

1

Parrot Biology

1.1

Anatomy and Physiology

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See Chapter 1.2. Parrots are a distinctive taxon. As a group, with some exceptions, they are diurnal, social, brightly coloured, arboreal birds found in tropical and subtropical climates. They have a distinctive, hooked bill they use for climbing and foraging. There are over 350 species in the order Psittaciformes, split into three families:

- **Cacatuidae:** Cockatoos, cockatiels
- **Psittacidae:** Parrots, parakeets, lorries, lorikeets, macaws
- **Strigopidae:** Kakapo, kea

The majority of birds seen in clinical practice are from the Cacatuidae and Psittacidae families (Figure 1.1.1).

Body Design

The majority of birds are designed for the unique and vigorous demands of flight, and parrots are no exception. Some of these attributes include:

- Strong, light skeleton
- Powerful muscles located close to the body with long tendons
- Highly specialised circulatory and respiratory systems
- Efficient and short digestive system

- High metabolic rate
- Well-developed visual processing centre and specialised eye structure
- Feathers which are fundamental to flight, communication and temperature regulation

Birds do not possess a diaphragm separating thoracic and abdominal cavities. Instead, they have a coelom, which is divided into 16 body cavities.

- Eight of the cavities are pneumatised and part of the respiratory system
- Eight of the cavities are not pneumatised – there are two pleural cavities, one pericardial cavity, four hepatic peritoneal cavities, one intestinal peritoneal cavity and one extraperitoneal space.

Integument

Like mammalian skin, avian skin has three layers; however, it is much thinner.

- **Epidermis:** The outermost layer, sebum is secreted from keratinizing basal cells.
- **Dermis:** The middle layer containing feather follicles, blood vessels, nerves and the smooth muscle and tendons that move the feathers.
- **Subcutis:** The deepest layer which contains fat and striated muscle for feather movement.



Figure 1.1.1 Species commonly seen in veterinary medicine. *Source:* Courtesy of Aidan Raftery.

The skin of the distal leg and foot is scaled, and the skin attaches directly to bone. The bottom of the foot has segmented digital fat pads underneath the scaled skin to cushion the weight-bearing surface (Figure 1.1.2).

Birds do not have true glands throughout the skin, instead they possess an uropygial gland, sometimes called a preen gland.

- The uropygial gland is a bilobed holocrine gland, located on the rump above the tail. It secretes an oily substance that is important for waterproofing and maintaining the feathers.



Figure 1.1.2 Plantar aspect of normal feet and nails. *Source:* Courtesy of Aidan Raftery.

- Some parrot species do not have an uropygial gland.

Feathers are a defining characteristic of class Aves; they are important for flight, temperature regulation and communication.

- Feathered skin is organised into two categories: pterylae and apterylae. Pterylae, or feather tracts, are the places where the feathers grow. Apterylae are the places where no feathers grow.
- The parts of a feather are:
 - The rachis, or shaft, which gives the feather structural integrity.
 - The vane, which is made up of filamentous barbs with interlocking barbules that allow the feather to maintain its shape during flight.
 - The calamus or quill where the feather attaches to the body.
- Feather colouration occurs as a result of dietary pigments and light refraction.
- There are six different feather types, and not all birds have all six types.
 - **Contour feathers:** These are the main feather type and are found all over the body; they include the remiges (primary flight feathers), the retrices (tail feathers) and coverts.
 - **Down feathers:** Small, fluffy feathers for warmth.
 - **Powder down:** Small and break down into a chalky powder that helps to maintain contour feather structure.
 - Filoplumes.
 - Semiplumes.
 - Bristle feathers.
- Different species have different numbers of remiges, but the majority of parrots have 8–10 primaries and 10–20 secondaries.

Moult is the process of losing and replacing the feathers and happens one to two times a year, usually following breeding. It is extremely metabolically demanding.

- Moult is regulated by both intrinsic factors (such as hormones) and extrinsic factors (such as photoperiod). It occurs gradually so the bird never loses the ability to fly.
- The pattern of moult is species-specific, but typically the primaries and retrices are lost and replaced in mirrored pairs.

Feather development occurs in a series of steps; the feather itself is a modified keratin structure.

- The new feather begins developing in the follicle, and as it grows, it displaces the existing feather. At this stage, the feather has a large, central blood supply.
- New feathers are encased in a fragile, waxy cuticle that protects them as they grow; these are often called pin feathers. The casing comes off as the feather matures, allowing the vane to take its shape.
- Once the feather is fully mature, the blood supply recedes, leaving a hollow quill.
- If the feather breaks while it still has a blood supply, significant haemorrhage will occur.
- Some feathers are rooted in the periosteum; the secondary flight feathers are anchored to the caudal border of the ulna in the wing.

Musculoskeletal System

Birds possess a lightweight, strong skeleton. Some bones are pneumatised; their central cavity is full of air and reinforced with trabeculae that act as internal scaffolding. The pneumatised central cavities arise from air sac diverticula and are extensions of the respiratory tract.

Osteomyelosclerosis occurs in reproductively active female birds where medullary bone is synthesised to act as a calcium reservoir during egg formation. It can be visualised radiographically as increased radiodensity in the medullary cavity of non-pneumatised bones.

The axial skeleton consists of the skull, the vertebral column and the sternum.

- The two most distinctive features of the avian skull are the large eye orbits and the bill.
 - The bill has an upper maxilla and a fused, lower mandible.
 - The rhamphotheca is the sheath of keratinised epithelium that makes up the outermost layer of the bill.
 - The bill grows continuously, and alignment is maintained by normal wear. The dorsal portion grows more quickly creating the hooked shape of the bill.



Figure 1.1.3 Lateral view of a macaw skull showing maxillary hinge. Source: Courtesy of John Chitty.

- Some species possess a sense organ called the bill tip organ.
- Larger birds, such as macaws, have a synovial hinge joint in the maxilla that allows for hyperextension of the upper bill (see Figure 1.1.3).
- The avian skull is lightweight and there is a large, complex infraorbital sinus which drains dorsally into the nasal cavity, not all of it is encased in bone and infections can cause soft swellings of the face (see Figure 1.1.4a and b).
- The avian vertebral column has free portions and fused portions. In some species, the vertebral bodies are pneumatised.
 - The cervical segment consists of free vertebrae with synovial joints between each vertebra, allowing for a long, flexible neck. The number of cervical vertebrae depends on the species.
 - The thoracic vertebrae are not fused, but they are inflexible and referred to collectively as the notarium.
 - The synsacrum is a fused segment of the caudal thoracic vertebrae, lumbar vertebrae and sacrum. It is fused with the pelvis to provide rigid stability during flight.
 - The caudal vertebrae are not fused and end with the pygostyle; their movement allows fine control of the tail feathers.
- The sternum is made up of the ribs and a well-developed ventral keel that provides an attachment site for the flight muscles.

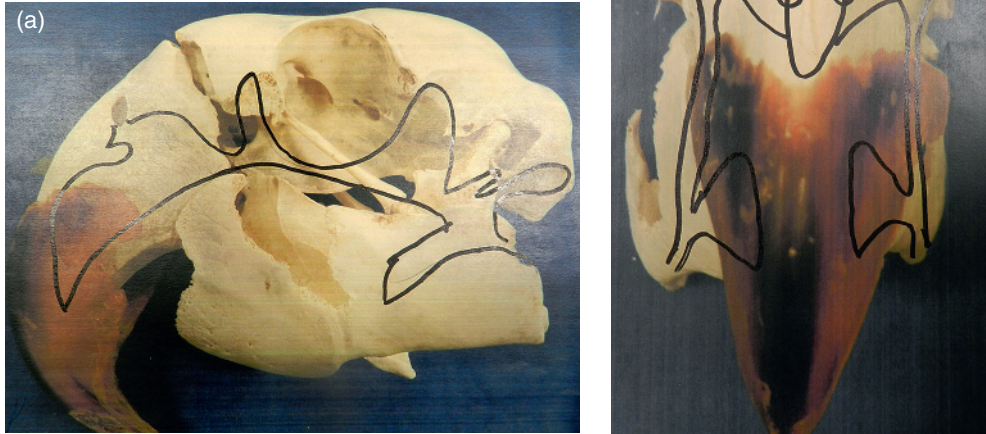


Figure 1.1.4 (a and b) Macaw skull lateral and rostro-caudal views showing extent of sinus system. *Source:* Courtesy of John Chitty.

The appendicular skeleton consists of the wing and the leg. In general, the muscle bellies are located close to the core of the body and have long tendons extending distally. This allows for a more streamlined silhouette for flight and better temperature regulation.

The wing is a defining feature of avian anatomy. It is a highly specialised structure that acts as a sail to both generate lift and catch air currents during flight.

- The bones and muscles that make up the thoracic girdle are what give the wing its power, particularly on the downstroke; they also prevent collapse of the thorax during wing movement.
 - The three major bones that make up the thoracic girdle are the coracoid, scapula and clavicle.
 - The coracoid is a rod that maintains the wing's position relative to the body during the downstroke.
 - The scapula lies parallel to the spinal column and protects the thorax.
 - The clavicle typically keeps the shoulders apart to prevent the wing impinging on the rib cage. In parrots, it is small or completely absent.

- The shoulder joint is highly flexible and has a wide range of motion, allowing the wing to move in multiple planes.

- There are two major muscles involved in the flight. The pectoralis muscle originates at the keel and inserts on the humerus; its contraction results in the powerful downstroke used to generate lift. The supracoracoideus muscle is deep to the pectoralis; it inserts on the dorsal humerus and tracks over and around the coracoid to the origin on the keel, and its contraction results in the upstroke during flight.

- The skeletal structure of the wing consists of the shoulder joint connecting the scapula and humerus, the elbow joint between the distal humerus, radius and ulna and the carpus connecting the radius and ulna to the manus.
 - The radius is thinner than the ulna.
 - The manus is a compressed structure with three parts. Partial fusion of the metacarpal bones has resulted in the carpometacarpus. Moving distally, it articulates with phalanx I followed by phalanx II. The alular digit helps with steering and articulates cranially with the proximal end of the carpometacarpus.

- There is a band of elastic tissue that runs from the shoulder to the carpometacarpus, creating a triangle of skin at the leading edge of the wing called the pterogonium. It helps maintain wing shape and prevents hyperextension of the elbow joint.

Parrots are bipedal and they use their legs for perching, climbing and manipulating objects. The proximal leg is well attached to the body, but the distal structures are very flexible.

- In the bird, the ilium, ischium and pubis are fused together. The pubic symphysis is absent in birds, instead the pubic bone is fused to the ventral border of the ischium. This means that the pelvis is open ventrally to allow egg laying.
- The femur articulates with the acetabulum and is held close to the body by the muscles of the body wall. It lies at a cranioventral angle and connects with the tibiotarsus at the stifle joint. The acetabulum is perforated in birds. Depending on the species a small patella may be present as part of the stifle joint.
- The distal limb consists of two simplified structures: the proximal tibiotarsus and the distal tarsometatarsus. They articulate to form the hock.
 - The tibiotarsus is a structure made up of the fused tibia and first row of tarsal bones. Similarly, the tarsometatarsus arises from fusion of the second row of tarsal bones to the metatarsus.
- The psittacine foot is zygodactyl and has four digits. Digits 1 and 4 point caudally and digits 2 and 3 point cranially. The number of phalanges in each toe is species dependent, typically the medial digits (1 and 2) are longer than the lateral digits.

Nervous System

In general, the nervous system is highly conserved in an evolutionary sense. While there are anatomical and physiological differences across species, there are many similarities.

The major similarities between the avian and mammalian nervous systems is summarised below:

- A three-layer meninges (pia, arachnoid and dura mater layers).
- Grey matter made up of neuron bodies and white matter made up of the axonal tracts of neurons.
- A spinal cord arranged in tracts that branch off as the cord extends caudally.
- An autonomic nervous system with sympathetic and parasympathetic branches.
- Use of neurotransmitters such as acetylcholine and noradrenaline.
- Paired spinal nerves that branch out to become the peripheral nervous system with both afferent motor fibres and efferent sensory fibres.

The major differences between the avian and mammalian nervous systems are summarised below:

- The avian brain has a high neuronal density, is relatively smooth and lacks gyri.
- The spinal cord extends the entire length of the vertebral canal. There is no cauda equina in avian species.
- Within the avian spinal cord is a structure called the glycogen body.
- The cerebrospinal fluid is thick and gelatinous, especially in the flexible cervical region. The thicker consistency acts as a better cushion for the spinal cord in such a flexible vertebral canal.

The nervous supply to the wing arises from the brachial plexus and the supply to the leg arises from the lumbosacral plexus.

- It is important to note that the sacral nerves run through the cranial and caudal divisions of the renal parenchyma and that renal pathology can present initially as leg weakness.

Special Sense Organs

Visual acuity is extremely important to parrots, and the eye is arguably the most important special sense organ. There are a number of differences in ophthalmic anatomy that make the avian eye uniquely specialised for visual processing.

- The optic nerve and visual processing centre of the brain are massive and are typically referred to as the optic lobe.

- The globe of the eye is flattened into an oval shape which allows for a 300-degree monocular vision field with 6°–10° of binocular vision directly in front of the beak (Figure 1.1.5).
- Movement of the eye is limited by both its shape and size relative to the skull. There is very little space for muscular attachment in the orbit, and there is a bony scleral ring that holds the eye in place.
- There are two external eyelids that move vertically over the eye and an internal nictans (third eyelid) that moves horizontally over the eye. The nictans can move independently of the outer eyelids and often protects the eye without the eye having to be closed completely.
- The iris divides the eye into the anterior and posterior chambers and surrounds the pupil space. Pupil size can be changed in response to light or as part of visual signalling. The colour of the iris depends on the species and in some species indicates the sex of an individual.
- The avian lens is flexible, and changes in its shape allow more control over the size and area of focus in the visual field. This shape change is achieved by muscles of the ciliary body which hold the lens in place.
- The pecten is an organ unique to birds; it can be visualised in the fundus as a dark brown, cone-shaped structure. It consists of a dense capillary bed that supplies nutrients to the fundic structures, allowing the retina to be avascular.



Figure 1.1.5 Species commonly seen in veterinary medicine. Source: Courtesy of Aidan Raftery.



Figure 1.1.6 Species commonly seen in veterinary medicine. Source: Courtesy of Aidan Raftery.

- The choroid in birds is well-developed and they lack a tapetum lucidum.
- The retina is adhered to the back of the eye and is composed of cones and rods. There is a higher density of cones than rods in the avian retina, and cones are innervated individually while rods are innervated as groups.
- Parrots possess three colour vision and can see into the UV spectrum.

Hearing and auditory processing are also important to parrots; the inner ear works in the same way as mammals.

- There are specialised ear coverts that lie over the external opening of the ear canal; this opening is often located caudal and ventral to the eyes on either side of the skull.
- The ear canal is relatively short and ends with a tympanic membrane.
- Vibrations picked up from the tympanic membrane are conveyed to the fluid of the inner ear via the extracollumellar cartilages and bones (Figure 1.1.6).

Gastrointestinal System

The avian gastrointestinal system is relatively short but highly efficient. Histologically, the gastrointestinal tract tubular organs consist of the outer serosal surface, the muscularis, the submucosa and the inner mucosal surface.

Birds do not have an epiglottis. Their larynx is more commonly referred to as the glottis and its opening is called the rima glottis.

- An important structure within the oropharynx is the dorsally located choanal slit. This opens into the nasal cavities. When the mouth is shut the glottis fits into the choanal slit effectively separating the respiratory tract from the oral cavity. The choanal slit has a number of finger-like projections called the choanal papillae.
- The tongue in parrots is fleshy and muscular; its primary function is for manipulation of food items rather than taste.

As food exits the oropharynx, it enters the oesophagus. The avian oesophagus is analogous to that of mammals with the exception of the ingluvies or crop.

- The crop is an outpouching of the oesophagus that acts as storage for food during foraging. Food in the crop is exposed to some digestive enzymes prior to entering the proventriculus.
- Food in the crop is often regurgitated as part of parenting and mating behaviour in psittacine species.
- The crop empties through regular intervals of smooth muscle contraction moving material to the proventriculus.

The avian stomach consists of two structures, the proventriculus and the ventriculus, which are connected by the isthmus. The proventriculus is primarily responsible for enzymatic digestion, while the muscular ventriculus is associated with mechanical digestion.

- Digesta moves back and forth between the proventriculus and ventriculus before moving on to the small intestine.
- The ventriculus possesses a cuticle, the koilin layer, on the digestive surface to help facilitate mechanical digestion.

As in mammals, the small intestine has three parts: the duodenum, the jejunum and the ileum. The duodenum is a U-shaped loop, and the trilobed pancreas sits within its mesentery. The jejunum is the longest part of the small intestine, and the short ileum moves digesta to the large intestine.

The avian large intestine consists of a short, straight colon and rectum emptying into the cloaca via the coprodeum.

The cloaca functions as the end structure for the gastrointestinal, urinary and reproductive systems. Each system empties into the cloaca before exiting the vent.

- Faeces enters through the coprodeum: the most proximal of the openings.
- The next outflow point is the urodeum: mature eggs and sperm enter the cloaca at this point.
- The distal opening is the proctodeum: urine and uric acid are secreted here. It is also the location of the bursa of Fabricius.
- The cloaca opens to the vent: a horizontal opening with dorsal and ventral lips.

The accessory gastrointestinal organs are the pancreas and liver. With few exceptions, parrots do not have a gall bladder.

- The liver is a bilobed, solid, parenchymal organ that synthesizes bile to facilitate digestion. The primary pigment it excretes is biliverdin rather than the mammalian bilirubin.
- The pancreas is a trilobed structure located in the U-shaped loop of the duodenum.
 - The lobes are the dorsal, ventral and splenic lobes.
 - Pancreatic islet cells are located in the splenic lobe and secrete glucagon and somatostatin, which are the major metabolic hormones in parrots. There are three types of islet cells: light, dark and mixed.

Urinary System

The kidneys are paired, symmetrical trilobed organs located in the extraperitoneal renal fossa of the synsacrum. There is no renal pelvis in the avian kidney, though a cortex and medulla are present. The renal tissue is subdivided into lobules and there are two nephron types.

- The avian nephrons are in the cortical areas; they do not have a loop of henle and secrete insoluble uric acid crystals.

- Conversely, the mammalian nephrons are in the medullary areas and have a loop of henle which secretes weakly concentrated urine.
- Once secreted, the urine and uric acid enter the collecting ducts, and smooth muscle contraction moves them to the ureter then out into the cloaca via the proctodeum. The mixture is called a urate.
- Retroperistalsis of urine back to the colon through the coprodeum allows urinary water to be resorbed before excretion.

The renal portal system is the major blood supply to the kidneys.

Reproductive System

The majority of psittacine chicks are altricial and when they hatch, they require intensive parental care.

Copulation occurs via cloacal touching between a male and female bird.

Unlike mammals, the male reproductive tract is internal. There are no accessory sex glands, and psittacine birds do not have a phallus.

- The testes are paired, above the kidneys, on either side of the vertebral column. The left is usually larger than the right.
 - The testes are smaller in the non-breeding season and get larger during the breeding period.
 - Sperm is made in the testicle then moves into the short epididymis and is stored in the larger ductus deferens. During copulation, sperm enters the cloaca via the urodeum and is transferred to the female.
 - During the breeding season, male budgerigars have a visible cloacal swelling called the seminal glomus that arises from the ductus deferens as a convoluted mass and stores sperm.

In parrot species, only the left side of the female reproductive tract is developed.

- The ovary is next to the cranial lobe of the left kidney. Like the testes, it is enlarged during the breeding season. Outside of the breeding season, it is small and quiescent.

- The active ovary is characterised by multiple, follicular structures. These structures can get very large and appear yellow.
- The inactive ovary is small and has a granular appearance, sometimes, small follicular structures can be visualised.
- Egg laying is of avian reproduction.
 - Ovulation of a mature follicle releases an ova into the funnel-shaped infundibulum, the first segment of the convoluted avian oviduct. The infundibulum catches the egg and puts down the chalazae and albumin that will hold the yolk in place while the egg develops. The next part of the oviduct is the magnum, the majority of the albumin is added here. Lastly, the developing egg will enter the isthmus segment of the oviduct, where the inner and outer shell membranes are synthesised.
 - The last section of the oviduct is called the uterus or sometimes the shell gland as this is where the calcified shell is added.
 - The now complete egg passes through the uterovaginal junction where lubricating mucus is secreted before entering the cloaca in preparation for laying.
- Clutch size is species specific.

Respiratory System

As in all birds, parrots do not have a diaphragm. Respiration is active and requires movement of the ribs and sternum to both draw air in and move it through the tract. It is characterised by unidirectional airflow and crosscurrent gas exchange.

During inspiration, air is drawn into the oropharynx directly or through the choanal slit via the nares. There are no vocal folds or vocal cords in birds.

The avian trachea does not have a glottis and possesses complete tracheal rings which allow it to stay patent despite the pressures generated during respiration.

At its end, the trachea branches into a Y-shaped organ called the syrinx. This structure is the source of the voice. It is made of cartilage, tympanic membranes and fine muscles that control the sounds produced.

From the branches of the syrinx arise the main stem bronchi, branching bronchi, bronchioles and parabronchi in the lungs.

The avian lungs are non-elastic and adhered to the dorsal body wall. This rigidity allows for a dense, three-dimensional surface for constant gas exchange.

- The respiratory unit in avian lungs is the air capillary. Unidirectional airflow passes over the capillaries in a cranial to caudal direction creating a countercurrent to the direction of blood flow through the air capillary maximising gas exchange.

The air sacs act as a reservoir and bellows. The air sacs do not participate in gas exchange, but the system allows gas exchange to occur during both inspiratory and expiratory phases of respiration.

- There are a total of nine air sacs: the single clavicular air sac and the paired cervical, cranial thoracic, caudal thoracic and abdominal air sacs.
- Sternal movements during inspiration and expiration change the local air pressures within the air sacs; these pressure changes control air movement throughout the respiratory system.
- The avian respiratory tract is approximately 10 times more efficient at gaseous exchange which predisposes them to the effects of inhaled toxins.

Cardiovascular System

The avian cardiovascular system is largely similar to that of mammals. Birds possess a large, four-chambered heart that beats relatively fast to give the large stroke volume and cardiac output necessary for flight. The cardiac chambers are laid out the same way as in mammals.

The renal portal system is a unique feature of avian species. It consists of a venous ring that supports both kidneys with muscular sphincters to control blood flow. The sphincters are controlled by acetylcholine (ACh) receptors, and when these receptors are stimulated by stress, the sphincters constrict to divert blood from the kidneys into the vena cava, massively increasing venous return to the heart.

Immune and Lymphatic System

Birds possess both primary and secondary lymphoid tissue; however, there are no true lymph nodes in birds.

The sites of primary lymphoid tissue are the bone marrow, thymus and bursa of Fabricius. In chicks, the yolk sac can also act as primary lymphoid tissue.

- The avian thymus persists throughout life and is found cranial to the heart and lungs. It is responsible for making T-lymphocytes.
- The bursa of Fabricius is a small nodule located in the dorsal proctodeum. It is responsible for making B-lymphocytes. It is largest in chicks then it involutes with age.

Sites of secondary lymphoid tissue include the spleen, gut-associated lymphoid tissue (GALT) and the Harderian gland in the nictans membrane.

Endocrine System

The primary endocrine glands in birds are similar to those in mammals; they include the adrenals, pancreas, thyroid and parathyroid glands. The ultimobranchial glands are unique to birds.

- The adrenal glands are paired and can be found on either side of midline near the cranial renal lobe. They are laid out and function similarly to mammalian adrenal glands. They are primarily responsible for the production of glucocorticoids, mineralocorticoids and some androgens.
- The thyroid glands are paired, round glands located at the thoracic inlet to either side of the trachea.
 - T3 and T4 are the major hormones secreted for the regulation of growth and metabolism.
 - One of the main functions of the thyroid gland is to control moulting.
- The parathyroid glands are a series of two to three pairs of small, spherical glands located near the thyroid glands. Their major function is to regulate calcium and phosphorus.
- The ultimobranchial glands are small, paired glands caudal to the parathyroid glands. Within these glands are the calcitonin-producing C-cells.

1.2

Natural History of Parrots

Felipe Martinho

Parrots, parakeets and cockatoos are included in the order Psittaciformes, sharing a set of common characteristics:

- 1) Proportionately large head, short neck and legs;
- 2) Characteristic downcurved upper mandible (rhamphoteca) with a sharp point and square-ended lower mandible (gnathotheca), fitting inside upper mandible;
- 3) Fleshy cere (sometimes covered with feathers);
- 4) Some degree of cranial kinesis, enabling some range of movements between the upper beak and the skull;
- 5) Zygodactyl feet, with digits II and III facing forwards and digits I and IV backwards;
- 6) Tongue muscular, thick and very tactile;
- 7) Crop present and intestinal caeca absent;
- 8) Fused clavicles (furcula) poorly developed or even absent in some species;
- 9) Usually brightly coloured plumage, with many species possessing powder down producing feathers;
- 10) Wings with 10 primaries and 10–14 secondaries. Tail with 12 rectrices;
- 11) Adults moult once a year, usually complete and after the breeding season;
- 12) Size ranging from very small *Micropsitta* parrots (10–18 g weight) to large macaws (up to 1.7 kg weight).

There are currently around 370 extant species of psittacines, mainly distributed throughout the tropics and subtropics of Africa, Australasia and Central-South America. Several remote islands on the Indian and

Pacific oceans have also been colonised by this group. Some species can be found in more temperate regions, with some *Psittacula* parakeets living in the Tibetan plateau and Afghan mountains, while a few others can be found in sub-Antarctic regions, with the austral conure (*Enicognathus ferrugineus*) reaching the southern tip of Patagonia and Tierra del Fuego. Due to global pet trade and release, some species established feral populations in regions where they are not native; there are currently several feral populations of ring-neck parakeets (*Psittacula kramera*) and Quaker parakeets (*Myiopsitta monachus*) in many European cities.

Most parrots can be found in a variety of tropical and subtropical forests, having a mainly arboreal lifestyle. There are some exceptions, with some species living in grasslands and mountains and being much more terrestrial. The majority of parrots are diurnal, with only two nocturnal species – the Kakapo (*Strigops habroptilus*) and the night parrot (*Pezoporus occidentalis*).

Species

The order Psittaciformes is currently divided into three families:

- 1) **Strigopidae:** Including the three endemic New Zealand parrots: Kakapo (*Strigops habroptilus*), Kea (*Nestor notabilis*) and the Kaka (*Nestor meridionalis*).
- 2) **Cacatuidae:** Including all the cockatoos and the cockatiel (*Nymphicus hollandicus*), with a restricted

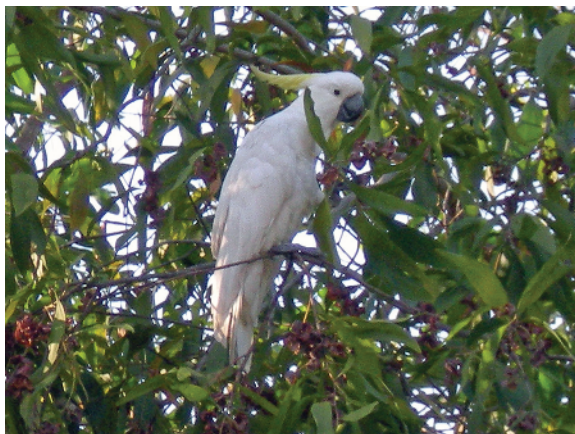


Figure 1.2.1 Sulphur-crested cockatoo showing erectile head crest. *Source:* Courtesy of John Chitty.

Australasian distribution. Members of this family differ from other psittacines by possessing an erectile head crest and by lacking the colours green and blue on their plumage (Figure 1.2.1).

3) **Psittacidae:** Including all the remaining species.

Despite the large number of species, not all are commonly found in captivity, with some groups being more popular pets:

- 1) **Cockatoos:** Easily recognized by their moveable head crest and predominately white or black plumage. Distributed in Australasia, from the Philippines to Australia, where found in forests and grasslands. Diet consists in a wide variety of seeds (including eucalyptus), fruits, berries, flowers, buds and some insect larvae, which can be consumed on the ground or in trees. Common species in captivity include the sulphur-crested cockatoo (*Cacatua galerita*), the galah (*Eolophus roseicapilla*) (Figure 1.2.2) and the white cockatoo (*Cacatua alba*). (See Figures 1.2.1 and 1.2.3).
- 2) **Cockatiel (*Nymphicus hollandicus*):** One of the most common psittacines kept in captivity. Common in arid and semi-arid habitats in Australia, where large flocks are formed, sometimes reaching hundreds of birds. Cockatiels feed mostly on seeds and can be agricultural pests. There are currently several colour morphs found in captivity, including albino and lutino (mostly yellow) varieties (Figure 1.2.4).
- 3) **Lories:** Australasian distribution, also present in some Pacific islands. Usually, small-sized



Figure 1.2.2 Galahs (aka roseate cockatoos) ground feeding – many parrot species will feed and forage on the open ground. *Source:* Courtesy of John Chitty.

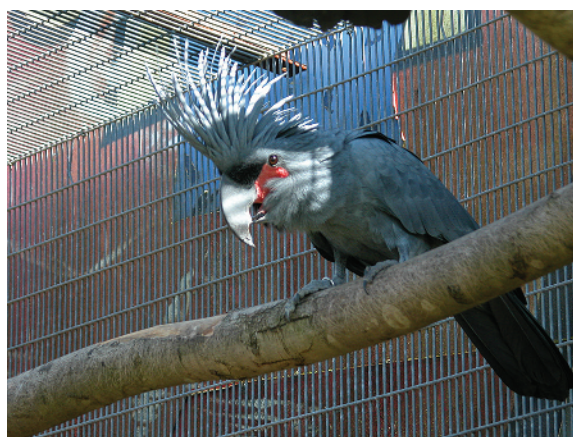


Figure 1.2.3 Goliath palm cockatoo – the group of black cockatoos are unusual in captivity and highly sought after. *Source:* Courtesy of John Chitty.

psittacines with colourful plumages. Lories have a specialized diet and the tip of their tongue is covered in papillae, which allows them to collect nectar and pollen. Fruits, flowers and insects constitute the rest of their diet. Due to these special diet requirements, lories require very specialized care and husbandry and never became very popular pets. The rainbow lorikeet (*Trichoglossus haematodus* complex) is probably the most well-known species (Figure 1.2.5).

- 4) **Eclectus parrot (*Eclectus roratus*):** A medium-sized parrot with striking sexual dimorphism, found in a variety of islands in Indonesia, Papua-New Guinea, North of Australia and the Solomon



Figure 1.2.4 Pair of cockatiels. The female (left) has barred tail feathering (ventral) and a duller cheek patch than the male (right). This holds for most colour varieties barring the lutino (yellow). *Source:* Courtesy of John Chitty.

Islands. Eclectus are usually quiet forest birds, living in pairs or small groups but differ significantly from other parrots based on their reproductive



Figure 1.2.5 Rainbow lorikeet pair beside nest hole – most parrot species nest in holes in trees. *Source:* Courtesy of John Chitty.

biology; they are polyandrous (one female mates with multiple males) and polygynandrous (both sexes have multiple sexual partners). It is believed that the extreme sexual dimorphism is related to a reproductive strategy where a brightly coloured female (red and blue) actively defends and signals an available nesting hole, while better camouflaged males (mostly green) are able to forage more effectively to feed females and chicks. Diet consists in fruit (especially banana, figs, papaya and *Pandanus*), blossoms, flowers, nectar as well as seeds and some nuts (Figure 1.2.6).



Figure 1.2.6 Sexual dimorphism in Eclectus parrots; males are green while females are red and blue. *Source:* Courtesy of John Chitty.



Figure 1.2.7 Rosella parakeet feeding on flower heads. Source: Courtesy of John Chitty.



Figure 1.2.8 Sexual dimorphism in King parrots – males have a red head. Source: Courtesy of John Chitty.

Figure 1.2.9 Budgerigars. The natural form is smaller and green. Domestication and selective breeding has produced a range of colours and much larger birds. Source: Courtesy of John Chitty.



5) **Australian parrots and parakeets:** A variety of small Australian psittacines, usually brightly coloured and long tailed, inhabiting grasslands and open forests, where feed on grass seeds, fruits, berries and insects. Common species in captivity include the rosellas (*Platycercus* sp.) (Figure 1.2.7) and, to a lesser extent, *Neophema*, *Psephotus* and *Polytelis* parakeets (Figure 1.2.8).

6) **Budgerigar (*Melopsittacus undulatus*):** Perhaps the most common and popular psittacine in captivity, budgies are also extremely common in Australia, occupying a variety of open habitats. They are extremely gregarious, feeding on a variety of grass seeds and usually are opportunistic breeders, whenever adequate food resources are available. Through selective breeding, a variety of colour morphs and mutations are found in captivity (Figure 1.2.9).

7) **Kakariki (*Cyanoramphus novaezelandiae*):** A small, mostly green with red head markings, parakeet endemic to New Zealand and some offshore islands, living mostly on open forests and feeding on a variety of fruits, berries, seeds, leaves but also some invertebrates. A yellow colour morph is also commonly found in captivity.

8) **Grey parrots (*Psittacus erithacus* (previously known as the African Grey) and *Psittacus timneh* (Timneh Grey)):** Two closely related medium-sized species, native to western African tropical forests and mangroves. Highly gregarious species,



Figure 1.2.10 African grey parrot – note yellow iris indicating the bird is over 6 months old (prior to this the iris is grey). *Source:* Courtesy of John Chitty.

feeding on a variety of seeds, fruits, nuts and berries. Probably one of the most popular parrot species in captivity (Figure 1.2.10).

- 9) **Lovebirds:** Small (less than 50–60 g), short-tailed birds, with bright green plumage and variable colour head markings. Found in wooded habitats of sub-Saharan Africa and Madagascar, in small- to medium-sized groups, feeding on a variety of grass seeds and the occasional fruit. The peach faced lovebird (*Agapornis roseicollis*) is probably the most popular species of this group. Several colour mutations and hybrids between different *Agapornis* species have been developed in captivity.
- 10) ***Psittacula* parakeets:** Small- to medium-sized long-tailed parakeets with mostly green plumage. When adult, sexually dimorphic (see Table 1.2.1). Live in a variety of wooded habitats, some species being present even in urban areas, throughout India, Southeast Asia, Indonesia and Africa. Diet includes a variety of fruits, seeds, berries, flowers and nectar. The most common species in the pet trade is the ring-necked parakeet (*Psittacula*

Table 1.2.1 Sexually dimorphic psittacine species.

Species	Male	Female
<i>Psitteuteles</i> lorikeets	More red on crown	Less red on crown or duller tone of red
<i>Charmosyna</i> lorikeets (green plumage species)	More red areas on plumage	No red areas on plumage or, if present, smaller and duller
<i>Charmosyna</i> lorikeets (red plumage species)	No yellow areas on back or rump	Yellow areas on back/rump
Black cockatoos (<i>Calyptorhynchus</i> sp.)	Plumage overall more solid black	More clear patches/stippling on upperparts and more white barred underparts
Cockatiel (<i>Nymphicus hollandicus</i>)	Yellower face, undertail, rump and underwings solid grey colour	Duller yellow face, barring on undertail, rump and underwing
Ecliptus parrot (<i>Ecliptus roratus</i>)	Green and red plumage	Red and blue/purple plumage
<i>Psephotus</i> and <i>Neophema</i> Australian parrots	Brighter plumage	Much duller plumage, occasionally with faint wing bar
Budgerigar (<i>Melopsittacus undulatus</i>)	Blue cere	Brown/pink cere
Ring-neck parakeet (<i>Psittacula krameria</i>) and Alexandrine parakeet (<i>Psittacula eupatria</i>)	Longer tail, black and pink collar	Shorter tail, lacks collar. Overall duller
<i>Forpus</i> parrotlets	Underwings blue; overall more bluish plumage	Usually duller, with no or little blue on plumage
<i>Amazona albifrons</i> , <i>Amazona xantholara</i> and <i>Amazona agilis</i>	Red on wings (primary coverts and lula)	No red on wings

krameri), which has several feral populations in urban areas of Europe descendant from escaped or released pet birds.

- 11) **Macaws:** Small to very large species, brightly coloured, with heavy beaks and long tails. Native to central and south American wooded areas, living in pairs or small groups. Diet consists of a variety of fruit (especially of palm trees), nuts, leaf buds and flowers. Although quite large and demanding, some species are popular pets, such as the blue-and-gold macaw (*Ara ararauna*) and the green-winged macaw (*Ara chloroptera*) (Figure 1.2.11).
- 12) **Conures:** Small- to medium-sized species, with long tail and predominantly green plumage. Found in a variety of wooded habitats in central and South America, although some species live in open grasslands. Very noisy and gregarious, feed on a variety of seeds, fruits and human crops, as well as insects and other invertebrates. The Patagonian conure (*Cyanoliseus patagonus*) and the monk parakeet (*Myiopsitta monachus*) are popular pet species (Figure 1.2.12 and Figure 1.2.15).
- 13) **Amazon parrots:** Medium to large species with predominantly green plumage. Tropical and



Figure 1.2.11 Green-wing macaws. Note the typical long tail and unfeathered face, typical of macaws. *Source:* Courtesy of John Chitty.



Figure 1.2.12 Patagonian conure. Note long tail (similar to macaw) and bare skin around the eyes (the face, though, is feathered unlike macaws). *Source:* Courtesy of John Chitty.

subtropical forest specialists, distributed along Central and South America, as well several Caribbean islands. Diet consists of a diversity of fruits, seeds and flower buds. Common species found in captivity include the blue-fronted amazon (*Amazona aestiva*), the orange-winged amazon (*Amazona amazonica*) and the yellow-headed amazon (*Amazona oratrix*). (Figure 1.2.13).

- 14) **Other South American psittacines:** A few other species of small- to medium-sized species

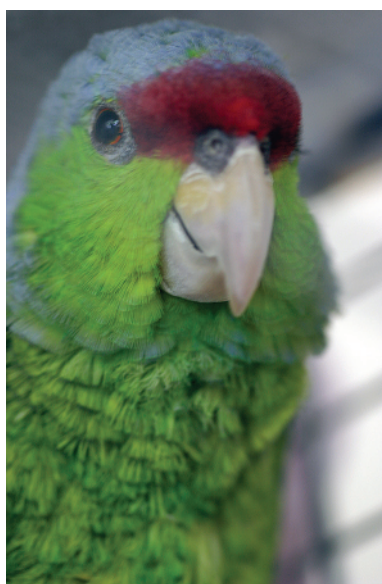


Figure 1.2.13 Lilac-crowned Amazon. *Source:* Courtesy of John Chitty.



Figure 1.2.14 White crowned Pionus (*Pionus senilis*).
Source: Courtesy of John Chitty.



Figure 1.2.15 Monk parakeet- these are now found in many cities around the world including Northern Europe.
Source: Courtesy of John Chitty.

are also occasionally kept as pets, including parrotlets (*Forpus* sp.), Caiques (*Pionites* sp.) and *Pionus* parrots (Figures 1.2.14 and 1.2.15).

Sexing

Only a few species show sexual dimorphism, and often, these differences can be subtle. In order to accurately sex most species, a blood sample (or

alternatively, some feathers or the inner egg membrane from a recently hatched chick) can be tested by PCR (polymerase chain reaction), identifying males (with ZZ chromosomes) or females (with ZW chromosomes). Alternatively, gonads can be directly visualised with laparoscopy.

Reproduction

Most parrot species are monogamous and the larger species tend to mate for life. This bond is constantly reinforced with mutual preening and feeding. The very few polygamous species include the New Zealand parrots (*Nestor* and *Strigops*).

As a general rule, parrots living outside the tropics tend to have defined breeding seasons, while the remaining species tend to be opportunistic breeders. Bonded pairs commence breeding and egg-laying whenever food resources and appropriate nests are available.

Most species nest in tree cavities, using naturally occurring hollow trees or ones that have been excavated by other species, such as woodpeckers. These cavities are usually enlarged by the breeding birds and the resulting wood shavings used as nesting material. Usually the female incubates, while being fed by males. It is speculated that the exposure to daytime darkness in cavity-breeding females can trigger some of the endocrine changes leading to egg-laying. Very few parrot species actually build nests, with some exceptions being some *Aratinga* conures that excavate holes in termite nests; Patagonian conures (*Cyanoliseus patagonus*) that dig burrows in banks or cliffs; Monk parakeets (*M. monachus*), building huge communal stick nests; and some lovebirds that carry grasses to build domed nests inside their breeding holes. Some species, especially Amazon parrots, can become quite territorial during breeding season, actively defending their nests.

Eggs are usually white and clutch size can vary between six eggs on the smaller species to one on larger parrots. Productivity also varies a lot, with some very prolific species laying two clutches of eggs per

breeding season, while other species not breeding at all if conditions are not ideal.

Parrot chicks are altricial, being born with closed eyes and either naked or with sparse down plumage, being completely dependent on parental feeding and

care. Most parrots reach sexual maturity between two and four years of age, but smaller species are a lot more precocious, with budgies reaching sexual maturity at around six months old.