

Professional Media Workshop

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Evolutionary Adaptations of the Family Ardeidae

Evolutionary adaptations are special physical features and behaviors of individuals that are beneficial for their survival. Without these adaptations organisms would not be able to fill the ecological niche they occupy. Most members of the Ardeidae live in wetlands where they stalk their prey in shallow waters. The fate of members of the Ardeidae is intimately connected to the fate of wetlands. This paper describes the physical adaptations that link the Ardeidae with the exclusive habitats that support them.

The family Ardeidae includes the long-legged waterbirds, Herons, Bitterns and Egrets. Although members of this family are distinct from one another, they have a set of traits that make them a unique and coherent group. Ardeidae mostly live in or near inland freshwaters shallow waters as well as marshy coastal wetlands (Sibley, Elphick, Dunning, & National Audubon Society, 2001). Cattle egrets are an exception since they are more likely to occur in grasslands. To accommodate their use of shallow waters Ardeidae have long legs and long toes that lack webbing. Their long, curved necks support a narrow head with a spear-like beak. These traits can also be found in other families of birds but the unique feature of all members of Ardeidae is the powder down that they produce. Although all birds have an undercoat of down feathers for insulation, the powder down of the Ardeidae grows continuously with tips that disintegrate into a powdery substance (Wetmore, 1920). These special adaptations will be described here and on the infographic to illustrate the intimate relationship between this family of birds and their precious wetlands.

The earliest possible fossil evidence for heron ancestry and the family Ardeidae is from the early Oligocene Epoch (33.0 mya). More definitive examples of birds in this family are much more recent, coming from the Miocene Epoch (<23 mya). Physical evidence is scarce and

adding to the uncertainty of when the Ardeidae emerged are fossils represented by only individual bones or even bone fragments. As sketchy as the fossil evidence is, the Ardeidae is fairly recent in geologic time but certainly predates the current Quaternary period which began 2.6 mya (Olson, 1979). DNA evidence more clearly shows affinities with similar families of birds. The larger order of Pelicaniiformes (pelican-like) is considered to have a suborder of Ciconiiformes including storks, ibises and spoonbills as well as the Ardeidae family. Ciconiiformes has more characteristics in common and is assumed, therefore, to have a more recent common ancestor than other Pelicaniiformes. Near relatives that are not in the Ciconiiformes include anhingas, cormorants, frigatebirds and gannets (Hackett et al., 2008). These are all long-legged, long-necked birds associated with near shore waters and wetlands.

The class of Aves is one of the most recent in evolutionary history. Bird-like dinosaurs were present at least 150 million years ago (mya). The genus *Archaeopteryx* had both teeth and wings but did not have a skeletal form to indicate that it possessed the ability of powered flight. Other fossils of the Cretaceous show bird-like dinosaurs, the bipedal predatory theropods, with feathers. No toothed bird-like reptiles survived the great extinction event at the end of the Mesozoic (65 mya). Presumably warm-blooded, feathered birds survived, most notably in the form of large flightless birds like ostriches. Like the warm-blooded mammals, birds quickly diversified in a new landscape devoid of most reptiles that had dominated the Mesozoic (Sibley, 2001).

Egrets are usually white feathered and are easily spotted whether flying, nesting or wading. Herons and bitterns have dark pigmented feathers. Bitterns tend to be secretive and nocturnal, lurking in the tall reeds and cattails of marsh perimeters. It is easy to see how the striped patterns and straw color camouflage of the least bittern are adapted to hiding. The Great Blue Heron, along with other herons is typically exposed during the day and is overlooked mostly because of its statuesque posture and stealthy hunting style. It is not as clear how the white color of egrets is adapted to wading in exposed marshes. A possible explanation is that white feathers reflect solar radiation more efficiently than dark feathers, especially in tropical, coastal climates. It is not clear how dark color under these same conditions is adaptive. Dark plumage

is a thermal disadvantage in hot tropical sunshine. There are, however, many examples of dark plumage in these same locations without any apparent disadvantages (Ellis, 1980, p. 370). Factors other than thermoregulation and camouflage will be needed to explain the other colors in this family.

While ornithologists do not always have enough information to explain every trait and behavior, there are several characteristics within the family Ardeidae that demonstrate remarkably successful adaptations to life in the shallow waters of marshes. This suite of appearance, behavior and anatomy combine with DNA and fossil evidence unites these individual species in their family and marks a specific divergence from other birds historically and evolutionarily. The following generalities apply broadly across all members of this family.

The typical feeding behavior of herons is to stand motionless or to stalk slowly waiting for prey, usually fish, to approach. The exaggerated adaptations of long legs, long toes and spear shaped beak are well suited to stalking prey in shallow waters. There are variations on this basic posture where the Great Blue Heron will have its neck extended upright or at a slight angle, the Green Heron typically crouches with its neck retracted (Kushlan, 1976, p. 87). As attested by van der Leeuw (2001, p. 1353) "only a few bird species show extreme functional demands in terms of velocity or force on the neck system, like the darting stroke in the heron" (Kral, 1965). Long legs keep the bird's body above the water level allowing it to walk through the water without alerting potential prey while helping to keep its feathers dry. The long toed feet provide balance and support on soft substrate. Webbing is not needed since the feet are not used as paddles. The long spear shaped beak is well designed to pierce the water surface and grab a fish. The fish is then repositioned to point head first into the heron's mouth and then down the gullet. The long toes are sometimes used to rake the substrate or rattle submerged vegetation, scattering the inhabitants then picking them off handily (Meyerriecks, 1971, p. 435). A variety of hunting techniques are used that take advantage of these birds' ability to wade secretively and strike decisively to feed on submerged prey without, themselves getting very wet.

Powder-down is usually found on the breast and rump but may be in other places, too. This powder is used for preening feathers (Sibley et al., 2001, p. 170). The texture of this powder down is greasy, not dry and is applied as a waterproofing while preening every feather (Wetmore, 1920). A pectinate claw has a comb-like texture that aids in grooming. Using its pectinate claw a bird runs the powder down along all of its feathers to clean and polish their surfaces (Bock, 1956, p. 6).

The long, curved neck in members of the Ardeidae family is adapted to foraging, especially fishing in shallow waters. The path of the neck bones is even more exaggerated than the outward appearance of the neck. From the head, the spine initially tracks toward the back of the neck but about half way it shifts toward the front of the neck. Unique among vertebrates, the esophagus is temporarily to the back of the spine. At the shoulders the spine and esophagus return to their typical positions. An awkward looking notch is sometimes visible about halfway down the neck where this transition occurs. At the crossover point a particularly elongated vertebra pivots to allow the head to strike quickly at its prey. This feature and its stealthy hunting style make it a formidable predator (Sibley et al., 2001, p. 171).

Summary

The various physical features mentioned here collectively describe a distinct family of birds that is especially well suited to life in and around marshes. These specialists' adaptations although contributing to their success over many millions of years of Earth's history are also quite restrictive since they do not permit the bird to wander far from its dedicated environment. Understanding these adaptations, their advantages and disadvantages is critical to landscape maintenance and wildlife management.

Globally and nationally roughly 50% of wetlands have been lost to agriculture and development. In Ohio, over 90% of pre-settlement wetlands are gone. Pressure continues to impact wetland quality and quantity everywhere. While there are many other reasons to preserve and restore wetlands, their wildlife value ranks highly. The disappearance of suitable wetland habitat has greatly impacted the populations the Ardeidae. Several species are listed in Ohio as 'endangered', 'threatened', or 'of concern'.

The value of rare habitats is better understood when their inhabitants are known to have no other alternatives. As wetlands around the world are threatened and destroyed, these finely-tuned wetland hunters are similarly threatened.

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