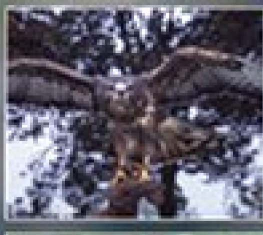
Essentials of

Avian Medicine & Surgery

Third Edition



Brian Coles

With Contributions from
Maria Krautwald-Junghanns
Susan E.Orosz
Thomas N.Tully

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Contents

Preface

This *Essentials of Avian Medicine and Surgery* is the third edition of the work originally published as *Avian Medicine and Surgery* more than twenty years ago. Since that time the subject has expanded beyond what was then envisaged. Many large, superbly illustrated multi-author volumes on the subject have been published. However it was felt that there was still a need for a small book that would enable the busy practitioner to have a quick reference or for the student just starting out to get a basic understanding of the subject.

The use of molecular biology in diagnostics and the variety of imaging techniques have advanced considerably, even since the second edition was produced. Because of the need for up-to-date information on this aspect, Professor Maria Krautwald-Junghanns kindly agreed to update the chapters on Aids to Diagnosis and Post-Mortem Examination.

Therapeutics is an important part of clinical practice, and so one of the forerunners in this field, Professor Tom Tully, generously agreed to look at and update the 'Avian Formulary'.

A third expert in her field, Dr Susan Orosz, very kindly agreed to write a chapter on The Special Senses of Birds. The original author requested this because it was felt that although the veterinarian has always considered animal welfare to be of primary importance, there is now an increasing interest on the part of the general public and an increase in well-intentioned but sometimes ill-informed *focus groups* looking into this matter. It is therefore imperative that the veterinarian should have the most up-to-date objective, scientific and unemotional information on the subject when advising their clients and the decision makers.

With the recent emergence of the importance of the viruses of avian flu and of West Nile virus, together with the general public's desire to visit 'exotic' habitats around the globe and to come in contact with unfamiliar habitats together with the indigenous animals, avian zoonotic diseases have been highlighted in the sections on infectious diseases.

I am very grateful to all those colleagues who have discussed their cases with me and contributed to my knowledge and to those friends who have given permission to use their photographs. I am indebted to my colleague Peter McElroy for bringing to my notice the long ago (1917) published work of Dr Casey Woods. I am grateful to veterinary nurse Cathy Smith for her observations on the chapter on nursing, to Adam Burbage and others at Blackwell Publishing for their help and patience. Also my thanks go to my copy editor, Judith Glushanok, for her many helpful suggestions.

My thanks goes to Ms Anne Meller who provided the main cover photograph of an Atlantic Puffin. This photograph has important conservation implications for this species. The quality of the fish held in the beak is of poor nutritive value. The sand eels are small and low in fat, moreover the pipe fish has a tough indigestible skin. A species reduced to feeding its young on such items is threatened with the combined effects of commercial over fishing and climate change.

Again my grateful thanks to the co-authors, all of whom are very busy clinicians, for their contributions, which have helped to make this third edition more comprehensive. Lastly grateful thanks to my colleague Nicola Miller for agreeing to proofread the finished book and to my ever patient and always forbearing wife, Daphne.

Brian H. Coles
2006

Diversity in Anatomy and Physiology: Clinical Significance

1

There are approximately 8900 species of living birds compared with only about 4200 species of mammals. In this chapter it is not possible to consider all aspects of anatomy and physiology. Only those variations in the more clinically important parts of avian anatomy and physiology will be considered, because knowledge of these is important when carrying out surgery and autopsies or interpreting radiographs.

To the casual observer there are many obvious differences in size, ranging from the hummingbird to the ostrich (*Struthio camelus*), in the varying forms of the bill and in the colour and profusion of the plumage occurring in different species of birds. However beneath this great variety of body form there is a greater degree of uniformity in the basic anatomy and some aspects of the physiology of the class Aves than there is in many single orders of other types of vertebrate. Even in the case of the large flightless birds, all present-day living birds have originally evolved from a flying ancestor and the capacity to be able to become airborne imposed quite severe restrictions on the basic anatomy and some aspects of the physiology which have been retained by their descendants. It is because of their ability to fly that birds have been able quickly (i.e. in evolutionary time) to reach and exploit a wide variety of habitats. This, in turn, resulted in the evolution of many different anatomical forms, all with the same overall basic pattern.

The field observations of Charles Darwin on the variations in body size and bill shape which adapted the bird to different habitats and sources of food, exhibited by otherwise apparently closely related finches in the Galapagos Islands, helped him formulate his theory of the origin of species. However Darwin was primarily concerned with the process of divergent evolution, while we now know that convergent evolution also takes place. Apparent externally recognised similarities are not always an infallible guide. For instance the martins, swallows and swifts all look quite similar and all behave similarly and occupy similar habitats. However while martins and swallows are taxonomically placed in the order Passeriformes, or perching birds, the swifts are more closely related to the hummingbirds, both being placed in the superorder Apodimorphae. Unlike most other birds, the skeleton is not well pneumonised in Apodimorphae, a condition only seen in the egg-laying female of other species. The Victorian biologists were great anatomists and much of today's taxonomy is based on their observations, such as those of T.H. Huxley (1867). Consequently we know quite a lot about the detailed anatomical variations between species. We still do not know a lot about the physiological differences.

Some Victorian-based taxonomy has been and is being overturned by present-day laboratory investigation using DNA analytical techniques (Sibley & Ahlquist, 1990). New World vultures, for example, are now considered to be more closely related to the storks than to the Old World vultures. Most of our knowledge of physiology has been derived from experimental work on domestic poultry (ducks and chickens) and particularly on the domestic fowl that originated from the red jungle fowl (*Gallus gallus*). This particular species is not really typical of birds as a whole.

Since the underlying skeleton of the bird largely influences the external appearance and anatomy, these two topics will be considered together.

THE SKELETAL SYSTEM AND EXTERNAL ANATOMY

When carrying out radiography or any imaging diagnostic technique, it is important to know what is normal for a particular species so that an inaccurate diagnosis is not made.

The skull

In all birds the cranial part of the skull is remarkably uniform. However that part of the skull associated with the mouthparts, as might be expected, does show considerable variation. In fact one aid in classifying birds used by the Victorian anatomists was to use the relative size and presence or absence of the vomer, the pterygoids and the palatine bones.

In hornbills (Bucerotidae) and cassowaries (Casuariidae) the frontal and nasal bones contribute to the horn-covered casque. In the cassowary this is used to push the bird's way through the thick undergrowth of tropical rainforest. In most hornbills the casque is very light and cellular in texture but in the helmeted hornbill (*Rhinoplax vigil*) it is solid and ivory like.

The many different types of articulation of the maxilla, premaxilla and mandible with the skull are illustrated in Figures 1.1(a) and 1.1(b). When considering the surgical repair

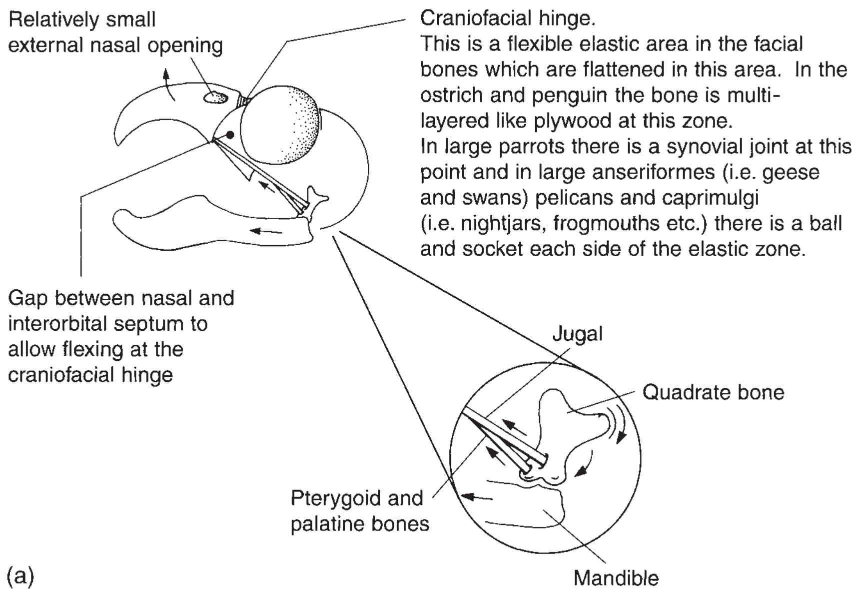

Fig. 1.1(a) Kinesis of the avian jaw (simplified and diagrammatic) – the prokinetic (hinged) lower jaw (adapted from an illustration by King & McLelland, 1984). This type of jaw articulation is found in most species of birds including the parrots.

As the quadrate bone rotates clockwise, horizontal forces are transmitted via the jugal arch (laterally) and the pterygopalatine arch (medially) to the caudal end of the ventral aspect of the upper jaw, causing this to rotate dorsally pivoting on the craniofacial hinge.

Injury to the cere is common in many birds and may involve the underlying craniofacial hinge. Fractures of the jugal, pterygoid and palatine bones occasionally occur and need good quality radiographs for diagnosis. All the injuries affect prehension of food.

of a traumatised or fractured beak it is important to take into account these interspecific variations.

The sheath of keratin overlying the skeleton of the bill also varies in thickness, composition and sensitivity. In ducks and geese (Anatidae) only the tip is hard, while in waders (Charadriidae) the bill tends to be soft, leathery and flexible, extending distally well beyond the underlying bone. Different races of the redshank (*Tringa totanus*) have developed different lengths of beak dependent on their preferred diet. In most species of parrot and most raptors the beak is hard and tough. Hardness depends on the content of orientated hydroxyapatite crystals. The hard tip of the bill of the Anatidae contains a tactile sensory structure – the bill-tip organ – while Herbst corpuscles, sensitive mechanoreceptors, are well distributed over the whole of the beak of waders. The beak of toucans is also a very

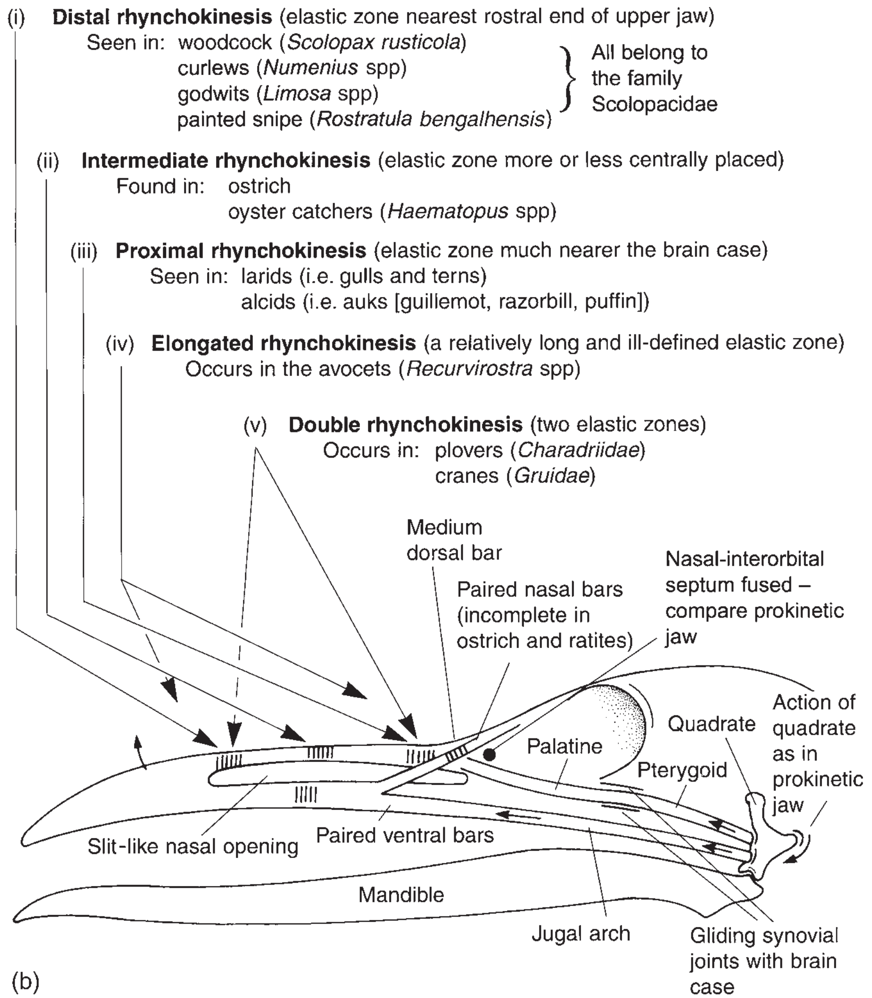

Fig. 1.1(b) The rhynchokinetic jaw. Most of the movement of the jaw occurs rostral to the junction of the upper jaw and the brain case within the area of the 'nose'. Among the many forms of rhynchokinetic articulation, proximal rhynchokinesis (iii) most nearly resembles prokinetic articulation, giving these birds (gulls, terns and auks) a wide gape so that they can more easily swallow their prey. Rhynchokinetic articulation overall is found mostly in the order Charadriiformes (i.e. waders and shore birds) which mostly feed on invertebrates and other aquatic organisms. Many species of these birds probe for their food in sand or soft earth.

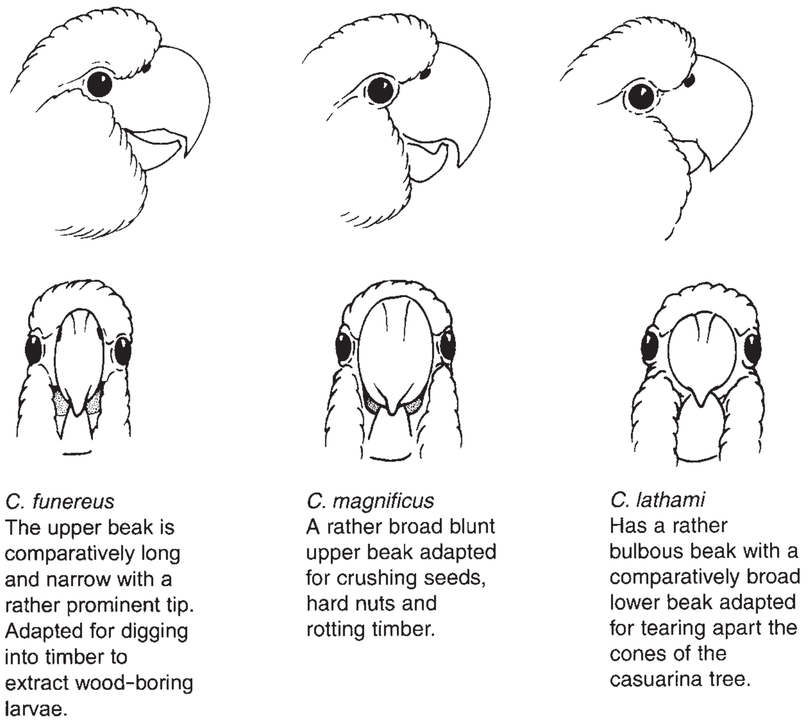

Fig. 1.2 Variations in the form of the beak among members of the genus *Calyptorhynchus*, the black cockatoos (after W.T. Cooper in Forshaw, 1978). Although *C. funereus* and *C. magnificus* inhabit parts of south-western Australia, all three species co-exist in parts of south-eastern Australia where, because of their different feeding habits, they are ecologically isolated.

sensitive structure, being well supplied by branches of the Vth cranial nerve (see p. 23). Figure 1.2 shows the variation in beak form of a closely related group of cockatoos.

The axial skeleton

The cervical vertebrae

In all species the atlas articulates with the skull via a single occipital condyle, but in some hornbills (Bucerotidae) the atlas and axis have fused, possibly to support the very large skull. Most birds, even small Passeriformes, which have an apparently quite short neck, have 14–15 cervical vertebrae compared with a total of seven in all mammals. The swans (genus *Cygnus*), most of the large herons in the family Ardeidae, most of the storks (Ciconiidae) and the ostrich have an obviously long and flexible neck and, as would be expected, an increased number of cervical vertebrae (in swans 25). Usually long necks go with long legs since the bird needs to use its bill to perform many tasks (e.g. manipulating food, grooming and nest building or burrowing) all of which are often carried out by the pectoral (or fore-) limb in mammals. In darters (genus *Anhinga*) there is a normal 'kink' in the neck between the 7th, 8th and 9th cervical vertebrae. This, when suddenly straightened, enables the bird to thrust the beak forward at the prey in a stabbing action.

The thoracic vertebrae

In many birds the first few thoracic vertebrae (2–5) are fused to form a notarium. This is present in Galliformes (pheasants, turkeys, guinea fowl, grouse and quails, etc.), Columbiformes (pigeons and doves), Ciconiidae (herons, egrets, bitterns, storks, ibises, spoonbills) and Phoenicopteridae (flamingos).

The notarium may not be very apparent on all radiographs. In all birds some of the posterior thoracic vertebrae together with all of the lumbar vertebrae, the sacral vertebrae and some of the caudal vertebrae are fused to form the synsacrum, which is also fused with the ilium, ischium and pubis. The exact numbers of fused vertebrae derived from the various regions of the spine is not possible to define accurately.

The caudal vertebrae and pelvis

The pygostyle (4–10 fused caudal vertebrae) gives support, together with the retrical bulb (a fibro-adipose pad), to the rectrices (the tail feathers). The pygostyle is well developed in most flying birds in which the tail is important to give added lift during hovering (e.g. the kestrel *Falco tinnunculus*) or soaring or for accurate steerage, as in the goshawk (*Accipiter gentilis*) and other woodland species. This area in the flying birds and those which use the tail for display purposes (e.g. the peacocks and the Argus pheasant) is well supplied with muscles, many of which are inserted into the inter-retrical elastic ligament.

The pygostyle and the free caudal vertebrae are well developed in woodpeckers, in which, together with specially stiffened tail feathers, they help to support the bird when it is clinging on to a vertical surface. The tail feathers may also help support such species as the Emperor penguin when standing or pygmy parrots, woodpeckers and tree creepers when climbing. In these many different types of birds damage to this area of the anatomy could have an effect on feeding, breeding, flying or roosting behaviour.

The *rigid synsacrum*, unlike the pelvis in mammals, in most birds is open on the ventral surface to allow passage of the often quite large shelled egg. However in the Ratides, the large flightless birds, it is fused either at the pubic symphysis (in the ostrich) or at the ischial symphysis. This may help to prevent compression of the viscera when the bird is sitting.

In all birds there is an antitrochanter situated dorsal to the acetabular fossa, but even these two anatomical structures vary between quite apparently similar species such as the peregrine falcon (*Falco peregrinus*) and the goshawk (*Accipiter gentilis*) (Harcourt-Brown, 1995). The pelvis tends to be comparatively wide in the running birds compared with the narrower and longer pelvis of the foot-propelled diving birds, e.g. loons (Gaviidae) and grebes (Podicipedidae) which closely resemble each other in body form and behaviour but are taxonomically unrelated. This is probably an instance of convergent evolution.

The thoracic girdle

In most birds the scapula is long and narrow, but in the ostrich it is short and fused to the coracoid. The clavicles are usually fused at the furcula to form a 'wishbone' and they function as bracing struts to hold the two shoulder joints apart during contraction of the supracoracoideus. They also act as a major attachment for the pectoral muscle; they are well developed and widely spaced in the strongly flying birds. As would be expected, the supracoracoid muscle and the pectorals, as well as the other wing muscles, are reduced in some non-flying birds. In the penguins, which literally 'fly' through the water, the supracoracoid muscle is greatly developed whilst many of the other wing muscles are tendinous.

In some birds pelicans, frigate birds and the secretary bird (*Sagittarius serpentarius*) the furcula is fused to the sternum. In the ostrich the scapulocoracoid bone is not quite fused but has a fairly rigid attachment to the sternum. In the albatrosses and fulmars (Procellariidae) the furcula forms a synovial joint with the sternum. However in some parrots the clavicles and the furcula are absent, being represented by a band of fibrous tissue. The coracoid is well developed in most species but the 'triosseal canal' normally formed between coracoid, scapula and clavicle, is completely enclosed within the coracoid in the hoopoe (*Upupa epops*) and also in hornbills (Bucerotidae). Both these species belong to the order Coraciiformes and it is possible that other members of this order may have this anatomical variation although this has not been documented.

The ribs and sternum

The uncinate processes are unusually long in the guillemots or murres (Alcinae) and the divers or loons (Gaviidae). This may help to resist the pressure of water on the thorax when the bird is diving. Guillemots and razorbills have been recorded at a depth of 150 metres, the emperor penguin at 350 metres. Water pressure increases at the rate of 1 atm/10 m, which is approximately 1 kg/sq cm.

As is the case in the pelvic girdle, the thorax in these birds is long and comparatively thin; consequently the sternum is long thus reducing the space between its caudal margin and the pubic bones and so making surgical access to the abdomen more difficult. The keel of the sternum is well developed in the flying birds particularly the swifts and the hummingbirds (Apodiformes). However it is absent or reduced in the ratites (i.e. with a raft-like sternum). It is reduced in many flightless island species in which other members of the same family are flying birds, e.g. the kakapo or the owl parrot of New Zealand (*Strigops habroptilus*) which can only glide downhill, or again some of the flightless island rails (e.g. *Atlantisia rogersi*). The sternal keel is well developed in penguins and in these birds the supracoracoid muscle is greatly increased in size compared with the pectoral. In some cranes (Gruidae) and the swans this part of the sternum has been excavated to accommodate coils of an elongated trachea as is illustrated in Figure 1.3.

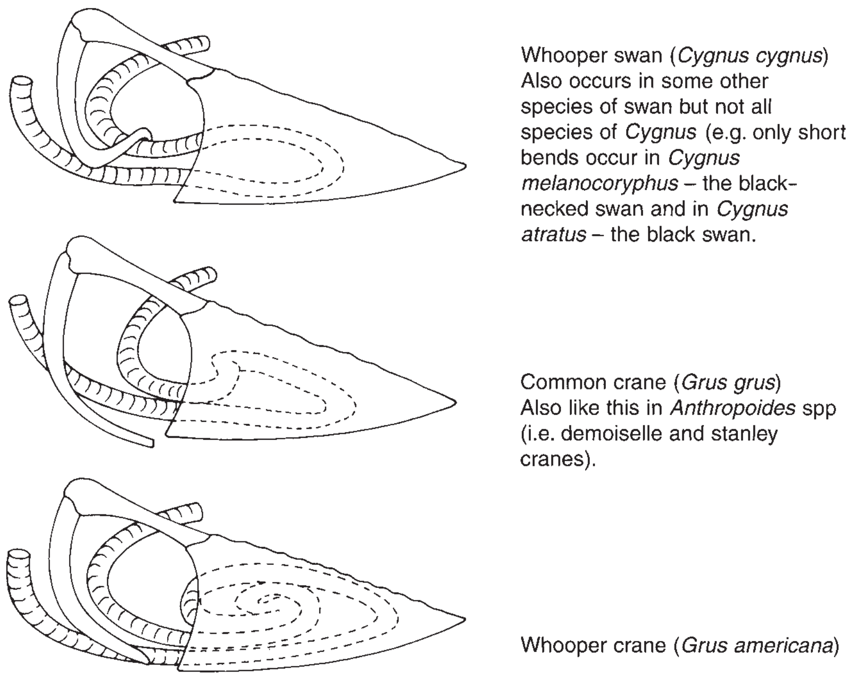

Fig. 1.3 Various types of looped trachea partly enclosed in the excavated sternum (redrawn after King & McLelland, 1989, by permission of Academic Press Limited, London). Knowledge of these variations is important in the interpretation of radiographs.

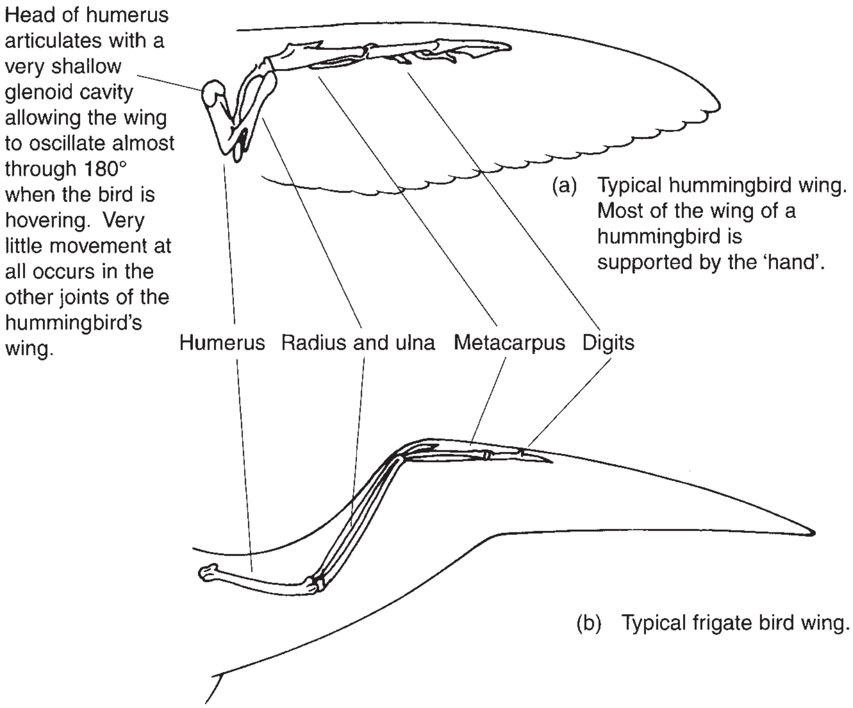

Fig. 1.4 The relative comparable sizes of the wing bones in two different types of bird (*not* drawn to the scale of the two species).

The pectoral limb – the wing

The overall layout of the skeletomuscular system of the wing is similar in all birds. However the relative lengths of the individual bones do vary (Fig. 1.4) (see also p. 209). In most specialised soaring birds, e.g. the gulls (Laridae), the humerus is short compared with the relatively longer radius and ulna. In contrast in the albatross, which spends most of its life soaring over very great distances, the humerus is longer than the radius and ulna. In the penguins, auks and diving petrels the humerus and the other bones of the wing have become flattened. The alula is a digit corresponding to the human thumb. It is usually well developed in most flying birds and when abducted from the wing it acts as a slot, as in an aircraft wing, to smooth the airflow over the aerofoil section of the wing at low airspeeds and when the wing is canted as the airborne bird comes in to land (see p. 168). During these conditions the airflow tends to break away from the surface of the wing and the bird or aircraft loses lift and begins to stall. As would be expected this structure is reduced or absent in some non-flying birds (e.g. kiwis and cassowaries). In the young hoatzin (*Opisthocomus hoatzin*) there are claws on the alula and the major digit which the bird uses for climbing around the nest site. Adult cassowaries, kiwis, emus, rheas and the ostrich also have vestigial non-functional claws on these digits. The varying types of avian wing are illustrated in Figure 1.5.

The legs

Again the basic layout of the hind limb is the same in all species with most of the evolutionary changes having taken place in the foot. In the long-legged birds the tibiotarsus and the tarsometatarsus are of approximately the same length. This is essential if the centre of

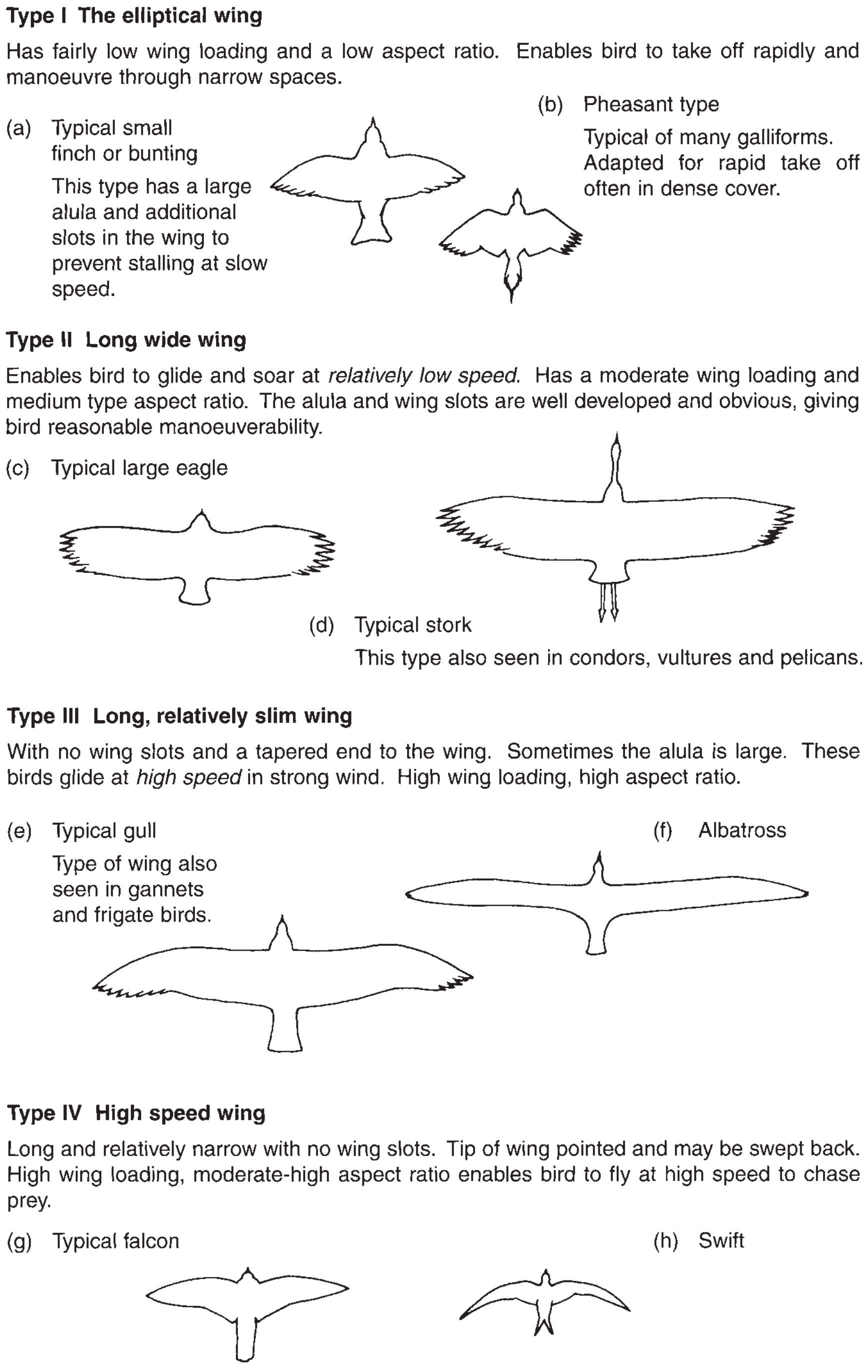

Fig. 1.5 Varying types of avian wing (definitely not to scale).

- Any loss of wing extension through fracture, trauma or damage to the propatagial membrane is most serious prognostically in birds with a high wing loading. Of course, if the damage is extensive enough it is significant in all species of birds. However, see p. 209.
- Trauma to the carpo-metacarpal region resulting in fibrosis or possible ankylosis is most grave in birds with a Type I or Type II wing plan. The author has seen a number of kestrels (*Falco tinnunculus*, type IV wing plan) and gulls (*Larus* sp., Type III wing plan) fly effectively with slight damage to the carpo-metacarpal area.

Clinical importance: assessment for release of wildlife casualties.

gravity of the bird's body is to remain above the feet when the bird is crouched and the limb is flexed, otherwise the bird would overbalance. In flamingos there are no menisci in the intertarsal joints. In the grebes (Podicipedidae) and divers or loons (Gaviidae), which are foot-propelled diving birds, the tibiotarsus lies almost parallel to the vertebral column and the limb is bound to the body by a fold of skin. The cnemial crest in these divers is well developed, projecting beyond the stifle joint. In grebes it is fused to the patella thus increasing the area of attachment for the crural muscles. In divers and grebes the gastrocnemius is greatly developed providing the main power stroke of the foot. Quite obviously all the leg muscles are powerful and well developed in the ostrich which can run at 40 mph (64 kph) and can produce a lethal strike forward with its foot. All the major types of avian foot are illustrated in Figure 1.6.

Feet with four toes

Anisodactyl i.e. three forward toes and one backward pointing toe. This type of foot is adapted for perching or grasping and is seen in songbirds and birds of prey. This is the pattern seen in most birds. The gannets have four webbed toes, so do cormorants.

Zygodactyl i.e. two forwardly directed toes (digits II & III) and digits I & IV are backwardly directed toes. This foot is seen mostly in birds which climb but also grasp with the foot, e.g. parrots, toucans, cuckoos, woodpeckers. In owls, touracos and the osprey the foot is basically of this type but digit IV can easily be moved forwards.

Pamprodactyl i.e. all four toes are directed forward. This type of foot is found in the swift. Unable to perch on the ground but clings to a vertical nesting site.

Syndactyl i.e. two digits are partially united, e.g. kingfishers.

Feet with only three toes, i.e. *tridactyl* feet

This type of foot is seen in running birds (e.g. plovers), wading birds, some climbing birds, some woodpeckers, the emu, diving petrels and auks, cassowaries, kiwis, tinamous and pheasants.

Many birds with webbed feet are like this with a vestigal first digit, e.g. gulls, penguins, loons, albatross, swans and ducks.

Feet with two toes

This is found only in the ostrich. Digits I & II are absent and digit III is much larger than digit IV. The foot is rather like that of the horse where one digit is greatly developed and adapted to running and walking over open country and grassland.

Fig. 1.6 Varying types of avian foot.
Clinical importance: Foot problems in birds are common. As well as obvious trauma, digits are sometimes congenitally maldirected so knowledge of what is normal is important.