

An additional trigeminal system in certain snakes possessing infrared receptors

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This communication describes a nucleus and tract of the trigeminal system whose existence is not mentioned in any account of brain stem architecture known to the present author. The structures were first recognised in the brain stem of a giant snake (*Python reticulatus*) and later were also found in rattlesnakes (*Crotalus cerastes* and *C. atrox*), but not in the brain of a viper (*Vipera ammodytes*).

The description is based primarily upon serial sections of python brains, 5 from normal animals and 9 from animals in which the trigeminal nerve roots had been transected (under Fluothane anaesthesia, 6-18 days before sacrifice). The normal series were stained by Luxol fast blue and cresyl fast violet, by cresyl fast violet alone or by gallocyanine and methyl green¹. The degeneration series was prepared according to the Fink-Heimer I procedure⁵. Reference series of rattlesnake and viper brains, stained by Luxol fast blue and cresyl fast violet, were kindly made available by Prof. P. Dullemeier, Leiden.

On entering the medulla oblongata the majority of the trigeminal sensory fibres either terminate in the main sensory nucleus, or turn caudally to form the descending tract, the fibres of which terminate partly in the associated nucleus, and partly continue as the spinal trigeminal tract. Those sensory fibres that ascend to the mesencephalon or cerebellum will not be discussed here.

Fig. 1. Semi-schematic drawings of sections through the brain stem of the python showing the distribution pattern of sensory trigeminal fibre contingents. A, at the level of the trigeminal roots; B, at the level of the abducens root; C, at the cranial level of the VIIIth root; D, just caudal to the VIIIth root; E, at the level of IXth and Xth roots; F, at the level of the XIIth root; G, at the beginning of the first cervical segment.

Key for both figures: 1, sensory root of V; 2, main sensory nucleus of V; 3, lateral descending tract of V (LTTD); 4, descending tract of V (TTD); 5, nucleus of the descending tract; 6, nucleus of the lateral descending tract; 7, spinal tract of V; 8, nucleus of the spinal tract; and a, motor root of V; b, ventrolateral motor nucleus of V; c, dorsomedial motor nucleus of V; d, colliculus caudalis; e, cerebellum; f, fourth ventricle; g, nucleus of VI; h, fasciculus longitudinalis medialis; i, root of VI; j, root of VIII; k, fasciculus solitarius; m, area acustica; n, roots of IX and X; o, motor nucleus of X; p, central canal; q, root of XII.



In the python an additional bundle is present, formed by fibres representing all of the 3 primary divisions of the sensory trigeminus. This bundle follows the peripheral aspect of the descending tract proper (TTD) and is provisionally named the lateral descending tract (LTTD). The two tracts are separated by a layer of coarse, loosely arranged fibres, tentatively assigned to the TTD. The two tracts can also be distinguished by the orientation of their fibres in transverse sections of the brain stem: the fibres of the TTD are cut obliquely, those of the LTTD transversely.

The fibres of the LTTD terminate in a large nucleus placed lateral to the TTD and extending from the level of entrance of the VIIIth nerve to the caudal part of the third cervical segment. The nucleus has its greatest cross-sectional area a short distance behind its rostral pole where it forms a conspicuous elevation on the dorso-lateral aspect of the brain stem. It tapers caudally and is reduced to a thin layer of gray matter at the level of exit of the IXth and Xth nerves.

The nucleus and the TTD migrate dorsally at the transition between medulla oblongata and cervical cord and the nucleus then comes to lie over the dorsolateral aspect of the trigeminal spinal tract where it is not easily recognised without the help of degeneration preparations. The detailed topography is given in Fig. 1.

Neurons are relatively sparse within the neuropil of the nucleus. Most are small, round or oval but some, in the rostral part of the nucleus, are larger and bi- or multipolar.

The projection of the TTD fibres to the associated nucleus and the cervical medulla was confirmed in the degeneration preparations; the details of the arrangement are the subject of current work. In these degeneration preparations the fibres of the LTTD were found to be more densely packed than the normal preparations had suggested. They run directly towards the lateral nucleus which they penetrate over the greater part of its surface; those which enter more caudally form a distinct fibre layer that sharply delineates the nucleus. After penetration, the fibres run in small bundles, mostly in a caudal direction, and abundant terminal degeneration is found throughout the nucleus.

In rattlesnake a similar distribution of the descending fibres was found (Fig. 2B). The large cell mass at the termination of the lateral tract forms an even more prominent ridge on the dorsolateral aspect of the medulla in this species. The cranial border of the nucleus is level with the root of the vagus nerve, caudal to the region in which the descending tract shifts dorsomedially to become the spinal tract. The main mass of the nucleus takes a position over the dorsolateral aspect of the spinal tract and thus the nucleus as a whole occupies a position corresponding to that of the tail of the nucleus in the python. A narrow caudal extension of the nucleus follows the dorsolateral aspect of the spinal tract.

In the viper neither a lateral descending tract nor a lateral nucleus could be identified (Fig. 2C).

It is remarkable that these large structures should previously have gone unnoticed, for, though relatively little is known of the anatomy of the reptilian brain stem, there is at least one article which deals specifically with the medulla oblongata of the rattlesnake, *C. atrox*⁷. The author of that study makes no mention of the

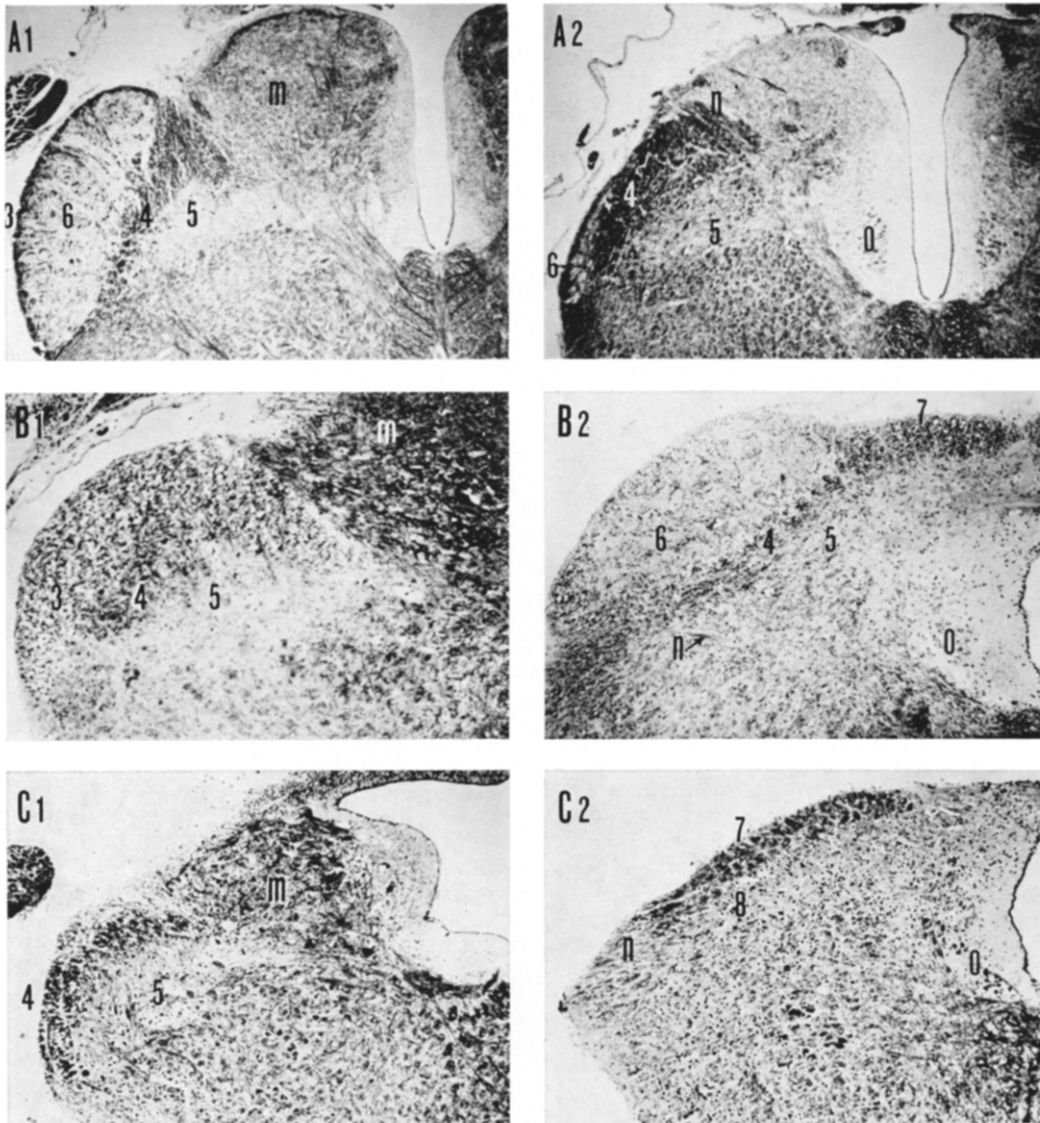


Fig. 2. Photomicrographs of transverse sections of brain stems of python (A), rattlesnake (B) and viper (C), at the level of the VIIIth root (1) and the motor X nucleus (2). Staining: Luxol fast blue and cresyl fast violet. Magnification: A1 and A2 $\times 30$; B1 $\times 50$; B2, C1 and C2 $\times 60$.

lateral descending tract and nucleus. His omission is perhaps explained by the limitations of the material available to him, since the structures are undoubtedly more obtrusive in degeneration than in normal preparations. Even so, the rostral pole of the nucleus appears to be present in his Fig. 10.

It is probably significant that the species which have been found to possess this additional system are distinguished from other reptiles by the possession of pit organs,

i.e. infrared sensors^{2,3} allowing the animal to recognise and locate warm-blooded prey⁴. Since it is known that all 3 primary subdivisions of the trigeminal nerve supply the pit organs², the finding that all 3 contribute to the lateral tract is consistent with this conjectured association. By analogy with other trigeminal sensory systems, involvement of some part of the trigeminal nuclear complex in mediating the information from the pit organs would be expected. No particular subdivision of the trigeminal complex, however, has yet been identified with the pit-organ sensorium, and it appears that the only relevant physiological finding published is that infrared stimulation of the pit organs activates units in the tectum mesencephali⁶.

Further degeneration experiments to determine the projections of the lateral descending tract in more detail, as well as the connections of the nucleus, are in progress, whilst investigation of the involvement of the lateral nucleus in infrared perception is planned.

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