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**Bigger than parakeets, smaller than parrots, cockatiels are good cage-bird research subjects. Above, co-author Tom Roudybush weighs a bird in a feeding trial.**

## Cage-bird research at Davis

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**F**or centuries the art of keeping and breeding birds has been practiced by aviculturists, who enjoy the companionship, beauty, and behavior of canaries, finches, parrots, and other aviary and cage birds. The science of aviculture is, however, still in its infancy except for some gallinaceous birds (chickens, turkeys, pheasants, and quail), domestic pigeons and doves, and some ducks and geese. For these food and game species, our scientific knowledge is good or sometimes excellent; for example, the nutrient requirements of poultry are well known, as are the effects of deficiencies or excesses of nutrients. In contrast, most companion birds are poorly understood with regard to needs for growth, maintenance, and reproduction. Some reasons for this disparity in information reside in the nature of the bird business, with its diversity of species and sizes of production units; the dependence of dealers on the supply of certain imported, wild-caught birds in-

stead of on local breeders; and the difficulties of studying altricial birds, which depend entirely on their parents for early care, as compared with precocial birds, which can feed themselves immediately after hatching.

Veterinarians have studied birds to keep them healthy in captivity, and, because birds may carry major poultry diseases, to avoid problems that may cause devastating financial losses to agriculture. Little research has been done on other aspects of bird biology, partly because of the scarcity and value of the birds themselves. Obtaining sufficient numbers to perform experiments is difficult, and with some endangered species it is virtually impossible.

To secure information about the nutrient needs and breeding management of a typical cage bird, we chose to study the Cockatiel, *Nymphicus hollandicus*, a native Australian psittacine that has been bred in captivity for decades. Mature cockatiels usually weigh 90 to 150

grams, which is more than budgerigars ("budgies," also called parakeets) and less than Amazon parrots or cockatoos. Their intermediate size makes them convenient for feeding and other studies, and they are relatively inexpensive, approximately \$25 to \$50 each, as compared with larger parrots, which may sell for hundreds of dollars. A pair kept in an aviary or cage may produce 10 or more chicks per year.

Despite the popularity of cockatiels, little is known of their biology. Breeders have identified six color mutants of the gray (wild-type), and there is information about the genetics of these forms, but little about heredity in relation to growth, reproduction, or normal development. Successful breeders have applied good judgment in using their own experience and that of others, including that published in popular bird magazines. However, we have found no reports of experiments or controlled trials to answer questions about space needs,

temperature and light effects, nutrient needs and deficiency symptoms, breeding management efficiency, reproductive biology, or of enterprise efficiency and investment returns, and production statistics. California is a major producer of cockatiels and other cage birds, and probably supplies more birds for this multi-million-dollar market than any other state.

Cockatiel research at Davis began in 1979 and became an official project in 1980. The originally acquired group of 68 birds was used to study light and temperature variables while the population increased. Allen E. Woodard and Leah Morrissey compared two cage sizes and two light schedules, and later, three constantly maintained temperature levels were compared in relation to reproductive success. These environmental variations had no major effects on reproduction (table 1). In contrast, birds such as chickens, Japanese quail, pheasants, or White-crowned Sparrows (*Zonotrichia leucophrys*) are especially sensitive to short days, which make them become sexually inactive.

Comparisons have recently been made between pairs maintained in cages that were 1 by 2 feet by 1 foot high and pairs in cages 1 by 4 feet by 2 feet high, plus either a wood or a stainless steel nest box. All pairs had produced eggs previously. Most of them had hatched eggs and many had reared young. Three-quarters of the birds had bred in 1- by 2- by 1-foot cages with stainless steel nest boxes, while the remaining birds had bred in flights (room-size cages) with wood nest boxes. The pairs were distributed into four groups with each group containing equal num-

bers of birds from flights or cages.

Although pretreatment conditions may have affected subsequent production, the data summarized in table 2 clearly show that there was no advantage in providing cockatiels with 8 cubic feet of breeding space instead of 2 cubic feet, and that there was no advantage in using wood instead of stainless steel nest boxes. Preliminary data of this sort will eventually need to be tested in field trials under commercial conditions (work of Richard Litsch).

Egg production, fertility, and hatchability in this uncultured flock have not been as high as commercial breeders expect. However, we have not found any published data to permit direct comparisons between our experience and that of others. There are no established criteria to use when culling breeding pairs; each breeder has developed his or her own system.

Nutritional requirements and cost-effective means of fulfilling them are important subjects for experimentation. The food of companion birds consists largely of such whole seeds as millet, canary, milo, sunflower, and safflower. Aviculturists also use fresh vegetable supplements and vitamin and mineral adjuncts or pelleted mixtures of ground feedstuffs. Formulations are usually based on the known requirements of chickens and turkeys, but no studies have been made that link the needs of parrots or finches with those of domestic birds kept for eggs or meat. The nutritional needs of birds and mammals that have been studied extensively have been found to be greatest during early growth of the young and during the reproductive period of the female. Early growth is difficult to study in altricial birds, because young birds must be hand-fed or fed indirectly through the parents.

Breeding-bird nutrition trials generally require many females (with cockatiels this means pairs) and results are slow to come. Cockatiels leave the nest (fledge) when they are four to five weeks old and may not be weaned from parents' feeding for another week or longer, by which time they may weigh 80 percent of their adult weight. We have used such subadult birds in experiments on values of single seeds, voluntary seed choices, and vitamin supplementation.

Most bird foods contain mixtures of four or more seeds, the individual nutrient values of which are not well known, even through chemical analysis. Lisa McDaniel, working with Pran Vohra, analyzed several popular seeds (table 3). She also attempted to determine the preferences expressed by birds given choices of four separate seeds. However,

**TABLE 1. Effect of photoperiod, cage size, and temperature on cockatiel reproduction**

Treatment	Mating pairs	Eggs/hen	Hatch
<b>Light:</b>		(9 mo.)	%
16L:8D	13	15.2	18.7
8L:16D	10	17.8	24.2
<b>Cage space:</b>			
2 & 4 ft <sup>3</sup> /bird	13	18.7	19.7
8 ft <sup>3</sup> /bird	10	13.2	24.2
<b>Chamber temperature:</b>		(3 mo.)	
°C	°F		
15.6	(60)	3*	6.0 11.1†
23.9	(75)	3*	8.3 52.0†
32.2	(90)	3*	6.0 47.3†

\*Each pair kept in a wire cage 1 × 2 × 2 ft.  
†Hatch of all eggs laid.

**TABLE 2. Egg production of cockatiels in small or large cages with wood or stainless steel nest boxes**

Nest box type	Number of eggs produced*		
	Cage 1×2×1 ft	Cage 1×4×2 ft	Total
Wood	8	14	22
Stainless steel	30	10	40
Total	38	24	62

\*Differences are not significantly different.

except for millet, which seemed to be slightly preferred, no clear results were obtained. Young birds ate more than breeders and were more willing to try new seeds. Breeders chose diets higher in protein and fat than did immature birds, which preferred carbohydrate. There were large differences among individual birds in the trial.

In a study carried out by Michael Flathers, the individual seeds that comprise common mixtures for maintenance nutrition were compared by using each of four seeds as the sole source of food. There was considerable diversity in the composition of the seeds used, as shown in table 3. The seeds fed in this study were whole and unhulled.

Four groups of five immature birds each were used. Their mean weight ( $\pm$  standard deviation) was 87.3  $\pm$  11.6 grams. The birds were given access to mineral blocks and were supplemented with a commercial vitamin product in the drinking water. The birds were weighed daily for the first 12 days, then every 4 days for the remainder of the 60-day trial.

Cockatiels fed the canary seed and millet gained weight steadily and appeared healthy, gaining 30.5 and 24.5 grams, respectively, in 60 days. Those fed whole sunflower seed lost weight initially, but within 10 days, all but one had increased in weight. (This bird continued to lose weight, so it was returned to the cockatiel mix, and it then resumed normal weight gain.) Mean gain at 60 days of four birds fed sunflower



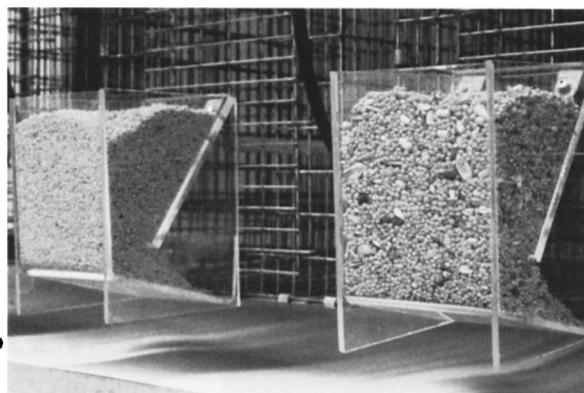
M. Escherick

**Cockatiel chicks, when hatched in an incubator, must be hand-fed until they are weaned at four to six weeks of age.**

**TABLE 3. Proximate composition of the kernel**

Seed	Moisture	Crude protein	Crude fat	Soluble	Crude fiber	Ash
				carbo- hydrate		
-----%						
Canary	6.9	22.1	3.8	16.0	18.0	2.5
Millet	8.1	13.8	3.7	27.3	17.0	0.8
Sunflower	2.8	30.2	49.0	8.9	15.8	3.8
Safflower	3.0	23.7	58.6	7.3	11.2	2.8

**Specially designed feed bins regulate birds' intake during nutrition studies, which make up a major part of the Davis research.**



M. Esberick

seeds was 22.5 grams.

The cockatiels fed only whole safflower seed generally avoided it, lost weight immediately, and displayed shivering. Two birds were returned to the mixed seed diet. They recovered and regained weight, but a third bird that was continued on the safflower seed died on day 33. The two remaining birds shivered constantly and fluffed their feathers but, during the experiment, gained a mean weight of 13.6 grams in 60 days.

Canary and millet seeds were satisfactory single sources of food for young cockatiels; sunflower seeds were satisfactory for four out of five birds. Safflower seed was not relished, and only two out of the five birds eventually ate enough to grow slowly.

Aviculturists use a variety of products to supplement seed mixtures, especially vitamins dissolved in the drinking water and minerals as a solid block of calcium and other salts. Veterinarians have reported case studies of chronic vitamin A deficiency in parrots, but controlled experimental production of the deficiency and its prevention or cure have not been reported. A study done by Lourdes Aguirre and Michael Flathers was designed to determine whether immature cockatiels would benefit from vitamin supplementation of the standard cockatiel seed mix, and whether symptoms of vitamin deficiencies would be observed as the experiment proceeded.

The study used three groups of eight birds, which were 12 to 20 weeks old at the start. Two levels of the vitamin mixture were added to distilled water. These were calculated to supply 200 times and 20 times the turkey requirements of the vitamins based on an average water intake of 5 ml per day per bird. The third group, maintained on distilled water, received no vitamin supplement. All birds were given free access to the mixture of millet, canary, oat groats, sunflower, and safflower. No mineral supplements were given to any birds. The original trial continued for

135 days. At the end of this period, the group given only distilled water (no vitamin supplement) was continued for a total of more than 500 days.

No significant differences were found among the groups in weight, behavior, appearance of feces, or feathering. A single bird in the distilled-water group (no vitamins or minerals) lost weight from day one and died on day 57. On day 219, a bird in the same group accidentally received a laceration and bled to death.

From this study, it appears that vitamin supplementation of a cockatiel seed mixture is not critical for continued maintenance of healthy birds, and that high levels of vitamins (estimates to exceed 200 times the requirement equivalent to poultry) are apparently not harmful. Generally, nutritional needs for maintenance may be expected to be low when compared with needs for reproduction, so it is important not to apply this information to breeding birds, which have not yet been studied.

These preliminary nutrition studies were designed as pilot trials for experiments on reproduction. In order to determine which nutrients are required, it is essential to know the composition of the diet and be able to manipulate it. This is best done by feeding a pelleted, purified diet composed of isolated proteins or amino acids, carbohydrates, fats, minerals, and vitamins. Feeding pellets to simulate natural seed diets presents its own problem of acceptability. When we fed such a diet composed of soybean meal, cereals, fats, vitamins, and minerals, some birds began immediately to eat the pellets, some took a few days to eat enough to maintain weight, and 4 out of 18 ate so little that they lost significant amounts of weight and never accepted the pellets as foods.

Unlike gallinaceous birds, cockatiel and other parrot chicks are fed by their parents until they are weaned to eat on their own. It has been stated that some parrots provide a kind of "crop milk" for the first two or three days, but this is not comparable in amount to the efforts of

pigeon parents in nourishing their squabs. Purified diet formulas and feeding techniques have been devised that now permit normal growth of chicks hatched in an incubator and hand-fed until they are weaned at four to six weeks of age. It is important to regulate the solids-to-water ratio of the food, as well as to provide adequate amounts of nutrients. This research is being supported in part by a grant from the American Federation of Aviculture.

With these techniques, a team from a caged-bird management class replaced isolated soy protein completely by a mixture of amino acids, and reared a chick from hatching until it could be weaned to a seed diet. This modest success presages a new period in nutrition studies with altricial birds.

The environmental and genetic factors that control breeding of cockatiels are not well understood, except that the presence of a nest box initiates breeding behaviors that lead to mating, laying, and incubation. D. Michael Fry, using radioimmune assay techniques to measure the daily excretions of steroid hormones, found that the urinary excretion of estradiol, one of the female hormones, rose rapidly at the time of yolk formation and declined slowly as eggs of the clutch were laid at two-day intervals. Testosterone excretion in males increased at the time of breeding, but fluctuated on a daily basis more than did estradiol levels in females.

Research on cockatiel science and management is a new field compared with that of chickens and other domestic birds. It promises to yield information that will be useful in understanding how these birds can live well and reproduce efficiently, and may also tell us something about the lives of other birds.

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