CHAPTER

45

GALLIFORMES

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Members of the order Galliformes occur on every continent except Antarctica. The Red Junglefowl, Common Turkey and Helmeted Guineafowl have been domesticated for centuries and are of considerable economic importance. Some varieties reach monstrous proportions and some members of the order, like the Japanese Quail and various pheasants, are approaching a level of complete domestication.

Many Galliformes are commonly maintained as game birds, some of which are stable in captivity, easy to breed and inexpensive. Other species are from niches with specific environmental requirements and need specialized diets, humidity or temperature to survive.

In this chapter, "domestic fowl" means *Gallus gallus, forma domestica* (domestic form of the Red Junglefowl); "domestic turkey" is *Meleagris gallopavo, forma domestica* (domestic form of the Common Turkey) and "domestic guineafowl" is *Numida meleagris, forma domestica* (domestic form of the Helmeted Guineafowl) (Table 45.1).

Maintaining, breeding, treating or dealing with gallinaceous birds may be regulated by laws that govern the protection of animals, property rights, exchange of goods, liability, epornitics, food for human consumption, hunting and (international) transport of animals.

Several gallinaceous birds have anatomic or physiologic peculiarities that should be discussed.[7] In the circulatory system, for example, most gallinaceous birds have right and left internal carotid arteries; however, the megapodes have only the right internal carotid artery.[28] The respiratory rates, heart rates and rectal temperatures of some gallinaceous birds are listed in Table 45.2

Anatomy and Physiology

Integument

Many gallinaceous species develop a durable, vascularized thickening of the corium in the ventral thoracic region called a brooding spot. The feathers in this region are temporarily lost, and body heat is transferred directly from the brooding bird to the eggs.[34]

The preen gland in the domestic fowl consists of two bilateral symmetric lobes, each with one secretory duct opening into the uropygial teat. Some breeds of domestic fowl have two uropygial teats. Tail-less breeds of the domestic fowl and the argus pheasants have no preen gland. A brush-like feather tuft that absorbs secretions from the gland is present on the uropygial teat (see Figure 24.7).[34] This feather tuft is absent in the megapodes.[28]

Some gallinaceous birds have unique skin appendages. Junglefowl possess marked unpaired carneous combs consisting of a wide intermediate layer, which is formed of a fibrillar network filled with mucus-like substances that impact elastic stability to the comb. The intermediate layer is covered by the strongly vascularized corium and the epidermis. Feathers are present on the comb bonnet in some domestic fowl breeds. The paired wattles of the throat are similar in structure to the comb (Figure 45.1). Like the comb, the size of the wattles is influenced by hormones, and both are better developed in cocks than in hens. Paired cheek or ear lobes are located ventral to the auditory canal and are red or white if subepithelial capillary sinusoids are absent.[34]

The structure of the skin appendages on the head and neck of turkeys varies from those described in junglefowl. These appendages have no elastic intermediate layer but do have superficial, muscular and vascular layers. The dewlaps of turkeys are smooth, can increase and decrease in size and can change color. Turkeys have a single snood on the forehead that can increase or decrease in length. Numerous red caruncles are located on the poorly feathered blue skin of the head. A beard consisting of tough dark bristles is present at the border between the neck and chest. Turkey hens have smaller skin appendages than cocks, and a beard is found occasionally in older hens[34] probably as a result of hormonal changes.

FIG 45.1 Fly bite dermatitis in the comb of a Rhode Island Red Rooster.

In New World quail, the edge of the lower bill is serrated or slightly toothed. An osseous process, which can be large in some species or subspecies, exists near the junction of the upper bill and cranium of Helmeted Guineafowl and some cracids.[28] This helmet consists of a cone of spongy bone covered by the corium and a keratinized epidermis. The wattles of the Helmeted Guineafowl are white to light-blue and, like the helmet, are larger in cocks than in hens.[34] Some other phasianids, some megapodes and some cracids also possess ornamental appendages of the head and the neck. In some species, these appendages are visible only during mating displays. Some breeds of the domestic fowl, some megapodes, some francolins, some tragopans and some pheasants have completely featherless heads and necks or featherless areas of the head or neck. Unfeathered areas of skin are frequently colored.[28] Many grouse species have red-colored supra-ocular combs. These unfeathered regions become swollen during the mating season.[5,17]

TABLE 45.1 Families and Subfamilies of Gallinaceous Birds[41]

Family Subfamilies	**No. of Genera**	**No. of Species**
Cracidae (cracids)	10	43
Megapodiidae (megapodes)	7	12
Phasianidae (phasianids)	70	203
Numidinae (guineafowl)	4	6
Pavoninae (peafowl)	2	3
Meleagridinae (turkeys)	1	2
Argusianinae (peacock pheasants and argus pheasants)	3	8
Phasianinae (pheasants)	8	21
Lophophorinae (monals)	1	3
Pucrasiinae (Koklass)	1	1
Ithagininae (Blood Pheasant)	1	1
Gallinae (junglefowl)	1	4
Tragopaninae (tragopans)	1	5
Galloperdicinae (spurfowl)	1	3
Ptilopachinae (Stone Partridge)	1	1
Perdicinae (partridges, snowcocks, francolins, Old World quail)	27	98
Odontophorinae (New World quail)	9	31
Tetraoninae (grouse)	9	16

The cocks of many gallinaceous birds have spurs, which are osseous eminences originating from the tarsometatarsus and are covered by keratinized epidermis (see Figure 12.34). If spurs occur in hens, they are generally smaller than in cocks and often have no osseous component.[34] The cocks' spurs are frequently sharp and can easily injure rivals, females, clients or veterinarians. Cracids and grouse do not have spurs.[5] In the Common Pheasant, annual rings are formed in the epidermis at the base of the spurs and can be used to determine the minimum age of the bird.[20]

Adaptations to Low Temperatures

The feet and toes of grouse are feathered. In ptarmigans, even the plantar surface of the foot is covered with fur-like feathers. Long nails and keratinous pins on both sides of the digits facilitate locomotion on snow. Dense plumage and a thick layer of subcutaneous fatty tissue help protect against the cold. Hair-like feathers cover the nostrils. In ptarmigans, shivering for the active production of body heat starts only below -12°C.[5,17,28]

Plumage

The chicks of all gallinaceous birds are nidifugous and hatch with a downy plumage.[33] The contour feathers of the plumage are formed of the deck feathers (tectrices), the flight feathers (remiges) and the tail feathers (rectrices). The number of rectrices varies among different species: the domestic fowl has 7 pairs; the Bulwer's Wattled Pheasant has 12 to 16 pairs. Ornamental feathers can originate from different portions of the plumage including tail coverts (peafowl), rectrices (many pheasants) and chin feathers (capercaillies). Birds that are indigenous to open terrain often have a patterned plumage that serves as camouflage.[28,34] Some species like the Golden Pheasant show polychromatism of the plumage.[28,33]

The eyes of many gallinaceous birds are hidden by dark periorbital feathers. Attempting to escape from predators by running or flying in open terrain is poor defense; thus, most ground-dwelling gallinaceous birds remain immobile when predators approach and flee only as a last ditch effort to escape.

Gallinaceous birds generally have well developed afterfeathers (hypopennae). Peafowl do not have afterfeathers. In some cracids, the vanes of the first primaries are curved and narrow, which, when a bird flies, produce a unique sound that is used to mark its territory.[28]

Most gallinaceous birds molt once a year, generally after the breeding season. Gallinaceous birds retain their ability to fly during a molt. The secondaries are molted in a divergent pattern from an inner starting point. The rectrices are molted randomly.[33] The Willow Ptarmigan lives in a subarctic-type habitat and molts three times a year in order to adapt to color changes in the environment, with the winter plumage being mainly white. Some grouse (capercaillies and ptarmigans) even molt the horny sheath (rhamphotheca) of the bill (in small pieces) after the breeding season. Ptarmigans also replace their nails.[17]

Some birds (notably grouse, pigeons) undergo a stress-induced physiologic response when attacked by predators that results in release of the feathers (the shock or fright molt). The predator or handler is left with a collection of feathers and the bird escapes.[14]

Gallinaceous birds normally fly at a low level, have a high frequency wing flap and tire quite rapidly. Their flight is often limited to gliding for short distances. Some species lead a nomadic life. Birds that dwell in high mountainous regions in the summer usually move to lower altitudes in the winter. The only true

migratory gallinaceous birds are the Common Quail and the Japanese Quail. Some gallinaceous birds move by running, which is assisted by quick flapping of the wings. A normal cruising speed for the Common Pheasant would be 20.5 mph (= 33 km/h) while the Common Turkey cruises through the forest at 15 mph (= 24 km/h). The nidifugous chicks of the gallinaceous birds are able to fly shortly after hatching. The chicks of the phasianids first attempt to fly at the age of ten to sixteen days, and the cracid chicks start to fly three to four days after hatching. Megapode chicks, which are not tended by their parents, are able to fly short distances just after hatching.[28]

Locomotor System

The furcula (wishbone) of the domestic fowl is V-shaped and has a ventral process (see Figure 12.32). In the Crested and Plumed Guineafowl, an indentation exists at the junction of the two clavicles. This indentation holds the U-shaped loop of the elongated trachea. The medial notch of the sternum extends far cranially, and the lateral and medial notches are connected by fibrous membranes. In this region, the liver is not protected by the sternum, and injections, abdominocentesis or handling procedures must be carefully performed.[35]

The ground-dwelling phasianids generally have a long femur, tibiotarsus and tarsometatarsus to facilitate ambulation, while the tree-dwelling cracids have shorter tarsometatarsi. The legs of all gallinaceous birds are well muscled.[35] Cracids are active climbers, and other gallinaceous birds need strong feet and legs to scratch the ground in search of food. The toes of cracids and megapodes are on the same plane, whereas the first toe of the phasianids originates more proximally than the other digits. The first digit of the gallinaceous birds is oriented mediocaudally and the three other digits are directed cranially.[28] Some breeds of the domestic fowl have five digits (Houdans, Faverolles, Dorkins, Chinese Silk Fowl), with the additional digit being located medial to the first.[33]

Respiratory System

Desert-dwelling gallinaceous birds such as sand partridges, possess well developed salt glands situated in an osseous indentation above the eyes. This extrarenal excretory organ for salt empties through a duct into the nasal cavity.[36]

TABLE 45.2 Respiratory Rate, Heart Rate and Rectal Temperatures of Selected Gallinaceous Birds[37,36]

Species	Respiratory Rate (per min)	Heart Rate (per min)	Temperature (°C)
Domestic Fowl	12-37	220-360	41.2
Domestic Turkey	28-49	93-163	40.7
Pheasant	12-37	–	–
Bobwhite Quail	–	–	44.0
Common Quail	40-85	249-494	42.2

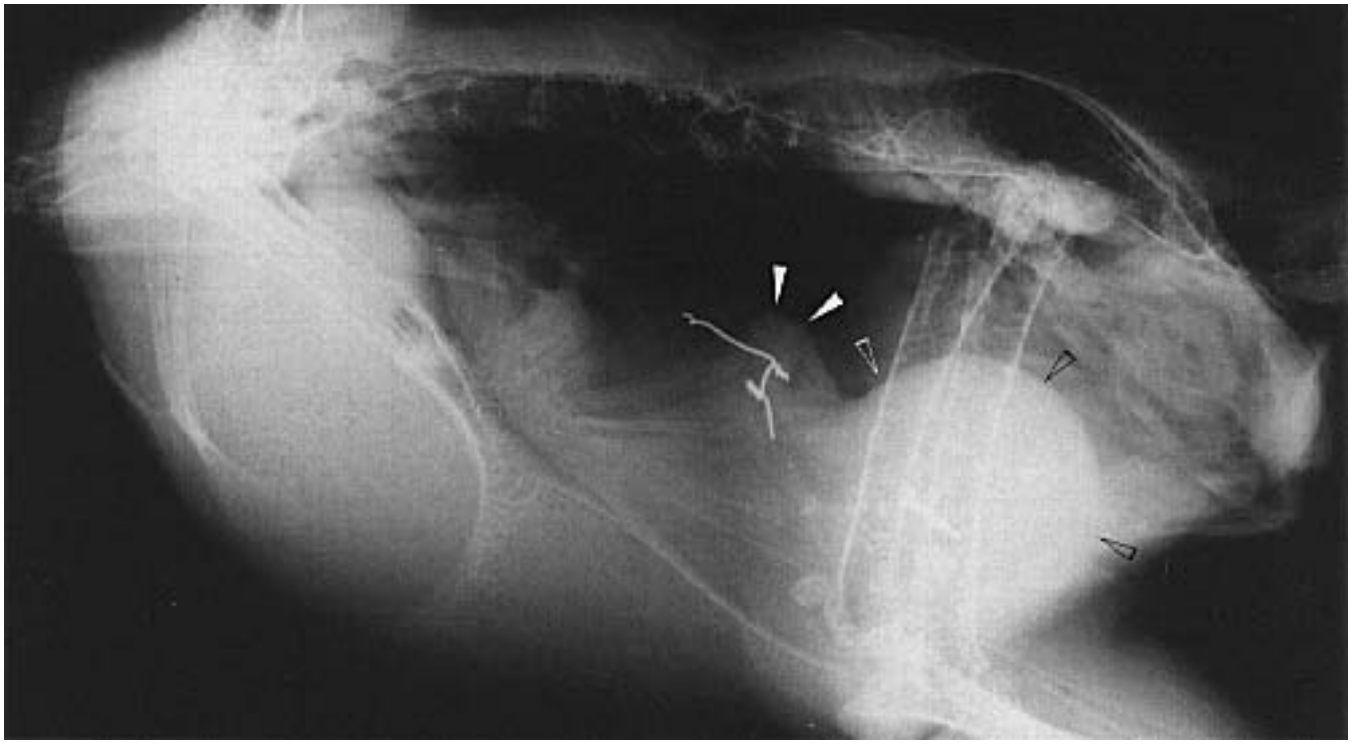
The cocks or both genders of some gallinaceous birds have elongated tracheas. The additional length produces a U-shaped or circular loop in the trachea that lies between the skin and the muscle layer in the ventral thoracic or cranial abdominal region. In Helmeted Curassows, the loop extends to the cloaca, and in some other cracids, it extends to the caudal end of the sternum. Crested and Plumed Guineafowl and the Common Capercaillie also have an elongated trachea. Although the function of the loop is not fully understood, it may be involved in generating deep sounds.[28]

The tracheobronchial syrinx of gallinaceous birds is a simple structure. The neopulmo, which is the phylogenetically younger portion of the lung, is well developed in Galliformes. A phylogenetic increase in the size of the neopulmo is accompanied by a decrease in the size of the caudal thoracic air sacs. The Common Turkey has a well developed neopulmo and has no caudal thoracic air sacs. Four clavicular air sacs are recognized in gallinaceous embryos. In the Common Turkey, only two of the four clavicular air sacs merge with the unpaired cervical air sac, and two clavicular air sacs remain distinct. In other birds, all the embryonic clavicular air sacs merge into one. With these adaptations, the Common Turkey has only seven air sacs, while most gallinaceous birds have nine air sacs: the unpaired clavicular air sac, and the paired cervical, cranial thoracic, caudal thoracic and abdominal air sacs.[36]

Alimentary Tract

Most gallinaceous birds have a pointed bill (rostrum) that is used to pick up food.[37] In grouse, the bill is stronger and is used for cutting tough vegetable matter.[5,17] In gallinaceous birds, the cere is usually limited to the base of the upper bill; however, in cracids, two-thirds of the bill is covered by the cere.[28]

The tongue of gallinaceous birds is shaped like an acute triangle, is stabilized by a bone and has no



intrinsic musculature. Most gallinaceous birds have a crop.[37] This esophageal diverticulum is missing in small cracids and snowcocks, and in its place is a slight bulge in the diameter of the esophagus or only an increased stretchability of the esophagus.[28] The Sage Grouse and some other North American grouse use a diverticulum in the middle part of the esophagus for territorial display and not for the storage of food. During display, the "inflatable esophageal air sacs" are inflated to expose featherless, brightly colored skin. The organ may also play a part in amplifying the voice.[5,17]

The ventriculus and its associated musculature is well developed in most gallinaceous birds (Figure 45.2). Grouse and snowcocks, which eat extremely rough food, possess the most heavily muscled ventriculus. The Sage Grouse, which feeds on soft food, has a thin-walled ventriculus.[5,17,28]

The secretory ducts of the liver and the pancreas open into the duodenum. Gallinaceous birds have a

FIG 45.2 Most gallinaceous birds have a well developed ventriculus with its associated musculature. Note the density of the thick ventriculus (open arrows) containing a partially digested screw and grit. In this case, a peafowl hen was presented for weight loss and regurgitation of several days' duration. An ingested wire had penetrated the proventricular mucosa. The formation of a granuloma (arrows) at the end of the foreign body had prevented the wire from penetrating through the proventriculus. A proventriculotomy was used to remove the wire.

gall bladder and two bile ducts. In the domestic fowl, the pancreas extends to the apex of the duodenal loop and generally has three secretory ducts. The largest pancreas is found in gallinaceous birds that feed on grain.[37]

All gallinaceous birds have well developed ceca. Fluid and small food particles are transported into the cecal lumen by peristaltic movements of the small intestine and antiperistaltic movements of the rectum. The contents of the ceca are dark-colored and have a sticky consistency.[10] The size of the ceca will increase or decrease depending on the amount of crude fiber in the diet.[15,27] In some species, bacterial digestion of cellulose occurs in the ceca,[12] and species like grouse and snowcocks that feed on foods with high amounts of crude fiber have particularly well developed ceca.[28]

The cecal flora probably plays an important role in the synthesis of vitamins and the metabolism of nitrogen.[9] Uric acid that enters the cloaca is transported into the ceca by antiperistaltic movements of the rectum and is used for the synthesis of bacterial amino acids.[6] The ceca are usually emptied once a day, typically in the morning.[28]

Urinary and Reproductive System

The testicles are generally yellowish or white, but can be pigmented in some species like the Common Capercaillie or in some breeds of the domestic fowl. The testicles enlarge during the breeding season. Fertile semen is not produced between breeding seasons. The ductus deferens and, in some species, an enlarged area of the caudal ductus deferens, serve as reservoirs for the storage of semen. Gallinaceous cocks have a non-erectile phallus.[38]

Husbandry

Most gallinaceous birds are best maintained in combination indoor and outdoor aviaries and can live to 6 to 20 years depending on the species (Table 45.3) In general, the available space should be as large as possible. In some countries the minimum areas are stipulated by law.

TABLE 45.3 Longevity of Selected Gallinaceous Birds[28,39]

Bird	Years
Peafowl	Approx. 20
Bobwhite Quail	Approx. 6
Grouse	8-10
Common Pheasant	10-18
Cracids	20 and more

A pair of pheasants can be maintained and bred in an aviary with a floor space 4 by 6 meters with an additional 4 square meter shelter. A Common Pheasant cock with 5 to 6 hens needs 30 to 40 square meters. An aviary for peafowl should be at least 3 meters wide, 3 meters deep and 3 meters high. These species are best maintained in open-air enclosures or big gardens. One pair of Bobwhite or California Quail needs a minimum of 1.5 m x 1.5 m floor space.[28] For grouse, small aviaries measuring 4 meters in depth and 8 meters in width are recommended, because these birds may injure themselves if they fly into netting at the high speeds attained in larger flights.[5]

Many Galliformes prefer to roost in elevated positions, making the height of an aviary important. Shelters should be provided to protect birds from sun, wind and rain. Tropical or subtropical species maintained in cold climates require an indoor aviary or, if kept outdoors in winter, a heated shelter. The mesh size of netting should be small enough to prevent a bird from placing its head through the mesh. It should also prevent the smallest predators from entering the aviary. Some gallinaceous birds, especially the Common Pheasant, fly straight up when panicked. For this species, the top netting in an enclosure should be loose to provide some give and reduce the chances of head and neck injuries. An opaque barrier can be placed at the back of the aviary, extending up to one-half of the height, to provide extra visual security for the birds.[28]

Ground-dwellers like some quail, some partridges and some francolins do not need elevated perches. Perches should be placed far enough from walls or wire netting to prevent the tail or wing feathers from contacting these surfaces. Peafowl, Reeve's Pheasant, argus pheasants and Phoenix Fowl require especially high perches, three to four meters above the ground, to accommodate their long tail feathers. Sharp corners should be avoided in designing the aviary. Curved corners or dense bushes planted in the corners reduce the possibility of trauma.[1,28]

Shrubs also help to landscape an aviary and provide shelter for the birds; however, the aviary should not

be overplanted. Too many plants will make an aviary difficult to clean. Natural turfs are attractive, but are not recommended when keeping birds that are highly susceptible to infectious diseases. An aviary with a concrete floor that is covered with an exchangeable layer of sand meets the needs of sensitive species (like grouse or the Cheer Pheasant) and is better than natural soil. Plants may be grown in containers that are removed when the aviary needs cleaning.

Snowcocks need large rocks for perching and shaping their bills. Some species like monals, eared pheasants and the Cheer Pheasant use their upper bill to search the soil for roots and insects. If these birds are maintained on artificial substrate, natural abrasion of the bill will not occur and manual trimming will be necessary. Gallinaceous birds do not bathe in water. Most gallinaceous birds like to take dust or sand baths. The placement of abrasive materials on the plumage may function to lightly abraid and polish the edges of the feathers, and may help reduce the number of external parasites as long as the sand itself is not contaminated. Insect powders should be used only if they are known to be nontoxic for the species concerned and only if the birds in fact have parasites. In the winter, Willow Ptarmigan bathe in the snow.[28]

Various bird species should generally not be mixed in one aviary because of possible interspecific aggression and the potential transmission of infectious agents. If species are combined, it is best to mix birds that do not compete for the same food or biotope. Ground-dwelling gallinaceous birds can be combined with bush- or tree-living species like thrushes, babblers, starlings, bulbuls and doves (with the exception of the Ground Pigeon); however, mixing of species is not recommended. Predatory species, including birds that feed on eggs, should not be combined with gallinaceous birds.

Silver Pheasant, eared pheasants, Golden Pheasant, Lady Amherst's Pheasant, Elliot's Pheasant, Swinhoe's Pheasant and Indian peafowl can be maintained in open-air enclosures that are fenced but not covered. Birds in open-air enclosures must have sufficient hedges, bushes or trees for cover. Higher trees should be available for roosting. Fruit trees or oaks (some are poisonous) provide a food source as well as cover. The flight capacity of a bird should be reduced by clipping the wings before introducing it to new surroundings.

Losses to predators can occur in open-topped facilities, particularly with respect to chicks. Rare species should not be maintained in an open-topped enclosure. A breeder who uses open-topped enclosures should expect that the loss of a bird to a predator is the responsibility of the breeder and not the fault of the predator. Some gallinaceous birds are noisy, especially the Indian peafowl and guineafowl during the breeding season, and should be maintained in secluded areas to avoid complaints from neighbors.

Nutrition

Many diseases and problems in captive Galliformes are directly or indirectly related to malnutrition. Breeders of gallinaceous birds should be aware of the natural foods consumed by any species maintained in captivity. Conclusive data on the nutritional demands (with respect to maximal egg or meat production and not for longevity and appearance) is available only for the domestic fowl, domestic turkey and the Japanese Quail. Some information is available for the domestic guineafowl, and less has been determined for the Common Pheasant. All nutritional guidelines for other gallinaceous birds are based on experience.

Generally, the protein requirement increases at the beginning of the mating season because of egg and semen production. After the breeding season, the amount of protein in the feed should be gradually reduced. With any change in the diet, the new feed should be mixed slowly into the daily diet until the conversion is complete.

"Easy" Birds

Many gallinaceous birds are omnivorous. The nutritional requirements of Common Pheasant, Golden Pheasant, Lady Amherst's Pheasant, Silver Pheasant, peafowl, guineafowl, turkeys, partridges and New World quail are relatively easy to provide. Commercial diets for domestic fowl, domestic turkey, Common Pheasant and Japanese Quail are available in many countries. Pellets designed for turkeys can be used in species without special requirements. Adding fresh green plants to the diet provides the birds with nutritional diversity. Grass or corn silage can also be offered in small quantities. During the breed-

ing season, the diet should contain 20 to 25% crude protein. Outside the breeding season, a maintenance diet containing less than 20% crude protein is best. Commercial diets for domestic turkey are usually better suited for pheasants than diets developed for domestic fowl. Feeding is best accomplished by providing small portions of the diet several times a day in the non-breeding season and offering food ad libitum during the breeding season.[28,31]

Most New World quail are primarily seed-eaters and are easy to feed. Forest-adapted species may be largely insectivorous and have higher and more specific protein requirements in comparison to other gallinaceous birds.[28] Cracids are mainly, but not exclusively, vegetarians. They can be sustained on pellets containing 21% crude protein supplemented with fruits but no grains. During the breeding season, they are fed soybean paste, chopped hard-cooked eggs, chopped meat or mealworms (larvae of the meal beetle).[25] Megapodes can be fed a commercial poultry diet.[28]

Birds with a High Protein Requirement

Some gallinaceous birds like peacock pheasants, argus pheasants and the Roulroul (Crested Wood Partridge) do best with high-protein diets. In addition to high-protein turkey or pheasant diets, adult peacock pheasants should be fed mealworms, chopped meat, fruits and a small quantity of grain. Green plants are rarely consumed by these species. The Roulroul is fed a commercial soft feed for insectivorous birds mixed with live insects, chopped hard-cooked eggs and chopped meat. The primarily meat diet of these birds results in an odoriferous feces.[28]

"Difficult" Birds

Some gallinaceous birds consume almost exclusively vegetable material. The Koklass, the Blood Pheasant, snowcocks, tragopans and grouse are examples. Feeding these species with game bird pellets or, even worse, with commercial diets for domestic fowl and turkeys, results in obesity, reduced fertility and imbalances in the intestinal microflora. These species should be maintained only where natural-type foods are available year round. These gallinaceous birds should be fed large amounts of fresh vegetables. Pellets should be provided only in small quantities, if at all. Koklass naturally feed on ferns, grasses, leaves, mosses, buds and berries. In captivity they should be provided soft green plants, fruits and berries and no grains. In the summer, grasses and lucerne can be provided. Spinach, romaine lettuce and fresh, frozen vegetables can be substituted in the winter months. Free-ranging Blood Pheasants feed on mosses, lichen, ferns, grass tips and conifer needle-buds. They browse constantly in planted aviaries. Snowcocks eat mostly grasses and leguminous plants. Their chicks feed on these plants immediately after hatching.

Tragopans consume oak trees, bamboo sprouts, grasses, mosses, oaknuts, berries and a few insects. In captivity, tragopans can be fed lucerne, grasses, cucumbers, apples and different kinds of berries.[28] In the spring, summer and autumn, grouse feed on a variety of plants. In the winter, most grouse species are restricted to consuming one or a few plant species. During the winter season, the Spruce Grouse, capercaillies and other grouse species feed almost exclusively on conifer needles, the Black Grouse on birch buds, and ptarmigans on buds from different deciduous trees (birch, alder, willow).

Captive grouse should receive natural foods or at least large amounts of leaves, grass and berries supplemented with a limited quantity of pellets and grain. Capercaillies and ptarmigans require a diet high in crude fiber.[5,17] Even with strict attention to the diet, the bacterial fecal flora in capercaillies in captivity is similar to the fecal flora of the domestic fowl, and differs substantially from the fecal flora of free-ranging capercaillies.[30] The tannin and essential oil content of natural food plants may support the growth of autochthonous intestinal flora in free-ranging grouse.[29] In the Sage Grouse, leaves and sprouts of the North American Big Sagebrush are the sole winter food and the main portion of food in the summer.[5,17]

Some commercial poultry diets contain coccidiostatic agents. Halofuginone is toxic for the Common Pheasant, guineafowl and the Common Partridge. Monensin is toxic for guineafowl.[14] Commercial diets for the Common Turkey contain antiflagellates. The presence of antimicrobial agents can be life-threatening in species that depend on a functional cecal flora and fauna (eg, grouse) for proper digestion. In general, the effects of coccidiostats and other medical feed supplements on gallinaceous birds have not been sufficiently studied. It is safer to provide food without these potentially toxic supplements.

All gallinaceous birds should have access to grit. The grit container should be emptied and refilled regularly because birds select only stones that are suitable for their body mass. Pellets or complete rations have an adequate supply of calcium and should not

be supplemented with lime or crushed shell. Fresh, clean water must be available at all times for all species.

Chicks

During their first few weeks of life, free-ranging gallinaceous chicks feed mainly on live invertebrates like insects, larvae of insects, worms and snails in order to obtain the protein levels needed to sustain rapid growth. Starting at five to six weeks of age, the protein requirements begin to decrease, and the intake of carbohydrates increases to meet energy requirements. By six months of age, most young gallinaceous birds have reached a mass equivalent to that of adults. The quantity of carbohydrates in the diet must then be reduced to prevent obesity.

Feed should be provided to newly hatched chicks on a large flat plate on which they can move around and practice picking. By five to seven days of age, food can be offered in larger containers. The change from the plate to larger containers should occur by offering feed in both containers at the same time. Small chicks may drown in large water containers. Placing stones or glass marbles in the container will reduce losses.

Chicks of unpretentious species (Common Pheasant, peafowl, guineafowl) are initially fed a starter diet like turkey starter (28% crude protein) and are transferred to a lower protein diet (18% to 20% crude protein) from the eighth to eighteenth week of age.[31]

Chicks of the vegetarian species are difficult to feed. It is best to provide these birds with foods that are similar to those eaten by their free-ranging conspecifics. A diet composed of turkey starter mixed with mealworms, ant cocoons, chopped hard-cooked eggs, diced romaine lettuce, spinach, dandelion and other green plants is a viable substitute. In several species (some grouse), chicks obtain food by picking at the ground and by cutting off parts of plants with the bill. In these species, it is important that chicks be provided intact plants that are placed in the ground or tied in bundles to facilitate natural food-gathering behavior.[5] Chicks that are to be released into the wild must be introduced to their natural foods to prevent starvation. Perhaps chicks are imprinted with food shapes and colors, or at the least, they learn what foods to consume from the hen.

The chicks of some gallinaceous birds will not pick downwards in the first days of life. This is because peacock pheasants, Crested Argus, Great Argus and some other gallinaceous hens feed their chicks for several days after hatching. Argus pheasant chicks can be enticed to pick by offering live food (mealworms). Monal chicks fed mealworms will pick at their siblings' toes.[28]

Reproduction

Some gallinaceous birds breed readily in captivity while others rarely reproduce. Breeding failures are an indication that the birds are not happy or healthy, and that the natural conditions of the bird are not being sufficiently simulated. Some pheasant and quail species are approaching a level of domestication that is advantageous for both the captive animal and the breeder. Comparatively, "semi-domesticated" animals are of no value if offspring are to be released to the wild with the intent of reintroducing genetic diversity into dwindling populations. Genetic selection and breeding to achieve color variants increase the expression of genetic abnormalities, semilethal factors and susceptibility to disease. The clutch size and incubation times for commonly maintained gallinaceous birds are listed in Table 45.4. Parameters for artificial incubation are listed in Table 45.5.

General Considerations

Gallinaceous birds to be used for breeding purposes should be introduced to each other before the breeding season in surroundings that are novel to all the candidates concerned. The female should be introduced to the enclosure a few hours prior to the male. In some species, it is possible to keep several males together if there are no females present. If females are present, only one male should be housed in an aviary or in one compartment. In monogamous species, only a single pair should be housed together.

Males of some species are very aggressive, and during the breeding season may attack other males, other bird species or even the keeper. Pursuit by the male and mock escape by the female is normal behavior in some species like eared pheasants and francolins. If there is insufficient space for the hen to escape, she may be injured or killed by the cock. Debeaking or restricting the flight capabilities of the male can prevent injuries to the hen, but are inferior

TABLE 45.4 Clutch Sizes and Incubation Times of Gallinaceous Birds[28]

	Species	Clutch Sizes	Incubation Time (days)
Megapodiidae			
	Alectura lathami	25-30	46-54
Cracidae			
	Ortalis spp.	3	26-28
	Penelope spp.	2-3	27-29
	Aburria spp.	2-3	unknown
	Chamaepetes spp.	unknown	unknown
	Penelopina sp.	2	unknown
	Oreophasis sp.	2	unknown
	Nothocrax sp.	2	28
	Mitu spp.	2	29-30
	Pauxi spp.	2	30
	Crax spp.	2	29
Phasianidae			
Numidinae	*Guttera* spp.	8-10	unknown
	Numida spp.	8-12	27
	Acryllium sp.	10-14	23-24
	Agelastes spp.	12	unknown
Pavoninae	*Afropavo* sp.	3-4	26-27
	Pavo spp.	3-5	28-30
Meleagridinae	*Meleagris* spp.	8-15	28
Argusianinae	*Polyplectron* spp.	2	18-23
	Rheinardia sp.	2	25
	Argus sp.	2	24-25
Phasianinae	*Chrysolophus* spp.	5-12	22-23
	Phasianus sp.	8-12	22-24
	Graphephasianus sp.	6-12	24
	Syrmaticus sp.	7-15	24-25
	Calophasis spp.	6-8	25-28
	Lophura spp.	5-15	22-25
	Crossoptilon spp.	4-14	24-28
	Catreus sp.	9-14	26
Lophophorinae	*Lophophorus* spp.	4-5	27
Pucrasiinae	*Pucrasia* sp.	5-7	20-21
Ithagininae	*Ithaginis* sp.	5-12	27
Gallinae	*Gallus* spp.	5-8	19-21
Tragopaninae	*Tragopan* spp.	4-10	28-31
Galloperdicinae	*Galloperdix* spp.	2-5	23
Ptilopachinae	*Ptilopachus* sp.	4-6	unknown

	Species	Clutch Sizes	Incubation Time (days)
Phasianidae			
Perdicinae	*Lerwa* spp.	5-7	unknown
	Tetraogallus spp.	5-8	28
	Tetraophasis spp.	4	unknown
	Tropicoperdix spp.	unknown	unknown
	Arborophila spp.	3-5	20-21
	Perdix spp.	8-20	24-25
	Alectoris spp.	8-14	24-26
	Bambusicola spp.	4-6	18-20
	Francolinus spp.	4-8	19-21
	Pternistis spp.	3-9	18-20
	Scleroptila spp.	3-6	22
	Dendroperdix spp.	4-9	19
	Peliperdix spp.	2-6	unknown
	Ortygornis sp.	4-8	18-19
	Perdicula spp.	4-8	22
	Cryptoplectron spp.	4-7	16-18
	Ammoperdix spp.	8-14	22-24
	Synoicus sp.	4-12	20-22
	Coturnix spp.	7-14	16-20
	Margaroperdix sp.	5	unknown
	Caloperdix sp.	8-10	18-20
	Melanoperdix sp.	5	unknown
	Rollulus sp.	4	18-20
	Haematortyx sp.	8-9	unknown
	Rhizothera sp.	5	unknown
Odontophorinae	*Colinus* spp.	7-28	22-23
	Callipepla spp.	9-17	22-23
	Oreortyx sp.	6-15	24-25
	Philortyx sp.	8-12	22-23
	Dendrortyx spp.	4-7	28-30
	Odontophorus spp.	4-5	26-27
	Dactylortyx sp.	5	unknown
	Cyrtonyx spp.	6-16	24-25
Tetraoninae	*Tympanuchus* spp.	5-17	24-25
	Bonasa sp.	11	24
	Tetrastes spp.	7-11	23-25
	Centrocercus sp.	7-13	25-27
	Dendragapus sp.	7-10	24-25
	Falcipennis spp.	4-10	21-22
	Lagopus spp.	6-9	20-23
	Lyrurus spp.	7-10	26-27
	Tetrao spp.	5-12	26

TABLE 45.5 Parameters for Artificial Incubation of Some Gallinaceous Birds[26,28]

	Incubation Chamber		Hatching Chamber	
Species	**Temp. (°C)**	**Humidity (%)**	**Temp. (°C)**	**Humidity (%)**
Common Pheasant	37.5	60	37.0	85
California Quail	38.5-39	50-60	-	80
Common Capercaillie	37.5	60-70	36.5-37	80-90
Black Grouse	37.4	55-60	-	85-90
Ruffed Grouse	37.5	60-65	-	70-75
Chukar Partridge	37.5	65	37.0	85

procedures to providing adequate space for a pair of birds to behave normally. Densely planted aviaries that provide a hen with areas to hide may still have inherent problems. Fiberglass panels leaned against the wall or concrete tubes provide similar protection and are easy to clean.[28]

For species in which there are substantial differences in body size between the genders, aviaries can be designed to allow the hens to visit the cock when she wishes. Small holes, just big enough for the hen, are used to connect adjacent enclosures. This allows the hen to enter the cock's enclosure, while preventing the cock from entering the hen's area. This is an effective method for breeding birds like the Common Capercaillie.[5] In some species, the hen chooses the most attractive of several cocks and if only one cock is available, breeding may not occur if the hen does not like the cock. In some species, the visual or acoustic presence of other males is necessary to stimulate display and mating behavior.

Most gallinaceous birds incubate eggs on the ground and should be provided with flat trays containing moss, foliage or hay for nesting material. Tragopans, the Congo Peafowl, the Bronze-tailed Peacock Pheasant, the Crested Argus Pheasant, the Mikado Pheasant, the Salvadori's Pheasant and the cracids nest in trees. A box placed approximately 150 cm from the ground and filled with hay and foliage can be used as an artificial nest. A slanted limb should be provided for easy access to the nest. Nests of ground- and tree-nesting birds should be inconspicuous to provide the pair with visual security but should be placed such that the birds can easily look out.[28]

Most gallinaceous birds are nondeterminant layers, and if the first clutch of eggs is removed, the hen will lay a second and sometimes a third clutch. Hatching is genetically determined and should not be assisted. Because gallinaceous chicks are nidifuguous, the family can stay together only if all the chicks hatch at the same time. Synchronization of the hatch dates can occur by two mechanisms: 1) The hen does not incubate the clutch until the last egg has been laid, allowing the eggs to cool (which slows the process of embryogenesis); or 2) The chicks in a clutch synchronize hatching through audible signals. This latter process occurs in species like the Japanese Quail. When sounds are heard from other eggs, the chicks increase the speed of hatching. When no sounds are heard from other eggs, the most developed chicks reduce their speed of hatching. Most gallinaceous chicks are independent by three months of age. The exception is the megapode chick, which is independent immediately after hatching.[28]

Foster Breeding

The hens of some gallinaceous birds are unreliable brooders in captivity. Cracid, Common Pheasant and nearly all species of New World quail hens are unamenable brooders in captivity.[28] These hens can be encouraged to produce two or three clutches per year instead of one by using foster parents or an incubator for hatching eggs. Chinese Silk Fowl and Bantams make excellent foster parents. Domestic turkey hens can be used to incubate the eggs of larger gallinaceous birds. Small and fragile eggs should be placed under Golden Pheasant hens, which are cautious brooders and excellent care-providers. During the last week of incubation, the eggs of tropical birds being raised in dry climates should be moistened with a clean mister once a day. After hatching, the hen and chicks can be placed in a small enclosure that is movable, and can be placed on fresh grassy areas on a daily basis. Chicks are prone to chilling the first few days post-hatching and must have supplemental body heat from the attending hen.[28]

The disadvantages of foster parenting are:

- crushing of small fragile eggs by heavy or clumsy adults;
- premature cessation of brooding if the natural incubation period of the foster hen is shorter than the fostered eggs;
- trauma or death of the chicks if the hen recognizes them to be strange (this is a particular problem when behavioral incompatibilities exist between the hen and chicks);

- transmission of infectious agents between hen and chicks.

Infanticide and disease transmission can be reduced by placing the eggs in an incubator for the last third of the incubation period (this method is often used for grouse). Generally, chicks that are to be released into the wild should be reared by a hen of the same species.[5,17]

For many pheasants, the percentage of carbon dioxide in the incubator must be increased up to approximately 1%, verified with a gas detector, during the last two days of incubation. This is achieved by reducing the intake of fresh air. Chicks should be taken out of the incubator immediately after hatching.

Specific Reproductive Characteristics

Megapodes

Megapode eggs differ from those of other gallinaceous birds, owing to the uncommon brooding biology of these birds. The eggs are not incubated by the parents but by solar heat, fermentation heat or geothermal energy. One egg can reach a size of up to 17% of the hen's body mass. The eggs are thin-shelled and contain a large yolk that is rich in lipids. Cocks or both sexes begin constructing an induction mound out of foliage and earth when the air temperature and atmospheric humidity reach a certain level. The hens lay their eggs every two to three days in previously prepared holes, which are quickly covered after oviposition. Eggs are deposited in a mound with the pointed pole downwards, and they are not turned during incubation. They do not have a fixed air chamber or chalaza.

The birds may determine the temperature of the mound, and perhaps other parameters, with the bill or tongue. The mean temperature in the incubation mound is around 34°C. The incubation mound is cooled when needed by scratching holes. This allows carbon dioxide to escape and oxygen to enter. The incubation period varies from 45 to 90 days, depending on the temperature in the mound. Brush Turkey chicks leave the mound 24 to 30 hours after hatching.[28] Normally, megapode chicks do not come into contact with their parents, who function only to care for the incubation mound. The chicks join their brothers and sisters who have hatched at around the same time. Megapodes are sexually mature by one year of age.[28]

The Australian Brush Turkey is easy to maintain and breed in captivity, and is the most common captive representative of the megapodes. This species is monogamous. In one breeding season, an Australian Brush Turkey hen lays about 25 to 30 eggs.

Cracids

Cracids are Central and South American species that are considered monogamous. The breeding season lasts from March until July. Most nests are well hidden in a fork or branch of a tree, but some species are ground-nesters. Only the hen incubates the eggs. A clutch consists of two to three eggs, which are rough-shelled with wide pores and a uniform white color. Newly hatched chicks are immediately able to climb trees. The family stays together until the next breeding season. Sexual maturity occurs by two years of age.[28]

Turkeys

The Common Turkey is polygamous. Behavior of free-ranging birds is dramatically different from that of domesticated breeds. The brain volume of domesticated turkeys is 35% smaller than that of their wild-type conspecifics. The nest is formed of a flat depression in the soil and may be padded with leaves, grass or twigs. The chicks are able to fly at two weeks of age. Several hens, together with their offspring, typically associate in a flock in winter. The young birds leave their mother before the next breeding season. Young turkeys of both species are sexually mature at two years of age.[28]

New World Quail

New World quail are monogamous. Both parents participate in building the nest and brooding the chicks. Young birds are sexually mature by one year of age, in some species even earlier. Outside the breeding season, the gregarious New World quail live together in large family groups (coveys). At the beginning of the breeding season, the older cocks become very aggressive toward young cocks. Captive Bobwhite Quail have become polygamous and it is possible to keep one cock with two hens, indicating the effects of domestication.[18,28]

Grouse

Some grouse species like ptarmigan, Ruffed Grouse, Hazelhen, Spruce Grouse and Blue Grouse are monogamous. In these species, cocks should not be allowed to see or hear other cocks. Hazelhen males may attack the female if a rival can be heard but not seen. Other grouse species are polygamous. In these species, the hen chooses one cock from a group of display-

ing males. One cock may be chosen to mate with several hens. Hens in captivity breed best when allowed to choose between two or more cocks. The cocks, which are housed in different compartments of an aviary, may see and hear each other if there are enough hiding places for the hens. In most grouse only the hen provides chick care. The chicks of different species can be distinguished by the varying color patterns on the head and back plumage. Most grouse are sexually mature at one year of age. Crossbreeding between different genera and species occurs in free-ranging birds. Similarities in the appearance and display behavior of hens seem to induce cocks to crossbreed. Hens will choose cocks of another species if a representative of their own species is not available.[5,17,28]

Peafowl

The Congo Peafowl is monogamous. The nest is always built in a tree. Both parents care for the chicks. The Indian and the Green Peafowl are polygamous. In captivity, it is possible to keep one cock with four to five hens. The hens care for the clutch and the chicks, which mature slowly. Hens reach sexual maturity in the second year and cocks in the third year of life. The Green Peafowl is more aggressive than the Indian Peafowl, but has a more pleasant call.[28]

Pheasant

Most pheasant species are polygamous. One Common Pheasant cock can be kept with five to six hens. The hens make poor care-providers in captivity. They tend to be indiscriminant in the placement of eggs and will not incubate the eggs. Young Common Pheasants are sexually mature at one year of age. Free-ranging Golden Pheasants are monogamous, but in captivity one cock can be kept with three to four hens. The hens are exceptional care-providers and de-

TABLE 45.6 Gender Determination of Selected Species of Gallinaceous Birds Without Marked Sexual Dimorphism[28]

Genus	Plumage Identical	Plumage Similar	Differences
Megapodiidae:			
Alectura	*		Cocks have neck appendages
Cracidae:			
Ortalis	*		Voice of cock is deeper
Penelope	*		In some species iris colors differ
Nothocrax	*		In cocks the tracheal loop is palpable
Pauxi	*		In hens, plumage is sometimes a red phase
Phasianidae:			
Numidinae:			
(all genera)	*		Cock's call has 3 syllables; hen's call has 2 syllables
Argusianinae:			
Polyplectron		*	Hen's plumage is dull; cocks have spurs
Phasianinae:			
Crossoptilon	*		In general, cocks have spurs
Catreus		*	Cocks have long, sharp spurs
Ptilopachinae:			
Ptilopachus		*	
Perdicinae:			
Tetraogallus	*	**	In some species, cocks have short spurs.
Arborophila	*	**	In some species, cocks have short spurs.
Bambusicola	*	**	
Frankolinus	*		
Pternistis	*		In some species, cocks have spurs.
Scleroptila	*		Cocks have spurs.
Ortygornis	*		Cocks have spurs.
Coturnix		*	
Odontophorinae:			
Odontophorus	*	**	
Tetraoninae:			
Tympanuchus		*	
Bonasa		*	
Tetrastes		*	
Lagopus	*		(only in winter)

** Some species of the genus are identically colored and some are similar.

fend their chicks. Young Golden Pheasant hens are sexually mature within one year, cocks within two years. Lady Amherst's Pheasant cocks and hens can be aggressive during the breeding season. Only a few of the birds found in captivity are purebred. Both male and female argus pheasants, peacock pheasants and the Copper Pheasant establish and defend their own territories. Males should be introduced to females only for a short time during the breeding season to prevent aggressive behavior and traumatic injuries from both genders.[28]

Junglefowl and Domestic Fowl

Junglefowl can be either monogamous or polygamous. The hens can breed year-round, but the main breeding season is from February to May in the northern hemisphere. A Red Junglefowl cock can be maintained with three to four hens. The young birds are independent at an age of four months, and sexually mature after the first year. Many domestic fowl breeds have lost their brooding behavior, and eggs must be artificially incubated.[28]

Gender Determination

Many gallinaceous birds show a marked sexual dimorphism. The size (height and width), the body mass (weight), the color of the plumage, the shape of certain feathers, the presence of spurs and the length and color of the tail feathers assist in gender determination between adults of some species (Table 45.6). In some breeds of domestic fowl, fertile cocks may have plumage that resembles that of hens.

CLINICAL APPLICATIONS

In rare and endangered species, the production of offspring by artificial insemination might be useful in several situations:

- The semen of one cock can be used to inseminate numerous hens; however, spread of genetic defects is increased, while the genetic diversity is decreased.
- In many species, the captive production of offspring is still difficult. Cocks may not mate with the hen, or if they do, insemination may not occur. (As an example, Brown-eared Pheasants will rarely produce fertile eggs in captivity. It has been assumed that the cocks were not producing fertile semen. Artificial insemination has proven that the semen is usually fertile, suggesting that breeding problems are primarily behavioral.)[40]
- Different aviculturists can exchange semen from their cocks; however, this procedure can result in the spread of venereal diseases, like leukosis.
- Semen can be used from cocks that are genetically and organically healthy but have been handicapped by an injury and are no longer able to mate.

Gender can be determined by highly skilled individuals by examining the cloaca in one-day-old chicks or adults. The cloacal examination in newly hatched chicks of small bird species must be done carefully (see Chapter 46). Holding a chick too tightly can cause asphyxiation. Restraint of a chick for gender determination should start by gently pressing on the abdomen from both sides distal to the keel bone to stimulate defecation. The procedure is then similar to that described for Anseriformes (see Chapter 46).

Behavioral clues like dominance and certain mating rituals may suggest a gender, but are not always indicative. Under certain conditions the hens of some gallinaceous birds behave like, and can have plumage like, the males.[19] Only endoscopic examination of the gonads provides definitive determination of gender in species with similar morphologic characteristics (see Chapter 13).

Artificial Insemination

Artificial insemination is of economic importance in the domestic turkey and domestic guineafowl. Domestic turkey cocks, like domestic fowl cocks, are fertile year-round, except during periods of extreme heat or during the molt period. Domestic guineafowl cocks are not fertile all year, and artificial insemination is used to induce year-round production.

The semen is collected by massaging the caudal region of the back or the abdomen, followed by stimulation of the cloaca. Fecal contamination of the semen may occur. It is best to collect the semen directly from the spermatic duct with a syringe and a blunted hypodermic needle. The semen may be diluted with Ringer's or Tyrode's solutions by up to a factor of three.

Avian semen has a short half-life and must be used as quickly as possible. The semen is introduced with a syringe and a blunted hypodermic needle into the hen's oviduct. It is best to inseminate the hen just after she has laid an egg. This ensures that the oviduct is open, providing the semen with unrestricted access to the infundibulum.[14,39]

TABLE 45.7 Checklist of Infectious Diseases in Gallinaceous Birds

Viruses (see Chapter 32)

Poxviridae
- Avian pox

Herpesviridae
- Infectious laryngotracheitis
- Marek's disease

Adenoviridae
- Quail bronchitis
- Inclusion body hepatitis
- Egg drop syndrome = (infectious salpingitis)
- Marble spleen disease
- Hemorrhagic enteritis of turkeys
- Chicken splenomegaly
- Adenovirus infection of the Blue Grouse

Parvoviridae
- Parvovirus infection of chickens
- Parvovirus-like infection of turkeys

Circodnaviridae
- Infectious anemia

Reoviridae
- Viral arthritis
- Other reovirus infections
- Rotavirus infections

Birnaviridae
- Infectious bursal disease

Togaviridae
- Eastern and western encephalitis
- Avian serositis
- Louping-ill
- Israel turkey meningoencephalitis

Coronaviridae
- Coronaviral enteritis of turkeys (bluecomb disease)
- Infectious bronchitis

Rhabdoviridae
- Rabies

Paramyxoviridae
- Newcastle disease
- PMV-2-infection (Yucaipa)
- PMV-3-infection (Wisconsin)
- Turkey rhinotracheitis
- Swollen head syndrome

Orthomyxoviridae
- Avian influenza, fowl plague

Retroviridae
- Leukosis
- Reticuloendotheliosis
- Lymphoproliferative disease of turkeys

Picornaviridae
- Avian encephalomyelitis
- Turkey viral hepatitis
- Infectious nephritis

Bacteria (see Chapter 33)

Staphylococcus spp.
- Staphylococcosis

Streptococcus spp.
- Streptococcosis

Mycobacterium avium
- Tuberculosis

Erysipelothrix rusiopathiae
- Erysipelas

Listeria monocytogenes
- Listeriosis

Clostridium spp.
- Ulcerative and necrotic enteritis (*Cl. colinum* and *Cl. perfringens*)
- Botulism (toxin of *Cl. botulinum*)

Escherichia coli
- Colibacillosis
- Coligranulomatosis

Salmonella spp.
- Salmonellosis

Klebsiella spp.
- Klebsiella infection

Yersinia pseudotuberculosis
- Pseudotuberculosis

Pseudomonas spp.
- Pseudomonas infection

Aeromonas hydrophila
- Aeromonas infection

Bordetella avium
- Bordetellosis (turkey coryza)

Campylobacter spp.
- Avian hepatitis

Borrelia anserina
- Spirochetosis

Treponema spp.
- Infectious typhlitis in chickens

Pasteurella spp.
- Fowl cholera

Actinobacillus salpingitidis
- Actinobacillosis

Haemophilus spp.
- Haemophilus infection

Francisella tularensis
- Tularemia

Mycoplasma (see Chapter 38)

Mycoplasma spp.

Ureaplasma sp.

Chlamydia (see Chapter 34)

Chlamydia psittaci
- Chlamydiosis

Rickettsia (see Chapter 38)

Coxiella burnetii
- Query (Q) fever

Aegyptianella pullorum
- Aegyptianellosis

Mycoses (see Chapter 35)

Aspergillus spp.
- Aspergillosis

Candida albicans
- Candidiasis

Dactylaria gallopavo
- Dactylariosis

Trichophyton spp.
- Favus

Mycotoxicoses (see Chapter 37)

Toxins of *Aspergillus* spp., *Penicillium* spp., *Fusarium* spp. and others

Parasites (see Chapter 36)

Protozoal Parasites:
- *Trypanosoma avium*
- *Spironucleus meleagridis*
- *Histomonas meleagridis* (blackhead disease)
- *Trichomonas* spp.
- *Chilomastix gallinarum*
- *Entamoeba* spp.
- *Endolimax* spp.
- *Eimeria* spp.
- *Toxoplasma gondii*
- *Sarcocystis* spp.
- *Cryptosporidium* spp.
- *Haemoproteus* spp.
- *Leucocytozoon* spp.
- *Plasmodium* spp.

Metazoal Parasites

Trematodes
- *Prosthogonimus* sp.

Cestodes
- *Davainea proglottina*
- *Raillietina* spp.
- *Amoebotaenia cuneata*
- *Choanotaenia infundibulum*
- *Hymenolepis* spp.
- *Metroliasthes lucida*
- *Fimbriaria fasciolaris*

Nematodes (in digestive tract)
- *Capillaria* spp.
- *Trichostrongylus tenuis*
- *Heterakis* spp.
- *Ascaridia* spp.
- *Gangylonema ingluvicola*
- *Cheilospirura* spp.
- *Dispharynx nasuta*
- *Tetrameres* spp.
- *Subulura* spp.

Nematodes (in respiratory tract)
- *Syngamus trachea*

Nematodes (in the eye)
- *Oxyspirura* spp.

Nematodes (in other locations)
- *Aproctella stoddardi*
- *Singhfilaria hayesi*

Acanthocephalans
- *Mediorhynchus papillosus*

Arthropods
- External parasites like lice, fleas, flies, mosquitoes, midges, and ticks occur in most gallinaceous birds. Mites occur above all in intensively reared gallinaceous birds, predacious bugs in some gallinaceous birds.

Restraint

Cocks with spurs can injure handlers, especially when they become increasingly aggressive during the mating season. The beak can also serve as a weapon. Although serious injuries are rare, the face and the eyes of handlers should always be protected from a bird's beak, even in small species. The legs of a gallinaceous bird should be the initial focus for restraint.

Catching gallinaceous birds in an aviary can be done gently with a hooked, long stick. The birds should never be restrained by the feathers alone. The whole body must be secured to prevent a shock molt. Shock molt is most common in tail feathers, but other feathers can be involved. Birds can be nearly "bald" after several failed restraint attempts. In larger species, the base of the wing is fixed with one hand and the legs are controlled with the other hand (see Chapter 44). The abdomen should be supported from below. If assistance is not available, a large bird can be restrained by placing it under one arm and pressing it gently against one's body.[11] Birds can usually be calmed by placing a loose-fitting, lightweight cotton sock over the head to reduce vision.

Disease Considerations[3,8,14,39]

Gallinaceous birds are susceptible to a wide variety of viral, bacterial, mycoplasmal, parasitic, chlamydial, rickettsial and fungal agents (Table 45.7). Information on these diseases may be found in the appropriate chapters.

Nutritional Diseases

Vitamin C deficiency does not occur in most birds; however, it has been reported in Willow Ptarmigan chicks, and may occur in other grouse chicks.[16] Though the chicks are able to produce endogenous vitamin C (as all gallinaceous birds probably can), the internal production is not sufficient in the first weeks of life, and has to be augmented by the intake of vitamin C from natural food plants (eg, blueberries). Clinical signs of vitamin C deficiency are abnormal behavior, enteritis, ruffled plumage, weakness of the wings and legs, bone fractures, retarded growth and death before the age of four weeks. Characteristic necropsy findings include weight loss, pale and edematous skeletal muscles, petechial hemorrhage in the muscles and mild subcutaneous edema. Fractures in the diaphysis of the humerus, radius, ulna, femur and tibiotarsus with massive callus formation and lateral twisting of the tibia may also occur. Feeding the chicks natural food stuffs will prevent vitamin C deficiency.

Integument Concerns

Amputation of the comb or the wattles may be indicated following extensive injury, infection or frostbite. Adequate hemostasis is necessary to prevent fatal hemorrhage. Occasional trimming of the keratinous tip of the bill is necessary if the horny layer grows too fast, or is insufficient abrasive materials are available to facilitate normal wear. The excessive horn is pared off prudently with a sharp knife without cutting into the viable parts of the bill.

Cannibalism may occur in some Galliformes and is characterized by vent-picking, feather-pulling, toe-picking, head-picking and egg-eating. Overcrowding, incorrect feeding, an inappropriate daylight cycle, poor housing conditions (eg, high proportion of toxic gases in the air), genetic predisposition and other factors may all promote cannibalism.

Amputating the comb and wattles and "debeaking" have been used to control cannibalism; however, these control methods should be viewed as cruel and unacceptable procedures. These procedures are painful, cause permanent loss of tissue, may heal improperly or become infected and cause a change in social ranking. The bill is not only important for the uptake of food, but also has sensory functions, and is necessary for preening. Damage to the beak should be considered a substantial handicap. In most cases, cannibalism can be successfully prevented by correcting deficiencies in the birds' environment; however, once feather picking is initiated, some birds never stop. In these cases, affected birds should be separated from the remainder of the flock.

Trimming of the flight feathers in one wing can be used to prevent birds from escaping from open aviaries, or to reduce the mobility of an aggressive cock during the breeding period. Usually all but the outermost two primaries and the innermost three secon-

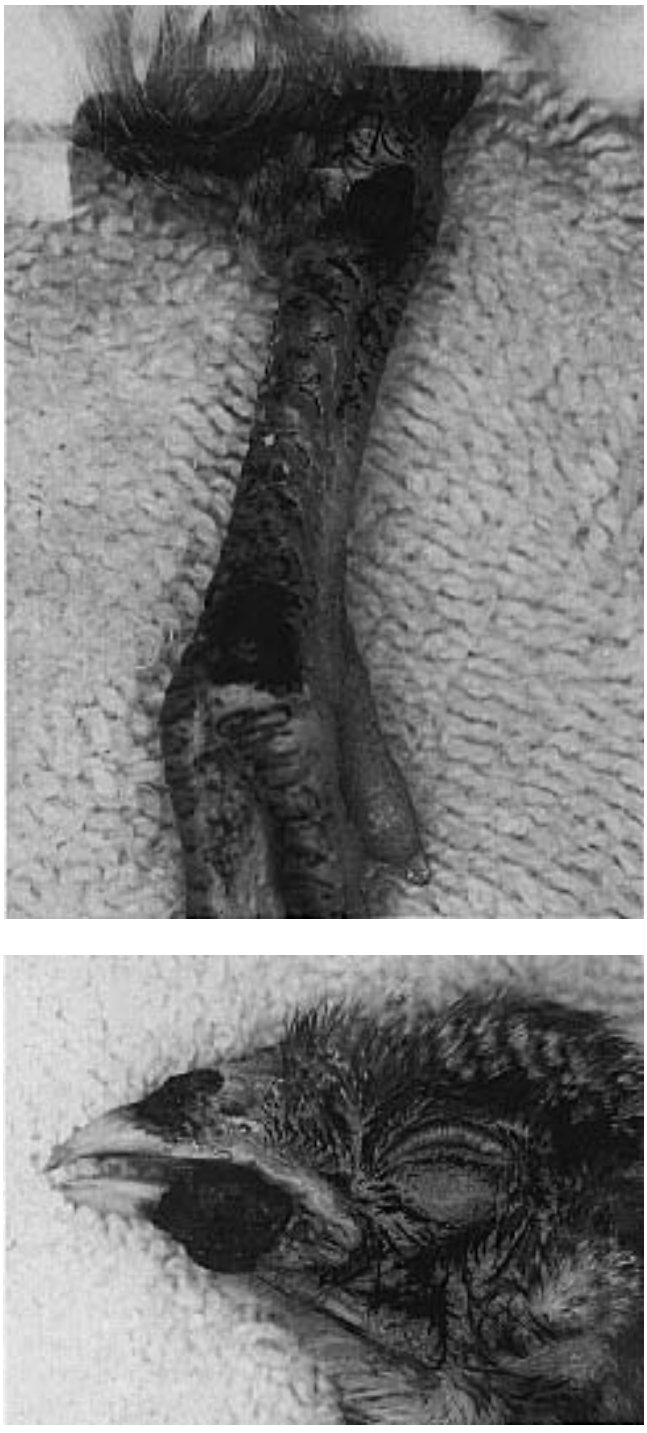


FIG 45.3 Poxvirus lesions on the legs and beak of a gallinaceous bird. The client had placed black shoe polish on the lesions, which is a commonly discussed lay treatment of poxvirus. The shoe polish will delay healing and may cause secondary infections.

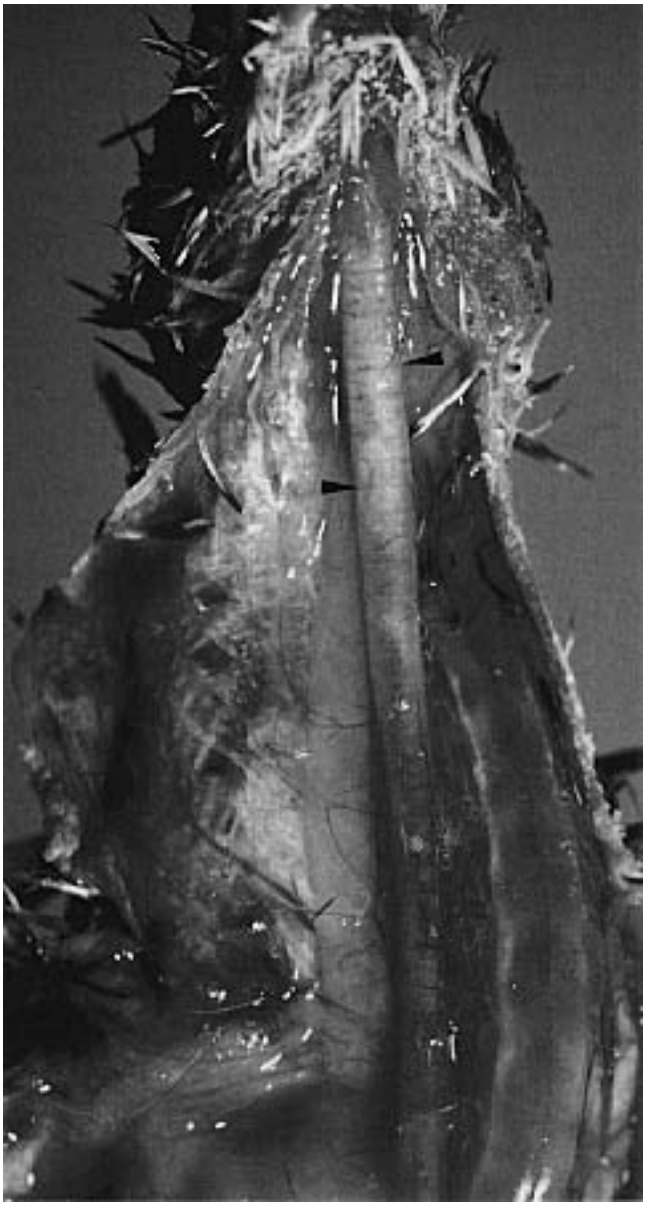


FIG 45.4 Necrotic tracheitis in gallinaceous birds is frequently caused by laryngotracheitis virus. Infected birds may develop sneezing and coughing and have audible tracheal rales. Gross necropsy findings frequently include diphtheritic tracheitis with the accumulation of necrotic debris (arrows) that may cause asphyxiation (courtesy of SW Jack).

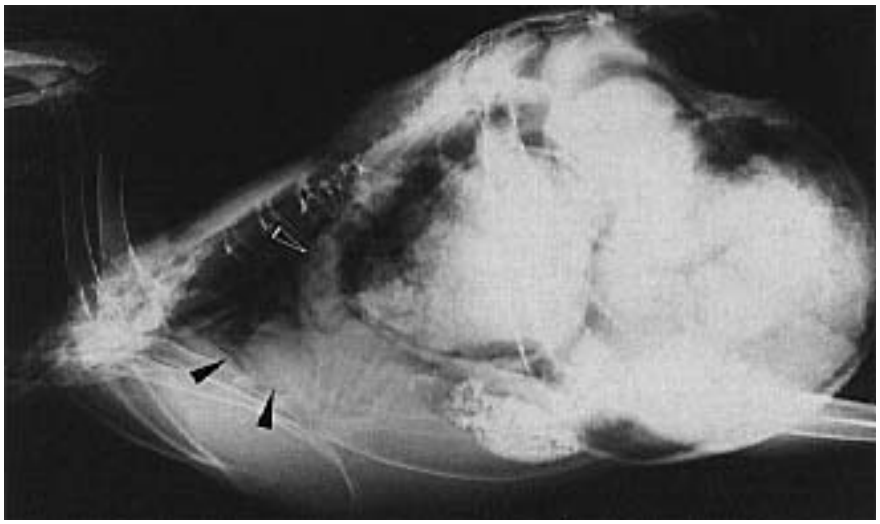
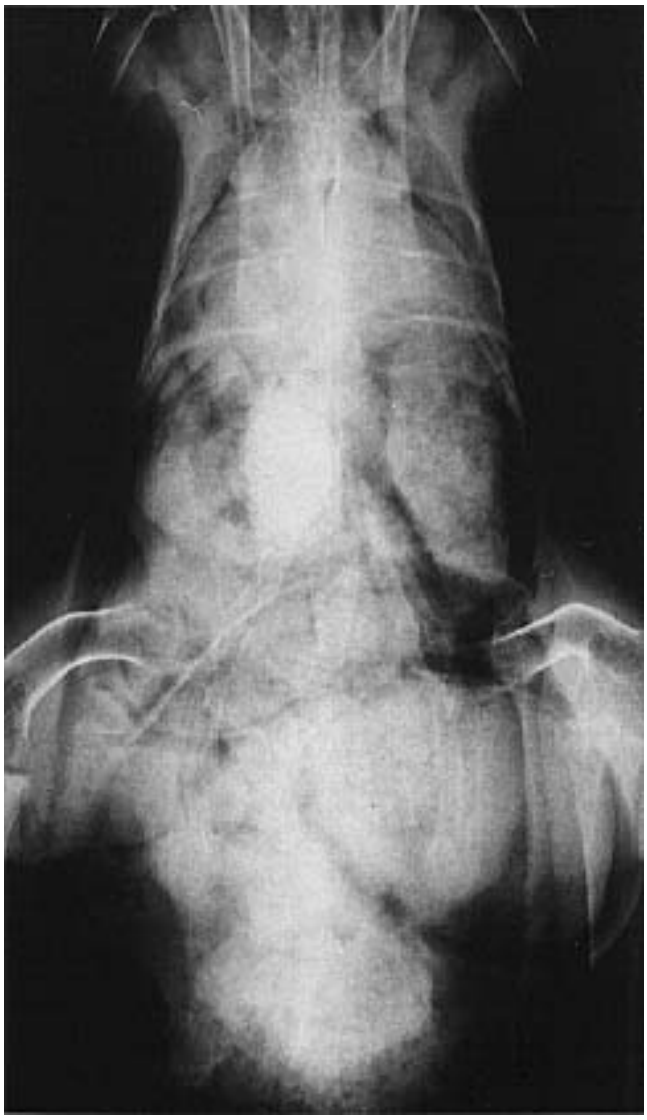


FIG 45.5 An adult Brown-eared Pheasant hen was presented for severe dyspnea and anorexia, which had initially been noted two days earlier when the hen produced a soft-shelled egg. Radiographs indicated gastrointestinal impaction with cranial displacement of the heart (arrows) and intestinal tract (open arrow). At necropsy, fibrous exudate and ingesta were covering the abdominal viscera. The ceca were impacted and had thickened walls. Histopathology indicated *E. coli* peritonitis with severe *Heterakis* sp. typhlitis.



daries are transected, creating an effective and cosmetic wing trim (see Chapter 1). With one wing trimmed, the bird is unbalanced and cannot gain speed during flight. Because the feathers will be replaced during the next molt, trimming must be repeated annually in adults. Under certain circumstances, it may be necessary to trim both wings. Other methods, like pinioning or cutting the short tendon of the extensor carpi radialis, make birds permanently unable to fly. The client should be made aware of the consequences of these procedures.

Heterakis sp.

Heterakis isolonche infections have been described in a number of free-ranging and captive Galliformes. This parasite causes typhlitis with clinical signs of infection including diarrhea, weight loss and depression. Mortality rates in captive pheasants may reach 50%. The parasite invades the wall of the cecum and causes lymphocytic infiltration and granuloma formation. In pheasants, the nodules merge, leading to substantial thickening of the cecal wall. The ceca may dilate and increase in size (volume) by up to ten times (Figure 45.5).

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