

## Some efferent connections of the superficial pretectum in the goldfish

R. GLENN NORTHCUTT<sup>1</sup> and MARK R. BRAFORD, Jr.<sup>2</sup>

*Division of Biological Sciences, University of Michigan, Ann Arbor, MI 48109, and Department of Anatomy,  
Georgetown University, Washington, DC 20007 (U.S.A.)*

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The diencephalic nuclei known as the lateral geniculate and rotundus in goldfish appear to belong to the pretectal region. They do not project to the telencephalon. A combination of degeneration and horseradish tract-tracing experiments show that the latter nucleus projects caudally to the so-called mammillary body and to a precerebellar cell group-nucleus lateralis valvulae.

The lateral geniculate nucleus and nucleus rotundus\* are two prominent cell groups (Fig. 1A) in the diencephalon of the goldfish<sup>20</sup>. These two nuclei have also been recognized in many other teleosts, as well as in other ray-finned fishes. The names given to these nuclei appear to have been based on the assumption that they lie in the thalamus and have carried with them at least the connotations of homologies with similarly named nuclei in other vertebrates. As such, one or both of these cell groups might well be expected to project to the telencephalon. However, based on a comprehensive cytoarchitectonic and topographic analysis of the diencephalon and pretectum of several ray-finned fishes including the goldfish, *Carassius auratus*, these two nuclei have recently been assigned to the pretectum and renamed nucleus pretectalis superficialis, pars parvocellularis (PSp) and pars magnocellularis (PSm), respectively<sup>2,3,18</sup>.

In order to determine whether any part of the superficial pretectal nucleus projects to the telencephalon, 4 specimens of *Carassius auratus* (total length: ca. 15 cm) were anesthetized with tricaine methanesulfonate and the pretectum was exposed by removal of one eye and the underlying neurocranial wall. The position of the superficial pretectal nucleus was ap-

parent as a small, surface mound lying between the arms of the dorsal and ventral optic tracts and was easily disrupted by aspiration with a small cannula. The animals were allowed to survive 8–13 days post-operatively at 21–25 °C and were then re-anesthetized and perfused with 0.7% saline followed by 10% formalin. The brains were subsequently processed and stained for degenerating axons and terminals using several modifications of the Fink-Heimer technique<sup>5</sup>.

No degenerating fibers or terminals were traced to or seen in the telencephalon. Degenerating retinofugal fibers and their terminals that resulted from the removal of one eye were seen largely on the side contralateral to the lesion. Ipsilaterally, a compact bundle of degenerating fibers was traced caudoventrally from the aspiration lesion in the pretectum (Fig. 2). This bundle corresponds, at least in part, to the tractus thalamo-mammillaris of Goldstein<sup>7</sup> and others and the tractus rotundus of Schnitzlein<sup>20</sup>. Near the caudal border of the diencephalon this tract passes through a field of large neurons (the nucleus lateralis thalami of Holmgren<sup>11</sup> and Bergquist<sup>1</sup> or the nucleus ruber of Goldstein<sup>7</sup> and Sheldon<sup>22</sup>) and may terminates sparsely on them. A large component of this bundle courses ventromedially and terminates ex-

*Correspondence:* R. G. Northcutt, Division of Biological Sciences, University of Michigan, Ann Arbor, MI 48109, U.S.A.

\* This nucleus has also been called nucleus anterior thalami<sup>6,7,11,22</sup>. It is not to be confused with either the nucleus rotundus of Sheldon<sup>22</sup> or the glomerular nucleus of the caudobasal diencephalon which has sometimes also been called nucleus rotundus.

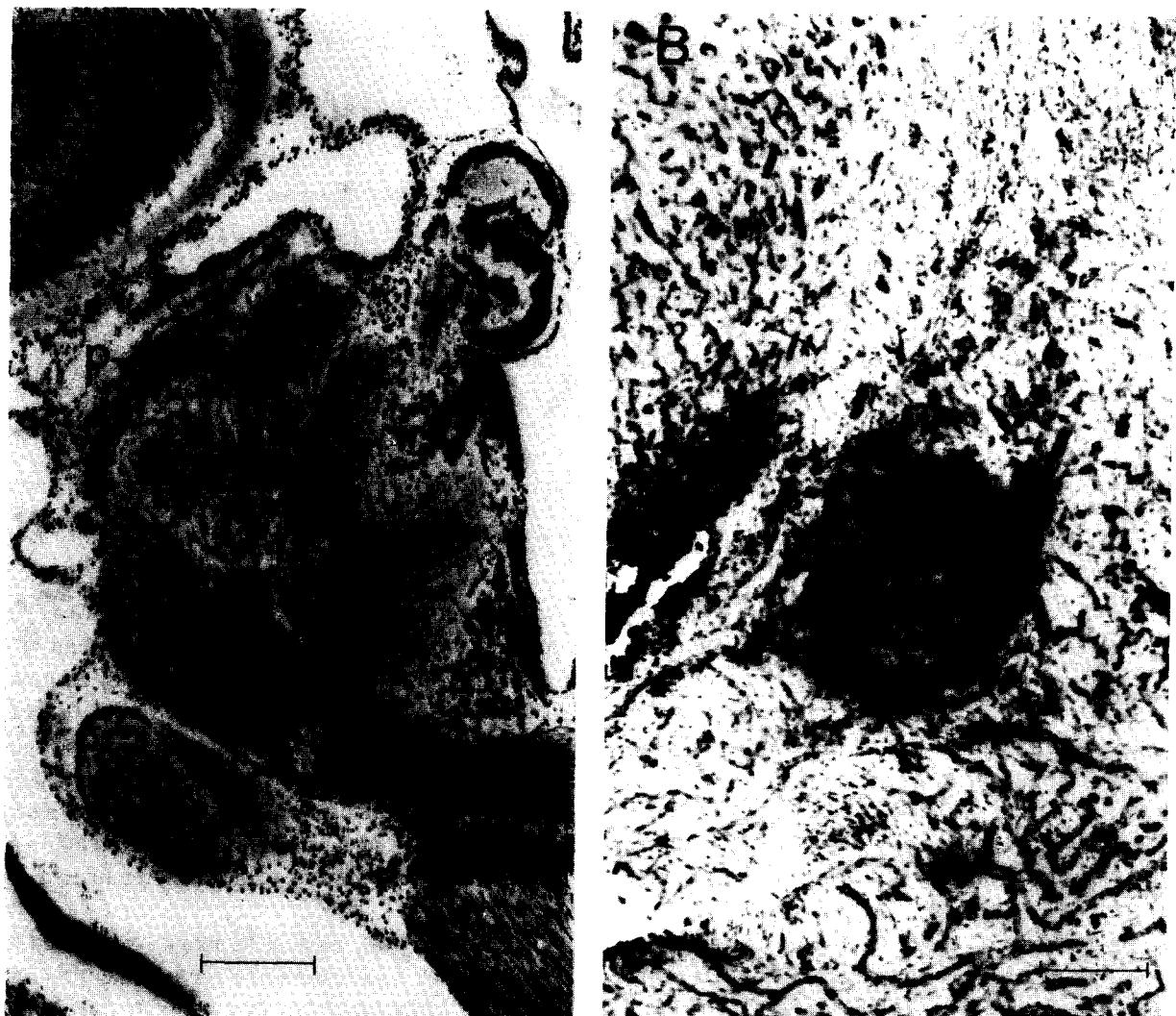


Fig. 1. A: photomicrograph of a transverse section stained by the Bodian method through one side of the diencephalon showing the relative positions of the pars parvocellularis (p) and the neuropil (n) and cell plate (m) of the pars magnocellularis of the superficial pretectal nucleus. B: photomicrograph of a transverse section through the pars magnocellularis demonstrating retrogradely labeled cell bodies and neuropil following an HRP injection into the ipsilateral corpus mammillare. Bar scales indicate 200 and 100  $\mu\text{m}$  in A and B, respectively.

tremely densely in a cell group which lies on the dorsomedial aspect of the inferior lobe of the hypothalamus. This cell group has traditionally been called the corpus mammillare or mammillary body. A smaller dorsal component of the main tract continues caudally for a short distance before sweeping dorsally to terminate in rostromedial portions of the nucleus lateralis valvulae.

In an attempt to determine which portion of the superficial pretectal nucleus gives rise to the major ventral component of this pathway, 40–60 nl of HRP (Sigma Type VI, 40%) was pressure injected unilaterally

into the 'mammillary body' in two additional animals. Following survival times of four days at 23 °C, the animals were sacrificed and the tissue was processed according to the methods of Mesulam<sup>13</sup> and Hanker et al.<sup>10</sup>. In one of the two cases the injection was centered in and restricted to the mammillary body. HRP-labeled fibers were seen in both the ventral and dorsal components of the pathway and nearly all of the large cells which form the rim of PSm were retrogradely filled with HRP (Fig. 1B). No HRP-labeled fibers, terminals or cell bodies were seen in PSp. We interpret these results to mean that the axons of these

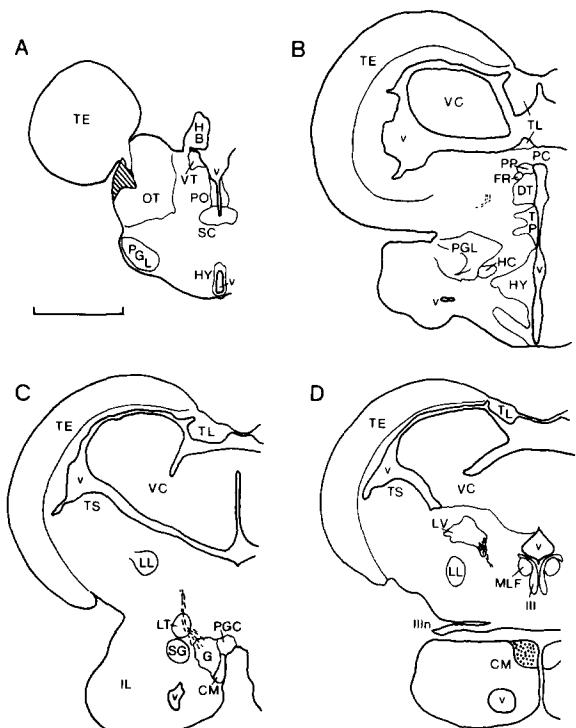


Fig. 2. Drawings of transverse sections through one side of the diencephalon and mesencephalon on which have been plotted degenerating fibers and terminals seen following an aspiration lesion of the superficial pretectum. The extent of the lesion is shown by hatching in section A, which is the most rostral section. Degenerating fibers are indicated by dashed lines and degenerating terminals by dots. Bar scale; 1 mm.

large neurons of PSm form a major part of tractus rotundus, that they project to the mammillary body, and that at least some of them send collaterals to nucleus lateralis valvulae.

#### LIST OF ABBREVIATIONS

CM	corpus mamillare
DT	dorsal thalamus
FR	fasciculus retroflexus
G	nucleus subglomerulosus of Schnitzlein
HB	habenula
HC	horizontal commissure
HY	hypothalamus
IL	inferior lobe of hypothalamus
LL	lateral lemniscus
LT	nucleus lateralis thalami of Holmgren and Bergquist
LV	nucleus lateralis valvulae
MLF	medial longitudinal fasciculus
OT	optic tract
PC	posterior commissure

PSm is known to receive a bilateral input from the optic tectum in *Carassius*<sup>8,9</sup> and in this respect resembles the nucleus rotundus of reptiles and birds. However, neither its topographical position nor its efferent connections, demonstrated here, support such a homology.

PSp is known to receive a direct retinal input in *Carassius*<sup>3,21,24</sup>, but its topographical position and the fact that it does not appear to project to the telencephalon make it a poor candidate for a homologue of the dorsal portion of the lateral geniculate nucleus of land vertebrates. Previous studies using various methods have suggested different targets for PSp. Holmgren<sup>11</sup> using the Golgi method, suggested that PSp projects to the optic tectum in *Osmerus*, but tectal HRP injections in *Cyprinus*<sup>12</sup> and *Lepomis*<sup>17</sup> have failed to label cells of PSp. This is consistent with the results of the present study. Retrograde labeling of PSp cells following HRP injections into the eye in *Jullidochromis* and *Tetraodon* has been reported<sup>4,15</sup>. A number of other studies using HRP or cobaltous-lysine have, however, failed to demonstrate this connection in other teleosts, including *Carassius*<sup>14,16,19,23-25</sup>. Further studies are needed to establish the efferent connections of PSp and can probably best be carried out in a species in which PSp is both larger and less closely associated with PSm than it is in *Carassius*, as is the case in many perciform teleosts.

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PGC	nucleus preglomerulosus commissuralis
PGL	preglomerular nuclear complex
PO	posterior parvocellular preoptic nucleus
PP	periventricular pretectal nucleus
SC	suprachiasmatic nucleus
SG	nucleus subglomerulosus
TE	optic tectum
TL	torus longitudinalis
TP	posterior tuberculum
TS	torus semicircularis
v	ventricle
VC	valvula cerebelli
VT	ventral thalamus
III	oculomotor nucleus
IIIIn	oculomotor nerve

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