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The bird as an experimental animal

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For those who are not familiar with birds as experimental animals perhaps it should be pointed out that they offer many advantages over mammals, although they are obviously not the ideal animal for certain experiments.

Few laboratories work with birds other than poultry, but canaries and other cage birds are occasionally used when their special qualities are applicable, as in work with low concentrations of carbon monoxide, or on bird malaria. At the present time an interest is developing in the laboratory use of the quail (Wilson, Abbott & Abplanalp, 1961).

Fertile chicken eggs, day-old chicks, growing and adult fowls form the main source of birds for laboratory work, although again there are times when other species, such as the duck or turkey, are specially valuable. For example, the duckling is the species most susceptible to the toxin of 'X' disease, a new malady which last year killed off nearly 200 000 commercial turkeys and which has been shown to be associated with the use of particular batches of Brazilian and other groundnut meals in feeds.

Bronze turkey poults exhibit deficiencies of lysine more obviously than other species, and they have a much higher requirement for many vitamins than the fowl and, therefore, are specially suited for such nutritional work.

Poultry have many economic advantages:

(1) They are freely available, by the dozen or the thousand on a year-round basis.

(2) On many occasions they can be sexed before purchase at little or no extra cost.

(3) Whenever necessary their genetic make-up can be semi-standardized, although highly inbred stock is not freely available. Even so, many 'hybrids' are now on the market, and some of the more established ones are more uniform than many cross breeds and pure breeds.

Many 'hybrids' contain a high proportion of White Leghorn blood, which means that they are more flighty than the heavier breeds (Rhode Island Red, Light Sussex, White Wyandotte), which has its disadvantages. Another adverse feature of these

hybrids is that they suffer from pseudo-broodiness, continuing to lay but showing all the external signs of having gone broody. Presumably their output of prolactin is insufficient to neutralize the secretion of follicle-stimulating hormone.

Bantams are sometimes used because of their small size ($1\frac{1}{2}$–$2\frac{3}{4}$ lb), but the latest hybrid (Thornber '606') weighs only $2\frac{3}{4}$–3lb and is capable of laying three to four times as many eggs as the bantam.

(4) They are cheap. The present-day prices of live poultry are shown in Table 1.

Table 1. *Present-day prices (per dozen) of live poultry*

Fowl:	
As-hatched chicks (broiler)	19s.
Day-old cockerels	6s. 6d.–19s.
Day-old pullets	22s. 6d.–40s.
4-week-old pullets	44s.–55s.
8-week-old pullets	95s.–110s.
Point-of-lay pullets	17s. 6d.–25s. (each)
Turkeys:	
Day-old	£4–£6
8-week-old	£12
Ducklings:	
Day-old, table	26s.
Day-old, wild	50s.
Wild duck eggs	25s.
Pheasants:	
Day-old	70s.
6-week-old	16s. (each)
8-week-old	20s.–25s. (each)
Pheasant eggs	30s.–40s. per sitting (fifteen)

(5) The numbers of maladies which are egg-transmitted are few, and pullorum disease can be avoided by the purchase of Accredited chicks or others from blood-tested stock. It is commonly assumed that Accredited stock are free from other diseases, but this is not true and they are just as susceptible to the common diseases as other stock, unless the breeder has taken particular steps to obtain resistance against, for example, the avian leucosis complex. As such stock has passed the blood agglutination test for bacillary white diarrhoea (*Salmonella pullorum* infection), it automatically means that they will not be transmitting *S. gallinarum*, the causal organism of fowl typhoid.

Management factors

Poultry are easily managed, but there are several important aspects of their environment that should be watched carefully.

Brooding. Infrared ray lamps with reflectors make excellent brooders, providing both heat and light, but susceptible chicks may suffer from crooked toes, a malady not to be confused with curly toes, which is due to deficiency of riboflavin. Dull emitters require a pilot light to assist in attracting the chicks to the source of heat, and it is an advantage if it can be made to flicker instead of being on continuously (Gray, 1961).

A surround of some sort, about 18 in. high, to confine the chicks to the source of heat for 4–5 days after hatching is usually necessary, except in small pens, about 6 ft square. In most brooding compartments the corners should be rounded off to avoid smothering.

Infrared ray equipment, of course, fails to warm the room, a feature which is overcome by the use of hot-air brooders. Catalytic gas brooders require consideration on economic grounds.

Tier brooders, gas or electric, are also popular, but the wastage of feed with some makes is a feature to be watched in nutrition experiments. Their thermostats are often faulty, but if the room temperature is satisfactory this is less serious.

Paraffin brooders are economical to run, but outlay on labour is higher and there are certain fire risks.

Thermometers. Maximum and minimum thermometers are a great help to the laboratory assistant for recording variations of room temperature.

Feeders. Conventional feed troughs for chicks of different ages are excellent if they are not more than one-quarter to one-half filled, otherwise great wastage of feed may occur. Plastic tubular feeders, with a separate base, can be used from day-old up to and throughout the laying stage. The design of any tubular feeder is important relative to feed wastage, and the method we have adopted for testing this feature is that recommended by the British Standards Institution (1961). The results were:

No. of feeders tested	Type of feeder	Wastage of feed
7	Tubular (broiler)	2·1% (range 0·4–3·9%)
4	Tubular (layers)	5·4% (range 1·6–11·1%)

For the test, four feeders are taken and their position rotated daily. They are housed over a wire grid through which all waste feed and some droppings pass. The waste feed is sieved from the droppings and weighed daily. Feeders for broilers are tested for a 7-week period from the 4th to the 10th week. For laying stock the test period lasts for 4–6 weeks.

Important points to note are (a) the height of the feed in the feeder from the floor, which should be level with the bird's back; (b) the size of the gap between the tube and the base. If it is too wide great wastage of feed occurs. The manufacturer's instructions should be followed closely.

Drinkers. Glass jam-jar type fountains for day-old chicks reflect light and thus attract chicks to them, and the poultryman can also see when they require to be refilled. If galvanized waterers are used, those which are interlocking are best. Automatic drinkers are recommended for larger numbers of poultry housed intensively.

Water spilt in the litter aids the development of coccidiosis and also the production of ammonia fumes.

Space heaters. Electric space heaters, 1–3 kW, or tubular heaters (80 W/ft run) can often be used economically in the brooder room but, with the former, care must

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be taken that they are cleaned and free of dust after being out of use for some time, otherwise a fire may result.

Fans. The usual equipment gives only a three-speed control—50, 65 and 100%. Self-oiling fans are preferable, as well as those which are reversible—pulling in or pushing out air, as required. Any fans used must be adequate for the purpose.

Lights. Although many experiments have been carried out, both with chicks and layers, none has shown that coloured lights or fluorescent tubes are superior to ordinary incandescent electric lighting. 'Flash' lighting, however, with 1500 W bulbs can be used for 20 sec periods in place of 1 h periods with 75 W bulbs, and may be of particular value for laying stock.

Humidity control. Unless special and rather expensive apparatus is installed, the humidity in a poultry house will be dependent upon the weather, water spillage, the number of birds housed, room temperatures and ventilation.

Weighing machines. Whether these are for weighing stock or eggs, they should be of an approved make, easily adjusted, of rigid construction and with an easily read dial.

Litter. For floor brooding the choice of litter is of considerable importance. Wood shavings now cost £6 or more per ton. Chopped straw, free from mould, is better still if not too expensive. (It has reached £12 a ton in some parts of the country). Peat moss holds moisture well, but creates a lot of dust, which also darkens the house.

Whichever litter is used, it should be well pressed down before the chicks arrive, and dried by means of the brooder which should have been switched on 24 h or more earlier. The feed and water must be placed so that they are readily seen, otherwise the chicks will eat their litter and suffer from impacted gizzards. In a recent feeding trial at Stoke Mandeville we bedded a batch of chicks on feather meal in comparison with wood shavings. Their body-weights and feed conversion were much improved, because of their freedom from semi-impactions of the gizzard. The litter must be kept free of such objects as nails, wing bands, sweet papers, cigarette ends, since these may be eaten and lead to ill-health.

Stale litter can often be used two or three times without harm if it is first 'heaped' so as to raise its temperature to 125–140°F for 48 h or more. Occasionally the use of stale litter leads to a heavy production of ammonia, causing a painful keratoconjunctivitis in chicks. Stale litter may also be found to be heavily infested with forage mites or small beetles, e.g. *Alphitobius.*

De-beaking. If chicks are to be confined beyond the age of 2–3 weeks they will feather-peck unless their environment is ideal. Pecking happens even more with growing and adult stock, hence the need to de-beak many units of intensively kept poultry. Unless cautery is applied at the same time that the first third of the upper beak is severed bleeding will take place, which has proved fatal on occasions.

Optimal environments

The features of such environments are set out in Table 2.

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Table 2. *Optimal environments for poultry*

	Chicks	Growing hens	Laying hens
Room temperature (°F)	80–60	55	55–65
Lighting (foot candles)	1, for 6–18 h daily*	1, for 6–8 h daily†	3, for 12–17 h daily‡ (1 × 60 W every 10 ft)
Relative humidity (%)	60–75	60–75	60
Ventilation	Allow a minimum of 1 ft^3 per lb live weight per min for all stock (air inlets = 3 ft^2/1000 ft^3 output). When ambient temperatures exceed 85°F ventilation can be increased by 50% with advantage		

*After 4 weeks of age ½–¾ h of white light alternating with 1½–1¾ h of red light suits broiler chickens or others required to grow at a fast rate. The chicks rest under the red lighting. (Some producers use red and blue lights alternating in the same way.)

†Different light patterns are now being recommended to delay sexual maturity, e.g. 24 h at birth decreasing by ½ h/week (Morris & Fox, 1961) or 6 h to point-of-lay, increasing by 18 min/week (King, 1961).

‡It may be an advantage to split the lighted period so that light and dark periods alternate day and night, e.g. 10 h by day and 4 h by night.

Foods and feeding

Types of feed. There are four main systems of feeding poultry.

(1) Home-mixed meals, given wet or dry.
(2) Home-mixed meals combined with a protein–vitamin–mineral concentrate.
(3) Complete balanced feeds in mash, crumb or pellet form.
(4) Grain and grain balancer feeds (mash or pellets and grain).

Home-mixed meals are satisfactory, but their formulation is naturally important, as well as the source of the raw materials. Labour charges are higher than with other systems. Their nutritional value is often improved if they contain a protein–vitamin–mineral concentrate.

Complete balanced feeds are more costly, but more standardized, generally more reliable, obtainable throughout the country from most corn merchants, and are often backed by a nation-wide advisory service. In case of error the company concerned is usually prepared to make amends. Such feeds must conform to certain declared chemical compositions at the time of sale.

The mash and grain system of feeding poultry is becoming less popular because of increased labour charges and because grains differ widely in their chemical composition. Mashes are more dusty than crumbs or pellets and also less palatable unless made into a wet mash, which involves labour. Crumbs lead to faster growth rates and less wastage. The same applies to pellets, but in certain situations, e.g. in twin-bird laying batteries, pelleted feeds lead to cannibalism unless the stock is de-beaked. Meals have the advantage that the poultryman can add various ingredients after manufacture which is not so with crumbs or pellets.

Feeding standards. Many British feed manufacturers accept the standards laid down by the (U.S.A.) National Research Council: Committee on Animal Nutrition (1954, 1960) for poultry; others start with these and then modify them according to feeding experiments carried out in this country with ingredients which are more commonplace over here.

Feed ingredients. In general the animal protein component is provided by fish or herring meals, meat or whale-meat meals, dried skim milk, feather or processed poultry offal meals. The chief vegetable proteins for further supplies of amino acids are soya, groundnut, sunflower. Synthetic lysine, methionine and glycine are also available commercially.

For sources of energy, home-grown and imported cereals, such as wheat, barley, oats, maize and sorghums, are used and also sugar, molasses and tallow.

If bulk is necessary (although most poultry feeds contain very much less fibre today than they did 10 years ago), wheat by-products, such as wheatfeed and bran, are used.

For sources of xanthophyll for pigmentation purposes, maize gluten and dried grass meals are popular, although the latter often have not the same fine qualities found in lucerne meals, especially after they have been harvested several months. Synthetic pigments (carotenoids) like 2-apocarotenal are coming to the fore, especially for yolk-colouration purposes.

Dried yeast has been for years a standard source of most of the B vitamins, but synthetic supplies are now so satisfactory that they are often preferred. Other synthetic vitamins available are vitamins A, B_{12}, C, D_3, E, choline and folic acid.

Dried distillers solubles, dried whey, dried fermentation residues, fish solubles and the like are all used as sources of unidentified growth factors for poultry.

The chief ingredients for supplying minerals are common salt, dicalcium phosphate, calcium carbonate, zinc carbonate, manganese sulphate and stabilized potassium iodide. It is rarely necessary to include any other minerals such as iron, potassium, magnesium, cobalt or selenium.

Additives include anti-oxidants, especially if the ration contains any supplementary fats (tallow), arsenicals and antibiotics, e.g. procaine penicillin for growth-stimulation purposes. Chlortetracycline and oxytetracycline are used occasionally at high levels (100–400 g/ton) for dealing with disease outbreaks, e.g. infectious synovitis. Some producers use them for overcoming 'stress' factors, but as many of these are due to mismanagement they would be better omitted owing to their high cost and the risk of encouraging antibiotic resistant bacteria. Anti-coccidiosis supplements are also used. Since 1950, these have included nitrofurazone, nitrophenide, sulphaquinoxaline and many proprietary preparations for preventing outbreaks of *Eimeria tenella*, *necatrix* and *acervulina* infestations. If Salmonellas or *Escherichia coli* infections are likely to be encountered, then furazolidone is also incorporated in the feed (0·01% for prevention, 0·04% for curative purposes). For turkeys there are other feed medicaments for controlling outbreaks of blackhead or hexamitiasis.

Grits. When a ration does not contain the optimum amount of calcium, users are advised to give limestone or oyster-shell grits daily, but most 'starter' rations are fully supplied with calcium compounds. However, except for 'complete' layers rations (which contain about $3\frac{1}{4}$% calcium), all others need to be supplemented with soluble lime-containing grits.

Insoluble grits for gizzard-grinding purposes, such as flint or granite, are essential where poultry have access to grass, green food or grain. As they do not disappear from the gizzard for many weeks or months, supplies need only be given every few weeks, the largest-sized particles for preference. Excessive amounts of grits overflow into the intestines and cause enteritis.

Special feeds. Special feeds for poultry of different ages and species are:

Broilers	Chicks	Laying hens	Breeding hens
Starter (0–4½ weeks)	Baby chick (0–8 weeks)	Hen battery	Poultry breeders
Finisher (4½–10 weeks)	Growers (8–20 weeks)	High-energy 'Complete' grain balancer	
Finisher depigmenting (4½–10 weeks)			

Turkeys					
Prestarter (0–4 weeks)	Starter (0–10 weeks)	Rearing (10–20 weeks)	Early turkey finisher (11–16 weeks)	Prebreeder (20–30 weeks)	Breeder (30+weeks)

Health measures

Apart from blood testing for bacillary white diarrhoea, vaccination against fowl pox, fowl typhoid and erysipelas can be carried out if necessary. Coccidiosis, blackhead and *Salmonella pullorum* infections can be prevented by the use of medicated feeds; piperazine (in the feed or water) gives good control over *Ascaridia*, and phenothiazine eliminates *Heterakis* infestations.

Broad-spectrum antibiotics in the feed often give good results in the treatment of roundheart disease, pullet disease, infectious synovitis, infectious sinusitis and *E. coli* septicaemias, but it is an advantage if they are supplemented with terephthalic acid (0·4%) or alternatively if the calcium content of the feed is reduced to less than 0·8%. The production of 'resistant' bacteria must be watched for carefully.

External parasites are easy to control, except when stock has been de-beaked and are unable to dust-bath themselves. Various preparations are used for controlling northern fowl mites, but many of these mites now appear resistant to nicotine sulphate and BHC (benzene hexachloride).

Mortality. If the stock is of good quality and environmental conditions are satisfactory, total mortality up to 10 weeks of age may be less than 1%, but up to 4% must be considered permissible, with a further 5% loss up to point-of-lay at about 20 weeks of age. During the laying year total mortality should not exceed 18%; it usually averages 12% and may be as low as 8%.

The early mortality among commercial chicks, during the first 2 weeks after hatching, is something about which the laboratory attendant can do very little. It may reach 2%, with the chief causes related to so-called 'chilling', congestion of the lungs and nephritis (bacteriological examinations are always negative). Infected yolk sacs (mushy chick disease) are also commonplace and never worth treating. Salmonella infections, e.g. *S. thompson* and *S. typhi-murium*, appear occasionally in certain stock, as also epidemic tremors. If infectious bronchitis occurs early it may be followed by *E. coli* septicaemia and air-sac infections at about 6–8 weeks of age. Neurolymphomatosis is not unknown even at the same age, and occasionally causes deaths exceeding 20%. Coryza can also be a problem of importance.

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In practice it never pays to treat individual birds; culling should be ruthless and continuous.

Summary

Poultry as laboratory animals are economical, easy to house, manage and feed. Other birds may be used for special purposes. Where space is an important consideration, Japanese quail may prove ideal once supplies of this species are available freely. Most diseases common to birds can be overcome by good management, but drugs and antibiotics can also be used for controlling many of their specific infections.

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Advances in nutritional knowledge through studies with birds

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It is not the intention to review in this paper the great body of work concerned directly with the nutrition of poultry, but instead to consider investigations of fundamental nutrition where birds have been peculiarly suited to a study of a particular problem.

As laboratory subjects, birds have several disadvantages compared with some of the other commonly used species. Because birds do not lend themselves to close inbreeding, they are genetically less uniform, so that a high variability between individuals may be expected. This variability is aggravated by the establishment of a social hierarchy in groups of birds kept together which results in differences in food consumption and uneven growth rates within experimental groups. They are not well adapted to digestibility studies since their feeding habits make accurate records of food intake difficult, and special techniques are necessary for the separate collection of urine and faeces. They are, however, relatively cheap and easy to produce in large numbers. Young chicks and turkey poults grow very rapidly and hence have high requirements for most of the known nutrients. They thrive on synthetic diets, and by simple omission of any desired nutrient an uncomplicated deficiency can readily be established and is usually characterized by easily recognizable signs. Further, birds do not practise coprophagy if kept on wire screens, so that dietary studies need not be complicated by ingestion of excreta.