RAPTOR RESEARCH

Volume 6 Supplement Part H 1972

SPECIAL CONFERENCE ON CAPTIVITY BREEDING OF RAPTORS–A REPORT

Sponsored by Raptor Research Foundation, Inc.
Held at Sioux Falls, South Dakota, U.S.A., November 21-23, 1971

Part H. Health and Nutrition of Young (Panel 10)

edited by
Richard D. Porter
Patuxent Wildlife Research Center
U. S. Bureau of Sport Fisheries and Wildlife
Laurel, Maryland 20810

Panel Members: Richard D. Porter, Chairman, William H. Halliwell, and David E. Allen; contribution of John Serafin was presented by R. D. Porter.

PORTER. Health and nutrition of young raptors or nestling raptors is a poorly known field of investigation. Although there is a considerable amount of information on the nutrient requirements of young chickens, there is not much known on this subject as regards young raptors.

Although Dr. John Serafin, the nutritionalist for the Rare and Endangered Program at Patuxent, was unable to attend, he authored the following discussion on nutrition of young poultry which has a degree of applicability to all young birds in process of rapid growth and development.

*PRINCIPLES OF NUTRITION, by John Serafin**

Nutrition is the process of assimilating food. The chemical reactions that cause the metabilic functions of the animal to occur are supplied with raw ma-

Nutrition is the process of assimilating food. The chemical reactions that cause the metabolic functions of the animal to occur are supplied with raw material from the environment, through processes lumped under the term "nutrition." This definition includes the ingestion, digestion and absorption of the chemical elements which make up food, and the distribution of these nutrients

*Patuxent Wildlife Research Center, U. S. Bureau of Sport Fisheries and Wildlife, Rare and Endangered Program.

within the animal organism in the proper form for use by the cells.

The complexity of the chemical substances that an animal must obtain from his environment varies widely throughout the animal kingdom. Some unicellular organisms have very simple nutritional needs, mainly some inorganic elements, a source of carbon and energy and a few nitrogen compounds. The bird has very complex nutritional needs with over forty specific compounds, classes of compounds, or specific elements required from the environment for the internal chemistry of this animal to function properly. Even this is a relatively simple list of raw materials from which to build the myriad of compounds present in the animal body.

Because of the economic importance of the chicken for food through the production of meat and eggs, much effort has been expended to determine adequately the nutritional needs of this animal. Because the young chick is an excellent experimental animal for fundamental nutritional studies, more information is available about the nutrition of the chicken than any other animal today. This reservoir of nutritional knowledge has placed the formulation of poultry feeds on a scientific basis and made possible scientific formulation of diets for other species of birds as well. Today feeds for many species of birds in zoos, birds captured from the wild and ornamental and show birds can be successfully reared using scientifically formulated diets.

Qualitative Nutritional Needs

These needs of birds can be divided into categories. These are:

1. *Sources of energy.* Many types of compounds can supply energy to birds but the primary energy sources are classes of compounds called fats and carbohydrates. Not all carbohydrates and fats can be digested by birds, so that only carbohydrates and fats that can be digested and absorbed by the digestive tract can be considered nutrients.

2. *Amino acids.* Proteins of the animal body are really polymers of some 22 amino acids that are arranged in an almost infinite variety of combinations to produce the specific proteins of the structural and enzymatic systems of the body. Some of these amino acids can be synthesized by the bird from simpler compounds, but others must be included in the diet of the bird.

3. *Vitamins.* This term encompasses a group of compounds widely differing in chemical structure. They are all required links in the chain of metabolic reactions that occurs in the animal body. The chief properties that set vitamins apart are the minute amounts in which they are required, and the types of metabolic functions they perform.

4. *Inorganic chemical elements.* Many individual chemical elements are required for proper metabolic functioning of the bird. Amounts required and functions of these elements vary tremendously from the large amounts of calcium required for bone structure and egg shells, to infinitesimal amounts of selenium required for presently unknown functions.

5. *Water and oxygen.* No description of the chemical relationship of an animal with its environment would be complete without mention of these two

very important components. Life is not possible without water and oxygen. Water forms the medium in which body chemistry functions and oxygen is required for the fire which releases energy from the foodstuff.

Quantitative Nutritional Needs

Although it is possible to define the qualitative nutritional needs of an animal in terms of individual chemical compounds, elements or classes of compounds, the quantitative nature of nutrition is not so simple. The amounts of a nutrient required in the diet depend on many factors. For example, the requirements for amino acids vary with the total amino acid content of the diet and also some amino acids specifically influence requirements of others. The saturated fatty acids content of the diet may influence the linoleic acid needs of the chick. Pantothenic acid and vitamin B_{12} requirements may vary with levels of each. The phosphorus content of diets, particularly for young, rapidly growing birds is dependent upon the calcium level in the feed and excesses or deficient amounts of one or the other can bring about severe skeletal deformities. As a percentage of the diet, most nutrient requirements vary with energy level. Chickens tend to regulate feed intake to a certain caloric consumption. From available evidence this seems to hold for other species as well. In high energy diets less feed is required to meet the energy needs than in diets with low energy concentration. Therefore a specific daily intake of a protein requires less protein as a percentage of the diet with a low energy concentration than with a higher energy concentration.

Ideally there is undoubtedly a specific quantitative combination of amino acids to give the most efficient conversion of dietary protein to body protein or egg protein. There is a specific relationship between amino acid levels, fat levels and carbohydrate levels to give maximum utilization of dietary energy for productive purposes with a minimum loss of heat.

Palatability and nutritional adequacy also are interrelated. Palatability is a rather ill-defined term that usually means that consumption of a given diet or substance by a bird is affected by taste, physical factors, and any other term usually felt to be unrelated to the nutritional addquacy of the diet. Through the years, increased research has shown that nutritional adequacy of a diet influences voluntary feed consumption far more than certain vaguely defined palatability factors. Diets in which pure amino acids supplied the protein needs of the chick used to be considered "unpalatable" for chicks because chicks would only consume small amounts of these diets. However, as research discovered better combinations of these amino acids, feed consumption improved. A diet with good quantitative balance between nutrients present is in most cases also a highly "palatable" one, that will be consumed readily in large amounts.

Supplying Nutrients

Nutrients can be supplied to birds in several ways. It is possible to produce pure forms of nearly all the nutrients required and to make diets using these

Table 1. The Nutrient Requirements of Chicks (0-8 weeks of age).

Nutrient	Amount required in diet
Metabolizable energy, Cal/kg diet	3000-3650
Protein (N x 6.25), 0-4 weeks	22%-28%
Protein (N x 6.25), 4-8 weeks	20%-24%
ME/P (ME Cal/gm protein), 0-4 weeks	13.2-13.5
ME/P, 4-8 weeks	15.0-15.3
Amino acids:	Percent of the protein
Arginine	6.0
Lysine	5.0
Methionine	3.5
or Methionine	2.0
+ Cystine	1.5
Tryptophan	1.0
Glycine	5.0
Histidine	2.0
Leucine	7.0
Isoleucine	4.0
Phenylalanine	7.0
or Phenylalanine	3.5
+ Tyrosine	3.5
Threonine	3.5
Valine	5.0
Fat	+
Linoleic acid	2.0
Fiber	
Minerals:*	Percent
Calcium	1.0
Phosphorus	0.6
Available phosphorus	0.45
Sodium	0.25
Potassium	0.3
Chlorine	0.15
Magnesium	0.05 (500 mg/kg)
Manganese	0.005 (50 mg/kg)
Zinc	0.005 (50 mg/kg)
Iron	0.0025 (25 mg/kg)
Copper	0.0003 (3 mg/kg)
Molybdenum	0.0002 (2 mg/kg)
Selenium	0.00001 (0.1 mg/kg)
Iodine	0.000035 (0.35 mg/kg)
Cobalt (required only as part of the vitamin B_{12} molecule)	
Sulfur (requirement supplied in form of methionine and cystine; also present in thiamine and biotin)	

Nutrient	Amount required in diet
Vitamins:*	
Vitamin A (stabilized)	1320 IU/kg
Vitamin D_3	550 ICU/kg
Vitamin E (acetate is more stable than alcohol)	15 IU/kg
Vitamin K_1 (menadione sodium bisulfite–Vitamin K_3 –approximately same requirement)	0.8 mg/kg
Thiamine (Vitamin B_1)	1 mg/kg
Riboflavin (Vitamin B_2)	4 mg/kg
Pantothenic acid	13 mg/kg
Niacin	33 mg/kg
Pyridoxine (Vitamin B_6)	4 mg/kg
Biotin	0.12 mg/kg
Folic acid (Folacin)	0.60 mg/kg
Vitamin B_{12} (Cobalamin)	0.01 mg/kg
Choline	1200 mg/kg
Ascorbic acid (Vitamin C)	Not required
p-Amino benzoic acid	Not required
i-Inositol	Not required
Thioctic acid	Not required
Mevalonic acid	Not required

*Mineral and vitamin requirements as given apply to diet containing 3000 Cal ME/kg. Requirements increase in proportion as energy content of diet is increased. (For example, at 3650 Cal/kg of diet, available phosphorus requirement is 3650/3000 x 0.45 = 0.55%.

Possible unidentified required nutrients:

1. Water-soluble-organic
   (a) Spares zinc requirement
2. Water-soluble
   (a) contains selenium
3. Fat-soluble
   (a) Present in vegetable fats, egg yolk fat and lard
4. Water-soluble
   (a) Present in intact proteins

[1]The "requirements" presented here are based upon interpretation of research evidence to date. Undoubtedly, they do not represent the optimum "balance" of nutrients. Further research on interrelationships between the various nutrients will lead to changes in the "required" levels of many of these nutrients.

pure nutrients. This is the method commonly used to study qualitative nutritional requirements. Vitamins and essential elements were discovered as diets of increasing purity were found to be deficient in factors present in impure ingredients.

Ordinarily, however, nutrient requirements of birds are met by making use of plant materials or animal by-products, mineral elements, along with some chemically synthesized vitamins, and amino acids. Many sources of various nutrients are available for use in bird feeds. Where it is possible to supply a vitamin such as riboflavin more economically through chemical synthesis rather than by milk products, for example, this then is the method ordinarily used.

Feed ingredients vary in their ability to supply nutrients required by birds. The amino acid composition of fish meal, for example, is closer to the needs of the chicken than the amino acid composition of peanut meal. Corn is a far better energy source than wheat bran. Niacin is poorly available in grains but is supplied readily in pure form or by yeasts. Feed ingredients differ markedly in their ability to meet nutritional needs of the bird because of their composition, digestibility, presence of toxic materials and many other factors. Part of the problem of applying scientific nutritional information is the evaluation of available feed ingredients, and their ability to supply the nutrients required. Table 1 lists the nutrients required by birds and gives the approximate amounts needed in the diets of chicks to support satisfactory growth. While the table happens to show the quantitative requirements for the chicks, it is possible to formulate for many species using these values as guidelines. Requirements between species vary only slightly in basic nutrient needs and while the form these nutrients are ingested in may vary greatly in some instances, the basic nutrients and amounts remain much the same. Thus diets can be formulated for almost all species of birds using ingredients which will supply ample amounts of these nutrients to support growth, well-being, and reproduction. By considering the nutrient composition of ingredients and blending those ingredients which are acceptable and will be consumed by a bird, one can provide wholesome, complete diets for nearly any species, be it a quail, chicken, goose or eagle.

A. DIGESTIVE TRACT BLOCKAGE BY FECALITHS

PORTER. We fed our captive American Kestrels chicken parts and whole ground rodents. Even though the diet seemed to be very adequate for the growth and development of young Kestrels, we ran into a problem in 1967 involving four out of about 130 young. The fur that was present in the food accumulated in their stomachs and they were unable to form castings so as to regurgitate it. As a result, fur blocked their digestive tract and they apparently starved to death. This affected only the very young nestlings. This was a very low mortality rate, involving only a small percentage of the young. The following year this kind of mortality was not evident.

HALLIWELL. A Golden Eagle at the Topeka Zoo at six or eight weeks of age died due to a fecalith made up of undigestible materials of fur, feathers and bone. These materials reformed into a hard calcareous mass and obstructed the intestinal tract. This same problem has been encountered in other young birds and seems to be reasonably prevalent. At the time the eaglets were hatched at the Topeka Zoo they were removed from ZuPreem and placed on rabbits and rats. In eagle nests visited in Colorado, Wyoming and Montana, there were considerable numbers of rabbits and some young foxes and coyotes. The percentages of fur, bone, teeth and other indigestible parts in the eagles' natural prey is about 30 percent of the total. Is there more parenchymous organs and less bone and fur in these prey species which would make them more digestible to the eaglets and thus eliminate the fecalith problem?

SCHUBERT. A zoo [name not given] that received an immature Bald Eagle from an animal dealer subsequently seemed to get the cramps and died. An autopsy revealed a ball of "Stay-dry" (a commercial preparation to put on the bottom of the cage), all balled up in its digestive tract.

OLENDORFF. Golden Eagles do the same thing; a bird that had an amputated leg and constantly was eating off the floor had a ball of Stay-dry two-thirds of the way down the intestine. Stay-dry is dried sugar cane; pieces of sugar cane passed all the way through the intestine; I guess one stuck and they kept clinging, even though the eagles were casting up a great deal in proportion.

WOLHUTER. Birds have a tendency to find their own castings, if they are not fed food containing casting material; if the bird is fed on the fist and given plenty of castings, there is no reason for it to pick them up from the floor.

B. NESTLINGS AND CASTINGS

1. Captive Birds

HUNTER. A captive jerkin picked off the pieces of chicken having feathers and ate them himself and fed the young only parts having no casting or bone.

OLENDORFF. Young captive buteos (hand fed) started casting when they were six to seven days old; they were given bone when they were three to five days old. Their diet was ground very finely and consisted of three pounds of mice, three pounds of pigeon, three pounds of jack rabbit and three pounds of cottontail. Vertebrae, bones and skull bones of sparrows were fed to them very early after hatching. The bones were taken very readily by the young hawks. Cracking of the bones seemed to stimulate the feeding response.

FYFE. The captive Peregrines were fed Coturnix quail. The male would pluck the bird surprisingly clean and usually in plucking he would eat the head. He would then take the prey to the nest or to the female; there wouldn't be a great deal of castings at that time. With the captive birds there was very little casting going into the nest from the very beginning other than perhaps bones which would be in the food itself.

HAMERSTROM. Young Red-tails seem to get their castings as soon as they start to care for themselves.

2. Wild Birds

TEMPLE. Yukon River Peregrines plucked their prey species up to a week before fledging, but they obviously had some castings before this.

GALICZ. Peregrines, observed from a blind in the Queen Charlottes some 10 years ago, did not appear to be feeding any casting material, only small pieces of lean meat.

C. TYPES OF FOOD GIVEN NESTLINGS IN THE WILD

HALLIWELL. During the initial period after hatching, hawks seem to feed their young quite a bit on the innards, particularly liver of the prey species; the liver seems to have quite a laxative effect.

HUNTER. When my jerkin came to the liver he made sure that the young got it; even when he was feeding away from the other birds and they were full, he would take the liver and feed it to them. The liver seems to have some special significance. Color had something to do with choice of food for the young; month old chicks have very light colored meat. The jerkin seemed to be avid when pigeons were fed and fed on all parts except the skin, whereas with the chickens he ate the bony structures.

GALICZ. My observations from a blind some 10 years ago with Peregrines on Queen Charlottes seem to support those of Hunter's. Peregrines were feeding the inner parts of Merlins to their very small young.

TEMPLE. Yukon Peregrines definitely fed their young a combination of muscle meat and viscera; on some larger shorebirds and ducks they definitely were feeding on breast muscle.

ENDERSON. A distinct impression from a frame (on a feeding sequence with Peregrines—time lapse photography in the Arctic) suggested that when the young were given small unidentifiable passerines the (adult) bird worked right down through the lungs, everything.

FYFE. Young, not quite a week old (Prairie Falcons), were getting mostly muscle meat from ground squirrels and birds at about four days of age. Captive

Peregrines fed young breast meat, possibly bits of liver, no entrails.

NELSON. On coast Peregrines–when the young were a very young age, their parents fed them breast muscle, and during the first couple of weeks the parents were extremely meticulous about not letting the young have any of the guts; they would offer the entrails to the young, then take them back, eat maybe 15 inches of the intestine, then resume feeding. Innards apparently were not fed the young at the beginning; it was almost entirely breast muscle–normally skinned, fairly well intact.

[Editorial Note: Figure 1 is a photograph I took at a Utah Peregrine eyrie in 1947 showing a youngster being fed entrails. R.D.P.]

HAMERSTROM. The subject of raptor baby food has been approached from several standpoints. Again I try to imitate what the parents would do. The raptors that I have watched closely by sharing the nest as a mate–Red-tailed Hawks and Golden Eagle–tend to feed liver, heart, lungs, and kidneys–but not intestines–of birds and mammals to small chicks. They fed some muscle even in the first few days after the hatch–especially that of young birds or mammals. Dr. Heinz Meng mentioned a preference for feeding dark meat to young chicks and,

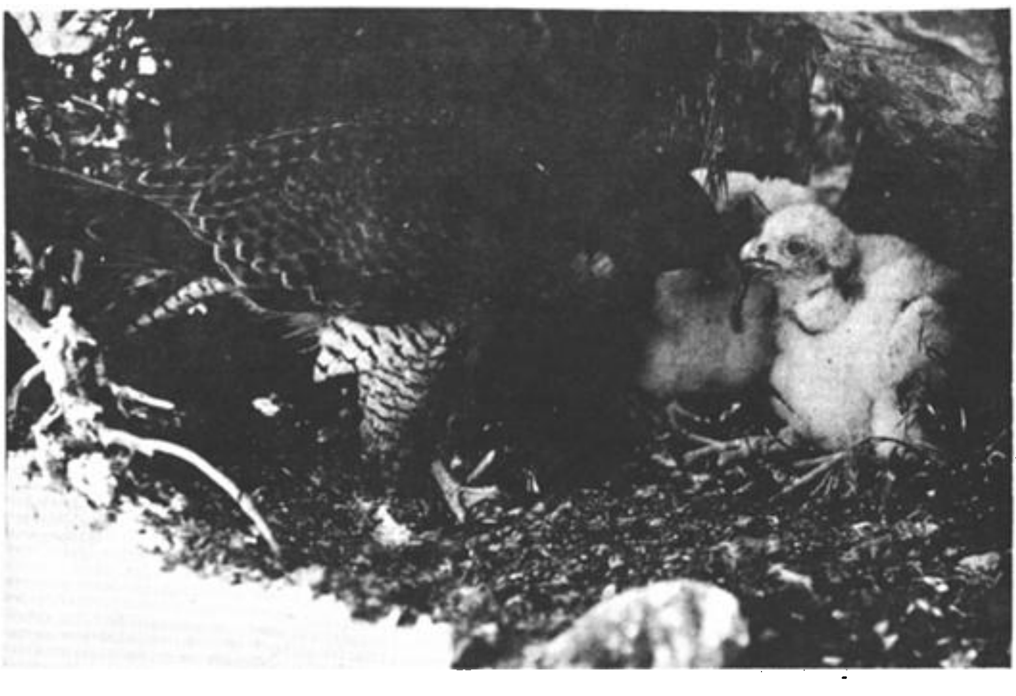

Figure 1. Peregrines at 1947 Utah eyrie feeding entrails to young. Photograph by Richard D. Porter.

as I think back, I agree. It seems to me that pigeon breast was fed before rabbit meat by both species.

My female Golden Eagle partially swallows and then "regurgitates" morsels to small chicks. My male Red-tailed Hawk and Dr. Meng's female Red-tailed Hawk do not regurgitate, but feed tidbits well moistened with saliva.

I feed any very young raptor that I hand rear the above diet and both moisten and warm each morsel in my mouth before giving it to the chick.

[More information is available in F. Hamerstrom, 1970, "An Eagle to the Sky," Ames, Iowa: Iowa State University Press, and F. and F. Hamerstrom, 1971, Potential eines männlichen Greifvogels (*Buteo jamaicensis*) in Bezug auf Nestbau, Brüten und Jungenaufzucht, *Die Vogelwarte* 26:192-197; English translation in *Raptor Research* 6(4):144-149, 1972.]

SIMONYI. In the wild the adult birds (Peregrines) never give feathers to the young ones, but after about four weeks the young begin playing with the leftovers at which time some feathers are eaten.

FYFE. Regarding early feeding, two things that were very obvious both in wild and in captive Peregrines was the extent to which the adults cleaned the prey before they take it to the nest. The general pattern was that the male would return to the young with the head removed from the prey.

TEMPLE. Peregrines on the Yukon plucked their prey so thoroughly that it was difficult to identify the prey items brought into the nest, indicating only a remote chance for the young to be given extraneous casting materials in large quantities.

OLENDORFF. Red-tails, Swainson's and Ferruginous Hawks get pieces of fur and pieces of bone from the very beginning.

STODDART. About two years ago a Swainson's Hawk and a Prairie Falcon were given pine shavings for castings without apparent problems. The shavings formed good castings and appeared to cast up normally.

FYFE. Young, not quite a week old [Prairie Falcons] were getting mostly muscle meat from ground squirrels and birds at about four days. Captive Peregrines fed young breast meat, possibly bits of liver, no entrails.

D. DISEASE, PATHOLOGY AND OTHER HEALTH FACTORS

1. Rickets

HALLIWELL. In rickets, legs are bowed and feet turn in excessively; caused by feeding nothing but muscle meat.

2. Miscellaneous

OLENDORFF. Referred to a paper by Andre Brosset, which he translated from French (*J. N. Amer. Falconers' Assn.* 6:38-42, 1967). Brosset raised his young raptors on the floor because he experienced a bird falling off the table.

3. Frounce (Trichomoniasis)

OLENDORFF. Two young Red-tailed Hawks, age about 20 days, contracted frounce. They were treated with "Emtril" and recovered without any problems.

HALLIWELL. Description of Frounce: it's caused by a very small flagellated protozoan. Must be placed under a microscope to be seen. It causes a lesion in the mouth which is a result of the lining of the mouth being irritated. It forms a cheesy-like growth there. Following treatment it would probably take a day or two for the lesions to drop off.

To diagnose trichomoniasis: with a well-moistened Q-tip, swab the bird's mouth, particularly the back throat region. Put it in a drop of water on a microscope slide. An examination under the microscope will reveal millions of rapidly moving organisms. After treatment you should not see trichomonads after 24 hours, although you may still have scales.

HALLIWELL. I have never seen a case of Frounce that has been refractory to Emtril. One treatment of Emtril is literally a "sure cure" for trichomoniasis and it works superfast.

McINTYRE. I agree with Dr. Halliwell with but one exception: a Prairie Falcon in Denver that was treated twice, skipped a 24-hour period with three tablets of Emtril, one of each dosage and still had evidence of Frounce. He was then placed on Enheptin and this got rid of it. Why did the Emtril not work? One can not give it to the bird in the first bite of food because it goes past the crop, where it is needed and on to the stomach. To administer, take the bird's bill, close its throat, and poke the food into the esophagus and down into the crop. I do not worry about the size of dose.

HALLIWELL. Emtril comes in two forms—one is powdered and the other is a tablet. The tablet contains 125 mg. I use 125 mg/2 lbs of bird. Best to use powdered form, which you have to place in a gelatin capsule; however, may have problem with gelatin capsule dissolving in quickly enough to release the drug while the medicant is still in the crop where it will do some good.

Cattle which were given one or two tablets every day, on post mortem, contained 3-5 tablets; hence some tablets were in the digestive tract 24-48 hours. There is need to develop a better method of administration of medicant since either form is a problem.

LAYMAN. I use a catheter tube (orally) to administer drugs and liquid foods to a Prairie Falcon.

SHERROD. When my Prairie Falcon got Frounce, I gave her one-third of a tablet of Emtril, but after three days the falcon still had Frounce. I then gave her an additional third of a tablet. This seemed to have adverse effects on the falcon causing her to go crazy.

HALLIWELL. Dosage (35-40 mg) given the Prairie Falcon was too low; treat with the entire 125 mg of the drug. However, indiscriminate use of the drug as a cure-all for everything is not wise.