ately 8·2 throughout. *Daphnia carinata* showed a reversed migration under both these conditions, but in the case of *Boeckella propinqua* males there was no evidence of reversed migration during the period of complete circulation.

Lake Rudolf and Lake Aroarotamahine are both associated with alkaline rhyolites in the form of either comendites or pantellerites[7,8] which are rich in sodium and potassium but very poor in calcium and magnesium. As a result of the chemical weathering of these rocks relatively large amounts of extremely soluble sodium carbonate have found their way into these lakes, so that they have come to contain a sodium carbonatochloride water in which alkaline earth and sulphate ions are present in only very small proportions.

It is interesting to note that the very low calcium content of the lakes mentioned here is not a limiting factor with respect to zooplankton productivity. On the contrary, there is evidence that both lakes are highly productive. In a series of 4 lakes, Worthington and Ricardo[6] found the zooplankton numerically richest in Lake Rudolf. Likewise Bayly[3] found far greater zooplankton densities in Lake Aroarotamahine than in 9 other lakes examined.

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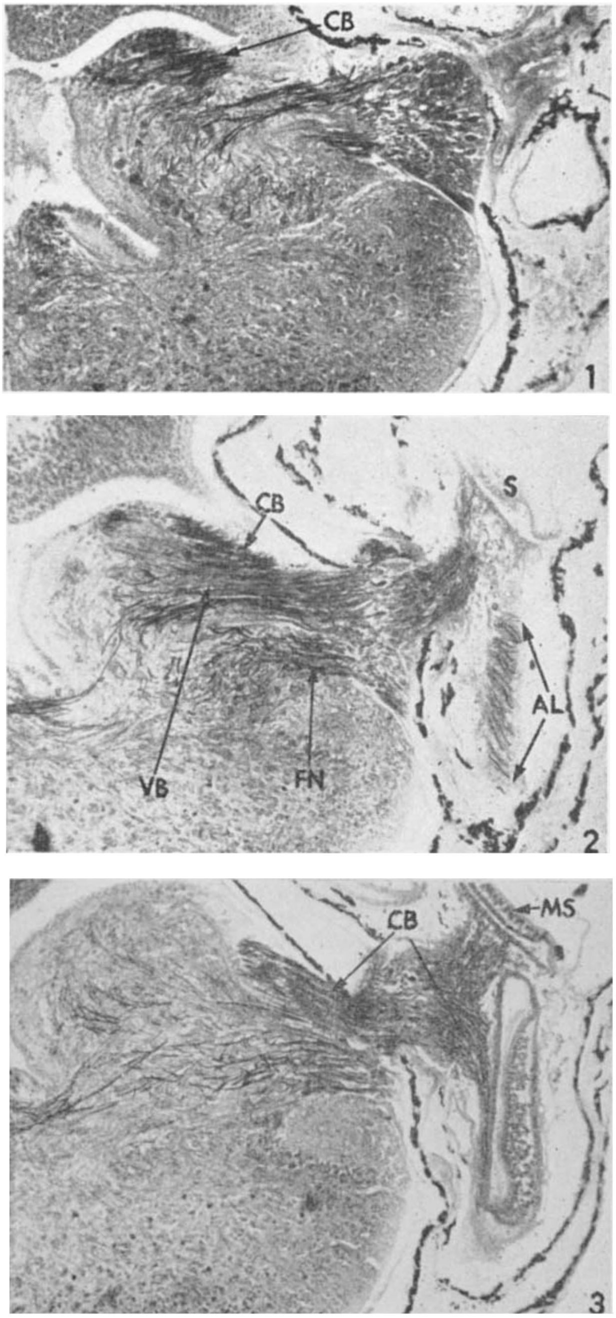
Posterior Division of the Eighth Cranial Nerve in *Lacerta vivipara*

Little information is available in the literature on the innervation of sensory areas in the inferior, or saccular, portion of the inner ear of the lizard. In order adequately to show nervous structure, histological techniques have been used in the past that preclude dealing with the intact animal ; usually the brain must be removed, thereby disrupting anatomical relationships. A notable exception is the work of Beccari[1] on embryonic material of *Lacerta* ; his primary interest, however, was in finding homologies in the central nervous system between reptiles and mammals, and he gives little consideration to the central terminations of fibres from specific sensory areas. Weston[2,3] has speculated on central terminations of sensory fibres in *Sphenodon* and has discussed structure of vestibular and auditory areas in brains of a number of reptiles.

Serial sections through the inner ears of two de Castro-stained specimens of *Lacerta vivipara* were available for examination, and de Castro-stained specimens of *Anniella pulchra* and *Anguis fragilis* were available for comparison, along with Bodian-stained serial sections of the inner ears in *Gongylus ocellatus, Calotes versicolor* and *Sceloporus undulatus*.

Nerve fibres from the macula of the utricle and cristæ of the anterior and lateral ampullæ project to the central nervous system through the anterior acoustic foramen and terminate rostral to the central projections of the remaining sensory areas (Fig. 4).

Of interest here is the qualitative difference in the posterior division of the VIIIth cranial nerve between fibres which project to the dorsal, acoustic area of the brain stem, and those that project ventrally to the vestibular areas of the brain stem.



Figs. 1, 2 and 3. Cross-sections through the inner ear in *Lacerta vivipara*, anterior to posterior, to show the course of the cochlear bundle and relationships between the sensory areas of the membranous labyrinth and the central nervous system. (For key to abbreviations see legend to Fig. 4)

Fibres which originate in the anterior, lagenar, portion of the cochlear duct (Fig. 2) and from the basilar papilla course posteriorly in the otic capsule to emerge from the capsule (via the posterior acoustic foramen) and, as a distinct, dark-staining bundle, cross caudal to fibres that arise from the macula of the saccule (Fig. 3). The bundle courses dorsally and rostrally within the central nervous system to terminate on small cells in the acoustic area of the brain stem (Fig. 1). For convenience, this group of fibres is termed the cochlear bundle.

The fibres projecting from the macula of the saccule, joined by those from the papilla neglecta of the utricle and crista of the posterior ampulla, terminate ventral to the termination of the cochlear bundle. The cells in the vestibular area with which these fibres synapse are larger

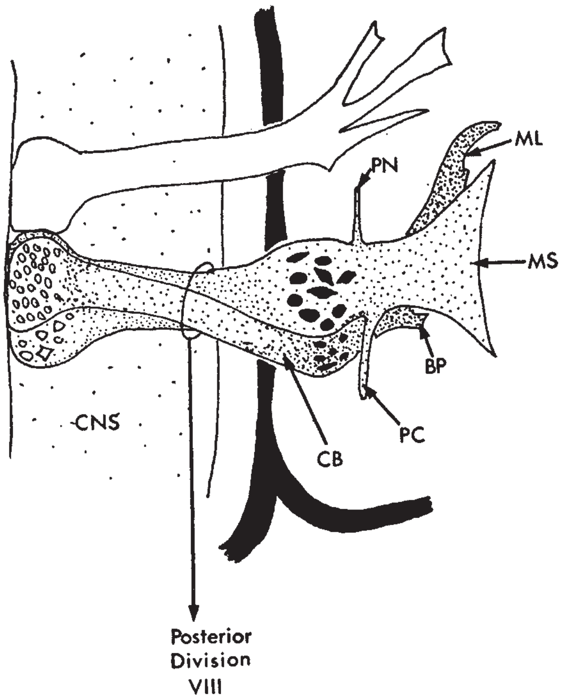


Fig. 4. Schematic representation of the course and relationships of the fibres of the posterior division of the VIIIth cranial nerve in *Lacerta vivipara*. The anterior division of VIII, with ramifications from the utricle, and anterior and lateral ampullæ, is shown in white.

AL, anterior, lagenar, part of the cochlear duct; *BP*, basilar papilla; *CB*, cochlear bundle; *CNS*, central nervous system; *FN*, facial nerve; *ML*, macula of the lagena; *MS*, macula of the saccule; *PC*, posterior crista; *PN*, papilla neglecta; *S*, saccule; *VR*, vestibular part of the posterior division of VIII

than those associated with the cochlear bundle (Figs. 1 and 2).

These relationships are shown schematically in Fig. 4. In *Lacerta*, then, the central terminations of fibres from the macula of the lagena are the same as those from the basilar papilla, and different from those of the macula of the saccule. A reasonable conclusion from the structural evidence in *Lacerta* is that the macula of the lagena has some auditory function, while the macula of the saccule is concerned mainly with equilibration.

This is not the case in forms in which sensory areas in the cochlear duct are reduced relative to the macula of the saccule, such as in *Anniella* and *Anguis*. In the latter specimens, there is no secondary tympanic membrane, and it is probable that these lizards do not hear as well as free-living forms, such as *Lacerta*, in which a well-defined secondary tympanic membrane is present. Other evidence (which will be published elsewhere) indicates that the inner ear in *Lacerta* is more highly evolved than that in either *Anniella* or *Anguis*, and it is possible that auditory function of the macula of the lagena is a phylogenetically advanced feature.

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Action of Piperazine on the Neuromuscular System of *Ascaris lumbricoides*

PIPERAZINE is the drug most commonly used for the treatment of ascariasis, in preference to other anthelmintics, because it produces a flaccid paralysis of the parasites[1] rather than hyperactivity. Though no direct evidence was available, it was suggested that such paralysis might be due to a curare-like effect, since piperazine prevents the stimulating action of acetylcholine on *Ascaris* muscle[2].

The electrical activity of the somatic muscle cells of *Ascaris lumbricoides*, var. *suum*, has recently been examined in this laboratory[3] and we have now taken advantage of the techniques and preparations used in this work to investigate the action of piperazine on the neuromuscular system of the worm.

This system is represented in Fig. 1. Each somatic muscle cell is connected to one of the two nerve cords by a slender process, or muscle 'arm', which tapers down and divides into a number of branches or 'fingers'. The fingers from adjacent arms interlace, forming a closely woven network which, shaped as a thin ribbon, runs parallel to the nerve cord. Although little is known about the fine structure of this network, experimental evidence[3] has shown that it behaves as a functional syncytium, the individual muscle cells being electrically interconnected at this level.

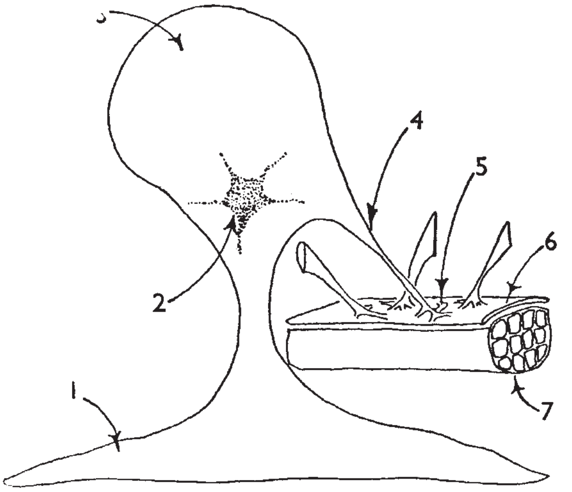

Fig. 1. Highly diagrammatic representation of the neuromuscular system of *Ascaris lumbricoides*. Only one complete muscle cell has been drawn, and the arms of three others; see text. It should be pointed out that the 'arm' of the muscle cell forms a right angle with the 'spindle', the latter being parallel to both the nerve cord and the longitudinal axis of the worm

1, Spindle; 2, nucleus; 3, nuclear bag or 'belly'; 4, arm; 5, fingers; 6, syncytium; 7, nerve cord

The complex formed by the nerve cord and associated syncytium has many of the properties of vertebrate smooth muscle, including that of autorhythmicity or automatic production of spike potentials. Microelectrode recording from the muscle cell 'bellies' shows a resting potential (average value about 30 mV) interrupted by rhythmic spike potentials, see Fig. 2*A*, which originated at the syncytium and are conducted along the arms and bellies to the spindles—the only part of the muscle cell which contains contractile material.

When piperazine citrate, as a solution adjusted to *p*H 7, is added to the saline bathing the *Ascaris* preparations (30 per cent sea-water) the amplitude of the spontaneous spike potentials is seen to decrease until the cells become electrically silent (Fig. 2). This effect is accompanied by an increase in the resting potential. In one experiment, for example, an average resting potential of 28·3 mV was increased to 41·0 mV on the addition of piperazine to the bathing solution to a final concentration of 10^{-4} (w/v). Increments of up to 15 mV have been observed when recording continuously from a belly.

In many cells the increase in the resting potential is concomitant with a considerable reduction in the frequency of the spike potentials, though in others the spikes disappear before any marked changes in their frequency can be detected. Often, the resting potential is seen to go on increasing after the spike activity is blocked.