tissue matrix. In general outline the mass is oval (Fig. 1). In the glandular region the antorbital cartilage is invested by the pterygoid and maxillary bones. The gland is richly vascular. Perhaps the most interesting fact connected with the gland in *Glyphoglossus* is that the buccal epithelium enters into the adenoid in the form of two invaginations so that in sections the gland seems to possess two ducts opening into the oral cavity. But the fact is the gland possesses no duct of its own, and the gland itself may be described as an oval cap surmounting, and closely adherent to, the two tubular recesses of the oral cavity.

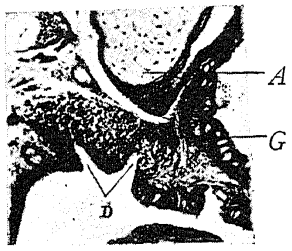


Fig. 1.

The glandular patch below the antorbital cartilage in *Glyphoglossus*.

G.—Gland.
D.—Ducts.
A.—Antorbital cartilage.

It is only appropriate that *Microhyla* and *Kaloula* should be treated together. In both these genera the anterior border of the gland touches the median vertical axis of the eye, and therefore is more posteriorly situated in regard to the antorbital process (Figs. 2 and 3). The hinder border does not reach however the tympanic area in both. The duct opens below the eye into the oral cavity, in other words, well in front of the angle of the mouth. In *Microhyla* histologically we can distinguish an outer cortical and an inner medullary portion, and both regions are richly vascular, and innervated by the maxillary branch of the fifth cranial nerve. The duct part is produced by a single extension of the ciliated buccal epithelium, which is numerously surrounded by mucous glands. (Fig. 4). The glandular tissue of the 'mundwinkeldrüse' does not extend into the region of the duct invested by the mucous glands. In both *Microhyla* and *Kaloula* the glandular cells bear cilia. There is, however, a small difference in the shape of the gland in the two forms. In *Microhyla* it is longer than broad and the reverse is the case in *Kaloula*. In the two forms the duct is composed of columnar epithelium with the nuclei situated terminally. The duct portion receives the secretion of the mucous glands poured through narrow channels. It is curious that at the apex of the gland two or three lymph sacs are present, and some of them are situated in such close proximity as to suggest a physiological relationship between the lymph sacs and the glands. There can be little doubt that the secretion of the gland is voided into the mouth through the ciliary action of the glands.

Fig. 2.

The gland in *Microhyla*.

C.—Cortex.
M.—Medulla.
D.—Duct.

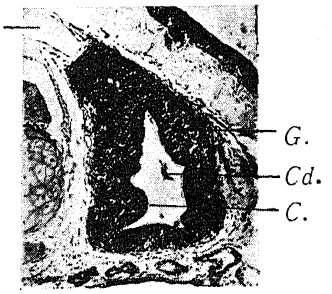


Fig. 3.

The gland in *Kaloula*.

G.—Gland.
L.—Lymph sac.
C.—Cilia.
Cd.—Cellular detritus.

Fig. 4.

The duct and gland of *Kaloula*.

In *Cacopus* (Fig. 5) the anterior border of the gland begins in a line with the anterior margin of the eye but its duct opens into the buccal cavity behind the angle of the jaws. Both as regards its anterior and posterior relationships *Cacopus* differs from *Kaloula* and *Microhyla*. The gland lies freely nearer to the pterygoid and above the maxilla. The gland itself is traversed by a system of lacunæ with well demarcated internal lining and is far more vascular than in the other two preceding genera. Usually the lacunæ contain cellular detritus and stray blood corpuscles, and it is noticed that they open into the lumen of the gland. The duct which is a buccal extension is surrounded by a large number of buccal

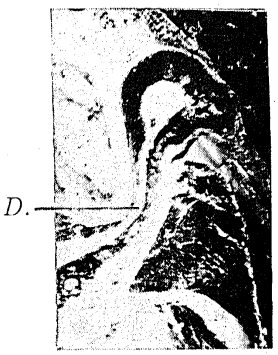


Fig. 5.

The gland in *Cacopus*.

D.—Duct.

glands. Neither the glandular cells nor those of the buccal epithelium of the duct are provided with cilia. In this respect *Cacopus* resembles *Glyphoglossus* and *Rhacophorus*.

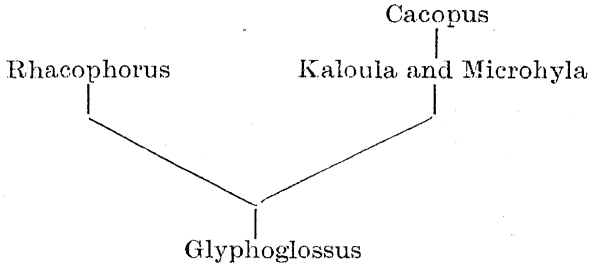
In *Rhacophorus* the gland situated above the maxillary bone has assumed large proportions (Fig. 6). It does not extend beyond the eye in front while posteriorly it touches the tympanic area, though its duct opens well in front of the angle of the jaws. In sections it is noticed that the gland has a large lumen with radiating branches, so that a star-shaped figure is noticed in some of the sections. The vascularization and innervation of the gland are identical with those of Engystomatidæ.

Fig. 6.
The gland in *Rhacophorus*.
G.—Gland.
Ma.—Maxilla.

A suggestion as to the probable line of evolution may be made at this stage. Assuming that the gland has a physiological significance it is noticed that it occurs in its simplest form in *Glyphoglossus* where it is a collection of highly nucleated vascular lymphatic tissue, opening into the buccal cavity by two ducts. It is distinctly antorbital in position, and probably this is the original position of the gland. In the other genera of the Engystomatidæ a backward movement of the gland has manifestly taken place. It has moved far behind in *Kaloula* and *Microhyla* than in *Cacopus*, only in respect of the anterior margin of the gland. The point to which evolutionary modification has taken place is not to be tested by the relation of the anterior border of the gland to the eye but by the position of its opening into the buccal cavity. *Kaloula* and *Microhyla* occupy an intermediate position between *Glyphoglossus* on the one hand and *Cacopus* on the other, which represent the two extreme points in the evolutionary scale. Further, while the gland retains its maxillary relation in *Kaloula* and *Microhyla* as in the case of *Glyphoglossus* it has shifted its position more towards the pterygoid in *Cacopus*.

The presence of ciliated cells in the gland of *Kaloula* and *Microhyla* should be regarded as a secondary feature and cannot have any relation with the origin of the structure which is mesenchymatous uniformly in Engystomatidæ and in other families.

Two available evidences furnished by the larva are in support of this view. In the early tadpole condition, I have studied the patches of loose mesenchymatous cells with darkly staining nuclei surrounded by fine capillaries in the antorbital region of *Cacopus* and *Microhyla*. In these tadpoles usually two glandular patches on each side of the dorsolateral aspect of the gill-arches, which in the sections appear slightly protruding in front of the eyes, can be made out. These patches do not establish at this stage buccal openings but they appear at about the time of metamorphosis when buccal recesses are being formed. When terrestrial habits are completely assumed, the glands acquire adult features. I have not been able to follow the development of the glands in the case of *Rhacophorus*, but from a study of the histological elements and topographical relations of the gland in the adults, I conceive that the line of evolution should have proceeded as in the following sketch which is not to be supposed to have any phyletic significance.



In this connection I may state that the sections of the head of examples of Apoda such as *Urœotyphlus* and *Ichthyophis* which have been studied do not show the presence of such glands. No reference is available as regards the occurrence or otherwise of the maxillary gland in Urodela, and it is difficult to decide whether the glands have any appreciable physiological function among the Anura in which their presence is reported.

I am appending below a tabular statement showing the topographical relations and dimensions of the gland in the forms discussed in this paper :—

Examples	Location	Extension	Size in μ
Glyphoglossus	As a patch below the antorbital cartilage invested by the pterygoid.	Commences before the eye and ends before the anterior limit of the eye.	230
Microhyla	Between the pterygoid and the maxillary.	Commences at a level with the median vertical axis of the eye and extends posteriorly to it. The duct opens well in front of the angle of the mouth.	270
Kaloula	do.	do.	500
Cacopus	Between the pterygoid and the maxillary with the mandible below.	Commences at the anterior extremity of the eye and opens behind the angle of the mouth.	880
Rhacophorus	do.	Commences at the anterior margin of the eye and the duct is seen in the region of the annulus tympanicus, but opens in front of the angle of the mouth.	1060

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Physical Nature of the Nerve Impulse.*

By Prof. A. V. Hill, O.B.E., F.R.S.

IN his Friday evening discourse delivered at the Royal Institution on 10th February 1933, Prof. A. V. Hill has discussed the nature of the nerve impulse, a subject which has engaged the attention of physiologists and which has given rise to much speculation. According to Prof. Hill, "the nerve impulse is an event, a wave, a propagated disturbance, not a substance or a form of energy. It is transmitted along a thread of protoplasm which in medullated nerve is surrounded by protecting or 'insulating' sheath. Its passage can be detected in several ways: (*a*) by its physiological effect on the organ to which it runs, (*b*) by the electric change which accompanies its transmission, (*c*) by the production of heat, and (*d*) by a consumption of oxygen and liberation of carbondioxide." The properties of the nerve impulse are discussed giving the methods of recording the variations that are brought about during the event. Under other effects of oxygen, the lecturer describes the result of the action of certain drugs like veratrine and curare.

The strength, duration, the manner in which excitation by an electric current occurs and the nature of the propagated disturbance are discussed. The factors which determine the excitation time are noted. The difference in the behaviour of different fibres or of the same fibre under different conditions which is due to the alteration in the electrical resistance is explained by the probable specific solubility in the lipoidal substance of the nerve sheath under the influence of potassium ions.

The account of the mito-genetic radiation in nerve on which the Russian school is working is indeed very interesting, if not exciting and if confirmed will gain very great social and industrial importance.

A. SUBBA RAO.

* *Nature*, April 8, 1933.