OBSERVATIONS ON THE TONGUES OF SOME NEW ZEALAND BIRDS

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ABSTRACT

The author illustrates and describes the tongues of some of the more notable Passeriformes of New Zealand, Meliphagidae and Callaeidae (as understood in the **Checklist** — Fleming **et al.** 1953). Illustrations and descriptions of one Sturnid **(Sturnus vulgaris)** and one Turdid **(Turdus merula)** have been introduced by way of comparison. The systematic classification of the Callaeidae is briefly touched upon, based on the lingual anatomy.

INTRODUCTION

In a previous paper (McCann, 1963) I contrasted the lingual structures of some of the New Zealand Psittaciformes and touched upon some aspects of the systematic classification. The Psittaciformes are, on the whole, a well-defined Order with common external features which make them readily recognisable as members of one group. While this is true of the Order, their classification at the family level is far from simple, and has been the subject of much controversy.

In the present paper, I propose to deal with some of New Zealand's peculiar Passeriformes based on the lingual characteristics. Unlike the Psittaciformes, the Passeriformes are a less compact Order consisting of a medley of many families grouped together as *Perching Birds*. The true affinities of some of the families, genera and species are debatable subjects. In New Zealand, such difficulties are well exemplified by the genera *Heteralocha, Philesturnus* and *Callaeas* all of which have been included in the family Callaeidae, as understood in the *Checklist*.

Before dealing with the Callaeidae, I give illustrations and descriptions of the tongues of two notable Passerines, the Bellbird *(Anthornis)* and the Tui *(Prosthemadera)*, both members of the family Meliphagidae. Unfortunately, the tongue of the Stitchbird *(Notiomystis)* is not available to me. Incidentally, it is worthy of note that the Stitchbird has long tactile vibrissae around the gape not present in either the Tui or the Bellbird.

In order to facilitate the discussion on the relationship of the three Callaeidae (as understood in the *Checklist*) I have introduced drawings and descriptions of one of the Sturnidae *(Sturnus vulgaris)* and one of the Turdidae *(Turdus merula)*. The drawings are semi-diagramatic, in part, because of the minuteness of some of the structures, and these have been exaggerated slightly for the sake of clarity.

MELIPHAGIDAE

THE TONGUE OF THE TUI, *Prosthemadera:* Fig. 1 a, b, c

The tongue of the Tui is linear-lanceolate and deeply canaliculate throughout its length. Anteriorly, the apex is produced into a brush, admirably adapted for the collection of nectar from flowers. Under high magnification the brush is seen to be composed of four subequal, acicular segments which, in turn, give off finer filaments. In the fresh state a blood vessel is clearly seen entering the main segments. The segments appear to be movable. Posteriorly, the tongue is provided

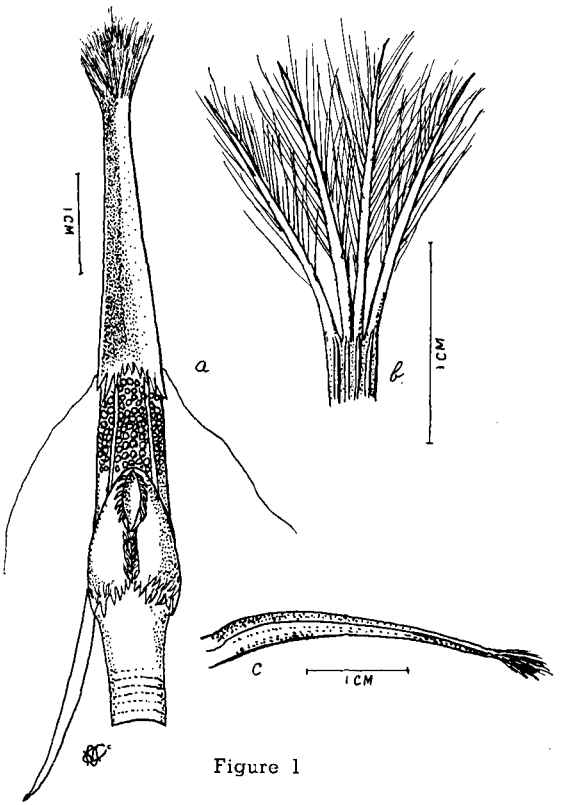

Figure 1

with backwardly directed horny papillae, the outermost being the largest. Between the base of the tongue and the glottis there is a fleshy area pitted with comparatively large 'taste pits.' Two large blood vessels traverse this area longitudinally. The 'laryngeal pad' is large and somewhat ovate with a series of large papillae posteriorly, divided by a sulcus. The margins of the opening of the glottis are provided with smaller papillae which margin the sulcus also.

The entire structure of the tongue of the Tui points to a predominently nectarivorous diet, but it will feed also on succulent fruits and insects. Like most nectarivorous birds, the Tui plays an important role in cross-pollinating many suitable flowers (see McCann, 1952).

THE TONGUE OF THE BELLBIRD, *Anthornis:* Fig. 2 a, b

The tongue of the Bellbird, like that of the Tui, is also canaliculate, but to a lesser degree. Its extremity is comparatively more deeply cleft into four segments. The extremity of each segment is provided with fine hair-like processes to form the brush. Posteriorly, the basal margin of the tongue is provided with denticles diminishing in size from the outer angles inwards. Between the base of the tongue and the glottis the area is profusely pitted with 'taste pits,' as in the Tui.

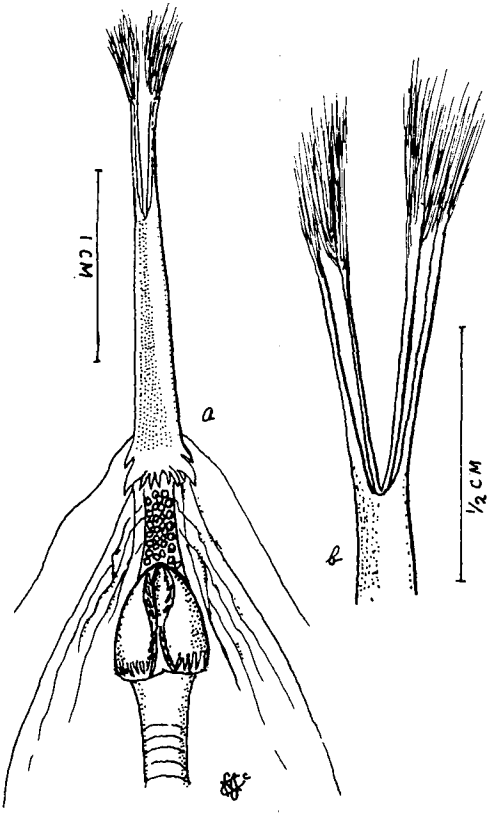

Figure 2

The 'laryngeal pad' is ovate with two series of denticles posteriorly, separated by a sulcus. The margins of the glottis and the sulcus are minutely denticulate.

The Bellbird is predominantly nectarivorous, feeding largely on the nectar of the New Zealand Flax *(Phormium),* the Tree Fuchsia *(Fuchsia excorticata)* and other suitable flowers. It will also take succulent fruits and insects.

Perhaps the difference between the tongue of the Tui and the Bellbird suggests some difference in the selection of the food plants or method of nectar collection.

PHILESTURNIDAE

THE TONGUE OF THE SADDLEBACK, *Philesturnus:* Figs. 3 and 4

The tongue of the Saddleback is lanceolate and shallowly channelled. Its extremity is bifid for a short distance. Each bifurcation is lacerate at its tip, the lacerations diminishing in size from the midline to the lateral margin, and inter-mixed with a few filiform bristles.

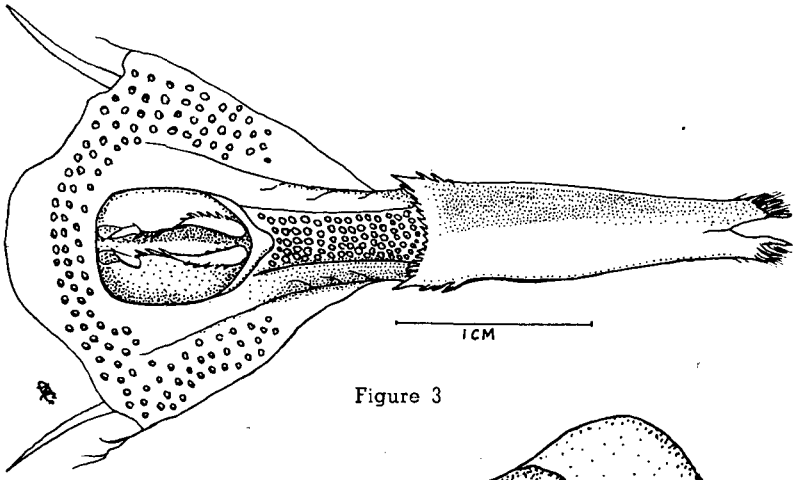

Figure 3

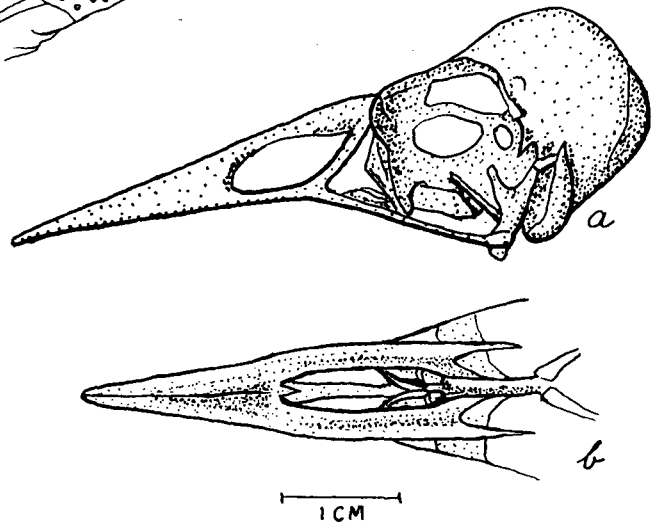

Figure 4

Posteriorly, the base of the tongue is denticulate, with the largest denticles at the outer angles; a few denticles appear on the lateral margins also, above the largest denticles. Between the base of the tongue and the glottis there is an area pitted with large 'taste pits,' similar to the corresponding area in the Tui and the Bellbird. The 'laryngeal pad' is somewhat large and oblong without any groups of denticles posteriorly. The margins of the glottis are provided with small teeth; the margins of the sulcus are toothed also, the largest appearing posteriorly. In addition to the 'taste pits' already referred to, between the tongue and the glottis, numerous pits are present in the buccal cavity.

The food of the Saddleback is composed of insects, fruits and nectar — insects appear to be its principal diet (Oliver, 1955).

STURNIDAE

THE TONGUE OF THE STARLING, *Sturnus vulgaris:* Fig. 5

Since the tongue of the Starling is in some respects very like that of the Saddleback (*cf* figures), it is illustrated and discussed as a comparison.

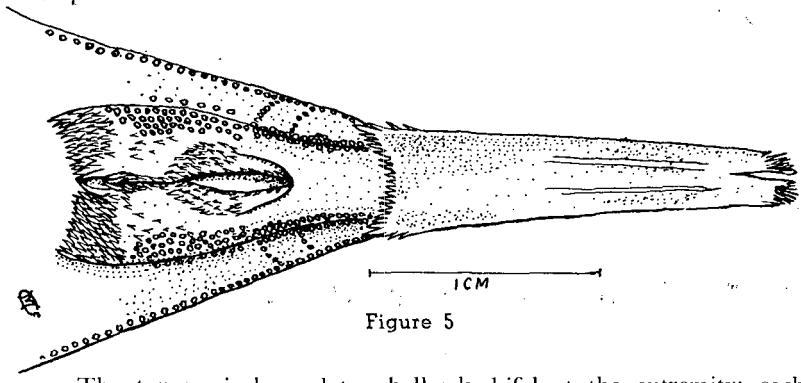

Figure 5

The tongue is lanceolate, shallowly bifid at the extremity; each bifurcation is lacerate at the tip, the segments diminishing in size from the midline towards the margins. Posteriorly, the base of the tongue is denticulate, the largest denticles appearing at the outer angles, with a few small denticles on the lateral margins, above the largest ones. The area between the base of the tongue and the glottis is provided with two rows of 'taste pits,' but tne space between the rows appears to be devoid of them. The glottis is margined by small teeth and an area of denticles surrounds the lower half of the glottis; the sulcus is margined anteriorly by small teeth, which become larger posteriorly. The 'laryngeal pad' is ovoid with two groups of denticles posteriorly, separated by the sulcus. A few minute teeth are scattered on the body of the 'pad.' The outer margins of the 'pad' are provided with numerous 'taste pits.' In addition, along the lingual aspect of the mandibles a row of pits is present which are connected, by oblique rows, to the median group.

The diet of the Starling is principally insectivorous, but its diet could almost be described as omnivorous. In addition to insects, it will feed on fruits and nectar. In New Zealand, the Starling, in addition to being a pest of orchards, plays an important role as a pollinator of New Zealand Flax *(Phormium)* for, when the flax is in bloom, Starlings visit the plants in numbers for the copious supply of nectar. As a result the crown and throat are often thickly smeared with pollen and acquire an orange-yellow hue (McCann, 1956). Perhaps as a pollinator the Starling is displacing the Tui *(Prosthemadera),* for the Starling is equal to the pugnacity of the Tui and is more gregarious.

TURDIDAE

THE TONGUE OF THE BLACKBIRD, *Turdus merula:* Fig. 6

The tongue of the Blackbird is shallowly canaliculate. The anterior extremity terminates in a shallowly bifid, hyaline, somewhat spathulate appendage. The lateral margins, from a little above the middle of their length, are fringed with progressively lengthening

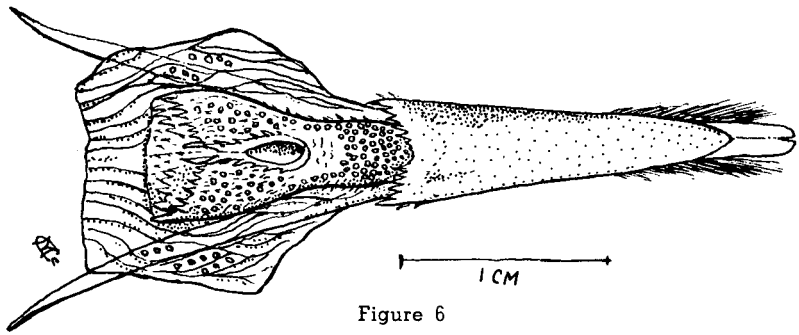

Figure 6

hyaline 'hairs.' Posteriorly, the base of the tongue is denticulate with the largest teeth at the outer angles; a couple of smaller denticles appear on the lateral margins above the largest ones at the angles. Between the tongue and the glottis there are numerous large 'taste pits'; a margin of fine spicules borders the area on either side. The 'laryngeal pad' is large and somewhat oblong with large denticles posteriorly followed by an area of scattered, small teeth. The area surrounding the glottis is provided with scattered 'taste pits' interspersed with fine spicules. On either side of the 'pad' small groups of 'taste pits' appear also. The margins of the glottis are armed with small denticles, terminating posteriorly in larger ones.

The food of the Blackbird consists principally of various fruits, insects and worms. It will also feed on kitchen refuse in the vicinity of human habitations. During their early stages the chicks are fed mainly on earthworms and spiders (McCann, 1955). I have not witnessed the Blackbird attending flowers and sipping nectar. Because of its frugivorous diet, the Blackbird becomes a pest of orchards.

CALLAEADIDAE

THE TONGUE OF THE KOKAKO, *Callaeas:* Figs. 7 and 8 a, b, c, d

The tongue of the Kokako is remarkably oblong in shape and abruptly truncated at the apex. The apex is very markedly lacerate with a short median ridge dorsally, which is correspondingly furrowed ventrally. The crest of the ridge is obliquely lacerate, the free ends

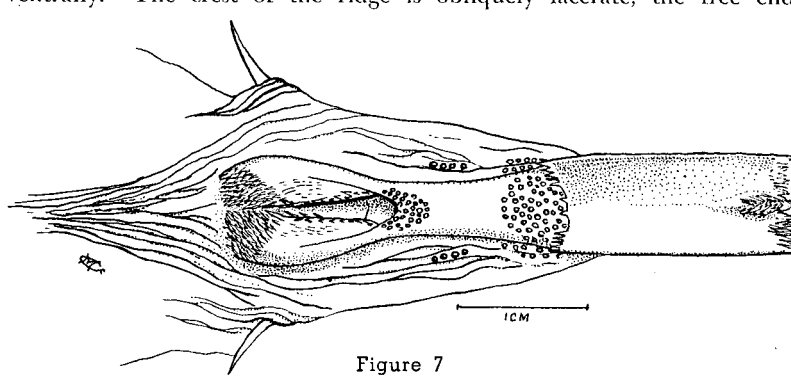

Figure 7

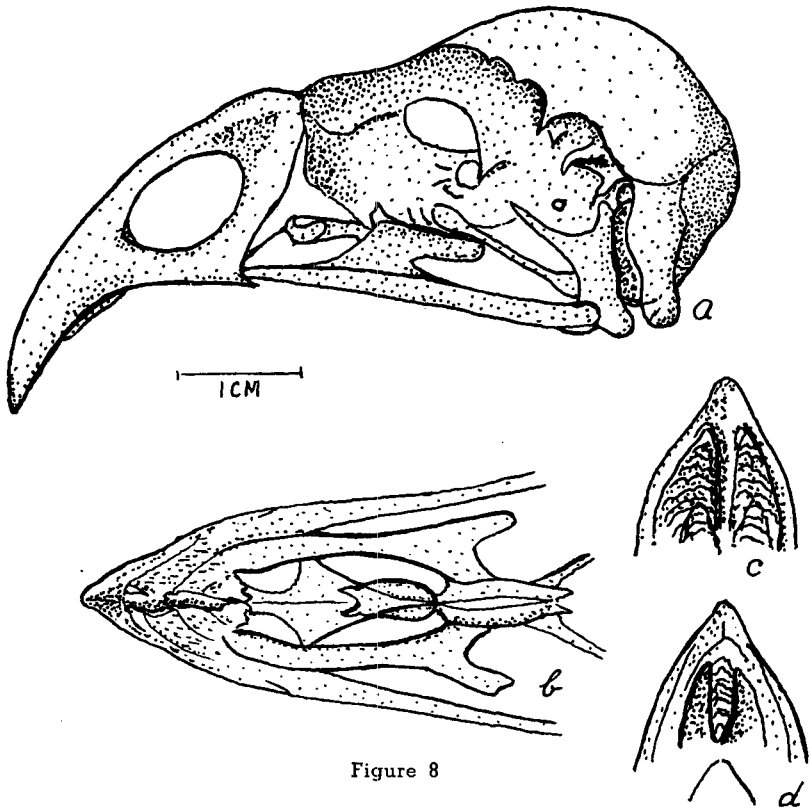

Figure 8

of the lacerations meeting or overlapping on the crest. Posteriorly, the base of the tongue is denticulate, the two median denticles being separated from the rest. Immediately behind the tongue is a group of 'taste pits' and another group, separated by a pitless interval, just anterior to the glottis; in addition, two groups of 'taste pits' appear between the mandibles and the tongue. The 'laryngeal pad' is ovoid, with two large areas of denticles separated by a sulcus. The margins of the glottis are toothed, the teeth becoming progressively larger posteriorly, and finally ending in two large denticles on the margin of the sulcus. On either side of the glottis, there are some fine acicular teeth.

The food of the Kokako is largely composed of young leaves and shoots, fruits and insects (Oliver, 1955). The curious form of the tongue and the bill is discussed below.

DISCUSSION

A comparison of the tongues of the Saddleback *(Philesturnus)* and the Starling *(Sturnus vulgaris)* raises the vexed question of the true systematic position of the Saddleback. Stonor (1942) considered that *Philesturnus, Heteralocha* and *Callaeas* belonged to the same family. Oliver (1945), on anatomical grounds, disagreed with Stonor's view in that he (Oliver) held that *Callaeas* should be placed in a separate family from the other two genera. Mayr and Amadon (1951), referring to the same three genera, wrote: "Stonor (1942) showed that Callaeas, Philesturnus and Neomorpha (= Heterolocha) belong to a single group. . . . We do not think the Callaeidae and the Sturnidae are allied." Fleming *et al.* (1953), apparently following Stonor, Mayr and Amadon, referred all three genera to the family Callaeidae. Oliver (1955) placed *Philesturnus* and *Heteralocha* together in the family, Philesturnidae, and *Callaeas* he retained in a separate family, by itself, Callaeadidae. In view of some of the anatomical differences in the skulls and the structure of the tongues, Oliver's (1955) interpretation appears to be more satisfactory.

Stonor (1942:9), referring to the presence of wattles in the three genera, stated: "and I regard it as a strong point of affinity." Fleming (1953) followed Stonor (1942) in grouping the three genera under the popular title: "New Zealand Wattle-birds." This view seems to suggest that Stonor (1942) and Fleming (1953) placed much stress on the mandibular wattles present in the three genera. The presence of wattles has, in itself, little or no bearing on the systematic relationship of the three genera concerned. Wattles, as is well-known, are mere 'adornment' and are found in widely different families having representatives with or without wattles. Apart from being mere 'adornment,' it appears to me that wattles play an important role in recognition for birds which occupy a crepuscular habitat, such as dense forest, in which light is poor. Normally, the wattles of such birds are of some brilliant hue of yellow, orange, red or blue, colours which stand out in poor light. In addition, the birds which possess such highly coloured wattles are often unicolourous, drab-coloured or cryptically coloured. As the mandibular wattles normally 'flap about' with every movement of the head the bright hues, in the poorly lit habitat, serve as 'attraction' points for rapid recognition within the species. Such wattles may be referred to as 'flash points' or 'flicker spots.' However, anatomically, *Callaeas* differs in several marked respects from both *Philesturnus* and *Heteralocha* (see below).

The inclusion of *Heteralocha* in Philesturnidae, as suggested by Oliver (1955) calls for some comment. Apart from the well-known remarkable differences in the shape and size of the bill between the sexes, there are, as might be expected, some slight differences in the elements constituting the roof of the mouth. Unfortunately, the tongue of *Heteralocha* is not available to me. But Garrod (1872) described the tongue, although without detail. His description reads: "Simple, horny, one third the length of the beak. It forms a flat elongated triangle, slightly bifid at the apex, and a little prolonged backwards at its lateral borders, enclosing a curved line for the base, the concavity being backwards and carrying retroverted papillae. The mucus membrane of the palate extends forward as far as the middle of the tongue; that of the mandible goes a little further." Finally, Garrod concluded that both *Philesturnus* and *Heteralocha* were closely allied.

After examination of the skulls of these two remarkable genera, I am fully in accord with Garrod's view.

The sterna of both *Philesturnus* and *Heteralocha* share the common factor of possessing a low keel, both species exhibiting retarded powers of flight, a feature not uncommon to several New Zealand 'land' birds. However, the sterna differ in that *Philesturnus* has two posterior lateral processes whereas the sternum of *Heteralocha* has two fontanelles instead of lateral processes. In the possession of lateral processes *Philesturnus* approaches the Starling *(Sturnus vulgaris).*

Whether *Philesturnus* and *Heteralocha* should be included in the same family is a debatable point, according to the characters on which an author places particular stress. Except for its remarkably sexual dimorphism, *Heteralocha* in most respects is undoubtedly closely related to *Philesturnus* and accordingly both genera should be included in the same family, Philesturnidae, as suggested by Oliver (1955).

The systematic affinity of *Philesturnus,* itself, calls for some comment. Except for the greater length of the premaxillae, the bony culmen (without horny sheath) is very similar in most details to that of *Sturnus vulgaris.* In both species the culmen is similarly depressed. A comparison of the tongues of the two species (*cf.* Figs. 3 and 4) also indicates a close relationship. In the choice of food the Saddleback is predominantly insectivorous, but it will feed also on fruits and the nectar of flowers. Likewise, the Starling is predominantly insectivorous, but will also feed on fruit and nectar. Within the vicinity of human habitation, the Starling becomes more omnivorous and will feed readily at garbage heaps.

As already indicated, the sterna in the two species resemble each other very closely in structure, except for the greater depth of keel in *Sturnus* than in *Philesturnus,* but, as the Starling is a powerful flier and is normally a long-distance migrant, a greater depth of keel is to be expected. *Philesturnus,* on the contrary, is more localised and as already remarked, has a retarded power of flight. This reduction in the power of flight possibly evolved because of the natural density of the vegetation of its habitat on the one hand and the lack of natural predators on the other. Stonor (1942) also made reference to the second factor as a possible cause of wing reduction and power of flight.

We come now to the systematic position of *Callaeas* which is at present grouped with *Philesturnus* and *Heteralocha.* Anatomically, *Callaeas* has little in common with either *Philesturnus* or *Heteralocha,* particularly in the arrangement of the cranial elements. Relatively, the bill is thicker and broader (Fig. 8). The structure of the tongue is outstanding. It differs markedly from that of *Philesturnus* in many details. Stonor (1942) figured the palatal region (Stonor, Fig. 5) and the tongue (Stonor, Fig. 7). Although Stonor's figure 7 shows the remarkably truncated apex clearly, it lacks sufficient detail in other respects. Stonor's figure, in spite of its shortcomings, is sufficiently characteristic and I feel that, had he contrasted the tongue of *Callaeas* and *Philesturnus* in greater detail, he would probably have arrived at quite a different conclusion to that expressed.

The differences in the structure of the bill and tongue between *Callaeas* and *Philesturnus* (and *Sturnus*) are, perhaps, reflected by the difference in their diet and habits.

The food of *Callaeas* consists of "tender leaves, fruits and insects" (Oliver, 1955). Among the "tender leaves," I presume, are included

the floral structures also. The leaf-eating habit appears to have resulted in certain modifications to the structure of the bill, particularly in the formation of the opposing horny sheaths of the culmen and mandible. The modifications are even further reflected on the ventral surface of the premaxillae, just above the horny sheath. The ventral surface of the horny culmen is divided, longitudinally, into two ridges separated by a deep groove; the ridges are transversely rugose, like a file; the opposing mandibular sheath possesses a median ridge with a groove on either side; the ridge is transversely rugose. When the bill is closed, the opposing surfaces interlock, forming an admirable pair of 'forceps' for grasping leafy material. (Fig. 8 c, d). Above the horny sheath of the culmen, the premaxillae form a callus-like area (Fig. 8 a), corresponding to the groove and ridges of the horny sheath. This callus seems to arise from the constant impact of the opposing mandibular ridge and grooves when the bird is feeding — similar 'impact calli' appear in some of the Psittaciformes which habitually eat hard foods. The presence of the 'impact callus' (slightly exaggerated in the figure) and the structure of the horny culmen and mandible suggest that the Kokako 'chews' its foliaceous food (in the manner of parrots) before swallowing it. This supposition appears to be supported by the large attachment area of the massetter and associated muscles.

The tongue of *Callaeas* (Fig. 6) as already indicated is remarkably truncated at its apex and its anterior margin is conspicuously lacerate, forming a 'brush,' but one quite unlike that of a true meliphagid. Mesially, there is a short ridge, dorsally, corresponding to the median groove in the culmen; ventrally, this ridge is represented by a furrow corresponding to the mandibular ridge. The horny tissue of the dorsal ridge is obliquely lacerate on either side of the ridge, forming a 'brush' along its length. The lacerate condition appears to result from the constant impact between the opposing surfaces of the bill, between which the tongue is constantly 'torn' while it is acting as a 'brush' to keep the grooves clear of 'masticated' material, at the same time assisting in the transfer of the food towards the gullet. The lingual 'brush' of *Callaeas* is more like a 'yard broom' when compared to the most delicate brush of the nectar-feeders, Meliphagidae.

The distribution of the 'taste pits' shows a corresponding difference between *Callaeas* and *Philesturnus* — there is more in common between *Philesturnus* and *Sturnus*.

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