collections, if we are to succeed in preserving the world's rare pheasants. Analysis of insect proteins, comparative digestive efficiency in different pheasants and studies of health and reproductive success relative to dietary protein intake should be made a priority.

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## Appendix I: published sources of data on Pheasant diets

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Table 3

DIET ITEM	crude protein	crude fat	soluble CHO/ sugar	crude fiber	water	calcium
insects	40-77%	8-50%	insignificant	5-18%	60-70%	<0.3
spiders	20-70%	20-50%	?	<5%	?	<.2%
seeds	5-15%	10-50%	20-40%	<5%	low	<.5%
nuts	5-15%	40-60%	20-40%	<5%	low	<0.5%
grains	5-15%	10-20%	30-70%	<5%	low	<0.5%
berries	<10%	low	50-80%	5-15%	65-90%	<0.2%
fruits	<10%	low	40-80%	5-15%	65-90%	0.6%
leaves	15-25%	low	15-40%	>15%	50%	0.3-2.0%
grass	15-25%	low	10-25%	>15%	50%	0.3-2.0%
shoots	15-25%	low	40-60%	5-15%	75-90%	0.3-2.0%
moss	15-25%	low	20-40%	>15%	50%	0.3-2.0%
roots	10-20%	low	40-70%	5-15%	80%	0.2-0.5%
flowers	10-15%	low	30-40%	10-20%	20-50%	0.5%
mollusks	40-60%	low	insignificant	<5%	75%	>10%
vertebrate	40-60%	mod-high	insignificant	<5%	75%	1.0%
crustacean	40-60%	low	low	5-15%	75%	>10%
worms	10-15%	10%	25-50%	10-20%	75%	1.0%



Table 5

>15% PROTEIN -----	>20% PROTEIN .....	>25% PROTEIN -----	>35% PROTEIN -----
FOLIVORES	VEGETARIANS	OMNIVORES	INSECTIVORES
Satyr Tragopan	Cheer Pheasant	Himalayan Monal	Green Junglefowl
Western Tragopan	Swinhoe's Pheasant	Kalij Pheasant	Great Argus
Cabot's Tragopan	Copper Pheasant	Red Junglefowl	Crested Argus
Blue Eared-Pheasant	Indian Peafowl	Silver Pheasant	Malayan Peacock-
Pheasant			
Mikado Pheasant	Temminck's Tragopan	Grey Junglefowl	Ceylon Junglefowl
Chinese Monal	Koklass Pheasant	Crested Fireback	Grey Peacock-
Pheasant			
Golden Pheasant	Green Pheasant	Lady Amherst's Pheasant	Bulwer's Pheasant
Brown Eared-Pheasant	Ring-Necked Pheasant	Sclater's Monal	Green Peafowl
Blue Eared-Pheasant	Blyth's Tragopan		Crestless Fireback
Reeves's Pheasant	Blood Pheasant		Siamese Fireback
			Congo Peafowl
			Mountain Peacock-
Pheasant			
			Siamese Fireback
Bronze-Tailed			
Peacock-Pheasant			

Legends:

Table 3: Proximate composition of items found in diets of Pheasants. All nutrients on a dry matter basis (except water)

Table 5: Estimated dietary protein for groups of wild Pheasants consuming different combinations of foods.