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Cerebellar Nuclei in the Beaver

[With Plates III & IV]

The study contains a description of the structure and topography of the cerebellar nuclei in 3 beavers (*Castor fiber* L i n n a e u s, 1758), from 6 to 18 months old. Cross-sections embedded in parafin and sectioned to 15 μ were stained alternately either the Nissl or Klüver-Barrere methods. It was found that the cerebellar nuclei are divided into 3 bands of cells: *nucleus lateralis, nucleus medialis* and *nucleus interpositus*. The very strong formation of *nucleus lateralis* and weak development of *nucleus interpositus*, which is not divided into an anterior and posterior part in the beaver, is remarkable.

I. INTRODUCTION

The purpose of this study was to examine the cytoarchitectonics and topography of the cerebellar nuclei in the beaver (*Castor fiber* L i n n a e u s, 1758), and it is intended to form part of the studies made on the brain of this animal in the Department of Biology of the Teaching College in Olsztyn. There are no data to be found on cerebellar nuclei in the beaver in the literature so far published, and as a comparatively small number of mammal species have so far been examined in this respect, the results obtained here may be of interest from the aspect of comparative anatomy.

II. MATERIAL AND METHODS

Examination was made of the brain of 3 beavers from 6 to 18 months old. The cerebellum of each was fixed in neutralized formalin, dehydrated with ethyl alcohol, then embedded in paraffin and sectioned to 15 μ slices. Every second slices, which was stained alternately by the Nissl and Klüver-Barrer method, was taken for these studies.

III. RESULTS

The grey matter situated in the medullary body of the cerebellum in the beaver can be divided into there bands of nerve cells: *nucleus lateralis, nucleus medialis* and *nucleus interpositus.*

Nucleus lateralis (NL — Fig. 1—6)

Nucleus lateralis of the cerebellum in the beaver is elongate, clearly demarcated from its surrounding, band of nerve cells situated in the lateral part of the medullary substance. *Nucleus lateralis* extends further forwards and backwards than the other cerebellar nuclei in the cross-section.

The posterior part of *nucleus lateralis,* seen in cross-section, forms several small clusters of cells, which rapidly enlarge and join in an anterior direction. *Nucleus lateralis* takes the form of a large uniform group of cells of semi-oval shape, the convex surface of which is directed ventrally and laterally, and the flat surface dorsally and medially. In the middle part of *nucleus lateralis* the cells in its interior are distributed increasingly loosely and consequently a cell-less sinus is formed in the centre of the nucleus, opening over a short section into the ventro-medial surface of the nucleus. Near the anterior pole the cross-section of the nucleus becomes smaller, separating into several groups of cells which gradually disappear.

Nucleus lateralis consists of fairly densely distributed intensively-staining multipolar and triangular cells from 25 to 50 μ in size. The cells contain a large spherical nucles situated near the centre and numerous large tigroid granules. In the ventral part of the nucleus the cells are far smaller than in the dorsal part and single spindle-shaped neurons, measuring from 40 to 50 μ along the long axis, are observed in this region. The large number of gliae located between the cells of *nuclues lateralis* give it the form of a compact band of grey matter.

Nucleus medialis (NM — Fig. 2—6)

Nucles medialis is a long, distinct and well-formed band of cells situated in the medial part of the medullary substance of the cerebellum, medially from the other nuclei. The posterior pole of *nucleus medialis* is situated at the height of the anterior boundary of 1/6 of the posterior part of *nucleus lateralis.* The anterior pole of this nucleus is situated at the level of the posterior boundary of 1/10 of the anterior part of *nucleus lateralis.*

In cross-sections the posterior pole of *nucleus medialis* consists of a small group of loosely distributed cells situated in the vicinity of the median plane, medially from *nucleus interpositus*. In an anterior direction the nucleus increases in size and takes on the form of a triangular group of cells, clearly distiguishable from its surroundings, which occupies the ventro-medial part of the medullary matter of the cerebellum. The middle and posterior parts of the nucleus are adjacent on the lateral side to *nucleus interpositus*, while the anterior part is situated medially from *nucleus lateralis*. In the middle part of *nucleus medialis*, where it is best formed, it extends practically to the median plane and almost contacts with *nucleus medialis* of the centrolateral side. The anterior part of the nucleus shifts gradually in a lateral direction to approach *nucleus lateralis*. The line of demarcation between these becomes less distinct. The anterior part of *nucleus medialis* is less compact, and its cells are separated from each other by numerous thick bundles of fibres. The anterior pole of the nucleus formed by a small group of loosely distributed cells situated near medial surface of *nucleus lateralis*, at a considerable distance from the median plane.

Nucleus medialis is formed by intensively-staining multipolar and triangular cells measuring from 25 to 60 μ. The cells are distributed irregularly in groups, within which they are similar in size. Fusiform cells measuring from 40 to 50 μ along the long axis are encountered in *nucleus medialis*. All the cells of *nucleus medialis* have large spherical nuclei, with a centrally located nucleolus and numerous coarse tigroid granules. As in the case of *nucleus lateralis*, a large number of glia elements occur between the cells of *nucleus medialis*, giving the nucleus its compact form.

Nucleus interpositus (NI — Fig. 1—3)

Nucleus interpositus is a short band of cells, only faintly demarcated from its surroundings, situated between the posterior parts of *nucleus lateralis* and *nucleus medialis*. The posterior pole of *nucleus interpositus* is situated at the level of the anterior boundary of 1/12 of the posterior part of *nucleus lateralis*. The anterior pole is situated at the level of the posterior boundary of 1/3 of the anterior part of *nucleus lateralis*.

The posterior part of *nucleus interpositus* is formed in cross-sections by single, loosely distributed cells, situated near the medial surface of *nucleus lateralis*. Further in an anterior direction, after *nucleus medialis* appears, the number of cells in *nucleus interpositus* slowly increase, and they are distributed over a greater area, almost completelly filling the region between *nucleus lateralis* and *nucleus medialis*. Over a short

length of the middle part of the nucleus it can be seen to be divided into two groups of cells: dorso-lateral and ventro-medial. The anterior part of the nucleus again becomes a uniform group of irregularly-shaped cells which forms a narrow band, near the anterior pole, connecting the lower edges of *nucleus lateralis* and *nucleus medialis*.

Nucleus interpositus is formed by loosely and irregularly ditributed fusiform and multipolar cells from 15 to 25 μ in size, and a few even from 30 to 40 μ. The cells have large spherical nuclei, with a centrally situated nucleolus and fairly numerous coarse tigroid granules. In the dorsal part of the nucleus the majority of the cells are fusiform, but multipolar cells are more numerous in the ventral part of *nucleus interpositus*.

IV. DISCUSSION

The very heterogenous structure of cerebellar nuclei in mammals does not permit of accepting one pattern only for their morphological structures, even for the various orders of these animals. In any case Brunner's early classification (1911), in accordance with which he divided mammals into four main groups with gradually increasing complexity of cytoarchitectonic structure of these nerve centres, on the basis of the shape of cerebellar nuclei, has not withstood the test of time. According to Brunner rodents have only one nucleus in the cerebellum, this nucleus being divided into lateral and medial parts by a band of fibres, and they occupy a place intermediate between *Monotremata, Chiroptera* and *Insectivora,* possessing one undivided cerebellar nucleus, and the group of animals including *Carnivora, Ungulata* and *Arctopithecidae,* with three nuclei in the cerebellum. Later studies have shown that the arrangement given by Brunner (1911) for mammals is unacceptable, for instance Szteyn (1966) observed four separate nerve centres in nutria, and Jastrzębski (1968) found three distinctly separate nuclei in *Microtidae,* as was also the case with the beaver.

The characteristic feature of the cerebellar nuclei in the beaver is the very strong formation of *nucleus lateralis,* which in both the frontal and the sagittal plane greatly exceeds the dimensions of the other nuclei. It may be concluded that *nucleus lateralis* in the beaver is the dominating centre among the cerebellar nuclei. Similarly *nucleus lateralis* has also been found by many authors (Rand, 1954; Carpenter & Stevenson, 1957; Jansen & Brodal, 1958) to play a dominating role in man and monkeys. In the beaver, however, *nucleus lateralis* exhibits a far simpler structure, since its external surface is smooth, whereas in *Primates* it is intensively folded; on the other hand

the sinus of *nucleus lateralis* is, as in the case of *Primates*, open in a ventromedial direction, which may form evidence that the main mass of nerve fibres run from this nucleus in a similar direction. In certain mammals, *e.g.* in the nutria (Szteyn, 1966), these relations are reversed — the sinus of *nucleus lateralis* opens in a dorso-lateral direction. It must be also emphasised that in ungulates, such as the roe-deer (Szteyn, 1969), or domestic ruminants (Jastrzębski, 1966) *nucleus lateralis* is relatively less strongly formed than in the beaver.

The second characteristic feature of the cerebellar nuclei in the beaver is the weak formation of *nucleus interpositus*. It does not form a compact band of cells and is only fainly demarcated from its surroundings. *Nucleus interpositus* in the beaver, as in the case of *Microtidae* (Jastrzębski, 1968), is a homogenous band of cells, and thus differs distinctly from *nucleus interpositus* in such animals as *Primates* (Rand, 1954), ruminants (Jastrzębski, 1966; Szteyn, 1969), the rabbit (Ono & Kato, 1928), *Cetacea* and *Pinnipedia* (Ogawa, 1935), nutria (Szteyn, 1966), the cat (Flood & Jansen, 1961) and other mammals (Ohkawa, 1957), in which this nucleus is distinctly divided into two bands of nerve: *nucleus interpositus anterior* and *nucleus interpositus posterior*.

Nucleus medialis is far more weakly formed in the beaver than, for instance, in ruminants (Jastrzębski, 1966; Szteyn, 1969) and does not exhibit features specific to this species.

The much stronger formation of *nucleus lateralis* than *nucleus medialis* suggests that far more nerve fibres run from the cerebellum in the beaver to such nerve centres as *nucleus ruber*, thalamus or *globus pallidus*, to which *nucleus lateralis* sends out nerve fibres, than run to *nuclei vestibulares* and the reticular substance of *medulla oblongata*, which receive fibres primarily from *nucleus medialis*.

The cell structure of the cerebellar nuclei in the beaver exhibits considerable similarity to the cytological structure of the cerebellar nuclei in other mammals, but it must be emphasised that *nucleus lateralis* is fairly distinctly divided into the dorsal zone, formed by cells far larger than in the ventral zone of this nucleus. No such cytoarchitectonic differences in *nucleus lateralis* have been found in other mammals.

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JĄDRA MÓŻDŻKU BOBRA

W pracy opisano budowę i topografię jąder móżdżku 3 bobrów (*Castor fiber* Linnaeus, 1758) w wieku od 6 do 18 miesięcy. Parafinowe skrawki poprzeczne grubości 15 μ barwiono na przemian metodami Nissla i Klüvera-Barrery. Stwierdzono, że jądra móżdżku podzielone są na 3 pasma komórkowe: *nucleus lateralis, nucleus medialis* i *nucleus interpositus*. Na szczególną uwagę zasługuje bardzo silne wykształcenie *nucleus lateralis* i słaby rozwój *nucleus interpositus*, które u bobra nie dzieli się na część przednią i tylną.

PLATES III & IV

EXPLANATIONS OF PLATES III—IV

Fig. 1—6. Cross-sections of the cerebellum in the beaver.

Plate III.

Fig. 1. — at the level of the posterior pole of *nucleus interpositus.*

Fig. 2. — near the posterior pole of *nucleus medialis.*

Fig. 3. — near the anterior pole of *nucleus interpositus.*

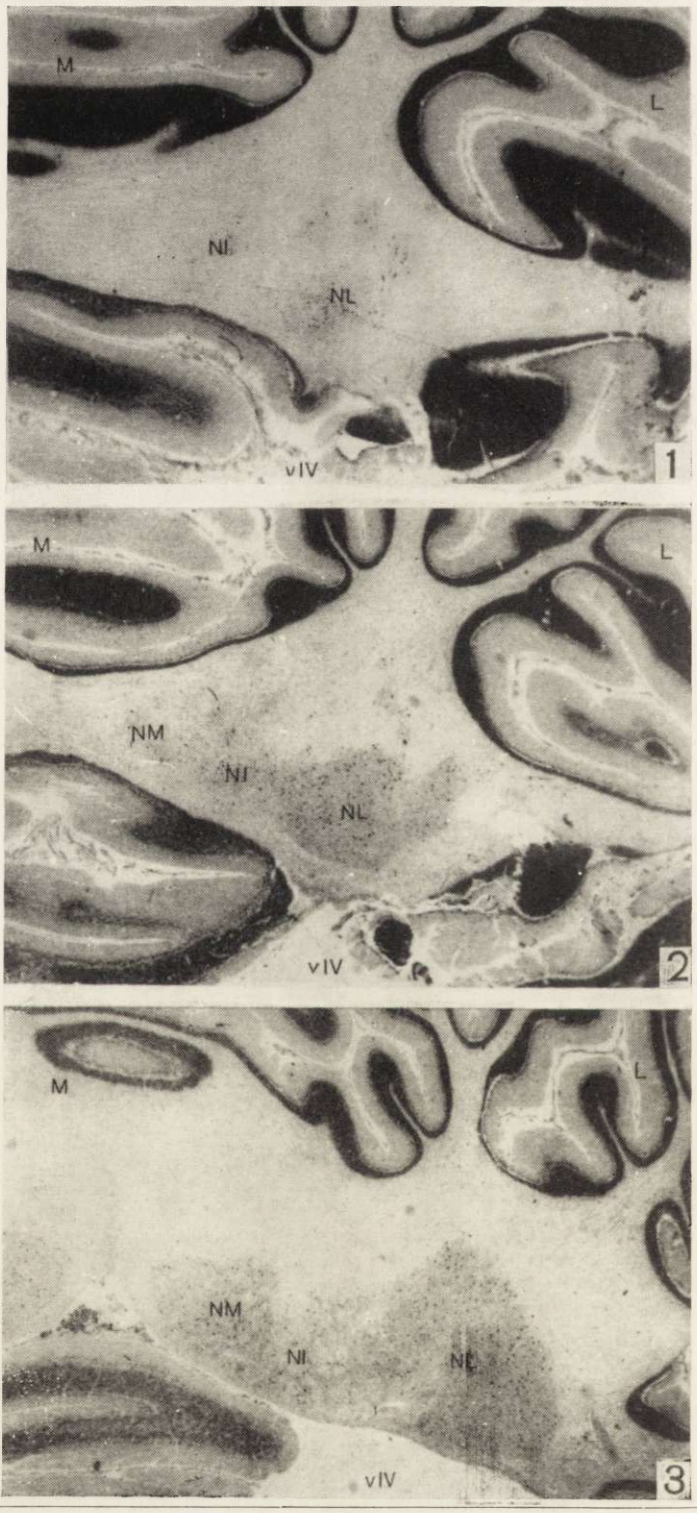
Plate IV.

Fig. 4. — at the level of the middle part of *nucleus lateralis.*

Fig. 5. — at the level of the posterior boundary of 1/4 of the anterior part of *nucleus lateralis.*

Fig. 6. — near the anterior pole of *nucleus medialis.*

Exlanation of symbols in figures. L — lateral side, M — medial side.



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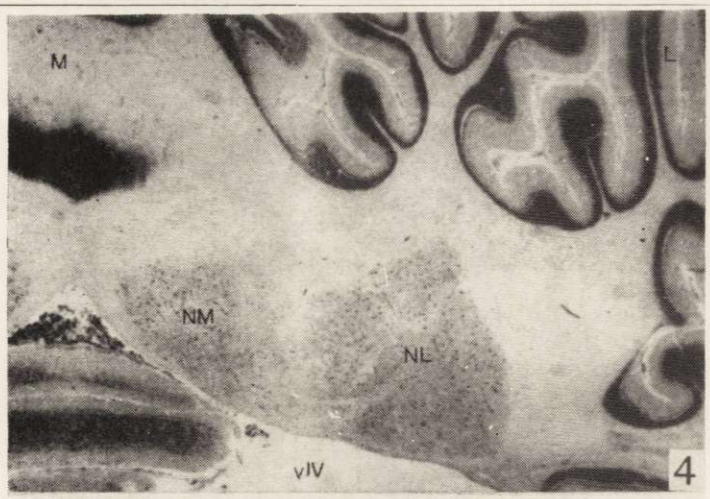

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