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RELATION OF BODY SIZE, GANGLIONS AND NEURON DIMENSIONS IN THE FRESH WATER MUSSEL *ANODONTA CYGNEA* L.

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Introduction

An ever increasing number of workers are dealing also in Hungary with the nervous system of the fresh water mussel (ÁBRAHÁM and MINKER 1959, NAGY 1962, BARANYI and SALÁNKI 1962, SALÁNKI and LÁBOS 1964, SALÁNKI 1964, PÉCSI and SALÁNKI 1964, ZS. NAGY 1964, GUBICZA and ZS. NAGY 1964). Inspite of this our morphological and physiological knowledge must be still regarded as insufficient.

Physiological examination of the fresh water mussel requires a more exact description of the structure of the nervous system. The objective of the present study is to supply data to the morphology of the ganglions of the fresh water mussel with special regard to their dimensions.

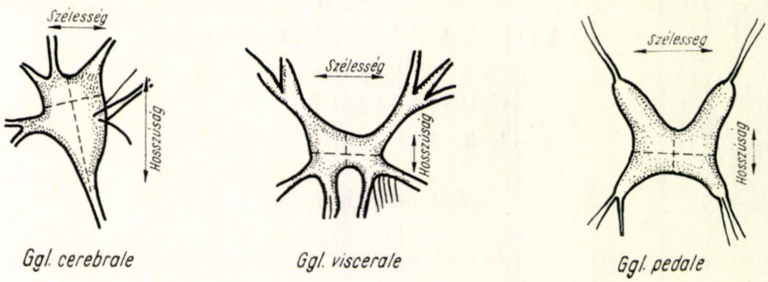
Material and method

Experimental animal was *Anodonta cygnea* L. originating from the back water of the Rábca river. Mussels of various size collected from similar biotopes were subjected to examination. Length and width of the *ggl. cerebrale*, *ggl. pedale* and *ggl. viscerale (Fig. 1)* were examined in small, medium and large size mussels. The ganglions of a total of 120 *Anodonta* were measured with microocularmeter.

The nervous elements of the ganglia were rendered suitable to microscopic examinations by two impregnation methods. The modified CAJAL I. method (GUBICZA, ZS. NAGY 1964) was employed to indicate the cells, while ROWELL's (1963) silver nitrate lutidine proceeding was found the best to demonstrate nerve fibres and glia. The length of the neurons was measured in the ganglions of the small and large mussels. In each ganglion the mean length of 250 to 3000 cells were taken. Measurement was carried out with microocularmeter at 650 × magnification.

The number of ganglions and glia nuclei have been determined in an indirect way. In the 10 to 12 μ thick sections (in 5 to 6 sections per ganglion) the neurons were counted, the mean of a section multiplied with the number of sections and divided by two. The latter proved to be necessary out of the following consideration. The neurons of *Anodonta cygnea* L. are generally 20 μ in size so that each cell occurs in two, less frequently in three successive sections. The small size cells get into the plane of two or one section. It is to be noted that the sections generally contained the same number of neurons and in the series section the first and last ones contained the cellular cortical part while mainly neuropile came into the middle part of a large surface.

Fig 1 — 1. ábra



The glia nuclei found in a section were multiplied with the number of sections but not divided by two because their length was 5 to 6 μ and their width no more than 4 μ.

Results

The first part of our investigation consisted of a comparison of the length and width data of the ganglions of mussels of different size.

The ganglions of the small, medium and large mussels *(Table 1)* are of different size *(Table 2)*.

Table 1

Length, width and tickness of the mussels examined

Denomination	Length mm	Width mm	Thickness mm
Small mussels	100	50	40
Medium mussels	140	75	60
Large mussels	180	90	75

Table 2

Length and width dimensions in mm of the ganglions of small, medium and large mussels

Denomination	ggl. cerebrale		ggl. pedale		ggl. viscerale	
	length	width	length	width	length	width
Small mussels	2.15 ±0.20	1.08 ±0.12	0.98 ±0.13	2.00 ±0.15	1.32 ±0.07	2.48 ±0.08
Medium mussels	2.88 ±0.28	1.32 ±0.12	1.14 ±0.13	2.28 ±0.15	1.80 ±0.17	3.40 ±0.23
Large mussels	3.28 ±0.20	1.42 ±0.15	1.36 ±0.10	2.50 ±0.11	2.04 ±0.08	3.88 ±0.14

According to the data of ***Table 2*** the ganglia of the small-size mussels are smaller than those of the larger ones.

In the general histological description of fresh water mussel ganglions (GUBICZA and ZS. NAGY 1965) we pointed to the fact that the dimension of length of the neurons depends on the size of the experimental animal. In various ganglions of the small and large mussel the so called great neurons are of different dimensions *(Table 3)*

Table 3

Average data of the length of large size neurons in the ganglions of small and large mussels*

	ggl. cerebrale		ggl. pedale		ggl. viscerale	
	mean μ	length μ	mean μ	length μ	mean μ	length μ
Small mussel	30	(36)	34	(45)	42	(47)
Large mussel	40	(47)	45	(55)	52	(63)

* Those neurons were regarded as large size cells which attained 70% of the longitudinal dimension of the largest cell; *e.g.* when the largest cell was 63 μ long, those over 44 μ length wore qualified as large size cells.

The data in bracket designate the length of the largest neuron found in measuring.

Two important statements can be made in connection with analysis of the dimensions of neurons.

1. Dimensions of the cells depend on those of the mussel.

2. In the various ganglions the cell dimensions are different (smallest in the *ggl. cerebrale*, largest can be found in the *ggl. viscerale)*.

On the basis of what was said up to now, a comparison of the longitudinal dimensions of the mussel, the ganglions and the neurons reveals both in large and small mussels that the neurons have grown slower.

Longitudinal dimension of small mussels (100 mm long) and of their ganglions and neurons was taken for 100%. In this case the ganglions of the 80% larger mussels are larger by 40 to 50 per cent while the average length of so called large neurons is 25 to 33 per cent larger *(Fig. 2)*.

Also the glia nuclei in the ganglions of mussels of different size were measured but no differences found. In the *ggl. cerebrale*, *ggl. pedale* and *ggl. viscerale* of both the small and large mussels 5 to 6 μ long and 3 to 4 μ wide glia nuclei occur.

We also determined, in an indirect way, the number of neurons and glia nuclei in the various ganglions *(Table 4)*.

Table 4

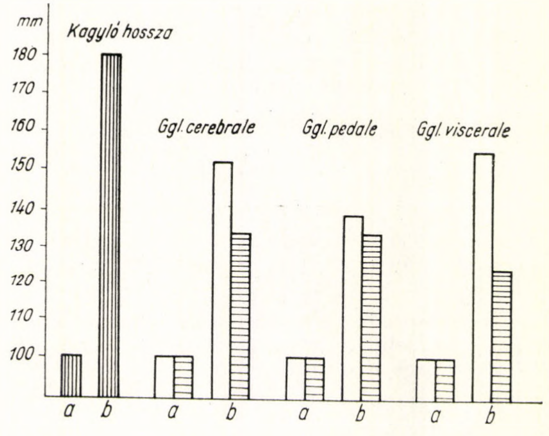
Number of neurons and glia nuclei in the ganglions of Anodonta cygnea L.

	ggl. cerebrale	ggl. pedale	ggl. viscerale
Neurons	30—35,000 units	65—70,000 units	70—75,000 units
glia nuclei	5— 7,000 units	25—30,000 units	16—18,000 units

There are most neurons in the *ggl. viscerale,* while the number of glia nuclei is highest in the *ggl. pedale.*

The distribution of neurons according to size is varying in the different ganglions. The so-called large cells are generally few. These constitute 0.5 to

Fig 2 — 2. ábra



Nagy kagylók ganglionjainak és idegsejtjeinek méretaránya, a kis kagylók 100%-os adataihoz viszonyítva.

Kagylók hossza %-ban
Ganglionok hossza %-ban
Idegsejt hossza %-ban
a Kis kagyló
b Nagy kagyló

1.0 per cent of the total cell stock. Most large size neurons are found in the *ggl. viscerale* (about 1 per cent) and least in the *ggl. cerebrale* (about 0.4 per cent). The overwhelming majority of the cell stock are small size (8 to 16 μ).

Discussion

In the telometrically growing young *Anodonta cygnea* mussels of 10 cm the ganglions are small and the neurons are smaller than in the older mussels of 28 cm.

The ganglions of the 80 per cent longer mussels are larger by 50 per cent, the neurons by 30 per cent. The dimensions of the glia nuclei are unchanged in the various ganglions of small and large mussels. From the data it also appeared that *ggl. viscerale* showed the most intensive growth. The nerve cells of largest size (motoric cells) also occurred in this ganglion in a high number. Also by the cell number determined in an indirect way the ggl. viscerale excels. The more complicated morphological structure of the *ggl. viscerale* has been referred to already in connection with the general histological description of ganglia.

The role of the single ganglions played in the reflex activity is not clarified so far. The *posterior adductor* of the fresh water mussel is innervated according to PAWLOW (1885) by the appendages of the motoric cells of the *ggl. viscerale* and these fibres are involved in tonic contraction. The impulses bringing forth relaxation arise from the *ggl. cerebale*. According to DREW (1908) in the *Ensis* species the movement of the foot is coordinated by the *ggl. cerebrale* and *ggl. pedale* together. FRANKEL later (1927) found that the adaptive character of the digging movement of the *Ensis* species discontinues when the *ggl. cerebrale* is removed. According to the statement of WOORTMANN (1926) in the movement of the feet and in the activity of bissus glands in *Mytilus edulis* the *ggl. pedale* is greatly involved.

According to the investigation of SALÁNKI (1963) the serotonine and antiserotonine substances applied to the *ggl. cerebrale* of the fresh water mussel change the character of the periodic activity. From the data of a number of physiological examinations it could not yet be precisely established which ganglion has the most important role in the reflex activity of the mussel. Probably the problem does not even arise in this form. So much is certain that the *ggl. viscerale* of *Anodonta cygnea* contains the most diversified nerve elements. This is also proved by the fact that recently several illustrious nerve morphologists (ÁBRAHÁM 1963, BULLOCK 1961, SUGAWARA 1964) subjected to investigation this ganglion of interesting from the morphological point of view.

Summary

1. The ganglia of the small (100 mm long) *Anodonta cygnea* L. have smaller dimensions than the large (180 mm long) mussels.

2. The neurons of the small size mussels are smaller than those of the larger ones.

3. Largest nerve cells occur in the ganglion viscerale; they constitute 0.5 to 1.0 per cent of the cell stock.

4. The glia nuclei are of the same size in the ganglia of small and large mussels.

5. The number of neurons is lowest in the *ggl. cerebrale*, highest in the *ggl. viscerale*.

6. Most glia nuclei are found in the *ggl. pedale*.

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TESTNAGYSÁG, GANGLIONOK ÉS AZ IDEGSEJTEK MÉRETÉNEK RELÁCIÓJA AZ ÉDESVÍZI KAGYLÓNÁL (*ANODONTA CYGNEA* L.)

Összefoglalás

Gubicza András

A szerző vizsgálta a különböző nagyságú *Anodonta cygnea* L. idegdúcainak és idegsejteinek méreteit. Közvetett úton meghatározta a *ggl. cerebrale, ggl. pedale* és *ggl. viscerale* idegsejt és gliamag számát.

Az adatokból megállapítható, hogy a kis (100 mm hosszú) kagylók ganglionjai és idegsejtjei kisebbek mint a nagy (180 mm hosszú) kagylóké.

Legkisebb sejtek a *ggl. cerebrale*ban, legnagyobbak a *ggl. viscerale*ban vannak.

A gliamagok a kis és nagy kagylók idegdúcaiban egyforma méretűek.

Az idegsejtek száma dúconként változó. Legtöbb sejt a ggl. visceraleban, legkevesebb a ggl. cerebraleban van.

A glia magok száma legtöbb a *ggl. pedale*ban.

ВЗАИМООТНОШЕНИЕ РАЗМЕРОВ НЕРВНЫХ КЛЕТОК, ГАНГЛИЕВ И ТЕЛА БЕЗЗУБКИ (Anodonta cygnea L.)

А. Губица

1. Размеры ганглиев беззубки малого роста (длиной 100 мм) ниже чем у беззубки большого роста (длинной 180 мм).

2. Нервные клетки у беззубки малого роста тоже меньшие, чем у беззубки большого роста.

3. Самые крупные нервные клетки обнаруживаются в висцеральном ганглии, они составляют 0,5—1% всего клеточного состава.

4. Ядра глии имеют одинаковые размеры как у малых так и у больших беззубок.

5. Меньше всех нервных клеток обнаруживается в церебральном ганглии, и больше всех — в висцеральном.

6. Число ядер глии самое высокое в педальном ганглии.