The Cranial Nerves 0f *Mabuya quinquetaeniata* IV: Nervus Facialis

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Abstract: The present study deals with the nervus facialis of *Mabuya quinquetaeniata*. The nervus facialis leaves the cranial cavity through the facial foramen to enter the geniculate ganglion. The ramus palatinus passes through the vidian canal. There is no palatine ganglion. The medial palatine ramus carries the ethmoidal ganglion which is represented by two parts. The main part lies on the medial palatine ramus. The ramus hyomandibularis carries the fibres of the medial cranial sympathetic nerve and receives those of the lateral cranial sympathetic ramus. It separates into the ramus hyoideus, the chorda tympani and the head sympathetic trunk. The ramus hyoideus innervates the depressor mandibularis, constrictor colli and the mandibulohyoideus muscles.

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1. Introduction

The neuroanatomical characters are very important not only phylogenetically but also systematically, functionally, and behaviorally. Despite of these important characters, the cranial nerves of reptiles in general and that of lizards in particular have not received adequate interest by investigators. Watkinson (1906) gave a short descriptive account of the cranial nerves of *Varanus bivittatus*. Willard (1915) made an extensive work on the cranial nerves of *Anolis carolinensis*. Oelrich (1956) gave a brief account of the cranial nerves of *Ctenosaura pectinata*. Soliman and Hegazy (1972) made a detailed study on the facial nerve of *Chalcides ocellatus*.

Also, Mostafa (1990a) gave an account on the facial nerve of *Acanthodactylus opheodurus*. Dakrory (1994) presented a detailed study on the cranial nerves of the limbless lizard *Deplometopon zarudnyi*. Abdel-kader (2005) gave a detailed study on the cranial nerves of the blind snake *Leptotyphlops cairi*.

There are differences in opinion concerning the final fate of the visceral motor components of the facial nerve among reptiles (Soliman and Hegazy, 1972; Abdel-Kader, 1990; Dakrory, 1994 & 2011). It is obvious from this brief review that studies on the cranial nerves in the family Scincidae are very few compared to the huge number of species in this family. Hence, the study of the cranial nerves of *Mabuya quinquetaeniata* was found necessary. This study deals with the nervus facialis and aims to analyze the fibre components of this nerve and to show the relation between it and the other cranial nerves and structures.

2. Material and Methods

The heads of two young specimens of *Mabuya quinquetaeniata* were decalcified using EDTA solution then dehydrated, cleared, mounted and embedded in paraffin wax and serially sectioned transversely at 12 µm thick. The serial sections were stained with Malory's Triple Stain (Pantin, 1946).

The transverse sections were drawn with the help of a projector microscope. From these drawings an accurate graphic reconstruction for the nervus facialis was made, together with the nervus trigeminus in a lateral view. In order to show the relations of the nerves to the different parts of the head, several sections were photomicrographed.

3. Results

In *Mabuya quinquetaeniata*, the nervus facialis (Figs. 1& 2, RO.VII) arises from the lateral side of the medulla oblongata as a stout root, ventrolateral to but in contact with the root of the nervus octavus. After its emergence, it extends anteriorly in the ventrolateral direction, within the cranial cavity. It touches the medial margin of the vestibular ganglion of the nervus octavus (Fig. 2, G.VE). This nerve leaves the cranial cavity through the facial foramen (Fig. 2, F.FA). This foramen is separated from the incisura prootica of the nervus trigeminus by the prefacial commissure. Immediately after its exit from the cranial cavity, the facial nerve enters the geniculate ganglion (Figs. 1 & 2, G.GE). This ganglion (Figs. 1 & 2, G.GE) is of an oval shaped structure that is located ventral to the auditory capsule (AC) and lateral to both the basisphenoid bone (BSP) and the facial foramen (F.FA). Then, the nervus facialis exits from the ganglion as two branches: an anterior ramus palatinus (Figs. 1 & 2, R.PA) and a posterior ramus hyomandibularis (Fig. 1, R.HYM).

Ramus Palatinus

The ramus palatinus arises from the ventromedial side of the anterior end of the geniculate ganglion (Figs. 1 & 2, R.PA). This ramus runs anteriorly passing lateral and ventrolateral and then ventral to the basispheniod bone (BSP). Here, it gives off a branch for the blood vessel (Fig. 1, N.BV). Anterior to the origin of the previous branch, the ramus palatinus continues forwards passing ventrolateral then ventral to the nervus abducens, medial to the basisphenoid bone and dorsomedial to the palatal epithelium. At the end of the previous course, and opposite to the origin of the bursalis muscle, this ramus enters a special canal; the vidian canal, on the basispheniod bone (Fig. 3, VC). More anteriorly, the ramus palatinus continues passing ventrolateral to both the bursalis and the retractor oculi muscles and lateral to the pituitary gland. Thereafter, this ramus leaves the canal and passes ventromedial to the protractor pterygoideus muscle and medial to both the depressor palpebrae inferioris muscle and the pterygoid bone. Here, it gives off two successive branches for the palatal epithelium (Fig. 1, Nn.EP). More forwards, this ramus passes ventrolateral to both the rectus lateralis muscle and the protractor pterygoideus muscle and dorsomedial to the pterygoid bone. Thereafter, it continues passing medial to the pterygoid bone and ventrolateral to the rectus lateralis muscle. Here, the ramus palatinus gives rise to a branch to the palate epithelium (Fig. 1, N.EP). Thereafter, this ramus gives a branch which ramifies on the mucous layer of the palate ventral to the pterygoid bone (Fig. 1, N.EP). Then, it enters the orbital region.

On the postorbital region, the ramus palatinus gives rise to three successive branches which terminate in the supralabial gland (Fig. 1, Nn.SLG). Shortly anterior, the ramus palatinus divides into two rami: the lateral palatine ramus (Fig. 1 & 4, R.PAL) and the medial palatine ramus (Figs. 1 & 4, R.PAM).

Lateral Palatine Ramus

After the separation of the lateral palatine ramus (Figs. 1 & 4, R.PAL) from the ramus palatinus, the former runs anteriorly passing ventrolateral to the eye ball, lateral to the medial palatine ramus and dorsal to the palatine bone. Here, the lateral palatine ramus gives off two branches to the palate ventral to the pterygoid bone (Fig. 1, Nn.EP). Thereafter, it runs anteriorly passing ventral to the eye ball, medial to the infraorbital nerve (the continuation of the ramus maxillaris). After a considerable distance, the lateral palatine ramus unites completely with the infraorbital nerve (Figs. 1 & 5, R.CM.IO+PAL). Few ganglionic cells are observed at the point of the union in the infraorbital nerve. The fibres carried by the lateral palatine ramus reach their final fate by the way of the infraorbital nerve (the ramus maxillaris) of the nervus trigeminus. Shortly anterior to the point of the union, the infra orbital nerve gives off four successive branches to the skin of the lower eyelid (Fig. 1, Nn.CU). Thereafter, the infraorbital nerve continues anteriorly passing ventral to the eyeball and medial to the jugal bone giving rise to lateral and medial branches. The lateral branch extends anterolaterally to end in the skin of the lower eyelid (Figs. 1, N.CU). The medial branch extends anterodorsally to enter and end in Harder′s gland (Fig. 1, N.HDG). Anterior to the origin of the previous branches, the infraorbital nerve gives off two or three successive branches for the skin of the check and the lower eyelid and the teeth (Fig. 1, Nn.CU+TE). After a forward course, the nerve gives off a ventral branch, which ramifies and ends in the palatal epithelium medial to the dental lamina (Fig. 1, N.EP). Two other branches arise from the nerve and pass to the palatal epithelium (Fig. 1, Nn.EP).

Medial Palatine Ramus

The medial palatine ramus (Figs. 1 & 4, R.PAM) runs anteriorly passing medial to the lateral palatine ramus, dorsal to the palatine bone and ventral to the depressor palpebrae inferioris and then to the rectus inferior muscles. After a long anterior course, the medial palatine ramus gives off a medial branch which ramifies in the palate ventral to the palatine bone (Fig. 1, N.EP). More forwards, the medial palatine ramus continues passing ventral and ventromedial to the rectus inferior muscle and dorsolateral and dorsal to the palatine bone giving rise to a branch which innervate Harder´s gland (Fig. 1, N.HDG). Shortly after that, the medial palatine ramus gives off two successive branches to the palatal epithelium ventral to the palatine bone (Fig. 1, Nn.EP). Thereafter, this ramus continues forwards carrying few ganglionic cells (Fig. 1, GC). At the anterior end of these cells the medial palatine ramus gives off an anastomosing branch to the infraorbital nerve as previously described (Figs. 1 & 6, R.CM.IO+PAM). Anterior to this anastomsis, the ramus palatinus gives off two successive branches to the palatal epithelium (Fig. 1, Nn.EP).

Anterior to the origin of the previously described branches, the medial palatine ramus continues anteriorly till it reaches the orbitonasal region. Here, it carries a well obvious ethmoidal ganglion (Figs. 1 & 7, G.ET). This ganglion will be described shortly later on. The medial palatine ramus gives off the intermediate palatine ramus just at its entrance to the ethmoidal ganglion (Figs. 1 & 8, R.PAI).

The medial palatine ramus (Fig. 1, R.PAM) leaves the ethmoidal ganglion and runs anteriorly giving off two successive branches to the palate (Fig. 1, Nn.EP). Moreforwards, it enters the nasal capsule giving off three branches to the palatal epithelium ventral to the internasal septum (Fig. 1, Nn.EP). More anteriorly, it runs at the full length of the nasal capsule giving off several branches to the epithelial lining medial to the choanae. Finally, it terminates as many fine branches in the epithelium of the palate (Fig. 1, Nn.EP).

Intermediate Palatine Ramus

The intermediate palatine ramus arises from the ventrolateral side of the medial palatine ramus at its entrance to the ethmoidal ganglion (Figs. 1 & 8, R.PAI). It runs anteriorly, in the lateral direction, passing ventral to the palatal process of the palatine bone and dorsal to the posterior part of the nasal duct. This ramus penetrates the latter bone and fuses with the infraorbital nerve forming a common nerve as previously described (Fig. 1, CO.N). Shortly anterior, the intermediate palatine ramus separates from the infraorbital nerve. After its separation, it extends anteriorly in the ventral direction, giving off several branches for the supralabial gland (Fig. 1, Nn.SLG). Thereafter, this ramus gives off several branches to the taste buds and the epithelium lateral to the choanae and medial to the dental lamina (Fig. 1, Nn.TB+EP). Finally, it terminates on the palatal epithelium and the glands at the anterior end of the upper jaw.

Ramus Hyomandibularis

The ramus hyomandibularis (Fig. 1, R.HYM) is the main posterior branch of the nervus facialis. This ramus originates from the posterodorsal side of the geniculate ganglion (Fig. 1, R.HYM). It runs posteriorly passing ventral to the auditory capsule and dorsal to the Eustachian tube. After a posterior course, it passes lateral and then ventrolateral to the auditory capsule, dorsal and medial to both the Eustachian tube and the columella auris (Fig. 9, R.HYM). Thereafter, this ramus passes ventromedial to the lateral cranial sympathetic ramus, lateral to the auditory capsule and dorsomedial to the depressor mandibulae muscle. After a short distance, the ramus hyomandibularis joins the lateral cranial sympathetic ramus (Figs. 1 & 9).

Shortly posterior to this connection, the ramus hyomandibularis passes medial to the quadrate bone and lateral to the auditory capsule. Here, it seperates from the main cranial sympathetic (Figs. 1 & 10, CSY.T). After a short distance, the ramus hyomandibularis divides into a medial ramus hyoideus (Figs. 1 & 10, R.HY) and a lateral chorda tympani (Figs. 1 & 10, CT).

Ramus Hyoideus

The ramus hyoideus (Figs. 1 & 10, R.HY) carries the entire motor fibres of the nervus facialis. It runs posteriorly passing medial to both the chorda tympani and the quadrate bone and lateral to the auditory capsule. Shortly posterior, it continues passing ventromedial and ventral to the quadrate bone and dorsomedial to the constrictor coli muscle. Thereafter, the ramus hyoideus divides into a lateral branch and a medial one. The lateral branch gives off a fine nerve to the constrictor coli muscle (Fig. 1, N.CC). Thereafter, the main lateral branch enters and ends in the depressor mandibulae muscle (Fig. 1, N.DM). The medial branch runs in a posteroventral direction passing ventromedial to the lateral branch and dorsomedial to the depressor mandibulae muscle. Thereafter, the medial branch passes lateral to the ceratobranchial cartilage and medial to the mandibulohyoideus muscle where it terminates (Fig. 1, N.MHY).

Chorda Tympani

After the origin of the chorda tympani (Figs. 1 & 10, CT) from the ramus hyomandibularis, it extends backwards for a short distance then descends ventrally running ventral to the quadrate bone (Figs. 1 & 11, CT). Thereafter, it changes its course anteriorly passing ventral to the quadrate bone. After a short anterior distance, the chorda tympani passes dorsolateral to the pterygomandibularis muscle. More anteriorly, the chorda tympani penetrates the latter muscle till it becomes dorsal to the articular bone (Fig. 11, CT). Thereafter, it enters the primordial canal inside the mandible through a special primordial fossa on its dorsal side. Inside this canal the chorda tympani runs anteriorly for a long course passing medial to Meckel′s cartilage (Fig. 12, CT & MC). After a long course, the chorda tympani shifts to extend dorsal then dorsolateral to Meckel′s cartilage and medial to the inferior alveolar nerve (the continuation of the ramus mandibularis within the primordial canal of the mandible). Finally, it fuses with the latter nerve forming a mixed nerve (Fig. 1, N.MI).

The fibres of the chorda tympani are more or less divided into two portions; one of them incorporates with the ramus intermandibularis oralis, and the other combines with the ramus intermandibularis medius (paralingualis). These two rami are branches of the inferior alveolar nerve of the nervus trigeminus.

From the aforementioned description, the branches of the nervus facialis carry general and special viserosensory, sympathetic and visceromotor fibres. The general viscerosensory fibres are carried with the ramus palatinus. The special viscerosensory fibres are carried through the chorda tympani to the taste buds found on the anterior two thirds of the tongue. The sympathetic ramus is carried by the chorda tympani. The visceromotor fibres are all included in the ramus hyoideus which innervates the constrictor coli, depressor mandibulae and the mandibulohyiodeus muscles.

Ethmoidal Ganglion

In *Mabuya quinquetaeniata*, the ethmoidal ganglion is represented by two unequal masses of ganglionic cells. The large mass is located along the medial palatine ramus (Figs. 1, 7 & 8, G.ET) while the small one is located on the anastomosing branch (Figs. 1 & 7, GC). The main part has more or less rounded shape and lies in the orbitonasal region of the skull. The main part of the ganglion (Figs. 7 & 8) is located dorsal to the palatal process of the palatine bone (PAPPA), ventrolateral to the origin of the oblique inferior muscle (M.OIF) and the interorbital septum (S.IO) and ventromedial to the prefrontal bone (PFR).

The main part of the ethmoidal ganglion is in connection with the ramus nasalis of the nervus trigeminus by a communicating branch. This branch carries few ganglionic cells at its connection with the ramus nasalis representing the small part of the ganglion (Figs. 1 & 7, R.CM.NA+G.ET). The intermediate palatine ramus arises from the ventrolateral side of the medial palatine ramus just posterior to its entrance to the main part of the ganglion. Also, the main part of the ethmoidal ganglion gives off a ventral branch which innervate the mucous epithelium lining the palate of this region and a dorsal branch for Harder´s gland (Fig. 1, N.HDG).

From the microscopic examination, it appears that, the ganglion consists of one type of cells but it is represented by two parts; the ventral part is the main one.

4. Discussion

In *Mabuya quinquteaniata* studied, the nervus facialis leaves the cranial cavity through the facial foramen. This foramen is bounded dorsally by the vestibular portion of the auditory capsule and is located anterior to the cochlear portion of the capsule and so the nervus facialis has no association with the auditory capsule and never traverse its cavity. This case is a common character among reptiles (El-Toubi and Kamel, 1959 & 1961; Soliman, 1969; Hegazy, 1976; Soliman and Hegazy, 1972; Soliman and Mostafa, 1984a; Soliman *et al*., 1990; Dakrory, 1994 & 2011; Dakrory and Mahgoub, 2004; Ramadan, 2009; Alfitouri, 2010).

In Amphibia, the nervus facialis emerges from the skull via a canal in *Necturus amphiuma* and *Amblystoma* (Gaupp, 1911). The presence of this canal was found by De Beer (1937) in *Amblystoma punctatum*. In most urodeles and anurans the nervus facialis leaves the cranium, together with the nervus trigeminus through the foramen prooticum (Soliman and Mostafa, 1984b).

In mammals, the facial and auditory nerves may run for a short distance together through a special region of the cranial cavity forming the internal auditory meatus (De Beer, 1937).

In this study, the geniculate ganglion of the nervus facialis is quite separated from the trigeminal ganglion. This is the case present in all reptiles and birds so far described. However, some exceptions were recorded. In the snakes *Liotyphlops albirostris* and *Anomalepis aspinosus* (Haas, 1964 & 1968, respectively), *Elaphe obsleta* and *Thammophis ordinoides* (Auen and Langebartel, 1977) and in *Natrix tessellate* (Dakrory and Mahgoub, 2004) where the geniculate ganglion adheres cranially to the trigeminal ganglion. On the other hand, Haller von Hallerstein (1934) stated that a part of the geniculate ganglion in birds is separated to form a ganglion for the parasympathetic components.

Among Amphibia, the condition is different where there is no separate geniculate ganglion for the nervus facialis in *Bufo virdis* (Soliman and Mostafa, 1984b) and the geniculate ganglion is associated with the trigeminal ganglion. In Urodela, there are two ganglia for the nervus facialis associated with the trigeminal ganglion forming the prooticum ganglion as mentioned by Haller von Hallerstein (1934).

In the present study, there is no connection between the geniculate ganglion and the cranial sympathetic ramus or with the ramus mandibularis of the nervus trigeminus. This condition agrees very well with that mentioned by Dakrory (1994) in *Diplometopon Zarudnyi*. On the other hand, in *Agama pallida* (Abdel-Kader, 1990; Soliman *et al*., 1990), the geniculate ganglion receives two medial cranial sympathetic rami. However, in *Ptyodactylus hasselquistii* (Soliman *et al*., 1990), in *Tarentola mauritanica* (Soliman and Mostafa, 1984a), and in *Uromastyx aegyptius* (Dakrory, 2011) the geniculate ganglion receives only one medial cranial sympathetic ramus. Dealing with Ophidia, the geniculate ganglion is in connection with the medial cranial sympathetic ramus in *Eryx jaculus* and with the ramus mandibularis of the nervus trigeminus in *Cerastes vipera* (Hegazy, 1976).

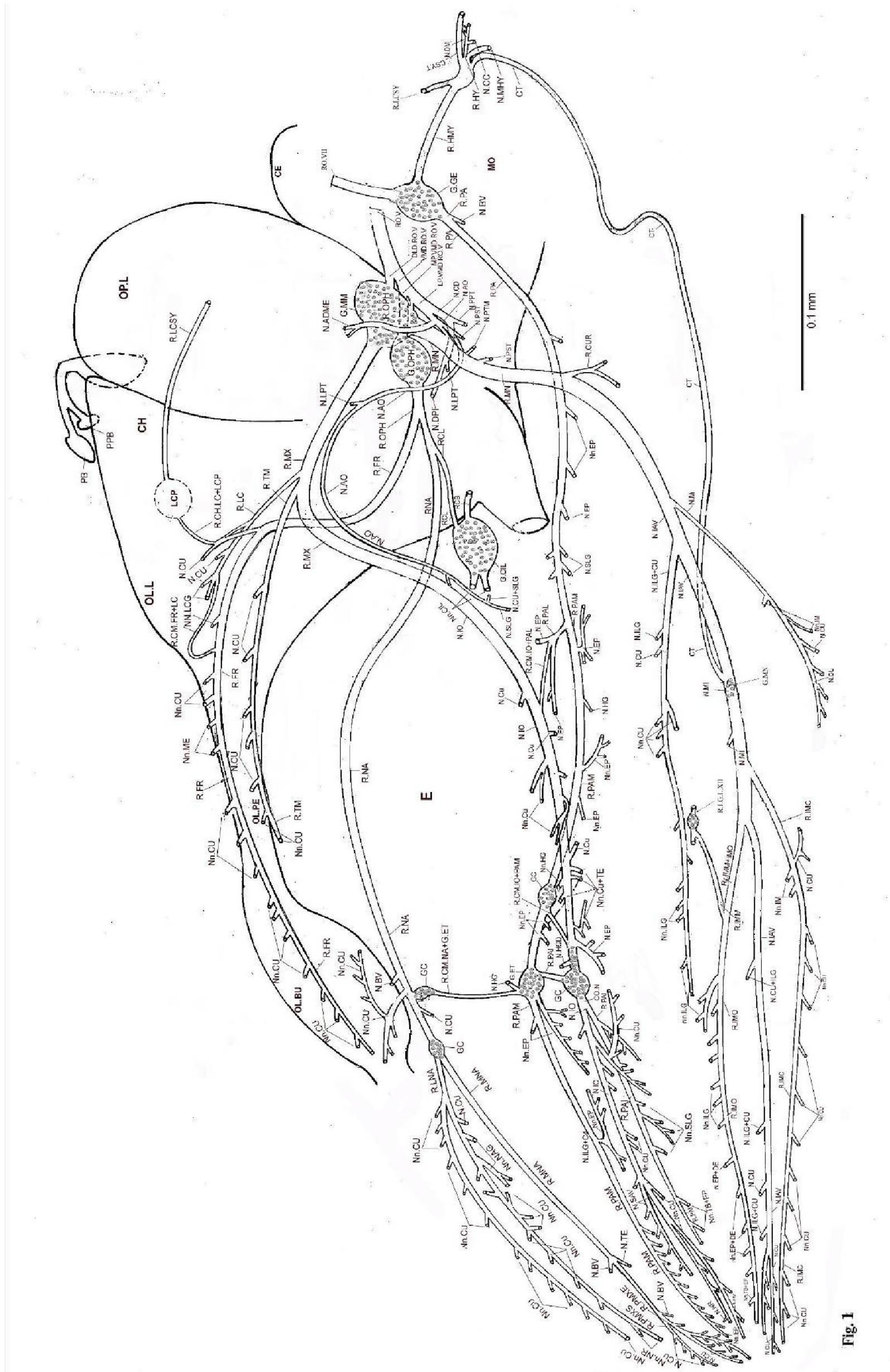

Fig. 1: Graphic reconstruction of the nervi trigeminus and facialis in a lateral view.

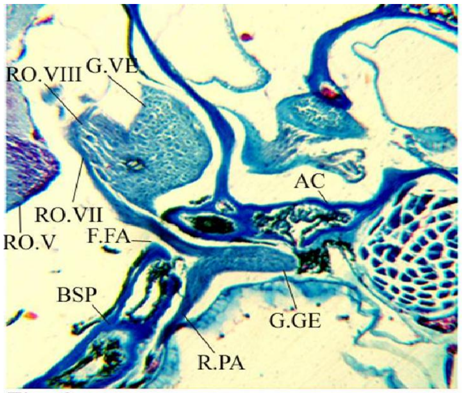

Fig. 2

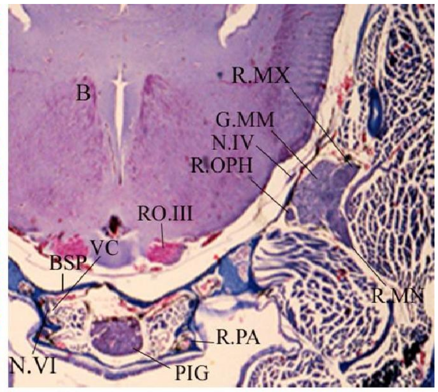

Fig. 3

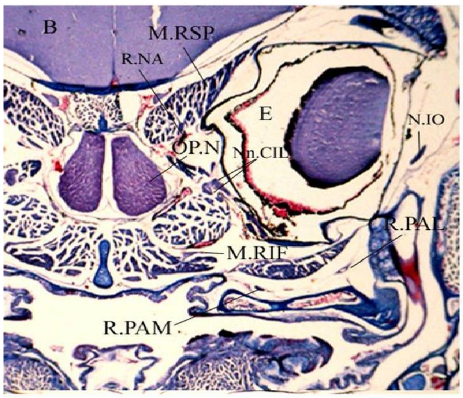

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Fig. 5

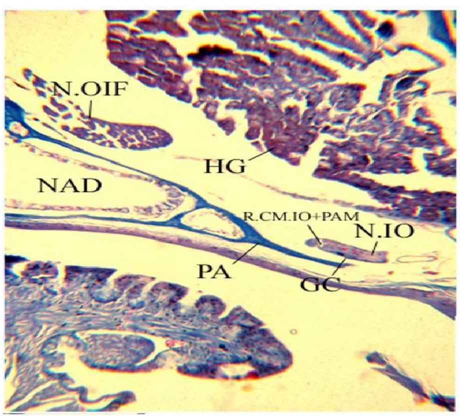

Fig. 6

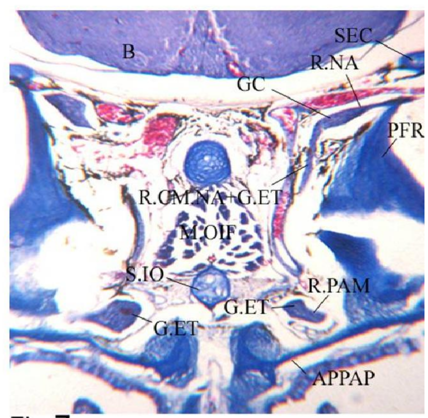

Fig. 7

Fig. 2: Photomicrograph of a part of a transverse section passing through the otic region showing the origin of the nervi trigeminus and facialis, the foramen facialis, the position of the geniculate ganglion and the origin of the ramus palatinus from the geniculate ganglion.

Fig. 3: Photomicrograph of a part of a transverse section passing through the postorbital region showing the ramus palatinus of the nervus facialis passing through the vidian canal.

Fig. 4: Photomicrograph of a part of a transverse section passing through the orbital region showing the position of the rami palatinus lateralis and medialis.

Fig. 5: Photomicrograph of a part of a transverse section passing through the orbital region showing the fusion of the infraorbital nerve and the ramus palatinus lateralis. It also illucidates the passage of the mixed nerve (ramus mandibularis and chorda tympani) through the primordial canal of the mandible.

Fig. 6: Photomicrograph of a part of a transverse section passing through the orbitonasal region showing the communication between the infraorbital nerve and the ramus palatinus medialis.

Fig. 7: Photomicrograph of a part of a transverse section passing through the orbitonasal region illucidating the ethmoidal ganglion, the ramus nasalis and the communicating branch in-between.

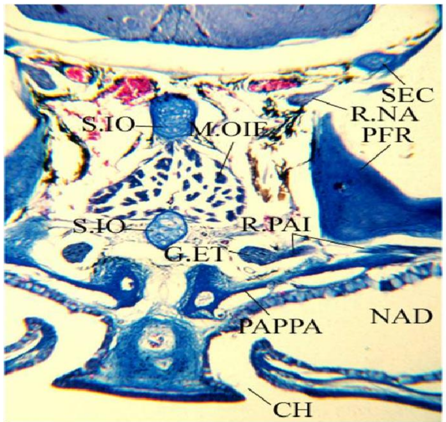

Fig. 8

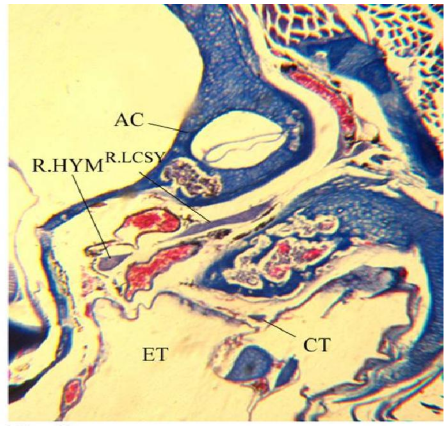

Fig. 9

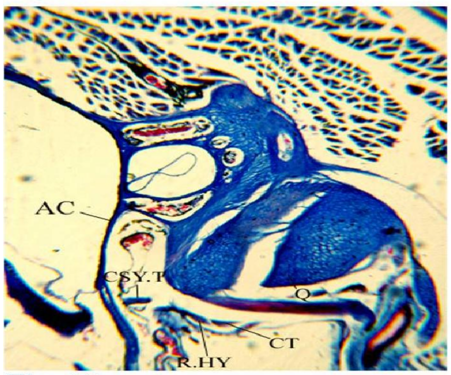

Fig. 10

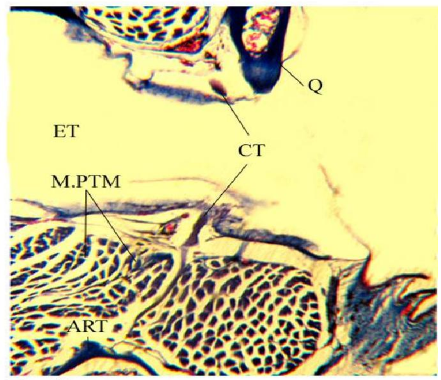

Fig. 11

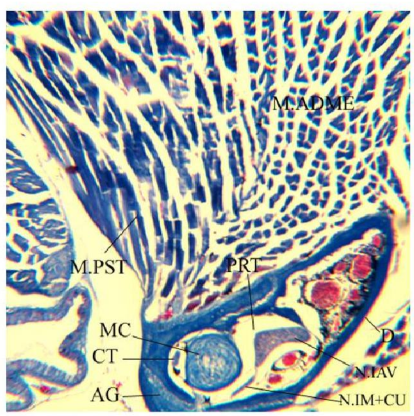

Fig. 12

Fig. 8: Photomicrograph of a part of a transverse section passing through the orbitonasal region showing the position of the ethmoidal ganglion, the origin of the ramus palatinus intermedius from the medial palatine ramus.

Fig. 9: Photomicrograph of a part of a transverse section passing through the postotic region showing the ramus hyomandibularis, the lateral cranial sympathetic ramus come to fuse with the ramus hyomandibularis and the position of the chorda tympani.

Fig. 10: Photomicrograph of a part of a transverse section passing through the postotic region showing the separation of the ramus hyomandibularis into ramus hyodius, chorda tympani and the cranial sympathetic trunk.

Fig. 11: Photomicrograph of a part of a transverse section passing through the postotic region showing the passage of the chorda tympani through the pterygomandibularis muscle to the mandible.

Fig. 12: Photomicrograph of a part of a transverse section passing through the postorbital region showing the passage of the chorda tympani and the ramus mandibularis in the primordial canal.

In this study, the ramus hyomandibularis receives the cranial sympathetic trunk, and the lateral cranial sympathetic ramus separates from it. A similar case was described by Soliman and Hegazy (1972) in *Chalcides ocellatus*, by Mostafa (1990a) in *Acanthodactylus ophrodurus* and by Dakrory (1994) in *Diplometopon zardunyi*.

In the studied *Mabuya quinquetaeniata*, the nervus facialis carries visceral sensory, visceral motor and sympathetic fibres. In this study, the somatic sensory fibres are not domenstrated for the nervus facialis, as no mention of such fibres was reported in other reptiles by any author. However, these fibres are found in Amphibia (Soliman and Mostafa, 1984b). In birds, Cords (1904) described a cutaneous sensory branch arising from the nervus facialis to the lining of the external auditory meatus, to which she gave the name "ramus auricularis", the same term which is applied to a nerve of similar components found in mammals, but derived from the nervus vagus.

In the present study, the visceral motor fibres of the nervus facialis pass to the depressor mandibulae muscle, branchiohyiodeus muscle and the constrictor coli muscle. The constrictor coli muscle is completely absent in *Diplometopon zardunyi* (Dakrory, 1994) and in the Ophidia (Hegazy, 1976, Mostafa, 1990b). Among ophidian, this muscle is only present in *Coluber natrix*, *Python* and *Tropidonotus natrix* (Edgeworth, 1935; Dakrory and Mahgoub, 2004).

In the studied *Mabuya quinquetaeniata*, the nervus facialis is in close relationship with the ramus maxillaris of the nervus trigeminus as the infraorbital nerve while passing in the orbital region fuses with the lateral palatine ramus and receives an anastomsing branch from the medial palatine ramus. In the orbitonasal region, it fuses for a short distance with the intermediate palatine ramus. The anastomosis of the infraorbital nerve with the ramus palatinus and its branches, before the former leaves the orbit, was mentioned by in some lizards such as *Varanus monitor* (Bellairs, 1949), *Tarentola mauritanica* (Soliman and Mostafa, 1984a), *Agama pallida* (Soliman *et al*., 1984; Abdel-Kader, 1990, *Acanthodactylus opheodurus* (Mostafa, 1990a), *Diplometopon zarudnyi* (Dakrory, 1994) and in *Acanthodactylus boskianus* (El-Ghareeb, 1997).

In Ophidia, the infraorbital nerve anastomosis with the ramus palatinus of the nervus facialis as in *Psammophis sibilans*, *Eryx jaculus* (Hegazy, 1976), *Elaphe obsolete*, *Thamnophis ordinoides* (Auen and Langebartel, 1977) and in *Natrix tessellata* (Dakrory and Mahgoub, 2005), while this was absent in *Spalerosophis diadema* (Mostafa, 1990b).

In the current study, the chorda tympani is well represented as commonly present in all reptiles so far described. In this respect, it can be stated with certainty that the presence of this nerve among reptiles is a general feature. The only recorded condition, where the chorda tympani is absent in the chelonian *Chelone imbricate* (Soliman, 1964).

In birds, the chorda tympani were found in species studied by Stellbogen (1930), Haller von Hallerstein (1934) and Soliman *et al*. (1986). While it is absent from some other birds; *Rhea* (Müller, 1963), *Streptopelia seneglensis* (Soliman *et al.,* 1986), *Gallinula chloropus* (Abdel-Kader, 1998) and in *Merops albicollis* (Abdel-Kader and Fathy, 2000). On the other hand, the nerve, which is present in *Ostrich* and described as the chorda tympani by Brock (1937), is probably a sympathetic branch as stated by Müller (1963).

In case of Amphibia, the chorda tympani was described as the ramus mandibularis internus as stated by Soliman and Mostafa (1984b). On the other hand, Francis (1934) discussed the possible homologies of this nerve and revealed that it represents the chorda tympani of higher vertebrates.

In the present study, the chorda tympani carries special visceral sensory (the fibres of the taste) and sympathetic fibres. These fibres innervates the taste buds found in the anterior part of the tongue and the adjacent parts, along with the other fibres of both the rami intermandibularis oralis and intermandibularis medius (ramus paralingualis). This was supported by many authors as Soliman *et al*. (1990), Abdel-Kader (1990), Dakrory (1994), El-Ghareeb (1997) and Dakrory and Mahgoub (2004).

The ethmoidal ganglion has various names (orbitonasal, sphenethmoidal and sphenopalatine) as mentioned by different authors, is well represented in the species studied. It lies in the most anterior part of the orbit, as it is the case in the majority of Squamata.

Among reptlies, the ethmoidal ganglion is found in most lizards and snakes as it was reported by several investigators. On the contrary, it is not represented in chelonian (Soliman, 1964) and in crocodilian (Shiino, 1914).

The present study showed that the ethmoidal ganglion is composed of two unequal parts of ganglionic cells. The main part is closely applied to the ramus palatinus medialis of the nervus facialis, whereas, the other small part is located along the ramus communicans at the point of its connection with the ramus nasalis of the nervus trigeminus. This ganglion is in connection with the ramus nasalis of the nervus trigeminus by a communicating branch. This is similar to what was described by Hegazy and Mostafa (1990) in *Agama sinaita* and Dakrory and Shamakh, (2008) in *Shenops sepsoides*. Among

Ophidia, this was found in the snakes *Cerastes vipera* (Hegazy, 1976) and *Spalerosophis diadema* (Mostafa, 1990b & 1991).

On the other hand, the ethmoidal ganglion is represented by a single part which is closely applied to the ramus palatinus medialis of the nervus facialis in *Agama sinaita* (Hegazy and Mostafa, 1990; Ramadan, 2009), in *Diplometopon zarudnyi* (Dakrory, 1994) and in both *Uromastyx aegyptius* and *Varanus griseus griseus* (Dakrory and Shamakh, 2008). The same finding was found in the snakes *Cerastes vipera* (Hegazy, 1976) and *Spalerosophis diadema* (Mostafa, 1990b & 1991). In *Tarentola mauritanica* (Soliman and Mostafa, 1984a) and *Ptyodactylus hasselquistii* (Abdel-Kader, 1990), one part of the ganglion is closely applied to the ramus nasalis, whereas the other part is close to the medial palatine ramus. In *Agama pallida* (Abdel-Kader, 1990), one part of the ganglion is close to the medial palatine ramus and the other lies at the middle of the anastomosing branch. In snakes, the two parts of the ganglion are closely applied to the medial palatine ramus as in *Psammophis sibilan* (Hegazy, 1976) and in *Coluber elegantissimus* (Mostafa, 1991). In *Eryx jaculus* (Hegazy, 1976), one part is applied to the ramus nasalis and the other to the medial palatine ramus. In *Psammophis schokari* (Mostafa, 1991), one part is entirely located on the medial palatine ramus and the other one is located on the communicating branch.

The location of this ganglion shows a wide variety in lizards, this ganglion is closely related to the ramus nasalis, and it is in connection with the medial palatine ramus in *Lacerta virdis*, *Ptyodactylus hasselquistii* and *Acanthodactylus boskians* (Soliman, 1968), *Chalcides ocellatus* (Soliman and Hegazy, 1972), *Stenodactylus selvini* (Hegazy and Mostafa, 1990) *Acanthodactylus opheodurus* (Mostafa, 1990a) and in *Diplometopon zardunyi* (Dakrory, 1994). On the other hand, the ganglion is found in the middle of the anastomosing branch which connects the rami nasalis and medial palatine ramus in *Ctenosoura pectinata* (Oelrich, 1956), *Agama mutabilis* (Soliman, 1968) and *Eumeces schneideri* (Hegazy and Mostafa, 1990).

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LIST OF ABBREVIATIONS

AC	:	Auditory capsule.
B	:	Brain.
BSP.	:	Basisphenoid bone.
CO.N	:	Common nerve.
CSY.T	:	Cranial sympathetic trunk.
CT	:	Chorda tympani.
CT+N.IAV	:	Chorda tympani + inferior alveolar nerve.
D	:	Dentary bone.
F.FA	:	Facial foramen.
G.CIL	:	Ciliary ganglion.
G.ET	:	Ethmoidial ganglion.
G.GE	:	Geniculate ganglion.
G.MM	:	Maxillomandinular ganglion.
G.MN	:	Mandibular ganglion.
G.OPH	:	Ophthalmic ganglion.
GC	:	Ganglionic cells.
IP	:	Incisura protica.
LP.VMD.RO.V	:	Lateral part of ventromedial division of the trigeminal root.
M.OIF	:	Obliquues inferior muscle.
MC	:	Meckel′s cartilage.
MI	:	Mixed nerve.
MP.VMD.RO.V	:	Medial part of ventromedial division of the trigeminal root.
MX	:	Maxillary bone.
N.AO	:	Anguli oris nerve.
N.BV	:	Nerve to blood vessel.
N.CD	:	Constrictor dorsalis nerve.
N.CU	:	Nerve to skin.
N.CU+ILG	:	Nerve to skin and infralabial gland.
N.CU+SLG	:	Nerve to skin and supralabial gland.
N.DM	:	Nerve to depressor mandibularis muscle.
N.DPI	:	Nerve to depressor palpebrae inferioris muscle.
N.EP	:	Nerve to epithelium.
N.EP+DE	:	Nerve to epithelium and dental lamina.
N.HDG	:	Nerve to Harder′s gland.
N.IM	:	Nerve to intermandibularis muscle.
N.IM+CU	:	Nerve to intermandibularis muscle and skin.
N.IAV	:	Inferior alveolar nerve.
N.ILG	:	Nerve to infralabial gland.
N.IO	:	Infraorbital nerve.
N.LCG	:	Nerve to lacrimal gland.
N.LPT	:	Nerve to levator pterygoideus muscle.
N.MI	:	Mixed nerve.
N.PTM	:	Nerve to pterygomandibularis muscle.
N.V	:	Nervus trigeminus.
N.VI	:	Nervus abducens.
N.VII	:	Nervus facialis.
Nn.BV	:	Nerves to blood vessel.
Nn.CIL	:	Ciliary nerves.
Nn.CU+TE	:	Nerves to skin and teeth.
Nn.EP	:	Nerves to epithelium.
Nn.HDG	:	Nerves to Harder′s gland.
Nn.IM	:	Nerves to intermandibularis muscle.
Nn.ME	:	Nerves to meninges.
Nn.SA	:	Nerves to saculus.
Nn.SLG	:	Nerves to supralabial gland.

Nn.TB	:	Nerves to taste buds.
PAPPA	:	Palatal process of palatine.
PRC	:	Primordial canal.
PRF	:	Primordial fossa.
R.CM.FR+LC	:	Ramus commuincans between the ramus frontalis and the ramus lacrimalis.
R.CM.FR+LCP	:	Ramus commuincans between the ramus frontalis and the lacrimal plexus.
R.CM.IO+PAL	:	Rramus communicans between the ramus intermandibularis oralis and the ramus palatinus lateralis.
R.CM.IO+PAM	:	Ramus communicans between the infraorbital nerve and the medial palatine ramus.
R.CM.LC+LCP	:	Ramus communicans between the ramus lacrimalis and the lacrimal plexus
R.CM.LP.VMD.RO. V+G.MM	:	Ramus communicans between lateral part of ventromedial division (N.V) and maxillomandinular ganglion.
R.CM.NA+G.ET	:	Ramus communicans between the ramus nasalis and the ethmoidal ganglion.
R.CUR	:	Ramus cutaneous recurrens.
R.FR	:	Ramus frontalis.
R.HY	:	Ramus hyoideus.
R.HYM	:	Ramus hyomandibularis.
R.IMC	:	Ramus intermandibularis caudalis.
R.IMM	:	Ramus intermandibularis medius.
R.IMO	:	Ramus intermandibularis oralis.
R.LC	:	Ramus lacrimalis.
R.LNA	:	Ramus lateralis nasi.
R.MN	:	Ramus mandibularis.
R.MNA	:	Ramus medialis nasi.
R.MX	:	Ramus maxillaris.
R.NA	:	Ramus nasalis.
R.OPH	:	Ramus ophthalmicus profundus.
R.PA	:	Ramus palatinus.
R.PAI	:	Ramus palatinus intermedialis.
R.PAL	:	Ramus palatinus lateralis.
R.PAM	:	Ramus palatinus medalis.
R.TM	:	Ramus temporalis.
RCB	:	Radix ciliaris brevis.
RCL	:	Radix ciliaris longa.
RO.V	:	Nervus trigeminus root.
RO.VII	:	Nervus facialis root.
S.IN	:	Internasal septum.
S.IO	:	Interorbital septum.
SMX	:	Septomaxillary bone.
VC	:	Vidian canal.
VMD.RO.V	:	Ventromedial division of the trigeminal root