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NOTES
Historical Notes article

AN EVOLUTIONIST NEURO-ANATOMICAL STUDY FROM THE BEGINNING OF XIXth CENTURY

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We present a study of the thesis of Apostol Arsaky (1784-1874), a famous physician and an important politician of Wallachia and then of Romania. The thesis is written in Latin and it is entitled "Piscium cerebro et medula spinali". It is the result of some minute researches carried out on more than 50 fish species for a few months in Naples in the summer of 1813. Apostol Arsaky was an Aromanian from Epir who established himself together with his father Chiriac and his uncle Gheorghe in Wallachia. He studied philosophy in Vienna and medicine at Halle in Germany where he was the pupil of J.F. Meckel, one of the great European anatomists and anthropologists at the beginning of XIX century. In the respective study he makes remarkable anticipations regarding the spinal cord, cerebellum, tectum opticum, olfactory lobs, hypophysis and the mamillary bodies of fish. He clarified some controversies regarding the cerebellum and the tectum opticum which was erroneously considered the equivalent of cerebral hemispheres. In the whole study he comparatively studies the fish nervous system of different species taken into account. He makes considerations of compared anatomy with the nevous system of the other vertebrates and even with some invertebrates. The most interesting part is that in this study of 1813 the author mentions the evolution of species. He uses evolutionist arguments to clarify some anatomic aspects and he also resorts to the compared embryology, a few decades before Darwin and Haeckel. The importance of the study results also from the fact that it was republished 23 years later with an ample commentary. It has an interesting bibliography and a suggestive iconography. It is a precious document for the history of evolutionist ideas, but which reflects at the same time the level of Wallachian élites at the beginning of XIX century.

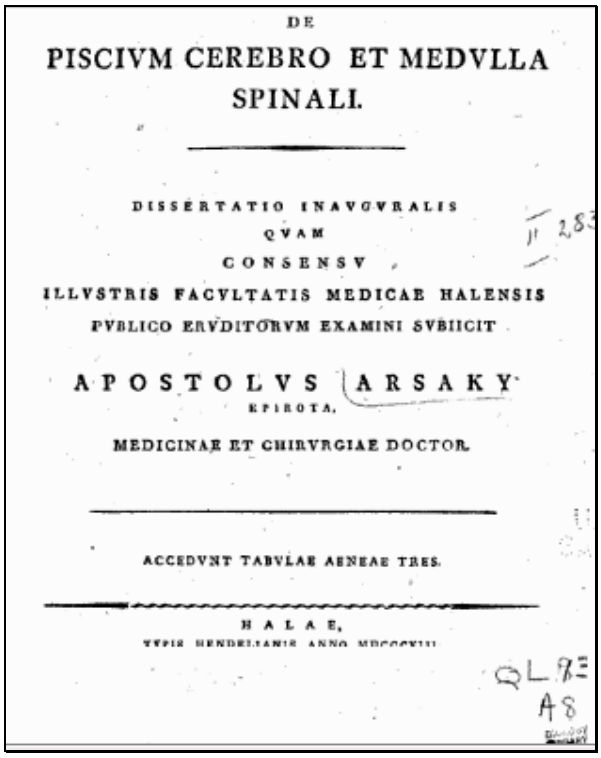
Key words: Apostol Arsaky, evolutionist, neuro-anatomical study.

INTRODUCTION

One of the most important theories that deeply changed the modern scientific thinking was incontestably the evolutionist theory in biology. Generally it is considered that the official birth date of the evolutionist theory is the year **1859**, when there were published concomitantly Ch. Darwin's studies ("On the Origin of Species") and Alfred Russell Wallace's studies ("On the Tendency of Varieties to Depart Indefinitely from the Original Type").

This model of evolution has been however preceded by that of Lamarck (Jean-Baptiste Pierre Antoine de Monet, Chevalier de la Marck, 1744–1829) who invoked final causes ("Le pouvoir de la vie")[1] which, aroused some interest and many controversies, but could not succed to be imposed as well as the timid suggestions of Buffon - Georges Louis Leclerc, comte de Buffon (1707–1788), of Erasmus Darwin (1731–1802) or of Etienne Geofroy de Saint Hillaire (1772–1844) whose confrontation with the creationist Cuvier (Jean Léopold Nicolas Frédéric Cuvier, 1769–1832) remained famous under the name of the crocodiles' quarrel of Caen.

In Germany, the origin homeland of the Enlightenement, some evolutionist ideas were cultivated especially by Johann Friederich Meckel the Younger (1781-1832), professor of anatomy, comparative anatomy, pathological anatomy and anthropology at Martin Luther University of Halle and the founder of teratology. The fact is surprising because he was a pupil and an admirer of Cuvier whose work "Leçons d'anatomie" he translated (1809).



DE

PISCIVM CEREBRO ET MEDVLLA SPINALI.

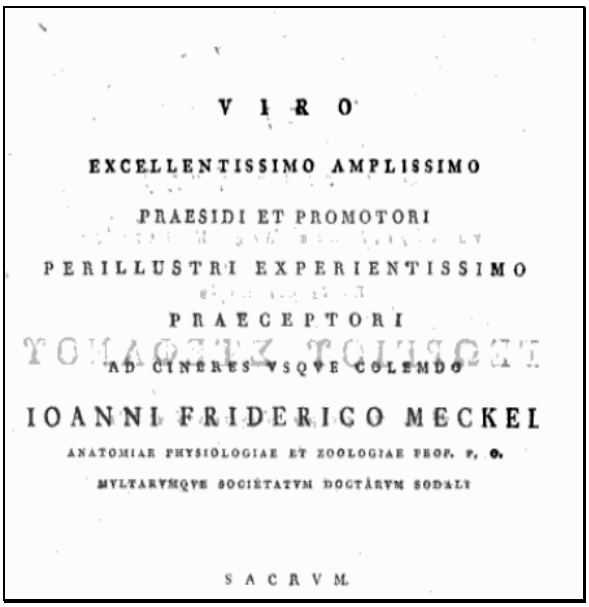
DISSERTATIO INAVGVRALIS
QVAM
CONSENSV
ILLVSTRIS FACVLTATIS MEDICAE HALENSIS
PVBLICO ERVDITORVM EXAMINI SVBIICIT

APOSTOLVS ARSAKY
EPIROTA,

MEDICINAE ET CHIRVRGIAE DOCTOR.

ACCEDVNT TABVLAE AENEAE TRES.

HALAE,



VIRO

EXCELLENTISSIMO AMPLISSIMO

PRAESIDI ET PROMOTORI

PERILLUSTRI EXPERIENTISSIMO

PRAECEPTORI

AD CINERES VSQVE COLENDO

IOANNI FRIDERICO MECKEI

ANATOMIAE PHYSIOLOGIAE ET ZOOLOGIAE PROF. P. O.

MVLTARVMQVE SOCIETATVM DOCTARVM SODALI

SACRVM

Arsaky's Thesis from 1813

His evolutionist ideas clearly appear in his famous work "System der vergleichenden Anatomie" (1821), where he also presents the mechanisms which – according to him – are at the basis of this evolution: the spontaneous generation of new species, the existence of an internal tendency of organisms to change, the hybridizations and the direct influences of the environment.[2]

In this time in Wallachia, where the Fanariot reigns drew to an end, there was living Apostol Arsaky, the nephew of Gheorghe and the son of Chiriac Arsaky, rich Aromanians, newly emigrated from Epyrus (now modern Albania) and established in Bucharest. By 1804 the young Apostol (20 years old) studied philosophy in Vienna and eventually by 1810 we find him studying medicine at Halle where in 1813 he obtains the title of doctor of medicine and surgery[3] under the guidance of J.F. Meckel.[4,5]

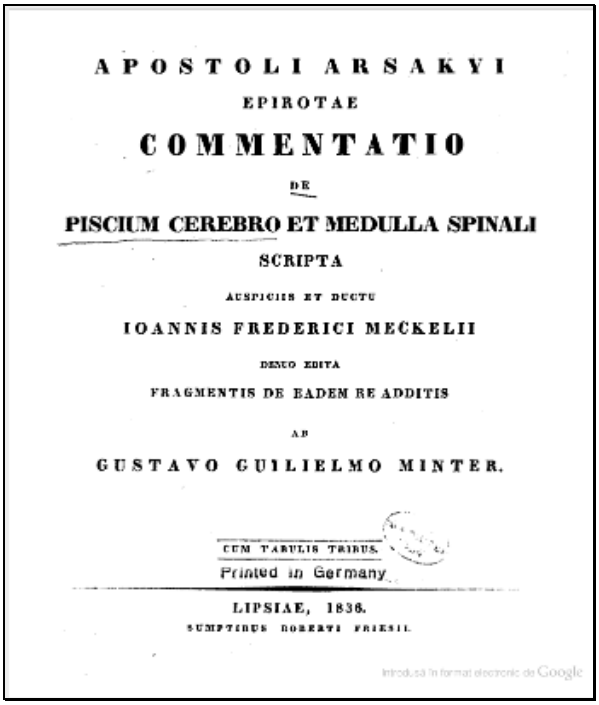
The researches of Arsaky in his thesis was carried out in Naples, where for a few months he studies the anatomy of spinal cord and brain on more than 50 Mediterranean fish species after being fixed in alcohol.

The thesis is entitled "**De piscium cerebro et medulla spinali: dissertatio inauguralis quam consensu illustris facultatis medicae Halensis"**. It was carried out under the guidance of Meckel and published in 1813. It has 33 pages with 14 chapters and three drawings. The thesis was enthusiastically praised by Meckel who expressed his opinions in a letter to Arsaky to whom he addresses himself with the words "amice carissimo", although he was only 30 years old.

The appreciation of which this thesis rejoiced results also from the fact that it was republished in Leipzig, 23 years later (which is very much for a scientifical paper) and 4 years after Meckel's death, by Gustav Wilhelm Minter or Münter who also adds an introductory study of 19 pages. It was also quoted by Freud[6] in 1877 in a study on the origin of spinal nerves roots in Petromyzon.

Gustav Wilhelm Minter (1804–1870) also studied medicine in Halle and was trained under the guidance of J.F. Meckel the Young. He was an anatomist of exception obtaining the title of doctor of medicine and surgery in 1836 with the thesis "Disertatio inauguralis phisiologia prodom systems zoologiae generalis". He became an important

professor of Yena and of Halle universities. He also was director of the museum of anatomic specimens of Meckel's family (in which there were exhibited the skeletons of Meckel and of his father). He materialized numerous anatomic preparations and he wrote studies, monographs and treatises. His importance was so great that he was the subject of a doctor's thesis of Babette Kapitza in 2004 at Martin Luther University of Halle.[7]


APOSTOLI ARSAKYI
EPIROTAE
COMMENTATIO
DE
PISCIUM CEREBRO ET MEDULLA SPINALI
SCRIPTA
AUSPICIIS ET DUCTU
IOANNIS FREDERICI MECKELII
DENUO EDITA
FRAGMENTIS DE EADEM RE ADDITIS
AB
GUSTAVO GUILIELMO MINTER.
CUM TABULIS TRIBUS.
Printed in Germany
LIPSIAE, 1836.
SUMPTIBUS HORRERI FRIESII.

Republication of 1836

Significant is the paper's motto, underlining the role of the compared anatomy for knowing the human's nervous system:

Tout le monde avouera sans difficulté, que nous devons à la dissection des animaux presque toutes les nouvelles decouvertes de ce siècle, et qu'il y a des parties, qu'on n'auroit jamais reconnues dans le cerveau de l'homme, si l'on ne les avoit remarquées dans celui des animaux.

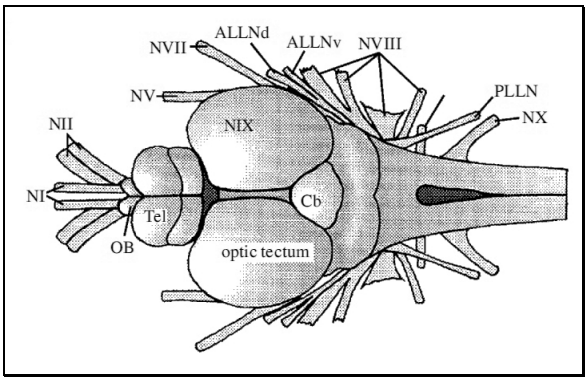
STENON

The author in his introductory word mentions the sacred monsters of brain sciences of his times: Willis, Haller, Vicq d'Azyr, Monro, Cuvier and so on. The paper is a macroscopic descriptive anatomic study of fish spinal cord and brain. The absence of a histologic analysis is explained because in those times there were not the techniques of preparation and especially of staining the sections necessary for a microscopic study.

In the first part of the thesis the exterior and the interior aspects of spinal cord in more than 50 species of fish are described very precisely. The author mentions the general ("universal „as he calls them) characters and then he comparatively details the differences existing among the studied fish species. He continues with comparative considerations with the spinal cord of the other vertebrates (batrachians, reptiles, birds, mammals and man) and he underlines the lack of intumescences in fish spinal cords which he correctly explains by the absence of limbs. He describes the relations with the vertebral duct and he comments on the length of spinal cord in relation to that of rachis and of encephalon size. He mentions pia mater (*membranulla tenuissam*), arachnoid web (*latice aquoso*), perimedullary lipids, presence of cephalo-rachidian liquid (*fluido*) and dura mater. He also describes the anterior and posterior roots of rachidian nerves together with spinal ganglions. Then he compares the paraspinal ganglionary chains with those of the insects and crustacea. He draws attention to the nerve which ties the spinal cord with the electric organ in some fishes and he concern himself with the origin of spinal nerves in the spinal cord. This description interested Sigmund Freud in his paper about the origins of spinal posterior roots in Petromyzon.[8] It is interesting the insistence by which he describes the ependymal canal, its aspect, its opening into the IV ventricle and the presence of cephalo-rachidian liquid. We should not forget that for centuries a very important role was erroneously attributed to the intracerebral cavities and of their content. He feels drived to appeal to the papers of Morgagni and Santorini in order to uphold the existence of this canal. He also describes the grey substance around the ependymal canal and of white substance around the grey one.

He specifies the uniqueness of spinal cord general ("universal") aspect in all the vertebrates, inclusively in man. The second part of the thesis refers to fish encephalon. In this part Arsaky's contribution is important.

After he asserts that fish encephalon is the smallest and simplest within the vertebrates, he specifies that he noticed how many compounds increase and develop in the more evolved animals (*altioribus animalibus*) reaching a maximum development (*summam magnitudinem*), a sentence **expressing an evolutionist thinking**.



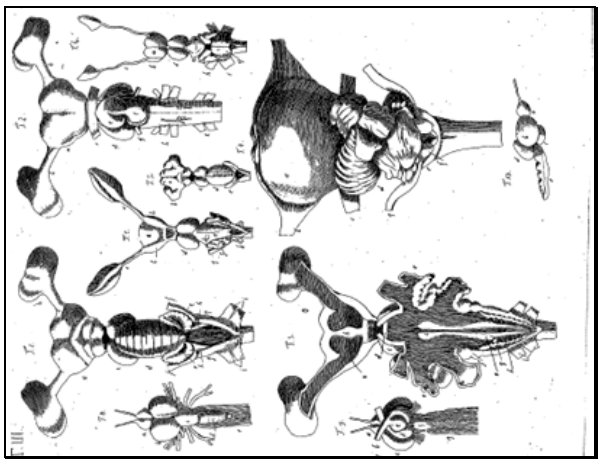
The Brain of a typical Sea Fish.
Tel: Telencephalon; Cb: Cerebellum; OB: Olfactoy Bulb; The rest are nerves.

According to him, the encephalon is a posterior-anterior succession of four pairs of "ganglions" situated in front (anterior) of the spinal cord. Today we can say that it is a succession of cerebral vesicles. Even if some seem an odd structure (*azygon*), it has lateral expansions or components. For him it is clear that the encephalon is an organ with a rigorous bilateral symmetry.

The first element he describes is the medulla oblongata which has the two olivary bodies (*posteriore gangliorum encephalum* or tubercula medulae *oblongata*) on its sides, to which he wrongly attributes he origin of trigeminal and vagus nerves. He does not attribute them any function, but we should mention that even today we do not know what is their role, although they are framed in an extremely complex connexional system.

The second element he describes is the cerebellum. From the beginning, he clearly rejects Cuvier's point of view who considered the cerebellum an odd unique ganglionar mass on the median line. He asserts, based on his dissections, that always the cerebellum is made up by a median part and two lateral parts (*"media impari, lateralibus paribus componi"*) which arrive to the pons (before the olivary bodies) and laterally border the IVth ventricle. Following his description, two bundles (which we name today inferior cerebellar peduncles) penetrates from the medulla oblongata into these lateral parts. He describes the fissures (*sulci*) on the surface of cerebellum and the lobes, but also the floor of the IV ventricle (sinus rhomboidalis) with round eminentiae, calamus scriptorius and auditory tubercles. He recognizes a "universal" pattern of cerebellum shape in all the vertebrates, including man. He describes the cerebellum variations of shape in different species which he ascribes to the evolution (*"ratione evolutione cerebeli modo"*).

The description and analysis of the third element, the optic tubercles, represent his most outstanding contribution. Anyone who looks at a brain of fish (as well as of batrachian or of reptile) notices the existence before the cerebellum of two big ovoid masses on the one part and on the other part of the median line *similar* to birds' and mammals' cerebral hemispheres.



Drawings from Arsaky's thesis

Arsaky describes these tubercles as two ovoid formations empty in the interior and made up of two veils – one external grey and one internal thinner and white. He asserts that they are the biggest components of fish brain. In their interior he describes the striated bodies with their kidney shape. To these ovoid formations two peduncles from the more posterior parts of the encephalon rise up and the internal cavity continued with Sylvius Aqueduct till the forth ventricle He describes between the optic tubercles the two white commissurae – anterior and posterior.

It is essential that he does not fall into the trap in which Cuvier did considering these formations as the equivalent of cerebral hemispheres of birds and mammals. He makes clear that these tubercles are the equivalent of the two optic tubercles of birds and of the four quadrigeminal tubercles of mammals, an assertion today unanimously accepted.

In order to support his thesis he invokes three arguments, one related to the optic tubercles shape, to their relations with hypophysis and thalamus as well as those with the cerebellum; the second one is based on the analysis of the relations with visual fibers (*"nervorum opticorum"*), and the third one – the most interesting – is of evolutive order.

"Tertium argumentum analogia evolutionis cerebri in seria animalium et in embryone altiorum animalium suppeditat" (The third argument is based on the brain shapes during their evolution in the animal series and the embryonic one of the other animals). He clearly mentions that the cerebral hemispheres – present in birds and mammals – do not exist in the inferior vertebrates. What seem to be cerebral hemispheres are only what in humans are the quadrigeminal tubercles (tectum opticum). In Meckel's letter (we mentioned above), he praises him for his demonstration (*"... quae Tu argumentis ingeniosissimis tubercula optica esse evincere studes..."*) and he affirms that he agrees to all his assertions (*"... in omnibus autem, quae protulisti, cum me omnium habeas consentientem, dubium tamen suprimere nequo"*).

This passage clearly shows us that Arsaky, influenced by the scientific atmosphere of Halle, **was a supporter of the evolution paradigm**, 46 years before Darwin. He successfully uses it in order to systematize the anatomy of fish brain. He also uses, in an evolutive spirit, the comparative embryology 53 years before Haeckel.

We should not forget that at Halle was formulated the law of Serres-Meckel[9] who established a parallelism between the embryologic evolution and the increasing complication of animal series organisms. Serres, Antoine Étienne Renaud Augustin (1786–1868) unlike Arsaky considered that the tectum opticum of fish are the equivalent of cerebral hemispheres in mammals. It is the first formulation of the "recapitulation law" or of the "biogenetic rule" of E. Haeckel in 1866.[10] After the description of optic tubercles, Arsaky describes the hypophysis, the mammilary bodies and above them the thalamus and he mentions the infundibulum which connects the hypophysis with the encephalon. He also mentions the epiphysis (*"glandula pinealis"*).

In front of these, in the anterior pole of the encephalon, Arsaky corectly describes two eminences called by him olfactive tubercles which have no cavities and which present many variations from species to species. The olfactive nerves depart from them. He describes with many details the shape of these olfactive tubercles and nerves, their variation of aspect and size from species to species, as well as different morphological details. He agrees with all the contemporary authors that these tubercles have a role in the olfactive perception which is developed in fish. He did infer that from *them the cerebral hemispheres will develop in birds and in mammals*.

The paper has an interesting bibliography presented as infrapaginal notes. Also it is accompanied by plates with engraved drawings characteristic of the respective epoch. It is written in a simple academic Latin language and an elegant style easy to read. For the translation of some more unusual expressions we have used a Latin-French dictionary of 1757 which was bought by boyar Ban Constantin Bălăceanu from Vienna in 1792.[11]

From those above mentioned it is clear that Apostol Arsaky was an accurate and skilful researcher and a fine observer as it is proved by his dissections and descriptions. At the same time it can be seen that he had a deep scientific thinking extremely modern for his times. He was sure that the living organisms are built on basis of a general, universal /pattern in the context of which there are achieved different aspects characteristic for species and for their variants. This principle is valid also for different systems and organs among which the nervous system about which he asserts that it is more stable regarding its diversification than other systems (for example the circulatory one). What is totally remarkable is that **he puts at the basis of the different variants an evolutive principle about half a century before Darwin**. He clearly mentions the evolution in animal series. Also in order to establish the analogies and the explanation for shapes of different nervous structures he uses also the elements of embryology and even the evolutionist embryology, over 50 years before Haeckel. This does not prove only his thinking modernity but that the evolutionist ideas were already taken into account in Germany even at the beginning of XIX century, evidently as a corollary of the Age of Enlightenment.[12]

If Apostol Arsaky would have continued his profession of a researcher in biology or neurology it is sure that he would have been one of the great scientific personalities of Europe. He came back to Romania where he carried out a double activity. He was a physician with high practice, being director (protoyatros) of Coltzea Hospital and then the chief physician (arhiyatros) of Bucharest.[13] But he was also an extremely active statesman with a strong orientation on the right wing, a conservative and anti-Marxists militant, strongly fighting against the concepts of proletarian and surplus value. He contributed to the realization of the Romanian United Principalities, and to the

foundation of the modern Romania. He became also an interim-prime minister of Romania after Barbu Catargiu' assassination in 1862.[14]

Apostol Arsaky (1784–1874)

He was distinguished by charitable activities and by the setting up in Athens of an Arsakyon foundation dedicated to the education for girls. This paper tries only to put him in a place he deserves in the history of the Romanian as well as of the European medicine and biology. It also proves the level of culture and the refinement of Romanian élites at the end of Phanariot epoch as well as the way in which they assimilated the European models.

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