Comparative Anatomy of Musophagidae

(Turacos)

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Introduction

The 20 species which comprise the avian order Musophagidae[1] (commonly called turacos) have a number of physical and anatomical characteristics that set them apart from many other birds. While uniformity among the 20 species is not complete, certain generalizations can be made. One of these is that the sexes are visually indistinguishable in all of the species save *C. leucogaster*, in which the males have a black beak and the females a green beak. Unfortunately, most of the literature regarding the anatomy of these birds was developed more than 40 years ago, leaving many questions unanswered and many generalizations suspect in light of new information about these species' ecology including behavior and diet.

Feathers

Probably the most distinguishing feature of these birds are two unique pigments deposited in their feather keratin. One, turacoverdin, is a green pigment found in the rami in all species of *Tauraco* and *Musophaga*, and in *Corythaeola cristata*. The other, turacin, provides the red colored feathers in species of the first two genera. Both pigments contain copper and spectral data demonstrates that the former is likely an oxidized version of the latter. (Dyck, 1992) In fact, the two pigments are intermingled within individual feathers in the breast patches and crests of some species and turacoverdin occurs only in the presence of turacin.

Other species outside the Musophagidae order have turacoverdin pigment, including *Ithaginis* (pheasant) and *Rollolus* (partridge), both members of the Galliformes. An additional interesting note is that both pigments are soluble in a weak base – which may have led to the myth that wild birds lose

feather color when exposed to rain.

Another uncommon feature of these birds is that the feathers of the head and breast of most species are deficient in barbules so that they seem hairy or have a "down-like texture." (Moreau, 1938; Moreau, 1958) These feathers make up the characteristic erectile "crests" found on all but three of the species. In addition, the contour feathers have an aftershaft. (Sibley & Ahlquist, 1990)

The wing to tail ratios are uniform across the species, with the wing length at four-fifths of the tail length. The wings are rounded with the secondaries usually a bit shorter than the primaries. Also, some of the primaries are slotted, probably related to the short, slow flight patterns used by these birds. (Moreau, 1958) None of the species have eyelashes but all of them do have a tufted, bilobed uropygial gland. (Lowe, 1943)

Feet

These birds are defined as having semi-zygodactyl feet with the fourth toe being reversible and not permanently directed backwards. A typical resting position will find the outer toe at approximate right angles to the main axis of the foot, but it can be moved further back or directed forward, depending upon the bird's perching needs. Additionally, the claws are short and abruptly curved. (Moreau, 1938) Some researchers have reported that nestlings have a short (approximately 1mm) wing-claw but this seems to vary from species to species and even among individuals within a species, and because of this it cannot be said with certainty that it is a defining anatomical feature. (Moreau, 1958; Fry, et al., 1988)

Beak & Head

All turacos have short strong beaks with curved culmen. In some species the culmen is ridged (*T. bannermani*, *leucolophus*, and *macrorhynchus*) and in others curves back into a frontal plate (*M. rossae* and *violacea*). The nostrils are located on the beak but vary in shape and position. Some species have slit-shaped nares while others have circles; in many species the nostrils are covered with feathers. (Moreau, 1958)

Internally, a single unifying factor is that all species lack a vomer. (Sibley & Ahlquist, 1990) Additionally, the palatine processes arise from the more proximal end of the maxillary bone and the distal ends of the uncinate bone end in a sharp curve where they meet the outer rim of the palatine. (Lowe, 1943) Moreover, the quadrate bone in turacos is pneumatized, one of the facts that earlier taxonomists relied upon to distinguish these birds from cuckoos that have a solid quadrate. Finally, the tongue is short and thick and of a triangular shape, consistent with the tongue shape found in other frugivorous birds.

Digestive System

Turacos have no crop but do have an exceptionally large and well developed proventriculus, with walls twice as thick as those of the gizzard. The gizzard, in turn, has only a thin muscular structure with no horny cuticle or koilin lining its interior. Additionally, turacos lack a caeca. These anatomical features are consistent with the fact that turacos are primarily frugivores, though they have been known to eat insects and snails, particularly when they are feeding young in the nest. (Fry, et al., 1988) The major exception to this diet is seen in the Great Blue Turaco *C. cristata* which ingests a significant number of leaves, algae, and rootless floating plants as part of its diet. (Sun, et al., 1997)

Since so little has been published regarding the digestive systems of the turacos it is difficult to make accurate generalizations regarding this portion of their anatomy. Two studies regarding intestinal parasites have been undertaken, primarily for the purpose of determining the phylogenetic relationship of these birds to other species, but these studies do not describe the anatomy in any detail. (Clay, 1947; Bennett, 1993)

As an aside, with the recent confirmation by Sun and his associates that a significant portion of the diet of *C. cristata* is leaves and related plant matter, it would be interesting to pursue the comparative anatomy of the digestive system of the turacos generally and the Great Blue in particular.

As stated below, recent research points to a possible evolutionary relationship between turacos and the hoatzin. The hoatzin is noted for being an herbivore that has a crop, which acts as a glandular muscular stomach used to grind up tough leaves. Thus, a reexamination of the digestive anatomy of the Great Blue might be in order to see if its foregut differs from other turacos in conformity with its variant diet. Likewise, the dietary research raises the additional question of whether the Great Blue actually lacks a ceca – since that organ is often involved in the fermentation-digestion of plant material.

Skeleton

The lack of a furcula is probably the most significant skeletal feature of these birds. (Sibley & Ahlquist, 1990) This is consistent with the fact that they are "strictly arboreal, but poor flyers, moving from canopy to canopy with bursts of flapping and unstable-looking gliding." (Fry, et al., 1988) With slight variation, all species have 15 cervical vertebrae, 19 presacral vertebrae and five dorsal vertebrae.

With respect to the skull, characteristics of note include relatively huge lacrymals that connect with the frontal bones and a large horizontal and backwardly projecting process of bone that is deeply grooved for the passage of the nasal ducts. (Lowe, 1943) Turacos are classified as desmognathous birds as stated above, there is not a complete "shelf" between the nasal and oral cavities.

It is interesting to note that studies of the fossil record demonstrates certain similarities between the "basal land bird assemblage" and turacos, tinnamous, galliformes, cuckoos, and hoatzins. (Olson, 1985; Houde, 1988) This conclusion is based, primarily, on the well-defined terminal iliac process of the modern birds resembling the lithornithid pelvis.

An observation based on ecology alone seems to have been proved correct: all of these birds inhabit an area surrounding the "equatorial rain belt" which has been "remarkably stable in shape and extension from early Tertiary times – that is, for long as Musophagidae are likely to have been a distinct family." (Moreau, 1958)

Muscles

The muscles of the wings and breast are "relative to most other birds, feebly developed, and are long, thin and narrow slips." (Lowe, 1943) The pelvic muscles include the caudofemoralis, iliofemoralis, semi-tendinosus, accessory semi-tendinosus, iliofemoralis externus, iliacus plantaris and the popliteus. (Sibley & Ahlquist, 1990; Lowe, 1943) Turacos have very well developed M. fibularis longus, which end in strong, rounded, cord-like tendons above the tibiotarsal joint. (Lowe, 1943) It is likely that the exaggerated development of this muscle is in keeping with the mode of locomotion utilized by these birds – short hops from branch to branch.

DNA & Phylogeny

Initially, taxonomists classified turacos with cuckoos as two families in the order Cuculiformes, based primarily on external appearance. Beginning in the early part of the 20th century, however, detailed examinations of the skeletal structure, feather tracts and digestive systems of both types of birds led to the conclusion that they were not as closely related as had been believed. (Lowe, 1943)

Even as recently as 20 years ago, some researchers continued to press the association based on an analysis of egg-white proteins. (Sibley & Ahlquist, 1972) However, in the mid-1980s, a comparative chromosome banding study was undertaken which revealed a lack of phylogenetic relatedness between turacos and cuckoos, justifying their assignment to a family of their own. (Tuinen & Valentine, 1984) Even more important, however, is the fact that based on this chromosome study, it appears that turacos as a group are more closely related to the gallinaceous birds from an evolutionary standpoint. (Houde, 1988)

Conclusion

While a brief flurry of investigation into the anatomy of the Musophagidae was undertaken nearly 50 years ago, nothing significant in the realm of comparative anatomy or physiology has been published since. The broad generalizations regarding certain physical characteristics of the members of this order need to be refined and more accurately delineated, particularly in light of recent discoveries with respect to ecology, diet, and DNA structure. With many of the turaco species listed as endangered or threatened by CITES, new information about their anatomy and physiology, which could contribute to successful captive breeding programs, is critical before the populations are lost entirely.

Footnote

[1] Currently, authorities believe that turacos should be afforded separate status as their own order (Musophagaformes) instead of being categorized as a family under the order Cuculiformes. Regardless, there are six genera of turacos - Corythaeola (1), Crinifer (2), Corythaixoides (2), Criniferoides (1), Musophaga (4), and Tauraco (10).

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