
External Anatomy

General Topography

Any description of external characteristics of birds generally uses some specialized terminology for particular regions, feathers, etc. Knowledge of these is especially important for identification and systematics.

Familiarize yourself with the topographic features illustrated in your field guide and in the figures provided in this handout. Pay special attention to the names set in *italics>*. Locate these features on several specimens to see how they vary.

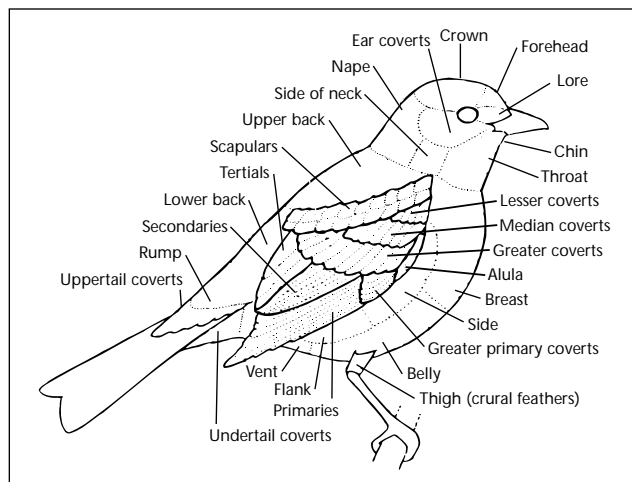


Figure 1. General Topography.

Trunk

Most of these features are self-evident, but familiarize yourself with the terminology (Figure 1).

THROAT. The throat is the ventral region extending from just under and below the lower mandible to the anterior margins of the sternum.

NAPE. The nape refers to the dorsal surface of the neck extending from the mid back of the skull to the beginning of the thoracic vertebrae.

BACK. The back is roughly the area between the wings.

RUMP. The rump overlies the pelvic bones anterior to the tail and is bounded by the flanks.

BREAST. The breast extends over the breast musculature nearly to the posterior end of the sternum.

ABDOMEN OR BELLY. The abdomen extends from the posterior sternum to the vent.

CRURAL FEATHERS. The crural feathers cover the tibial portion of the leg and are continuous with the feathers of the abdomen. In some species (i.e. the Rough-legged Hawk, family Accipitridae) these feathers extend all the way to the top of the foot.

SIDE. The side extends from the abdominal region up to the base of the wings.

AXILLARY REGION. The base of the underside of the wing, extending to the ventral wing lining.

FLANK. The lateral area posterior to the side, extending back to the base of the tail.

Head

Be familiar with the following terminology, especially for those regions of the head that serve as frequent field marks (Figure 2).

FOREHEAD. The forehead extends from the base of the upper mandible to a line drawn across the top of head approximately over the middle of the eyes.

CROWN. The crown extends from just posterior to the forehead to the beginning of the cervical vertebrae of the neck.

LORE. The lore is the lateral area of the head between the front of the eyes and the base of the bill.

SUPERCILIUM AND SUPERCILIARY LINE. The supercilium is a line of feathers immediately above the eye. It is distinctly colored in many birds (especially sparrows, family Emberizidae) and is called the supercilary line.

EYE RING. The eye ring is a group of feathers surrounding the eye at the edge of the eyelids. These feathers often contrast with those immediately surrounding them, forming a distinct eye ring that can be a useful field mark.

EYELINE. The eyeline extends back along the side of the head from the posterior angle of the eye. Another potentially useful field mark.

NARIAL FEATHERS. Narial feathers are dense, stiff feathers that extend forward along the upper mandible to partially cover the

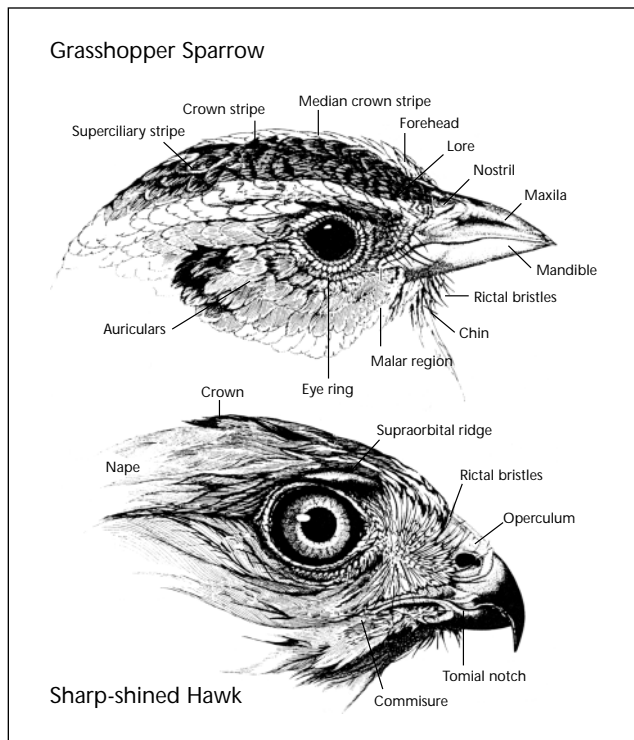


Figure 2. Topography of the head.

nostrils. These feathers are particularly evident on the crows (family Corvidae).

AURICULARS OR EAR COVERTS. The auriculars are a patch of feathers just behind and below the eye that cover the external ear. They are often loosely webbed.

MALAR REGION OR MUSTACHE FEATHERS. The malar feathers lie between the eye and the throat, extending back from a point where the upper and lower jaw meet (the commisure). They are distinct on the male Northern Flicker (family Picidae).

Bill

The overall size and shape of the bill can be useful for identification and can indicate general foraging ecology. For instance, seed-eating birds tend to have heavy, conical bills (sparrows, family Emberizidae), insect-gleaning birds have slender, sharply pointed

bills (warblers, family Parulidae), sallying birds tend to have broad, flattened bills (flycatchers, family Tyrannidae), aerial insectivores have small external bills with a large gape (nightjars, family Caprimulgidae), and piscivorous birds tend to have long, heavy, sharply pointed bills (loons, family Gaviidae). Note: a decurved bill curves downward (Brown Creeper, family Certhiidae), while a recurved bill curves upward (stilts, family Recurvirostridae). We will cover foraging ecology and function morphology in more detail during the BOW labs.

NOSTRILS. The external nostrils are located on the top of the bill. The shape of the nostril occasionally serves as a taxonomic character. For example, albatrosses and other members of the order Procellariiformes have tubular nostrils that extend down the bill (and are associated with salt glands that remove salt from seawater) while superficially similar gulls (family Laridae) have linear nostrils. Accipiter hawks (family Accipitridae) have oval nostrils, while falcons (family Falconidae) have circular nostrils.

OPERCULUM. The operculum is a soft, fleshy structure at the base of the upper bill that covers the external nostrils. It is especially evident in pigeons (family Columbidae).

TOMIA. The tomia (singular, tomium) is the cutting edges of either the upper or lower mandible. The tomia are notched in some birds (falcons, family Falconidae), and serrate in others (mergansers, family Anatidae).

Wing

Locate the following features on the illustrations (Figures 3 and 4) and on the spread wings or the study skins, but please don't try to open the folded wings of the study skins. Although some terms related to the skeletal structure of the wing are introduced here, we will cover them in greater detail during the internal anatomy lab.

REMIGES. The flight feathers are collectively called remiges (singular, remex) and attach to the bones of the wing. These long, stiff feathers fall into two major groups, the primaries and the secondaries, based on their point of attachment.

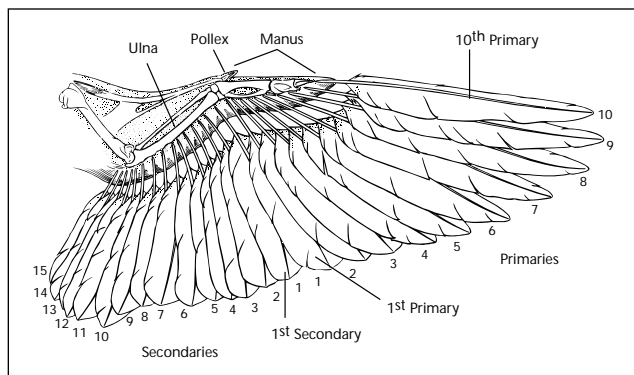


Figure 3. Ventral surface of the wing.

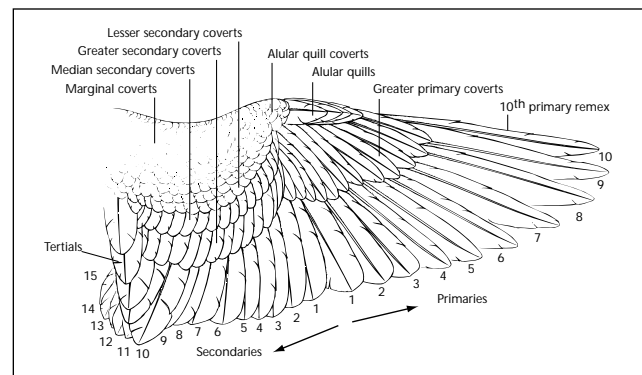


Figure 4. Dorsal surface of the wing.

PRIMARIES. The primaries attach to the bones of the hand (the manus) and are numbered from the innermost one outward. They provide the main propulsive force of the outer wing during powered flight, and are strongly asymmetrical (compare them to the secondaries), each acting as an individual airfoil. Most birds have eleven primaries (the eleventh, the remicle is often rudimentary or missing), but Ostriches have sixteen, a small number of groups have twelve, and many passerines (songbirds) have nine.

SECONDARIES. The secondaries attach to the trailing edge of the ulna and are numbered from the outside in. They form the trailing edge of the wing's airfoil. The surface area of the wings of large soaring birds consists mostly of secondaries. The number of secondaries in the wing varies with wing length, ranging from nine in most passerines to twenty-five in the larger vultures.

ALULA. The alula, a group of three small, stiff feathers (the alular quills), arises from the first digit (or pollex) of the hand. The alula acts as an aerodynamic slot, controlling the flow of air over the wing during flight.

TERTIARIES. The tertiaries are a group of three or four feathers just proximal to the innermost secondaries.

SCAPULARS. The scapulars arise from the shoulder and overlie the scapula (shoulder blades) at the base of the dorsal wing. These feathers often cover much of the folded wing on a perched bird.

AXILLARIES. The axillaries are the ventral counterpart of the scapulars, and are found on the ventral base of the wing (in the "armpit"). In many species these feathers are pale, but in a few (i.e. the Black-bellied Plover, family Charadriidae) they are dark and serve as a good field mark for a bird in flight.

WING COVERTS. Overlying the alula and the remiges on the dorsal and ventral surface of the wing are rows of small overlapping feathers called coverts. They are named depending on their location, size, and the remiges they cover. The marginal coverts are small feathers in two or more rows that cover a portion of the anterior dorsal surface of the wing. The greater coverts are formed of a single row of larger feathers adjacent to and overlying the bases of the primaries and secondaries. The median coverts are a single row of feathers just proximal to the greater coverts. In larger birds, the last few distinct rows of feathers lying between the marginal coverts and the larger (greater and median) coverts are called the lesser coverts. The coverts can further be specified as dorsal or ventral, and secondary (when they cover the secondaries) or primary (when they cover the primaries): hence "dorsal greater secondary wing coverts". The marginal underwing coverts are sometimes collectively termed the wing lining, and although these feathers do form rows, individual rows are usually difficult to distinguish.

Pale tips on the upperwing coverts, (when viewed on a folded wing) form wing bars that are often useful for identification purposes.

Tail

The flight feathers of the tail (the rectrices) help the bird steer during flight, and provide a certain amount of lift (Figure 5).

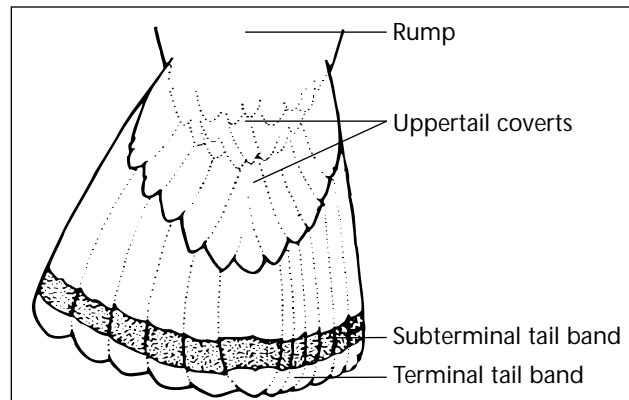


Figure 5. Feathers of the tail.

RECTRICES. The paired tail feathers or rectrices (singular, rectrix) are the flight feathers of the tail, and are usually twelve in number. While the rectrices are likewise long and stiff, they are often more symmetrical than are the remiges and are thus easily identified in the hand. The rectrices provide lift and act as a "rudder" to steer the bird while in flight. Some birds, notably the woodpeckers (family Picidae) and swifts (family Apodidae), have modified rectrices that function as props when the bird clings to a vertical surface.

The outer rectrices of many birds are either completely white (Northern Junco, family Emberizidae) or have "windows" of white at the tips (Eastern towhee, family Emberizidae); other species have a distinct terminal (Cedar Waxwing, family Bombycillidae) or subterminal band on the rectrices. These and other patterns on the tail often serve as useful field marks.

The general shape of the tail can likewise be useful for identification. Purple Martins (family Hirundinidae) have emarginate (notched) tails, while Barn Swallows (family Hirundinidae) have deeply forked tails. The tail tip of a Cooper's Hawk (family Accipitridae) is rounded, while that of a Sharp-shinned Hawk (family Accipitridae) is square. Mourning Doves (family Columbidae) have narrow, pointed tails and Yellow-billed Cuckoos (family Cuculidae) have graduated tails. Motmots (family Momotidae) and some hummingbirds (family Trochilidae) have a pair of elongated rectrices that form a "racket-tipped" tail, and woodpeckers (family Picidae) have inner rectrices modified for support while perching.

TAIL COVERTS. Like the remiges, the bases of the rectrices are covered by coverts. The upper tail coverts are generally indistinguishable from the rump. The undertail coverts are collectively termed the crissum, and are distinctively marked in some species (i.e. the Gray Catbird, family Mimidae).

Topography of the Foot

Toe Arrangements

These terms apply to the position of the toes (usually four, but fewer in some exceptional cases) on the foot (Figure 6). On an anisodactyl foot, the toes are numbered starting from the hallux (digit one, the “thumb”), then to the inside front toe (digit two), the middle front toe (digit three) to the outside front (digit four).

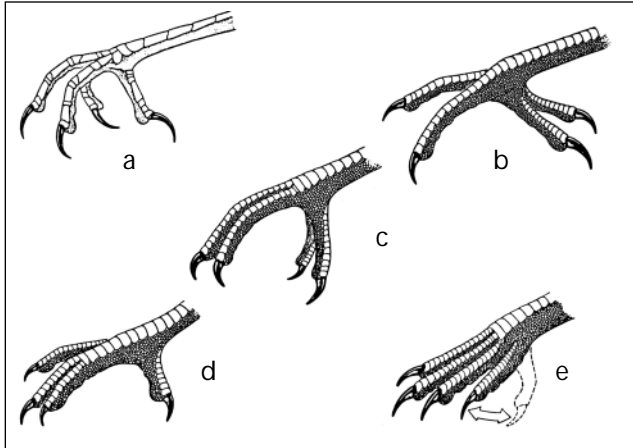


Figure 6. Toe arrangements: anisodactyl (a), zygodactyl (b), heterodactyl (c), syndactyl (d), pamprodactyl (e).

ANISODACTYL. Anisodactyl feet are characterized by three toes facing forward (digits 2-4) and one toe (digit 1, the hallux) facing backwards. The anisodactyl foot is the most common arrangement: songbirds (order Passeriformes) and most other birds that regularly perch have anisodactyl feet.

ZYGOACTYL. The zygodactyl foot is characterized by two toes facing forward (digits 2 and 3) and two toes facing backward (digits 1 and 4): in other words, the outer toe is reversed. This is the second most common toe arrangement in birds. It is found in most woodpeckers (family Picidae), owls (order Strigiformes), cuckoos (order Cuculiformes), most parrots (order Psittaciformes), mousebirds (order Coliiformes), and others.

HETERODACTYL. The heterodactyl foot is like the zygodactyl foot except that the inner toe is reversed (digits 3 and 4 face forward, 1 and 2 face backward). Heterodactyl feet are only found in trogons (order Trogoniformes).

SYNDACTYL. Syndactyl feet are characterized by a fusion of the second and third toes (the inner and middle digits) along part of their length. This condition is found in the kingfishers and other members of the order Coraciiformes.

PAMPRODACTYL. In the pamprodactyl foot the first and fourth (outer) digits pivot freely forward and backward. Birds with this arrangement can face all four toes to the front. Most swifts exhibit this condition, and rotate all four toes forward when hanging from vertical surfaces.

Webbing and Other Modifications

Webbed and lobed toes (Figure 7) are found primarily in aquatic birds, and assist in swimming and wading over soft substrates.

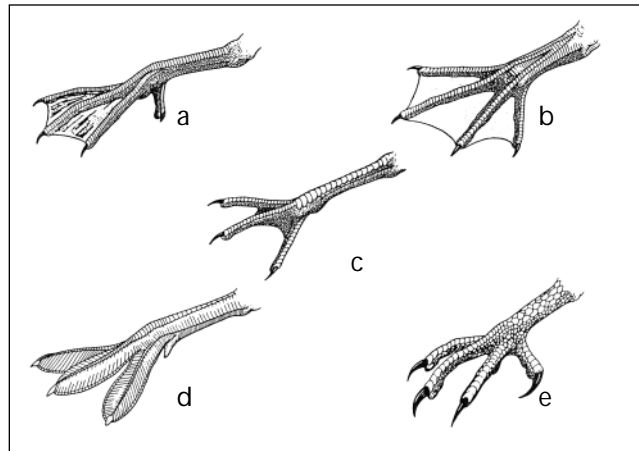


Figure 7. Toe webbing: palmate (a), totipalmate (b), semipalmate (c), lobate (d), raptorial (e).

PALMATE. The palmate foot is characterized by webbing between the front three toes (toes 2, 3, and 4). This is the most prevalent type of webbed foot, and is found in the ducks, geese, and swans (order Anseriformes), gulls and terns (family Laridae) and other aquatic birds.

TOTIPALMATE. Totipalmate feet have webbing between all four toes, and are found in all members of the highly aquatic order Pelecaniformes (pelicans, cormorants, gannets, boobies, and others).

SEMIPALMATE. Semipalmate feet have a reduced webbing between the front three toes (toes 2, 3, and 4). Unlike palmate feet, the webbing doesn't extend all the way to the tips of the toes. This condition is found in some sandpipers and plovers (order Charadriiformes), storks (family Ciconiidae), all grouse (family Phasianidae), and other groups.

LOBATE. Lobate feet are an evolutionary alternative to the webbed foot., and are characterized by toes that are flattened and edged with flexible ridges that collapse on the forward stroke of the foot through water. Lobate feet are found in grebes (order Podicipedidae) and coots (family Rallidae).

RAPTORIAL. The raptorial foot is characterized by long, strong digits armed with heavy claws for catching, holding, and killing prey animals. Raptorial feet are found in the members of the Falconiformes.

Investments of the Foot and Tarsus

These terms refer to the shape and pattern of scales covering the foot and tarsus (Figure 8).

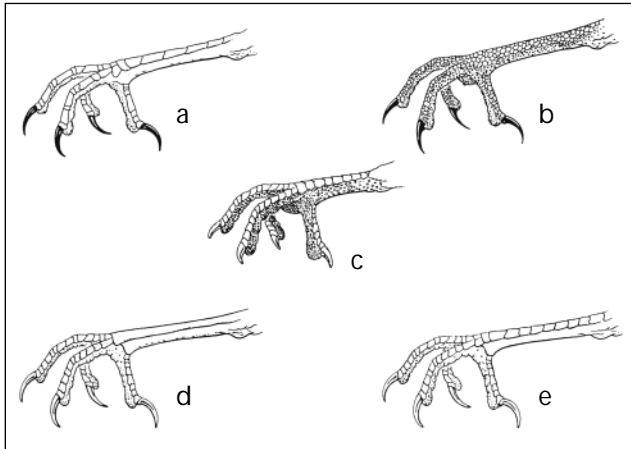


Figure 8. Investments of the foot and tarsus: scutellate (a), reticulate (b), scutellate-reticulate (c), booted (d), scutellate-booted (e).

SCUTELLATE. The scutellate foot is characterized by rectangular scales arranged in overlapping rows along the anterior edge of the tarsus and foot. Scutellate feet are found in most passerines.

RETICULATE. The reticulate foot is characterized by small, irregularly arranged granular scales. Reticulate feet are found in parrots (family Psittacidae), plovers (family Charadriidae), and many other groups.

SCUTELLATE-RETICULATE. Scutellate-reticulate feet have both scutes and reticulate scales on the tarsus and foot. Pigeons and doves have scutellate-reticulate feet.

BOOTED. The booted foot is characterized by several long, continuous platelike scale covering the tarsus, with no small overlapping scales. Thrushes (family Turdidae) have booted feet.

SCUTELLATE-BOOTED. The scutellate-booted foot has a scutellate anterior edge and a single booted scale on the posterior edge. Gray Catbirds (family Mimidae) exhibit this condition.

Feather Structure, Types, and Distribution

General Feather Structure

A typical contour feather consists of a main shaft and a broad flexible vane on each side (Figure 9). The main shaft is divided into two parts: the solid upper part that gives rise to the vanes is called the rachis; the hollow lower end below the vane is called the calamus. At the base of the calamus is an opening called the inferior umbilicus, through which blood and nutrients flowed to the feather during its development. When the feather is fully developed, this opening is closed by a horny plate.

Each vane consists of hundreds of tiny barbs that branch off of either side of the rachis (Figure 10). Each barb itself gives rise to a series of lateral projections, the barbules, on either side. The bar-

bules on the distal side (the barbules on the side of the barb that faces the feather tip) have tiny hooklets (barbicels) that project distally to hook over a flange on the proximal barbules (the barbules on the inner side of each barb) of the next higher barb. Thus the barbs of the vane “zip” together to form a strong, flat surface. Feathers that lack interlocking barbicels are soft and downy. Examine this mechanism under the demonstration microscope. Pull gently downward on the vane to separate the barbs, then pull the feather between two fingers to rehook the barbules: this is the same movement a bird does with its bill when preening.

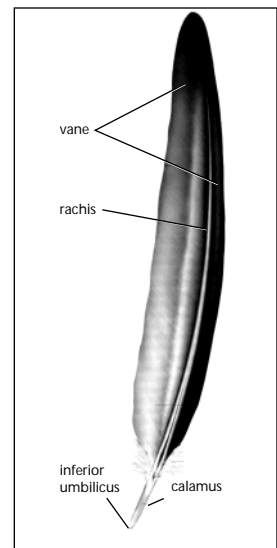


Figure 9. Feather structure.

The contour feathers of some species (notably the pheasants and grouse, family Phasianidae) have an auxiliary structure called an aftershaft or afterfeather that emerges from the central shaft just below the vanes. The aftershaft consists of a rachis and a series of barbs without barbicels, and thus is downy.

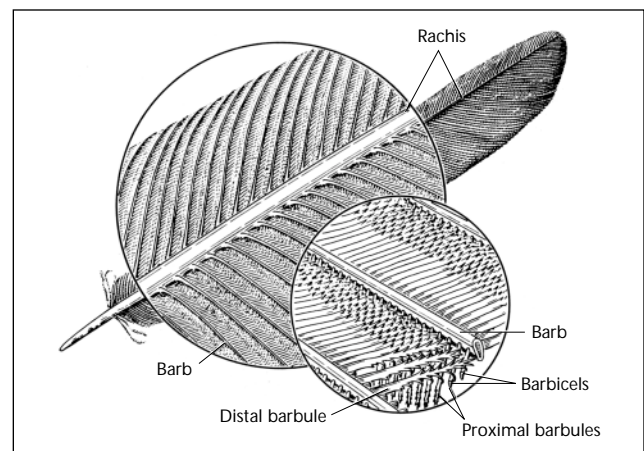


Figure 10. Feather structure.

Feather Types

There are six principal types of feathers, each serving one or several unique services (Figure 11). Examine samples of each macroscopically and microscopically.

CONTOUR OR VANED FEATHERS. Contour feathers include both the vaned feathers that cover the body and the flight feathers of the wings and tail. The contour feathers distributed over the body vary in shape, size and texture, but tend to be symmetrical and provide an aerodynamic yet protective surface. The flight feathers tend to be asymmetrical and provide the lift and propulsive force necessary for powered flight.

DOWN FEATHERS. Down feathers are small with poorly developed rachis and no interlocking barbules (and hence are downy). Down

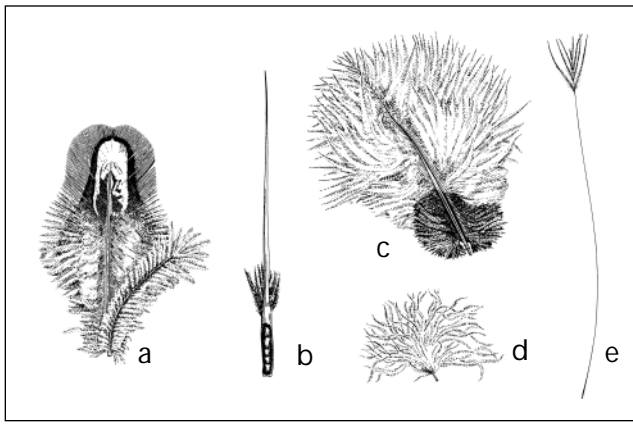


Figure 11. Feather types: contour feather with aftershaft (a), bristle (b), semiplume (c), down feather (d), filoplume (e).

feathers cover hatchling birds and provide insulation in most adults. They lie under the contour feathers. Powder down or powder feathers. The barbs of powder feathers disintegrate, providing a fine powder that is thought to aid in preening and waterproofing the other feathers. They are the only feathers that grow continuously and are never molted. While many species have powder feathers scattered within patches of normal down, they are most prominent in the herons and bitterns (family Ardeidae), and are located on the breast and belly.

SEMIPLUMES. Semiplumes are intermediate in structure between the vanned contour feathers and the vaneless down feathers. Semiplumes have a short rachis but are softly webbed and downy. They lie under the contour feathers and provide insulation and contribute to smooth body contours.

FILOPLUMES. Filoplumes are long hair-like feathers with small barbs at the tip and a sensory corpuscle at the base, and are scattered throughout the plumage. Filoplumes monitor the position of other feathers, especially those on the wings and tail, and provide a sense of touch within the plumage.

BRISTLES. Bristles are stiff and hairlike, consisting of a central rachis without vanes, and provide both protective and sensory functions. Bristles occur most prominently around the eyes (“eyelashes”), the lores, the nostrils, and around the rictus (corners) of the mouth. Not all birds have bristles. Rictal bristles are prominent in many aerial insectivores (i.e. nightjars, order Caprimulgiformes, and flycatchers, family Tyrannidae), and are used as sensory organs to help locate and capture prey, much like mammals use whiskers.

Feather Tracts

In most birds contour feathers are not evenly distributed over the body, but are concentrated in tracts called pterylae (singular pteryla) which are separated by featherless spaces called apteria (singular apterium). While the apteria lack contour feathers they usually show some down feathers and filoplumes. The distribution of pterylae over the body depends on the taxonomic group in question; you don't need to bother with their names.

Highly aquatic birds like loons (family Gaviidae) and ducks (family Anatidae) tend to have reduced apteria that are be densely feather with down to insulate the body. Some groups, notably the penguins (family Spheniscidae) and some flightless birds like the Ostrich and rheas (order Struthioniformes), have feathers that are uniformly distributed over the skin's surface and not organized into tracts.

Feather Color

The coloration of a feather may due to the presence of pigments (chemical coloration) or due to physical properties of the feather (structural coloration), or both. There are three principle pigments found in birds: melanins (blacks, grays, and browns), carotenoids (reds and yellows), and porphyrins (reds, browns, and some greens). Melanin granules tend to strengthen feathers and can reduce feather wear: in many large species the tips of the primaries of are infused with melanin and thus tend to be black.

Blues, most greens, whites, and iridescent colors are structural in nature. They are produced by complex patterns of selective light reflection and refraction determined by the microstructure of the cell wall surfaces of the barbs and barbules. Such feathers are not really colored, and only appear so as long as the integrity of the feather remains intact. A blue feather ground up (or worn out) appears brown. The color of some feathers (especially green, yellow-green, blue-green, and iridescent feathers) are due to both structural features and underlying pigments.