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Structural Organization of the Optic Tectum of *Barbus meridionalis* Risso.

I. Inner Strata (SPV, SAC and SGC)

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With 14 Figures

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Summary: The histological features of the three deepest strata of the Optic Tectum of *Barbus meridionalis* were studied with several staining and impregnation techniques. The boundaries between SPV, SAC and SGC were easily established and furthermore the myelinization pattern of the SAC is described. Several neuronal types were distinguished according to their dendritic and axonal features. Pyriform multipolar neurons were found in the SPV; in the SAC, pear-shaped, horizontal and multipolar neurons; in the SGC, fusiform, horizontal, multipolar and pyriform neurons. Some of the pyriform neurons of the SAC are described with axonal characteristics which has allowed us to consider these neurons as a new type of efferent tectal neuron.

Introduction

The stratification of the optic tectum of teleosts has received considerable attention with respect to the number of strata of which is composed (STIEDA, 1861; NEUMAYER, 1893; VAN GEHUCHTEN, 1893; MIRTO, 1895; P. RAMÓN, 1899; LEGHISSA, 1955). However, more recent studies have led to the establishment of a general model (VANEGAS et al., 1974; MEEK and SCHELLART, 1978) comprising the following strata: Stratum Periventriculare (SPV), Stratum Album Centrale (SAC); Stratum Griseum Centrale (SGC); Stratum Fibrosum et Griseum Superficiale (SFGS); Stratum Opticum (SO) and Stratum Marginale.

Studies carried out using the Golgi technique have permitted researchers to locate, within almost all of the strata, different neuron types with particular dendritic and axonic characteristics which are seen to be more or less constant throughout the species of teleosts studied, though certain specific differences maybe observed as is the case with the extension of the strata themselves (KISHIDA, 1979).

The Stratum Periventriculare (SPV), owing to its clear-cut boundary, was from the very beginnings of research into this field considered as a well-differentiated stratum, though it has received various names from different works (P. RAMÓN, 1899; LEGHISSA, 1955; VANEGAS, 1975; MEEK and SCHELLART, 1978; KISHIDA, 1979). According to studies carried out on teleosts, the neuron types characteristics of this stratum is that of neurons with a pyriform soma with a vertical ascending dendritic trunk.

The Stratum Album Centrale (SAC) was also clearly distinguished at the start of research owing to its predominance in myelinated fibres clearly confined within an upper and a lower limit (P. RAMÓN, 1899; LEGHISSA, 1955; ITO, 1971). In different works various kinds of neuron types have been described with an almost general distribution throughout the teleosts studied; these are: multipolar neurons, possibly efferent, (MEEK and SCHELLART, 1978; MEEK, 1983); monopolar, horizontal and pyriform neurons (P. RAMÓN, 1899; LEGHISSA, 1955; VANEGAS et al., 1974; VANEGAS, 1975; SCHROEDER and VANEGAS, 1977; MEEK and SCHELLART, 1978; KISHIDA, 1979; LARA et al., 1980).

In contrast to the clear differentiation in these two strata, the Stratum Griseum Centrale (SGC) has received different divisions, according to different author's criteria, probably due to its cytoarchitectural heterogeneity. P. RAMÓN (1899) divided it into "middle layer of grey substance" and "large plexiform layer"; LEGHISSA (1955) proposed a "central grey zone" of which only the "internal grey" and "internal plexiform" strata could correspond to central grey stratum presently considered. In the most recent studies, certain authors tend to distinguish within the SGC an upper portion, or "internal plexiform stratum", considering it to be structurally differentiated (VANEGAS et al., 1974; MEEK and SCHELLART, 1978; LARA et al., 1984). Ultrastructural studies, however, point to structural homogeneity in the different levels of this stratum (MEEK, 1981). Cytoarchitecturally, the SGC is characterized by the presence of typical vertically developed fusiform neurons. A large number of

pyriform, horizontal and multipolar neurons may also be observed (ROMESKIE and SHARMA, 1979; VANEGAS, 1975).

The present work offers confirmation of the stratification of the optic tectum of *Barbus meridionalis*, together with a description of the principal neuron types to be found in the deeper strata of this structure (Periventriculare Album Centrale and Griseum Centrale).

Material and Methods

The studies were performed on the Cypriniform teleost *Barbus meridionalis* (Fam. Cyprinidae). This fish was obtained from the Duero river and kept in tap water at the laboratory. Specimens were anaesthetized with MS 222, 0.03%, sacrificed by cutting the medulla oblongata and extracted its mesencephalons. These were immediately submerged in the corresponding fixing solution. One group was fixed in Carnoy and embedded in Paraplast. The sections (sagittal and transversal) of 10 μm were stained by the NISSL method at pH = 4.6. Another group was fixed in Bouin and sections were stained by Hematoxyline-Eosine and by two specific techniques for myelin demonstration: KULSCHITZKY and KLUVER-BARRERA. A third group of mesencephalons were processed according to the GOLGI-COLONNIER technique, embedded in Celloidin and cut along the same planes as above at varying thicknesses from 80 to 100 μm .

Results

Macroscopically, the optic tectum of *B. meridionalis* is similar to that of other Teleosts and is formed by two half-domes covering the mesencephalon. However, the notable development of the valvula cerebelli gives rise to dorsal separation between the two hemitecta which becomes increasingly more pronounced as one moves in a caudal direction.

The different techniques employed in this work permitted us to distinguish in *B. meridionalis* six strata; from the ventral to the pial limit these are: Stratum Periventriculare (SPV), Stratum Album Centrale (SAC), Stratum Griseum Centrale (SGC), Stratum Fibrosum et Griseum Superficiale (SFGS), Stratum Opticum (SO) and Stratum Marginale (SM). The Inner Plexiform Layer (SPI), which would correspond to the external portion of the SGC, was not considered as separate, since in *B. meridionalis* it is very difficult to establish an exact lower limit. Myelin-staining techniques revealed that the SO and SAC are the most abundantly myelinated strata and that they follow a precise ordering.

Stratum Periventriculare (SPV)

This the innermost layer and is well distinguishable from the rest of the tectal strata by its dense packeting of cell somata (Fig. 3).

The tight population of somata of certain areas of this stratum is interrupted by axonic bundles of different kinds. In the dorsal region unmyelinated bundles of approximately transverse disposition run through the SPV (Fig. 6b); in many cases they are surrounded by a covering of myelin fibres (Fig. 2). In certain sections, some of these bundles may be seen to cross the SPV and reach the SAC. At approximately the middle horizontal plane there are thick myelin bundles stemming from the SAC which cross the SPV in the direction of the tegmentum (Fig. 11). In the rest of the SPV the structure corresponds to the cell packeting already described.

In the ventral zones, between the ependymary epithelium and the greater part of cellular elements, a continuous layer of myelin bundles may be observed.

A large part of the cell elements of the stratum corresponds to a neuron type of pyriform or round soma with a large dendrite prolongation running perpendicularly to the surface of the optic tectum. According to the dendrite morphology, two varieties may be described: in the first, the long dendritic trunk, with a relatively small diameter, crosses the SAC and SGC and reaches the SFGS, where it develops into a horizontal tree; it may also reach the SO, giving rise to lateral branches only from the middle level of the SGC (Fig. 13b). The other neuron type displays a thick principal dendrite which crosses the tectal structure radially until it reaches the SO; fine lateral branches may be found in the SAC and at different levels in the SGC. Their final ramification is clearly vertical (Fig. 13a).

The Golgi techniques employed for the study of the tectal cytoarchitecture also permit the observation of the most characteristic glial elements of

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Fig. 1. Soma of a pyriform neuron lying in the SAC (→). Hematoxylin-Eosin 400 \times .

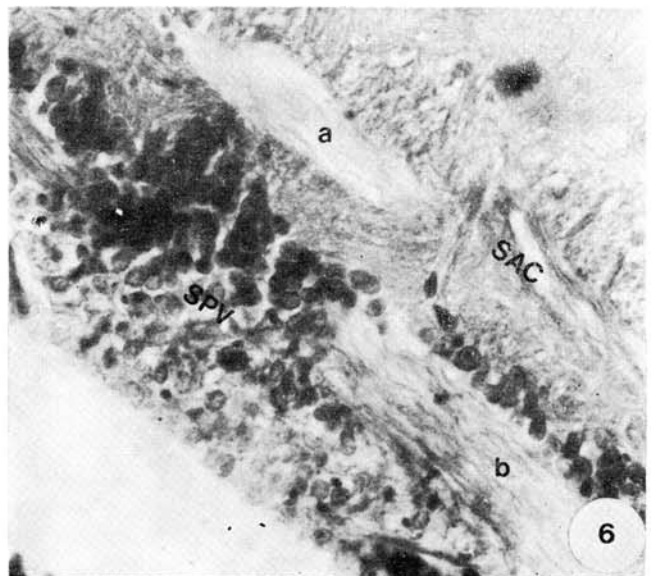
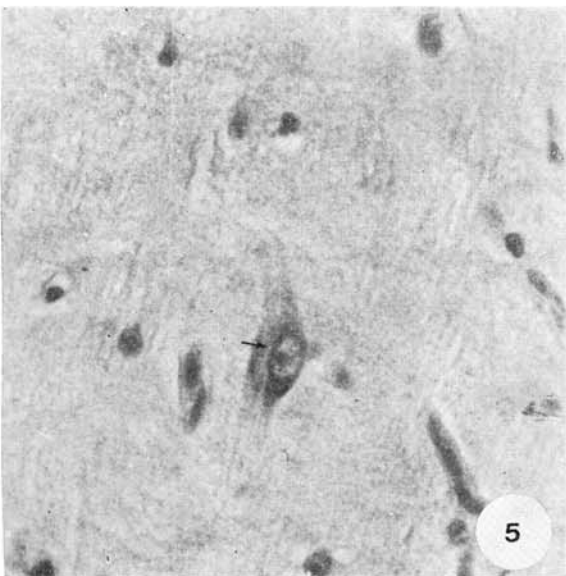
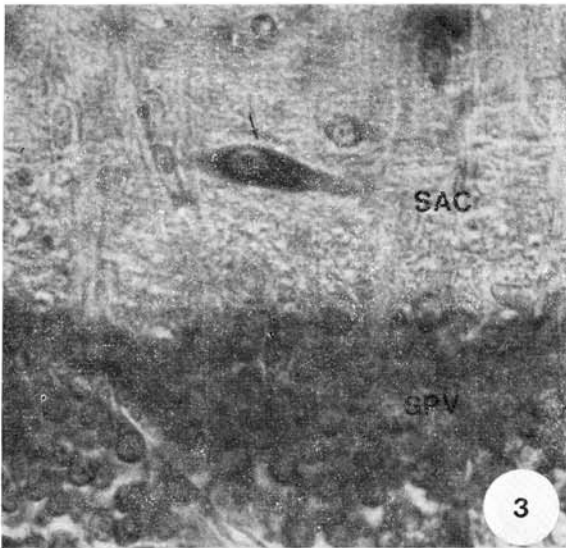
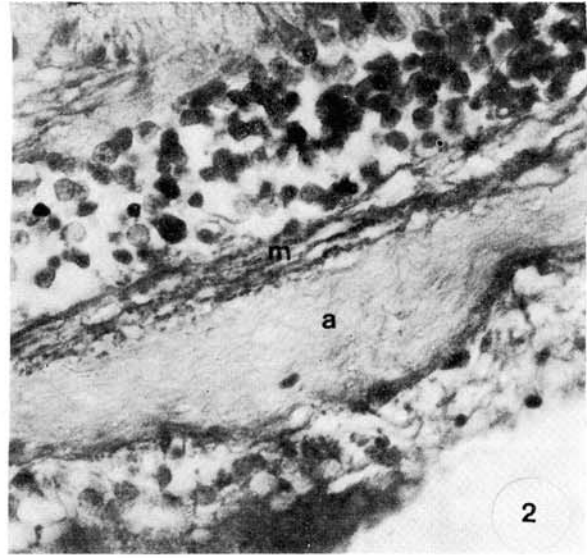
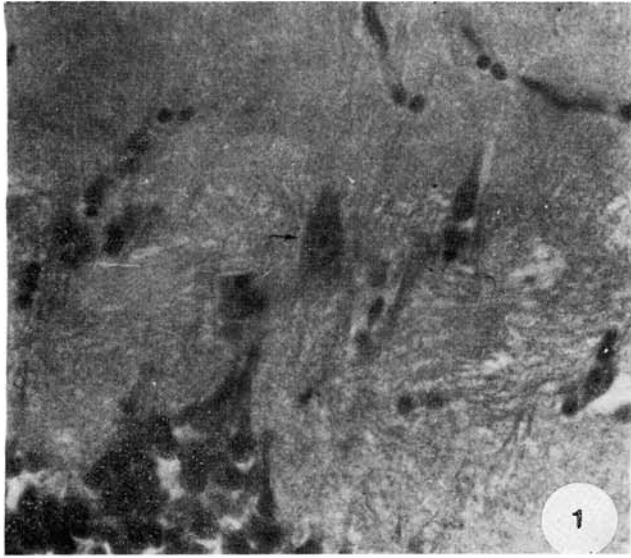
Fig. 2. Unmyelinated bundle (a) surrounded by a covering of myelin fibers (m) and running through the SPV. Kulschitzky 400 \times .

Fig. 3. Partial view of the SPV and SAC. Note the dense package of pyriform neuron somata in the SPV. Arrow shows a typical horizontal neuron of the SAC. Nissl 400 \times .

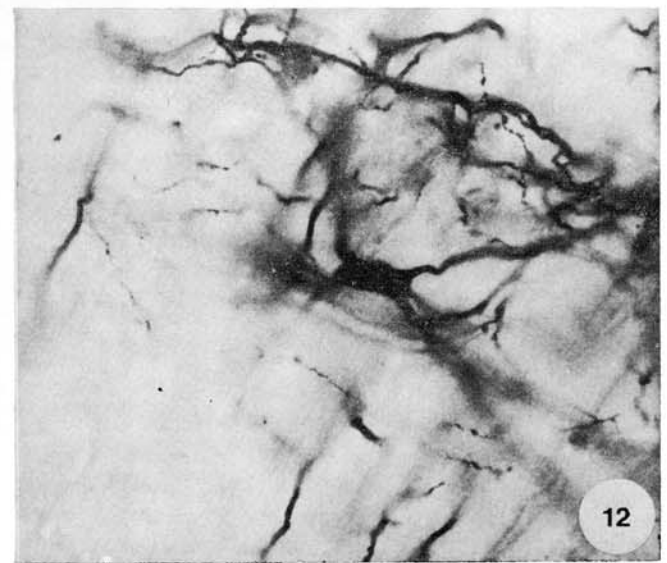
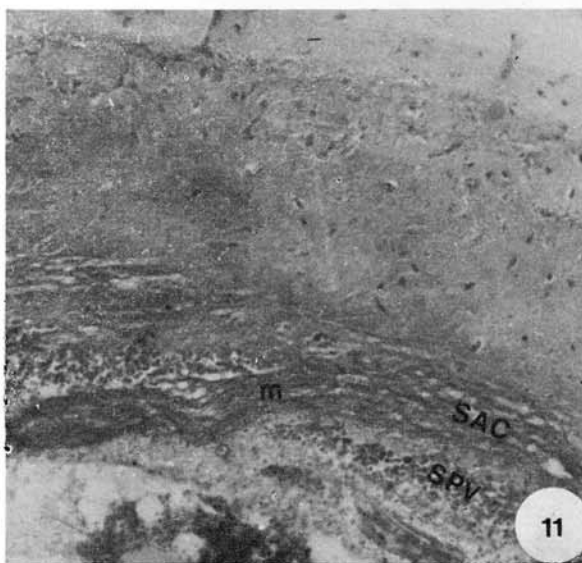
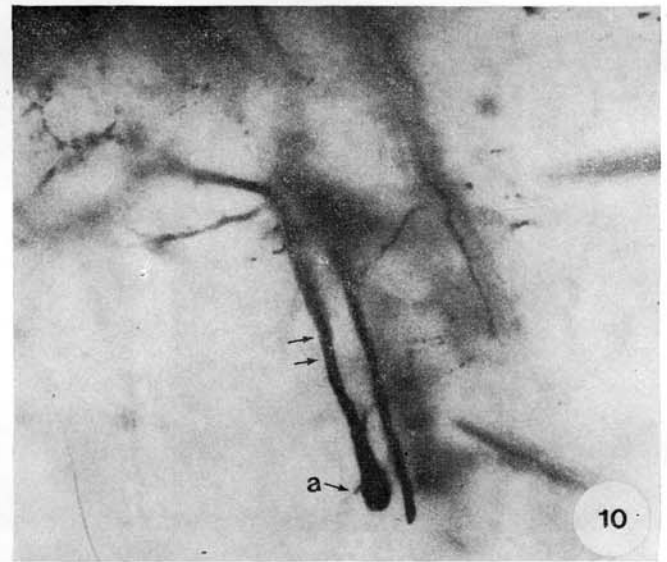
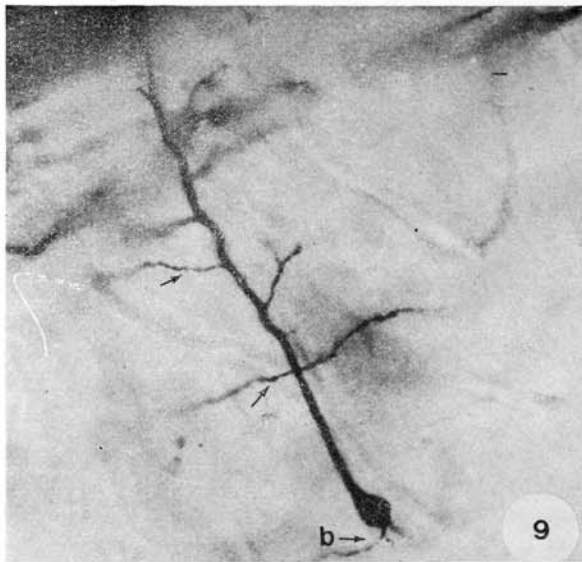
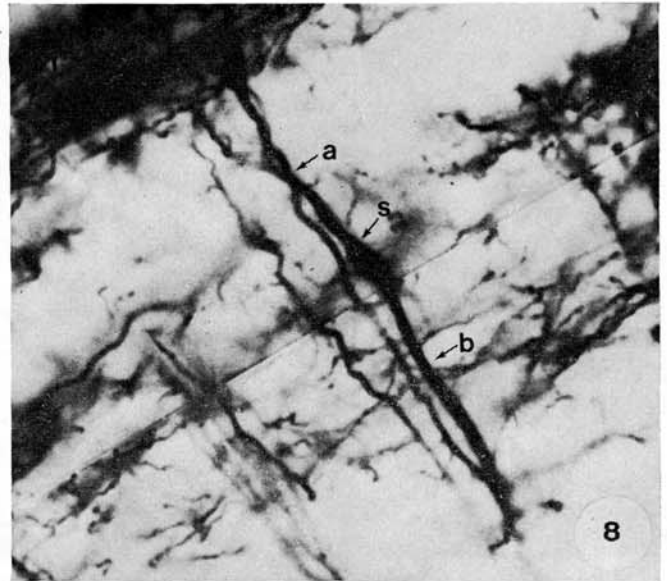
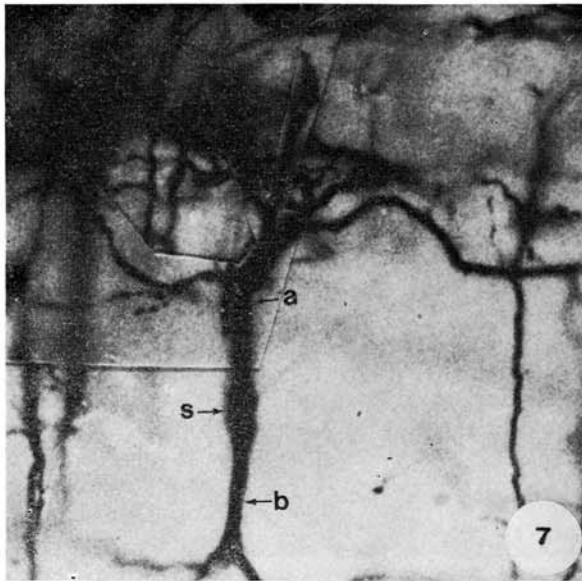
Fig. 4. Unmyelinated packet running through the SAC (p) and dividing into several bundles (a) which ascends to upper strata. Kulschitzky 160 \times .

Fig. 5. Fusiform neuron of the SGC with relatively large nucleus (→). Hematoxylin-Eosin 400 \times .

Fig. 6. Unmyelinated bundles of the SAC (a) and the SPV (b). Kulschitzky 400 \times .



Figs. 1-6



Figs. 7–12

this stratum: the ependimocytes. Their morphology is similar to that described for other teleosts: a fusiform or polygonal soma with an apical prolongation, ascending and radial, in each case free of ramification in their initial portion, which crosses all the strata up the subpial limit, with a profuse and interwoven lateral ramification of variable thickness and extension. In many cases it is also possible to observe a short thick basal prolongation which connects with the ventricular surface (Fig. 14f).

Stratum Album Centrale (SAC)

Though the thickness and myelination of this stratum varies from one tectal region to another, it is well-differentiated from the SPV and SGC by its scarcity in cellular elements, compared with the SPV, and by its predominance of myelinated fibres with respect to the SGC.

Both in transversal and parasagittal cuts, the myelin packets which run under the SPV in the ventral zones, cross this stratum and incorporate themselves into the SAC on approximately the middle horizontal plane (Fig. 11); this integration gives rise to the typical myelination pattern in this stratum, maximum in dorsal zones and minimum in ventral zones.

In the dorsal zones of the tectum the SAC is crossed, or includes for more or less short trajectories, by isolated unmyelinated bundles or by bundles with a covering of myelin fibres, which ascend until they reach the SM, sometimes dividing into smaller packets of lesser diameter (Fig. 4).

Within this stratum may be differentiated somata of different morphologies: horizontally-developed fusiform neuron bodies. The pyriform somata

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Fig. 7. Fusiform neuron of the SGC with relatively short dendritic shafts. s: soma; a: ascending dendritic shaft; b: descending dendritic shaft, Golgi-Colonnier 400 ×.

Fig. 8. Fusiform neuron of the SGC with relatively long dendritic shafts. s: soma; a: ascending dendritic shaft; b: descending dendritic shaft. Golgi-Colonnier 400 ×.

Fig. 9. Pyriform neuron of the SAC with thin basal dendrites. Arrows show dendrites horizontally arranged and stemming from the main dendritic trunk. Golgi-Colonnier 400 ×.

Fig. 10. Pyriform neuron of the SAC with the axon sprouting from the soma (a). (⇔: dendritic shaft. Golgi-Colonnier 400 ×.

Fig. 11. Section stained by Kluver-Barrera method in which a large myelin bundle is observed crossing the SPV and running into SAC (m). 400 ×.

Fig. 12. Multipolar neuron of the SAC with polygonal soma. Golgi-Colonnier 400 ×.

(Figs. 9, 10) correspond to the pattern of dendrite development described for the second variety of neurons of the SPV, and may be differentiated from them by the position of the soma and because the soma is usually more voluminous in the SAC, and by the presence of an axon stemming from the upper portion of the dendritic trunk. However, in the present study it was possible to observe certain elements which, due to their dendritic and/or axonic characteristics, seem to be different to the described in the SPV; they display a fusiform soma with the characteristic dendrite trunk which ascends to the SFGS or even to the SO extending lateral branches in the SGC; at the basal pole of the soma arises very thin dendritic prolongations and from one of these arises an axon-like process with a short descending course, rapidly curving to run horizontally through the SAC (Fig. 9).

Another cell type exhibits an elongated pyriform soma and the main dendrite reaches the upper level of the SGC where it curves to follow a horizontal course with numerous thinner lateral processes. It is also possible to observe a lateral dendritic ramification, near to the soma, which extends horizontally. In these neurons, an axon is observed to stem laterally from the soma, after which it follows a descending path and then adopts a horizontal course in the lower levels of the SAC (Fig. 10).

Within the multipolar neurons, the evidence points to two types: one corresponds to an irregular or polygonal soma out of which extend a fair number of dendritic processes, with a horizontal path, together with a considerably thicker dendrite which extends to higher strata, giving rise to horizontal branches in the upper regions of the SGC or in the lower parts of the SFGS. The axon stems from the soma, following an approximately horizontal course within its own stratum (Fig. 14a).

The other type of multipolar neuron, which is to be found in the proximity of the SAC-SGC limit, is composed of neurons with a polygonal soma. In contrast to the previous type, which has a single thick ascending dendrite, in this case it is possible to observe several dendrites of similar thickness stemming from the angles of the soma; certain of these ascend to the SGC and others follow a fairly long horizontal course within the SAC itself (Figs. 12 and 13c).

A type of bipolar fusiform horizontal neuron was also observed, whose dendrites are considerably spread out on the horizontal plane (Figs. 3 and 14c).

Stratum Griseum Centrale (SGC)

This is the thickest stratum of the optic tectum, particularly in lateral regions. It is clearly distin-

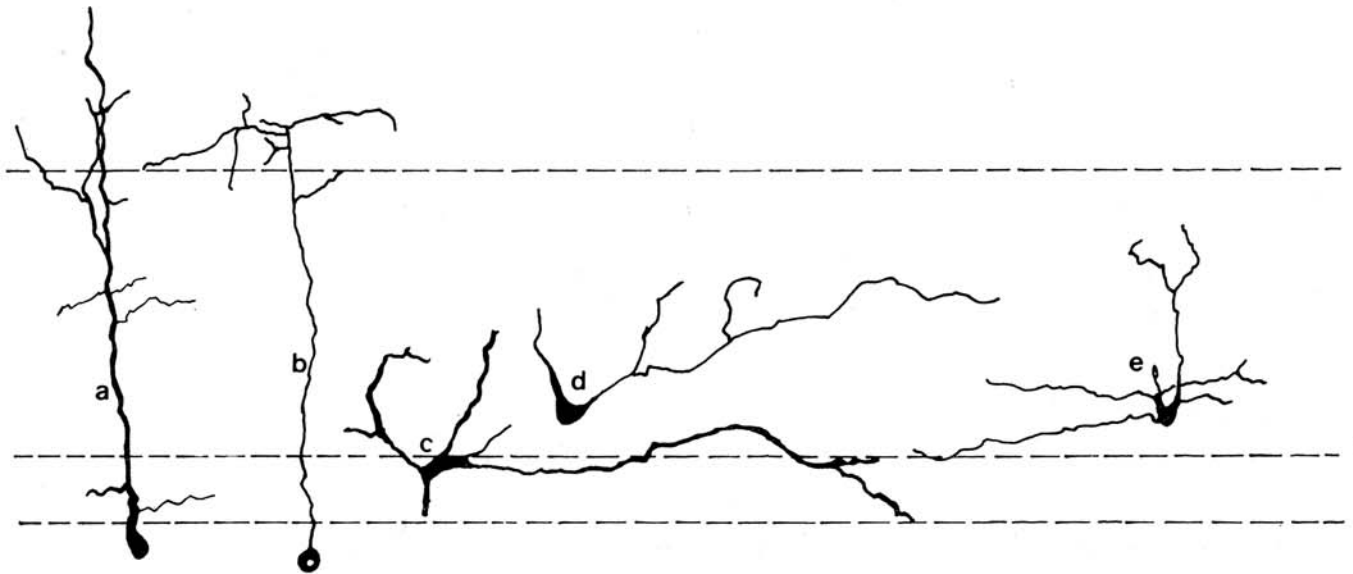


Fig. 13. Some neuronal types of SPV, SAC and SGC:

a) Pyriform neuron of thick ascending dendritic shaft. b) Pyriform neuron of thin ascending dendritic shaft. c) Multipolar neuron of the SAC with polygonal soma. d) Bipolar neuron of the SGC with halfmoon-like soma. e) Multipolar neuron of the SGC whose dendrites spreads into several levels.

Projected drawings from Golgi preparations.

guishable from the SAC and the SFGS by its low degree of myelination. Only in its upper half, and then intermittently, it is possible to observe thin myelin bundles following a horizontal course, which may be confused at certain parts with the SFGS; this would correspond to what some authors have called the internal plexiform layer (SPI).

Upon observation of Nissl and Eosin-Hematoxylin stained preparations, the stratum is well characterized by the relative abundance of vertically developed fusiform neurons with a large nucleus occupying almost the entire soma (Fig. 5). Certain arrangements observed point to a possible location in definite levels within the same stratum. In Golgi-Colonnier preparations two thick dendrites may be seen to stem from opposite poles of the soma, one towards the external surface and the other towards the ventricle. This neurons type exhibits two varieties: in the first (Fig. 7) the two dendritic trunks run for relatively short distances, though the upper end branches in high levels of the SGC, giving rise to vertical and horizontal expansions in the SFGS; in turn, the basal process branches on the horizontal plane before reaching the SAC. In the second variety, the two main dendrites are comparatively larger and reach, respectively, the external limit of the SAC, without changing course and giving rise to a horizontal branching at the two ends (Fig. 8).

Another type, only observed in the SGC, is composed of piramidal neurons with a very thick vertical dendritic prolongation which ascends to the SO

where it branches vertically and on passing through the SFGS originates horizontal lateral branches; from the apex of this dendrite stems an axon which immediately curves to follow a downward course. Thin dendrites arranged on the horizontal plane stem from the basal pole (Fig. 14e).

In common with the other strata of the optic tectum, the SGC exhibits horizontally developed fusiform neurons located in the upper portion of the stratum (Fig. 14d). Piriform neurons have also been observed with a similar arrangement and with a monopolar aspect, whose principal dendrite gives rise to lateral branches in the SGC and reaches the SFGS where it bifurcates into two horizontal prolongations; from one of these stems an axon like process with an initially descending course (Fig. 14g).

There is also a set of cells which are difficult to classify due in that they may exhibit horizontal development; they may be also bipolar or multipolar and are all of very diverse dendritic morphology. However, they all display a common characteristic: all their dendritic prolongations, apart from reaching strata above and below the SGC, extend throughout the SGC, covering it to a large extent both radially and tangentially (Fig. 13d and e).

Discussion

The optic tectum of *Barbus meridionalis* displays an anatomical characteristic common to other Cyprinids studied such as *Carassius auratus* (MEEK and SCHELLART, 1978; MEEK, 1983) and *Cyprinus carpio*

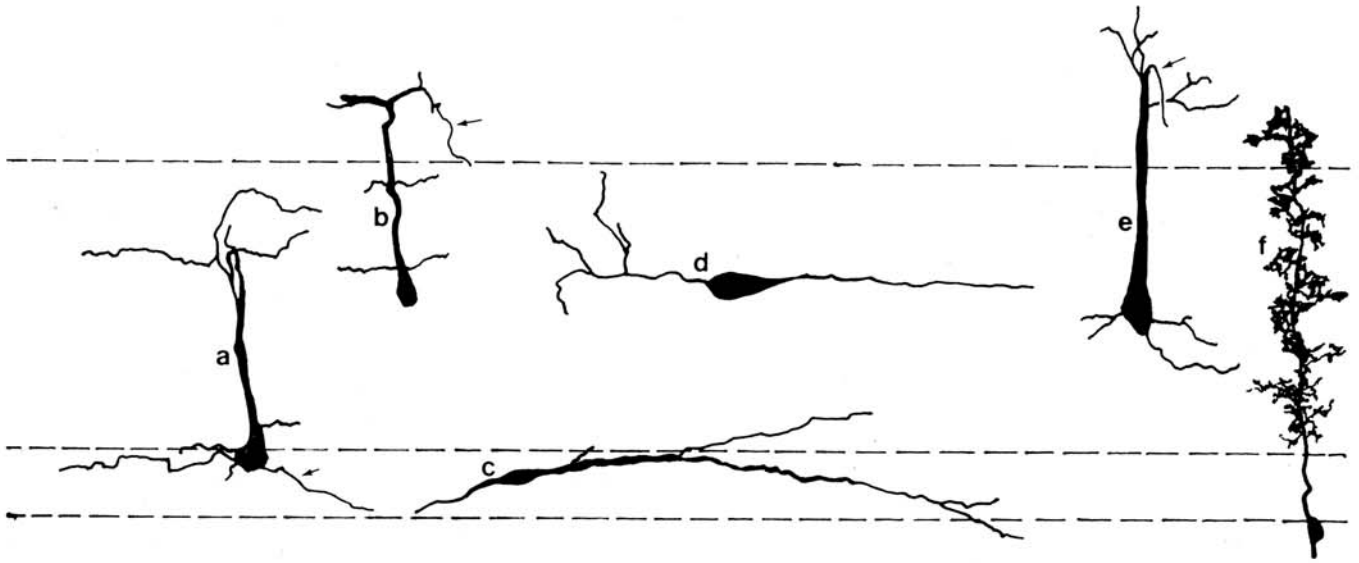


Fig. 14. Some neuronal types of SPV, SAC and SGC: a) Multipolar neuron of the SAC with an axon emerging from the soma (\rightarrow). b) Short pyriform neuron of SGC with axon stemming from a dendrite (\rightarrow). c) Fusiform horizontal neuron lying in the SAC. d) Fusiform horizontal neuron lying at the middle level of the SGC. e) Pyramidal neuron with a hooked axon (\rightarrow). f) Ependymal cell. Projected drawings from Golgi preparations.

(LARA, 1982) in that it has two hemitecta widely separated on the dorsal plane due to the considerable development of the valvula cerebelli.

The stratification proposed in this work is similar to that put forward by other authors for *Eugerres plumieri* (VANEGAS et al., 1974); *Bagrus* sp. and *Ictalurus punctatus* (SCHROEDER and VANEGAS, 1977); *Carassius auratus* (MEEK and SCHELLART, 1978); *Cyprinus carpio* (LARA, 1982) and a large number of species studied by KISHIDA (1979). However precise information is still lacking with respect to the demarcation of the PI since the presence alone of disperse thin myelin bundles parallel to the tectal surface can be indicative of a certain division of the SGC. Studies carried out on *C. carpio* (LARA, 1982; LARA et al., 1984) consider the stratum as a whole as forming the central grey zone and have distinguished within this zone the GC and PI strata on the basis of light and electron microscopical data which would confer a certain consistency to such a division. However, the results of ultrastructural studies carried out on *C. auratus* (MEEK, 1981) suggest that the similarity in fine structure between the SPI and the SGC does not permit a distinction between the two as different strata.

Stratum Periventriculare (SPV)

The general configuration of this stratum coincides with the description made by other authors concerning species of the same Family (Cyprinidae), both due to its relative thickness and to other characteristics (KISHIDA, 1979; MEEK and SCHELLART, 1978; LARA, 1982). Accordingly, in *C. carpio* (LARA, 1982) a description was also made of groups of

myelin fibres running below this stratum or interrupting the continuity of the dense cell packing, together with unmyelinated bundles surrounded on their periphery by myelin fibres (Fig. 14f).

Among the non-neuronal elements, the ependymocytes constitute the commonest characteristic of this stratum. According to Golgi-Colonnier preparations their morphology coincides with that established in other studies for *B. fluviatilis* (P. RAMÓN, 1899), *Carassius auratus* (LEGHISSE, 1955), *Paralabrax nebuliger* (KRUGER and MAXWELL, 1966), *Eugerres plumieri* (LAUFER and VANEGAS, 1974), *Poecilia reticulata* (CIANI et al., 1975) and *Cyprinus carpio* (LARA et al., 1980) such that it could be feasibly be an universal type in Teleosts. (Fig. 14f)

As in the case of other authors, (P. RAMÓN, 1899; VANEGAS, 1975; KISHIDA, 1979) in the present study it was only possible to identify vertical pyriform neurons with different morphological variants in this stratum; in our results we have summarized these as two (Fig. 13a and b). One corresponds (Fig. 13b) to the fourth type described by P. RAMÓN (1899) in *Barbus fluviatilis* and the first type of ROMESKIE and SHARMA (1979) in *C. auratus*; similar neurons have been described by MEEK and SCHELLART (1978) in the same species and by LARA et al. (1980) in *C. carpio* though MEEK and SCHELLART (1978) describe greater morphological variety in their type "XIV" according to the length and distribution of the dendrites and axonic development.

The second type considered is not exclusive to the SPV but also appears in the SAC (Fig. 13a), corresponding to pyriform neurons with a thick ascending dendrite with numerous prolongations in

upper strata. Several subtypes described by P. RAMÓN (1899) in *B. fluviatilis*, whose soma is located between the SPV and the SAC, correspond to our second type, though the detailed descriptions of P. RAMÓN (1899) emphasize axonic development, which coincides with that of certain typically periventricular neurons described by VANEGAS (1975) in *E. plumieri* and *Holocentrus rufus* and by MEEK and SCHELLART in *C. auratus* (1978).

In the present study it was not possible to locate in *B. meridionalis* any short-dendrite neurons, which scarcely extend outside the SAC or only penetrate for short distances into the SGC, and which have been described by other authors for different species (P. RAMÓN, 1899; MEEK and SCHELLART, 1978; LARA et al., 1980).

Stratum Album Centrale (SAC)

The myelination of this stratum is minimum in the ventral zones and maximum in the dorsal zones; taking into account the density in neuron bodies, this suggests that it resembles, in the ventral zones, the SFGS (LAUFER and VANEGAS, 1974; VANEGAS et al., 1974). However, according to its myelin ordering, other authors have compared it to the SO (LARA, 1982). On the other hand, our observations in the SAC of thick unmyelinated packets oriented rostrocaudally in parasagittal sections support the descriptions of the entry of unmyelinated fibres, originating in the Torus Longitudinalis, through the SAC towards higher strata (ITO and KISHIDA, 1978). As well as occurring on the transverse plane, this incorporation also takes place on the saggital plane in the form of multiple ascending bundles stemming from the thick packet which runs through the SAC (Fig. 4); the exit of myelinated fibres from this stratum takes place approximately at the height of the middle horizontal plane.

Regarding cytoarchitecture, the types described may be identified, according to their most salient characteristics with those also found in other species. In this sense, multipolar neurons (Fig. 13c and 14a) of the type considered were also described by P. RAMÓN (1899) in *B. fluviatilis* as "ganglionic corpuscles of the secondary variety", by VANEGAS et al. (1974) in *E. plumieri* and by MEEK and SCHELLART (1978) and ROMESKIE and SHARMA (1979) in *C. auratus*. These authors describe axons which stem from the neuronal body and follows a horizontal course through the SAC, in a similar situation to that observed by us for the same neurons.

The pyriform neurons of *B. meridionalis* also coincided with the type described by other authors in different Teleosts (P. RAMÓN, 1899; LEGHISSA, 1955; VANEGAS, 1975; LARA et al., 1980). Neuron

somata belonging to large pyriform neurons, may be observed in sections stained with hematoxylin-eosin or Nissl and it was possible in the present study to distinguish axons stemming from the cell body or from basal dendrites of these neurons. Only LEGHISSA (1955), working with *C. auratus* describes a similar situation. Different authors postulate that the axons of this neuron type originate in the upper parts of the dendritic trunk, with a short descending course which later curves in a hook within the SGC (P. RAMÓN, 1899; VANEGAS et al., 1974; VANEGAS, 1975; MEEK and SCHELLART, 1978; ROMESKIE and SHARMA, 1979; MEEK, 1981, 1983). Some of these authors have reported the existence in different species of axons, which, with the same origin as in the previous case, leave the tectum through the SAC, emitting in the initial course collaterals within the SFGS and SGC (P. RAMÓN, 1899; MEEK and SCHELLART, 1978). The problem then arises of the origin of the axon in all these cases: P. RAMÓN (1899) proposed that the origin of these axons would lie in the need to provide collaterals directly to the plexa of the SGC and in the shortest time possible with respect to the entry of dendrites to the neuron; this would even explain the case when the axon leaves the tectum through the SAC, as long as it provides collaterals to the strata it crosses or to higher strata. VANEGAS et al. (1974) hold the large pyriform neurons to be mainly visual neurons, precisely because their axon protrudes very close to the zone of retinotectal terminals, which would constitute a safety factor for the transfer of visual information. However, morphological studies carried out in fish with underdeveloped or atrophied visual system (SCHROEDER and VANEGAS, 1977) show that the characteristics of the pyriform neurons, regarding their location and distribution, are similar to those of other Teleosts with a developed visual system. This suggests that these neurons could be used in the reception of afferences, not necessarily visual ones, located in the upper zone of the SGC and that the tectum is responsible for an important non-optic correlation function. Even then, the pyriform cells would participate in the intratectal flow of information acting either as interneurons (ROMESKIE and SHARMA, 1979) or emitting axonic collaterals before reaching the SAC (MEEK, 1983). In the present study, the finding of pyriform neurons whose axons stem from within the stratum itself has prompted us to suspect that these are lacking in intratectal terminals such that of they do project to other centres, they do not need stem from the SFGS nor the SGC, like those which emit collaterals, but rather directly from the base, of the dendrite or from the soma.

Stratum Griseum Centrale (SGC)

The neurons types encountered in *B. meridionalis* are similar to those described in other Teleosts (VANEGAS et al., 1974; MEEK and SCHELLART, 1978; KISHIDA, 1979; MEEK, 1981). Accordingly it is possible to find fusiform neurons with a pale nucleus which occupies almost the whole soma, like those reported by VANEGAS et al. (1974) in *E. plumieri*.

The characteristics of neuron prolongations of elements with soma in this stratum display manifest similarities with those reported in other studies: the horizontal fusiform neurons (Fig. 14d) correspond to the tangential cells of horizontal branches described by P. RAMÓN (1899) in *B. fluviatilis*; to type "V" of MEEK and SCHELLART (1978) in *C. auratus* and the horizontal neurons of the SGC reported by VANEGAS et al. (1974) in *E. plumieri*. Contrariwise, LEGHISSA (1955) did not describe this neuron type.

The two subtypes of vertically oriented fusiform neurons described in the present work (Figs. 7 and 8) coincided with the types observed by VANEGAS (1975) in *E. plumieri* and *Holocentrus rufus*; with types "VII" and "XII" of MEEK and SCHELLART (1978) described in *C. auratus* and with the observations of KISHIDA (1979) in different species of Teleosts.

P. RAMÓN (1899) described in this stratum a type of pyramidal neuron with a descending axon stemming from the base of the soma; this was very rare in *B. meridionalis* and could not be observed in this study on *B. meridionalis*.

The hooked axon pyramidal neurons (Fig. 14e) correspond to the large and medium sized neurons reported by P. RAMÓN (1899), though according to the localization of the soma and axonic development they could be included in a single group with the descending axon neurons.

Small pyriform neurons with similar characteristics to those described by us (Fig. 14b) in the present work were observed in *E. plumieri* (VANEGAS et al., 1974) and in *Carassius auratus* (MEEK and SCHELLART, 1978) though in the former of these species the authors situate the origin of the axon in the neuron soma and in the second case it has not been observed. In *B. meridionalis*, it was possible to locate the cylindroaxis by starting from one of the upper dendritic branches.

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