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The Nuclei of the Cerebellum in the Roe Deer

[With Plates IV & V]

Studies were made on the basis of cross-sections (at 15 μ) of the cerebellum of roe-deer. The sections were stained by the Nissl method. A description is given of the position, formation and cellular structure of the cerebellar nuclei in roe-deer: *nucleus lateralis, nucleus interpositus anterior* and *nucleus medialis*. A characteristic feature of cerebellar nuclei in roe-deer is the very strong formation of *nucleus medialis*, which exhibits a distinct division into *pars magno-* and *parvocellularis*.

I. INTRODUCTION

Literature dealing with the nuclei of the cerebellum in mammals is relatively scanty. The studies so far made have however revealed great heterogeneity in the structure and formation of these nerve centres in different species of mammals, particularly among the species belonging to systematically distant groups (Brunner, 1911; Ohkawa, 1957). It would therefore appear interesting to make a comparison in respect of the morphological structure of the cerebellum nuclei in animals closely related but leading completely different ways of life, *e. g.* the nuclei of the cerebellum in domestic ruminants and those in free-living ruminants.

Detailed studies on the nuclei of the cerebellum in domestic ruminants were made by Jastrzębski (1966). There are, however, no data in available literature on the nuclei of the cerebellum in free-living ruminants, which was the reason for undertaking the present studies, the aim of which is to obtain a knowledge of the structure, formation and topography of the cerebellar nuclei in the roe-deer.

II. MATERIAL AND METHODS

Examination was made of the cerebellum of 3 sexually adult roe-deer, *Capreolus capreolus* (Linnaeus, 1758). The cerebellum was fixed in ethyl alcohol, embedded in paraffin and sectioned in frontal plane at 15 μ. Every third section was taken for examination. The sections were stained with Lauth's blue by the Nissl method. Ogawa's (1935), nomenclature for the cerebellar nuclei which is now most often applied, was used in this study.

III. RESULTS

1. *Nucleus lateralis* (NL — fig. 1, 2 and 4) is situated in the lateral part of the posterior part of the medullary substance of the cerebellum, laterally from *nucleus interpositus posterior*. The anterior part of this nucleus, situated in front of *nucleus interpositus post.*, lies on the ventro-lateral side of *nucleus interpositus ant.* Behind *nucleus lateralis* appears very slightly to the fore of the posterior pole of *nucleus medialis*, at the level of the anterior limit of 1/3 of the posterior part of *nucleus interpositus post.* In the front *nucleus lateralis* disappears at the level of the transverse plane drawn by the anterior limit of 1/3 of the posterior part of *nucleus interpositus ant.* The length of *nucleus lateralis* is approximately the same as the length of *nucleus interpositus post.* but it protrudes in relation to the latter nucleus by 1/3 in the anterior direction. In the animals I examined the average length of *nucleus lateralis* was 3.0 mm. In cross-sections in the medial part *nucleus lateralis* is a large, distinct group of cells similar in shape to a filled horseshoe. The straight edge of this horseshoe is turned in a dorso-lateral direction, and the rounded edge ventrally and towards the centre. In the anterior and posterior parts the outline of the nucleus is not so regular and it is less distinct than in the medial part. The short anterior part of *nucleus lateralis* lies very close to *nucleus interpositus ant.* and in this place it is somewhat difficult to distinguish the limits of these nuclei.

Nucleus lateralis form intensively staining, fairly loosely and irregularly arranged multipolar cells, triangular and fusiform, measuring from 15 to 60 μ. The cell nucleus is spherical, with the nucleolus located centrally. The tigroid substance occurs in the form of numerous small granules. The relatively very large amount of glial substance distributed between the cells of this nucleus cause the picture of the nucleus to be compact and distinct.

2. *Nucleus interpositus posterior* (nip — fig. 1, 2 and 5) extends the furthest in a posterior direction of all the nuclei of the cerebellum of the roe-deer. This is a somewhat indistinct band of cells situated in the middle part of the posterior part of the medullar substance of the cerebellum, laterally from *nucleus medialis* and medially from *nucleus lateralis* (with the exception of the posterior part, which extends beyond the posterior poles of these nuclei). In front this nucleus disappears minimally in an anterior direction from the posterior pole of *nucleus interpositus ant.* and is situated on its ventral side. The average length of *nucleus interpositus post.* is 3.0 mm. In cross-sections the outline of the nucleus is irregular and variable and its cells are distributed over a large area.

Nucleus interpositus post. is formed by very irregularly distributed, scattered, intensively staining multipolar and triangular cells and single fusiform cells measuring from 15 to 35 μ. The cell nucleus is indistinct, spherical, with nucleus situated centrally. The cells are filled with numerous small granules of tigroid substance.

3. *Nucleus interpositus ant.* (nia — fig. 3 and 6) is a fairly long band of cells situated in the medullar substance of the cerebellum, laterally from *nucleus medialis.* The posterior part of the nucleus is situated on the dorso-medial side of *nucleus lateralis.* Behind, *nucleus interpositus ant.* appears minimally in an anterior direction as from half the length of *nucleus lateralis,* in front disappears in the region of the transverse plane drawn by the posterior limit of 1/5 of the anterior part of *nucleus medialis.* The average length of *nucleus interpositus ant.* is 3.8 mm. In the posterior part this nucleus consists in cross-sections of a narrow group of cells situated on the dorso-pericentral side of *nucleus lateralis.* To the front from the anterior pole of *nucleus lateralis* the section of *nucleus interpositus ant.* rapidly enlarges and the nucleus takes on the form of a large, rounded group of cells situated on the lateral side of *nucleus medialis.* In the anterior part *nucleus interpositus ant.* is a narrow, elongated, vertically arranged accumulation of cells.

Nucleus interpositus ant. is formed by very loosely and irregularly distributed, not very intensively staining, multipolar, triangular and fusiform cells and a few rounded cells measuring from 20 to 50 μ. The cell nucleus is spherical, with the nucleolus situated in the centre. The tigroid substance occurs in the form of small and medium granules.

4. *Nucleus medialis* (nm — fig. 1—3, 7 and 8) is the largest and best formed of the nuclei of the cerebellum in the roe-deer. It is a very long band of cells situated in the medullar substance of the vermis of the cerebellum. The posterior pole of this nucleus appears slightly to the rear of the posterior pole of *nucleus lateralis,* at the level of the anterior limit of 1/4 of the posterior part of *nucleus interpositus post.* In the anterior direction this nucleus extends further forward than the other nuclei of the cerebellum. The average length of *nucleus medialis* was 6.7 mm. The posterior part of *nucleus medialis* exhibits in cross sections the outline of an elongate oval situated obliquely from the dorsolateral side towards the ventro-pericentral side. In this part the nucleus is situated at half the distance between the central plane of the cerebellum and the central plane of *nucleus interpositus post.* In the anterior direction the nucleus rapidly enlarges, approaches the central plane and takes on the form of a vertically elongated group of cells arranged in the form of an arch in the lateral direction. In this part the cells of *nucleus*

medialis are distributed over a large area from the dorsal to the ventral margin of the medullar substance of the vermis of the cerebellum. The cells in the upper and lower part of *nucleus medialis* lies very close to the central plane and almost contact the cells of the *nucleus medialis* on the opposite side. This picture of the nucleus is maintained up to the anterior pole of *nucleus interpositus ant.* Further in the anterior direction *nucleus medialis* decreases in size, disappearing from the dorsal side. The anterior part of the nucleus takes the form, in cross-sections, of a rounded group of cells.

The cellular structure of *nucleus medialis* is not uniform. In the cyto-architectonics of the nucleus it is possible to distinguish two very clearly differing parts: the *pars magnocellularis* and *pars parvocellularis. Pars magnocellularis* forms the dorsal region of the nucleus and consists of multipolar and triangular cells measuring from 70 to 100 μ (Fig. 8). The cell nucleus is large, spherical, with the nucleolus situated in the centre. The tigroid substance occurs in the form of numerous granules of different size. *Pars parvocellularis* forms the ventral region of *nucleus medialis.* It consists of multipolar, fusiform and rounded cells measuring from 15 to 70 μ, the majority being formed by cells which do not exceed 40 μ in size. The cell nucleus is spherical, with the nucleolus situated in the centre. The tigroid substance is either of foam-like consistency, or occurs in the form of numerous small granules. The cells of *pars parvocellularis* stain slightly less intensively than the cells of *pars magnocellularis. Pars magno-* and *parvocellularis* are contiguous, but the cells of these two parts do not mix.

IV. DISCUSSION

There are four nuclei clearly separated from each other in the cerebellum of the roe-deer. Four cerebellar nuclei have also been distinguished by Ono & Kato (1928) in the rabbit, Ogawa (1935) in *Pinnipedia* and *Cetacea,* by Jastrzębski (1966) in domestic ruminants, by Bujak (1967) in pigs, by Flood & Jansen (1961) in the cat, by Szteyn (1966) in nutria and Jansen & Brodal (1958) and also Rand (1954) and others in man and *Primates.*

The occurrence of four nuclei in the cerebellum of the roe-deer forms yet another breack in Brunner's theory (1911). This author, in his comparative studies on cerebellar nuclei in mammals, divided these animals into 4 groups depending on the number of nuclei in the cerebellum. Brunner (*l. c.*) considered ruminants, like other ungulate animals, and also *Carnivora* and *Arctopithecidae,* to belong to the group of mammals having three cerebellar nuclei.

It would seem that the cerebellar nuclei are more distinctly demarcated in the roe-deer than those of domestic ruminants in which, as Jastrzębski states (1966), the nuclei are situated close together and connected in certain parts. In the roe-deer it is only the short anterior part of *nucleus lateralis* which lies very close to *nucleus interpositus ant.* and in this place the line of demarcation of the nuclei is fairly difficult to discern. In addition to the distinct demarcation of the cerebellar nuclei in the roe-deer, they are also distinguishable from each other by the different cellular structure.

The very strong formation of *nucleus medialis,* which is more than twice as long as *nucleus lateralis* and *nucleus interpositus post.,* and almost twice as long as *nucleus interpositus ant.,* is particularly remarkable in the cerebellar nuclei of the roe-deer. *Nucleus medialis* in domestic ruminants (Jastrzębski, 1966) is far more weakly formed in comparison with its counterpart in the roe-deer. In addition to its great size, a characteristic feature of *nucleus medialis* in the roe-deer is also its cellular structure. The very distinct differentiation of *nucleus medialis* in roe-deer into two zones of cells made it possible to introduce the division of this nucleus in to the *pars magno-* and *pars parvocellularis.* No such differentiation in the cellular structure of *nucleus medialis* was found in either domestic ruminants (Jastrzębski, 1965) or in other species of mammals. Although the present investigations did not permit of drawing definite conclusions as to the functions connected with the very strong formation of *nucleus medialis* in the roe-deer, attention should be given to the fact that according to certain authors (Carpanter & Stevens, 1957) it is only the medial nucleus from among the cerebellar nuclei which sends efferent fibres descending directly to the vertebral medulla.

The other cerebellar nuclei in the roe-deer do not exhibit any great differences in respect of shape or formation in comparison with the cerebellar nuclei of domestic ruminants and other species of mammals, in which four cerebellar nuclei occur.

It must, however, be emphasised that *nucleus lateralis* in the roe-deer, as in domestic ruminants (Jastrzębski, 1966) is far less strongly formed than the *nucleus lateralis* in *Primates* and man. In the latter it is far larger and strongly folded.

REFERENCES

1. Brunner H., 1911: Die zentralen Kleinhirnkerne bei der Säugetiere. Arb. Neurol. Inst. Wien, *22*: 200—277.
2. Bujak A., 1967: Rozwój jądra bocznego i przyśrodkowego świni. Pol. Arch. Wet., *10*: 425—444.

3. Bujak A., 1967: Rozwój jąder wtrąconych móżdżku świni. Ibidem, *10*: 693—704.
4. Carpanter M. B. & Stevens G. H. 1957: Structural and functional relationship between the deep cerebellar nuclei and the brachium conjunctivum in the rhesus monkey. J. Comp. Neurol., *107*: 109—163.
5. Flood S. & Jansen J., 1961: On the cerebellar nuclei in the cat. Acta Anat., *46*: 52—72.
6. Jansen J. & Brodal A., 1958: Das Kleinhirn. Handbuch der Mikroskopischen Anatomie des Menschen. Springer-Verlag: 91—162. Berlin.
7. Jastrzębski M., 1966: Jądra móżdżku przeżuwaczy domowych. Annals Univ. M. Curie-Skłodowska, DD *21*: 263—278.
8. Ogawa T., 1935: Beiträge zur vergleichenden Anatomie des Zentralnervensystems der Wassersäugetiere. Über die Kleinhirnkerne der Pinnipedien und Zetazeen. Arb. anat. Inst. Sendai, *17*: 63—136.
9. Ohkawa K., 1957: Comparative anatomical studies of cerebellar nuclei of mammals. Arch. Hist. Jap., *13*: 21—57.
10. Ono M. & Kato H., 1928: Beitrag zur Kenntnis von den Kleinhirnkernen des Kaninchens. Anat. Anz., *86*: 245—259.
11. Rand R. W., 1954: An anatomical and experimental study of the cerebellar nuclei and their afferent pathways in the monkey. J. Comp. Neurol., *101*: 167—224.
12. Szteyn S., 1966: Budowa i topografia jąder móżdżku nutrii. Pol. Arch. Wet., *10*: 309—320.

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Streszczenie

Badania wykonano na móżdżkach sarn. Móżdżki cięto w płaszczyźnie czołowej na skrawki grubości 15 μ. Skrawki barwiono błękitem Lautha wg metody Nissla. W pracy opisano położenie, ukształtowanie i budowę komórkową jąder móżdżku sarny: *nucleus lateralis* (nl — ryc. 1, 2 i 4), *nucleus interpositus posterior* (nip — ryc. 1, 2 i 5), *nucleus interpositus anterior* (nia — ryc. 3 i 6) i *nucleus medialis* (nm — ryc. 1—3, 7 i 8). Cechą charakterystyczną jąder móżdżku sarny jest bardzo silne wykształcenie *nucleus medialis*, stosunkowo znacznie silniejsze niż u przeżuwaczy domowych. W budowie komórkowej *nucleus medialis* sarny istnieje wyraźny podział na dwie części: wielko i małokomórkową (ryc. 7 i 8). Natomiast *nucleus lateralis* sarny jest stosunkowo znacznie słabiej wykształcone niż np. jądro boczne naczelnych i człowieka.

EXPLANATION OF PLATES

Plate IV

Cross-sections of the cerebellum of roe-deer. (Magn. 7.5 ×)

Fig. 1. Near the posterior pole of *nucleus lateralis.*

Fig. 2. Near the anterior pole of *nucleus interpositus posterior.*

Fig. 3. Halfway along the length of *nucleus medialis.*

Plate V

Cells of the cerebellar nuclei of the roe-deer. (Magn. 35 ×).

Fig. 4. *Nucleus lateralis.*

Fig. 5. *Nucleus interpositus posterior.*

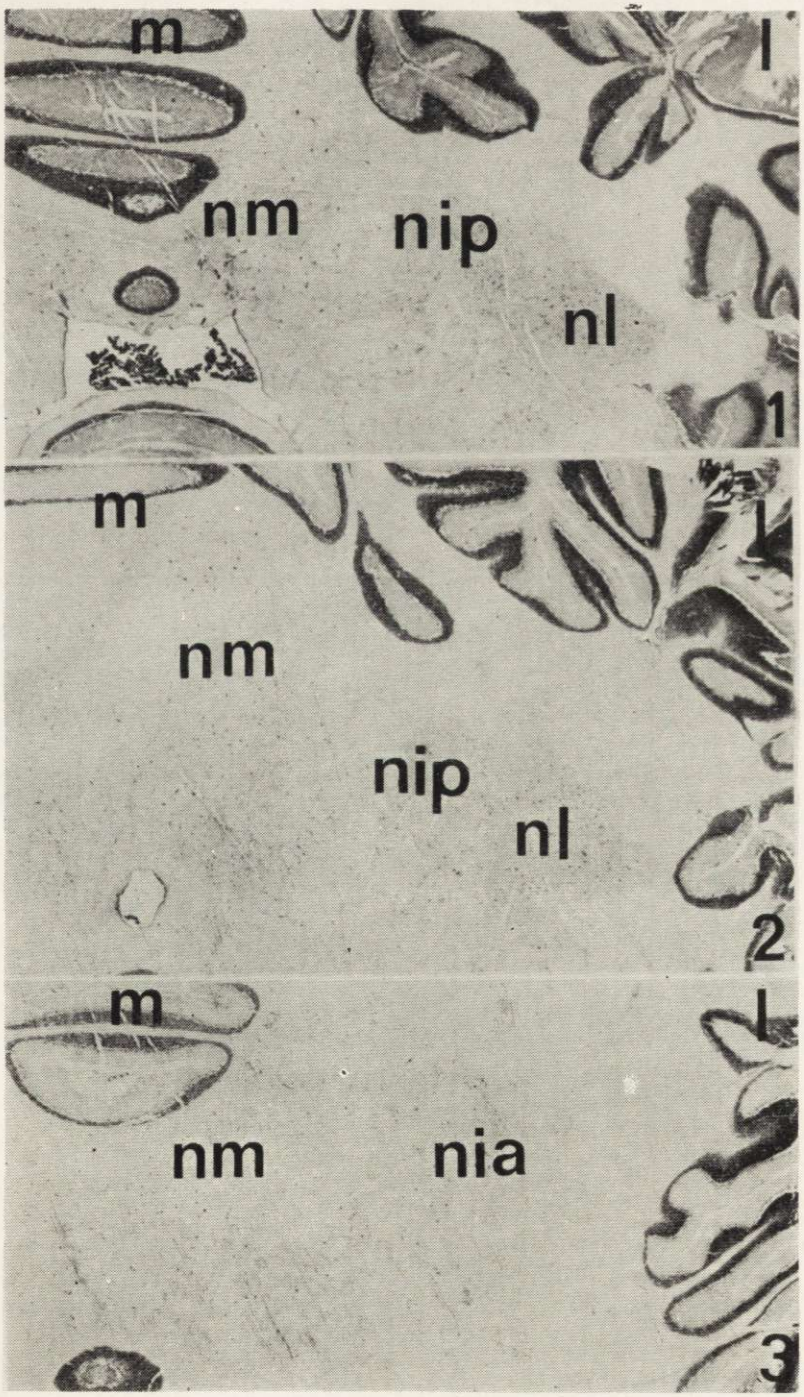
Fig. 6. *Nucleus interpositus anterior.*

Fig. 7. *Nucleus medialis — pars magnocellularis.*

Fig. 8. *Nucleus medialis — pars parvocellularis.*

Abbreviations

l — lateral side
m — medial side,
nia — *nucleus interpositus anterior,*
nip — *nucleus interpositus posterior,*
nl — *nucleus lateralis,*
nm — *nucleus medialis.*



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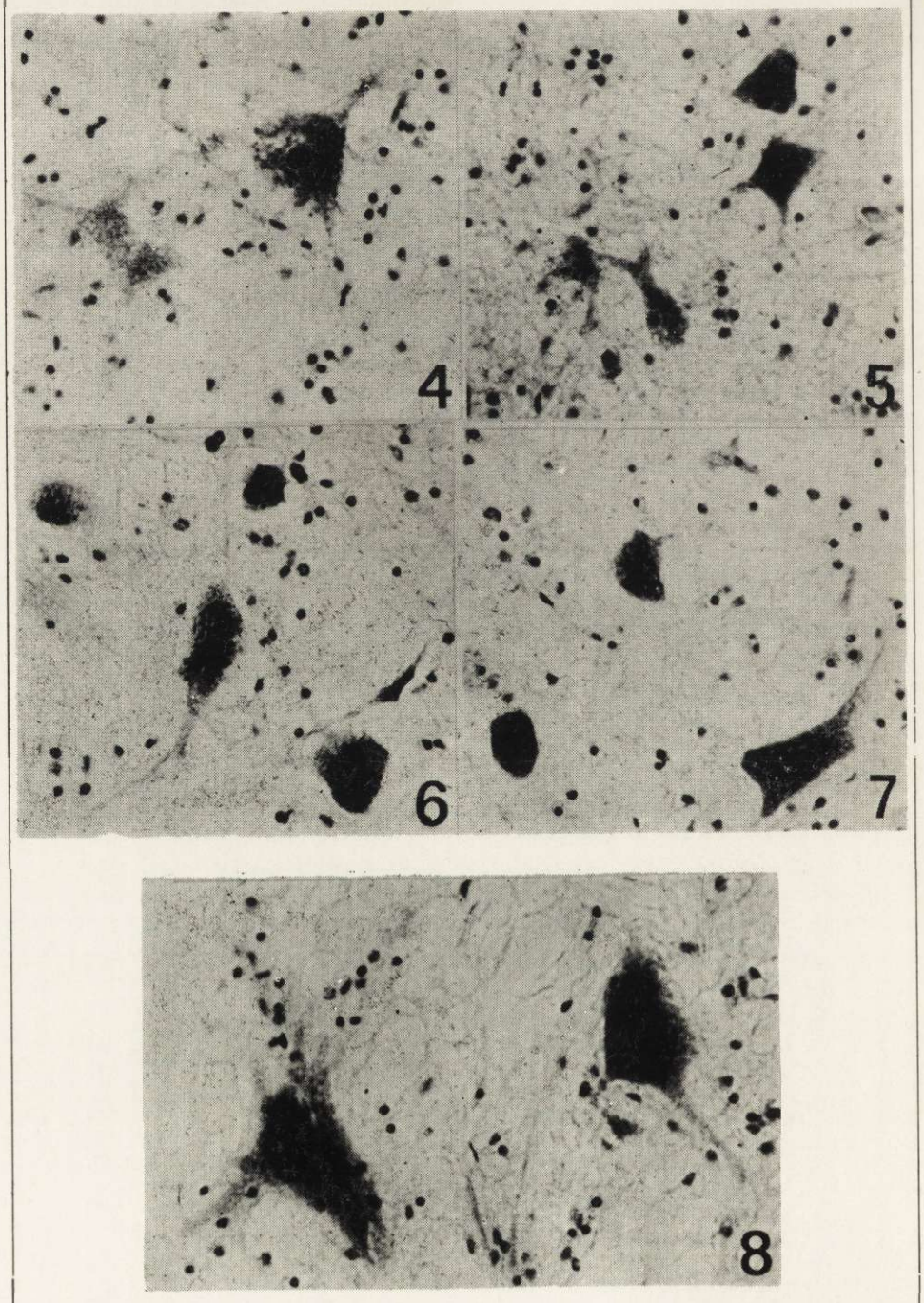

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