Animal tongue evolution unsupported

Jerry Bergman

The tongue is a critically important organ required for speech, taste, capturing food, and especially for swallowing. It aids in food digestion by helping to break down food. This complex tongue system employed in each type of animal was designed for its specific environment and lifestyle. Evolutionists posit that the evolution of the tongue was a critical step to allow life to evolve from an aqueous to a terrestrial environment. The peer-reviewed scientific literature acknowledges that not only is evidence lacking for the evolution of the tongue, but even plausible stories of its evolution do not exist. This complex, well-designed organ is used in virtually all vertebrates, and can be modified to fit the requirements of a wide variety of animals.

All known amphibians, birds, and mammals have a tongue.[1] Major functions of the tongue include swallowing of food, enabling human speech and vocalization. The association of the tongue with speech is so close that expressions including 'hold your tongue' or 'watch your tongue' are universally understood to relate to language. It is also the primary organ of taste. Further functions include the manipulation of food to facilitate chewing and breaking down the food into small chunks (i.e., mechanical digestion) in order to allow digestive enzymes to efficiently break down food further (i.e., chemical digestion). It is critical for almost all terrestrials to enable the swallowing of food. It is also critical in all snakes and most lizards as a means of obtaining air samples to be placed for evaluation in the organ of the vomeronasal (Jacobson's) organ, located on the roof of the mouth.[2] Evolutionists concede that in order to pass the aquatic–terrestrial barrier, enabling food to be transported towards the esophagus, there must be a tongue supported by the hyoid bone.[3]

The tongue would be critically important as "a key innovation in the evolution of a terrestrial lifestyle as it allows animals to transport food particles through the oral cavity."[4] In fact, "Without tongues, few if any terrestrial vertebrates could exist."[5] Furthermore, the tongue is speculated to have been the basis of "even more complex behaviors—such as thinking—[which] could have arisen from the brain-power that initially evolved to coordinate the tongue."[6] In addition, the tongue is considered by evolutionists "a primary factor" in the "evolutionary success of amphibians" and, by extension, the evolution of all terrestrial animals.[7] The tongue, which has a critical role in food intake by vertebrates, exhibits significant morphological variations that allows animals to adapt to local environmental conditions.[7] Evolutionist's explain this variety as a result of mutations producing small differences in tongue design. Natural selection then fine-tunes these variations, resulting in the tongue design variety existing today. No evidence exists for this evolution but, evolutionists argue, it must be true even if evidence does not exist. All that exists, as will be discussed below, are several basic tongue design differences, and evolutionists use the natural selection of small differences explanation to account for these variations.

Physical traits of the tongue

Tongues differ in design regarding form and texture. Their variation is especially great in reptiles, so consequently the tongue is a major means of classifying lizards.[8] In contrast, the design of the tongue of snakes is consistently uniform.[9] Although the tongue also varies considerably in mammalian orders, the basic design is very similar.

The tongue's upper surface (dorsum) in most mammals is covered by thousands of taste buds housed in numerous lingual papillae. The five tastes are sweet, sour, bitter, salty, and umami (savoury, for tasting glutamates and nucleotides). It is also covered with mucous glands and often contains sensory organs. The tongue is kept moist by saliva, and taste can occur only when food is dissolved in water or another solvent which allows it to enter the taste buds.

Anyone who has bitten their tongue soon learns that the mammalian tongue is richly supplied with nerves and blood vessels. The complex blood supply and nervous system built into the tongue is controlled by the brain. The tongue receives its blood supply primarily from the lingual artery, a branch of the external carotid artery.[10]

Tongue design exhibits significant morphological variations in order for vertebrates to adapt to the environmental conditions of their specific habitats.[1] Many mammals, including dogs, members of the cat family, beavers, and even bats, have a very rough-textured tongue that enables them to remove dirt, oils, and parasites from their body. One extreme example is the okapi tongue, which is 30–36 cm (12–14 in) long; long enough for it to wash its eyelids, clean out its ears, and swat insects. In dogs, the

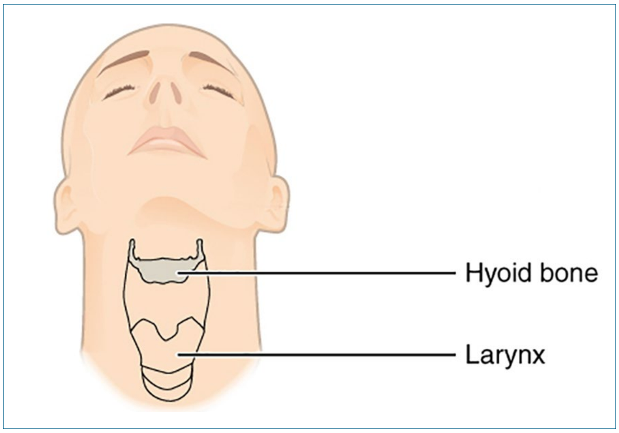

Figure 1. Illustration showing the location of the hyoid bone

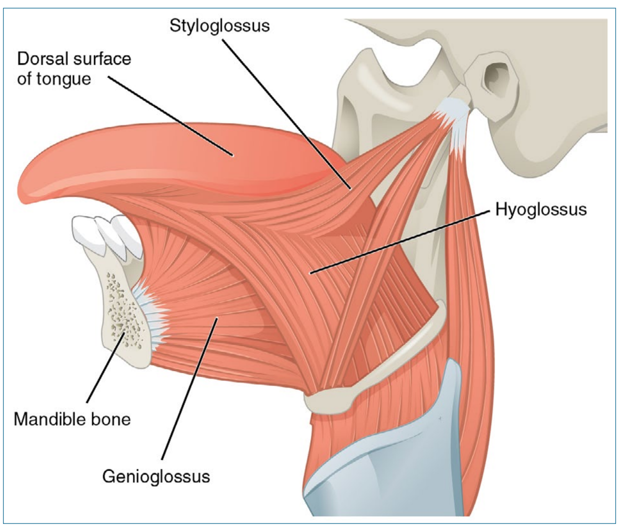

Figure 2. The human tongue's extrinsic muscles. The hyoid bone is not shown in this illustration.

tongue is critical to regulate their body temperature (achieved by panting), which causes cooling by evaporation from the tongue's surface. In humans, the tongue serves as a natural means of helping to swallow food, but also to help clean both the teeth and the mouth cavity.

The tongue's muscle control system

The complex architecture of the human tongue is composed mainly of skeletal muscle tissue.[11] The tongue shape and movement in most mammals is controlled by four *intrinsic* muscles. In contrast, its position in the mouth is controlled by four paired *extrinsic* muscles that are anchored to the hyoid bone (figure 1). The lingual frenulum, located below the tongue, extends from the floor of the mouth to the midline of the underside of the tongue. It functions to help anchor the tongue to the mouth and to help stabilize the tongue's movements.

The complex biomechanics of the tongue involve the floor of the oral cavity; these include sublingual salivary glands, submandibular ducts, the oral component of the submandibular salivary gland, the geniohyoid and genioglossus muscles, and the lingual and hypoglossal nerves (figure 2).[11] Sensory information is obtained by several afferent cranial nerves located in the brainstem to control the muscles that control both the tongue and the oropharyngeal system. At the back of the mouth, the tongue is anchored to the hyoid bone, the only bone in the body not connected to another bone.

With the exception of whales, mammalian tongues have all of the traits described above. Other non-mammalian tongue designs, though, have most of these traits, and many tongues employ other design innovations. The mammalian tongue, except in whales, can move back and forth and up and down, plus cover every area in-between, largely due to the complex set of nerves and muscles described above (see figure 3). The process of swallowing is very complex and involves not only the tongue, but also the muscles in the mouth, pharynx, larynx, and esophagus. Even minor damage to the nerves or muscles connected to the tongue significantly affects its function. Among other things, this can lead to difficulty in swallowing (dysphagia).[12]

Major tongue modifications

Some major design modifications include reptilian tongues, which, although very fleshy, are not protrusible, with some notable exceptions, such as chameleons.[7] Most reptiles have a forked tongue split into two distinct tines at the tip. They use the tip of their tongue to transport smell molecules to their vomeronasal receptors in the roof of the mouth. Their forked tongue allows them to sense from which direction a smell emanates, a very useful trait in seeking prey.[13] The crocodilian tongue is mostly flat, lacks intrinsic musculature, and is attached to the floor of the mouth along its entire length.[14]

All amphibians, which are cold-blooded vertebrates, including frogs, toads, salamanders, and caecilians, have tongues. The tongue is a critical part of the amphibian anatomy both for capturing and consuming food.[15] In many species, their muscular tongues can be protruded to catch flying insects. The highly mobile tongue in amphibians is attached to the front of the mouth. Its design allows the amphibian to rapidly extend and retract it to capture prey.[16] To achieve this goal, the tongue is usually covered with a sticky substance that both helps to immobilize their prey and prevent it from escaping. Many frogs can shoot their tongues out a considerable distance in order to catch prey. In short, the tongue of amphibians is essential to their survival.

Avian tongues

Bird tongues lack an internal intrinsic musculature and rely on the external musculature to move. Birds are unique in the animal kingdom for many reasons, including having feathers, lacking teeth, and their ability to fly.[17] Their tongue can be very long or short, feathered at the tip, employ barbs of various sizes, and display specific adaptations for feeding.[18] Many have a slender design, covered with horny papillae. The best example is the woodpecker's long tongue (see figure 4). The finely tuned tongues of woodpeckers make their high-impact pecking possible in both surprising and ingenious ways.[19] Their tongue is so long that it extends around the back of their skull. The woodpecker tongue is fully a third of the total body length to enable them to reach deep into tree crevices in search of insects (figure 4). The tongue cavity design also helps to protect the bird's brain from the impact resulting from them pecking trees.[20]

A hummingbird's forked tongue is both split and lined with hair-like extensions called lamellae. The hummingbird inserts its tongue into a nectar-rich flower to draw nectar, its principal source of nourishment, up into its body. Its tongue can extend out as far as its bill is long.[21] These few examples illustrate the variety of tongue designs existing in the animal world.

The evolution of the tongue

The problem with the supposed evolution of the tongue is related to the wider question of the evolution of language. The problem in both areas is that after the "publication of *On the Origin of Species* … [the literature was] filled with pseudoevolutionary speculations … scholars produced a series of baseless proposals".[22] No fossil or other evidence exists for the evolution of the tongue from a non-tongue, nor for the evolution of one tongue design into another design, as outlined in the paragraphs above. I found the Wikipedia articles on the tongue very comprehensive, covering details of tongue design and function. But they failed to discuss claims about its evolution even though Wikipedia commonly covers evolution in articles related to biology. The main article only had one reference source addressing tongue evolution.

Because the fossil record has failed to reveal evidence of tongue evolution, evolutionists are forced to infer tongue evolution from taxonomic relationships deduced from tongue structure.[23] Consequently, a great deal of speculation is required to create even a hypothetical phylogeny.[24] Of note is that McDowell's phylogeny differs considerably from the orthodox phylogeny. For example, the 'toothless palate' appearance of the living *Varanus* lizard (the Komodo Dragon) is because its teeth, like in snakes, are embedded in the gums rather than affixed to the jawbone surface. Though this design is used in a good number of living lizards, the Komod's is one of the most snake-like. This is a major reason why the orthodox phylogeny views it as the best candidate for the evolution of snakes from lizards.[25] McDowell argues for another candidate, listing five reasons for his claim. This example illustrates the difficulty of inferring phylogeny from living animals.

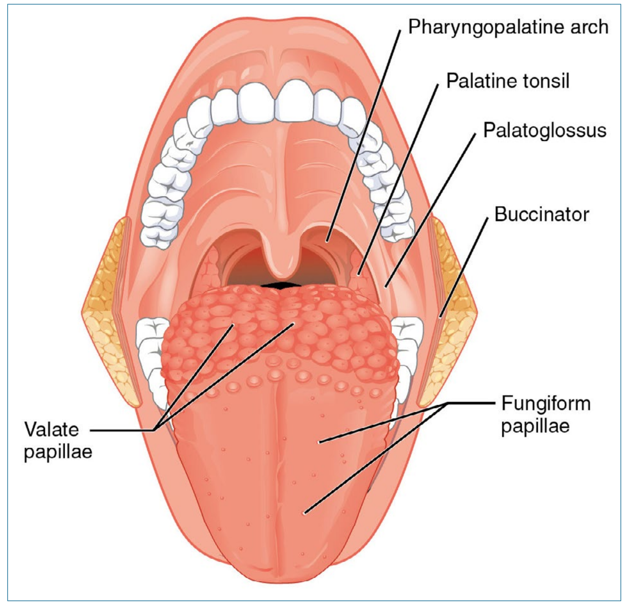

Figure 3. The basic parts of the mammalian tongue

Much variety exists in the tongue's design to meet the requirements of animals that employ the tongue system to survive. The dominant evolutionary theory since the turn of the last century is that the tongue evolved from the floor of the mouth of fish:

> "Although fishes possess no functional *tongue* the material out of which a tongue is to be constructed is present in the form of the anterior part of the hyobranch apparatus. The anterior border of this complex lies in the floor of the mouth cavity, following the outlines of the jaw, and by certain actions of the visceral muscles may be projected upwards so as to form a noticeable elevation [emphasis in original]."[26]

This fleshy fold is called a 'tongue' only because it is assumed by evolutionists to be a forerunner of a tongue that evolved into the modern tongue.[27] No evidence exists of the evolutionary progression from the floor of the mouth in a fish into a functional vertebrate tongue. Nor have any 'just-so' stories been able to provide a viable route from the fish mouth floor to the terrestrial tongue design. Reasons for this include the fact that the fish mouth floor lacks intrinsic muscles and virtually every other trait of a tongue. Those animals that lack a tongue rely on sucking water into their mouth and then to the back of the throat where food is swallowed. This

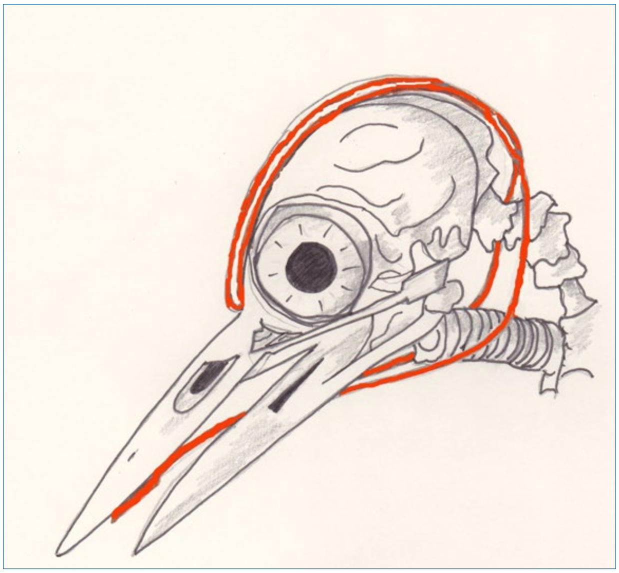

Image: Jimfbleak, Wikimedia / CC BY SA 3.0

Figure 4. The woodpecker tongue which wraps around its head

process is similar to how humans use a drinking straw to suck a beverage into their oral cavity.

The problem for evolution is to evolve a tongue from a system that sucks in water containing food into the mouth. "But on land surrounded by air, this sucking mechanism does not work. Instead, land-dwelling vertebrates evolved a tongue that catches and moves food to the back of the throat for swallowing."[28] Urquhart admits that although "how the first fish began to move on land and breathe in air" may be theorized, "how vertebrates switched from feeding via suction to evolve a tongue remains unclear."[28] Another problem is that tongue design varies so greatly that evolutionists postulate that it evolved many times through convergent evolution, the independent evolution of similar features in species not closely related.[17]

The mudskipper experiment

Atlantic mudskippers have been researched in an attempt to understand the supposed water-to-air transition of life because they can take in oxygen both in water and in terrestrial environments. In order to achieve this, it requires that "mudskippers carry water in their mouths, which they spit forwards to help grab food then suck it back to swallow, mimicking the action of a tongue."[28] This involves movement of "the hyoid bone in the floor of their mouth upwards prior to feeding—the opposite of what fish do to feed underwater."[28] Fish generate enough suction to draw both prey and the surrounding water into their buccal cavity in order to transport it towards the esophagus.

The hyoid bone causes buccal volume to *increase* by depressing the buccal cavity floor. This expansion of the buccal cavity volume draws the water-containing food into their buccal cavity. Significantly, "The steps in the transformation of the hyoid (and its associated muscles and ligaments) from a suction-generating structure to supporting and moving the tongue, however, remain unknown."[3] We do know that, on land, for mudskippers using flows of air to transport food into the buccal cavity is virtually impossible.[3] For this reason, the functional tongue system would have had to first evolve in the water before fish could live on land to take in food.

However, if the tongue system evolved while the fish lived in water, the fish could not survive, as it would lose its ability to suck water while evolving into the tongue design. The two very different designs are opposed to each other—which is why any possible method of aquatic-to-terrestrial conversion remains unsolved. This is one of many lethal problems of tongue evolution for evolutionists.

To gain insight into this conversion was the goal of the Michel *et al.* research team. They compared the mouth movement of the mudskipper with how newts eat using their tongue and found that "mudskippers combine the tongue-like grabbing action of some land amphibians with the sucking mechanism of fish."[28] Evolutionists have speculated that some system in-between sucking and the tongue buccal intake system must have existed

> "… from which a fleshy tongue could have evolved. This has never been considered a possibility, until now… . To test the 'water tongue's' effectiveness, the team placed food on a feminine hygiene pad to absorb the water. The mudskippers could still capture the food in between their jaws, but in most cases they could no longer swallow the food"[28]

This documented the failure of their theory. The Michel *et al.* research team admitted:

> "However, a fundamental gap in this hypothesis is that the tongue-based intra-oral transport by modern terrestrial salamanders moves a prey that is already brought deep into the mouth cavity by the foregoing protrusion and retraction of the tongue: it does not explain how the first land-dwelling tetrapods managed to bring prey inside their mouth cavity. Consequently, this hypothesis presents an incomplete scenario of the evolution of terrestrial feeding."[29]

To solve this problem, Michel *et al.* proposed hypothetical solutions, admitting that "It remains an open question which of these two scenarios is the most plausible."[30] They concluded that,

> "To capture and swallow food on land, a sticky tongue supported by the hyoid and gill arch skeleton has [supposedly] evolved in land vertebrates from aquatic ancestors that used mouth-cavity-expanding actions of the hyoid to suck food into the mouth. However, the evolutionary pathway bridging this drastic shift

in feeding mechanism and associated hyoid motions remains unknown."[31]

Although much variation exists, depending on the environment, all tongues are modelled on the same basic design. The postulated evolution of vertebrates is used as a guide to speculate on the tongue's early evolution in fish. For example, Iwasaki writes that, as vertebrates evolved into quadrupedal land animals, the tongue likewise was required to evolve, necessitating

> "Keratinization of the lingual epithelium … to have been acquired concomitantly with the evolution of amniotes … . We can infer that the main role of the tongue is to facilitate eating on land, in cooperation with other organs within and near the oral cavity. It is proposed that, during adaptation from a wet to a dry habitat in the evolution of vertebrates, stratification and keratinization are the most important changes in the lingual epithelium."[32]

This explanation involves many assumptions, including that land animals evolved from aquatic animals. The creation worldview proposes that tongue-design differences resulted from design constraints in differentiating an aquatic from a terrestrial creature. Much speculation is required to postulate a viable transformation from reptiles to mammals, such as postulating that:

> "Primitive mammals may have originated from completely terrestrial reptiles, with keratinization of the lingual epithelium being irreversible during evolution. The same may be true for birds."[33]

Some evolutionary dead ends

Although "a tongue-like piston is found in the oral opening of the adult lamprey … this organ is not homologous to the tongues of gnathostomes." Thus, this tongue-like piston is not regarded as an evolutionary precursor to the vertebrate tongue.[34] Neither is the cyclostome plunger-like 'tongue' of the jawless fish superclass Agnatha in the phylum Chordata considered a precursor to the vertebrate tongue. It has protractor and retractor muscles that serve as a 'boring organ' using a very different design than a vertebrate tongue.[35] In amphibia, the moveable 'tongue' is a very different design than the vertebrate tongue. Nonetheless, evolutionists have attempted to determine possible scenarios that explain the variety of tongue designs achieved by evolution:

> "Comparisons of the morphology and function of the lingual epithelium among extant vertebrates suggest that adaptation has been a factor in the evolution of vertebrates. It seems likely that a movable tongue appeared during adaptation from an aquatic environment to life on land. It is possible that the appearance of the tongue in amphibia proved useful for terrestrial feeding and allowed adaptation to a larger range of habitats."[36]

Another problem is that certain auxiliary structures used for food uptake appear to have existed in jawless fishes, but are absent in jawed fishes, then are again re-employed in tetrapods. The fold of tissue on the floor of the mouth of the Chondrichthyes and Osteichthyes, while it can be raised or lowered slightly, is covered with epithelium and does not serve any of the tongue's functions.[37] The tongues of lampreys are so different from vertebrate design that they are postulated to have evolved separately, evolutionists concluding that "The lamprey tongue and the tongues of tetrapods originated independently during evolution."[34]

Although the tongue, as soft tissue, is rarely preserved in the fossil record, the skeletal bones associated with the tongue, including the hyoid bone, are more often preserved. The hyoid bone functions as an attachment system for the tongue and muscles in the floor of the oral cavity above, the larynx below, and the epiglottis and pharynx behind.[38] The presence of a hyoid bone and related jaw evidence support the conclusion that vertebrates had a functional tongue very early in history.[39] Although no evidence for the evolution of the tongue exists, "It is postulated that a mobile, muscular tongue evolved when tetrapods first began to feed in a terrestrial environment."[7] In summary, although claims in the literature on the evolution of the tongue are common, none has stood the test of time. As Michel *et al.* admitted, in addition to the lack of fossil evidence,

> "… modern tetrapods show no evidence for an intermediate evolutionary step in combining tongue-retraction transport with foregoing inertial transport: feeding behaviors of reptiles mapped on a phylogenetic tree suggests that their ancestor already used a protruding tongue to capture prey, and so do virtually all extant amphibians that feed on land."[30]

Summary

Although a wide variety of oral-cavity designs are evident in vertebrates, no evidence of tongue evolution exists, either from tongueless fish or from one tongue design to another significantly different design. Many tongue differences exist in animals, as illustrated by the woodpecker and the hummingbird design, but no evidence exists for how these differences could have evolved from some basic tongue design except to claim that they did. The differences in tongue design are so great that the tongue is postulated to have evolved independently numerous times, despite lacking evidence that it evolved even once.[40]

Consequently, all claims for tongue evolution from life-forms without tongues, as well as evolution of the tongue in one type of animal into the tongue of another type of animal, are based on speculation rather than empirical evidence. Thousands of 'living fossils' exist (such as the turtle), but claimed 'millions-of-years-old' life-forms have not provided insight or support for tongue evolution. In summary, University of Antwerp functional morphologist Sam Wassenbergh concluded that "how tongues came about 'is one of the biggest mysteries in our evolutionary history'."[5]

References

1. Iwasaki, S., Evolution of the structure and function of the vertebrate tongue, *J. Anatomy* **201**:1–13, 2002; p. 1.
2. Smith, K.K. and Mackay, K.K., The morphology of the intrinsic tongue musculature in snakes (Reptilia, ophidia): functional and phylogenetic implications, *J. Morphology* **205**(3):307–324, 1990.
3. Michel, K.B., Heiss, E., Aerts, P., and Van Wassenbergh, S., A fish that uses its hydrodynamic tongue to feed on land, *Proceedings of the Royal Society B: Biological Sciences* **282**(1805):20150057, p. 5, 22 Apr 2015.
4. Taha, A.M., Comparative anatomical, histological and histochemical study of tongue in two species of insectivorous vertebrates, *Australian J. Basic and Applied Sciences* **7**(1):401–410, 2013; p. 401.
5. Pennisi, E., Tales of the tongue, *Science* **380**(6647):786–791, 2023; p. 786.
6. Pennisi, ref. 5, p. 791.
7. Iwasaki, S., Erdoğan, S., and Asami, T., Evolutionary specialization of the tongue in vertebrates: structure and function; in: Bels, V. and Whishaw, I.Q. (Eds.), *Feeding in Vertebrates*, Springer Link, New York, pp. 333–384, 2019; p. 335.
8. McDowell, S., The evolution of the tongue of snakes, and its bearing on snake origins, Ch. 8; in: Dobzhansky, T., Hecht, M.K., and Steere, W.C. (Eds.), *Evolutionary Biology*, Appleton-Century-Crofts, New York, pp. 191, 193, 1972.
9. Iwasaki *et al.*, ref. 7, p. 344.
10. Parada, C., and Chal, Y., Mandible and tongue development, *Current Topics in Developmental Biology* **115**:31–58, 2015.
11. Kajee, Y., The biomechanics of the human tongue, *International J. Numerical Methods in Biomedical Engineering* **29**(4):492–514, 2013.
12. Sasegbon, S. and Handy, S., The anatomy and physiology of normal and abnormal swallowing in oropharyngeal dysphagia, *Neurogastroenterology & Motility* **29**(11), 2017.
13. Greene, H., *Snakes: The evolution of mystery in nature*, University of California Press, Berkeley, CA, pp. 12, 28, 1997.
14. Schwenk, K. *Feeding: Form, function and evolution in tetrapod vertebrates*, Academic Press, New York, p. 44, 2011.
15. Duellman, W.E. and Trueb, L., *Biology of Amphibians*, Johns Hopkins University Press, Baltimore, MD, pp. 23, 233–238, 1994.
16. Goin, C. and Goin, O., *Comparative Vertebrate Anatomy*, Barnes & Noble, New York, p. 88, 1966.
17. Johnson, N., The avian tongue, Jun 2014.
18. Iwasaki *et al.*, ref. 7, pp. 350–355.
19. Heisman, R., The amazing secrets of woodpecker tongues, abcbirds.com, 10 Jun 2021.
20. Jung, J.-Y. *et al.*, Structural analysis of the tongue and hyoid apparatus in a woodpecker, *Acta Biomaterialia* **37**:1–13, 2016.
21. Skutch, A., *The Life of the Hummingbird*, Crown Publishing Group, New York, pp. 43–44, 1973.
22. Bickerton, D., Can biomusicology learn from language evolution studies? Ch. 10; in: Wallin, N. *et al.* (Eds.), *The Origins of Music*, MIT Press, Cambridge, MA, p. 154, 1999.
23. McDowell, ref. 8, p. 193.
24. McDowell, ref. 8, pp. 194–265.
25. McDowell, ref. 8, pp. 265–270.
26. Wilder, H.H., *History of the Human Body*, Henry Holt, New York, p. 283, 1909.
27. Kingsley, J.S., *Outlines of Comparative Anatomy*, P. Blakiston's Son & Co., Philadelphia, PA, p. 242, 1926.
28. Urquhart, J., Tongues may have evolved from a mouthful of water, *New Scientist*, 18 Mar 2015.
29. Michel *et al.*, ref. 3, p. 5.
30. Michel *et al.*, ref. 3, p. 6.
31. Michel *et al.*, ref. 3, p. 1.
32. Iwasaki, ref. 1, pp. 1–2.
33. Iwasaki, ref. 1, p. 8.
34. Iwasaki, ref. 1, p. 2.
35. Kingsley, ref. 27, p. 242.
36. Iwasaki, ref. 1, p. 9.
37. Goin and Goin, ref. 16, p. 87.
38. Sokoloff, A. and Burkholder, T., Tongue structure and function; in: *Craniofacial Muscles. A new framework for understanding the effector side of craniofacial muscle control*, Springer, New York, pp. 207–227, 2014.
39. Frayer, D. and Nicolay, C., Fossil evidence for the origin of speech sounds, Ch. 14; in: Wallin, N.L., Merker, B., and Brown, S. (Eds.), *The Origins of Music*, MIT Press, Cambridge, MA, 1999.
40. Pennisi, ref. 5, p. 788.

Jerry Bergman *has nine academic degrees, including five masters and two Ph.Ds. His major areas of study for his graduate work included anatomy and physiology, biology, chemistry, and psychology. He is a graduate from Wayne State University in Detroit, Medical University of Ohio in Toledo, University of Toledo, and Bowling Green State University. He has taught at college level at The University of Toledo Medical College, The University of Toledo, Bowling Green State University, and other schools for close to 50 years in the areas of biology, microbiology, anatomy and physology, chemistry, biochemistry, geology, astronomy, and psychology. A prolific writer with close to two thousand publications to his credit, including 60 books and monographs, Bergman is now retired from teaching but is still writing and speaking full time.*