A COMPARATIVE STUDY ON THE EXTERNAL MORPHOLOGY OF THE ENCEPHALON IN THREE FISH SPECIES BELONGING TO CYPRINIDAE FAMILY: AMBLYPHARYNGodon MOLA, DANIO MALABARICUS, AND RASBORA ARGYROTAENIA

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The present article comparatively analyses the main characteristics regarding the external morphology in three cyprinid species: Amblypharyngodon mola, Danio malabaricus, Rasbora argyrotaenia. One can notice significant variations in size and shape for the main divisions and subdivisions of the encephalon both intraspecific and interspecific. Depending on the development of the facial lobe and the vagal lobes at the myelencephalon level, the studied species belong to two major groups: - group I, with the facial lobe and the vagal lobes poorly developed (Danio malabaricus and Rasbora argyrotaenia); - group V, with an absent facial lobe to the exterior and reduced vagal lobes (Amblypharyngodon mola)

Introduction

All the analyzed species belong to Danioninae (Rasborinae) subfamily. Amblypharyngodon mola originates in India, met in reophile waters, but in clear lakes, too. Good swimmer, it predominates in the midwater. It has a tall and laterally compressed body; the slightly terminal upper mouth is barbels. The food it prefers consists of various invertebrates. Danio malabaricus is a nectobenthonic species, living in running and stagnant waters in India and Sri Lanka. The waist is small, with a prolonged and laterally compressed body. The mouth has an upper position. Rasbora argyrotaenia is a species with a small waist, originating in the rivers of the South-Eastern Asia. It is frequently met in the water mass. It has a prolonged and laterally compressed body, with a dark stripe on its sides. It presents a terminal mouth, without barbels.

The present paper aims at comparing, from the morphological point of view, the divisions and the subdivisions of the encephalon in three cyprinid species: Amblypharyngodon mola, Danio malabaricus, Rasbora argyrotaenia, in order to see which of the encephalon divisions presents a greater variability of the brain.

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Material and methods

The material I used was offered to me by Acad. dr. doc. Bănescu P. The encephalon, which was removed from the skull by using of classical methods, was drawn at the camera clear connected to a microscope, and then entirely and partially measured, in divisions and subdivisions. There was performed a comparative analysis of the telencephalon, the lateral and median lobes of the hypothalamus (located on the ventral part of the diencephalon), the optic lobes, the corpus cerebelli, the valvula cerebelli, the facial lobe, the vagal lobes, the acoustic tubercles.

Results and discussions

When referring to the telencephalon, we have noticed an asymmetry of the cerebral hemispheres in *Rasbora argyrotaenia*, the left hemisphere being larger than the right one. (Fig. 1.b). We consider the cause to be of a mechanical nature, being influenced by the skull. There might be even a genetic cause; this asymmetry can be explained on account of the environment. The cerebral hemispheres have a dorsal area crossed by furrows (sulci) that delimitate the tubercles. The number of the sulci, as well as the form, size and number of the tubercles vary both among the individuals of the same species and among species (Fig. 1 a-f). The olfactory bulbs, of a cyprinid type, are oval in *Amblypharyngodon mola* and *Danio malabaricus* and slightly rounded in *Rasbora argyrotaenia*. The olfactory tracts are generally short. For the individual with small size in *Danio malabaricus* and *Rasbora argyrotaenia*, the olfactory bulbs, resembling some caps, are attached to the rostral part of the hemisphere; in this case the very short olfactory tract cannot be dorsally distinguished. (Fig. 1.b, f).

Among the subdivisions of the diencephalon, we have analyzed the hypothalamus lobes. Although we have had only three species under research, we have noticed significant shape variations regarding the hypothalamus aspect. The lateral lobes are united on the median line in *Rasbora argyrotaenia* and *Danio malabaricus*. They are very little posterior-caudally distanced in *Amblypharyngodon mola* and 2 individuals of *Danio malabaricus*. The lateral lobes for these species are small and without visible sulci to the exterior; they present a large median lobe, with a rhombic shape (Fig. 1.c, f). In *Rasbora argyrotaenia* the following sulci are distinct on the surface of the lateral lobes: longitudinal, median and mammillary (Fig. 1.a, b); these do not delimitate the corresponding tubercles.

The optic lobes of the mesencephalon have a different aspect. They are median line united in *Amblypharyngodon mola*, an individual of *Rasbora argyrotaenia* and two individuals of *Danio malabaricus* (Fig. 1.b, c, f). They are rostrally united and caudally distanced at one individual of *Rasbora argyrotaenia*; at this level one can distinguish the torus longitudinalis (Fig. 1. a). They are distanced on the median line at *Danio malabaricus*, very little at two individuals, level where the torus longitudinalis are distinct (Fig. 1,d); in one individual there is a more visible distance, level where it distinguishes from the valvula cerebelli (Fig. 1,e). We have considered the distancing among the optic lobes as a consequence of the valvula cerebelli development, according to the information in the specialty literature, too (Bănărescu, 1949).
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Fig. 1 – Dorsal view (left) and ventral view (right) of the encephalon in 3 species of danionine: a., b. – *Rasbora argyrotaenia*, c. – *Amblypharyngodon mola*, d., e., f. – *Danio malabaricus*. Scara – 4,9:1 (a.); 4,83:1 (b.); 4,65:1 (c., e.); 4,31:1 (d.); 4,57:1 (f.).

Abbreviations: BO – bulbus olfactorius; TrO – tractus olfactorius; CH – cerebral hemisphera; LMH – lobus medialis hypothalami; LLH – lobus lateralis hypothalami; LO – lobus opticus; TL – torus longitudinalis; VC – valvula cerebelli; CC – corpus cerebelli; CrC – crista corpus cerebelli; EG – eminentia granularis; TA – tuberculum acusticum; LF – lobus facialis; LV – lobus vagus; FR – fossa rhomboidea; Myel – myelencephalon; sal – sulcus (s.) anterolateralis; sam – s. anteromedianus; std – s. laterodorsalis; spl – s. lateroposteriorus; spd – s. posteroanteriorus; spp – s. posteroposterior; sl – s. longitudinalis; sm – s. medianus; smm – s. mammillaris; ta – tuberculum (t.) anterior; tm – t. medianum; tp – t. posteriorum; tl – t. laterale; tpl – t. posterolaterale; tpt – t. postremum; tmm – t. mammillarum
The corpus cerebelli has various shapes: it is small and spherical in most of the individuals of *Danio malabaricus* (Fig. 1.d, e); it is rhombic in the individual with the smallest size (Fig. 1.f); it has a pentagon shape in *Rasbora argyrotaenia* and *Amblyparyngodon mola* (Fig. 1.a, b, c). We have noticed, in *Danio malabaricus* and *Amblyparyngodon mola*, well-developed eminentia granularis. In the caudal and ventral part of the corpus cerebelli we have noticed a well-developed, extended part that we called the *crista corpus cerebelli*, which distinguishes dorsally, too. This is obvious with *Amblyparyngodon mola*. The valvula cerebelli is wider than the corpus cerebelli in *Amblyparyngodon mola*. It is at the same level with the corpus cerebelli in *Danio malabaricus* and it is less wide in *Rasbora argyrotaenia* and the individual with small waist in *Danio malabaricus* (L = 3.89 cm). The lateral parts exceed the median sections in *Rasbora argyrotaenia* and *Danio malabaricus*. For the individual with the size of 6.78 cm in *Danio malabaricus*, the lateral parts are anteriorly distanced and they are smaller than the median part (Fig. 2 d). The lateral parts in *Amblyparyngodon mola* are also anteriorly distanced, but they are located at the same level with the median part, which has a trapezoidal shape. Excepting the *Rasbora argyrotaenia* species and two individual of *Danio malabaricus*, the other 2 species present a sulcus longitudinalis on the dorsal area of the lateral parts: long at *Danio malabaricus* and short at *Amblyparyngodon mola* (Fig. 2 a-d).

![Fig. 2. The valvula cerebelli at: a. –*Amblyparyngodon mola*; b. –*Rasbora argyrotaenia*; c., d. –*Danio malabaricus*.](image)

pmv – median side of valvula cerebelli; plv – lateral side of valvula cerebelli; sl – sulcus longitudinalis; Scara – 7,85:1 (a.); 7,3:1 (b.); 4,68:1 (c.); 3,87:1(d.).

The vagal lobes (associated with the internal taste given by the gustative buds placed in the oropharyngeal cavity) and the facial lobe (associated with the external taste given by the gustative buds placed on the anterior part of the body, on the snout, lips etc) (Evans, 1931) are characteristic to the myelencephalon. According to the classification made by Bânculescu (1949), the analyzed species belong to two major groups:

– group I, with the facial lobe and the vagal lobes poorly developed. The following species belong to this group: *Danio malabaricus* and *Rasbora argyrotaenia*. The facial lobe is round, little, poorly developed, flanked latero-posteriorly by poorly represented lobes of the vagal, located on both sides of the fossa rhomboidea (Fig. 1. a, b, d-f). The fossa rhomboidea has the shape of a narrow or larger triangle, with its base
rostrally disposed. Its aspect depends on the nuclear region of the nerves which originate at this level (Harder, 1975). The acoustic tubercles, which lie antero-laterally against the facial lobe, are big, convex, caudally distanced among them. Their median-anterior part is covered by the corpus cerebelli.

– according to the structure aspect, *Amblyparyngodon mola* belongs to the group V, with an absent facial lobe at the exterior and reduced vagal lobes (Fig. 1. c). The vagal lobes are very near; therefore the fossa rhomboidea is narrow. Anterior to the vagal lobes one can notice the well-developed and bulging acoustic tubercles.

Taking into account the morphological criterion and the information in the specialty literature (Kotrschal et al., 1988, 1992, 1998), the encephalon of the species *Amblypharyngodon mola* belongs to the brain group type octavolateralis, characterized by large octavolateralis and visual centers, but with very small chemosensorial centers. At these species one can notice well-developed eminentia granularis, acoustic tubercles and *crista corpus cerebelli*; this thing allows a better space orientation in the environment and a quick visual localization. The encephalon of the species *Danio malabaricus* and *Rasbora argyrotaenia* is an intermediary between the basic brain type cyprinid and the brain type octavolateralis; they have well-developed optic lobes; while at *Danio malabaricus* the eminentia granularis are well-developed, in *Rasbora argyrotaenia* the *crista corpus cerebelli* is well-developed. All the three species have a preference for swimming in the midwater and they localize the food using their sight.

Conclusions

The species under research present a great variation both intraspecific and interspecific regarding the encephalon shape, depending on allometry, the way of life and the type of habitat, mechanical factors.

According to the development of the facial lobe and the vagal lobes at the myelencephalon level, the investigated species belong to two major groups: - group I, with poorly developed facial lobe and vagal lobes (*Danio malabaricus* and *Rasbora argyrotaenia*); - group V, with an absent facial lobe to the exterior and reduced vagal lobes (*Amblyparyngodon mola*).

From the morphological criterion point of view, the encephalon of the species *Amblyparyngodon mola* belongs to the brain group type octavolateralis. The encephalon of the species *Rasbora argyrotaenia* and *Danio malabaricus* is an intermediary between the cyprinid type brain and the octavolateralis type brain.
Bibliography