THE TONGUES OF BIRDS.

BY

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The tongues of birds have been not exactly overlooked, but somewhat neglected, by ornithologists, and it is the object of this paper to note a few of their interesting features and to call attention to some of the problems connected with them, in the hope that our younger ornithologists may devote some time to their study. The collecting of skins is undoubtedly the most attractive form of ornithological work, and I do not wish to be looked upon as in anyway disparaging this branch of ornithology with its bearing on the questions of individual variation, color changes, geographical distribution, and the like; but there are so many points on which general deductions can only be made through the patient accumulation and careful sifting of facts that it seems at least unfortunate that more attention is not paid to them by those who have the leisure to do so. It is an easy matter for anyone engaged in collecting skins to gather abundant material for the study of tongues,[1] and it seems a pity that so many good specimens should have been wasted when they could so readily have been preserved.

While the tongue is so intimately related to the beak, there is less unity of purpose between them than might at first sight be supposed, and the size or shape of the one is no criterion as to the size or shape of the other. The beak of a bird serves the purpose of a hand. With it he chips the shell and introduces himself to the world; with the beak the bird gathers its food, preens its feathers, builds a nest. He may use it, like the parrots, in climbing, or, like the Carolina parrakeet, may even hang himself up to sleep on the inside of a hollow stump. It would sound well to continue the simile, and say that as the bird's beak is a hand, so the tongue is a finger; but the true and the beautiful are by no means as synonymous as one might wish, and all that can be truthfully said is that sometimes, or to some extent, the tongue

[1] Thus, my friends, Messrs. William Palmer, E. J. Brown, and the late R. S. Matthews, while collecting the birds of Washington and the vicinity, have supplied me with a large amount of material, all the more valuable because it was quite fresh.

plays the rôle of a finger. This use of the tongue may be very evident as when a parrot manipulates a nut, turning it about with the tongue while holding it between the mandibles, and it seems quite evident, too, that many graminivorous birds, like the crossbill and goldfinch, must use their tongues in a similar manner to extract seeds. But if not used as a finger, the indications are that the tongue does play an important part either in obtaining food or in its subsequent

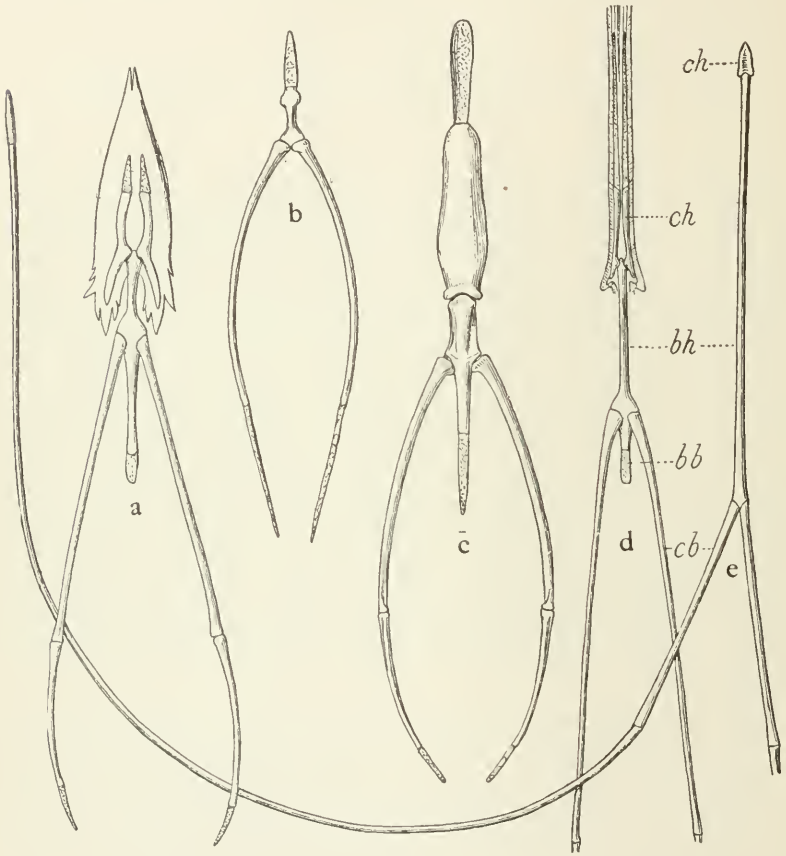


Fig. 1.

manipulation. As there are very many things still to be learned regarding the food of birds, and as we can seldom watch them closely in their native wilds, it is in the majority of cases impossible to directly prove the relation between the food and the tongue. If positive evidence is lacking, however, circumstantial evidence is plentiful, and there are numerous cases where it is difficult to account for the shape of the tongue, if it does not have a direct bearing on the question of food.

Before passing on to a consideration of the tongue, it will be well to look at the bones which support and form a part of it, for these have

to do not only to some extent with the shape of the tongue, but on them depends the power of movement, of extending and retracting the tongue, and the ability to suck up the nectar of flowers. These little bones (fig. 1 *a*), when all are present, are eight in number, the three foremost corresponding to the hyoid, the five hindmost to the first gill arch, of a fish. The shape of these may vary somewhat, the proportions much more, but, after all, the differences between them are not very great. The tongue is attached principally to the two foremost bones, while the others are mainly concerned with the motions of the tongue, furnishing attachment for the muscles by which it is protruded and retracted, as well as serving as guides to make the apparatus run true. The varying proportions of the bones tell something of the importance of the tongue and something of its use. If the foremost bones are well developed, then the tongue is thick and fleshy, as in the duck, and has considerable to do in obtaining or manipulating food (fig. 1 *c*). If the foremost bones are small, or are represented by cartilage, then the tongue plays an insignificant part, as in the cassowary, or is a mere rudiment, as in the cormorant and pelican (fig. 1 *b*). If the hindmost bones are long, the tongue is protruded in getting food, and the length of these bones is a direct measure of the extent to which the tongue can be extended. The proportions of the intermediate bones, the ceratobranchials, have to do with the length of the bill.

The hyoid probably has a more direct relation to the tongue in birds than in any other group of vertebrates. Among mammals the most important office of the hyoid is to support the larynx, and this duty it often performs very effectively. In reptiles the hyoid has much to do with breathing, and in turtles, whose ribs are so tied up as to be of no use in respiration, the hyoid may be seen working backward and forward, forcing air into the lungs. The hyoid of frogs is mostly ornamental, being a hint that the tadpole had an elaborate and well-developed system of gills, which was put off together with the tail. In fishes the hyoid forms a firm support to the gill arches, although it also supports the tongue. In birds the two ceratohyals, or glossohyals, as they are sometimes called from their intimate connection with the tongue, are embedded in the tongue and usually terminate in cartilages which are prolonged for some distance forward well toward the tip of the tongue. Their posterior portions end in the main posterior points of the tongue (fig. 1 *a*).

There is an intimate relation between the dermis and the epidermal layer of the tongue, and if a thin tongue is held up to the light, the little blood vessels may be readily seen running into the harder portion. At the same time, if a tongue is allowed to macerate for a little, the connection between the dermis and epidermis is easily broken down and the horny external layer may be slipped off as a glove is drawn from a finger.

A very curious thing happens in the titmice—to be exact, this is

known to happen in *Parus carolinensis*, the only species in which I have examined the young and traced the growth of the tongue; but the tongues in this group are so similar that I have ventured to generalize from an observation, which is, I admit, a very bad practice—where the epidermal sheath of the tongue is perforated in front, allowing the cartilaginous anterior portions of the ceratohyals to project through.

The smallest and simplest style of tongue is found in some of the fish-eating birds, those which, like the cormorant and pelican, gulp down their food whole, and here tongue and hyoid are mostly, or entirely, in the soft pouch. Flesh eaters, too, have comparatively simple tongues, and so have many of our little song birds, such as the thrushes; and as this type of tongue is the ground plan on which much more complicated tongues are found, it will serve as a good starting point. The tongue of the robin is rather thin and horny, somewhat thicker toward the base, or hinder portion, slightly split or feathered at the tip, and provided at the back with a row of fleshy backwardly-directed spines. With the exception of these spines, whose purpose seems to be to start food in its downward course, this tongue bears no evidence of adaptation to any particular kind of food.

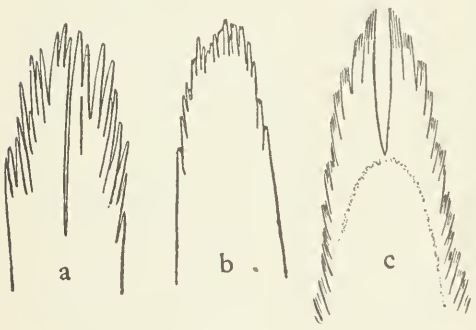


Fig. 2.

This style of tongue, thin, slightly cleft, and more or less feathered at the tip, may be called the typical pattern for thrushes, warblers, and the great host of our North American birds. An almost endless number of tongues may be derived from this simple pattern by slight changes in proportions, amount of curvature, number of posterior points, and extent of feathering. Trim off the tip a little and curl up the edges, and we have the tongue of a shore lark (Plate 1, fig. 12); lengthen the tongue and feather it more at the tip, and we have the tongue of a rusty blackbird, and between these two we have no end of varieties. Still, among all these there is no special modification hinting at adaptation to some particular kind of food, for most of our small birds have considerable latitude in the way of diet.

Not only is there much specific variation in birds' tongues, but there is also a considerable amount of individual variation in the degree of feathering or whipping out of the tip. Part of this is due to wear, for some birds, like some people, appear to use their tongues more than others, with a consequent loss of the delicate fringing at the tip, but part of it is due to natural variation, for the unworn tongues of two birds of the same species may have a very different aspect. Whether or not the outer sheath of the tongue is molted, as some birds shed

and renew the horny covering of their beaks, is not known to me, but if this is not the case, the growth of the tongue must be comparatively rapid to prevent it from being worn to the quick.

The tongues of the North American honeycreepers of the genus *Certhiola* are an elaboration of the warbler type, being finer and more complicated in detail, long and slender, much hollowed out toward the tip, deeply cleft, and decorated with long incurved featherings. An Australian honeysucker, *Acanthorhynchus tenuirostris*, carries the fining down of parts to an extreme, having a delicacy of structure which can be appreciated only with a glass. The tongue of still another genus of North American honeycreepers, *Coereba* (fig. 3 *c*), differs from those just described in the matter of detail by splitting the tongue

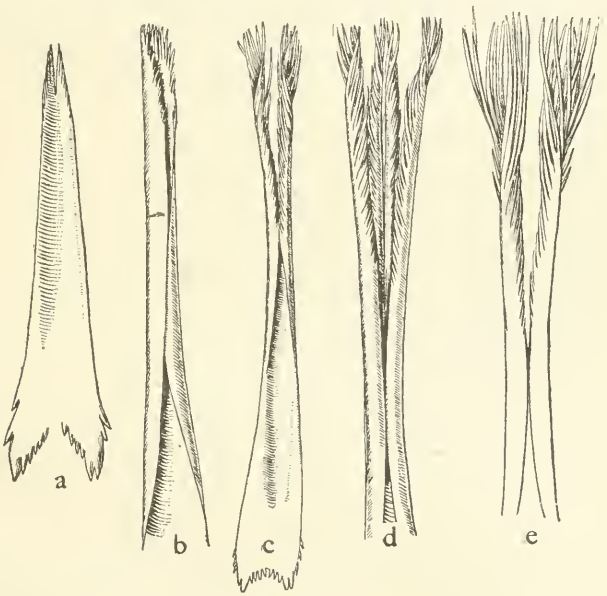


Fig. 3.

more deeply and increasing the length of the feathering which rolls inward from either edge so that the tongue ends in two spiral brushes of extreme delicacy. The Hawaiian and Australian honeysuckers show a still farther advance on this, for in them each of the main branches of the tongue is cleft in twain, and these may again bifurcate so that the tongue ends in four or eight small spiral brushes. By a very little modification a true suctorial tongue, such as that of the sunbirds, *Cinnyris*, or of the genus *Hemignathus* (fig. 3 *b*), may be derived from that of the warbler type. If, instead of splitting and feathering the tip, the edges of the tongue are rolled upward and inward until they meet, a tube will be formed, and this tubular tongue, as well as the others, is subject to various modifications and may become quite complicated. In the sunbirds the edges simply touch each other and

the tube is single; in *Vestiaria* the edges pass by and the tube becomes triple, while by division it may terminate in two or four tubes, as the case may be.

The real effectiveness of a tubular tongue depends not only on the tongue itself, but on the action of the hyoid and its controlling muscles, just as the usefulness of a pump does not lie in the pipe, but in the valves. The manner in which suction is effected has been well described by Doctor Gadow,[1] and is, in substance, as follows: By the contraction of the mylo and serpio hyoid muscles which underlie the tongue, that organ, together with the larynx, is pressed up against the roof of the mouth. The tongue is then protruded and the larynx and back part of the tongue depressed, thus creating a vacuum between tongue and palate, and into this vacuum will flow any liquid into which the tip of the tongue may have been inserted. The fringing of the tip of the tongue, or its conversion into a spiral brush, causes liquid to

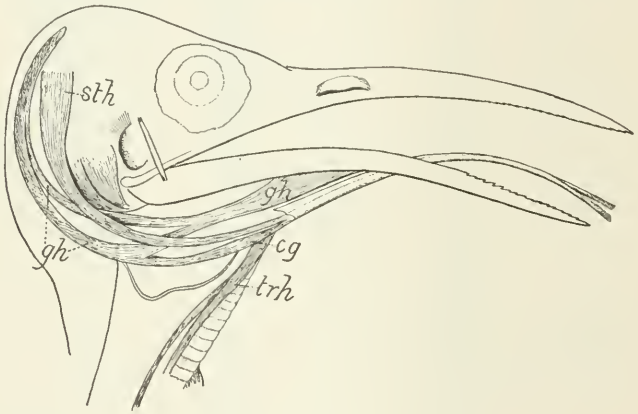


Fig. 4.

ascend to the tubular portion of the tongue by capillary attraction, and thus overcomes any tendency of air to enter the tongue and prevent suction.

If we go back to what we may call the primitive pattern of tongue and make the upper surface thick and fleshy instead of thin and horny, we will have such a tongue as characterizes many, if not the majority, of seed-eating birds, while between the two come such tongues as those of the swifts and swallows, owls and goatsuckers. The amount of variation in these last-named groups is not great, and there is no wide departure from what may be termed the standard pattern. The tongues of the titmice and nuthatches may either be looked upon as modifications of the sparrow type, or as having a pattern of their own. Those of the titmice (Plate 1, fig. 14) suggest a four-tined pitchfork, and can be better understood from the figure than from any description. Those

[1] Proc. Zool. Soc. Lond., 1883, pp. 62-69.

of the nuthatches, while constructed on the same plan as those of the titmice, are more complicated, and resemble a series of rods placed side by side.

The tongues of swifts and swallows (Plate 1, figs. 1–3), just referred to, may be called typical insectivorous tongues, since they are found in birds whose food consists largely, if not entirely, of insects. This style of tongue is slightly fleshy, but not so thick as in the seed eaters, and in a great many species bears, toward the base, numerous papillæ, while in others papillæ are distributed more or less regularly over the tongue. These may be small and blunt, or they may assume the form of spines; in any case their object appears to be to work food backward toward the gullet. Furthermore there is often a plenteous supply of sharp backwardly directed points about the glottis, all to the end that food may glide safely past the windpipe. The tongues of owls (Plate 2, fig. 5), while having an individuality of their own, are intermediate between those of the goatsuckers and the diurnal birds of prey, being rather fleshy and armed with small spines on the posterior half. In some birds of prey there is a system of large pores opening on the base of the tongue, and in advance of the glottis.

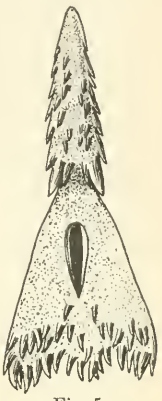


Fig. 5.

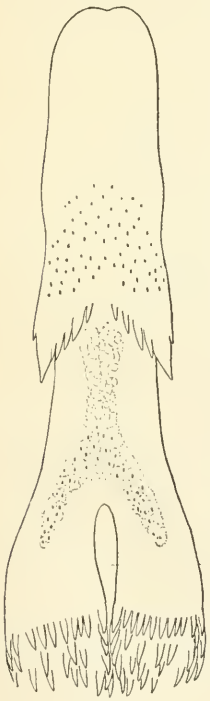


Fig. 6.

Many water birds, such as gulls, sandpipers, rails, and herons, may also be said to have simple tongues, and so do at least some of the pigeons and fowls. From their simplicity it would seem that the tongues of these birds do not play an important part, unless, indeed, the slender tongues of some of the snipe family have a delicate sense of touch which enables them to discriminate in the matter of food, and this, from the horny condition of the tip, seems rather improbable.

There are other types of tongues found in other groups of birds, while there are many birds whose tongues have an individuality of their own and decline to follow any general pattern; in fact, when we come to know more about the tongues of birds, that the exceptions are as numerous as the resemblances, or, as with the votes on a preliminary ballot, there are many scattering.

The humming birds, so far as known, have a uniform pattern of tongue (Plate 2, fig. 12), long and slender, deeply cleft, with each slender branch bordered with a delicate inrolled membrane, which gives the

front half of the tongue the character of a double tube.[1] The base of the tongue is formed by the soft, fatty, fibrous envelope of the basihyal, which stretches like a mass of india rubber when the tongue is protruded, and, like rubber, contracts when the tongue is retracted. Immediately in front of this is the dense cartilaginous sheath of the ceratohyals, forming the bulk of the tongue and practically consisting of two portions—that investing the bony part of the ceratohyals and that surrounding their cartilaginous prolongations. The difference between the character of the epidermis of these two parts is such that in badly preserved or slightly macerated specimens the anterior part may be slipped off intact. If this is done, it will be found to be a hollow tube of cartilage, grooved along the middle above and below, and slightly grooved along the upper, outer surface. This tube is soon divided by a vertical partition, while a little more than halfway between base and tip the tongue forks, each branch continuing hollow for some distance. A fold, or flange, commences near the base of the tongue, on either side, and continues to the tip, growing wider and

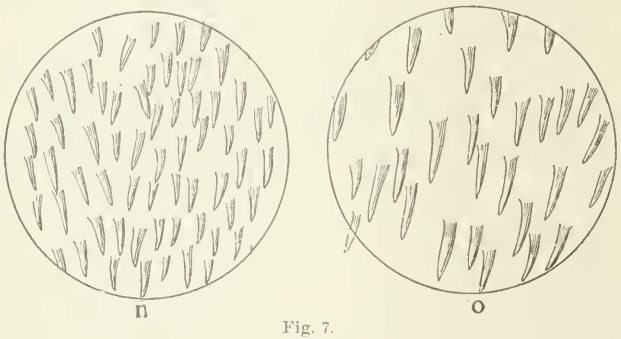


Fig. 7.

thinner as it proceeds, until along the branches it becomes a very delicate membrane. As previously stated, it is these two membranous portions which become rolled into tubes, and when the tongue of the humming bird is spoken of as being tubular, it is these branches which are meant. To say that the tongue consists of two parallel muscular tubes is quite erroneous, as is the statement that the tubular portion of the tongue is drawn back into a muscular sheath. It seems a little doubtful if the tongue of the humming bird can be a true suctorial tongue, for the tubes formed by the anterior part of the tongue are not long enough to reach the back of the mouth, neither are they tight along the edges, although, owing to their small size, liquid would undoubtedly rise in them by capillary attraction. Gosse, who observed these birds in confinement, seems to furnish the clue to the action of

[1] Much confusion and bickering have been caused by more or less loose descriptions of humming birds' tongues, unaccompanied by good explanatory figures, and it has been vigorously asserted, and quite as vigorously denied, that the tongue of the humming bird was hollow, or tubular.

the tongue when he says that in drinking sirup the tongue is protruded for half an inch or so and worked rapidly backward and forward. In doing this the tip of the tongue would naturally fill with sirup when protruded, and when the tongue was retracted it would either be brought far enough back for a vacuum to be formed at the base or liquid could be forced out by pressing the tip against the roof of the mouth as the tongue was again extended.

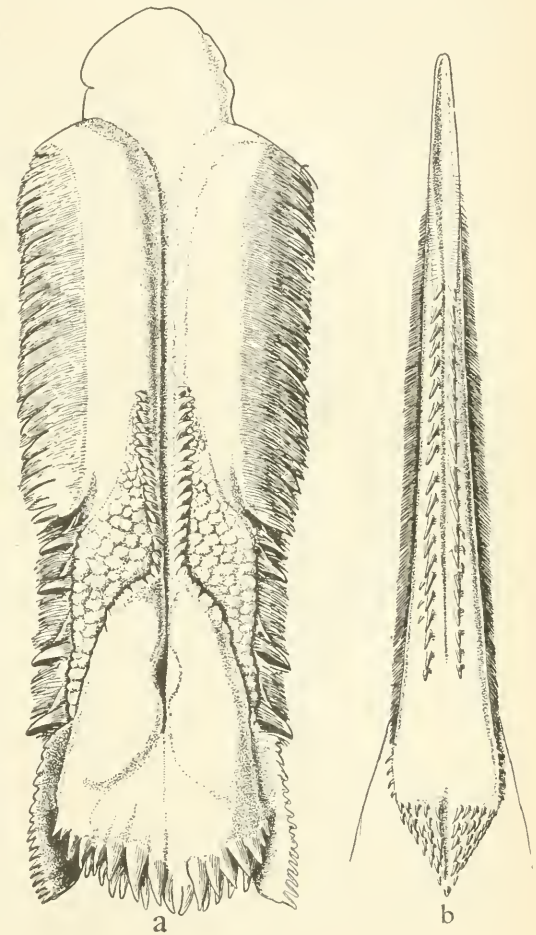


Fig. 8.

The tongues of woodpeckers (Plate 2, figs. 8, 9), so far as they have been observed, are constructed on one plan, being long, slender, and pointed, round or elliptical in cross section, slightly barbed on either side at the tip, and with the upper surface covered with backwardly directed spines so minute that it needs a magnifying glass to properly appreciate them (fig. 7). There are no spines at the base of the tongue itself, as in most birds, for the tongue, when retracted, is withdrawn into a sheath, or makes its own sheath, as when a gloved finger is drawn back and the glove doubles upon itself. In most species the tongue is very extensile—the sapsuckers (*Sphyrapicus*) are exceptions—and since, as said in the beginning, the extensibility of the tongue depends on the length of the epibranchials, we find that these are very long, in most cases even longer than the head. Such being the case, some special provision has to be made for disposing of the hyoid when the tongue is retracted, and this provision is obtained as follows: The two branches of the hyoid pass up over the back of the skull, coming together at the top, and then (usually) turn to the right and continue onward over the forehead, onward beneath the nostril into the beak, and thence quite to the tip. Still another method is found in some

individuals where the ends of the hyoid curl about the eyeball instead of dipping into the beak, but this is found less often than the other. The tongues of some species—the flicker, for example—have but one or two barbs at the tip, others have half a dozen, and still others twenty to thirty, the barbs becoming finer as they become more numerous. Finally, in the sapsucker the barbs have degenerated into stiff hairs, which, instead of raking backwards, stand out from the side like the bristles on a chimney cleaner.

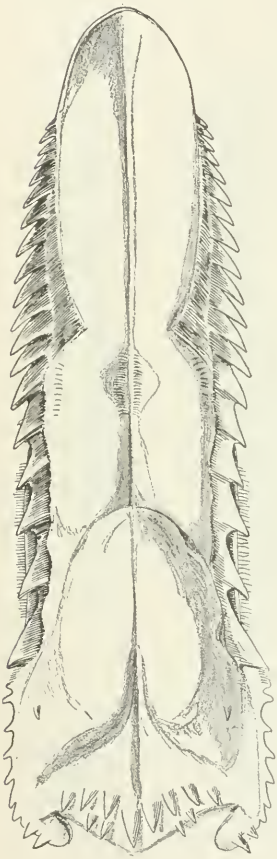


Fig. 9.

It is interesting to note the modifications by which the hyoid is made effective as a probe, or spear, since for this last purpose it should be as rigid as possible. The two foremost pieces of the hyoid are much reduced in size, and are united to form a leaf-shaped point, although we have a hint, in the presence of a groove or perforation, that this point really consists of two bones. The shaft of the spear is partly formed by the long and slender basihyal and partly by the two ceratobranchials, which are brought close together when the tongue is protruded. These last are attached directly to the rear of the basihyal—an arrangement which increases the power of the thrust. (See fig. 1 *e*.)

The ducks have one general type of tongue, and while the mergansers differ much from the broad-beaked species, as might naturally be expected, it is possible here, as among the woodpeckers, to see underlying the modifications that all are but variations of one type. The sides of the tongue are provided with several series of overlapping bristles, interspersed with tooth-like projections, which are simply bristles on a large scale, or bristles fused together, as the horn of a rhinoceros is composed of agglutinated hairs. There may be only three or four of these teeth toward the base of the tongue, as in the ring-necked duck (fig. 8 *a*), or they may preponderate, as in the Canada goose, a species in which they reach the maximum of development, the tongue being armed on either side with a row of saw-like teeth. Finally, there may be no teeth at all, as in the hooded merganser (fig. 8 *b*), whose slender, gutter-shaped tongue bears on its edges only a series of bristles pointing obliquely upward. Ordinarily they point obliquely downward, suggesting a straw-thatched roof, but in any case their apparent function is that of a strainer to aid in securing food.

Other types of tongues are doubtless found in other groups of birds, but whatever the general plan on which the tongue is built, the variations in the execution of details appear to be almost infinite in number, as if nature had striven to have no two tongues exactly alike.

It is a question of interest to ornithologists whether the tongues of birds are modified according to the nature of the food, or whether, underlying all modifications, are certain definite plans of structure indicative of relationship. If the tongues of birds do bear a direct relationship to the character of the food, or the manner in which it is taken, we should not be surprised to find that birds which are only distantly related have very similar tongues, provided their food or feeding habits were similar, while near relatives might be very different in this respect. We should also be able in many cases to see the connection between the shape of the tongue and the character of the food. On the other hand, if the tongue is of any value in classification, it should be possible to tell something of a bird's affinities from an examination of the tongue. Theoretically, too, we would suppose that the less the tongue was used the smaller the probability of its being adaptively modified, and that the chances of finding a likeness between the tongues of the various members of a group ought to be greatest in a group in which the tongue played an unimportant part in getting or manipulating food. Conversely, differences between the tongues of nearly related species might be expected if those species used their tongues, while the greater the similarity between the two species in the manner of obtaining food the greater would be the chances of finding their tongues modified in the same manner, although small differences might be expected since the chance of absolute identity would be small.

To make a fair test of the correctness or incorrectness of these propositions, we should compare nearly related species with entirely different food habits, or very distinct species with similar food habits.

Were we to be guided by the members of a group like the humming birds, we would at once say that the tongues did have a decided value in classification, since we find that all these little birds have the same style of tongue. To offset this, we have the fact that the humming birds have all practically the same habits, eat the same kind of food, and take it in the same manner, so that really they throw no light on the subject. The penguins present an analogous case, for while the tongues of all are strikingly similar to one another, the habits and food of all are also similar.

The tongues of woodpeckers, at least those of our North American species, can readily be distinguished as such, although they differ considerably from one another in length and in the amount and character of the barbing at the tip. It is an easy matter to follow, step by step, the changes by which the sharp barbed tongue of the pileated woodpecker is converted into the brushy tongue of the sapsucker, and as we pass from species to species we can see the barbs becoming more

numerous, longer, and more slender, changing from barbs to bristles and from bristles to hairs, until the transformation is complete and the spear has become a brush;[1] or, if we strip off the adaptive disguises, we will find that the hyoid, whether long or short, is constructed on the same plan, and may see at a glance that *Ceophlœus* and *Sphyrapicus* are akin to one another. At the same time it is an equally easy matter to tell considerable of the food and habits of a woodpecker from the tongue, to make a guess as to the probable preference of the species for animal or vegetable food, and to say whether it spears grubs, eats insects, or probes after ants. Here the tongue apparently points two ways, not only indicating relationship, but more than hinting at the dietary habits of its possessor.

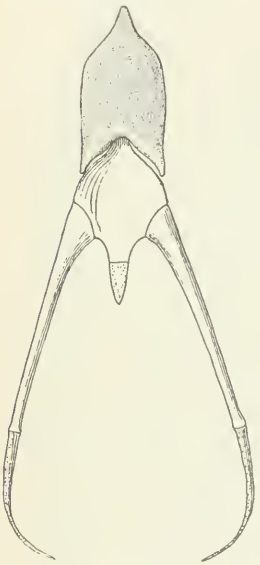


Fig. 10.

The tongues of the swifts have a very close resemblance to one another, so do those of the swallows (Plate 1, figs. 1–3), and the two groups are so much alike in this respect that it is extremely difficult, if not impossible, to tell them apart. Now externally swifts and swallows are very much alike, their food and the mode of taking it is identical, and yet structurally the two are widely separated, pterylosis, skeleton, muscles, alimentary canal, all being different. Here, then, if we followed the tongue, we should be at sea, and in this case we may feel pretty safe in saying that the resemblances between the tongues of swifts and swallows are due to the influence of food. The case may be further strengthened by showing that birds not very closely related to either swift or swallow resemble them in the general style of their tongues, and this is true of at least the cedar bird and one of the trogons (Plate 1, figs. 4 and 5), *Priotelus*, while further examination will probably bring to light further resemblances.

The owls furnish good examples of similarity of tongues arising from, or at least correlated with, similarity in habits, for the genera *Megascops*, *Asio*, *Nyctea*, *Speotyto*, and *Strix* have tongues built on the same plan, the main difference being that *Strix*, which is a long-faced bird, has a long tongue. It might perhaps be assumed that because the beak was long the tongue would of necessity be long also, but this by no means follows, for the short tongues of the long-billed kingfishers warn us that there is no necessity in the case at all, and that the length of the bill is no index to the length of the tongue.

The opposite state of affairs, differences among related birds, is well

[1] Lucas, F. A. The Tongues of Woodpeckers. Bulletin No. 7, U. S. Department of Agriculture, Division of Ornithology and Mammalogy.

shown in certain finches where members of the same genus even may have quite different tongues, although the direct connection between these differences and the character of the food may not be evident. The tongues of the several species of the genus *Spinus*, shown on Plate 2, figs. 6–10, although constructed on the same general plan, offer considerable differences of detail, our common goldfinch, *Spinus tristis*, being the most highly specialized. The members of the genus *Melospiza* differ even more among themselves, and while Lincoln's sparrow, *M. lincolni*, may have the tip of the tongue perfectly simple, the song sparrow, *M. fasciata*, has the tip quite elaborately fringed. So common a bird as the English sparrow has an aristocratically unique tongue, quite unlike that of any of his relatives on this side of the Atlantic, and still other finches might be adduced to show how great is the range of form in this family.[1]

The hooded and the red-breasted mergansers are quite different from each other in their tongues, and yet, so far as we know, there is not sufficient difference in the nature of their food to account for this discrepancy; neither does the fact that they have been deemed sufficiently far apart to be placed in two distinct genera signify, for the swifts and swallows show that birds belonging in different suborders even may have very similar tongues.

The reasons for the modifications of the tongue of the red-breasted merganser are evident; the two rows of sharp, reverted spines on the tongue, which are more nearly teeth than are the serrations of the bill, are to help the bill in catching and swallowing small fishes, while the feathering of the edge may be to aid in capturing still smaller fry, although it is quite as probable a hint of affinity with the other ducks. The tongue of the hooded merganser, which is like that of a duck reversed, is a puzzle whose solution calls for a better knowledge of the food and habits of the bird.

Finally, not to needlessly multiply instances of differences between the tongues of related species, it may be said that while the petrels have much similarity in food and habits they differ very materially in the matter of tongues.

It is next in order to produce circumstantial evidence in the shape of tongues whose peculiarities can be apparently explained by the character of the food or known habits of feeding, in order to demonstrate the close relations between the two. The number of evident adaptations would undoubtedly be very much increased could we observe birds more closely in their native state, for we might then see the relation some curious tongue bore to some special kind of food, or catch the particular trick of manipulation for which it was adapted.

Most insectivorous birds swallow their prey without any special manipulation, and this, to a great extent, is true of the fruit eaters.

[1] Lucas, Frederic A. The Taxonomic Value of the Tongue in Birds. The Auk, XIII, No. 2, April, 1896, pp. 109–115.

Graminivorous birds either need, or find it advantageous to have, some special device for getting seeds or for husking them before they are swallowed, and these have fleshy tongues, which, together with the character of the tip, must enable them to hold seeds well while removing the husk. Apparently the delicacy of the tongue is no direct criterion of the quality of the work done by it, for the cow bunting, which cleans small seeds most dexterously, is by no means remarkable for the character of its tongue, and, on the other hand, it is not easy to see why the song sparrow should have a tongue so finely fringed at the tip.

Such scoop-like tongues as those of the cross-bill and goldfinch (Plate 1, figs. 6 and 11) seem to bear a direct relation to the procuring of food and to be specially designed for extracting seeds. Were thistles in seed the year around, the tongue of *Spinus tristis* would be a clear case of adaptation, for it appears admirably fitted either for gathering thistle seeds or for removing the husks after they are gathered. However, Mr. Palmer tells me that the gullet of the goldfinch often contains finely-comminuted food, almost in the condition of dough, and the tongue is very likely the instrument by which this state is brought about. Knowing that the shore lark feeds largely on small grass seeds, the tongue is seen to be a nice little scoop for collecting them, while the miniature pitchforks of the titmice (Plate 1, fig. 14) are equally good instruments for picking spiders, eggs of insects, and similar food, out of the crevices into which these little birds are perpetually prying, although it would apparently be more efficient could it be protruded farther.

The brush-tongued birds, the South American *Coerebidæ* and the honeysuckers of the Sandwich Islands and Australia, are good examples of similarity of tongue structure in very different birds due to adaptation for a certain kind of food or method of obtaining it. These birds frequent flowering trees, either for the nectar of the blossoms or for the insects which lurk therein, or for both, and their tongues are all more or less extensile, and brushy at the tip. Whether the liquid is actually sucked up or whether it is dipped up by the tongue tip as by a swab, the result attained is the same.

Some of the brush-tongued birds certainly eat insects and spiders, but the tongue would seem to be as well adapted for sweeping up these as for sucking up sweets. Moreover, it should be remembered that a tongue may be a special adaptation for a given kind of food, procured at certain seasons of the year, and therefore specially desirable only for a short time. Or a bird may prefer a particular kind of food, and yet eat something else when that is not to be had, just as the hairy and downy woodpeckers have tongues specially adapted for spearing grubs, and still eat beechnuts. We know that humming birds are fond of sweets, and we are equally certain that the bulk of their food consists of insects,[1] and if they dine on one and make their dessert of the

[1] Lucas, Frederic A. The Food of Humming Birds. The Auk, X, No. 4, October, 1893, pp. 311-315.

other, the adaptive features of the tongue can still be accounted for. So the fact that the honeycreepers eat berries and the honeysuckers and sunbirds spiders and insects does not disprove the primary adaptation of their tongues for getting nectar. At the same time it is to be noted that tubular and brushy tongues occur only (?) in birds of tropical or subtropical regions, where flowers are to be found throughout a great part of the year.

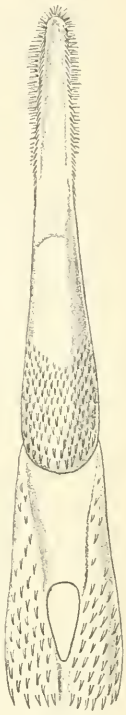


Fig. 11.

The woodpeckers afford a good illustration of the modifications of the tongue according to the nature of the food, for in this group each variation in the tongue appears to be accompanied by a corresponding variation in the general character of the food.[1] The flicker has fewer barbs on its tongue than any other species; also it has one of the longest tongues and the largest salivary glands. Now, the flicker eats more ants than any other species, these insects constituting about forty per cent of its food, and it not only obtains them from the surface of the ground but by probing for them in anthills. The three-toed woodpecker heads the list of eaters of grubs, and this bird has, in addition to a long and fairly well barbed tongue, an unusually good bill for cutting into trees; in fact, it may be said that the two go together, for similar conditions are found in other species. The little downy woodpecker comes next as a destroyer of wood-boring larvæ, unless it should be exceeded by the great pileated woodpecker, with its powerful beak and sharp tongue. The sapsucker seems to eat no boring grubs, but as an ant-eater it stands next the flicker, the contents of its stomach averaging thirty-six per cent of ants. It is, as its popular name implies, a drinker of the sap of sweet trees, and it also preys upon the flies and other insects which are attracted by the exuding sap. The brushy tongue (fig. 11) is well adapted for procuring such articles in the bill of fare, but it is quite useless for extracting grubs from their hiding places, being barbless and capable of but little extension. The red-headed woodpeckers, although possessed of very extensile tongues, have these organs rather feebly barbed, while they also have

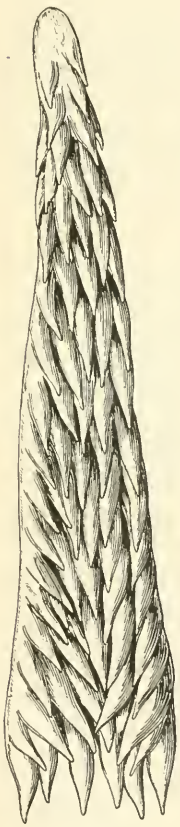


Fig. 12.

[1] Beal, F. E. L. Preliminary Report on the Food of Woodpeckers. <Bulletin No. 7, U. S. Department of Agriculture. Division of Ornithology and Mammalogy.

pointed, little compressed beaks, not well adapted for cutting into wood, and the members of the genus *Melanerpes* are seemingly more fond of fruit than are any other species, and they are the most omnivorous of the North American woodpeckers.

In all these cases the relation between form and food is plain, but there are many others in which peculiarities of the tongue imply modification for some special end without that end being obvious. Such is the case with the penguins, whose curious spiny tongues (fig. 12) must play some definite part in their domestic economy, but whether modified for the catching of fish, crustaceans, or squids is not quite clear, although such tongues would seem to be well adapted for catching small crustaceans.

The tongues of our American vultures too should have some bearing on their diet, and possibly their hollow shape and roughened edges are for the purpose of rasping meat from bones, although it may be that the adaptation is to quite a different end. The long, slender, feathery tongues of toucans present another riddle which can only be answered by one having full knowledge of their habits, although it certainly seems a curious adjunct to the stout beak with which it is associated.

From what has been said above it will be seen that, in a large number of cases, there is certainly a clear relation between the shape of the tongue and the character of the food; that some closely related birds differ as to their tongues while distant relatives present similarities that seem to be connected with similarities in their food, and that, on the whole, the modifications of the tongue appear to be adaptive and do not offer characters that can be safely used in classification.

A final point, deserving of study, is that of the changes which take place during growth and the rapidity with which they are performed. As is well known, the bills of long-beaked birds are acquired after hatching, and long tongues grow in a like manner, such a slender, extensile tongue as that of the humming bird being developed between the time the young emerges from the egg and the date of quitting the nest. The first indication of the long branches into which the tongue is ultimately divided consists of a little notch in the tip, while there is only the merest rudiment of the membrane which is to border these branches (Plate 2, figs. 10–13).

The growth of the tongue, and of the hyoid as well, must be quite as rapid in woodpeckers as in humming birds, for in a full-fledged nestling of the downy woodpecker, a species which is provided with one of the longest of tongues when adult, the hyoid barely reached to the center of the skull, between the eyes. The same specimen showed also that the barbs at the tip of the tongue are developed comparatively late, for the only trace of spines in this bird, which would have soon quitted the nest, was a number of reflexed hairs representing the upper series on the tongue of the sapsucker. It seems prob-

able that the barbs make their appearance at, or shortly after, the time the bird leaves the nest, when the young cease to be fed and begin to feed themselves, but a little positive evidence in the shape of specimens is needed to settle the question.

In birds with shorter tongues than those just described the changes during growth are, naturally, not so marked; but even in tongues like those of the chimney swift and screech owl there is a very obvious difference between the tongue of the embryo, or nestling, and that of the adult.

The question of growth with its change of form connected with change of food, or in the manner of getting it, is worthy of careful consideration, but perhaps the most interesting problem presented by the tongues of birds is whether underlying the infinite modifications of the tongue are certain definite forms which may be of use in classification, or whether these forms are all cases of adaptation to particular kinds of food.

The evidence seems to point plainly in the latter direction, but what is needed is a large collection of carefully sifted and assorted facts.

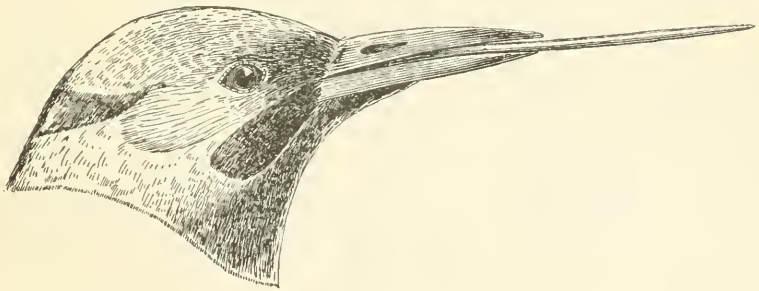


Fig. 13.

EXPLANATION OF TEXT FIGURES.

Fig. 1. Relation of the hyoid to the tongue.
a. Hyoid of Pewee, *Sayornis fuscus.*
b. Hyoid of Cormorant, *Phalacrocorax urile.*
c. Hyoid of Muscovy Duck, *Cairina moschata.*
d. Hyoid of Humming-bird, *Selasphorus rufus.*
e. Hyoid of Flicker, *Colaptes auratus.*
All figures drawn to the same absolute scale.
ch. Ceratohyal.
bh. Basihyal.
bb. Basibranchial.
cb. Ceratobranchial.

Fig. 2. Changes produced in tongues by wear.
a. Tip of tongue of Cape May Warbler, *Dendroica tigrina*, unworn.
b. Tip of tongue of Mourning Warbler, *Geothlypis philadelphia*, much worn.
c. Tip of tongue of Chestnut-sided Warbler, *Dendroica pennsylvanica*, unworn.
All figures greatly enlarged.

Fig. 3. Modifications of tubular and brushy tongues.
a. Connecticut Warbler, *Geothlypis agilis.*
b. Honeysucker, *Hemignathus olivaceus.*
c. Honey Creeper, *Certhiola bahamensis.*
d. Australian Honeysucker, *Tropidorhynchus* sp.
e. Tip of tongue of Honey Creeper, *Certhiola bahamensis.*
All figures much enlarged.

Fig. 4. Principal muscles of the tongue, after Gadow.
cg. Ceratoglossus.
gh. Geniohyoideus.
sth. Stylohyoideus
trh. Tracheohyoideus.

Fig. 5. Tongue of a Goatsucker, *Nyctidromus albicollis*, enlarged.

Fig. 6. Tongue of a hawk, *Archibuteo lagopus sancti-joannis*, showing system of pores, enlarged.

Fig. 7. Spines on basal portion of tongues of Woodpeckers, greatly enlarged.
n. *Dryobates scalaris.*
o. *Melanerpes erythrocephalus.*

Fig. 8. a. Tongue of Ring-necked Duck, *Aythya collaris*, enlarged.
b. Tongue of Merganser, *Merganser serrator*, enlarged.

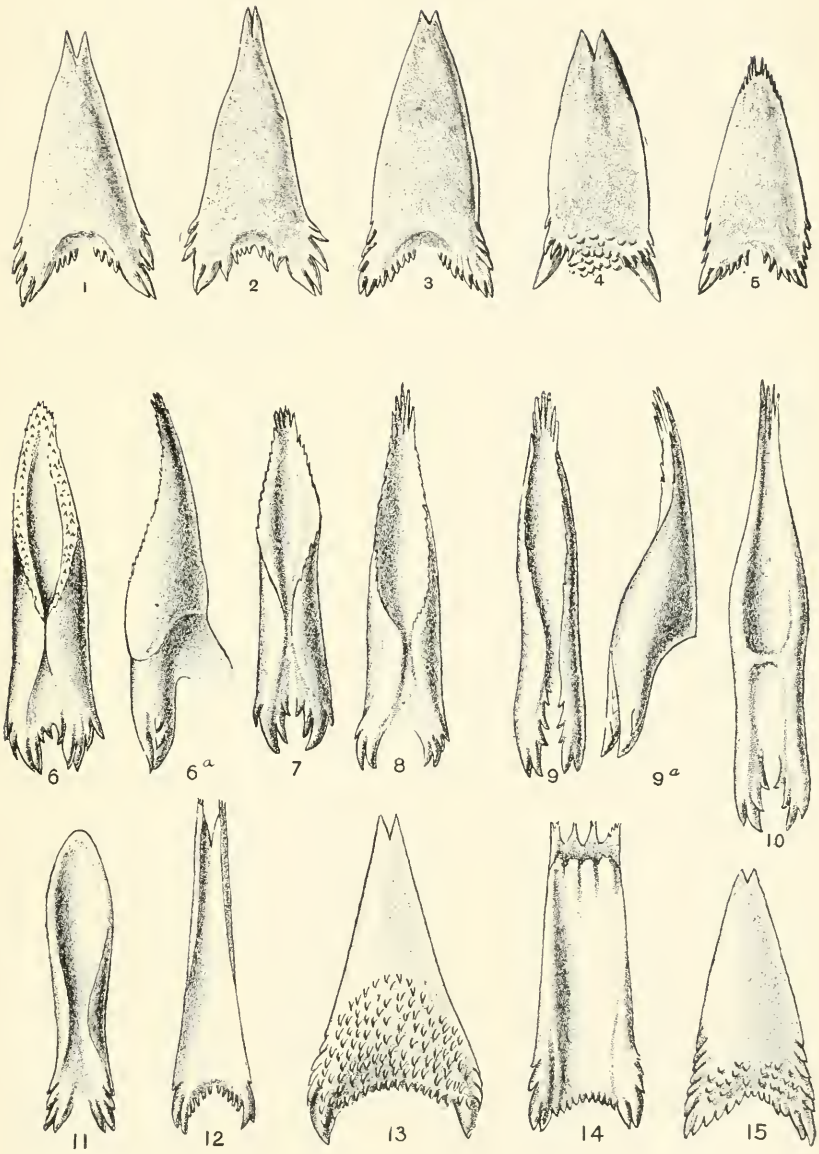
Fig. 9. Tongue of Canada Goose, *Berniela canadensis*, somewhat enlarged.

Fig. 10. Tongue of Belted Kingfisher, *Ceryle alcyon*, enlarged.

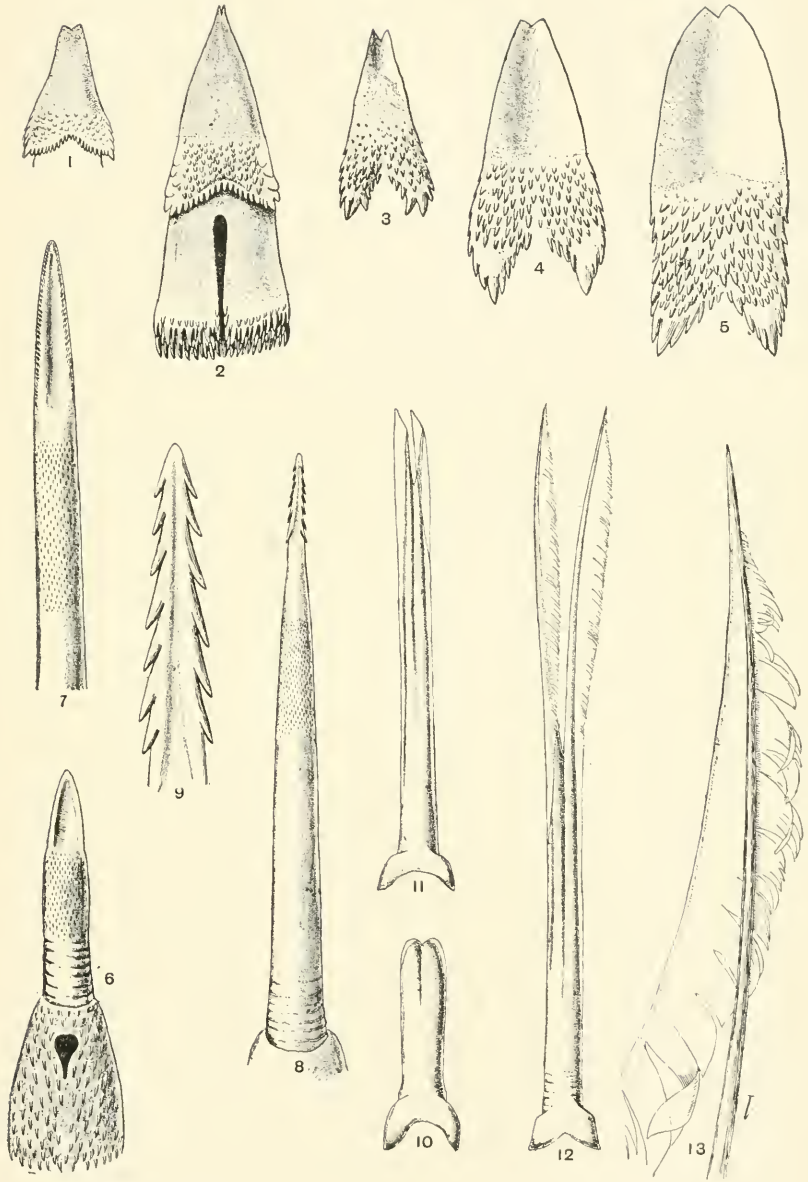
Fig. 11. Tongue of Sap Sucker, *Sphyrapicus varius*, enlarged.

Fig. 12. Tongue of Penguin, *Aptenodytes longirostris*, slightly enlarged.

Fig. 13. Head of Flicker, *Colaptes auratus*, with tongue protruded.



TONGUES OF BIRDS.



TONGUES OF BIRDS.