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RESEARCH ARTICLE

Anatomical studies on the cranial nerves of fully formed embryonic stage of *Liza ramada* (Risso, 1827). II.Nervus Facialis

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Abstract

This study deals with the facial nerve of the bony fish *Liza ramada*. The nervus facialis arises from the medulla oblongata by one root. It fuses with the anteroventeral lateral line nerve forming commen nerve. The geniculate ganglion is located intracranially, from which arises the ramus palatinus as two rami. The nervus facialis exits from the cranial cavity through the facial foramen. The ramus palatinus innervates the submucosa of the roof of the mouth, the epithelial lining of the palate and the taste buds. The truncus hyomandibularis gives off the ramus opercularis to the adductor arcus palatini and the adductor hyomandibularis muscles. Then, it divides into the ramus hyoideus ventrally and the ramus mandibularis facialis dorsally. The ramus hyoideus innervates the opercular skin, the branchiostegal membrane, the skin covering the posterior intermandibularis muscle, the neuromasts of the opercular lateral line canal and the muscles superior hyoideus, inferior hyoideus and interhyoideus. The ramus mandibularis innervates the anterior and the posterior intermandibularis muscles, the tissues found lateral to the dentary bone, the floor of the mouth and the taste buds of the lower jaw.

Introduction

The sensory system of fishes (receptors, their nerves as well as their centers) play a major and sometimes a decisive role in many fish behavioral patterns (feeding, defense, spawning, schooling orientation, migration, etc.).

The study of the cranial nerves is important because their distribution is correlated to the habits and habitats of animals and also because they show an evolutionary trend among the animals of the same group.

The most valuable works of these early ones were those carried out by Allis (1903, 1909 & 1922) and Herrick (1901).

Northcutt and Bemis (1993) on Latimeria chalumnae, Piotrowski and Northcutt (1996) on Polypterus senegalus, Dakrory (2000) on Ctenopharyngodon idellus, Ali (2005) on Tilapia zilli, Hussein (2010) on Mugil cephalus and Taha (2010) on Hypophthalmichthys molitrix have presented detailed works on the morphology of the cranial nerves.

It is quite evident from the above historical review that there are numerous works on the cranial nerves of fishes, but few studies has been made concerning the cranial nerves of species belonging to mugillid fishes which is an interesting group among teleosts. Thus it was suggested that a detailed microscopic study on the facial nerve in Liza ramada belonging to family Mugillidae will be very useful.

The main and fine branches of these cranial nerves, their distribution, their relations with other nerves and with the other structures of the head, their analysis and the organs they innervate are studied thoroughly, hoping that they may add some knowledge on this important subject and also to the behavior and phylogeny of this group of fishes.

MATERIALS AND METHODS

The thinlip mullet is found in the eastern Atlantic Ocean from Cape Verde and Senegal North to the Baltic Sea. It is also found in the Mediterranean Sea and Black Sea.

The fully formed larvae were collected from fish farm in Kafr El-Sheikh Governorate, Egypt. The heads of the fully formed larvae were separated and fixed in aqueous Bouin's solution for 24 hours. This was followed by several washing with 70% ethyl alcohol for 3-4 days to get rid of excess Bouin's solution and its yellow colour from the specimens. Decalcification of bones was necessary before sectioning and staining the specimens, this was carried out by placing the heads in EDTA solution for about 40 days with changing the solution every 4 days. Thereafter, the embryonic heads were washed several times with 70% ethyl alcohol.

The heads were made ready for blocking and this was followed by sectioning the heads transversely at 10 micron in thickness by the microtome. The serial sections were stained in Mallory triple stain. The serial sections were drawn by the aid of a projector microscope. From these drawings an accurate graphic reconstruction for the nervus facialis was made in a lateral view. In order to avoid confusion of lines, few rami were slightly displaced from their normal position. Also, parts of certain sections were photomicrographed to demonstrate the relation of the nerves with other cranial structures.

RESULTS

In this study, the nervus facialis arises from the mid-lateral side of the medulla oblongata by one root just anterior to the origin of the anterior lateral line nerve (Figs. 1 & 2, RO.VII). Shortly anterior, to its origin, this nerve runs laterally passing ventral to the anterodorsal lateral line nerve and dorsal to the anteroventral lateral line nerve and medial to the utricle of the membranous labyrinth. The nervus facialis continues forwards resting on the medial surface of the utricle for a considerable distance, where it anastomoses with the anteroventral lateral line nerve, forming a common nerve (Fig. 1, CO.N).

Anterior to this anastomosis, the common nerve continues passing dorsomedial to the utricle, ventromedial to the anterodorsal lateral line nerve, and lateral to the brain. This nerve separates again into two divisions one dorsal to the other. The dorsal division represents the ramus palatinus (Fig. 1, R.PA) and the ventral one; the commont trunk (Fig. 1, CO.T) which constitutes the truncus hyomandibularis facialis and the anteroventral lateral line nerve.

Ramus Palatinus

After its separation, the ramus palatines (Fig. 1, R.P) runs anteriorly within the cranial cavity passing medial to the utricle, ventromedial to the anterodorsal lateral line nerve, lateral to the origin of the nervus trigeminus from the mylencephalon, and dorsal to the ventral division (anteroventral lateral line nerve and truncus hyomandibularis).

Shortly afterthat, the ramus palatinus enters the geniculate ganglion. This ganglion (Figs. 1& 3, G.GE) is irregular in shape and lies intracranially in a position surrounded medially by the brain (B), the nervus trigeminus (N.V) dorsally, the anterodorsal lateral line nerve (N.ADLL) dorsolaterally and the common trunk (CO.T) (anteroventral lateral line nerve and truncus hyomandibularis) ventrolaterally. It is connected with the common trunk through two branches (Fig. 1, Rr.CM.G.GE+CO.T). From the ventral side of the anterior part of the geniculate ganglion arise two branches one medial and the other lateral. The medial branch represents the ramus palatinus anterior (Fig. 1, R.PA) and the lateral one constitutes the posterior palatine ramus (Fig. 1, R.PP).

Ramus Palatinus Anterior

The ramus palatinus anterior (Figs. 1 & 3, R.PA) arises from the ventral side of the anterior part of the geniculate ganglion and medial to the origin of the ramus palatinus posterior from the ganglion, as previously mentioned. Immediately after its origin from the ganglion, the ramus palatinus receives a branch from the cranial sympathetic nerve (Fig. 1, R.CM.PA+N.SY). Anterior to this connection, the ramus palatinus runs anteroventrally in a medial direction passing ventromedial to both the geniculate ganglion and the facial foramen, ventral to the brain, dorsal to the sphenotic bone, and dorsolateral to the posterior myodome. Shortly anterior, it leaves the cranial cavity and enters the posterior myodome from its dorsolateral corner (Fig. 4).

Within the myodome, the ramus palatinus anterior runs anteromedially passing ventrolateral to the rectus lateralis muscle and dorsomedial to the prootic bone. More forwards within the myodome, this ramus continues passing ventromedial to the rectus lateralis muscle and dorsomedial to the lateral bone. The ramus palatinus leaves the myodome through a large anterolateral gap together with the rectus lateralis muscle in the anterior part of the prootic region of the head. In this site, it runs forwards passing ventromedial to the latter muscle, dorsomedial and dorsal to the adductor hyomandibularis muscle, medial to the pseudobranch artery, and lateral to both the rectus superior muscle and the parasphenoid bone. More forwards, it runs ventral to the latter artery and dorsal to the adductor hyomandibularis muscle (Fig. 5, R.PA).

By reaching the orbital region, the ramus palatinus anterior (Fig. 1, R.PA) runs anteriorly passing dorsal to the adductor hyomandibularis muscle and ventral to both the rectus inferior muscle and the nerve of the obliquus inferior muscle, and ventrolateral to the rectus medialis muscle. More forwards, it continues passing dorsal to the adductor arcus palatini muscle, ventromedial to the rectus inferior muscle, ventral to the rectus medialis muscle, and ventrolateral to the nerve of the obliquus inferior muscle. Thereafter, it shifts medially to continue dorsal to the adductor arcus palatine muscle, dorsolateral to the parasphenoid bone, and ventromedial to the rectus medialis muscle. The two rami palatine anterio of the opposite side extend side by side along the mid-line passing dorsal to the parasphenoid bone, ventral to the nerve of the obliquus inferior muscle and ventromedial to the rectus medialis muscle, where it gives off a ventrolateral branch. This branch extends forwards passing lateral to the parasphenoid bone and dorsal to the adductor arcs palatini muscle. This branch extends anteriorly to penetrate the latter muscle and ramifies and ends in the palatal epithelium and the oral taste buds of this region (Fig. 1, N.PEP+TB).

Anterior to the origin of this branch, the ramus palatinus continues passing side by side along the middle line ventral to the nerve of the obliquus inferior muscle, dorsal to the parasphenoid bone, and medial to the rectus medialis muscle. After a long anterior course in this position, the ramus palatinus gives off a ventral branch to the palatal epithelium and the oral taste buds in the orbital region (Fig. 1, N.PEP+TB). More forwards in the orbital region, the ramus palatinus continues passing lateral to the trabecula commonis; dorsolateral to the parasphenoid bone, and ventromedial to the nerve of the obliquus inferior muscle, where it gives off a ventrolateral branch. This branch (Fig. 1) runs anterolaterally and penetrates the adductor arcus palatini muscle to ramify and end in the palatal epithelium and taste buds ventral to the anterior part of the latter muscle (Fig. 1, Nn.PEP+TB).

Anterior to the origin of the previous branch, the main ramus palatinus anterior (Fig. 1, R.PA) continues anterior ventrolaterally extending ventrolateral to the trabecula communis, dorsolateral to the adductor arcus palatini muscle, and ventromedial to the obliquus inferior muscle. Thereafter, it runs forwards passing ventral to the trabecula communis and dorsal to the most anterior end of the adductor arcus palatini muscle, where it gives off a lateral branch (Fig. 1). This branch extends anterolaterally in a ventral direction passing lateral to the latter muscle and medial to the lamina orbitonasalis. Thereafter, it shifts posteriorly passing dorsal to the anterior end of the adductor arcus palatini muscle and ventromedial to the lamina orbitonasalis, and dorsal to the palatal epithelium. In this site, it divides into two nerves one lateral to the other. Both nerves run posteriorly and branch to innervate the palatal epithelium and the oral taste buds on the anterior orbital region (Fig. 1, N.PEP).

The ramus palatinus anterior runs more forwards passing through the orbitonasal region extending ventral to the ethmoidal plate and dorsomedial to the palatoqudrate cartilage, where it gives off a lateral branch. This branch extends posterolaterally passing ventral to the palatoquadrate cartilage for a considerable course. After this posterior course, this branch ends in the palatal epithelium and the oral taste buds (Fig. 1, N.PEP+TB).

More forwards, the ramus palatinus anterior enters the olfactory “ethmoidal” region of the head. This ramus continues anteriorly passing ventrolateral to the ethmoidal plate and the internasal septum, where it gives off a fine nerve to the mucous epithelium of the roof of the mouth. Shortly anterior, it gives off a second medial branch to the palatal epithelium ventral to the ethmoidal palate and near the mid-dorsal line (Fig. 1, Nn.PEP+TB).

Thereafter, the ramus palatinus anterior (Fig. 1, R.PA) continues anteriorly passing ventral to the palatine bone. More forwards, it continues passing medial to the latter bone and ventral to the ethmoidal bone. Thereafter, the ramus penetrates the palatine bone laterally. Lateral to the latter bone, the ramus palatinus runs forwards passing dorsal to the palatal epithelium, and ventromedial to both the ramus maxillaris of the nervus trigeminus and the lacrimal nasal sac. Shortly anterior, the ramus palatinus continues passing lateral to the vomer bone and medial to the ramus maxillaris. During this course, it gives off four branches to the palatal epithelium and the oral taste buds (Fig. 1, Nn.PEP+TB). More forwards, this ramus continues passing dorsomedial, dorsal and then lateral to the maxillary ramus of the nervus trigeminus and ventral to the maxillary bone. At the end of this course, it joins the ramus maxillaris forming a common trunk (Fig. 1, CO.T). The anterior extention of this nerve was described previously with nervus trigeminus.

Ramus Palatinus Posterior

Immediatlely after its origin from the geniculate ganglion, the ramus palatinus posterior (Figs. 1 & 3, R.PP) run ventrally to leave the cranial cavity through the facial foramen. During its exit, it passes medial to the common nerve (truncus hyomandibularis and the anteroventral lateral line nerve). Extracranially, this ramus extends anteromedially running dorsal to the pseudobranch and ventral to the sphenotic bone. After a long anterior course, this ramus penetrates the adductor hyomandibularis muscle to pass on the dorsal surface of the pseudobranch. By reaching the anterior end of the pseudobranch, it shiftes ventrally and posteriorly within the latter muscle. Shortly anterior to the opening of the pseudobranch into the pharynx, this ramus gives off many neumerous nerves to the pseudobranch (Fig. 1, Nn.PSB). Immediately after that, it passes ventromedialy to reach the pharyngeal mucosa. By reaching the latter mucosa, the ramus palatinus posterior (Fig. 1, R.PP) extends forwards towards the mid line where it branches to innervate the mucous epithelium of the pharyngel roof and pharyngeal taste buds ventral to the posterior part of the adductor hyomandibularis muscle (Fig. 1, Nn.PHE+TB). More forwards, the posterior palatinus ramus continues giving of numerous fibres to the mucous epithelium and the oral taste buds along side the length of the orbital region (Fig. 1, Nn.PHE+TB).

Truncus Hyomandibularis

As previously mentioned, the nervus facialis anastomoses with the anteroventral lateral line nerve forming a common nerve. This nerve passes for a short anterior distance and then separates into the ramus palatinus dorsally and the truncus hyomandibularis and the anteroventral lateral line nerve, as a common trunk, ventrally (Figs. 1 & 6, CO.T).

The common trunk (truncus hyomandibularis and the anteroventral lateral line nerve) (Fig. 1, CO.T) extends forwards resting on the medial surface of the utricle. It runs medial to the utricle, ventral to both the ramus palatinus and the anterodorsal lateral line nerve, lateral to the medulla oblongata, and dorsomedial to the nervus octavus. Shortly anterior, it enters a small ganglion on its ventral side. This ganglion represents the anteroventral lateral line nerve ganglion (Figs. 1 & 6, G.AVLL). It lies within the cranial cavity, being ventromedial to both the utricle and the ramus ampullaris anterior of nervus octavus, lateral to the brain and ventral to the ramus palatinus. From its anterior end, the common trunk arises.

Shortly anterior, the trunk receives a stout branch from the octaval nerve (Figs. 1, 2 & 6, R.CM.CO.T+VIII). Thereafter, the common trunk continues forwards passing ventral to the geniculate ganglion, lateral to the brain and ventromedial to the ampulla of the horizontal semicircular canal. Thereafter, the common trunk leaves the cranial cavity through a large facial foramen together with the ramus palatinus posterior. This foramen (Fig. 3, F.FA) is found in the pleurosphenoid bone just ventromedial to the vena capitis lateralis. During its exit through the facial foramen, it receives two branches from the geniculate ganglion and one branch from the cranial sympathetic facial ganglion.

Extracranially, the common trunk extends posterolaterally passing dorsolateral to the pseudobranch and ventral to the vena capitiles lateralis. In this site, it gives off a motor branch to the adductor hyomandibularis muscle (Fig. 1, N.AHY). This branch represents the ramus operculais facialis.

Shortly posterior, the common trunk shifts ventrally passing lateral to the pseudobranch and medial to the symplectic bone of the hyosymplectic cartilage of the hyoid arch, where it gives off an anastomosing branch. This branch runs forwards to anastomose with maxillomandibular ganglion of the nervus trigeminus. Shortly posterior, the common trunk drops ventrally to enter the operculum and then changes its course anteriorly, where it gives off three branches; dorsal, middle and ventral (Fig. 1).

The dorsal branch extends posterolaterally passing through the hyosymplectic bone of the hyomandibular cartilage and then shifts anterolaterally giving a dorsal nerve which ends in the sixth neuromast of the opercular lateral line canal (Fig. 1, N.ONU.6). The main branch runs posteriorly reaching the origin of the opercular lateral line canal from the main lateral line canal, where it gives off a medial nerve. This nerve runs posterodorsally to end in the skin and its taste buds on the upper posterior part of the operculum (Fig. 1, N.CU+TB). The main branch then branches giving off a dorsolateral branch to the skin and the cutaneous taste buds. More posteriorly, it divides giving off two lateral branches to the skin and cutaneous taste bud. Finally this branch ends as many nerve twinges in the skin and the cutaneous taste buds on the middle and the ventral parts of the operculum (Fig. 1, N.CU+TB).

The middle branch runs posteroventrally to enter the subopercular bone. It runs inside this bone posteroventrally to end in the fifth neuromast of the opercular lateral line canal (Fig. 1, N.ONU.5).

The ventral branch originates from the ventrolateral side of the common trunk just at its droping into the operculum and shortly posterior to the division of the common trunk into the ramus hyoideus and the ramus mandibularis facialis (Fig. 1). The ventral branch extends posteroventrally to penetrate the subopercular bone. After a short posterior course within this bone it ends in the fourth neuromast of the opercular lateral line canal (Fig. 1, N.ONU.4).

Anterior to the origin of these three branches from the common trunk, the latter divides into two main rami; a ventral ramus hyoideus (Figs. 1 & 7, R.HY) and a dorsal ramus mandibularis facilais (Figs. 1 & 7, R.MD.VII); both of these ramus carry fibres to the anteroventral lateral line nerve.

Ramus Hyoideus

Directly after its separation from the ventral division, the ramus hyoideus (Figs. 1 & 7, R.HY) extends posteroventrally inside the operculum, passing medial to the subopercular bone, dorsal to the interopercular bone and lateral to the branchial chamber. More backwards, and being medial to the interopercular bone, ventral to the opercular chamber and dorsolateral to the superior hyoideus muscle, it continues its course anteriorly, where it gives off two posterior branches one dorsal and the other ventral (Fig. 1).

The dorsal branch extends posteriorly passing medial to the subopercular bone, ventrolateral to the opercular chamber, and dorsolateral to the superior hyoideus muscle, where it gives off a ventral motor nerve to the latter muscle (Fig. 1, N.SH). Thereafter, this branch continues backwards giving off two fine nerves to the wall of the branchial chamber (Fig. 1, Nn.BC). More backwards it gives off a branch to the inferior hyoideus muscle (Fig. 1, N.IH). It also gives off a branch for the branchiostegal membrane (Fig. 1, N.BSM). Thereafter, the posterior branch divides into dorsal and ventral nerves. The dorsal nerve ends in the wall of the branchial chamber at the branchiostagal membrane (Fig. 1, N.BC). The ventral nerve runs backwards in a ventromedial direction and ends in the branchiostegal membrane (Fig. 1, N.BSM).

The main ramus hyoideus then continues its course anteriorly passing dorsomedial to the hyoideus superior muscle and ventrolateral to the branchial chamber. Then, it gives off two ventral branches; one enters the hyoideus superior (Fig. 1, N.SH) and the second enters the hyoideus inferior muscle (Fig. 1, N.IH), where they both end in these muscles. Thereafter, the ramus hyoidous continues passing medial to the hyoideus superior muscle, ventrolateral to the branchial chamber, and dorsolateral to the hyoideus inferior muscle, where it gives off a ventral motor branch to the latter muscle (Fig. 1, N.IH). Moer forwards, the ramus hyoideus gives off a ventral branch to the inferior hyoideus muscle (Fig. 1, N.IH). Shortly anterior, it gives off another branch to the latter muscle (Fig. 1, N.IH). After that, the ramus hyoideus continues anteroventrally within the operculum passing ventrolateral to the inferior hyoideus muscle, ventromedial to the preopercular bone, and dorsal to the superior hyoideus muscle, where it gives off a third motor nerve to the inferior hyoideus muscle (Fig. 1, N.IH). More forwards, it gives off a larg branch to the branchiostegal membrane (Fig. 1, N.BSM). Thereafter, the ramus hyoideus extends forwards passing ventral to the inferior hyoideus, dorsal to the superior hyoideus muscles, and medial to the preopercular bone, where it enters the branchiostegal membrane giving off a large branch to this membrane (Fig. 1, N.BSM). More and more forwards, it gives off a fine branch to the inferior hyoideus muscle. Finally, the ramus hyoideus ramifies giving off a motor nerve to the latter muscle (Fig. 1, Nn.IH), the other nerves pass into the branchiostegal membrane (Fig. 1, Nn.BSM) and the interhyoideus muscle (Fig. 1, Nn.ITH).

Ramus Mandibularis Facialis

Anterior to its separation from the common trunk, the ramus mandibularis facialis (Figs. 1 & 7, R.MD.VII) runs forwards passing medial to the adductor mandibularis posterior muscle, lateral to the branchial chamber, and ventral to the dilator operculais muscle. Thereafter, it continues passing medial to the adductor mandibularis muscle and lateral to the hyomandibular cartilage, where it gives off a medial branch. This branch (Fig. 1) runs anteriorly passing lateral to the pterygoid bone and medial to the adductor mandibularis muscle for along anterior course. At the end of this course, this branch penetrates the pterygoid bone to continue forwards passing medial to it and lateral to the pharyngeal mucosa. Then, it gives off two successive nerves to the lateral mucosa of the pharynx (Fig. 1, Nn.PEP). Thereafter, it fuses again with the main ramus mandibular facialis.

Shortly anterior to the origin of the previous branch, the main ramus mandibularis gives off a ventral branch. This branch passes ventral between the hyomandibular cartilage medially and the subopercular bone laterally. Thereafter, this branch shifts posteriorly passing medial to the latter bone, ventral to the hyomandibular cartilage, and dorsolateral to both the interopercular and preopercular bones. After a short posterior course, it enters a canal within the subopercular bone. After a long posterior course within this bone, it ends in the third neuromast of the opercular lateral line canal (Fig. 1, N.ONU.3).

Anterior to the origin of the previous lateralis branch, the ramus mandibularis continues forwards passing medial and ventral to the adductor mandibularis posterior muscle and lateral to the hyomandibular cartilage, where it gives off two successive branches which fuse together into one nerve. This nerve penetrates the subopercular bone and continues its course posteriorly within the latter bone giving a branch to the skin and then ends in the second neuromast of the opercular lateral line canal (Fig. 1, N.ONU.2).

Lateral to the origin of the last branch, the main ramus mandibularis gives off another ventral one (Fig. 1, N.CU). The latter branch runs anteriorly passing ventrolateral to the ramus mandibularis facialis and medial to the adductor mandibularis medius muscle. Thereafter, it continues passing medial, ventral and lateral to the adductor mandibularis muscles. Then it gives off a cutaneous branch to the ventrolateral skin covering the latter muscles. Shortly forwards, it gives off another cutaneous branch to the skin ventral to the subopercular interopercular bone. The main branch continues forwards giving off many fine cutaneous nerves to the skin ventral and lateral to the latter bones.

Anterior to the origin of the last described branch, the main ramus mandibularis facialis continues passing lateral to the pterygoid bone and ventral and medial to the adductor mandibularis muscle. Thereafter, it passes anteromedially extending ventral to the pterygoid bone and dorsal to the subopercular bone. More forwards, it extends medial to the pterygoid bone and dorsal to the subopercular bone, where it gives off a lateralis branch. This branch runs anteroventrally passing inside the subopercular bone till it ends in the first neuromast of the opercular lateral line canal (Fig. 1, N.ONU.1).

More forwards, the main ramus mandibularis facilais continues in the same position and dorsal to the anterior end of the subopercular bone. Thereafter, it becomes dorsolateral to the latter bone and medial to Meckel's cartilage, where it gives off two successive branches. The first branch runs anteroventrally passing ventral to the palatoquadrate, and dorsolateral to the mandibular lateral line canal. Then, it gives off a fine nerve that ends in the skin and taste buds lateral and ventral to the mandibular lateral line canal (Fig. 1, N.CU+TB). The main branch then fuses with the second one. The second branch runs anteroventrally passing lateral to the preopercular bone and medial to the mandibular lateral line canal (Fig. 1), where it gives a fine nerve that ends in the skin and taste buds medial to the latter canal (Fig. 1, N.CU+TB).The medial branch gives off a posterior branch. This branch extends posteriorly passing dorsomedial to the preopercular bone, where it branches and ends in the skin and taste buds ventromedial to the preopercular bone (Fig. 1, N.CU+TB). The main second branch then fuses with the first one forming a common branch. This common branch runs anterolaterally passing lateral to the mandibular canal and ventral to the palatoqudrate bone. Thereafter, it continues forwards passing lateral to the dentary bone giving a small cutaneous nerve to the skin. Anterior to this sit, the common branch receives a branch from the ramus mandibularis trigeminus. This resulted nerve was described previously with the nervus trigeminus (Fig. 1, R.CM.MD.VII+MD.V).

Anterior to the origin of these branches, the main ramus mandibularis facialis continues forwards passing dorsomedial to Meckel's cartilage, dorsolateral to the preopercular bone, and lateral to the buccal mucosa. Thereafter, it continues forwards passing dorsal and medial to the palatoqudrate bone and lateral to the oral mucosa, where it receives its own branch arising previously from it (Fig. 1). Anterior to this anastomosis, the ramus mandibularis facialis extends ventrolateral to the adductor mandibularis anterior muscle and dorsal to the maxillary bone, where it separates again from its own branch. More forwards, the ramus mandibularis facilais runs ventral and lateral to the adductor mandibularis anterior muscle, dorsal to the dentary bone, and medial to the maxillary bone, where it gives off a large ventral branch. This branch (Fig. 1) gives off a lateral branch to the fifth neuromast of the mandibular lateral line canal (Fig. 1, N.MDNU.5). The ventral branch runs forwards passing dorsal to the dentary bone and ventral to the main ramus mandibularis facilais. After an anterior course, this branch enters the mandibular lateral line canal through a foramen in the dentary bone. Then, it runs forwards within this canal passing dorsal to it. After a long anterior course in this position, this branch ends in the neuromast of the fourth mandibular lateral line canal (Fig. 1, N.MDNU.4).

Shortly anterior to the origin of the main ventral branch from the ramus mandibularis facialis; the latter gives off a small ventral branch. This branch extends posteroventrally, passing medial to the dentary bone to branch and end in the skin and cutaneous taste buds on the ventral side of the dentary bone (Fig. 1, N.CU+TB).

The main ramus mandibularis facialis continues forwards giving a fine anastomosing branch which joins the ramus mandibularis externus of the nervus trigeminus (Fig. 1, R.CM.MD.V+MD.VII). Thereafter, it runs passing dorsal to the dentary bone and medial to Meckel's cartilage. More forwards it becomes ventromedial to Meckel's cartilage and dorsal to the dentary bone, where it receives and fuses with the ramus mandibularis externus of the nervus trigeminus forming a common nerve (Fig. 1, CO.N).

The anterior distribution of the fibres of the common nerve was described previously with the nervus trigeminus.

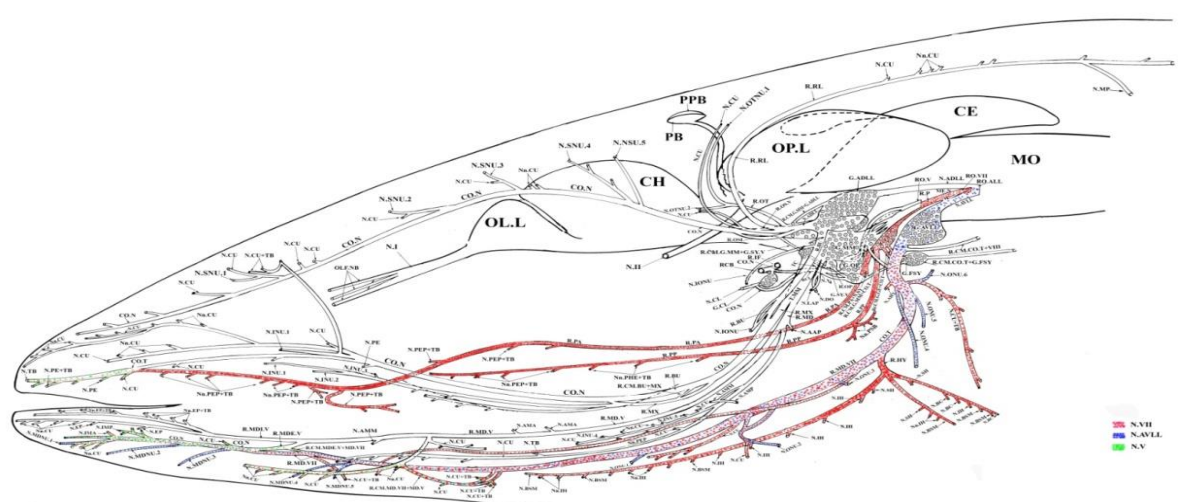

Fig.1

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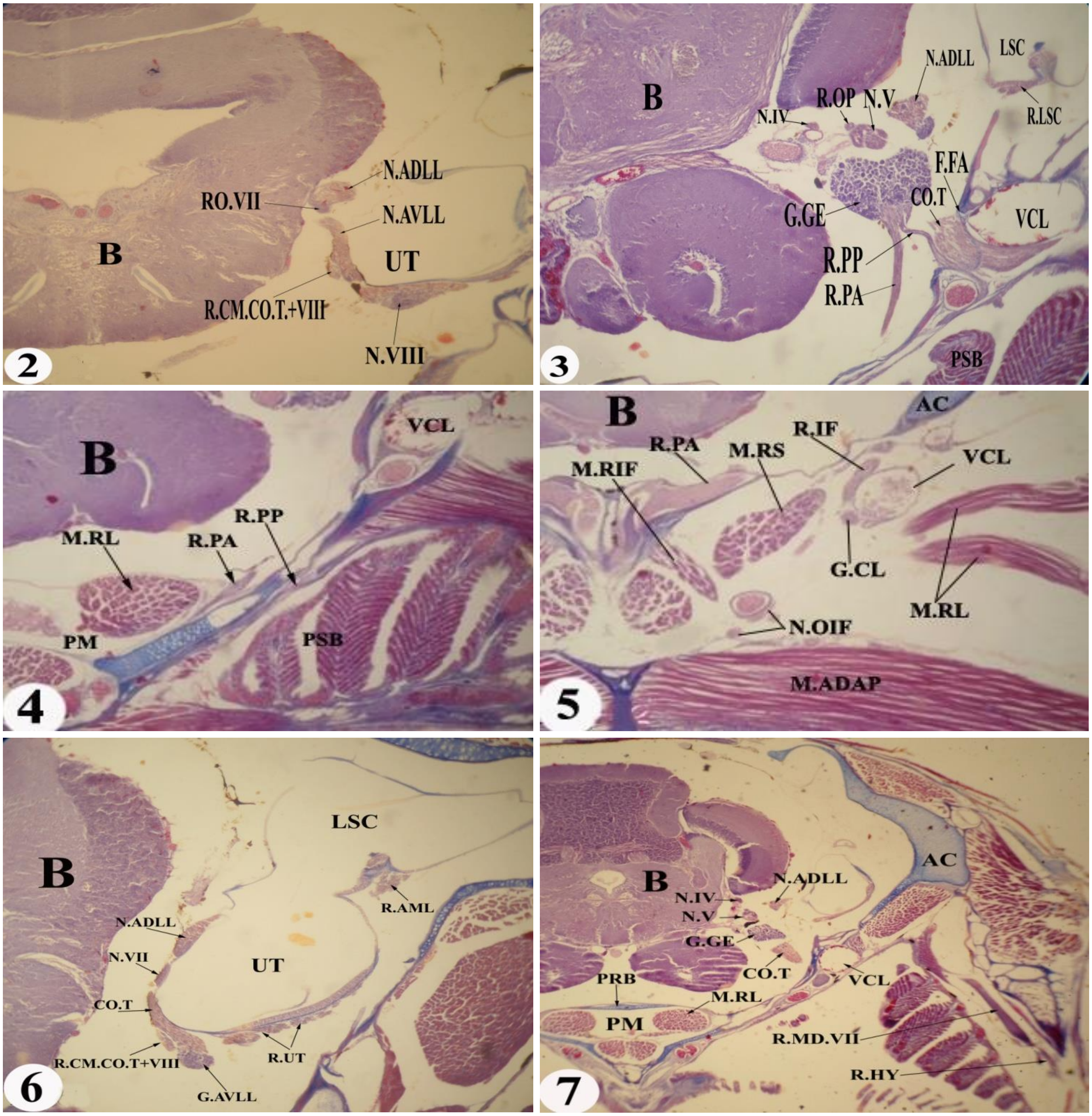

LIST OF ABBREVIATIONS

AC: Auditory capsule. **B**: Brain. **CO.N**: Common nerve. **CO.T**: Common trunk. **F.FA** : Facial foramen. **G.ADLL**: Anterodorsal lateral line ganglion. **G.AVLL** : Anteroventral lateral line ganglion. **G.CL**: Ciliary ganglion. **G.FSY**: Facial sympathatic ganglion. **G.GE** Geniculate ganglion. **G.MM**: Maxillomandibular ganglion. **G.OP**: Profundal ganglion. **G.SY.V**: Trigeminal sympathatic ganglion. **LSC**: Lateral semicircular canal. **M.ADAP** : Adductor arcus palatine muscle. **M.RIF**: Rectus inferior muscle. **M.RL**: Rectus lateralis muscle. **M.RS**: Rectus superior muscle. **MO**: Medulla oblongata. **N.ADLL**: Anterodorsal lateral line nerve. **N.ALL**: Anterior lateral line nerve. **N.AHY**: Nerve to the adductor hyomandibularis muscle. **N.AVLL**: Anteroventral lateral line nerve. **N.BC**: Nerve to the branchial chamber. **N.BSM**: Nerve to the branchiostagal membrane. **N.CU**: Cutaneous nerve. **N.CU+TB**: Cutaneous and taste buds nerve. **N.IH**: Nerve to the inferior hyoideus muscle. **N.IMA**: Nerve to the nerve for anterior intermandibualris muscle. **N.IMP**: Nerve to the posterior intermandibular muscle. **N.IV**: Nervus trochlearis.

N.MDNU.1: Nerve to the first neuromast of the mandibular lateral line canal. **N.MDNU.2**: Nerve to the second neuromast of the mandibular lateral line canal. **N.MDNU.3**: Nerve to the third neuromast of the mandibular lateral line canal. **N.MDNU.4**: Nerve to the fourth neuromast of the mandibular lateral line canal. **N.MDNU.5**: Nerve to the fifth neuromast of the mandibular lateral line canal. **N.OIF**: Nerve to the obliquues inferior muscle. **N.ONU.1**: Nerve to the first neuromast of the opercular lateral line canal. **N.ONU.2** : Nerve to the second neuromast of the opercular lateral line canal. **N.ONU.3** : Nerve to the third neuromast of the opercular lateral line canal. **N.ONU.4** : Nerve to the fourth neuromast of the opercular lateral line canal. **N.ONU.5** : Nerve to the fifth neuromast of the opercular lateral line canal. **N.ONU.6** : Nerve to the sixth neuromast of the opercular lateral line canal. **N.PE**: Palatal epithelium nerve. **N.PEP**: Nervus to the palatal epithelium. **N.PEP+TE**: Nervus to the palatal epithelium and epithelium teeth. **N.PEP+TB**: Nervus to the palatal epithelium and oral taste buds. **N.SH**: Nerve to the superior hyoideus muscle. **N.TB**: Nervus to the teste buds. **N.V**: Nervus trigeminus. **N.VII**: Nervus facialis. **N.VIII**: Nervus octavus. **Nn.CU**: Nerves to skin. **Nn.EP+TB**: Nerves to the epithelium and the oral taste buds. **Nn.IH**: Nerves to the inferior hyoideus muscle. **Nn.PEP+TB**: Nerves to the palatal epithelium and the oral taste buds. **Nn.PHE+TB**: Nerves to the Pharyngeal epithelium and the oral taste buds. **Nn.PSB**: Nerves to the neumerous nerves pseudobranch. **PM**: Posterior myodome. **PRB**: Prootic bridge. **PSB**: Pseudobranch. **R.AMA**: Ramus ampularis anterior. **R.BU**: Ramus buccalis. **R.CM.CO.T+ G.FSY**: Ramus communicans between common trunk+facial stmpathetic ganlgiom. **R.CM.CO.T+ VIII**: Ramus communicans between common trunk + nervus octavus. **R.CM. G.MM+ CO.T**: Ramus communicans between maxillomandibular ganglion+ common trunk. **R.CM.MD.V+MD.VII**: Ramus communicans between ramus mandibularis trigeminus and ramus mandibularis facialis. **R.CM.MDE.V+MD.VII**: Ramus communicans between ramus mandibularis externus trigeminus and ramus mandibularis facialis. **R.CM. PA+ CO.T**: Ramus communicans between maxillomandibular ganglion+ cranial sympathetic nerve. **R.HY**: Ramus hyoideus. **R.LSC**: Lateral semicircular canal ramus. **R.MD**: Ramus mandibularis trigeminus. **R.MD.V**: Ramus mandibularis trigeminus. **R.MD.VII**: Ramus mandibularis facialis. **R.MDE.V**: Ramus mandibularis externus trigeminus. **R.MDI.V**: Ramus mandibularis internus trigeminus. **R.MX**: Ramus maxillaries. **R.OP**: Ramus ophthalmic profundus. **R.P**: Ramus palatines. **R.PA**: Ramus palatinus anterior. **R.PP**: Ramus palatinus posterior **R.UT**: Ramus utriculus **RO.ALL**: Root of the anterior lateral line nerve. **RO.V**: Root of the nervus trigeminus **RO.VII**: Root of the nervus facialis **Rr.CM. G.GE+ CO.T**: Rami communicans between geniculate ganglion+ common trunk. **UT**: Utriculus. **VCL**: Vena capitis lateralis.

EXPLANATION OF FIGURES

Fig.1: Lateral view of a graphic reconstruction of the facial, trigeminal and lateral line nerves of *Liza ramada*.

Fig.2: A photomicrograph of part of transverse section passing through the postorbital region of *Liza ramada* showing the root of nervus facialis, the anterior dorsal lateral line nerve, the anterior ventral lateral line nerve, the nervus octavus and the ramus communicans between the common trunk and the octaval nerve.

Fig.3: A photomicrograph of part of transverse section passing through the otic region of *Liza ramada* showing the geniculate ganglion, the anterior palatine ramus, the posterior palatine ramus, the facial foramen, the anterodorsal lateral line nerve, nervus trigeminus and the common trunk.

Fig.4: A photomicrograph of part of transverse section passing through the anterior otic region of *Liza ramada* showing the anterior palatine ramus and the posterior palatine ramus.

Fig.5: A photomicrograph of part of transverse section passing through the postorbital region of *Liza ramada* illustrating the anterior palatine ramus, the ciliary ganglion, ramus superior and ramus inferior.

Fig.6: A photomicrograph of part of transverse section passing through the postorbital region of *Liza ramada* showing the nervus facialis, the anterior dorsal lateral line nerve, the ganglion of anterior ventral lateral line nerve and the ramus communicans between the common trunk and the octaval nerve.

Fig.7: A photomicrograph of part of transverse section passing through the anterior otic region of *Liza ramada* showing the geniculate ganglion, the anterodorsal lateral line nerve, the nervus trigeminus, the common trunk, the ramus hyodius, the ramus mandibularis facialis and the auditory capsule.

DISCUSSION

The present study reveals that the nervus facialis originates from the medulla oblongata separated from the anterior lateral line nerve.This condition was reported by some authors such as Song and Northcutt (1991) in *Lepisostus platyrhincus*, New and Singh (1993) in *Letalurus punctatus*, Piotrowski and Northcutt (1996) in *Polypterus senegalus*, Dakrory (2000) in *Ctenopharyngodon idellus*, Taha (2010) in *Hypophthalmichthys molitrix*, Hussien (2010) *in Mugil cephalus and* Mattar (2012) in *Gambusia affinis affinis*. However, the exit of the nervus facialis together with the anterior lateral line nerve appears to be a common character in fishes (El-Toubi and Abdel-Aziz, 1955; Bhargava, 1959; Ali, 2005).

In the mugillid fish, *Liza ramada* the nervus facialis originates by a single root. This condition was found also in *Mastacembelus armatus* (Bhargava, 1959), *Ctenopharyngodon idellus* (Dakrory, 2000), *Hypophthalmichthys molitrix* (Taha, 2010), *Mugil cephalus* (Hussien, 2010) and in *Gambusia affinis affinis* (Mattar, 2012). However, in most bony fishes, the number of the facial roots is variable; two facial roots were recorded in *Tetrodon oblongus* (Bal, 1937). Also, El-Toubi and Abdel-Aziz (1955) reported that there are two facial roots in *Polypterus senegalus* and the posterior one arises in contact with the root of the auditory nerve. However, the nervus facialis has four roots in *Scorpaena scrofa* (Allis, 1909) and in *Polycentrus schomburgkii* (Freihofer, 1978).

Among cartilaginous fishes, the nervus facialis arises by either one root as mentioned by Dakrory (2000) in *Rhinobatus halavi* or by two independent roots as reported by Mazhar (1979) in *Pteroplatea altavela*.

Regarding Agnatha, Kuratani *et al*., (1997) stated that in *Lampetra japonica*, the facial nerve originates by a single root. However, in *Myxine glutinosa* and *Eptatretus stoutii*, Braun (1998) mentioned that the nervus facialis arises by single root this root originates from the brain between the anterior and the posterior octaval roots.

In amphibians, some authors reported that the nervus facialis arises in conjunction with the nervus acousticus by a common stout root in *Bufo viridis* (Soliman and Mostafa, 1984b), *Bufo regularis* (Shaheen, 1987) and *Ascaphus truei* (Reiss, 1997).

In the present investigation, the geniculate ganglion of the nervus facialis lies intracranially. This condition was also found in *Polycentrus schomburgkii* (Freihofer, 1978), *Ctenopharyngodon idellus* (Dakrory, 2000), *Tilapia zillii* (Ali, 2005), *Mugil cephalus* (Hussein, 2010), *Hypophthalmichthys molitrix* (Taha, 2010) and in *Gambusia affinis affinis* (Mattar, 2012). On the other hand, an extracranially located geniculate ganglion was described by Allis (1909) in *Scorpaena scrofa*, El-Toubi and Abdel-Aziz (1955) in *Polypterus senegalus* and Bhargava (1959) in *Mastacembelus armatus*. Ray (1950) reported that in *Lampanyctus leucopsarus* there are two extracranial facial ganglia; a geniculate ganglion and an anterior facial ganglion. In *Polypterus senegalus*, Piotrowski and Northcutt (1996) described an extracranial ganglion which is continuous caudally with the anteroventral lateral line ganglion.

With respect to the cartilaginous fishes, the geniculate ganglion is located extracranially as reported by Dakrory (2000) in *Rhinobatus halavi*. Many authors (Hamdy and Hassan, 1973; Khalil, 1979b; El-Satti, 1982; Dakrory, 2000) reported that in *Torpedo ocellata*, *Trygon pastinaca*, *Selachii* and *Rhinobatus halavi*, respectively, the proximal part of the geniculate ganglion together with the trigeminal and acoustic ganglia lie in a fossa found in the medial wall of the cranium, called acoustico-trigemino-facialis recess. This recess was found to be absent in *Rhinoptera bonasus* (Hamdy, 1960) and *Rhinoptera jayakari* and *Squatina oculata (*El-Satti, 1982).

The present study shows that the geniculate ganglion is separated from the ganglion of the anteroventral lateral line nerve but it receives the anteroventral lateral line nerve during its exit from its ganglion. The same is mentioned in *Gambusia affinis affinis* (Mattar, 2012). In this respect, the geniculate ganglion contains ganglionic cells of the anteroventral lateral line nerve in *Ctenopharyngodon idellus* (Dakrory, 2000) and in *Hypophthalmichthys molitrix* (Taha, 2010). However, in *Tilapia zillii* (Ali, 2005) the geniculate ganglion is partially fused with the ganglion of the anteroventral lateral line nerve and is separated from the Gasserian ganglion of the trigeminal nerve. Piotrowski and Northcutt (1996) reported that in *Polypterus senegalus*, the geniculate ganglion is continuous caudally with the ganglion of the anteroventral lateral line nerve.

Among cartilaginous fishes, the geniculate ganglion was separated completely from the ganglia of the anterior and posterior lateral line nerves as reported by Norris and Hughes (1920) in *Squalus acanthias,* McCready and Boord (1976) in *Mustelus canis* and Puzdrowski and Leonard (1993) in *Dasyatis Sabina*. However, in *Rhinobatus halavi*, Dakrory (2000) stated that the geniculate ganglion is continuous for a very short distance with the ganglion of anteroventral lateral line nerve.

In jawless fishes, separate facial and trigeminal ganglia are present in *Lampetra japonica* (Kuratani *et al.*, 1997). In *Eptatretus stoutii* and *Myxine glutinosa*, Braun (1998) described a small facial ganglion which is located distal to the otic capsule.

Regarding amphibians, the facial ganglion is either fused with the trigeminal one forming a single prootic ganglion as reported by Sokol (1981) in *Pelodytes punctatus*, Soliman and Mostafa (1984c) in *Bufo viridis* and Shaheen (1987) in *Bufo regularis* or it is separate and independent as described by Reiss (1997) in *Ascaphus truei* and Bauer (1997) in some urodeles. However, Bauer (1997) and Reiss (1997) reported that the facial ganglion is located extracranially in most amphibians.

The geniculate (facial) ganglion, in reptiles and birds, is well developed and quite separate from both the trigeminal and acoustic ganglia as so far described by many authors. However, Haas (1964 & 1968) mentioned two cases of fusion between the geniculate and trigeminal ganglia in the snakes *Liotyphlops albirostris* and *Anomalepis aspinosus*, respectively. Haller Von Hallerstein (1934) stated that a part of the geniculate ganglion, in birds, is separated forming a ganglion for the parasympathetic components.

In the studied bony fish, the nervus facialis passes outside the cranial cavity through a facial foramen located in the pleurosphenoid bone. This is the case found in *Mastacembelus armatus* (Bhargava, 1959), *Tilapia galilee* (Ismail and El-Shabka, 1982), *Cyprinus carpio* (Ismail and Salama, 1983; Ismail *et al*., 1991), *Tilapia zillii* (Ali, 2005) and in *Gambusia affinis affinis* (Mattar, 2012). On the other hand, Ray (1950) in *Lampanyctus leucopsarus*, Dakrory (2000) in *Ctenopharyngodon idellus* and Taha (2010) in *Hypophthalmichthys molitrix* found that the facial nerve gives off the truncus hyomandibularis, the ramus palatinus anterior and the ramus palatinus posterior. The truncus hyomandibularis and the ramus palatinus posterior leave the cranial cavity through the facial foramen, however, the ramus palatinus anterior exits from the cranium through a special foramen. A jugular canal for the passage of the truncus hyomandibularis and a separate exit for the ramus palatinus were described by El-Toubi and Abdel-Aziz (1955) and Piotrowski and Northcutt (1996) in *Polypterus senegalus*. In many bony fishes, the nervus facialis and the nervus trigeminus leave together the cranial cavity such as in *Tilapia nilotica* (Abdel-Aziz, 1959) and *Arius jella* and *Plotosus canius* (Srinivasachar, 1959).

With respect to cartilaginous fishes, the nervus facialis leaves the cranial cavity through the facial foramen, which is separated from the prootic foramen as described in some fishes such as *Rhinoptera bonasus* (Hamdy, 1960), *Zygaena malleus* (Khalil, 1978), *Echinorhinus prucus*, *Rhinoptera jayakari* and *Squatina oculata* (El-Satti, 1982) and in *Rhinobatus halavi* (Dakrory, 2000). However, Hamdy (1954) and Khalil (1979a) reported that in *Mustelus manazo* and *Galeocerdo cuvier*, there are a single foramen for the exit of the facial nerve and the ramus buccalis of the anterior lateral line nerve. On the other hand, Hamdy and Hassan (1973) stated that the ramus palatinus leaves the cranial cavity through a small foramen, while the facial foramen gives exit only for the hyomandibular trunk in *Torpedo ocellata*. This agrees completely with the description of El-Toubi (1949) in *Acanthias vulgaris* and that of Grogan *et al*., (1999) in the shimmered *Callorhinchus millie*.

In Cyclostomata, Jollie (1968) mentioned that the otic capsule has a large internal fenestra for the common root of the facial and auditory nerves. Among amphibians, in *Salamander macula* (De Beer, 1937) and *Discoglossus sardus* (Sokol, 1981), the nervus facialis emerges from the cranial cavity through a separate facial foramen. Reiss (1997) reported that in *Ascaphus truei*, the nervus facialis passes out from the cranial cavity, together with the anterior acoustic nerve through a foramen known as anterior auditory meatus, which leads into a facial canal that lodges the facial ganglion and is continuous dorsally with the auditory capsule. This canal opens distally by two separate foramina; an anterior palatine foramen and a posterior hyomandibular foramen. The hyomandibular foramen is termed the secondary facial foramen by Van- Eden (1951). On the other hand, the nervus facialis emerges from the cranial cavity together with the nervus trigeminus, through the prootic foramen as described by Soliman and Mostafa (1984c) in *Bufo viridis*, Shaheen (1987) in *Bufo regularis*, Trueb and Hanken (1992) in *Xenopus laevis*, Hall and Larsen (1998) in *Scaphiopus intermontanus*, Larson and De Sá (1998) in *Leptodactylus* and Sheil (1999) in *Pyxicephalus adspersus*.

In Reptilia, the nervus facialis has its own foramen, which is anterior to the otic capsule, and never traverses its cavity. This is the condition mentioned in the reptiles so far described, and seems to be a common character among reptiles. In this respect, De Beer (1937) mentioned that the typical relation of the nervus facialis to the auditory capsule in reptiles is that the nerve passes out in front of the capsule and never traverses any part of its cavity.

In the present study, the ramus palatinus arises as two branches; one anterior and the other posterior from the facial nerve anterior to the geniculate ganglion. The same case was mentioned in *Gambusia affinis affinis* (Mattar, 2012). On the other hand, there is only one as reported by Ray (1950) in *Lamapnyctus leucopsarus*, El-Toubi and Abdel-Aziz (1955) and Piotrowski and Northcutt (1996) in *Polypterus senegalus*, Marathe (1955) in *Pseudorhombus arsius*, *Saxena* (1969) in *Nandus nandus*, Dalela and Jain (1968) in *Clarias batrachus*, Harrison (1981) in *Trichiurus lepturus* and Ali (2005) in *Tilapia zillii*. However, two distinct palatine rami, an anterior one arising from the the geniculate ganglion and a posterior one arising from the hyomandibular trunk were observed in *Wallago attu* (Sinha, 1964), *Mystus seenghala* (Mithel, 1964a), *Mastacembelus armatus* (Maheshwari, 1965) and *Xenentodon cancila* (Saxena, 1969). In *Bagarius bagarius,* these two palatine rami anastomose near the middle of their course (Mithel, 1964b). Ray (1950) stated that in *Lampanyctus leucopsarus*, the anterior palatine ramus is lacking, inspite of the presence of the posterior accessory palatine ramus that extending lateral to the usual posterior palatine ramus.

Among cartilaginous fishes, the ramus palatinus arises as a single nerve, which is divided into an anterior division and a posterior one in *Squalus acanthias* (Norris and Hughes, 1920). However, Dakrory (2000) described four branches arising from the geniculate ganglion in *Rhinobatus halavi* which represent the ramus palatinus.

In the species under investigation, the main ramus palatinus traverses the posterior myodome (posterior eye muscle canal). In this respect, the ramus palatinus anterior traverses the posterior myodome in *Lampanyctus leucopasarus* (Ray, 1950), *Ctenopharyngodon idellus* (Dakrory, 2000), *Tilapa zillii* (Ali, 2005) and in *Hypophthalmichthys molitrix* (Taha, 2010). On the other hand, the ramus palatinus runs laterally to the eye muscle canal in *Polycentrus schomburgkii* (Freihofer, 1978).

Among Amphibia, the ramus palatinus has two branches; one medial and the other lateral as reported by Paterson (1939) in *Xenopus laevis* and Shaheen (1987) in *Bufo regularis*. However, in *Bufo viridis* (Soliman and Mostafa, 1984c) described that the ramus palatinus arises by a single nerve.

In the present study, the ramus palatinus does not anastomose with any ramus of the trigeminal nerve. However, in *Ctenopharyngodon idellus* (Dakrory, 2000) it anastomoses with both the maxillo-buccalis division of the nervus trigeminus and the anterodorsal lateral line nerve. While in *Tilapia zillii* (Ali, 2005), the ramus palatinus anastomoses with the ramus maxillaris of the trigeminal nerve. In this respect, the ramus palatinus anterior fuses with the maxillo-buccalis division of the nervus trigeminus in the ethmoidal region as recorded by Taha (2010) in *Hypophthalmichthys molitrix*.

In *Cyclothone acclinidens*, Gierse (1904) mentioned that the ramus palatinus facialis anastomoses with the oculomotor and abducens nerves. This case is not found in the present study and in other bony fishes so far described by some authors such as (Ray, 1950; Freihofer, 1978; Piotrowski and Northcutt, 1996).

In the present work, the main nervus facialis anastomoses with the cranial sympathetic nerve. This condition was also observed in *Argyropelecus hemigymnus* (Handrick, 1901), *Uranoscopus scaber* (Young, 1931), *Lampanyctus leucopsarus* (Ray, 1950) and in *Tilapia zillii* (Ali, 2005). On the contrary, such connection was not found in *Cyclothone acclinidens* (Gierse, 1904). In this respect, both the ramus palatinus posterior and the truncus hyomandibularis receive an anastomosing branch from the facial sympathetic ganglion in *Ctenopharyngodon idellus* (Dakrory, 2000) and in *Hypophthalmichthys molitrix* (Taha, 2010).

In the mugillid fish under investigation, the truncus hyomandibularis of the nervus facialis carries the fibres of the anteroventral lateral line nerve. This appears to be common character among bony fishes.

In the studied bony fish, the ramus opercularis arises as a single branch from the hyomandibular trunk. However, Dakrory (2000), Ali (2005) and Mattar (2012) recorded that this ramus originates by two separate branches in *Ctenopharyngodon idellus, Tilapia zillii and in Gambusia affinis affinis*, respectively.

In the current study, the ramus opercularis innervates the adductor hyomandibularis muscle. In this respect, the ramus opercularis innervates the adductor hyomandibularis, adductor opercularis and levator opercularis muscles in

Lampanyctus leucopsarus (Ray, 1950) and in *Hypophthalmichthys molitrix* (Taha, 2010). However, in *Tilap iazillii*, the ramus opercularis innervates the adductor hyomandibularis, adductorar cuspalatinus, adductor opercularis and levator operculari smuscles (Ali, 2005). Harrison (1981) described special nerve for the adductor arcus palatinus muscle, while the ramus opercularis innervates only the adductor and levator opercularis muscles in *Trichiurus lepturus*. Freihofer (1978) stated that in *Polycentrus schomburgkii*, the ramus opercularis arises as three branches; two are purely motor and the third is purely sensory. The author termed the firs ttwo branches together the ramus opercularis profundusVII. The first branch of the latter ramus innervates the adductor arcus palatinus muscle, while the second one passes to the adductor hyomandibularis muscle. The third sensory branch is termed ramus opercularis superficialis and carries fibres from the lateral line. In *Polypterus senegalus*, Piotrowski and Northcutt (1996) described that the ramus hyo-opercularis carrying not only visceromotor fibres but also somatic sensory and fibres from the lateral linen erve.This author added that the motor fibres of this ramus pass to innervate the adductor hyomandibularis, opercularis and hyohyoid muscles.

In *Liza ramada*, the ramus opercularis facialis carries only viscero-motor fibers. This finding was also recorded in Lampanyctus leucopsarus (Ray, 1950), *Trichiurus lepturus* (Harrison, 1981), *Ctenopharyngodon idellus* (Dakrory, 2000), *Tilapia zillii* (Ali, 2005; Dakrory and Ali, 2005) and *in Gambusia affinis affinis* Mattar (2012). However, this ramus carries viscero-motor fibers, general somatic sensory fibers and general viscero-sensory fibers in *Hypophthalmichthysmolitrix* (Taha, 2010).

In the current investigation, the ramus hyoideus carries visceromotor fibres to the hyoid muscles (hyoideus superior, inferior and the interhyoideus muscles) and somatic sensory fibres to the skin. The same was found in *Gambusia affinis affinis* (Mattar, 2012). However, these motor fibres pass to the hyohyoideus and geniohyoideus (retractor hyoideus) muscles in *Lampanyctus leucopsarus* (Ray, 1950), to the adductor hyoideus, protractor hyoideus and adductor hyohyoideus muscles in *Polycentrus schomburgkii* (Freihofer, 1978), to geniohyoideus muscle in *Trichiurus lepturus* (Harrison, 1981), to hyoideus superior, hyoideus inferior and interhyoideus muscles in *Tilapia zillii* (Ali, 2005; Dakrory and Ali, 2005), and to hyoideus superior and inferior muscles in *Hypophthalmichthys molitrix* (Taha, 2010).

In the studied *Liza ramada*, the ramus mandibularis facialis is not divided into rami mandibularis internus and externus. This condition was observed in *Polypterus senegalus* (Piotrowski and Northcutt, 1996), *Tilapia zillii* (Ali, 2005) and in *Gambusia affinis affinis* (Mattar, 2012). On the other hand, this ramus is divided into the ramus mandibularis internus and externus in *Lampanyctus leucopsarus* (Ray, 1950), *Polycentrus schomburgkii* (Freihofer, 1978), *Ctenopharyngodon idellus* (Dakrory, 2000) and *Hypophthalmichthysmolitrix* (Taha, 2010). Harrison (1981), dealing with *Trichiurus lepturus*, stated that there is no ramus mandibularis internus facialis. It is either lacking or totally incorporated into the ramus mandibularis externus facialis.

In the present study, the ramus mandibularis facialis anastomoses with both the main ramus mandibularis trigeminus and the ramus mandibularis externus trigeminus. The same was found in *Gambusia affinis affinis* (Mattar, 2012). In *Tilapia zillii* (Ali, 2005), the ramus mandibularis facialis fuses with the ramus mandibularis trigeminus externus. In this respect, the first branch arising from the ramus mandibularis facialis externus, in the siluroid catfish, is a cutaneous branch (Adriaens and Verraes, 1998). This was confirmed by Herrick (1901) in *Ictalurus melas* (Ameiurus), Atoda (1936) in *Parasilurus asotus* and Harrison (1981) in *Trichiurus lepturus*. The latter author stated that in all the species, in which this branch is present, it is in connection with the nervus trigeminus. A similar branch is seen in *Ctenopharyngodon idellus* (Dakrory, 2000) but without any connections with the nervus trigeminus. Such nerve is lacking in *Mystus seenghala* (Mithel, 1964a). Harrison (1981) described chorda tympani innervating the tip of the tongue in *Trichiurus lepturus*. The chorda tympani or its homologue is not represented in the present study. In Amphibia, the chorda tympani are well developed as described by Soliman and Mostafa (1984a) in *Bufo viridis* and by Shaheen (1987) in *Bufo regularis*. In other amphibians, however, it is described either as the ramus alveolaris or the ramus mabdibularis internus (Bender, 1907; Francis, 1934). On the other hand, it is lacking in *Xenopus laevius* (Paterson, 1939).

In the studied mugillid fish, the ramus mandibularis carries viscerosensory, general somatic sensory and special somatic sensory fibres (from the anteroventral lateral line nerve), and visceromotor fibres. However, Dakrory (2000) described that in *Ctenopharyngodon idellus*, the ramus mandibularis divides into internus and externus rami. The ramus mandibularis internus facialis is wholly viscerosensory and innervates the pharyngeal lining and the taste buds.

It is clear from the detailed anatomical study of the head serial sections of the studied mosquito fish that the nervus facialis carries general and special somatic sensory and viscerosensory fibres and visceromotor fibres.

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