

GUTBERLET

On the Osteology of some of the Loricati

Zoology

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ON THE OSTEOLOGY OF SOME OF THE LORICATI

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JOHN EARL GUTBERLET

A. B. Bethany College, Kansas, 1909

THESIS

Submitted in Partial Fulfillment of the Requirements for the

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

John Earl Gutberlet, A.B. Bethany College, Kansas, 1909

ENTITLED On the Osteology of some of the Loricati

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Master of Arts

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INTRODUCTION.

The suborder LORICATI is characterized by the extension of the third suborbital bone across the cheek to the preopercle. This group has a wide range of variation and Gill has divided them into several families, of which the rock fishes, or SCORPAENIDAE, are more generalized and the sculpins, or COTTIDAE, are the most specialized. The family HEXAGRAMINIDAE comes between the two extremes, being more nearly related to the SCORPAENIDAE than to the COTTIDAE.

The purpose of this paper is to make a comparative study of the osteology of these forms in order to determine their relationship. Allen ('05) states that there are many points of resemblance to the COTTIDAE to be found in their osteology, visceral organs and vascular systems, and that Ophidon is about as closely related to Scorpionichthys, a sculpin, as it is to Hexagrammos, and should be regarded as a type of a distinct family.

For this study Ophidon elongatus and Hexagrammos decagrammos of the HEXAGRAMMIDAE and Scorpionichthys marmoratus of the COTTIDAE were selected. The material was collected at Monterey Bay, California by Wm. F. Allen under whose direction the work was carried on at the Zoological Laboratory of the University of Illinois.

OPHIDON ELONGATUS

THE SKULL

Except for a few ridges and grooves the entire dorsal surface (Fig.1) is flattened. On the anterior half there is a median rectangular groove which extends from between the posterior boundaries of the orbits to the median ridge of the ethmoid. Posterior to the groove the parietals form a ridge on either side extending laterally and posteriorly from the median line to the lateral edges of the epiotics. These ridges are continuations of the long rounded ridges of the frontals that form the sides of the rectangular groove. The surface of the frontals, posterior to the orbits, is somewhat porous and has striations which pass caudad and mesad from the edge of the orbits toward the parietals.

The TEMPORAL FOSSA (Fig.1,TF) are formed by the pterotics, frontals, parietals and epiotics. They extend caudad from the latero-posterior edge of the frontal to the caudal end of the skull. In the anterior half it is comparatively shallow but throughout the posterior half it has a depth of nearly one third that of the skull. The fossa harbour some of the muscles for the shoulder girdle.

DILATATOR FOSSA (Fig.2) are pits which occur on the dorso-lateral edges of the skull, directly above the two articular facets of the hyomandibular. Anteriorly, the pit lies in the sphenotic and posteriorly in the pterotic. The pterotic forms the greater part of the roof of the pit while the most dorsal edge of the pterotic forms a part of the ventral edge. Two foramina are present in the pit for the branches of the oticus vessels.

The arch of the pterotic which forms the bridge over the foramina for the fifth and seventh nerves, the jugular vein and the external carotids is conspicuous in Ophidon. It begins at the anterior central portion of the bone and extends dorsad to the ventral edge of the anterior articular facet of the hyomandibular on the sphenotic.

The vomer(Fig. 1, V) is the anterior bone of the skull and caps the cartilage from the ends of the ethmoid and the prefrontals. It possesses both dorsal and ventral processes. The dorsal and anterior one passes upward and posteriorly and articulates with the ethmoid and prefrontals, while the ventral one forms a part of the ventral surface. It passes posteriorly and gradually tapers to a point in the parasphenoid. A V-shaped slit is present in the dorsal process and forms a trough like cavity with the ventral process, allowing the cartilaginous portion of the ethmoid to pass into it. The anterior edge is broad V-shaped in the median line and rounded from the median portion laterad forming a large expansion at each side. Two kinds of teeth are present on the vomer, an inner row of large canine shaped ones and an outer row of ^{the}villiform variety, in which the teeth are irregularly arranged. Both kinds are slightly curved caudad and are placed in sockets. The maxilla and premaxillary both articulate just above the vomer and cover it entirely.

ETHMOID.

The anterior dorsal portion of the ethmoid(Fig. 1,6, ETH) is strongly keeled while the posterior portion is concave longitudinally and ends between the frontals where it tapers to a point. There is a narrow median ridge on the keeled portion extending its full length with a V-shaped slit in the anterior end. The ventro-lateral depression of the anterior portion forms a cavity between it and the prefrontal, which are the ventral and mesial walls of the nasal pit. The concave portion possessing the longitudinal groove is formed by a dorso- lateral expansion on either side at its anterior end. From this point the groove passes caudad and becomes a part of the rectangular groove between the ridges of the frontals. The sides of

the posterior portion are concave from the point at which the lateral expansions extend out from the median line. On each side of the lateral concave surfaces there is a deep pit produced by several pores.

PREFRONTAL.

The paired prefrontals, or ectethmoid (Fig. 1, 6, PFR) are lateral to the ethmoid and anterior to the frontals. They are lateral expansions from the ethmoid and the frontals having a broad base-like portion and a wing-like portion extending out from it. It forms the anterior boundary of the orbit. The anterior portion is somewhat ventral and has a shelf like appearance by the side of the ethmoid on account of a depression on its dorsal edge at the anterior end. This depression together with a similar depression on the latero-ventral surface of the ethmoid forms a part of the nasal pit. The wing like expansion is narrow anteriorly but broad and flattened dorso-ventrally. The end is rounded off forming a facet for its articulation with the palatal and the first exorbital bone. A small ventral process is present on the wing which meets a process from the palatine. From the base of the wing like portion the bone flattens out antero-posteriorly as it extends ventro-mesad to its articulation with the parasphenoid. There is a foramen through the wing near its suture with the ethmoid through which passes the olfactory nerve and also the orbito-nasal vein and artery to the nasal pit. Above the point where the prefrontal unites with the parasphenoid they come in contact with each other in the median line holding between them the ventral edge of the cartilaginous orbito-sphenoid which extends dorsad and caudad forming a partial partition between the orbits.

FRONTAL.

The paired frontals (Fig. 1, 6, FR) form the greater part of the dorsal

surface of the skull. At the anterior end of each there is a small groove produced by pores in the bone. The lateral edges of the anterior portion form the mesial boundaries of the orbits. The posterior portion broadens out and forms the posterior and dorsal boundaries of the orbits. At this point the frontals are slightly rounded dorsad and the bone is somewhat porous possessing several striations which originate at the posterior boundary of the orbit and radiate caudad and mesad to the median line and to the parietal bones. The lateral edges of the posterior portion form the mesial border of the anterior part of the temporal fossa. At the lateral edge on the posterior border of the orbit it unites with the sphenotic. The lateral edge of the frontal rests on the prefrontal and the mesial edge rests on the ethmoid. In the median line on the ventral surface there is a cartilaginous orbito-sphenoid bone extending to the parasphenoid forming a partial partition between the orbits. The ventral surface of the roof of the orbit is filled with large pores and two deep grooves which become deeper as they pass caudad into the deeper part of the frontal. The mesial edge of the inner groove forms a large flange which projects ventrad along the lateral edge of the brain case. The outer edge of this flange narrows down, and as it passes ventrad it is drawn out to a thin process; this flange and the thin process clasp between them the small alisphenoid, as in Scorpaena described by Allis. The ventral surface of the posterior portion is smooth and forms the roof of the brain case in connection with supra-occipital, which forms a plate beneath the parietals and posterior part of the frontals.

POST FRONTAL.

The post frontal (Fig. 1, 6, PFO) is a small tube like bone similar to the one described by Allis in Scorpaena scorpus except that it is

without spines. It lies on the dorsal surface of, the sphenotic on the part that is not covered by the frontal and pterotic. The tube extends from the lateral edge of the sphenotic caudo-mesad to the anterior end of the temporal fossa.

SPHENOTIC.

The sphenotics(Fig. 1, 6, SPO) are located at the lateral margins of the skull just posterior to the orbits and they in conjunction with the lateral expansions of the frontals form the posterior boundary of the orbit. The dorsal surface of this bone is nearly flat with the exception of the groove formed for the post-frontal bone which lies within it. It thus forms supports for the frontal, the postfrontal and the pterotic. It forms anterior, lateral and ventral portions of the skull. The anterior end borders on the orbit and the ventro-lateral edge forms a facet for the articulation with the anterior head of the hyomandibular. Directly dorso-anterior to the facet is a roughened surface which serves for the attachment of one of the palatal muscles. Dorso-posterior to the facet is a depression which is the dilatator fossa. The posterior part of the sphenotic forms the anterior part of the depression for the fossa. Between the dorsal part of the sphenotic and the frontal, beneath the post-frontal, there is a small recess which transmits one of the branches of the oticus vessels. The sphenotic forms a part of the internal brain case; the internal part being smooth and is possessed of two depressions which are separated by a thin partition of bone which extends mesad into the brain cavity.

PROOTIC.

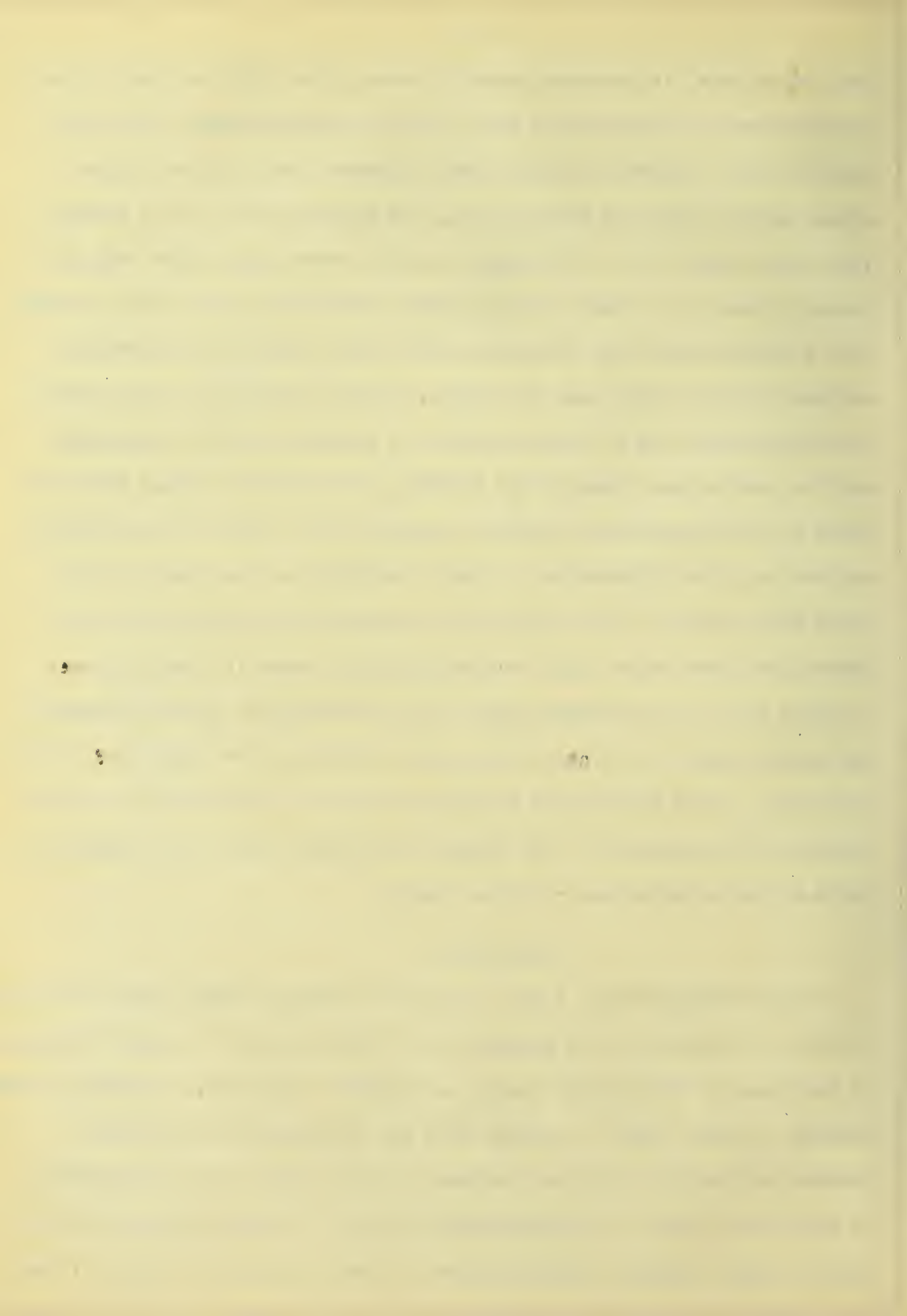
The prootic(Fig.6,PRO) forms a large part of the lateral surface of

the skull. It is bounded dorsally by the sphenotic and pterotic, anteriorly by the alisphenoid and the dorso-lateral process of the parasphenoid, ventrally by the parasphenoid and posteriorly by the basi-occipital and exoccipital. Mesially it articulates with the basisphenoid and the prootic of the opposite side. On the ventral surface it is overlapped by the lateral edges of the posterior portion of the parasphenoid. The prootics form the lateral walls of the brain case and also the roof and walls of the myodome. The brain cavity and the myodome are separated by a mesial longitudinal partition like process which unites with a similar one from the opposite side in the median line. This partition originates at the basioccipital, which also forms the posterior part of the floor of the brain case, and extends dorso-cephalad until it reaches the processes which support the T-shaped basisphenoid leaving a small wedge shaped slit between the basisphenoid and the partition, for the opening of the pituitary body from the brain case. In the partition near the lateral wall just posterior to the process that supports the basisphenoid there is a small foramen perforating the partition, which is for the sixth nerve. Between the prootic, alisphenoid and the dorso-lateral process of the parasphenoid there is a large foramen through which passes the anterior cerebral vein, the ciliary nerve and ciliary artery. On the front edge of the foramen and slightly mesad, at the base of the process supporting the basisphenoid, there is a second small foramen through which the third nerve passes. On the lateral surface of the prootic ^{there} is a bridge or arcade, the prootic arcade, which is located slightly dorso-posterior to the foramen, between the bones just described, and directly ventral to the anterior articular facet for the hyomandibular on the sphenotic. This arcade partly shelters two foramina. The anterior and larger one is for the passage of

the juglar^v vein, the external carotid artery, the fifth and part of the seventh nerves. The posterior one is for the hyomandibular part of the seventh nerve. There is another small foramen just anterior to the arcade which is for the fourth nerve. The arcade forms an arch through which the jugular vein and external carotid artery pass after they have passed through the foramen. On the inner surface the brain case is smooth with a large broad ridge produced by the broad groove on the external surface extending from near the middle, directly posterior to the arcade to the posterior end of the bone where it sutures with the exoccipital and the ventral most edge of the pterotic, and continues caudad with the ridge on the exoccipital. Directly ventral to the ridge on the internal surface is a deep depression or groove bordering on the floor of the brain case parallel to the ridge and extending the length of it. This groove continues caudad into the basioccipital where it finally forms a recess with the overhanging edge of the exoccipital. Directly beneath the arcade there is a flange-like process extending from the floor of the brain case to the dorsal edge of the bone where it unites with a similar process of the sphenotic. This flange like process forms two recesses for parts of the anterior semi-circular canal.

ALISPHEOID.

The alisphenoids (Fig. 6, ALS) are small irregular bones located ventral to the articulation of the sphenotic and frontal where it is held in place by the clasp of the ventral flange and slender ventro-mesial process of the frontal. It also comes in contact with the parasphenoid and prootic ventrad and caudad. The outer surface is porous while the inner surface is smooth and forms the latero-anterior edge of the brain case. There is found a large foramen, postero-ventral to the alisphenoid, between it and



the prootic and the dorso-lateral process of the parasphenoid, through which passes the anterior cerebral vein, the ciliary artery and the ciliary nerve. Allis('09) found a small foramen for the anterior cerebral vein perforating the alisphenoid in Scomber, Cottus, Trigla, Peristedion, Dactylopterus, and Scorpaena and states that Allen('05) did not describe it in Ophidon. I do not find a foramen perforating the alisphenoid in Ophidon nor do I find it in Scorpionichthys. The anterior cerebral vein in Allen's('05) description passes through the foramen formed by the prootic, the dorso-lateral process of the parasphenoid and the posterior edge of the alisphenoid.

PARASPHENOID.

The parasphenoid(Fig.6,PS) is the **longest** bone of the skull and forms the ventral surface of the entire length of the skull with the exception of the process of the vomer which passes caudad into the parasphenoid. The anterior portion is almost perfectly straight on the ventral surface, while the posterior portion is slightly curved upward and the edges of the bone turn up dorso-laterally from the edge the entire length of the bone. In the middle portion the edge extends upward into a long process which extends dorso-laterally to the edge of the alisphenoid. Directly posterior to the process in the angle between it and the prootic there is a foramen through which the internal carotid artery passes. The entire length of the bone has a concave longitudinal groove on the dorsal surface which, in the anterior portion, is divided by a tall partition which extends from a point immediately anterior to the tall processes to the anterior end of the bone, where it terminates in the ethmoid and the vomer. At the anterior^{end} there is a V-shaped slit on the ventral edge for the postero-ventral

process of the vomer; the posterior end also has a V-shaped slit extending cephalad which is the posterior opening of the myodome. The dorsal surface of the posterior portion forms a part of the floor of the myodome between the prootics and the two tall dorso-lateral processes of the bone itself. This portion also forms a support for the prootics and the basioccipital.

BASISPHEOID.

The basisphenoid (Fig. 6, BS) is a T-shaped bone forming the anterior part of the roof of the myodome being attached to the processes extending mesad from the prootic just postero-ventrad to the alisphenoid. The pedicle is curved ventro-cephalad to the parasphenoid where it is united to it by a bulb of cartilage. It is laterally flattened and the rest of the bone between the prootic processes is dorsally flattened but rounded ventrally and slightly curved cephalad at the point where the pedicle process projects out.

PTEROTIC.

The pterotics (Fig. 1, 6, PTO) are bones that form the lateral edges of the dorsal surface of the skull, posterior to the sphenotics and the post-frontals. They form the lateral borders of the temporal fossa. On the dorsal edge of the bone there is a narrow ridge from the anterior end to beyond the middle of the bone. From the ridge the bone gradually slopes to the lateral edge of the skull. A foramen is present on the surface at the posterior end which is for a lateral line canal. The whole surface is more or less perforated. The lateral surface of the pterotic is bounded cephalad by the sphenotic and the prootic and ventrally by the prootic, exoccipital, and opistbotic. At the anterior end of the bone there is a depression which forms the posterior edge of the dilatator fossa.

Immediately posterior and slightly dorsal to the dilatator fossa is a facet for the articulation of the posterior head of the hyomandibular. Posterior to the facet is a broad shallow groove, the dorsal edge ^{of bone} forming the edge of the groove, extending to the posterior end of the bone where it narrows down with the bone itself. Ventro-caudad to the facet there are two or three, more or less developed ridges extending from the lower edge of the facet to the ventro-posterior edge of the bone where it suturates with the opisthotic. The ventral edge of the bone curves inward rapidly thus forming a broad rounded ridge between the facet ~~and the facet~~ and the point where it unites with the prootic and the exoccipital. The antero-ventral edge of the facet forms a flange like shelf and beneath it is a slight depression forming a broad groove together with a flange-like expansion of the prootic, extending from that point antero-ventrally onto the the prootic. The inner surface of the pterotic forms the dorso-posterior part of the lateral wall of the brain case; there being a large cavity passing latero-caudad from the main portion of the brain case and lying ventro-mesad to the facet of the hyomandibular. This cavity harbors a part of the external semicircular canal.

EPIOTIC.

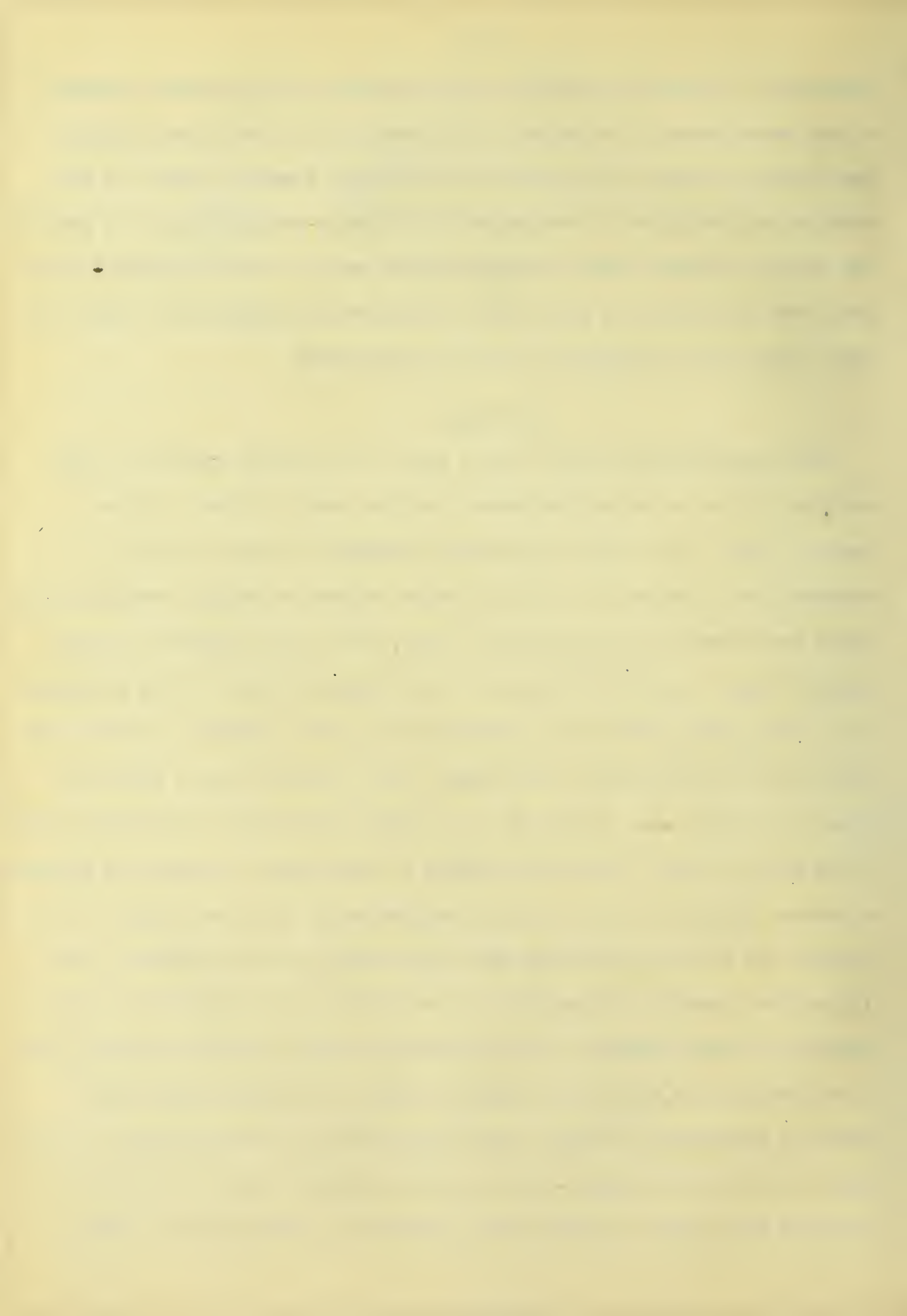
The epiotics (Fig. 1, EPO) form a part of the dorsal surface of the skull. Its lateral surface forms the mesial boundary of the temporal fossa; its mesial edge forms the lateral border of the supra-temporal pocket. The bone is bounded laterally by the posterior process of the parietal and pterotic; ventrally and postero-ventrally by the exoccipital and mesially by the supra-occipital. It forms a tall ridge extending postero-laterally as far caudad as the pterotic and the opisthotic above the



exoccipital and nearly parallel to the pterotic. On the dorsal surfaces at the caudal ends of the epiotic and pterotic lies the supra-scapular, thus forming a roof at the posterior end of the temporal fossa. At the anterior end the bone is overlapped by the supra-occipital and the parietal. The internal surface forms the dorso-caudal wall of the brain case, this part forms posteriorly a pocket for the posterior semicircular canal directly above and in connection with the exoccipital.

PARIETAL.

The parietals (Fig. 1, 6, P) form a part of the dorsal surface of the skull. The lateral edges of the bones form the mesial borders of the temporal fossa. This bone is somewhat irregular in shape with its broadened end cephalad and a long slender process extending caudad slightly dorsal and laterally on the epiotic ridge, and in this position projects over and forms a part of the roof of the temporal fossa. At the posterior end of the process there is a foramen which passes cephalad into the bone forming one of the lateral line canals. This process forms a ridge and extends antero-mesiad uniting with a similar ridge from the opposite side in the median line. The dorsal surface of the ridge is porous and possesses several striations which extend longitudinally with the ridge. At the anterior end the bone suturates with the frontal and is supported laterally by the pterotic and mesially and ventrally by the epiotic and supra-occipital. In the suture of the parietal and supra-occipital on each side of the median line, there is a foramen through which passes the ramus lateralis accessorius vessels. The inner surface of the bone lies on the dorsal surface of the supra-occipital for the most part, but lateral to the plate like supra-occipital which covers the greater part of the



cranial cavity, the parietal forms a part of the dorsal surface of the cavity where it arches over the space between supra-occipital and pterotic

OPISTHOTIC.

The opisthotic(Fig.6,OPO) is a small plate-like bone, oval in outline. It lies between the pterotic and the exoccipital. The antero-dorsal edge overlaps the postero-ventral edge of the pterotic and the ventral edge overlaps the exoccipital thus forming the latero-caudal edge of the skull. It is drawn out caudad into a rounded process which projects beyond the exoccipital and even with the pterotic. The opisthotic forms the posterior lateral wall of the temporal fossa from the point of its union with the pterotic on the mesial surface. The posterior end of the bone has a bulb like appearance and is united by a cartilaginous ligament to the supra-scapular.

EX-OCCIPITAL.

The exoccipitals(Fig. 1,6,8,EO) are irregular bones which form a part of the lateral and a part of the posterior surface of the skull and of the brain case. A well defined angle lying ventral to the opisthotic separates the lateral from the caudal surfaces. That part which forms the posterior portion lies directly below the epiotic and a part of it forms the base of the epiotic ridge. The dorsal edge also borders on and forms the posterior edge of the floor of the temporal fossa. That part posterior to the angle extends backward and forms a rounded head, the condyle process, which looks caudad and slightly ventrally, articulating with an anterior process of the first vertebra. The condylar processes lie dorso-laterally to the basioccipital and laterally to the foramen magnum. Ventral to the epiotic ridge and the temporal fossa, the bone

extends caudad and mes_ad and unites in the median line with its fellow from the opposite side and forms the roof of the medulla oblongata. It is overlapped in the median line by a ventro-posterior process of the supra-occipital. Slightly above the angle separating the posterior and lateral surfaces there is a small depression or groove, lying dorso-cephalad to the condylar process, extending up to the posterior end of the temporal fossa. The lateral surface of the bone is irregular in shape and possesses a broad deep groove extending from slightly anteriorly to the angle separating the lateral and posterior surfaces to about the middle of the prootic. At the posterior end of the groove there is the foramen for the vagus nerve ~~and~~ and slightly anterior to this one, another foramen perforates the bone in the same groove, that of the glossopharyngeus nerve. On the posterior end, on the dorsal surface anterior to the condylar process there are two foramina perforating the bone which are for the passage of the occipital nerves. The internal surface forms part of the posterior and part of the lateral walls of the brain case and the dorsal wall of the medulla oblongata. The ventro-mesial edge overlapping ~~over~~ the basioccipital forms a lateral recess with the groove of the basioccipital on each side of the cavum sinus imparis. Dorsal to this recess is a larger cavity which lies slightly dorso-cephalad to the vagus foramen lodging the ampulla of the posterior semicircular canal. The exoccipital unites cephalad with the prootic, ventrally with the basioccipital, dorsally with the opisthotic and epiotic and mes_ad with its fellow from the opposite side and the supra-occipital.

SUPRA-OCCIPITAL

The supra-occipital (Fig. 1, 8, SO) forms the dorso-posterior portion

of the skull, lying between the epiotics with a process between the exoccipitals, also lying beneath the parietals and the posterior part of the frontals, thus forming the roof of the brain case as well as a part of the posterior wall. Lying between the epiotics it has developed itself into a deep groove extending from the dorsal surface, postero-ventrally almost to the foramen magnum where it ends in a process between the exoccipitals. The groove, the supra temporal pocket, is formed by giving off a process each way and overlapping the epiotics. On the dorsal surface it has a small longitudinal crest in the median line extending cephalad from the anterior end of the groove to the point where the bone is overlapped by the parietals. The inner surface forms the roof of the brain case as it has developed into a thin plate-like bone beneath the parietals and the posterior part of the frontals. It has a smooth surface with a ridge at the posterior end extending postero-ventrally from the dorsal surface toward the foramen magnum. Beneath the point of articulation with the parietals and frontals it has a small flange developed on the ventral surface near the lateral margin and extending latero-cephalad, which unites with a similar flange from the sphenotic by a cartilaginous ligament. The base of the flange possesses a foramen for ramus lateralis accessorius vessel which passes over the supra-occipital, between it and the parietal.

BASIOCCIPITAL.

The basioccipital (Fig. 1, 6, 8, BO) forms the ventro posterior end of the skull and the posterior end of the myodome, also the posterior part of the floor of the brain cavity. On its dorsal surface, the floor of the brain case, there are two longitudinal grooves one on each side of the

median line lying along the lateral walls of the bone and separated by a rounded ridge in the median line. These grooves are open throughout the anterior half but covered in the posterior half by the edges of the exoccipitals which overlap into the brain cavity and form recesses on each side with the groove, as it passes backward on each side of the pit of the cavum sinus imparis, reaching almost to the conical vertebra-like depression on the posterior end. The cavum sinus imparis is a deep pit on the dorsal surface in the median line near the posterior end, only separated by a single thickness of bone from the conical vertebra-like depression. This pit lies on the surface of the median rounded ridge between the lateral grooves which form the recesses in connection with the overlapping mesial edges of the exoccipitals. As the cavum sinus imparis passes backward it gradually becomes deeper until it forms a saccular cavity at the posterior end. The ventral surface of the bone possesses a long groove of which the ventro-lateral edges almost form a circle in connection with the parasphenoid. This groove tapers gradually into a narrow tube which passes to the posterior end and opens to the exterior by a slit like opening on the ventral surface. This tube forms the posterior portion of the myodome. On the lateral surface of the bone there is a rounded ridge from the dorso-anterior edge where it is a continuation of a similar ridge from the prootic and extending postero-ventrally nearly to the ventral surface of the bone. The posterior end is rounded with a slight conical depression forming the facet for the articulation with the first vertebra.

MYODOME.

The myodome is a long funnel shaped cavity and formed by the basi-

sphenoid, the two prootics, the parasphenoid and the basioccipital. The funnel is triangular in outline, located between the two prootics and ventral to the basisphenoid with its pedicle bisecting the anterior end of the cavity. It becomes narrow as it extends caudad into the basioccipital where it tapers to a tube and opens to the exterior by a slit on the ventral surface. There is an oval shaped opening between the basisphenoid and the partition of the prootics, the opening for the pituitary body of the brain. Immediately posterior to this opening on the dorso-lateral surface of the myodome there is a pocket which extends upward toward the trigemino-facial chamber and is only separated from it by a thin partition. At this portion the myodome is widest and narrows rapidly caudad until it forms the tube. At the median ventral edges of the prootics and also of the basioccipital there is formed a long slit like opening, the hypophysial fenestra, covered over by the parasphenoid except at the posterior end where it opens to the exterior. The myodome is for the location of the eye muscles which are attached to the walls and roof of the cavity and pass cephalad into the orbit. The principal muscles are the rectus superior, rectus inferior, and the rectus externus.

THE ORBIT.

The orbit is formed by the prefrontal, frontal, sphenotic and sub-orbitals. They are large in Ophidon and the two are separated by the partial partition of the orbito-sphenoid which is cartilaginous at its anterior portion and membranous at the posterior. At the anterior end the partition comes in contact with the prefrontals in the median line and at the posterior end it comes in contact with the dorsal surface of the basisphenoid and the pedicle unites with the membrane at the point of

contact with the parasphenoid. Dorsal to the basisphenoid the membranous partition divides and extends laterally and unites on each side with the ventro mesial edge of the alisphenoid and the ventral processes of the frontal, thus forming the posterior wall of the orbit and the anterior wall of the brain cavity. Directly dorsal to the basisphenoid and slightly lateral to the median line there is an opening through the membrane for the passage of the optic nerve. Above the openings for the optic nerves in the median line against the dorsal wall there is an opening for the olfactory nerves which pass cephalad and divide, one passing on either side of the partition through the foramina in the prefrontals into the nasal sac.

BRAIN CAVITY.

The brain cavity in Ophidon is quite large and extends from the posterior end of the orbit where it is separated from it by the lateral partition of the infraorbital membrane, to the posterior wall of the skull. The cavity has a series of recesses on the dorso-lateral walls for parts of the brain, and on the ventral surface there is a groove like cavity, *cavum sinus imparis*, beneath the foramen magnum. On the floor of the brain case there are two grooves which extend caudad along the lateral walls of the basioccipital parallel to the *cavum sinus imparis* to the posterior end. The mesial edges of the exoccipitals overlap and form saccular recesses of these grooves. Above this saccular recess there is a cavity which forms the labyrinth for the posterior semicircular canal. This one is located in the exoccipital. Dorsal to this, is a large recess lying in the epiotic which is for a part of the posterior semicircular canal, as a part of that canal passes into it. Antero-lateral to this recess in the

pterotic there is a large recess for the external semicircular canal. In the ventral surface of this recess there are two smaller pits for the ampulla of the external canal. One of these pits is located in the prootic and the other in the pterotic. Anterior to this recess there is another for the anterior semicircular canal. This one is divided into two parts by a flange like partition which extends from the floor of the cavity dorso-cephalad. One part, the anterior, of the cavity lies in the prootic and lodges the ampulla of the canal while the posterior part lies in the sphenotic and lodges the body of the canal. Directly anterior to the anterior semicircular canal there is another shallow cavity which is the trigemino-facial chamber. This cavity lies nearly in ~~the~~ line with the pituitary opening between the basisphenoid and the prootics. The dorso-anterior edge of the brain case is located between the ventral flanges of the frontals.

FACIAL BONES.

PREMAXILLARY.

The premaxillary (Fig. 9) is a long curved bone bearing teeth. Its anterior end is thickened and possesses two dorsal processes extending dorso-caudad having a V-shaped slit between them. The anterior process is long and slender and laterally flattened at the base and the process gradually becomes rounded as it gets farther from the base until at its end it is antero-posteriorly flattened, where it articulates with the ethmoid. The posterior process is broad and thick at the base and as it nears the end it makes a sharp curve and comes to a point at its anterior edge; on its anterior mesial surface it has a deep depression into which an angular process of the maxilla passes as it articulates with that bone.

It is rounded on its dorso-lateral surface except at a point slightly posterior to the middle where it has broadened and flattened into a sharp edge; from this point it gradually tapers to a long slender point which passes out on the lateral surface of the mandible. The anterior end of the bone, anterior to the processes, is rounded and thickened as it nears the median line where it unites with its fellow from the opposite side. Two kinds of teeth are present on the premaxillary, an inner row of canine shaped ones and from one to several irregular rows of the villiform type.

MAXILLARY.

The maxillary is a long curved bone without teeth, having a thick articular head and a flat expanded hind end. The head end has a large articular facet which has the appearance of a double head on account of its V-shaped form between its articular surfaces. The antero-mesial process curves mesad and locates inside of the dorsal process of the premaxillary with which it articulates directly dorsal to the dorsal limb of the vomer. The antero-lateral process is drawn out into a pointed projection lateral to the process of the premaxillary with which the other process articulates, and upon which rests the anterior ends of the nasal and palatine bones. At the apex of the V-shaped angle between the articular processes, the bone is rounded mesad at the point where it fits over the process of the premaxillary. On the dorsal surface of the maxilla the ventral edge of the first suborbital rests for some distance back from the anterior end. The posterior, flattened and broadened, end rests on the lateral edge of the mandible as it passes postero-ventral from the anterior end.

NASAL.

The nasal is a small bone connecting the prefrontal, ethmoid, and the maxilla, forming the roof of the nasal pit. It is Y-shaped with one edge of the broad end lying on a small process on the dorso-anterior edge of the prefrontal and the other edge lying on the antero-lateral process ~~of the process~~ of the ethmoid. The pedicle extends cephalad and rests upon the maxilla, thus forming the roof of the nasal pit.

THE SUBORBITALS.

The suborbital bones lie on the lateral surface of the skull and are three in number. The anterior end is firmly attached to the dorsal edges of the palatine and maxillary, also articulated with the prefrontal at its lateral facet. At the posterior end the third bone is attached to the preopercular thus forming a bridge from the anterior to the posterior ends across the cheek; also this forms the ventral boundary of the orbit. The suborbitals are composed of three flat plate like bones . The anterior bone is broad, somewhat oval in shape, lying on the surface of the maxillary for some distance from the anterior end. It articulates with the maxillary and palatine at the anterior end and with the facet of the prefrontal at the dorsal edge; caudad it is united with the second suborbital bone. The second bone is elongate in shape and about one half as broad as the anterior one. This bone really forms the ventral boundary of the orbit. The third bone is the longest and passes from the edge of the orbit and is extended caudad forming the suborbital stay. It is elongate in shape slightly broadened at the posterior end. Near the anterior end of this bone there is a small bone, postorbital, forming the posterior edge of the orbit extending to the edge of the sphenotic. In younger specimens this

is merely a cartilage but in more mature forms it becomes ossified. This is a small plate-like bone lying in the dermal tissue.

PALATINE.

The palatine is an irregular shaped bone composed of two portions, a broad plate-like portion and an anterior rod-like portion. The plate-like portion is posterior and somewhat triangular in shape with the apex pointing caudad. On the lateral surface it is smooth except for some small narrow ridges which extend postero-ventral from the dorso-anterior end. On the dorsal edge there is a large facet for the articulation with the prefrontal and an edge of the first suborbital. This facet possesses a deep pit which extends caudad forming a groove on the dorsal edge to the posterior end. This groove is for the articulation with the mesopterygoid. The mesial edge of the facet is extended dorsally into a tall process which becomes attached to the ventral edge of the prefrontal. The mesial surface of the palatine is roughened by porous openings and possesses a deep groove extending from the anterior end of the posterior portion to the posterior end of the bone. This groove is formed by the dorso-mesial and the ventro-mesial edges of the bone. Two kinds of teeth are present on the ventral surface which are the same as on the vomer and premaxillary, an inner row of large teeth of the canine variety and an outer row of small villiform type, more or less irregularly arranged. The anterior part of the bone is rod shaped and is somewhat curved antero-ventro-laterally from the dorsal edge of the plate like triangular portion directly anterior to the articular facet of the prefrontal and the suborbital bone. This rod shaped portion is somewhat flattened dorso-ventrally at the anterior end where it articulates by a

cartilaginous ligament with the dorsal surface of the maxillary on the antero-lateral process of the head of that bone.

MESAPTERYGOID.

The mesopterygoid, the ectopterygoid of some authors, is a long slender curved bone which unites the palatine with the quadrate. The anterior end of the mesopterygoid lies in the groove on the dorsal edge of the palatine, from there it passes caudad for a distance when it curves ventrally and articulates with the anterior edge of the quadrate. It is flattened laterally at the posterior and middle parts but at the anterior end it is flattened dorso-ventrally. There is a small groove on the ventral edge where it lies in the groove on the dorsal edge of the palatine. On the dorsal edge of the mesopterygoid there is a long slender groove which is for a membranous bone, the entopterygoid, which forms a part of the ventral boundary of the orbit. At the point where the bone curves ventrally there is a plate like process on the dorsal edge which connects with the mesopterygoid and the entopterygoid. On the posterior edge the bone possesses a slight groove where it unites with the quadrate. The bone tapers to a point at its postero-ventral end.

HYOMANDIBULAR.

The hyomandibular is an arrow head shaped bone with the shank extending from the ventral edge. The anterior end is drawn out into a thin, pointed, plate like process. Slightly dorso-posterior to the pointed end there is a thickened part which passes ventro-caudad across the middle of the head and also across the shank, thus forming an irregular cross with the shank. At the anterior end of the bar forming the cross there is formed a facet, the anterior head which articulates with

the facet of the sphenotic directly above the prootic arcade. On the posterior end of the bar forming the cross there is a facet for the articulation with the opercular. The shank passes upward through the body of the bone and forms a double facet, the posterior head of the hyomandibular which articulates with the facet of the pterotic immediately posterior to the dilatator fossa. The dorso-posterior part of the posterior head articulates with a flange like process dorso-posterior to the facet. The long shank extends ventrally and is united to the symplectic at its ventral end by a mass of cartilage. The metapterygoid articulates with the hyomandibular at its anterior process which is a thin membrane bone filling the space between the anterior bar of the cross and the shank. Likewise the spaces between the other bars are also filled with a thin sheet of membrane bone, thus leaving slight depressions between the bars. On the mesial surface there is a deep pit at the angle between the anterior bar and the shank which gives rise to two canals. One passes ventrally into the bone and opens on the lateral surface of the shank just anterior to the ridge which forms the groove for the articulation of the preopercular. This canal bears the truncus hyoideo-mandibularis facialis. The other canal passes ventrad and caudad dividing into two parts, one opens to the exterior at the dorsal edge of the groove for the articulation of the preopercular and between the opercular bar and the shank, the other opens at the hind edge of the bone directly beneath the opercular bar. These two canals transmit branches of the nerve of the latero-sensory canal that lies in the region of the opercular. Another small foramen is present in the dorsal edge of the groove for the preopercular which transmits a part of the hyoid nerve between the hyomandibular and the preopercular.

SYMPLECTIC.

The symplectic is a small paddle shaped bone with a broadened end and a long slender process. It articulates at its dorsal and broadened end with the shank of the hyomandibular by a long cartilaginous ligament. The bone for the most part lies on the lateral surface of the quadrate in a triangular groove with its long process penetrating the bone almost to its articulating facet for the mandible.

METATERYGOID.

The metaterygoid is a broad plate like bone, more or less, quadrant shaped with two plate like processes. The quadrant shaped part is the ventral portion of the bone with the round edge uniting by a cartilaginous ligament with the dorsal edge of the quadrate. Two processes extend from ~~from~~ the dorsal edge of the quadrant shaped part. One of the processes is somewhat elongated and extends dorso-cephalad coming in contact with the anterior process of the hyomandibular. The other process extends caudad from the dorso-posterior edge of the quadrant. This process forms a V-shaped slit on its ventral edge which is for the passage of the hyoid artery. The posterior edge of the comes in contact with the anterior edge of the shank of the hyomandibular. On either surface of the anterior process there is a small flange which forms a groove on the dorsal edge extending nearly the entire length of the process. The groove is for the union with the hyomandibular.

QUADRATE.

The quadrate is a quadrant shaped bone with the ventral point thickened and formed into a head for the articulation of the articular. The dorsal or rounded edge is broken near the posterior edge where the

bone forms a deep groove on the inner surface for the articulation of the symplectic where it passes downward into the quadrate. There is a groove on the posterior edge extending almost the length of the bone for the contact with the preopercular. The anterior edge is somewhat roughened and possesses no groove where it articulates with the mesapterygoid. On the dorsal edge the quadrate unites by a cartilaginous ligament with the ventral edge of the metapterygoid and cephalad with the entopterygoid and the mesapterygoid, caudad it unites with the preopercular and the symplectic.

PREOPERCULAR.

The preopercular (Fig. 4) is a long flat curved bone which possesses three small barbs on its posterior edge. This bone has a latero-sensory canal throughout its length, the canal opening near the edge of the ventral barb and at the dorsal tip of the bone. There are also other sensory canals throughout the bone with openings at various points. The outer surface is smooth except that it has a narrow ridge at its posterolateral edge which is located slightly anterior to the spines. The notch or pit formed by the curve is filled with a thin wavy sheet of bone which slightly overlaps the caudal edge of the shank of the hyomandibular. Slightly dorso-anterior to the ridge there is a small roughened area for the articulation of the suborbital stay.

THE MANDIBLE.

The mandible is made up of three bones, the dentary, articular and the angular. The mandible possesses a broad rounded ridge from slightly anterior to the head of the articular and extending nearly to the anterior end of the dentary. On the inner surface the dentary has a

corresponding cavity within the bone which forms the ridge on the exterior; the articular has no cavity but a groove that corresponds to the ridge. In the bone beneath the ridge there is a latero-sensory canal which extends from the anterior end of the dentary to the posterior end of the articular. The dentary is a long bone having two long processes at the posterior end which form a V-shaped angle which fits over the anterior process of the articular for its articulation with that bone. The lower surface is broadened by a mesial extension of a plate like bone forming the ventral surface. Two kinds of teeth are present on the dentary, an inner row of the large canine type and several irregular rows of the villiform variety. The articular is united to the dentary by several cartilaginous bands where it fits into the V-shaped angle for the union of the two bones. This bone has a large facet for its articulation with the quadrate. At this point the bone is quite broad and gives off three processes. Slightly anterior to the facet it gives off a dorsal anterior process which unites with the dorsal process of the dentary by a cartilage. Immediately ventral to this process and anterior to the facet it gives off a long process at the anterior end which fits into the V-shaped angle of the dentary. On the ventro-anterior edge it gives off another process which fits over the ventral process of the dentary. The inner surface possesses a groove in each, the anterior and ventral processes and a deep pit on the antero-ventral edge of the facet. Ventro-posterior to the facet is located the angular bone serves as an attachment for some of the mandibular muscles to the quadrate and also to the intraopercular.

SCORPIONICHTHYS MARMORATUS

THE SKULL.

The skull (Fig. 2,5) of Scorpionichthys differs from that of Ophidon only in a few points. The dorsal surface is somewhat more rounded and is covered with a granulated network. In this form the temporal fossa are slightly different in shape and the orbits are smaller and more circular in outline, also the surface between them is narrower and concave. On the dorsal surface of the ethmoid the longitudinal groove which is present in Ophidon does not occur, and a large erect process extending antero-laterally from the median line takes the place of the small ethmoid processes. There is a broad flange on the posterior end of the skull extending mesad from the caudal end of the epiotic ridge to the median line, also the supra-occipital possesses a crest on the posterior surface extending from the dorsal edge to the end of the postero-ventral process. The anterior end of the temporal fossa is formed mainly by the edges of the granulated network of the parietals and pterotic. The parietal projects over the fossa for a distance as also does the epiotic which goes to make up a part of the mesial edge of the roof. Most of the roof is formed by the extra-scapular lying on the dorsal surfaces of the epiotic and pterotic across the fossa. In the DILATATOR FOSSA the sphenotic forms the greater part of the roof contrary to the condition in Ophidon, also the fossa in this fish possesses no foramina for the passage of the branches of the oticus vessels.

The VOMER (Fig. 2,5,V) is relatively smaller than in Ophidon but it possesses the same general shape except that the lateral expansions are not as long and the dorsal process is shorter. Only one kind of teeth, the villiform, are present which are numerous and irregularly arranged. The dorso-anterior surface, slightly lateral to the median line, possesses

a small articular facet for the articulation with a similar facet on the mesial edge of the maxilla.

The ETHMOID (Fig.2,5,ETH) possesses no depression on its lateral surfaces for the nasal pit. A tall antero-lateral process forms a V-shaped crest in the median line which supports the nasal bones to form that pit.

The PREFRONTALS (Fig. 2,5,PFR) are relative large, especially at the anterior portion, and do not possess depressions for the nasal pits. From the wing like expansions there is a thin flange extending ventro caudad from the lateral edge on the ventral surface to the mesial portion where it unites with the parasphenoid in the median line. On the lateral edge of the anterior portion directly posterior to the vomer and anterior to the wing, there is a small facet for the articulation with the palatine.

The FRONTALS (Fig. 2,5,FR) are somewhat shorter than in Ophidon and the surface between the orbits is much concaved. They unite with the sphenotics in the usual position and form a part of the orbit. The surface directly posterior to the orbit is somewhat depressed and forms a ridge on the ventral surface in the posterior part of the orbit. On the dorsal surface of the posterior portion of the bone there is a granulated network arranged more or less in longitudinal ridges. In the median line of the posterior portion there is an irregular groove formed by the granulated edges. The ventral surface is comparatively smooth and the part within the orbit is not porous as in Ophidon. There is a single ventral flange-like process on each side of the median line forming a part of the anterior boundary of the brain case. At the caudal end the flange process is thickened and unites with the alisphenoid. From this point there extends a ridge laterad to the edge of the bone at the point where it unites with the

sphenotic forming a triangular pit between this ridge and the anterior edge of the sphenotic. There is also a small depression anterior to the ridge between it and the flange process. In some specimens the flange process comes in contact with the dorso-lateral process of the parasphenoid on the anterior edge of the alisphenoid.

The ventro-posterior edge of the SPHENOTIC (Fig. 2,5,SPO) forms a facet in connection with the dorsal edge of the prootic, dorsal to the arcade, for the articulation with the anterior head of the hyomandibular. In Scorpionichthys the prootic forms nearly half of the facet while in Ophidon it forms only a very minor part of it. The sphenotic forms the greater part of the roof of the dilatator fossa, a condition slightly different from Ophidon where the pterotic forms the roof.

The PTEROTIC (Fig. 2,5,PTO) forms only a small part of the dilatator fossa and has a granulated surface.

The ALISPHEOID (Fig. 5,ALS) is not porous and is not held within the grasp of the two ventral processes of the frontal. It does not possess a foramen for the passage of the cerebral vein as Allis ('09) found in Scorpaena and others. It forms the dorsal edge of a large foramen which is made by the edges of the prootic and the parasphenoid process.

The BASISPHENOID and PARASPHENOID (Fig.5,PS) are the same as in Ophidon, except in the parasphenoid ~~where~~ there is a small partition between the two dorsal processes which separates the anterior and posterior portions.

The PROOTIC (Fig.2,5,PRO) possesses on its dorsal edge a flattened process which lies directly ventral to the hyomandibular facets and causes that bone to extend out laterally from the skull. The ventral surface of

the process possesses a rounded pit which extends dorsad, almost between the hyomandibular facets. On the dorso-anterior edge, immediately dorsal to the arcade the bone forms a part of the facet for the anterior head of the hyomandibular. In other respects this bone is like the one in Ophidon except that the foramen for the external carotid artery, the jugular vein and the parts of the fifth and seventh nerves is located in a pit slightly mesial to the arcade.

The EPIOTIC (Fig. 2,5,7,EPO) is flattened on the dorsal surface and extends caudad into a flattened process forming a part of the dorsal surface of the skull. On the meso-posterior edge there is a flange process from the posterior end of the bone extending meso-cephalad to the median line where it unites with a similar process on the supraoccipital. The lateral edges of the epiotics project slightly over the fossa and form a part of the roof.

The PARIETALS (Fig. 2,5,P) have a granulated surface such as described in the frontal and pterotic. They lie on the dorsal surface of the supraoccipital and form only a small part of the roof of the brain case at the edges of the supraoccipital. In the median line the bones do not meet for a part of their length and leave the supraoccipital exposed.

The SUPRA-OCCIPITAL (Fig.2,7,SO) possesses on the posterior surface a flange process which is a continuation of a similar one from the epiotic. The flanges from either side fuse in the median line where they come in contact with the crest which extends from the dorsal edge of the bone to the ventral edge of the process. Near the dorsal edge of the skull it forms a slight depression on the caudal surface in connection with the parietal.

The BASI-OCCIPITAL (Fig. 2,5,7,BO) and EXOCCIPITALS (Fig.2,5,7,EO) are the same as in Ophidon except that in Scorpionichthys, the condylar processes and the basioccipital are longer.

FACIAL BONES.

The MAXILLA is shorter and more flattened throughout its entire length than in Ophidon. On its ventro-mesial edge it possesses a small facet for an articulation with a similar facet on the dorsal surface of the vomer.

The PREMAXILLARY (Fig.9,10) is much shorter than in Ophidon but the dorsal processes are the same. Only the villiform teeth are present which are numerous.

The PALATINE is similar in all respects except that the mesial process is larger than in Ophidon. Only the villiform teeth are present on this bone.

The HYOMANDIBULAR has a large flange process on the outer surface extending ventro-posteriorly from the dorso-anterior angle, formed by the irregular cross, to nearly the postero-ventral edge of the shank. The shank is broad and flattened throughout and unites with the preopercular, symplectic, and metapterygoid.

The PREOPERCULAR (Fig.3,4,) bears two spines, a long pointed one and a short somewhat rounded one, which is a condition not found in Ophidon. The dorsal edge of the bone is drawn out into a long slender process which lies on the posterior edge of the hyomandibular shank.

The MANDIBLE is shorter than in Ophidon. There is no ridge on the lateral surface of the dentary nor is there a cavity within it, also there

is no mesial process on the ventral edge. It possesses the villiform teeth but there seems to be a modification of the teeth in the inner row. These are longer than the others and have assumed, more or less, a canine shape which will place the Scorpionichthys and Ophidon closer together.

HEXAGRAMMOS DECAGRAMMOS.

THE SKULL.

The dorsal surface is smooth and more rounded than either Ophidon or Scorpionichthys, on account of the lateral extensions of the pterotic and prootic which make a broad and flat, rather than a deep temporal fossa. The supraoccipital is especially conspicuous as it separates the two parietals and comes to a spine like point. On each side of the median line the parietals form narrow ridges which extend postero-laterally on the lateral edges of the epiotics and form the mesial edges of the roof of the temporal fossa.

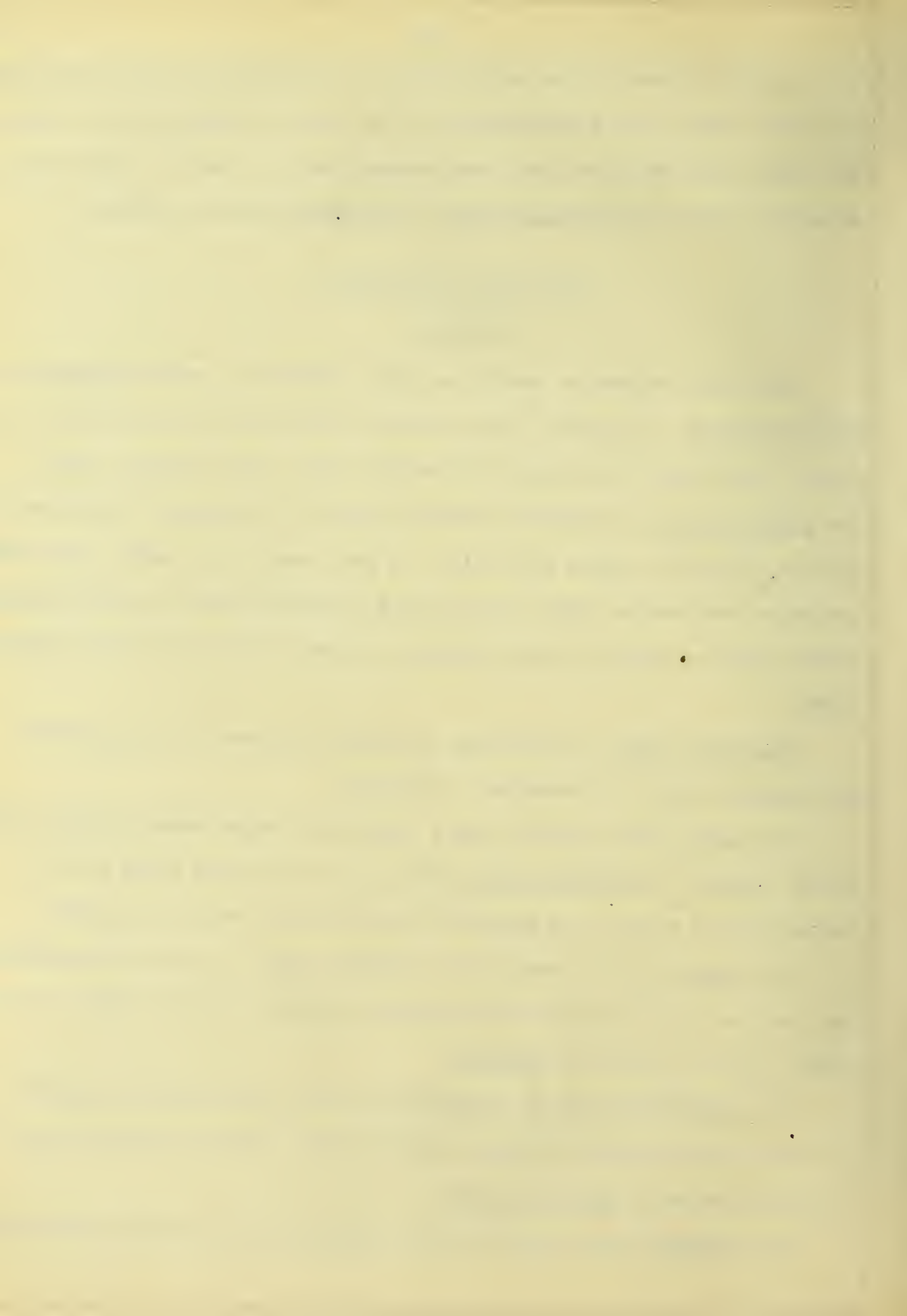
Dilatator fossa in this form are shallow grooves in the sphenotic and pterotic bones. It possesses no foramina.

The vomer in this species has a relatively longer dorsal process than either Ophidon or Scorpionichthys. There is no articular facet on the dorso-anterior edge of the maxilla. Only villiform teeth are present.

The ethmoid is not grooved but slightly keeled. It has no depressions for the nasal pits and the antero-lateral processes for the support of the nasal bone are similar to Ophidon.

The prefrontals have no depressions on the dorso-anterior edges for the nasal pits and have articular facets on the anterior-lateral edges for the palatines as in Scorpionichthys.

The frontals have a smooth dorsal surface which is slightly grooved



between the orbits. On the ventral surface it is not porous and possesses a single flange process as in Scorpionichthys. Differing from Ophidon and Scorpionichthys in not uniting with the sphenotic to form the posterior border of the orbit. As in Scorpionichthys, the sphenotic in connection with the prootic forms the facet for the anterior head of the hyomandibular.

The pterotic is a thin flange like bone extending postero-ventrally from the sphenotic thus forming the ventro-lateral boundary of the temporal fossa.

On the prootic there is a lateral flange process ventral to the facets for the hyomandibular which extends out laterad below the facet for some distance as in Scorpionichthys. The prootic forms a large part of the anterior facet for the hyomandibular. No special peculiarities are shown in the arcade or the location of the foramina.

The parasphenoid has no partition between the lateral processes to separate the anterior and posterior portions and differing from Ophidon in that the ventral surface of the anterior portion possesses a conspicuous ridge.

Posteriorly the epiotic ends in two processes.

In the exoccipitals the condylar processes are relatively longer than in Ophidon but not as long as in Scorpionichthys.

FACIAL BONES.

The premaxillary is relatively shorter than in Scorpionichthys and much shorter than in Ophidon. Villiform teeth are present but there is a modification of these in the outer row as they are much heavier and longer than those of the inner rows.

The maxilla possesses a flange on its dorsal surface where it comes in contact with the first suborbital bone. Posterior from this flange it is

flattened.

There is a facet on the anterior mesial edge of the palatine where it comes in contact with the ethmoid. Only the villiform teeth are present.

In the hyomandibular the shank forms nearly a rectangular cross with the bar that has the facets for the anterior head and the opercular bone. This causes the shank, which extends ventrally and slightly posteriorly in Ophidon, and directly ventral in Scorpionichthys, to extend antero-ventrally in this form.

The metapterygoid has a short rounded anterior process and possesses a groove, formed by lateral and mesial flanges, on the posterior edge for the shank of the hyomandibular and the hyoid artery.

There are no particular differences shown in the quadrate except that it lies more anterior in this fish than in the other species described. This condition is brought about by the position of the hyomandibular shank. The quadrate lies ventral to the anterior edge of the orbit while in Ophidon it lies ventral to the posterior edge and in Scorpionichthys it is ventral to the central portion of the orbit.

The preopercular possesses no barbs or spines and has no grooves or ridges. It lies postero-ventral on account of the shank of the hyomandibular and the position of the quadrate. On this account the posterior end of the suborbital stay lies somewhat lower.

On the mandible no lateral ridge is present and no cavity within the dentary, nor is there a mesial flange on the ventral edge, as in Ophidon. The dentary is relatively much shorter than in Ophidon and somewhat shorter than in Scorpionichthys. Villiform teeth are present but there is a slight modification of those of the outer row. They are longer and much heavier than those of the inner rows.

SUMMARY.

Since Ophidon and Hexagrammos are in the same family HEXAGRAMMIDAE, one might expect something of a similarity in their osteology and that there would be more marked differences between Scorpionichthys, belonging to the family COTTIDAE, and Ophidon. From a study of these forms I find that there are more differences between Ophidon and Hexagrammos than between Ophidon and Scorpionichthys.

Some of the differences between Ophidon and Hexagrammos are,-

1. The dorsal surface is more rounded in the latter.
2. The supraoccipital possesses a conspicuous spine-like crest in the median line which entirely separates the parietals in Hexagrammos.
3. Foramina are present in the dilatator fossa in Ophidon but absent in Hexagrammos.
4. In Hexagrammos the nasal pit depressions are absent on the ethmoid and prefrontal. The ethmoid is but slightly keeled and the anterior portion of the prefrontal possesses a lateral facet.
5. In Ophidon the frontal is thick and porous, but in Hexagrammos, thin and smooth possessing a single flange and a single groove on the ventral surface.
6. The sphenotic does not form part of the posterior edge of the orbit in Hexagrammos.
7. In Ophidon only a small part of the anterior hyomandibular facet is formed by the prootic, while in Hexagrammos this bone forms at least one half of it. Also there is a conspicuous lateral prootic process below the hyomandibular facet.
8. In Ophidon the hyomandibular shank extends ventro-caudad while in Hexagrammos it extends ventro-cephalad, placing the quadrate further

cephalad.

9. In Hexagrammos the preopercular spines and ridges, found in Ophidon, are absent and the bone itself occupies a more ventral position.

10. Relatively the mandible is twice as long in Ophidon as in Hexagrammos, and the dentary possesses no lateral ridge or cavity within the bone, or a mesial flange on the ventral surface.

11A marked difference is found in the teeth in Ophidon and Hexagrammos. Both canine and villiform are found in the former, but only the villiform in the latter.

Some of the likenesses found in Ophidon and Scorpionichthys are,-

1. Dorsad, both skulls are flattened and have similar temporal fossa.
2. The sphenotic and the frontal bones form the posterior edge of the orbit.
3. The prootic arcade and the location of the foramina are identical in both.
4. The alisphenoid and the parasphenoid are alike with the exception of a small partition between the dorso-lateral processes of the parasphenoid in Scorpionichthys.
5. Except for the longer premaxillary in Ophidon, the maxilla and the premaxillary are alike in both species.
6. The pterygoids, symplectic, and quadrate are alike in every respect.
7. In Ophidon, canine and villiform teeth are present and only villiform in Scorpionichthys, but in the latter the inner row of mandibular teeth is better developed.

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ABBREVIATIONS USED IN THE PLATES.

All figures are one half natural size photographed from the original drawings.

ALS.	-----	Alisphenoid.
BO.	-----	Basioccipital.
BS.	-----	Basisphenoid.
EO.	-----	Ex-occipital.
EPO.	-----	Epiotic.
ETH.	-----	Ethmoid.
FR.	-----	Frontal.
OPO.	-----	Opisthotic.
P.	-----	Parietal.
PFO.	-----	Postfrontal.
PFR.	-----	Prefrontal.
PRO.	-----	Prootic.
PS.	-----	Parasphenoid.
PTO.	-----	Pterotic.
SO.	-----	Supra-occipital.
SPO.	-----	Sphenotic.
TF.	-----	Temporal fossa.

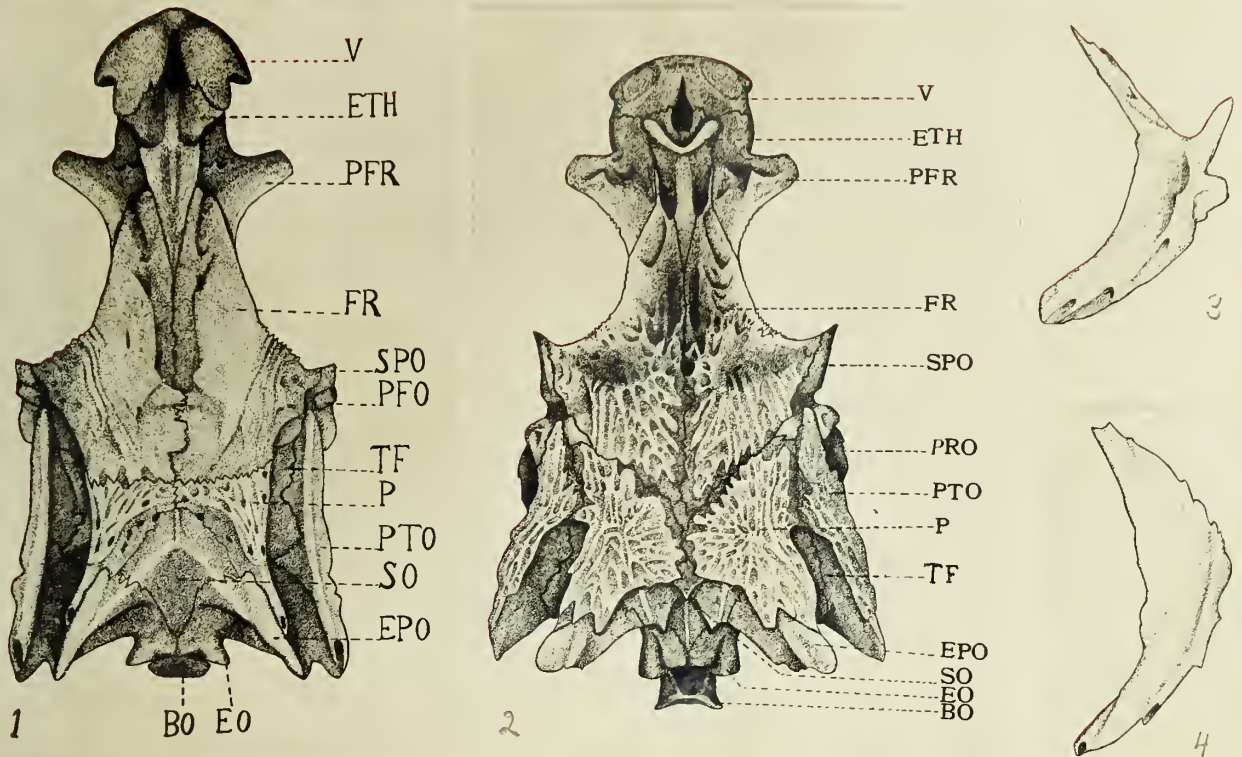
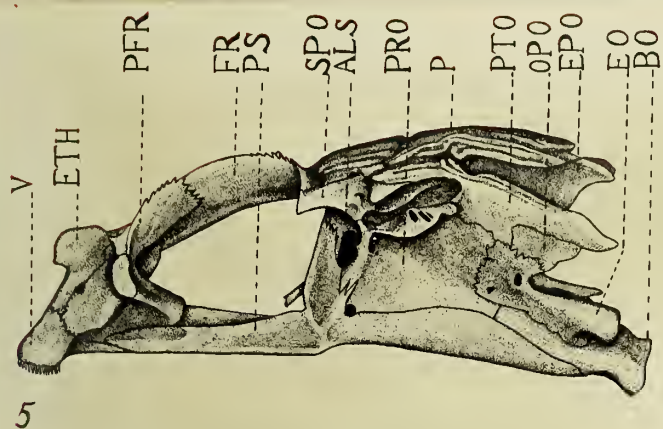
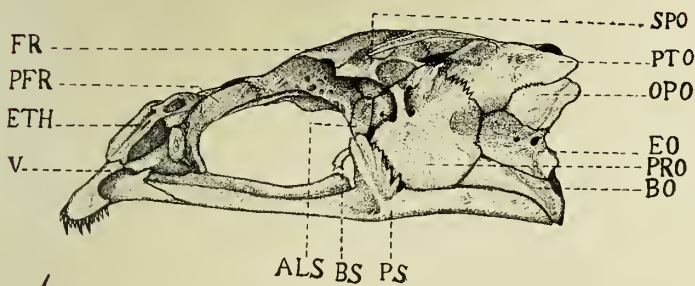


PLATE I.

- Fig. 1. Dorsal view of *Ophidon elongatus*.
- Fig. 2. Dorsal view of *Scorpionichthys marmoratus*.
- Fig. 3. Preopercular of *Scorpionichthys marmoratus*.
- Fig. 4. Preopercular of *Ophidon elongatus*.



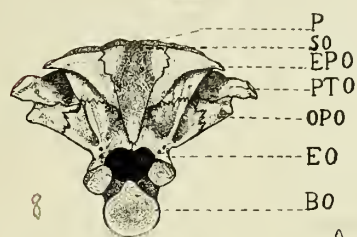
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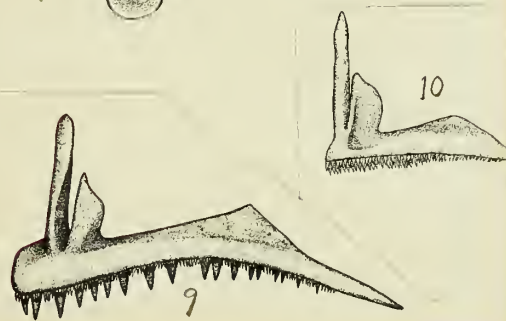
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PLATE II.

Fig. 5. Lateral view of *Scorpionichthys marmoratus*.

Fig. 6. Lateral view of *Ophidon elongatus*.

Fig. 7. Posterior view of *Scorpionichthys marmoratus*.

Fig. 8. Posterior view of *Ophidon elongatus*.

Fig. 9. Premaxillary of *Ophidon*.

Fig. 10. Premaxillary of *Scorpionichthys*.





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