S41: Comparative Aspects of Avian Morphology

S41.01

Bipedal hopping in birds and rodents: evolutionary and morphological aspects

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Hopping as a specialized form of bipedal locomotion has evolved in birds and non-primate mammals on several occasions. Hopping in birds is confined exclusively to the so-called perching birds, belonging to the order Passeriformes. It is definitely related to the hopping from branch to branch continued to be used by many species on the ground. Although some of the passerines are running on the ground, this adaptation should be considered as secondary. All the passerines have lost a number of hindlimb muscles, used by other birds while walking or running. They also retain the enlarged hind toe – a clear adaptation for perching. Bipedal saltation in rodents evolved in at least five groups. As adaptation to acquire food and to escape from predators in deserts and other sparsely vegetated areas, bipedal saltation has resulted in morphological changes in hindlimbs, partially convergent to the avian morphological changes. Loss of two digits and extensive fusion of metatarsalia II-IV, displayed by the extreme mammalian saltator Jaculus orientalis, cannot be treated as true convergence to hopping birds. Reduction and fusion of the mentioned elements in birds have happened in the cursorial ancestor, prior to the appearance of perching and hopping forms. Despite the better development of four extensors of shank in hopping rodents, some of the extensors from the group are surprisingly underdeveloped. This strikingly resembles the situation in perching and hopping birds, when certain muscles, responsible for the balancing on one leg during walking are reduced or absent altogether.

S41.02

Comparative anatomy of the postural mechanisms of the forelimbs of birds and mammals

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Birds and mammals represent distinct lineages that have been on separate evolutionary paths for millions of years. One difference between avian and mammalian forelimbs is that the typical mammal limb must provide locomotion and body support, whereas the avian forelimb powers locomotion but does not support the body when the animal is standing. This dichotomy is reflected in forelimb muscles and their fiber types. In mammals, much of the musculature is modified into a "pectoral sling" that supports the trunk and keeps it from "falling through" the limbs. Because mammals use the same muscles for postural and dynamic movements, their muscles possess a combination of different muscle fiber types that function in postural and dynamic activities, specifically slow and fast muscle fibers, respectively. For a specific muscle (and the actions made possible by its attachments), slow muscle fibers can perform postural actions via isometric contraction with minimal fatigue, or fast fibers can elicit dynamic, rapid, and forceful actions. In contrast, birds need only hold the wing folded while on the ground. The muscles specialized for forelimb posture are small and uniformly slow, and likely do not function in locomotion. Thus birds and mammals have evolved different strategies to deal with their limb postures, and have different muscles specialized for posture. In contrast, the avian hindlimb is more like the mammalian hindlimb, in that its muscles must function in posture and locomotion. Evolving the avian forelimb for flight has shifted most muscles of that limb into largely dynamic, fast-contracting muscles.

S41.03

Frugivory in birds and mammals: Analogous adaptations of the jaw apparatus

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Fruits are excellent food sources that are widely used by both birds and mammals. Both groups have jaw adaptations for picking and processing fruits. Birds, in addition, have adaptations for swallowing large food items whole, but the specific jaw adaptations for frugivory differ among avian taxa, such as hornbills or bulbuls. One of the adaptations is an immobile upper jaw to resist the force exerted by the lower jaw when firmly attached fruits are picked. A reduction of the free part of the tongue and a simplification of the hypoglossal apparatus allow the enlargement of the oral cavity to facilitate the swallowing of large food items. In contrast, some mammals that feed mainly on fruits, such as Spiny-tailed Squirrels (Anomaluridae, Rodentia), display different adaptations to being able to feed on firmly attached fruits, such as an enlarged anterior part of M. masseter, a shortening of the rostrum, and modifications of the incisor shape, such as a lateromedial narrowing and an anteroposterior thickening. The different and analogous adaptations to frugivory in birds and mammals are a result of their fundamentally different skull, jaw and tongue morphology that has been modified under a selection for efficient and effective use of fruits as a food source.