Bull. Inst. Oceanogr. & Fish, ARE, 8 (2) 1982: 109 - 135

THE ELASMOBRANCHS OF THE MEDITERRANEAN
VI - THREE TORPEDOS.

FATMA M. M. MAZHAR
Department of Zoology, University College for Women,
Ain Shams University.

ABSTRACT

Three species of the genus **Torpedo** are reported from Alexandria shores. The external morphology of the three species is studies and taxonomically treated.

A key for their identification is elaborated. The anatomy of the digestive system, the heart and afferent branchial vessels, as well as the nervous system is given.

INTRODUCTION

The present investigation is a continuation to my work on the elasmobranchs of the Egyptian Mediterranean shore. The author described seven species on 1967, and five species on 1974 from Alexandria shores.

I describe here three Torpedos from the Alexandria shore giving their systematic position and a comparison of their anatomy. These are **Torpedo marmorata, Torpedo fuscomaculata** and **Torpedo alexandrinsis** Sp. nov.

The material examined consisted of fresh specimens obtained off Alexandria shores.

A key is supplied for the identification of the above mentioned Torpedos and other two Torpedos (**Torpedo torpedo** and **Torpedo narke**) previously described by the same author (1967 and 1974) from the Egyptian Mediterranean shore.

I- Systematic Position

Order BATOIDEI

Sub-Order TORPEDINOIDEA

Family TORPEDINIDAE

Genus **Torpedo** Houttuyn, 1764

Key to the Species of the Genus **Torpedo:**

A. - Five blue ocelli on back
B. - Spiracle with no tentacles
C. - Pelvic fins originate somewhat behind pectorals....**Torpedo torpedo** L., 1758.
B_2. - Spiracle with seven small tentacles
C_2. - Pelvic fins are partly covered by pectorals....**Torpedo narke** Risso, 1810.
A_2. - No blue ocelli as above
B_3. - Spiracle with seven tentacles
C_3. - Pelvic fins origin before end of peotorals
D. - Disc broader than long
E. - Anterior margin of disc rounded
.....**Torpedo marmorata** Risso, 1810.
C_4. - Pelvic fins origin opposite to end of pectorals
E_2. - Anterior margin of disc truncate
.....**Torpedo fuscomaculata** Peters, 1855.
C_5. - Pelvic fins origin posterior to end of pectorals
D_2. - Disc longer than broad
E_3. - Anterior margin of disc slightly outcurved
.....**Torpedo alexandrinisis** Sp. nov.

Torpedo marmorata Risso, 1810 (Figs. 1, 2 and 3)

This electric ray is plentiful in Alexandria shores, and ranges through the Mediterranean and the eastern Atlantic.

Nine specimens - five males and four females - measuring from 15-38 cm., were obtained from Alexandria market in August.

The colour of this ray is dirty brown dorsally, sometimes darker spots are spread on the dorsal side and the fins. The margins of the disc, the pelvic fins, the caudal fin and the two dorsal fins are creamy. The ventral surface is also creamy, but the margins of the pectoral and pelvic fins are chocolate in colour.

The disc is almost circular, slightly broader than long. The median sector of the anterior margin of the disc is more or less rounded. Eyes are small, about 1/3 of the preorbital length. The spiracle is small, oblique,

and its length is nearly equal to the length of the eye, which lies a small distance anteriorly. The margins of the spiracles are surrounded with seven thin papillae. The nostrils are small, somewhat oblique. They are closely set and partly covered by the nasal curtain which reaches backwards to the anterior margin of the lower jaw. There is sex difference in the shape of the nasal curtain. It is more rounded in females than in males. The mouth is small, arched anteriorly and its width equals about $\frac{1}{2}$ of the preoral length. The tooth bands reach only about 2/3 of the width of the mouth. The teeth are minute and arranged in quincunx close together. Each tooth has one sharp conical cusp. There are 26-30 rows, and each row has 6-9 teeth, of which the anterior 5-8 are functional.

The pectoral fins are thin and fleshy, with narrow rounded posterior ends which cover the anterior most part of the pelvic fins.

The pelvic fins have rounded margins and originate little before the hind end of the pectoral fins.

The two dorsal fins are small and rounded. The first dorsal fin originates nearly over half the pelvic and ends posteriorly little before the end of the pelvic fins. The second dorsal fin equals about 2/3 of the first dorsal fin, but has a similar shape and originates little posterior to its end.

The tail is stout, rounded above, flattened below and is provided with a thick ridge which separates the dorsal side from the ventral one.

The gill-slits are equidistant. The first gill-slit is smaller than the rest four, which are all equal in length.

The electric organs, as ususally found in the members of the family Torpedinidae are two large kidney-shaped. They occur ventrally one on each side of the disc extending nearly from the anterior margin posteriorly till somewhat behind the fifth gill-slit.

My specimens conform with those of Fraser-Brunner (1949) as well as Collignon and Aloncle (1972). However, Fowler (1936) described this species under the synonym **Torpedo torpedo.**

Torpedo fuscomaculata Peters, 1855
(Figs. 4,5 and 6)

This is the first time this species is recorded in the Mediterranean. It was recorded before from Zanzibar, Seychelles, Mauritius, Madagascar and Mozambique (Fraser-Brunner, 1949).

Four males measuring from 25-32 cm. and two females of 24 cm. each, were obtained from Alexandria market in August, together with the specimens of **Torpedo marmorata.**

Confusion may occur between this species and **Torpedo marmorata,** but **Torpedo fuscomaculata** is mainly characterized by the median sector of the anterior margin of the disc, being truncate. There are other differences between the two species which are mentioned below.

The colour of **Torpedo fuscomaculata** is dark chocolate to dark grey dorsally, but the margins of body and fins are creamy. The ventral surface is creamy, although the ventral margins of the pectoral and pelvic fins are dirty grey.

The disc is sub-circular, somewhat broader than long. Eyes are about $\frac{1}{2}$ of the preorbital length. They are bigger and more bulging than in **Torpedo marmorata.** The spiracle is oblique, and its length is nearly equal to the length of the eye. The matgins of the spiracles are surrounded with seven papillae, which are thicker and longer than those in **Torpedo marmorata.** There is sex difference in the shape of the nasal curtain, but on the contrary to **Torpedo marmorata,** the posterior margin of the nasal curtain is rounded in males, but nearly straight in females. The mouth is moderate and the preoral length is shorter, compared with **Torpedo marmorata.** The teeth are small but somewhat larger than in **Torpedo marmorata.** There are 23-28 rows, and each row has 6-9 teeth, of which the anterior 5-6 are functional.

The pectoral fins differ from those in **Torpedo marmorata** in being broader and do not cover the anterior part of the pelvic fins.

The pelvic fins resemble those in **Torpedo marmorata** but differ in their origin, as they originate just opposite to the hind end of the pectoral fins.

The two dorsal fins are rounded and of the same shape. The first dorsal fin orginates nearly over half the pelvics - as the case is in **Torpedo marmorata** - but differs in ending opposite to the end of the pelvic fins. The second dorsal fin equal about $\frac{1}{2}$ of the first dorsal.

The tail, the electric organs and the gill-slits resemble those in **Torpedo marmorata.**

Torpedo alexandrinsis (Figs. 7 and 8)

Five male **Torpedos** measuring from 25-30 cm. long were obtained from Alexandria together with the previously described two species. However, the new **Torpedos** cannot be referred to any previously described species.

A new species has, trherefore to be created to receive them and I propose to call this species **Torpedo alexandrinsis.**

Confusion may occur between this species and **T. marmorata,** but the new species **T. alexandrinsis** is mainly characterized by its elongated form and the disc being somewhat longer than broad.

The colour of this species is dark brown dorsally, darker small spots and lighter small patches are spread on the dorsal side. The posterior margins of the dorsal fins are creamy. Also the ventral side is creamy, but dark borwn patches are found on the margins of the pectoral and pelvic fins.

The disc is sub-circular, somewhat longer than broad. The median sector of the anterior margin of the disc is slightly outcurved. Eyes are small, about 1/3 of the preorbital length. The length of the spiracle is little larger than that of the eye. The spiracular papillae are seven, but shorter and thinner than those in **Torpedo marmorata.** The nasal curtain is rounded and differs from that described in **Torpedo marmorata** and **Torpedo fuscomaculata** in being much shorter and do not reach the mouth. The mouth is larger than in the preceding two described species. The mouth width is about the preoral length. The teeth are larger than in **Torpedo marmorata.** There are 28-30 rows, and each row has 5-8 teeth of which the anterior 5-6 are functional.

The pectoral fins are thicker than those of **T. marmorata.** They have narrow posterior ends which do not reach to the origin of the pelvic fins.

The pelvic fins are narrower and longer than those in **T. marmorata.** The anterior margin of the pelvic fin is smooth and straight while the posterior margin is nearly sigzag like.

The two dorsal fins are elongated and are less broad in comparison with those of T. marmorata. The first dorsal originates opposite to the posterior part of the pelvic find and ends little posterior to it. The second dorsal fin equals about ½ of the first dorsal.

The electric organs as well as the tail are longer and narrower than in T. marmorata. But the ridge of the tail which separates the dorsal side from the ventral one is very thin.

The gill-slits resemble those of T. marmorata.

II- Internal Anatomy

The identification of the three described species is based on the morphological differences as well as some internal anatomical differences.

The digestive system, the heart and the brain are studied.

1. Digestive System

The digestive system (Figs. 3,6 and 8) is moulded to the shape of the body cavity in each of the three species. Thus, in the elongated **T. alxandrinisis,** the digestive system has a more elongated shape than the other two species.

Mouth and bucco-pharyngeal cavity :

The mouth is compared in the three species in their morphological and systematic description. However, the mouth is small in the bottom living Torpedos compared with other bottom living rays described before Gohar and Mazhar (1964). The teeth are minute, with cusps pointing posteriorly and are suitable for securing the slippery bottom worms, small fishes and small prawns which proved to form most of their diet. The mouth leads into a markedly low dorsoventrally depressed buccopharyngeal cavity. The mucous lining of the roof is thrown anteriorly into a thin incurved fold covering the non-functional posterior teeth. The maxillary valve which is found in rays is present in the .three species as a thick incurved fold, extending from the mucous lining of the roof of the mouth upwards. However, this valve does not hang down as described in most rays (Owen, 1866, and Gohar and Mazhar, 1964).

The lining of the floor of the buccal cavity extends anteriorly as a thick fold which is the mandibular valve. This is anteriorly incurved in **T. marmorata** and **T. fuscomaculata,** but deeply and acutely incurved in **T. alexandrinsis.**

The oesophagus.

This follows the pharynx as a short thick-walled tube, which lies dorsal to the liver. Externally, the oesophagus can be demarchated posteriorly from the stomach by a slight constriction between the two regions.

Internally, the oesophageal lining is thrown into longitudinal folds ranging from 4-6 in number. These are slightly wavy smooth surfaces. The lining forms a wrinkled belt at the junction between the oesophagus and the stomach.

The stomach.

As is the case in most elasmobranchs, the stomach in Torpedo is a more or less U-shaped tube, of which the cardiac region is wide and ends

posteriorly in a small caecum. The pyloric region is narrow and is less thick in walls than the cardiac portion. The mucous lining of the stomach is thrown into high irregularly corrugated walls in the cardiac region. However, the mucous lining of the pyloric portion is thrown into low and faint longitudinal folds. At the posterior end the pyloric lining is more or less smooth passing to the pyloric valve.

The intestine.

a- Duodenum

This part which follows the pyloric valve is thin-walled and has the mucous lining thrown into very thin anastomosing folds, forming a net-like internal wall. This duodenal part leads posteriorly to the valvular portion of the intestine.

Daniel (1934) stated that the duodenum is variable in different elasmobranchs, as it is represented in some species as **Rhinobatis** and **Trygon,** however in the great majority of types, the intestinal valve has so encroached upon the pylorus that no free portion exists e.g. **Galeus, Carcharias,** Lamnidae, Notidanidae, Scyllidae, Rhinidae, and some of the Rajidae. Gohar and Mazhar (1964) described some elasmobranchs having the intestinal valve touching the pyloric valve. However, they described other species with a valve free duodenum.

b- Valvular intestine.

This portion follows the duodenum and leads posteriorly to the colon. The intestinal valve, characteristic to the elasmobranchs, is of the spiral type. This type resembles that described by Garman (1913), white (1937), Ishiyama (1958) and Gohar and Mazhar (1964). Although the spiral type is found in the three described Torpedos yet the number of turns is fixed for each species but varies from one species to the other. In **T. marmorata** the spiral valve consists of twelve thin and low turns. In **T. fuscomaculata** eleven thicker and more elevated turns of the spiraln valve are found. The spiral turns in **T. alexandrinsis** are only nine and are somewhat lower and thinner than in **T. fuscomaculata.** The spiral truns were found to be 12 high turns in **T. panthera** which is an endemic species to the Red Sea (Gohar and Mazhar, 1974).

c- Colon and rectum.

The colon is short, narrow and muscular. It extends posteriorly following the narrow constriction of the valvular intestine. Internally, the lining is thrown into longitudinal very thin and low folds.

Following the colon is a short thin rectum. Internally, the lining is more or less smooth, and the opening of the rectal gland forms a line of demarcation between the colon and the rectum.

Rectal Gland :

This finger-like gland characteristics of elasmobranchs is small and slender

in the members of the Torpedinidae. It possesses a very narrow central canal-like cavity, and is attached to the dorsal wall by means of the posterior mesentry. It lies on the left side of the rectum with the apex pointing towards the axis of the body, and the stalk towards the rectum where it extends at its middle part to open between it and the colon. The rectal gland in Torpedos resembles that described in some rays (**Taeniura, Mobula** and **Aetobatus**) by Gohar and Mazhar (1964).

d- Cloaca

This is conical chamber which lies posterior to the pelvic girdle between the bases of the pelvic fins, with the apex towards the tail. Both the digestive tract and the urinogenital system empty into the cloaca, which leads to the outside by the cloacal aperture. Two papillae are found one on each side of the latero-posterior sides of the cloaca. Each papilla is perforated by an abdominal pore which pust the abdominal cavity into connection with the outside.

Glands of the Digestive Tract:

The liver:

This is a yellowish brown organ which extends along the abdominal cavity just posterior to the transverse septum and covers the greater part of the viscera. It hangs anteriorly by the falciform ligament. It consists of two lobes of nearly equal length, but the left is broader and more voluminous than the right. Both lobes are moulded to the shape of the short abdominal cavity, and completely enclose the alimentary canal between them. The two lobes are connected anteriorly at the vertebral side. The gallbladder is rounded and is partly embeded in the anteriormost part of the right lobe. It drains by a tubular slender ductus choledochus which pours in the latero-dorsal wall of the deodenum.

The liver in the members of the Torpedinidae resembles that of the rays **Taeniura lymma** and **Aetobatus narinari** described by Gohar and Mazhar (1964).

The pancreas :

In the three species of Torpedo, the pancreas is a cream-coloured organ formed of two well-developed lobes; a clear compact triangular ventral lobe, resting terminally on the ventral surface of the proximal left part of the duodenum, and a dorsal oval lobe attached to the former by a short limb, and hidden in a pocket formed by the junction of the suspensory ligament of the spiral intestine, and the gastro-choledochtic omentum. A single commom duct extends from the ventral lobe and passes dorsally to the duodenum to open on the left side of the bile duct.

The spleen:

As in most rays described before (Gohar and Mazhar, 1964) the spleen occurs in the region of the lesser curvature of the stomach as a compact triangular shaped organ.

2. Circulatory System (Fig. 3,6 and 8)

The circulatory system is shown in Fig 3, 6, and 8. It is suggested to deal only with the differences found in the circulatory system of the three species of **Torpedo** described only and some other elasmobranchs described before (Garman, 1885; Daniel, 1928; White 1937; Ishiyama, 1958; Gohar and Bayoumi, 1959; and Gohar and Mazhar, 1964).

The heart is small in **the** three described species, however it is largest **T. alexandrinsis.** Such a small size of the heart suits the limited activity of these bottom inhabitants. This description agrees with that of Gohar and Mazhar (1964), who stated that "the heart differs in size in the different species of the elasmobranchs, not only according to the sise of the animal, ut also according to the mode of life and activity".

The auriculo-ventricular valve has four cusps, though Daniel (1934, p. 171) stated that "this valve consists in elasmobranchs of two pocket-like flaps". However, the four cuspid valve described here in the three species of **Terpedo** agrees with the description of Gohar and Mazhar (1964) to many selachoids and batoids.

The conus arteriosus (Fig. 11) is short in the three species, although it was described to be short in sharks and rather long in batoids (Gohar and Mazhar , 1974). The valves of the conus are constructed on the common plan found in all elasmobranchs, as they are arranged in three longitudinal rows, one dorsal and two latero-ventral. Three valves are found in each row. The anteriormost set of valves has larger and somewhat stronger pockets than the rest. An accessory row consisting of three minute cusps occurs between the dorsal and right latero-ventral rows.

The number of valves in the conus arteriosus, has been subject of discussion from time to time. Garman (1885) suggests that the large number of valves is a primitive character and that reduction has occured in the sharks with the increase in specialization, and he adds that in the rays the rule does not hold so well. This opinion has been accepted by Daniel (1928). In contrast to this view, white (1937) stated that the tendency in the elasmobranchs is for duplication of valves rather than reduction. Gohar and Mazhar (1964) examined thirteen species of sharks, six species of rays and four species of transitional forms, and they concluded that "among batoids the number of valves is small in sluggish and bottom living individuals, increasing with the advance of specialization and the activity of swimming".

However, my specimens agree with the conclusion of Gohar and Mazhar (1964), yet the number of conus valves (three) is less than that in **Torpedo panthera** (four cusps) described by them from the Red Sea. This difference shows that the Mediterranean species are more sluggish than the Red Sea endemic **Torpedo.**

Ventral aorta and afferent branchial arteries:

As in all elasmobranchs, the ventral aorta in the three examined species, continues from the conus arteriosus anteriorly as a tube which passes along the floor of the pharynx, and ends forward at the region of the mandibular symphysis, where it divides into two trunks, a right and a left (Figs. 3, 6 and 8). Each of these divides in turn into two arteries, the first (hyoid) supplies the hyoid arch, and the second supplies the first gill arch as a first afferent branchial artery. The second afferent branchial artery arises separately, while the third and fourth arise from a short common trunk. This is not in agreement with Daniel's statement (1934, p. 172-73) that "in rays in general, only two stems leave the ventral aorta". On the other hand this case agrees with that described in the ray **Dasyatis dipterura** (Daniel, 1934, and in the shark **Nebrius concolor** (Gohar and Mazhar 1964).

3- Nervous System:

The Brain (Figs. 9 and 10):

To study the brain, 40% formaldehyde solution was injected to the head and after allowing it sufficient time to harden, brain was exposed and studied in situ.

In the three examined species, the brain is relatively small and occupies about the posterior half of the brain-case to the shape of which it is moulded. The brain is elongated and somewhat compressed laterally. It is worth mentioning that the general shape of the brain and its situation in the skull differs from the rays but resembles pelagic sharks as **Heterodontus francisci** (Daniel, 1934), **Galeocerdo cuvier** and **Nebrius concolor** (Gohar and Mazhar 1964); and **Squalus fernandinus** (Mazhar 1974).

As usual in elasmobranchs, the brain in these species is made up of five divisions, the telencephalon, the diencephalon, the mesencephalon, the metencephalon and the myelencephalon.

The Telencephalon (Figs. 9 and 10)

This is the anterior part of the fore brain. Dorsally, the telencephalon appears as a compact rounded mass resembling the sharks more than the rays described by Gohar and Mazhar (1964). The bilobed nature found in some elasmobranchs e.g. **Heterodontus francisci** (Daniel, 1934, p. 231),

is indicated by an anterior sulcus. The dorsal surface of the telencephalon is elevated to form the so-called pallial eminences.

The median olfactory nucleus is rounded and is directed ventrally. It is separated dorsally from the pallial eminences by a superficial transverse sulcus, the pallial sulcus.

Ventrally, a median superficial septum, divides the telencephalon into two massive corpora striata.

On either side of the telencephalon, two small olfactory lobes bulge laterally and are attached dorsally to the median olfactory nucleus and ventrally to the corups striatum. The olfactory lobes join the olfactory bulbs posterior to the corresponding olfactory organ by means of the olfactory tracts. These are thin and markedly long as the brain occupies a posterior position in the brain-case. Each olfactory tract diverges towards its corresponding olfactory organ.

The Diencephalon (Figs. 9 and 10)

This is an elongated continuation to the telencephalon. The diencephalon encloses a vavity - the third ventricele - roofed by a thin layer, the anterior choroid plexus. A ganglionic part the, "habenular ganglion", from which the pineal stalk had arisen is found in the middle of the thin roof of the diencephalon.

Ventrally, the diencephalon continues posteriorly, gradually narrowing to the place of the optic chiasma. From the posterior and ventral surface of which the infundibulum hangs down and backward. On each side of the infundibulum, lies a rounded small inferior lobe anteriorly, and a thin oval vascular sac posteriorly. The pituitary organ lies as an elongated part along the middle portion in between the case of both sides. The pituitary and the sacs are developed, as is the usual case in elasmobranchs, but the saccus vasculosus which is believed to be particularly well developed in deep-sea fish and is thought to be a pressure receptor (Dammerman, 1910) is less developed, because the described species of the Torpedinidae are shallowwater inhabitants which spend most of the day out of sight burried in the sand or mud.

The Mesencephalon (Fig. 9)

The roof of the mesencephalon is composed of a right and a left rounded optic lobes, which are clear dorsally although partly covered posteriorly by the cerebellum.

The Metencephalon (Fig. 9)

This segment of the hind brain is well developed, the usual case in elasmobranchs. Dorsally, the metencephalon is developed into a large smooth cerebellum. This is smooth and its dorsal surface appears as four equal parts, as a transverse superficial sulcus crosses the middle of a longitudinal one. The cerebellum in this bottom-living ray agrees with that

of the pelagic sharks, and on the other hand differs from the bottomliving sharks and rays, where the cerebellum tends to be lobulated (Gohar and Mazhar, 1964; and Mazhar 1974).

The Myelencephalon

This is the last segment of the brain formed of the medulla oblongata. As in all elasmobranchs, it is a Y-shaped structure, the anterior limbs of the Y being ear-like structures which are the restiform bodies (corpora restiform). These are clear dorsally and form the lateral boundaries of the cavity of the medulla oblongata, the fourth ventricle. This is seen dorsally as a traingular elongated space through a thin translucent roof, the "tela choroidea". The medulla tapers gradually rearwards to the spinal cord.

The Cranial Nerves:

I. The Olfactory Nerve (Figs. 9 and 10)

This nerve is thin, long and extends from the olfactory bulb forward to the epithelium olfactory capsule.

II. The Optic Nerve (Fig. 10)

This nerve is slightly developed, and originates from the diencephalon, then the two nerves cross to form the optic chiasma. Each nerve passes upwards and laterally penetrating the lateral side of the chondrocranium through the optic foramen, to the retina of the eye.

III. The oculomotor nerve (Fig. 10)

This nerve originates from the floor of the mesencephalon as a slightly developed one. It passes under the associated structures of the infundibulum toward the lateral side of the chondrocranium, penetrating it through the oculomotor foramen and passing to the muscles of the eye where it gives four branches, three of which to the internal, superior and anterior rectus muscles (respectively) and the fourth to the inferior oblique muscle of the eye.

The degree of development of the optic and the oculomotor nerves in these sluggish Torpedos agrees with their poorly developed eyes. Gohar and Mazhar (1964), stated that "these two nerves are best developed in strong swimmers of elasmobranchs, where sight is most needed, moderately developed in the benthic forms and poorest in the sluggish forms".

IV- The trochlear nerve (Fig. 9)

It is a thin long nerve which arises from the roof of the mesencephalon, at the posterior end of the optic lobe. It passes upwards and penetrates the chondrocranium, through a small trochlearis foramen and passes to supply the superior oblique muscles of the eye.

V- The trigeminal nerve (Fig. 10)

This nerve is thick and arises from the ventrolateral surface of the

anteriormost portion of the medulla oblongata. It is directed a short distance anterolaterally, and then passes through the trigeminal formen together with the buccalis branch of the facial. Then the trigeminal nerve divides into its three branches, the ophthalimcus, maxillaris and mandibularis.

VI- The abducens nerve (Fig. 10)

This nerve is short and arises from the ventrolateral surface of the medulla oblongata, just below the origin of the trigeminal, then passes outwardly and leaves the brain through an abducens foramen (just posterior to the trigeminal foramen), and proceeds to supply the external rectus muscle of the eye.

VII- The facial nerve (Fig. 10)

This nerve is thick and arises in two roots. The first root originates from the ventro-lateral side of the medulla oblongata just posterior to the trigemenal. The second root originates from the lateral side of the medulla oblongata from a point under dorsal to the first root. The buccalis branch of the facial joins the trigeminal, while the other root passes outwards for a short distance to come out through the facial foramen and gives rise to its branches, the ophthalmicus, the hyomandibularis and the palatine.

VIII- The auditory nerve (Fig. 10)

This nerve is very short and arises separately from the ventro-lateral side of the medulla oblongata, dorsal to the origin of the facial nerve. It passes laterally penetrating its own foramen to supply the auditory capsule of its side.

IX- The glossopharyngeal nerve (Fig. 10)

This comes out from the lateral side of the medulla oblongata, somewhat posterior to the facial nerve and very close to the origin of the vagus nerve. It is then directed, a little outwards posteriorly side by side with the vagus and then penetrates the lateral wall of the skull separately through its own foramen, the glossopharyngeal foramen to supply the first gill

X- The vagus nerve (Fig. 10)

This nerve is markedly thick and arises with six maxillaries from the lateral wall of the medulla oblongata, just posterior to the glossopharyngeal origin. The roots of the branches are short and penetrate the lateral wall of the skull through one foramen, the vagus foramen. The first four branches extend to supply the last four gills, while the fifth and sixth branches extend side by side to a short distance posteriorly and laterally, then the fifth which is the ramus visceralis diverges lateralwards and the sixth which is the ramus lateralis extends nearwards as it is sensory to the lateral line canal all the way to the tip of the tail.

Nerves Supplying The Electric Organs (Fig. 10)

The electric organs in **Torpedo** are abundantly supplied with highly developed nerves. Each electric organ receives one branch of the trigeminal

nerve and four branches of the vagus nerve (Vagus branches which supply the last four gills). These nerves are thick and all arise together from a special lobe of the brain, known as the "lobus electricus" (Bigelow and Schroeder, 1953). Distally, the nerves branch again and again into smaller branches which penetrate the ventral surface of the electric organ and pass to the dorsal side dividing through their way into numerous smaller nerves. Bigelow and Schroeder (1953) mentioned that "the discharge produced by the electric organ as a whole passes through the latter from the ventral side toward the dorsal".

The electric shocks produced by the electric organs enable Torpedos to stun smaller fishes, so that they may easily be captured.

SUMMARY

1. Three species of the genus **Torpedo** (**T. marmorata, T. fuscomaculata** and **T. alexandrinsis**) are reported from Alexandria shores.

2. The external morphology of the three species is studied and taxonomically treated and a key for their identification is elaborated.

3. **Torpedo fuscomaculata** is a new record to the Mediterranean.

4. A new species, **T. alexandrinsis** is described.

5. The anatomy of the digestive system, the heart and afferent branchial vessels and the nervous system is given.

LIST OF ABBREVIATIONS

Ab. N.VI, abducens nerve; Ad. C., Abdominal cavity; AFA 1, 2, 3, 4, first, second, third and fourth afferent branchial arteries; Ao. V., ventral aorta; At., Atrium; Aud. N. VIII, Auditory nerve; CS., cardiac stomach; Cb., cerebellum; Cl.O., cloacal opening; Cls, clasper; Cn.,colon; Cn.A., conus arteriosus; Corp.Rs., corpora restiforme; Du., duodenum; Fac.N.VII, facial nerve; Glos.IX., glossopharyngeal; HA., hyoid artery.

LvL., liver left lobe; LvR., liver right lobe; MOB., medulla oblongata;

N.S., nasal septum; N., nostril; Ocu.N.III., oculomotor nerve; Ol.N. med., median olfactory nucleus; ORT., olfactory tract; Olbr., right optic lobe; Pn.Vn., ventral lobe of pancreas; PlEm., pallial eminences; Pi., pituitary; PS., pyloric stomach; RC., rectum; RcG., rectal gland; SpVa., spiral valve; SnCd., spinal cord; Trig.V., trigeminal nerve; Tro.N.,IV., trochlear nerve; Va.1-3, first to third valve; Va.II, secondary valve; Vag.X, vagus nerve; Vc., ventricle.

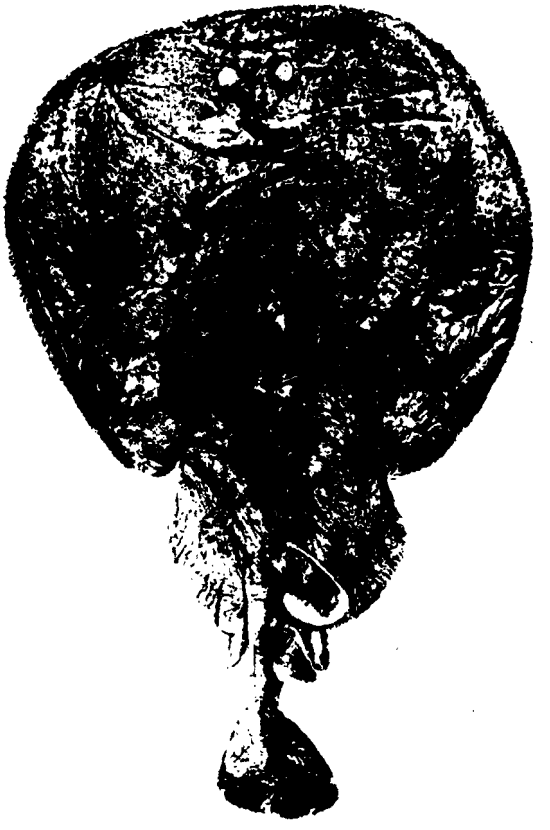

Fig. 1. **Torpedo marmorata** Risso, 1810.
Dorsal view.

Fig. 2. **Torpedo marmorata** Risso, 1810.
Ventral view.

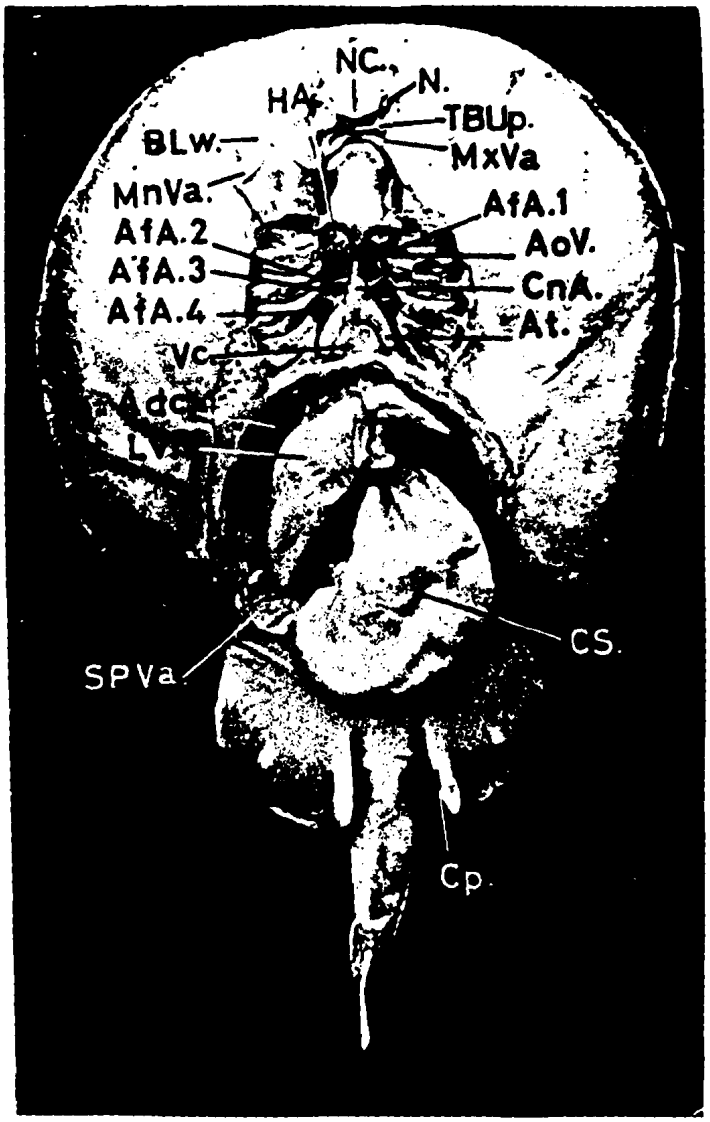

Fig. 3. **Torpedo marmorata**, ventral view dissected to show heart and digestive system.

Fig. 4. **Torpedo fuscomaçulata** Peters, 1855.
Dorsal view.

Fig. 5. **Torpedo fuscomaculata** Peters,1855.
Ventral view.

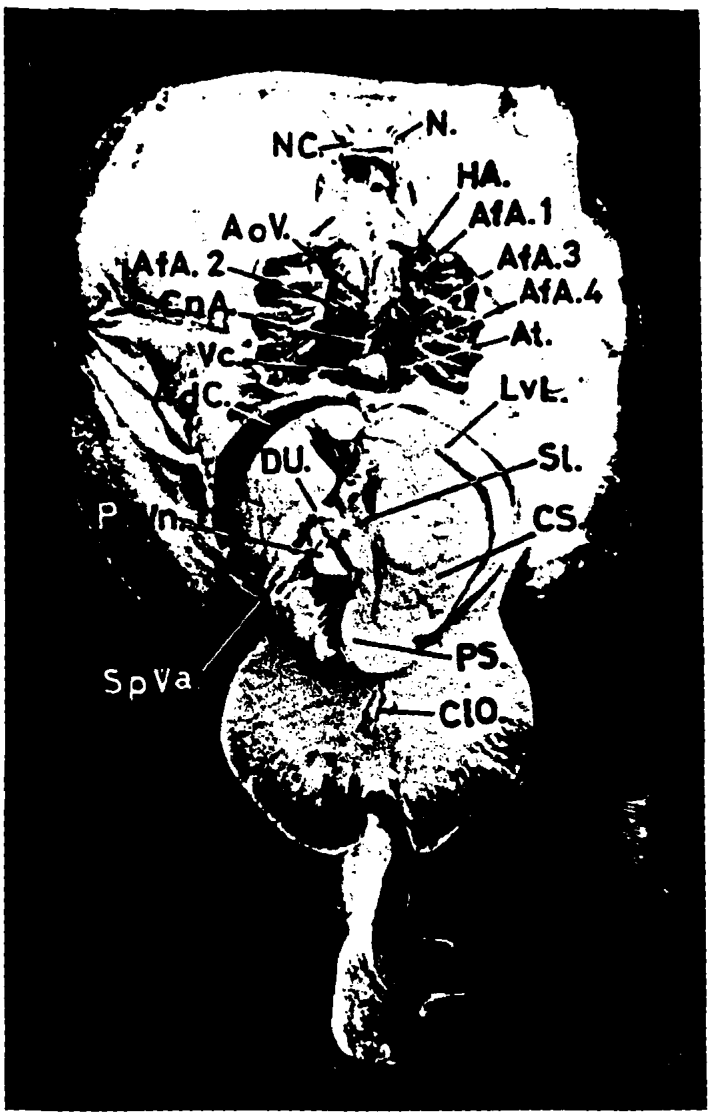

Fig. 6. **Torpedo fuscomaculata**, ventral view dissected to show heart and digestive system.

Fig. 7. **Torpedo alexandrinsis** Sp. nov.
Dorsal view.

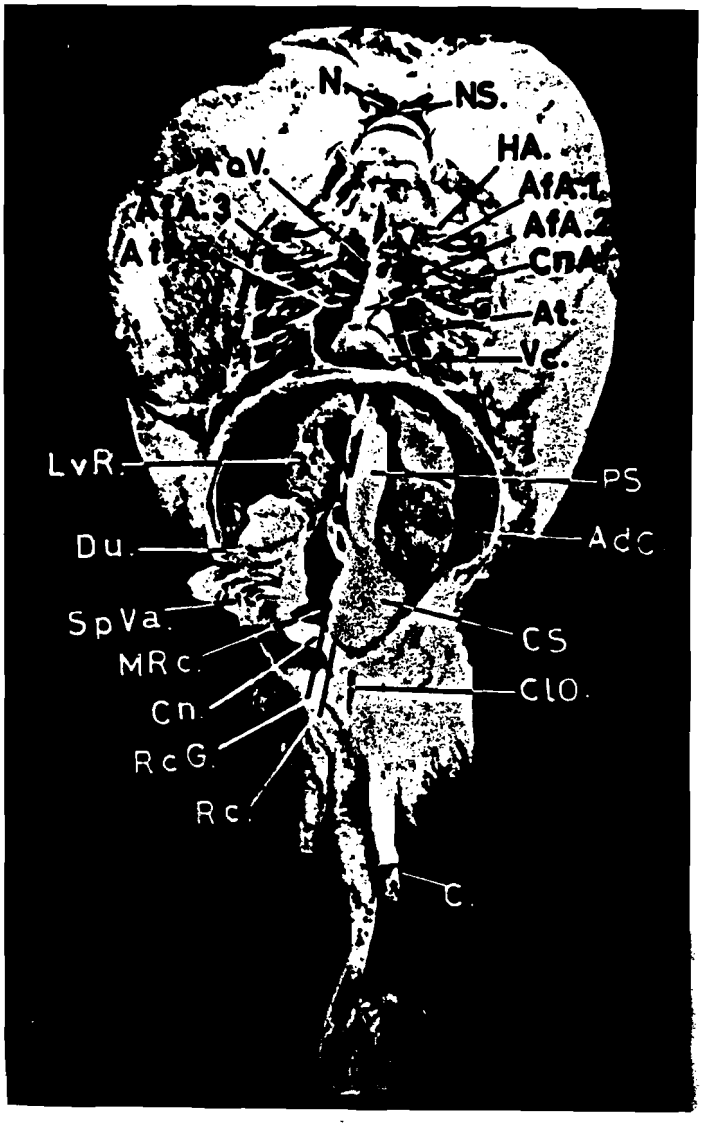

Fig. 8. **Torpedo alexandrinsis**, ventral view dissected to show heart and digestive system.

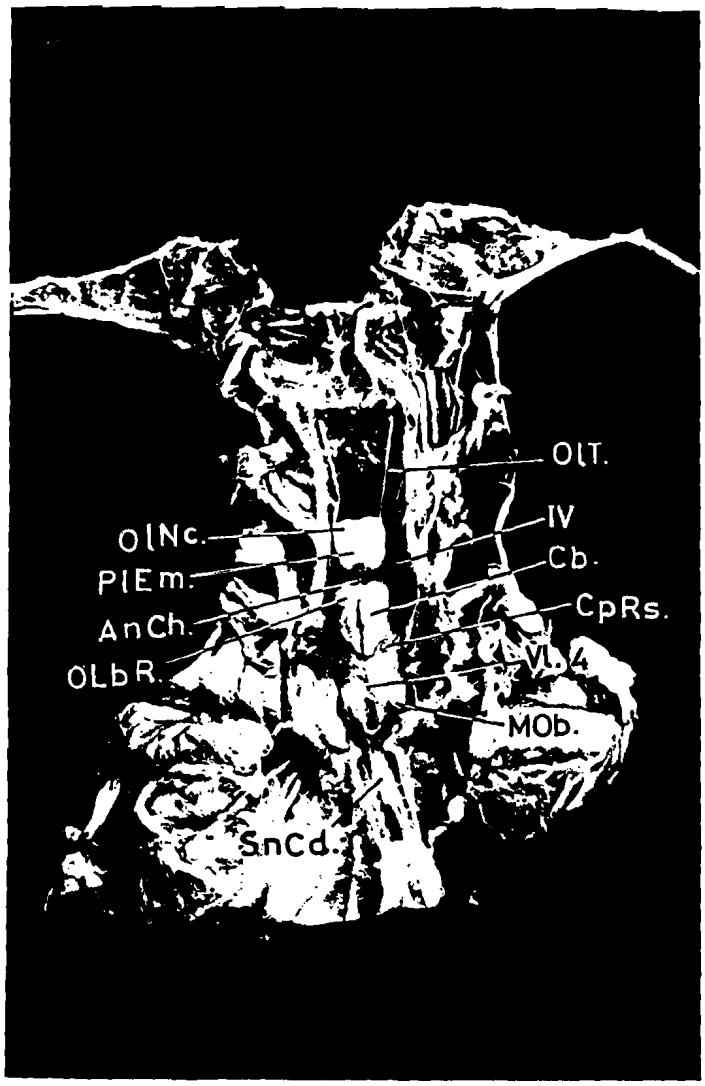

Fig. 9. Torpedo marmorata,
dorsal view of brain in situ.

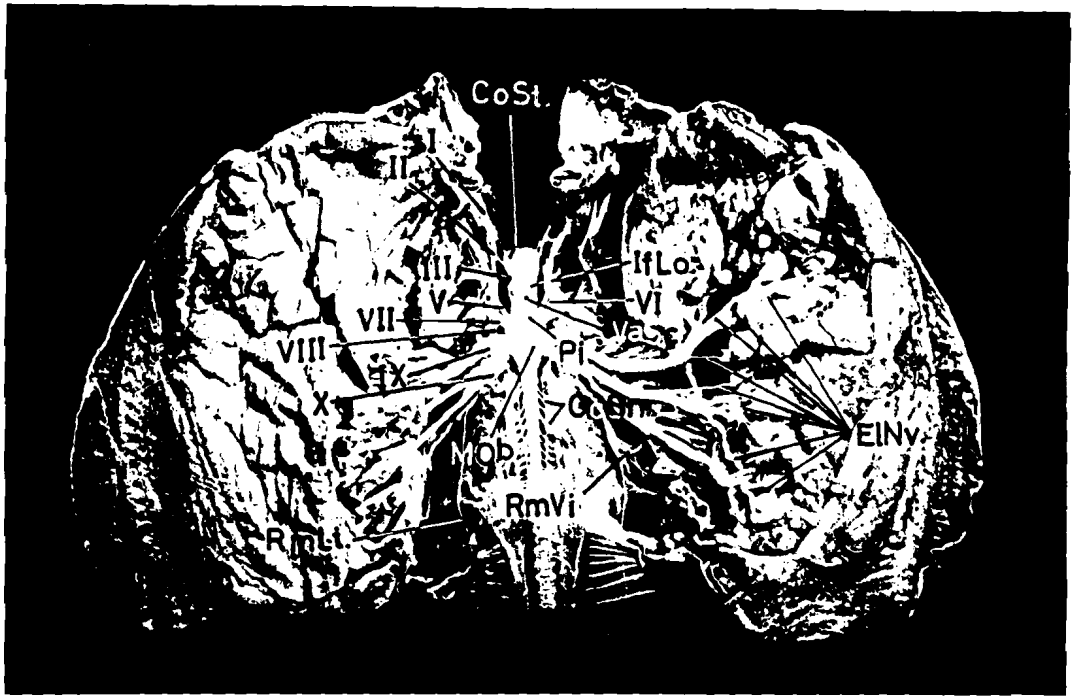

Fig. 10. **Torpedo marmorata**, ventral view of brain, cranial nerves and electric organs. The left electric organ is dissecated to show the nerves branches penetrating to the dorsal side.

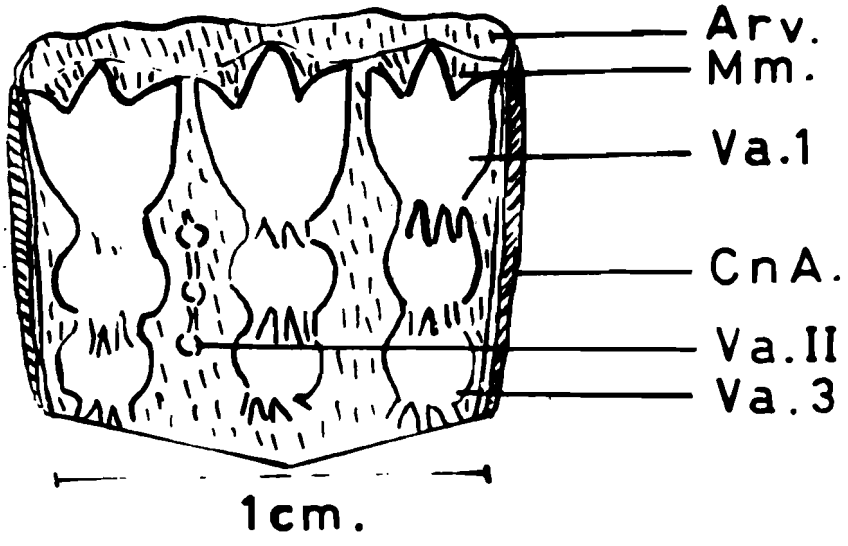

Fig. 11. **Torpedo marmorata**, conus arteriosus opened from ventro-lateral side to show valves.

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