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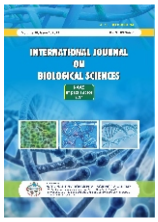

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# STUDY OF BEAK ADAPTATIONS AND THEIR FUNCTIONAL ROLES IN SOME BIRD SPECIES AT HARSI RESERVOIR, GWALIOR DISTRICT, (M.P.), INDIA

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## ABSTRACT

The wide variety of beak shapes in birds is commonly thought to reflect adaptations to different diets and feeding behaviours. However, because the beak also plays important roles beyond feeding and because most previously documented links between beaks and diet focus on size rather than shape it is still uncertain how much of beak shape diversity can be attributed to feeding ecology.

I quantified the relationship between beak shape and diet and found that diet is strongly and significantly correlated with beak shape in waterfowl. Ancestral reconstructions of beak shape, together with the inferred diet of the anseriform fossil Presbyornis, support filter-feeding as the ancestral condition for most waterfowl. This ancestral state was followed by multiple, significantly convergent transitions from a duck-like beak to a more goose-like form. The evolution of a goose-like beak is associated with increased leaf consumption, reduced intake of invertebrates, and greater mechanical advantage of the beak.

These findings indicate that feeding ecology has been the dominant selective pressure driving the diversification of waterfowl beak shapes, including the repeated, convergent evolution of geese. Rapid and convergent adaptation of the beak to feeding is therefore not unique to passerines, nor is it restricted to size-related changes in shape. The observed positive evolutionary relationship between mechanical advantage and herbivory further demonstrates that lever mechanics can account for the functional evolution of the kinetic upper beak in birds. Overall, the results suggest that functions other than feeding have likely played a relatively minor role in shaping overall beak diversity.

**No. of Pages: 8**

**Keywords:** Bird, Beak modification, Feeding behavior, Feet Adaptations Harsi Reservoir.

## INTRODUCTION

Bird beaks are modified jaws covered by a hard, horny sheath known as the rhamphotheca. Since birds do not have teeth, the beak carries out all the functions related to feeding, including capturing, holding, cutting, crushing, and swallowing food. Through natural selection, beaks have evolved in different shapes and sizes according to a bird's diet, feeding habits, and habitat, leading to adaptive radiation. Different bird species utilize a wide variety of food resources, such as seeds, insects, fish, nectar, fruits, and small vertebrates, through specialized beak adaptations. These adaptations enable birds to efficiently exploit specific food sources.

Beak size and shape are widely recognized as adaptations to the specific food resources available in a bird's environment (Storer 1971; Grant 1986; Gosler

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1987; Benkman & Lindholm 1991; Smith 1993; Gosler & Carruthers 1994; Weiner 1995; Barbosa & Moreno 1999; Bardwell et al. 2001; Grant & Grant 2002; Marquiss & Rae 2002; Parchman & Benkman 2002; Temeles & Kress 2003). However, other potential functions of the beak have received comparatively less attention. Recent comparative research suggests that certain features of beak morphology may also be influenced by additional environmental pressures, such as the need to control harmful ectoparasites (Marshall 1981; Moyer et al. in press). For example, species with longer maxillary overhangs tend to carry fewer feather lice than species with shorter overhangs (Clayton & Walther 2001). Similarly, within a single species, populations exhibiting longer overhangs have lower louse burdens than those with shorter overhangs (Moyer et al. 2002b). Collectively, these findings indicate that the maxillary overhang likely plays an important role in ectoparasite control through preening.

Specialized beaks help reduce interspecific competition, allowing multiple bird species to coexist peacefully within the same habitat. Studying different types of beaks offers valuable insights into avian diet, behaviour, habitat preferences, and evolutionary patterns among species.

The remarkable diversity of bird beaks allows different species to occupy separate ecological niches with very little overlap. This specialization represents one of the clearest examples of evolutionary adaptation in birds, illustrating how structure is shaped by function in the design of nature.

## MATERIALS AND METHODS

The study area, Harsi Reservoir, is constructed on the Parwati River and is located near Harsi village in Dabra Tehsil of Gwalior District, Madhya Pradesh (Fig.1). The reservoir lies approximately 100 km from Gwalior city. It was built across the Parwati River between 1928 and 1935. Harsi Reservoir is surrounded by hills and small hillocks on three sides and consists of a composite earthen dam. The dam is situated at latitude 25°57'59" North and longitude 77°58'00" East. The reservoir provides an important habitat and attracts a variety of migratory bird species.

Sampling was conducted from 6:00 a.m. to 11:30 a.m. in the morning and from 4:00 p.m. to 6:00 p.m. in the evening, with timings varying according to seasonal conditions. The study was carried out using two methods: (1) the Point Count Method (Javed and Kaul, 2002) and (2) the Line Transect Method. Photographs were taken using a digital camera (Nikon D-5300) for identification and documentation, while an Olympus binocular was used for visual observation and counting. All observed aquatic bird species were recorded and identified with the help of field guide books by Grimmett et al. (1999) and Ali (2006).

## BEAK MODIFICATION AND THEIR FUCTION IN SOME BIRD

Modern birds lack teeth, and their upper and lower jaw bones are elongated to form a distinctive beak or bill. This beak is covered by a horny sheath known as the rhamphotheca. As the forelimbs are modified into wings for flight, they lose many of their original functions. These functions are largely taken over by

**Fig. 1(a): A view of Harsi Reservoir.**

**Fig. 1 (b): A view of Harsi Canal.**

the beak and feet, making the beak serve the roles of both the mouth and the forelimbs. The beak plays a crucial role in obtaining and handling food, preening feathers, gathering and arranging nesting materials, offense and defence, and feeding the young. Beaks exhibit remarkable variation in shape, size, and structure, reflecting their adaptation to different modes of life and feeding habits.

Beaks exhibit great diversity in shape, size, and structure. Some of the important modifications and types are as follows:

**Seed-eating beak:**

Granivorous, or seed-eating, birds possess strong, stout, short, and conical beaks. These beaks are well adapted for cracking and crushing seeds. Examples include sparrows, finches, and cardinals. Birds with particularly strong and powerful beaks can break large and hard seeds, while those with smaller and comparatively weaker beaks are suited for picking up small seeds, which are either swallowed whole or crushed before eating.

**Cutting Beaks:**
Some birds have long, sharp, and slender beaks with cutting edges. These beaks are adapted for multiple functions such as cutting food, breaking eggs, and slicing fruits. An example of such a bird is the crow.

**House sparrow (*Passer domesticus*)**

**House crow (*Corvus splendens*)**

**Parakeet (*Psittacula krameri*)**

**Fruit-Eating Beak:**
Many birds feed primarily on fruits, and their beaks are specially adapted for breaking hard fruits, nuts, and tough seeds. Examples include parrots and hornbills.

In parrots, the beak is sharp, massive, deeply hooked, and extremely strong. This powerful structure enables them to crack open hard seeds and nuts with ease.

In hornbills, the beak is very large, heavy, and appears cumbersome. However, despite its size, it is relatively light in weight. The large beak, along with the casque on top, acts as a resonating chamber that helps the bird produce exceptionally loud calls.

**Insectivorous Beak:**
Many birds are insectivorous, and their beaks are specially adapted for catching insects, often while in flight. Generally, the beak is small, wide, and delicate. Examples include hoopoes, robins, and kingbirds.

In the hoopoe, the beak is long, slender, and slightly curved. It is used for probing into the soil or turning over leaves to search for insect grubs and pupae.

In flycatchers, such as kingbirds, the beak is short and strong. It is equipped with numerous rictal bristles at the base, which help in capturing insects during flight. Green bee-eater (*Merops orientalis*)

**Green bee-eater (*Merops orientalis*)**

**Wood-Chiselling Beak:**
This type of beak is long, straight, strong, and chisel-shaped. It is specially adapted for drilling into tree bark or wood to extract insect larvae and to excavate holes for nest building. The woodpecker is a typical example of a bird with this kind of beak.

**Black rumped Flameback (*Dinopium benghalense*)**

**Tearing and Piercing Beak:**
Carnivorous birds that feed on flesh, such as eagles, owls, kites, hawks, and vultures, possess short, pointed, sharp-edged, and strongly hooked beaks. These powerful beaks are specially adapted for tearing and piercing flesh. They are supported by well-developed mandibular muscles, which provide the strength necessary to grip and rip apart their prey. Examples include vultures, hawks, eagles, owls, and kites.

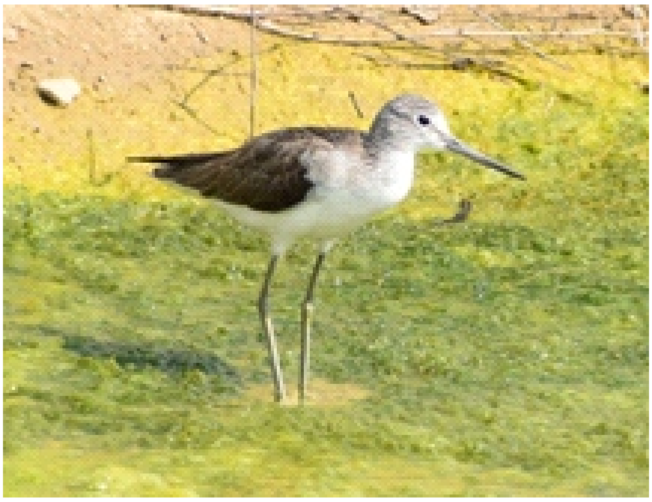
**Spotted Owlet (*Athene brama*)**

**Fish-Catching Beak:**
Aquatic birds possess long, strong, and sharply pointed beaks that are well adapted for catching fish, frogs, toads, and other aquatic animals. Examples include herons and kingfishers, whose beaks enable them to swiftly seize slippery prey.

In cormorants, the beak is long and narrow, with edges that bear sharp, backwardly directed tooth-like projections. These structures help in firmly gripping and holding fish once they are captured.

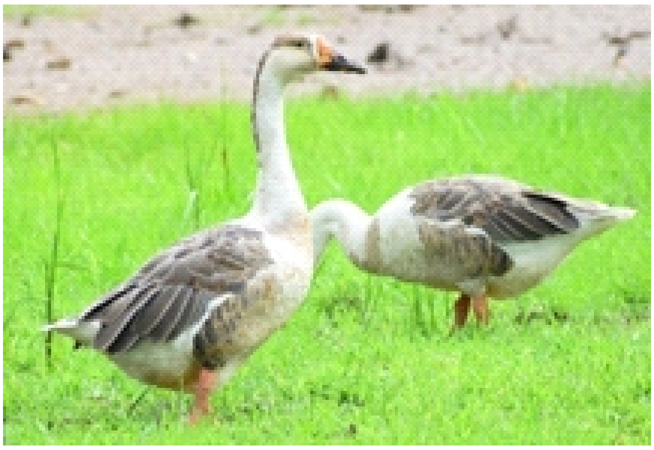
**Kingfisher (Halcyon smyrnensis)**

**Mud-Probing Beak:**
Birds with mud-probing beaks, such as lapwings, sandpipers, stilts, and snipes, have extremely long and slender beaks. These beaks function as elongated probes, allowing the birds to thrust them deep into water or soft mud in search of worms, larvae, and other small invertebrates. Examples include lapwings, sandpipers, stilts, and snipes.



**Common Greenshank (*Tringa nebularia*)**

**Water and Mud-Straining Beak:**
This type of beak is broad and flat, with the edges of the jaws modified into horny serrations or transverse lamellae. These lamellae act like sieves, allowing water and mud to pass out while retaining food particles in the mouth. Birds with this adaptation include ducks, teals, geese, and flamingos.



**Swan Goose (*Anser cygnoides*)**

**Spatulate Beak:**
The spoonbill has a highly specialized spatulate beak, which is flattened along its entire length and widens into a broad, spoon-like tip. This unique shape is adapted for dabbling in water and mud to search for insects, fish, worms, mollusks, and other small aquatic animals.

**Eurasian Spoonbill (*Platalea leucorodia*)**

**Grey pelican (*Pelecanus philippensis*)**

**Pouched Beak:**
Birds such as pelicans, which consume large quantities of fish, have a large beak equipped with an extensible gular pouch attached to the lower mandible. This pouch functions like a fishing net, allowing the bird to scoop up and hold significant amounts of water and fish at a time.

**Flower-Probing Beak:**
Birds that feed on the nectar of flowers develop long, slender, and pointed beaks. These beaks are specially adapted for reaching deep into flowers to suck nectar and sometimes capture small insects. Examples include hummingbirds and sunbirds.

**Purple Sunbird (*Cinnyris asiaticus*)**

**RESULTS AND DISCUSSIONS**
All birds possess bills, or beaks, and these structures vary greatly in form. Because of this wide variation, bills are often used as an important characteristic for distinguishing among bird species. Although birds lack teeth as adults, their embryos briefly develop them. The bill itself is covered by a hard, horny sheath. Many differences in bill shape are linked to specialized feeding habits. However, bills are not used only for feeding. They also play roles in several other behaviours. Some birds use their bills in ritualized displays, such as threat or appeasement displays. In addition, bills can be used for digging, building nests, sewing leaves together, drilling into wood, and performing many other tasks.

Watching different species of birds feed creates a sense of wonder at the wide range of foods they consume and the diverse shapes of their bills that are adapted for obtaining them. Birds eat many kinds of items, including nuts, hard and soft seeds, insects, larvae, roots, flowers, sap, fungi, nectar, carrion, and other

**Table 1: Type of Beak and Their Functional Roles in Some Bird Species at Harsi Reservoir, Gwalior district.**

| S. No. | Type of Beak | Shape | Use | Example |
|---|---|---|---|---|
| 1. | Seed-eating | Strong, Conical, Base broad, pointed tip | Cruses hard seed | sparrows, finches, and cardinals. |
| 2. | Cutting and Biting | Strong, long, slender, sharp edge | Cutting and biting | crow |
| 3. | Fruit-Eating | Sharp, hooked, strong | Breaking hard fruits | parrots and hornbills |
| 4. | Insectivorous | Small, wide, delicate | Catching flying insect | hoopoes, robins, and Green bee-eater |
| 5. | Wood-Chiselling | Long, straight, chisel like | Drilling into wood | woodpecker |
| 6. | Tearing and Piercing | Short, hooked, sharp | Scavenger birds | vultures, hawks, eagles, owls, and kites |
| 7. | Fish Catching | Sharply pointed, saw like | Capture fish, frog, etc | kingfishers |
| 8. | Mud-Probing | Long, slender | Catching flying insect | lapwings, sandpipers, stilts, and snipes. |
| 9. | Water and Mud Straining | Broad, flat, transverse lamellae | Straining food from mud and water | ducks, teals, geese, and flamingos. |
| 10. | Spatulate | Flat, spoon shape | Dabbling into water and mud | Eurasian Spoonbill |
| 11. | Pouched | Pouch like extension | Acts as fishing net | pelicans |
| 12. | Flower-Probing | Long, pointed | Nectar of flower | hummingbirds and sunbirds |

organic materials. The form of a bird's bill reflects its adaptation to particular types of food. Although it is impossible in a short discussion to describe all the variations in bill size and shape, examining a few examples helps illustrate the remarkable design and function of these structures.

In carnivorous birds of prey, such as falcons and owls, the beak functions like a meat hook. These birds usually capture prey with their feet and kill it by biting the neck and dislocating the cervical vertebrae. Their bills contain a feature called a tomial tooth on each side of the upper bill, located just behind the curved tip. A corresponding notch in the lower mandible fits into this tooth, helping the bird grip and tear flesh.

Birds that catch insects in flight, such as flycatchers, have broad, slightly hooked beaks. Many also possess long bristles or feathers at the base of the bill, which help them detect and capture fast-moving insects while flying.

Different shapes and types of bills and beaks serve a variety of functions. One fascinating specialization can be seen in the beaks of tropical fruit pigeons. These birds feed on large fruits, and their bills can open not only vertically but also horizontally, similar to the jaws of a snake when it swallows large prey. Another remarkable example is the beak of the toucan, which acts as a natural radiator, helping to cool the bird while it searches for food.

The woodpecker finch, found only in the Galápagos Islands, also shows an unusual adaptation. Unlike typical woodpeckers that use their long tongues to pull insects from trees, the woodpecker finch has a relatively short beak and tongue. To compensate, it uses tools such as cactus spines to probe into crevices and extract insects. In general, the shape of a bird's beak is closely related to its function. In some species, males and females have different types of beaks. The male has a relatively straight and sharp beak, while the female possesses a thinner, longer beak that curves downward. Males use their strong beaks to break open the tunnels of grubs found in dead wood. Once the tunnels are opened, females use their longer, curved beaks to extract the grubs. These differences in beak structure between males and females reflect a unique division of labour during feeding.

These examples clearly show how bird bills have evolved to suit specific feeding habits. In some species, the bill has become so specialized for a particular type of food that the survival of the bird depends entirely on the availability of that food source. Thus, the study of bird bills continues to provide valuable insights into evolution and the history of life on Earth.

Anatomically, a bird's bill consists of a compact, modified layer of epidermal cells that forms around the bony core of the upper and lower jaws, known as the mandibles. The bill is usually hard and thick, but it is not completely rigid. Depending on the species, bills can bend or twist to varying degrees. Despite their strength, bills are relatively light for their size, which is one of the many adaptations that help birds maintain the ability to fly.

Although birds do not have teeth, some bill structures perform functions similar to them. For example, certain bills have sharp edges that can cut or tear food. In addition, birds possess specialized bony and muscular structures that work together with the bill to handle the physical stresses involved in feeding.

It is also interesting to note the location of birds' nostrils. In most species, the nostrils are located near the base of the upper mandible, though there are a few notable exceptions.

In some bird species, such as pelicans, certain structures or projections develop on the bill only during the breeding season. These features are temporary and are shed after the reproductive period ends.

Another example is the puffin, which has a brightly coloured, triangular-shaped bill. During the breeding season, scales appear on both the upper and lower mandibles of the bill. These scales are believed to play a role in courtship and mating displays.

## CONCLUSION

Birds use their beaks for many important purposes. Different birds have different types of beaks that help them survive in their environment. Beaks are used for eating food, catching prey, breaking seeds, drinking water, building nests, feeding their young, and protecting themselves. The shape and size of a bird's beak are specially adapted to the type of food it eats and the way it lives. Therefore, the beak is a very important and useful part of a bird's body that helps it live and survive in nature.

Different bird species have evolved distinct bill shapes that help them obtain and consume specific types of food, illustrating the concept of adaptive radiation. A well-known example is the finches of the Galápagos Islands and the Hawaiian honeycreepers. These birds adapted to their environments by developing specialized bills suited to different food sources such as seeds, insects, and nectar.

In some species, sexual dimorphism is also seen in bill structure, meaning that males and females have different bill shapes or sizes. These differences often relate to their specific feeding roles. In addition, certain species experience seasonal changes in bill coloration, usually influenced by hormonal changes during breeding periods.

Overall, the wide range of shapes and specializations seen in bird beaks and bills reflects their evolutionary adaptations to different ecological niches and feeding strategies.

## REFERENCES


1. **Ali S.** (2006). The Book of Indian Birds, Bombay Natural History Society, Bombay.
2. **Barbosa A, Moreno E.** Evolution of foraging strategies in shorebirds: an ecomorphological approach. Auk. 1999; 116:712–725. [Google Scholar]
3. **Bardwell E, Benkman C.W, Gould W.R.** Adaptive geographic variation in Western Scrub-Jays. *Ecology*. 2001;82:2617–2627. [Google Scholar]
4. **Benkman C.W, Lindholm A.K.** The advantages and evolution of a morphological novelty. *Nature*. 1991;349:519–520. [Google Scholar]
5. **Clayton D.H, Walther B.A.** Influence of host ecology and morphology on the diversity of neotropical bird lice. *Oikos*. 2001; 94:455–467. [Google Scholar]
6. **Gosler A.G.** Pattern and process in the bill morphology of the great tit Parus major. *Ibis*. 1987;129:451–476. [Google Scholar]

7. **Gosler A.G, Carruthers T.D.** Bill size and niche breadth in the Irish coal tit Parus ater hibernicus. *J. Avian Biol.* 1994;25:171–177. [Google Scholar]

8. **Grant P.R.** Princeton University Press; Princeton: 1986. Ecology and evolution of Darwin's finches. [Google Scholar]

9. **Grant P.R, Grant B.R.** Unpredictable evolution in a 30-year study of Darwin's finches. Science. 2002;296:707. doi: 10.1126/science.1070315. [DOI] [PubMed] [Google Scholar]

10. Marquiss M, Rae R. Ecological differentiation in relation to bill size amongst sympatric, genetically undifferentiated crossbills Loxia spp. Ibis. 2002;144:494–508. [Google Scholar]

11. **Marshall A.G.** Academic Press; London: 1981. The ecology of ectoparasitic insects. [Google Scholar]

12. **Moyer B.R, Peterson A.T, Clayton D.H.** Influence of bill shape on ectoparasite load in Western Scrub-Jays. Condor. 2002b;104:675–678. [Google Scholar]

13. **Moyer, B. R., Pacejka, A. J. & Clayton, D. H.** In press How birds combat ectoparasites. *Curr. Ornithol.*

14. **Parchman T.L, Benkman C.W.** Diversifying coevolution between crossbills and black spruce on Newfoundland. Evolution. 2002; 56: 1663–1672. doi: 10.1111/j.0014-3820.2002.tb01478.x. [DOI] [PubMed] [Google Scholar]

15. **Smith T.B.** Disruptive selection and the genetic basis of bill size polymorphism in the African finch Pyrenestes. *Nature*. 1993;363:618–620. [Google Scholar]

16. **Storer R.** Adaptive radiation of birds. In: Farner D.S, King J.R, editors. Avian biology I. Academic Press; New York: 1971. pp. 149–188. [Google Scholar]

17. **Temeles E.J, Kress W.J.** Adaptation in a plant–hummingbird association. Science. 2003;300:630–633. doi: 10.1126/science.1080003. [DOI] [PubMed] [Google Scholar]

18. **Weiner J.** Vintage Books; New York: 1995. The beak of the finch: a story of evolution in our time. [Google Scholar]

19. **Ali S.** (2006). The Book of Indian Birds, Bombay Natural History Society, Bombay.

20. **Grimmett R., Inskipp C. and Inskipp T.** (2001). Pocket guide to the birds of the Indian subcontinent, Oxford University Press, Mumbai. https://doi.org/10.1016/japb.2018.03.001.

21. **Bird, David M.** The Bird Almanac: The Ultimate Guide to Essential Facts and Figures of the World's Birds. Rev. and updated ed. Firefly Books, 2005.

22. **Weiner, J.** The Beak of the Finch: A Study of Evolution in Our Time. Alfred A. Knopf, 1994.