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The Topography and Structure of the Habenular Nuclei of the European beaver

Stanisław SZTEYN & Janusz DYNOWSKI

Szteyn S. & Dynowski J., 1977: The topography and structure of the habenular nuclei of the European beaver. Acta theriol., 22, 28: 371—376 [With Plates XIX—XX].

This study was carried out on the brains of 3 beavers (*Castor fiber* L i n n a e u s, 1758) sectioned transversely at 15 μ. The sections were stained alternately by Nissl's and Klüver-Barrera's methods. The paper contains a description of 2 habenular nuclei which occur in the beaver, the medial (*nucleus habenulae medialis*) and the lateral (*nucleus habenulae lateralis*). The beaver's habenula is characterized by a very marked development of the medial nucleus and a poor development of the lateral. The habenula of the beaver has been found to show a very great resemblance in structure to the corresponding nerve centres of the coypu.

[Teacher's Training Coll., Dept. Biol., Żołnierska 14, 10-561 Olsztyn, Poland].

I. INTRODUCTION

The present work is a continuation of the studies carried out on the anatomy of the brain in the beaver (*Castor fiber* L i i n a e u s, 1758) at the Teachers Training College at Olsztyn. Its purpose was to get acquainted with topography and structure of the habenular nuclei (*nuclei habenulae*) of this mammal. There are no records of these nerve centres of the beaver in literature. A comparison of the results of this study with the corresponding data from the publications dealing with other mammals permits some comparative-anatomic conclusions.

II. MATERIAL AND METHOD

The study was made on the brains of three beavers, aged 6—18 months. The study material was fixed with neutralized formalin, dehydrated in a series of ethyl alcohol, embedded in paraffin and sectioned transversely at 15 μ. Every other section was used for study. The sections were stained alternately with Löffler's methylene blue by Nissl's technique and with cresyl violet and luxol fast blue according to Klüver-Barrera's method.

III. RESULTS

The medial habenular nucleus (Figs. 1—4, HM) of the beaver is a well-developed and elongate cellular tract, sharply demarcated from its surroundings. It is situated in the dorsomedial portion of the posterior part of the thalamus, in the medial region of the medullary stria of thalamus and forms a distinct bulge in the dorsal part of the wall of the third ventricle. The posterior pole of the medial nucleus appears at a short distance to the rear of the anterior margin of the habenular commissure. Its anterior end disappears in front of the transverse plane that passes through the posterior pole of the dorsolateral thalamic nucleus. The average length of the medial nucleus in the beavers examined was about 3.25 mm.

In transverse sections the posterior part of the medial habenular nucleus is a small upright oval group of cells, situated close to the wall of the third ventricle. Towards the front the section area of the nucleus increases rapidly and assumes the shape of a large rounded cellular agglomeration. Compact bundles of nerve fibres appear in the centre half-way along the medial nucleus and they gradually push the cells aside to the periphery and the nucleus assumes the shape of a ring. At three-quarters of the length from the posterior border-line the section of the medial nucleus decreases, the cells vanish from its lateral part, and the nucleus itself forms a narrow strip of cells, parallel to the wall of the third ventricle. Towards the front number of cells in the nucleus and the area of its section decrease very slowly and the medial nucleus dwindles away gently somewhat to the front of the posterior end of the dorsolateral thalamic nucleus.

The medial habenular nucleus is composed of intensely staining multipolar and triangular cells, measuring 15 to 25 μ. The cells contain a big spherical nucleus each with a centrally situated nucleolus. In the neuroplasm there are numerous fine grains of tigroid. There are also single spindle-shaped cells, measuring 15 to 20 μ along the long axis, and spherical cells, 10—15 μ in diameter. The cells of the medial nucleus are distributed irregularly, more densely in the periphery than in the centre.

Nucleus habenulae lateralis

The lateral habenular nucleus (Figs. 1—4, HL) is a long cellular tract, not very sharply demarcated from the surroundings, situated in the lateral part of the medullary stria of thalamus. The posterior end of the lateral nucleus appears at a short distance to the front of the posterior end of the medial nucleus. Its anterior end lies slightly to the rear of

the anterior end of the medial nucleus. The length of the lateral habenular nucleus in the examined animals averages about 2.8 mm.

In transverse sections the posterior part of the lateral nucleus consists of single cells lying by the ventrolateral surface of the medial nucleus. The boundary between the two nuclei is indistinct and they can be discriminated only on the basis of their different cellular structures. Towards the front the nucleus grows upwards and assumes an irregular shape of a group of cells, which lies close to the lateral surface of the medial nucleus. Starting from the mid-length the shape of the lateral nucleus changes gradually. In transverse sections it has the form of a horizontally situated narrow strip of cells. The medial margin of this strip nearly touches the lateral surface of the medial nucleus. In this region the boundary between the two nuclei is more distinct. Towards the front the number of cells in the nucleus decreases gradually and the lateral nucleus dwindles away gently, posteriorly to the anterior end of the medial nucleus.

The lateral nucleus is composed of loosely and irregularly arranged cells and it is indistinctly demarcated from the surroundings. The lateral nucleus is composed of not very intensively staining rounded cells, measuring 12—16 μ, and multipolar cells, 25—35 μ in dimension. The multipolar cells are fewer than the rounded cells. There are also sporadic single spindle-shaped cells, which measure 20—30 μ along the long axis.

IV. DISCUSSION

The habenular nuclei are nerve centres that have roused interest of both neuroanatomists and neurophysiologists since a long time ago. As has been shown by morphological studies, in most mammals, e.g. in the opossum (Tsai, 1925) lemur (Le Grose Clark, 1930), *Carnivora* (Rioch, 1931), cat (Ingram *et al.*, 1932), boar (Solnitzky, 1938), swine (Welento, 1964), goat (Szteyn & Welento, 1967), sheep (Szteyn, 1967), rat (Craige, 1925) and coypu (Szteyn, 1968), two nuclei can be distinguished in the habenula, a lateral and a medial. Only Malone (1910) found one nucleus in the habenula of man, but it should be emphasized that Marburg (1944), investigating the same region of the brain in man, distinguished as many as 5 morphological nerve agglomerations in it.

Studies carried out on the connections of the habunular nuclei (Rioch, 1929, 1931; Huber & Crosby, 1929; Papez, Aronson & Marburg, 1944, and others) demonstrated that they are connected with the nerve centres of the midbrain, thalamus, hypothalamus, hippocampal gyrus, amygdaloid nucleus and *globus pallidus*. So nu-

merous connections of the habenular nuclei allow suppositions about their great functional importance, associated not only with the sense of smelling.

The characteristic feature of the habenular nuclei of the beaver is the very strong development of the medial nucleus and the poor development of the lateral nucleus, which despite its spreading over a fairly long space is, as can be seen from transverse sections, made up of a small number of cells, often of hardly more than ten. This picture much resembles the structure of the analogous nerve centres in the coypu (Szteyn, 1968). No such great disproportions in size have been found between the medial and the lateral nucleus in other mammals.

In the beaver, as in the coypu and most mammals, the cells of the medial habenular nucleus are clearly smaller than those of the lateral nucleus. Only Gurdijan (1925) and Craige (1925) found a reverse situation in the rat, *i.e.* the considerably smaller cells of the lateral nucleus than those of the medial. In addition, the cells of the medial nucleus stain considerably more intensively than the cells of the lateral nucleus, which was observed by Ingram *et al.* (1932) in the cat, Welento (1964) in the swine, Szteyn (1967, 1968) in the sheep and coypu, and which is also visible in the beaver.

The very similar shape and structure of the habenular nuclei in the coypu and beaver, two rodent species closely associated with water environment and at the same time great differences that they show in comparison with the morphology of the analogous nerve centres in the rat may suggest that the decisive factor in the development of these nuclei is the habitat and the ways of life of the animal and not its phylogenetic affinity. Naturally, these suppositions need confirming in further studies.

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Stanisław SZTEYN i Janusz DYNOWSKI

TOPOGRAFIA I BUDOWA JĄDER WĘDZIDEŁKA BOBRA EUROPEJSKIEGO

Streszczenie

Badania zostały przeprowadzone na mózgowiach trzech bobrów (*Castor fiber* Linnaeus, 1758), ciętych na skrawki poprzeczne o grubości 15 μ. Skrawki barwiono na przemian metodami Nissla i Klüvera-Barrery. W pracy opisano dwa jądra wędzidełka występujące u bobrów: przyśrodkowe (*nucleus habenulae medialis*) i boczne (*nucleus habenulae lateralis*). Cechą charakterystyczną jąder wędzidełka bobra jest bardzo silne wykształcenie *nucleus habenulae medialis* i słabe wykształcenie *nucleus habenulae lateralis* (Fot. 1—4). Stwierdzono, że budowa jąder wędzidełka bobra wykazuje bardzo duże podobieństwo w porównaniu z budową analogicznych ośrodków nerwowych nutrii.

Plate XIX

Figs. 1—4. Transverse sections of the brain of the beaver

Fig. 1. — in the proximity of the posterior end of the medial habenular nucleus.

Fig. 2. — in the region of the middle section of the medial habenular nucleus.

Fig. 3. — at a height of one-third of the length of the anterior part of the medial habenular nucleus.

Fig. 4. — in the proximity of the anterior end of the medial habenular nucleus.

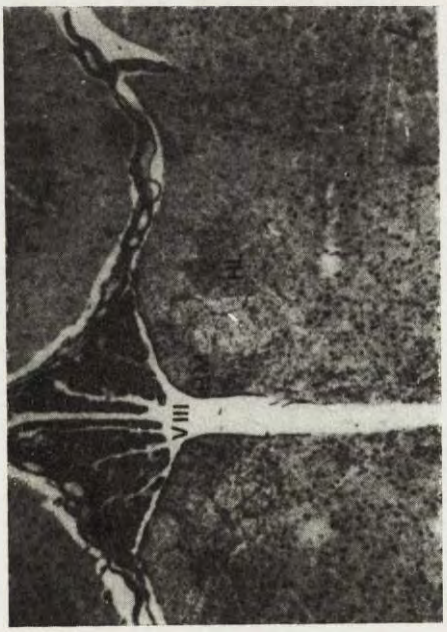
Abbreviations used in the figures

CM — *commissura habenularum*

HL — *nuclues habenulae lateralis*

ML — *nucleus habenulae medialis*

v III — *ventriculus* III



S. Szteyn & J. Dynowski *auctores phot.*