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Institute of Biology UMCS
Department of Comparative Anatomy and Anthropology
*Institute of Animal Anatomy, Agricultural University, Lublin

ZOFIA SKRZYPIEC, MAREK JASTRZĘBSKI*

Topography and structure of centres of eyeball motor nerves in spiny mouse (*Acomys cahirinus* Desmarest 1891)

Topografia i budowa ośrodków nerwów gałkoruchowych u myszy kolczystej (Acomys cahirinus Desmarest 1891)

Some significant differences in the structure and topography of cerebral nerve nuclei – oculomotor, trochlear and abducent in numerous species of animals (1, 3, 4, 5, 7, 12, 16, 17), including rodents (10, 11, 15), have induced to undertake examinations involving the greatest number of species. The examinations run by Jastrzębski (10, 11) on the common domestic rodents: bank vole (*Clethrionomys glareolus*), field vole (*Microtus agrestis*) and European pine vole (*Pitymys subterraneus*) showed considerable differences in the size and dismemberment of the nervous centres. The differences may be connected with the environment the species stay at as well as the course of their life. The results of researches made on gopher (*Sphermophilus suslicus*) and dormouse (*Muscardinus avellanarius*) by Skrzypiec and Jastrzębski (14) seem to confirm the assumption. The observations of Galert and Szteyn's (8) dealing with a mole are extremely interesting as in this case no nuclei of eyeball motor nerves were recorded. Quite characteristic is a poor development of abducent nerve nucleus in large mouse-eared bat (*Myotis myotis*), an animal that orients in the space by means of specific echolation, confirmed by Schober (13) and Zvorykin (17).

In the recent years there have been issued many papers on the representatives of *Acomys genus*. The examinations are carried out within a very broad range, from the biology of these species to immunological and genetic problems (2, 6, 9). Therefore, extending the knowledge by the results of investigations on nervous system morphology is reasonable indeed.

MATERIAL AND METHODOLOGY

The examinations were conducted on the brains of sexually mature males and females (two brains of each sex) bred in the Department of Comparative Anatomy and Anthropology UMCS. The brains were fixed in formalin then, having gone the alcoholic series of increasing concentration, they were paraffin embedded. The serial sections of 10 µm thickness were stained with cresyl violet according to the Klüver and Barrera's method.

RESULTS AND DISCUSSION

Motor nucleus of oculomotor nerve
(*nucleus motorius nervi oculomotorii*)

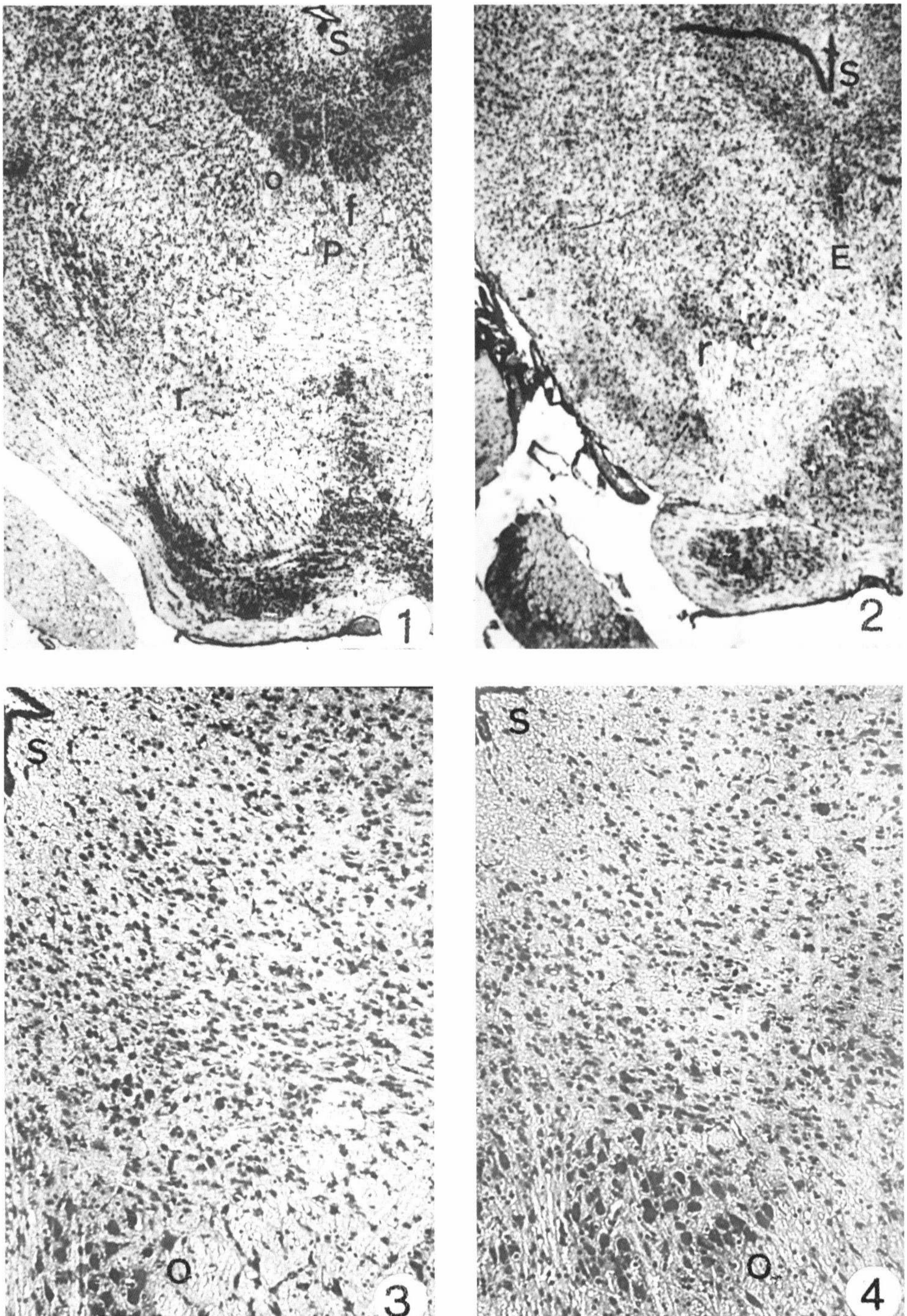
This nucleus is a big very clear cluster of nervous cells that lies, just like in other species, dorsally of *fasc. longitudinalis medialis* (Phot. 1). The caudal pole of the nucleus is positioned exactly in the extension of the trochlear nerve nucleus, quite close to the last one. Its beginning is made by a small group of a few cells and their number increases very fast so the nucleus in the transverse cross--sections of the mesencephalon is observed as a group of rounded-shape cells that are spaced closely (Phot. 3). The transverse cross-sections of the oculomotor nerve nucleus enlarge and approximately in half of its length they reach the greatest diameter (about 0.7 mm). In some places the cells arrange irregularly developing small clusters that amount to a dozen of cells each (Phot. 4). The transverse cross-sections of the nucleus anterior portion (about 1/3) diminish progressively and then nucleus is seen as a group of some cells spaced a little looser as against the rest of the portion (Phot. 5).

The motor nucleus of oculomotor nerve consists of the cells intensively stained of 20-25 µm size. There are primarily multi-polar cells, while these spindle-shaped occur in small numbers. Cell nuclei are relatively small and round; nucleus membrane is not always well noticeable. Tigroid, microgranular in the main often forms greater clusters (Phot. 12).

Parasympathetic nuclei of the oculomotor nerve
(*nuclei parasympathici nervi oculomotorii*)

These are little and not very clear clusters of nervous cells in *Acomys cahirinus* – *Perlia nucleus* and Edinger-Westphal's one.

The *Perlia nucleus* is positioned abdominally of the anterior half of motor nucleus of oculomotor nerve, very close to the suture (Phot. 1) that makes the bilateral nuclei form predominantly one cluster. In the transverse cross-sections they are visible as a small vertical group (Phot. 6). Cells that enter the



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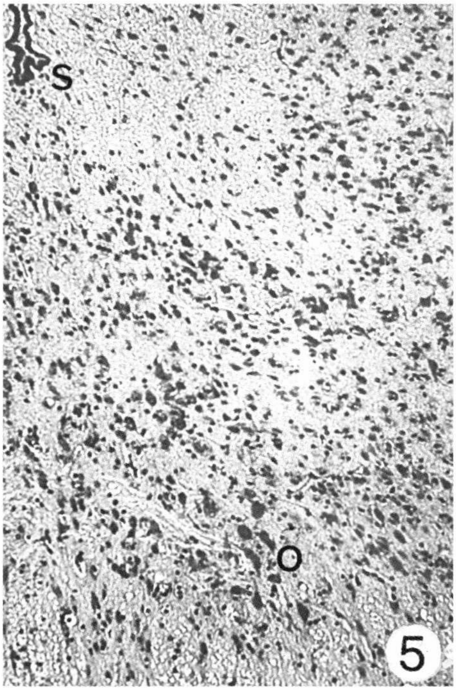

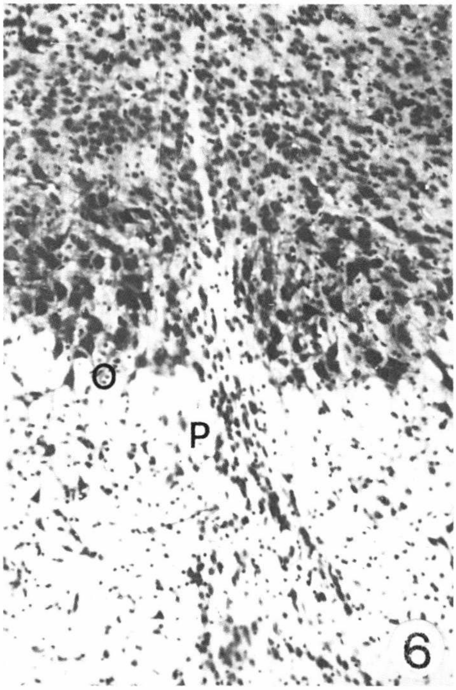

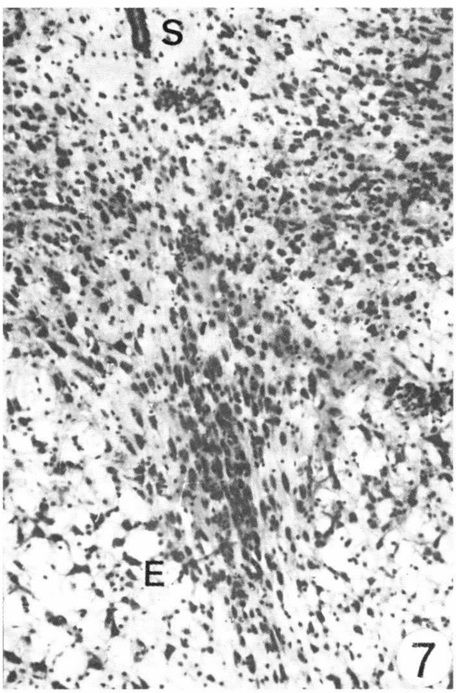

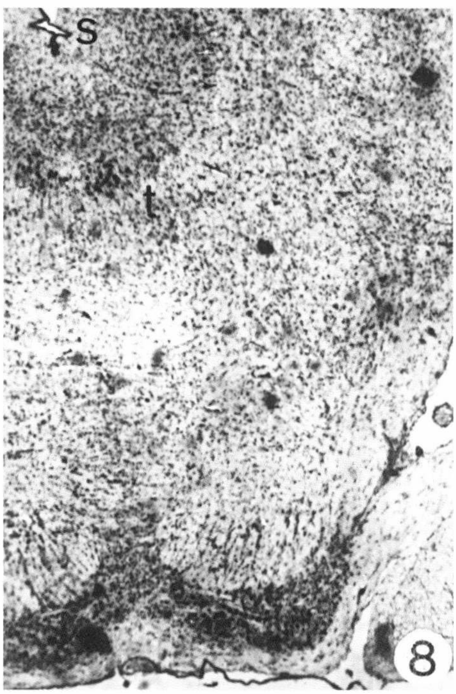

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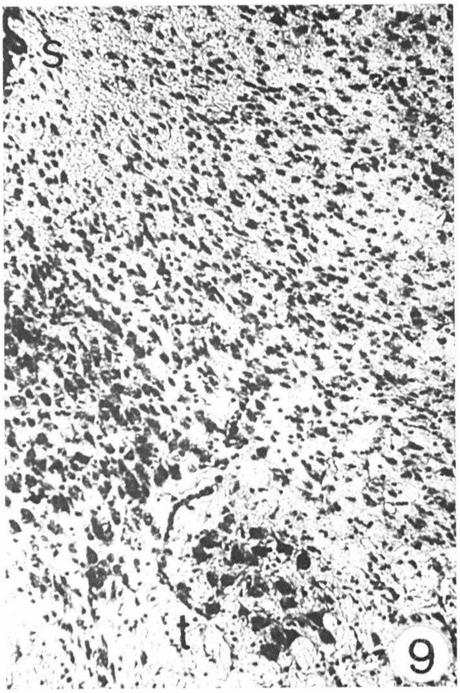

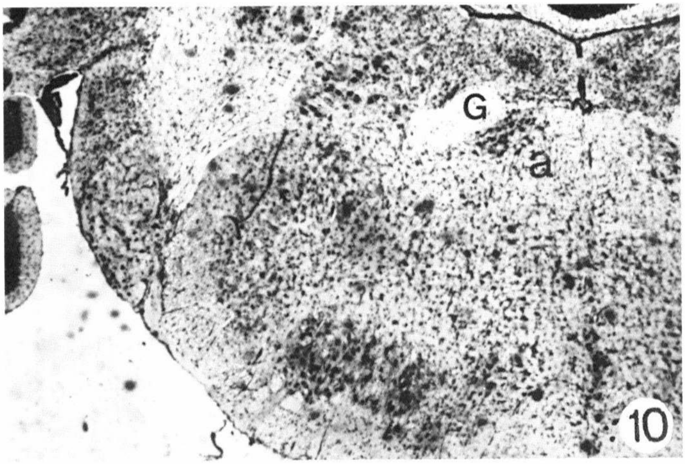

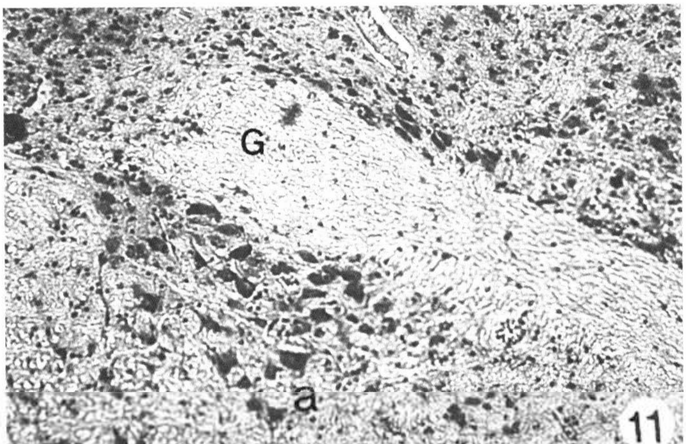

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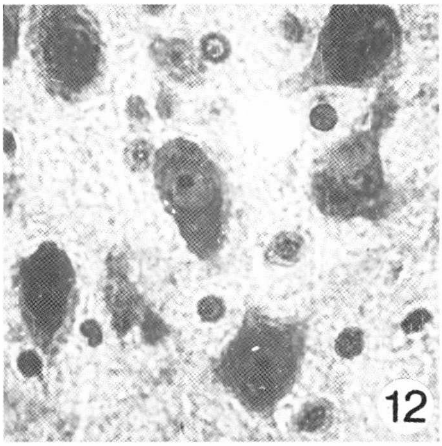

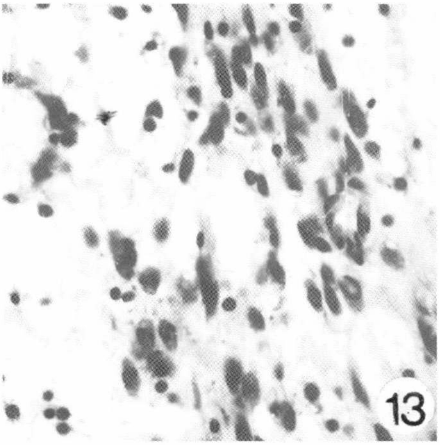

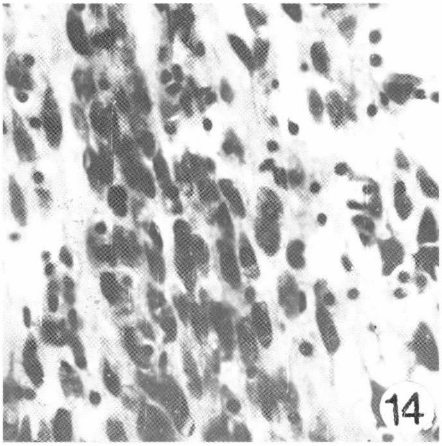

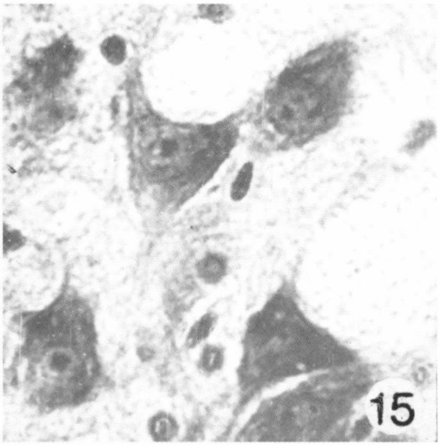

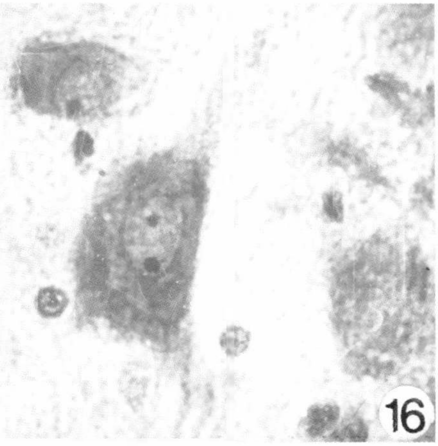

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composition of *Perlia nucleus* are closely arranged, spindle-shaped (Phot. 13), of 12-15 μm, some of them are rounded under 10 μm. The cell nuclei are poorly noticeable and tigroid occurs in a form of very fine granules.

The Edinger-Westphal's nucleus lies in the extension of the previous one. Its transverse cross-sections are plainly bigger (Phot. 2) and alike *Perlia nucleus*, it shows contours of a vertical tract (Phot. 7). It reaches a nasal edge of the mesencephalon with its anterior pole, yet the pole's contours are rather blurred so it is not possible to fix its range. The nucleus is built of spindle-shaped and closely arranged cells of about 15 μm side or a bit smaller. Tigroid is microgranular; cell nuclei difficult to observe (Phot. 14).

Motor nucleus of trochlear nerve
(*nucleus motorius nervi trochlearis*)

The motor nucleus of trochlear nerve shapes backwards of nucleus of oculomotor nerve. There appears a very short, still quite distinct, acellular space between two nuclei. The posterior pole of the nucleus is composed of a group of some loosely spaced cells. The anterior pole is formed in a like manner. The nucleus is much spread out in its medial portion (Phot. 8), so it is of a spindle shape. The transverse cross-sections have got a rounded contour, their diameter is equal about 0.5 mm in the widest place. The cells arrange quite closely (Phot. 9). These are multipolar cells of up to 25 μm and spindle-shaped as well as rounded ones (about 15 μm) occurring singly. Tigroid is micro-granular and abundant, therefore the cells stain intensively. The cell nuclei are not very clear, rather small at the main and positioned centrally (Phot. 15).

Motor nucleus of the abducent nerve
(*nucleus motorius nervi abducentis*)

The motor nucleus of abducent nerve is shaped on the abdominal and medial side of the facial nerve genu (*genu nervi facialis*) (Phot. 10). Alike the anterior pole of the nucleus, the posterior one is made by narrow tracts of cells (a few or a dozen in a transverse cross-section), while the medial portion shows a considerably bigger cross-section (up to 0.5 mm). This portion has a contour of a thick, slightly elongated cluster positioned parallely to the genu of facial nerve (Phot. 11). In the medial portion of motor nucleus of the abducent nerve the cells arrange irregularly developing small groups. In the portion adjacent directly to the genu of the facial nerve the cells are always placed a little closer.

Motor nucleus of the abducent nerve is composed of multipolar cells and fewer spindle-shaped ones. The cell size ranges from about 15 up to 35 μm.

Generally, the cells are of 20 to 25 μm in size. Cell nuclei are small, round and often blurred. Tigroid is mainly microgranular, yet some clear greater clusters can be recorded (Phot. 16).

Taking into account the environment an animal lives in, the relation between a development degree of eyeball motor centres and the importance of sense of vision for a species seems to be beyond any dispute. The examinations made on domestic animals (3, 4, 5) proved that in a pig, an animal with short and little mobile neck, nucleus of abducent nerve is much better developed in comparison with cow, in particular with horse whose neck is long and quite mobile. According to the examinations of Flieger et al. (7) made on camels, it is apparent that nucleus of abducent nerve in this species is worse developed than in other domestic animals.

It may be relevant to a substantially smaller number of visual stimuli that a camel receives in its natural, a little monotonous desert environment as well as considerable length and mobility of an animal's neck.

The observations of the surroundings is a question of life and survival for small and, in fact helpless, rodents. Gopher living in the open space is gifted with a perfect long sight. Its big eyeballs (about 2 cm diameter) and their position at both sides of head ensure an animal for a large visual angle while watching the surroundings from an upright position. The representatives of *Acomys cahirinus* species behave differently. These monogamous rodents watch the space sitting side by side with their noses turned into opposite directions, therefore a visual angle and in turn, the area inspected by one animal is much smaller than in case of gopher. Comparing the structure of nuclei of oculomotor nerves and trochlear one in *Acomys cahirinus* and domestic species – European pine vole and bank vole some similarities can be stated. In these species the nucleus of oculomotor nerve is more poorly developed in comparison with gopher, its structure is little differentiated. This statement may account for a fact that an animal spends most time in its underground burrows where the sense of sight is less important than for other terrestrial species.

REFERENCES

1. Bujak A., Milart Z., Jastrzębski M., Zioło I., Hereć S.: Topografia i cytoarchitektonika jąder nerwów: okoruchowego, bloczkowego i odwodzącego piesaka (*Alopex lagopus*). Ann. Univ. Mariae Curie-Skłodowska, sectio DD **41**, 13-19 (1986).
2. Chevret P., Denys C., Jaeger J. J., Michaux J., Catzeflis F. M.: Molecular evidence that the spiny mouse (*Acomys*) is more closely related to gerbils (*Gerbillinae*) than to true mice (*Murinae*). Proc. Natl. Acad. Sci. USA. **90**, 3433-3436 (1993).
3. Chomiak M.: Jądra ruchowe rdzenia przedłużonego krowy, świni i konia. Ann. Univ. Mariae Curie-Skłodowska, sectio C **5**, 373-440 (1951).
4. Chomiak M.: Topografia i budowa jąder ruchowych rdzenia przedłużonego kozy. Ann. Univ. Mariae Curie-Skłodowska, sectio DD **8**, 181-219 (1953).

5. Chomiak M.: Topographie und Kernbau des Mesencephalon der Haustiere. V. Teil. Kernbau des Mesencephalon der Ziege. Ann. Univ. Mariae Curie-Skłodowska, sectio DD **18**, 19-36 (1963).
6. Denys C., Gautun J. C., Tranier M., Volobouev V.: Evolution of the genus *Acomys* (*Rodentia, Muridae*) from dental and chromosomal patterns. Isr. J. Zool. **40**, 215-246 (1994).
7. Flieger S., Strzałka B., Jastrzębski M.: Ośrodki nerwów czaszkowych: okoruchowego (III), bloczkowego (IV) i odwodzącego (VI) u wielbłąda (*Camelus dromedarius* L.). Pol. Arch. Wet. **24**, 253-260 (1984).
8. Galert D., Szteyn S.: Structure and topography of the nuclei of oculomotor trochlear and abducent nerves in *Insectivora*. Folia Morphol. **38**, 277-289 (1979).
9. Haim A., Yedidia I., Haim D., Zisapel N.: Photoperiodicity in daily rhythms of body temperature, food and energy intake of the golden spiny mouse (*Acomys russatus*). Isr. J. Zool. **40**, 145-150 (1994).
10. Jastrzębski M.: Motorische Kerne des Hirnstammes bei einigen Microtidae (*Rodentia*). Acta Theriol. **7**, 1-14 (1963).
11. Jastrzębski M.: Jądra śródmózgowia nornicy rudej (*Clethrionomys glareolus*) i darniówki (*Pitymys subterraneus*). Ann. Univ. Mariae Curie-Skłodowska, sectio DD **28**, 11-26 (1973).
12. Miller I. D.: Die Zytoarchitektonik der Nuclei nervi oculomotorii, trochlearis und abducentis. J. Hirnforsch. **20**, 3-10 (1979).
13. Schober W.: Zur Cytoarchitektonik und Cytologie der *Medulla oblongata* der Mausohr--Fledermaus, *Myotis myotis* (Borkhausen). Wiss. Z. Univ. Leipzig, Math.-Nat. R. **9**, 745-771 (1959/1960).
14. Skrzypiec Z., Jastrzębski M.: Zentren der Nerven: *Nervus oculomotorius, Nervus trochlearis* und *Nervus abducens* bei Perl-Ziesel (*Spermophilus suslicus* Güld.) und Haselmaus (*Muscardinus avellanarius* L.). Ann. Univ. Mariae Curie-Skłodowska, sectio C **50**, 199-207 (1995).
15. Szteyn S.: Topographie und Kernbau des Mittelhirns des Sumpfbibers. Acta Theriol. **12**, 253-279 (1967).
16. Taber E.: The Cytoarchitecture of the Brain Stem of the Cat. I. Brain stem nuclei of cat. J. Comp. Neurol. 116, 27-52 (1961).
17. Зворыкин Б. П.: Морфологические основы локационных и ультразвуковых свойств летучей мыши. Арх. Анат. Москва-Ленинград. т. 36 (1959) – cit. Schober W. 1959/1960.

PHOTOGRAMS

Phot. 1. Transverse cross-section of *Acomys cahirinus* mesencephalon in half length of motor nucleus of oculomotor nerve. Mag. 25 ×.

Phot. 2. Transverse cross-section of *Acomys cahirinus* mesencephalon at the height of Edinger-Westphal's nucleus. Mag. 25 ×.

Phot. 3. Transverse cross-section of nasal segment of the motor nucleus of oculomotor nerve. Mag. 60 ×.

Phot. 4. Transverse cross-section in half length of motor nucleus of oculomotor nerve. Mag. 60 ×.

Phot. 5. Transverse cross-section of caudal segment of motor nucleus of oculomotor nerve Mag. 60 ×.

Phot. 6. Transverse cross-section of *Acomys cahirinus* mesencephalon in half length of *Perlia nucleus*. Mag. 60 ×.

Phot. 7. Transverse cross-section of *Acomys cahirinus* mesencephalon forward of nasi pole of motor nucleus of oculomotor nerve. Edinger-Westphal's nucleus is visible. Mag. 60 ×.

Phot. 8. Transverse cross-section of *Acomys cahirinus* mesencephalon in half length of motor nucleus of trochlear nerve. Mag. 25 ×.

Phot. 9. Transverse cross-section of *Acomys cahirinus* mesencephalon in half length of motor nucleus of trochlear nerve. Mag. 60 ×.

Phot. 10. Transverse cross-section of *Acomys cahirinus medulla* in half length of motor nucleus of abducent nerve. Mag. 25 ×.

Phot. 11. Genu of nerve VII and motor nucleus of abducent nerve. Mag. 60 ×.

Phot. 12. Cells of motor nucleus of oculomotor nerve. Mag. 500 ×.

Phot. 13. Cells of *Perlia nucleus*. Mag. 200 ×.

Phot. 14. Cells of Edinger-Westphal's. Mag. 200 ×.

Phot. 15. Cells of motor nucleus of trochlear nerve. Mag. 500 ×.

Phot. 16. Cells of motor nucleus of abducent nerve. Mag. 500 ×.

ABBREVIATIONS USED

a – motor nucleus of abducent nerve, E – nucleus of Edinger-Westphal's, f – fasc. longitudinalis medialis, G – genu of facial nerve, o – motor nucleus of oculomotor nerve, P – *Perlia nucleus*, r – nucleus ruber, S – mesencephalon Sylvian aqueduct, t – motor nucleus of trochlear nerve.

STRESZCZENIE

W pracy opisano budowę ośrodków gałkoruchowych u *Acomys cahirinus*. Do badań pobrano po dwa mózgowia (samicy i samca) utrwalone w formalinie. Parafinowe skrawki grubości 10 μm barwiono na obecność komórek fioletem krezylowym wg metody Klüvera i Barrery. Jądro nerwu okoruchowego jest dużym, wyraźnym skupieniem komórek nerwowych. W części środkowej jądra wyróżnia się kilka nieregularnych grup. Jądro nerwu bloczkowego ma kształt wrzecionowaty; komórki jądra nerwu bloczkowego układają się ściśle. Jądro nerwu odwodzącego jest stosunkowo niewielkim, jednolitym skupieniem. W porównaniu z innymi gryzoniami jest ono słabiej rozwinięte. Jądra Perlia i Edingera-Westphala są niezbyt wyraźne, na przekroju poprzecznym widoczne są w postaci pionowych pasm dość ściśle ułożonych komórek.