

EOCENE FISHES AND TURTLES FROM THE SUBATHU FORMATION, BERAGUA COAL MINE, JAMMU AND KASHMIR.

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ABSTRACT

A Middle Eocene fish fauna from the topmost beds of Subathu Formation found in association with terrestrial mammals is described in this paper. Fishes are represented by fragmentary skulls, girdle elements, vertebrae, opercula and scales. The fauna includes mainly brackish and fresh water fishes *Ophiocephalus lydekkeri* sp. nov., *Scorpaena* sp., *Polydactylus* sp., cf. *Nandus*, cf. *Epinephelus*, *Polycanthus* sp., *Arius sahnii* sp. nov., *Arius* sp. as well as a single marine *coelodus* sp. The fragmentary remains of the turtles *Hemichelys* cf. *H. warthi* and *Trionyx* sp. are also found in association. *Notidanus primigenius* is known from the olive shales (Ypresian) of Subathu Formation. The palaeoecological diversity of the fishes is in conformity with the sedimentary evidence and indicates a estuarine coastal—plain environment.

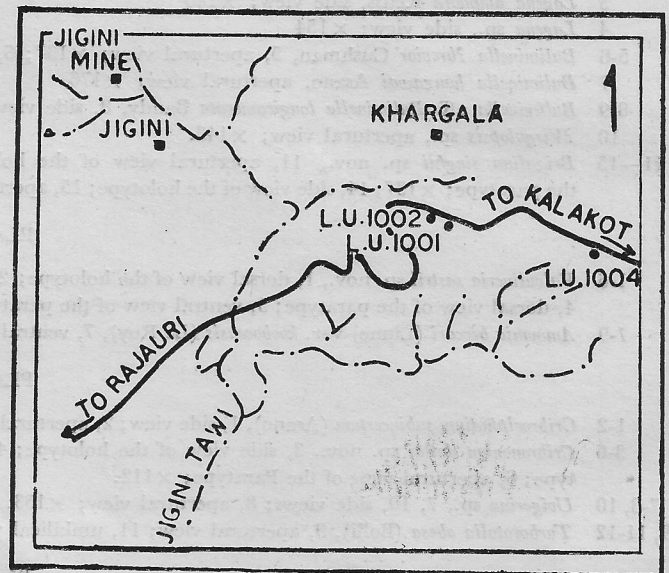
INTRODUCTION

The present paper deals with the systematic description of some of the better preserved fish and chelonian remains collected from the Subathu Formation exposed near Beragua Coal field ($74^{\circ}24'9''$: $33^{\circ}13'53''$), Jammu and Kashmir. The collection of lower vertebrates was made from the upper mammal producing horizon described, among others by Sahni and Khare (1972, 1973). The ossiferous horizon forms the top of the Subathu Formation grading conformable into the Murree Formation and is of Middle Eocene (Lutetian) age. The localities from where the material was collected are shown in text figure 1. Prior, to the present investigations there is hardly any report of the Palaeogene lower vertebrates from the lesser Himalayas of Northern India. In the present collection, fishes are represented by two slightly damaged skulls, dentaries, isolated opercula, preopercula, pectoral girdles and spines, isolated post cranial material as well as numerous scales. Turtle consists of isolated carapace pieces.

All material described here is stored in Vertebrate Laboratory, Geology Department, Lucknow University.

SYSTEMATIC DESCRIPTION

- Class* Osteichthyes
Subclass Actinopterygii
Infraclass Teleostei
Superorder Acanthopterygii
Order Ophiocephaliformis



Text-figure 1: Sketch map of the area northwest of Beragua Coal Mine showing fish localities.

Family Ophiocephalidae

Ophiocephalus Bloch 1794

Ophiocephalus lydekkeri sp. nov.

(Pl. 1, Figs. 1-4)

Holotype: L.U.V.P. 15103, A nearly complete skull, broken anterior to frontals.

Paratypes: L.U.V.P. 15104, an isolated left operculum and L.U.V.P. 15105, an isolated scale.

Diagnosis: Skull wide, thin, low with a wide supraoccipital, no suggestion of parasphenoid teeth, suture between right and left frontals nearly straight. The relative size, shape of parietals and supraoccipital and suture pattern distinguish L.U.V.P. 15103 from the recent skull of *Ophiocephalus striatus* (Srinivasachar, 1955) as well as from the fossil species—*Ophiocephalus* sp. *A* and *O.* sp. *B* known from the Neogene Siwalik beds (Lydekker, 1886). The height of skull is nearly half to that of *O.* sp. *A*.

Description: L.U.V.P. 15103, crushed and poorly preserved skull represented in pl. 1, figs. 1 & 2 is low, flat, dorsoventrally compressed, wide posteriorly and narrowing anteriorly lacking the bones anterior to frontals. All cephalic plates are sculptured by shield like scales, which have become obscure as a result of wear but are better preserved in the counter part. Sutures between the cephalic bones are not distinct except between a few bones.

Frontals are thin, anteroposteriorly elongated plates, joined together by a nearly straight, medially situated suture; posteriorly, in contact with the anterior border of the supraoccipital. Frontals are widest in their middle. Except for the anteroexternal border which forms the inner margin for the orbits, the entire bone is bounded by various cephalic bones viz. externally by sphenotics, posteroexternally by pterotics, posteriorly by parietals and posterointernally by the supraoccipital. Sphenotics are paired, subtriangular elements having slightly convex external border. Internally, the sphenotic is joined with the frontal and posteriorly with the pterotic by well marked sutures. Pterotics are paired, elongated, pentagonal bones, internally in contact with the parietals and posteriorly with supratemporals. Supratemporals are paired, 'L' shaped bones with a posteriorly projecting process (broken in the specimen) which rests on post-temporals. Parietals are paired, hexagonal in shape and bounded anteriorly by frontals, posteriorly by epiotics, externally by pterotics and supratemporals and internally by supraoccipital. Supraoccipital is a single, medially situated and octagonal in shape bearing a posteriorly projecting medially placed supraoccipital spine on its posterior margin (broken in the specimen). Anteriorly, the suture of the supraoccipital in contact with frontals is an inverted 'V' shape. Only the left epiotic is preserved in the specimen along with a slightly broken epiotic lamella.

As a result of crushing, the specimen is slightly deformed and the basioccipital has slightly shifted towards the left side from its original median position. Basioccipital is a single, medially situated bone, gently sloping anteriorly with an oval centrum for the reception of first vertebra, and ventrally, it is in contact with the parasphenoid. On either side of the centrum there exists

two small exoccipital condyles. In Recent and Siwalik specimens the parasphenoid generally bears a patch of parasphenoid teeth but in L.U.V.P. 15103 there is no suggestion of such teeth. On the lateral sides of parasphenoid near the junction of the pterotics, sphenotics and supraoccipital two bulbous anterolaterally directed prootics can be seen. Each prootic branches into two elevated ridges. Between them a shallow fossa lies for the hyomandibular. Anteriorly, the parasphenoid and other bones are damaged.

Measurements in mm:

Measured length	..	74.00
Measured width	..	76.50

Comparisons:

L.U.V.P. 15103 has been compared with the skull of the living *Ophiocephalus striatus* found in Gomti river of the Indo-Gangetic Plain as well as with the fossil species of *Ophiocephalus* described from the Siwalik beds (Lydekker 1886). The present specimen differs from the Neogene and Recent species in the absence of parasphenoid teeth, shape, size and the suture pattern of cephalic bones. The height of *O. lydekkeri* sp. nov. is nearly half times to that of *O.* sp. *A*. Suture between the right and left frontals in *Ophiocephalus lydekkeri* sp. nov. is nearly straight while in Recent species (Srinivasachar 1955) the suture bears a convexity in the middle of the left frontal. Supraoccipital also differs in shape and size from the Recent specimen; width of the supraoccipital is also greater than that of living specimen.

Type Locality and Horizon: L. U. 1001, Maroon argillaceous sandstone, Middle Eocene (Lutetian).

Repository: Vertebrate Laboratory, Geology Department, Lucknow University.

Etymology: After Dr. R. Lydekker, for his pioneering work on the fossil ophiocephalids.

OPERCULUM L.U.V.P. 15104:

L.U.V.P. 15104 an isolated left operculum was collected in the close association with L.U.V.P. 15103 and is referred to *Ophiocephalus lydekkeri* sp. nov. Operculum is thin triangular in outline with a damaged dorsal and posterior borders. The anterior border is gently sloping while the ventral is convex. Fossa for the reception of hyomandibular is triangular, shallow and dorsoventrally situated on the internal surface of operculum. From this fossa a posteroventrally directed ridge originates flattening towards the posteroventral border. Anteriorly, operculum is in contact of preoperculum and ventrally with the suboperculum forming the opercular apparatus.

SCALE L.U.V.P. 15105:

Scale incomplete, regular, only basal part preserved while the rest of the scale is represented by its impression. Subtriangular in shape with a slightly rounded apex tapering posteriorly. Scale slightly longer (length 16 mm) than broad (width 14 mm). Nucleus centrally placed. Basal radii occupy the major part of the base of the scale and are fifteen in number. Lateral basal radii are short, running posteriorly upto a short distance while the median radii are long and reach up to the nuclear area. On the lateral sides of the scale, numerous concentric thin circuli run parallel to the entire posterior margin. L.U.V.P. 15105 closely resembles the regular scale of *Ophiocephalus striatus*. *Ophiocephalus* is a fresh water fish generally found in the rivers of Indo-Gangetic Plain. In fossil form this genus is only known by fragmentary skulls from the Siwalik Hills of India described for the first time by Lydekker (1886) and from Pleistocene of Java (Boeseman, 1949).

I have followed Nair's (1945) terminology regarding scale morphology. He has divided scale into two main sub-division: regular and irregular. Nair (1945, p. 122) states.

"A typical or regular scale is one taken from the broadest part of the body where all characters are generally fully developed, and its structure can be relied upon with a fair certainty for the identification of a particular species. An "irregular" scale, on the other hand, is one from any other part of the body, namely head, caudal region, ventral surface and bases of fins, where the scale are not properly developed and does not show all the characteristic structures of the scales of the species".

Order Synbranchiformes

Suborder Scorpaenoidei

Family Scorpaenidae

Scorpaena Linnaeus 1758

Scorpaena sp.

(Pl. 1, fig. 5)

Material: L.U.V.P. 15106, right operculum.

Description: L.U.V.P. 15106, right operculum is subtriangular with slightly convex dorsal and anterior margins, and an upwardly projected ventral border. The posterior angled margin bears concentric rings and is forked into two arches, dorsal and ventral having a concavity between them. A ridge runs along each arch uniting in the form of 'V' at the anterodorsal border. The dorsal arch is longer than the ventral one.

Locality: L. U. 1001.

Order Perciformes

Suborder Mugiloidei

Family Polynemidae

Polydactylus Lacepede 1803

Polydactylus sp.

(Pl. 1, fig. 6)

Material: L.U.V.P. 15108, Upper limb of preoperculum with broken anterior portion of operculum.

Description: L.U.V.P. 15108, represented in pl. 1 fig. 6 is well preserved, thin, elongated and narrow comprising mainly of an upper limb with a small anterior part of the operculum. The upper limb is long, narrow having a width of 0.3 mm and length of 22 mm. Lower limb is broken off from a position ventral to the angle of upper limb. Upper limb possesses a smooth anterior and serrated posterior border. Anterior margin of the operculum is attached to the apex of the posterior unserrated part of the preoperculum. Serrations on the posterior border increase in size and are slightly inclined towards the angle, but, decrease in size and have a tendency to straighten out towards the upper limb. Finally, at the place of junction of the operculum the serrations diminish in size. Ecologically, recent species of *Polydactylus* lives along the warm sandy shore. Fossil remains of *Polydactylus* are rare and only known from the Tertiary of Eastern Europe and now from Eocene of Jammu and Kashmir. In India, recent species *Polydactylus indicus* are found in marine waters.

Locality: L. U. 1002.

Suborder Percoidei

Family Nandidae

Nandus Cuvier Valenciennes 1831

Cf. *Nandus*

(Pl. 2, fig. 3)

Material: Six isolated scale, L.U.V.P. 15114.

Description: L.U.V.P. 15114, an irregular scale has a greater width (9 mm) than the length (7 mm). Posterior margin is rounded while the basal is straight. Basal radii are eight in number, straight and occupy the whole basal region. Lateral radii are shorter than the median and do not extend to the centre of scale. All radii are closely placed. On the lateral margins, circuli exist in form of concentric rings. All circuli are continuous

throughout the rounded apical area. Two outer-most circuli are thicker than the inner ones. Central portion of the scale is devoid of circuli. No definite nucleus is present. L.U.V.P. 15114 closely resembles Hora's specimen No. K 1/318 from Paharsingha and differs from K 29/628 only in the poor preservation or unexposed apical teeth and in the absence of a definite nucleus. Two specimens of fossil fish scales No. K 1/318 and K 29/628 belonging to family Nandidae were described by Hora (1938) from the Intertrappean beds of Paharsingha and Deothan. According to him the scale from Deothan (K 29/628) bears a general similarity with the scale of recent *Nandus*. Nair (1945) also described the scales of this family from lower Nimadric system (lower Murree formation) of Kandana, Salt Range and suggested a close similarity in general form and structure with the scale of *Nandus nandus*. *Nandus* generally occurs in rivers and lakes of Great Sunda Islands, and the fresh and brackish waters of India, Burma, Tenasserim and Malay Peninsula.

Locality: L. U. 1002.

Family Serranidae

Epinephelus Block 1873

Cf. *Epinephelus*

(Pl. 2, fig. 4)

Material: Eleven isolated scales, L.U.V.P. 15115.

Description: L.U.V.P. 15115, is an irregular scale having a length (11.5 mm) about twice that of the width (6 mm). Basal margin is uneven and wider than the apical area. Apical portion is sub-rounded and tapering posteriorly. Nuclear area long, narrow and ornamented by a few minute tubercles. Circuli are not well preserved. Basal radii are undulating and twelve in number. Median radii are longer than the lateral ones. L.U.V.P. 15115 closely resembles with the fossil scale No. K 39/565 No. 23 described by Nair (1945) from the lower Nimadric system (Lower Murree formation) of Kandana, Salt Range for the first time. *Epinephelus* occurs mainly in marine condition with the exception of a few species inhabiting fresh water. Genus ranges from Eocene to Present time and is widely distributed in tropical and sub-tropical seas.

Locality: L. U. 1002.

Order Labyrinthici

Suborder Anabantoidei

Family Polycanthidae

Polycanthus Swainson 1839

Polycanthus sp.

(Pl. 2, fig. 5)

Material: Five isolated scales, L.U.V.P. 15113.

Description: L.U.V.P. 15113, an irregular scale, quadrangular in shape, with a convex angular margin. Width (10 mm) is greater than the length (6.5 mm). Twenty basal radii are present. All radii are diverge from the central region and spread over the whole basal area. Circuli poorly preserved. Nucleus is situated close to the apical border. L.U.V.P. 15113 bears similarities up to a great extent with the scale (K 39/565 No. 36) described from the lower Nimadric system (Lower Murree formation) of Kandana, Salt Range (Nair, 1945). According to Nair his specimen (K 39/565 No. 36) is closely allied to *Polycanthus* usually found in fresh water and estuaries along the shore. Fossil remains mainly scales belonging to Family Polycanthidae were first described by Hora (1938) from the Intertrappean beds of Deothan and Kheri, and also have been reported from the Lower Tertiary of Sumatra (Berg, 1940, p. 285).

Locality: L. U. 1002.

Superorder Ostariophysi

Order Siluriformes

Family Ariidae

Arius Cuvier & Valenciennes 1840

Arius sahnii sp. nov.

(Pl. 3, fig. 1).

Holotype: L.U.V.P. 15101, right half of the pectoral girdle with a complete pectoral spine.

Diagnosis: Spine complete, straight, slightly convex distally, length 98 mm; ornamented by longitudinal striations gradually converging towards the distal end. In shape, size, presence of small closely placed denticles in a shallow groove on posterior side and the sculpturing of dorsal and ventral surfaces, the specimen differs from *A. kitsoni*, *A. heward-belli*, *A. russi*, and the species of *Arius* described from Balasore by Hora (1939). From *A. russi* it also differs in having a small central cavity. In *A. egertoni* both anterior and posterior margins are serrated whereas in L.U.V.P. 15101 both are denticulated. Cleithral process small and externally marked by low irregular ridges.

Description: Right half of the pectoral girdle, L.U.V.P. 15101 is well preserved comprising of a complete pectoral spine, cleithral process, cleithrum and the short arm of the cleithrum (represented only by an impression).

Cleithrum comprising of the major part of the girdle, is large, sculptured by longitudinal striae. Dorsally, cleithrum curves posteriorly to bear an elongated subtriangular cleithrum process as well as an upwardly directed short arm of cleithrum. Anteriorly, it bears a ridge on its outer side becoming less marked in the direction of the glenoid facet. The cleithral process is small elongated and sculptured by irregular low ridges; having a length of 24 mm. Length and width of the cleithrum are 82 and 32 mm respectively.

Pectoral spine stout, robust, long (98 mm), dorso-ventrally compressed with a complete articulation facet. Spine thins distally and ornamented by a series of longitudinal striations, gradually converging towards the distal end. Anterior and posterior margins are denticulated. Denticles on anterior border are long, closely placed, and directed towards the distal end while those on the posterior border are small, directed towards the proximal end and closely placed in a shallow groove originating from a deep cavity present on the articulation facet with a tendency to become sparsely placed distally. Denticles are absent at the extreme distal end of the spine.

Comparison: L.U.V.P. 15101, can be distinguished from *Arius egertoni* from the Middle Eocene of England and Belgium (Woodward, 1901), *A. kitsoni*, *A. russi*, *A. heward-belli* described from the Eocene of the Nigeria (White, 1926) and the species known from the Miocene of Balasore (Hora, 1939) in shape, size and sculpturing of dorsal and ventral surfaces. Both dorsal and ventral surfaces are marked by irregular longitudinal ridges partly tuberculated in *A. egertoni* and *A. kitsoni*; by fine and rather irregular longitudinal rugae in *A. heward-belli*; by reticulating longitudinal rugae in *A. russi* and being devoid of any ornamentation in the species described from the Balasore whereas in L.U.V.P. 15101 only longitudinal striations are present converging towards the distal end. Central cavity not as large as in *A. russi*. Presence of small closely placed denticles in a shallow groove on the posterior side differentiates the new species from *A. kitsoni*, *A. heward-belli*, *A. russi* and the Balasore species. In the new species both anterior and posterior margins are denticulated and not serrated as in *A. egertoni*.

Type Locality and Horizon: L.U. 1004, Maroon argillaceous sandstones; Middle Eocene (Lutetian).

Repository: Vertebrate Laboratory, Geology Department, Lucknow University.

Etymology: After Dr. M. R. Sahni, Retd. Prof. of Geology, Chandigarh University.

Arius sp.

(Pl. 2; figs. 1 & 2)

Material: Posterior part of the skull, L.U.V.P. 15102.

Description: L.U.V.P. 15102, the posterior fragment of the skull represented in pl. 2 figs. 1 & 2 is well preserved, wide and broken anteriorly and anterolaterally has been tentatively assigned to the genus *Arius*. Posteriorly, the skull is higher than the other preserved cephalic bones where the keel is not exposed. Two sensory grooves arising from the middle of the supraoccipital, diverging at an angle of 30° run anteriorly up to the broken anterior extremity. On both sides of the sensory grooves the tubercles are aligned longitudinally, which are larger than those present on the posterolateral sides of the supraoccipital. Anteriorly, between the sensory grooves in median plane a 2 mm wide shallow groove exists. The posterior higher portion of the supraoccipital is sculptured by a longitudinal linear pattern of closely united small tubercles, while anteriorly, this pattern shows a divergence towards the anterolateral margins. On the posterolateral sides, coalesced tubercles exhibited a radiating pattern. Suture between supraoccipital and right pterotic and left parietal is zig-zag and distinct. The right pterotic is laterally broken and has been displaced slightly to the right along the suture with supraoccipital. Left pterotic is partially preserved and is ornamented by cancellate tubercles, as is the triangular parietal.

Basisphenoid is wide, stout and medially situated. It is widest posteriorly with two tuberosities forming the lowest point of the skull. Each tuberosity bears a posterolaterally directed bar like projection to meet the post-temporal bars. From the lowest point of the skull, the basisphenoid runs anteriorly with a gentle slope, becoming narrow. Anteriorly, the lateral margins of basisphenoid are attached to the posterior projections of parasphenoid by zig-zag suture.

Measurements in mm:

Measured length of skull	..	58
Measured width of skull	..	55
Height of skull	28

Affinities:

The supraoccipital of *Arius* sp., L.U.V.P. 15102 closely resembles with that of *A. egertoni* from the Middle Eocene of Bracklesham, England (Woodward, 1901) in size, basic pattern of ornamentation, though the tubercles are not conical, and in the position and angle of divergence of sensory grooves.

Skull is larger than of *A. crassus* from the Upper Eocene of Barton, England and *A. iheringi* from the Tertiary

lignite of Brazil (Woodward, 1901) but smaller than two fossil species known from India: *A. sp. a* from Siwalik hills (Lydekker, 1886), and *A. kutchensis* from the Lower Eocene of Kutch (Rao, 1956). Further it can be distinguished from *A. crassus*, *A. iheringi* and *A. sp. a* in ornamentation and presence of sensory grooves. Divergent angle and the position of sensory grooves and ornamentation are also the points of differentiation between *Arius sp.* and *A. kutchensis*.

Locality: L. U. 1002.

UNASSIGNABLE SILUROID MATERIAL:

Besides, the species described the collection also includes a number of isolated skull bones, vertebrae, dentaries, isolated teeth, opercula, and scales. This material is indeterminable at the generic level with any amount of certainty owing to their fragmentary and isolated nature.

Infraclass Holostei

Order Pycnodontiformes

Family Pycnodontidae

Coelodus Heckel 1856

Coelodus sp.

(Pl. 3, figs. 2 & 3)

Material: Five isolated tooth of the principal series of splenial dentition, L.U.V.P. 15107.

Description: L.U.V.P. 15107, an isolated tooth of the principal series of splenial dentition, is transversely elongated, sub-oval in shape with one side being drawn out in form of an alar projection. Tooth has a width (2.5 mm), more than twice that of the length (1.00 mm). Occlusal surface of tooth is convex, smooth with two parallel crenulated ridges. Basal surface is flat with a long pulp cavity filled with matrix. The specimen closely resembles with *C. fimbriatus* Woodward, 1893, from Turonian of Kent, *C. ellipticus* Egerton, 1877 from the Gault of Kent, *C. inaequidens* Woodward, 1893 from the Cenomanian of Cambridge and *C. costae* Heckel, 1856 from Upper Jurassic of South Italy (Woodward, 1901) in morphology. The only known species of *Coelodus* from India is *C. jacobi* from the Sizu limestone (Middle Eocene) of Assam (Prasad and Menon, 1958), represented by its splenial dentition consisting only a tooth in principal series and two rows of flanking series *Coelodus sp.* differs from *Coelodus jacobi* in its considerably smaller size and length width ratio of 1 : 1.5.

Locality: L. U. 1001.

Subclass Elasmobranchii

Order Selachii

Suborder Hexanchiodea (Notidanoidea)

Family Haxanchidae (Notidanidae)

Notidanus Cuvier 1817

Notidanus primigenius Agassiz 1843

(Pl. 3, figs. 4 & 5)

Material: Isolated teeth, L.U.V.P. 15117.

Description: L.U.V.P. 15117, is a small tooth nearly as high as broad with one principal and three accessory cusps all inclined posteriorly. All cusps are unserrated, laterally compressed with sharp apices and inclined anterior and convex posterior margins. Principal cusp is the largest, with three denticles at base on its anterior side. The root is elongated and unforked.

Measurements in mm:

Breadth of the tooth	..	3.2
Height of the tooth	..	2.7
Height of the principal cusp	..	1.5

Locality and Horizon: Middle Subathu Formation exposed in a road section, about 0.5 km from Beragua Coal Mine, Olive shales; Lower Eocene (Ypresian).

Class Reptilia

Subclass Anapsida

Order Chelonia

Suborder Cryptodira

The present collection of turtle from Subathu Formation consists mainly of fragmentary pieces of carapace and plastron plates. In the collection two genera *Hemichelys* and *Trionyx* have been identified. The identification at specific level is not possible because of the fragmentary nature of material.

Superfamily Carettochelyoidea

Family Carettochelyoidae

Hemichelys

Hemichelys cf. H. warthi

(Pl. 3, fig. 10)

Material: Nearly complete marginal costal plate of carapace, L.U.V.P. 15119, and other fragments of carapace.

Description: L.U.V.P. 15119, the marginal costal plate is broken laterally, measuring 51 mm in length and 24 mm in width. Ventrally, plate is slightly convex in the middle. Dorsal surface is sculptured by pattern of pentagonal pits bounded by ridges.

Hemichelys warthi is known from the Salt Range, Pakistan from a bed situated 10 feet below the coal seam at Nila, believed to be of estuarine origin and of Lower Eocene in age (Lydekker, 1887).

Locality: L. U. 1001.

Superfamily Trionychoidea

Family Trionychidae

Trionyx

Trionyx sp.

(Pl. 3, fig. 11)

Material: L.U.V.P. 15118, slightly broken part of the costal carapace plate.

Description: L.U.V.P. 15118, a slightly broken piece of costal carapace plate is ornamented by polygonal arrangement of pits bordered by ridges. From India, a number of turtles belonging to genera *Emyda* and *Trionyx* are reported from the Neogene Siwalik sequence of Himalayan Foot-Hills.

Discussion: There is a close similarity between the scales in the present collection and those described from the lower Nimadric system (Lower Murree formation) of Kandana, Salt Range Pakistan (Nair, 1945) as also those from the Intertrappean fauna described by Hora (1938). Ecologically, the fishes from the Beragua Coal field area range from marine to fresh water forms. This variation in ecological range is not surprising if one considers the proximity of the shore line which was probably not more than 100 kms away. In fact, certain marine fishes may also frequent in fresh water such as *Arius* and *Epinephelus*. The lower vertebrates particularly the fishes record the transition of a predominantly marine sequence to that of a fluvio-terrestrial environment.

Locality: L. U. 1002.

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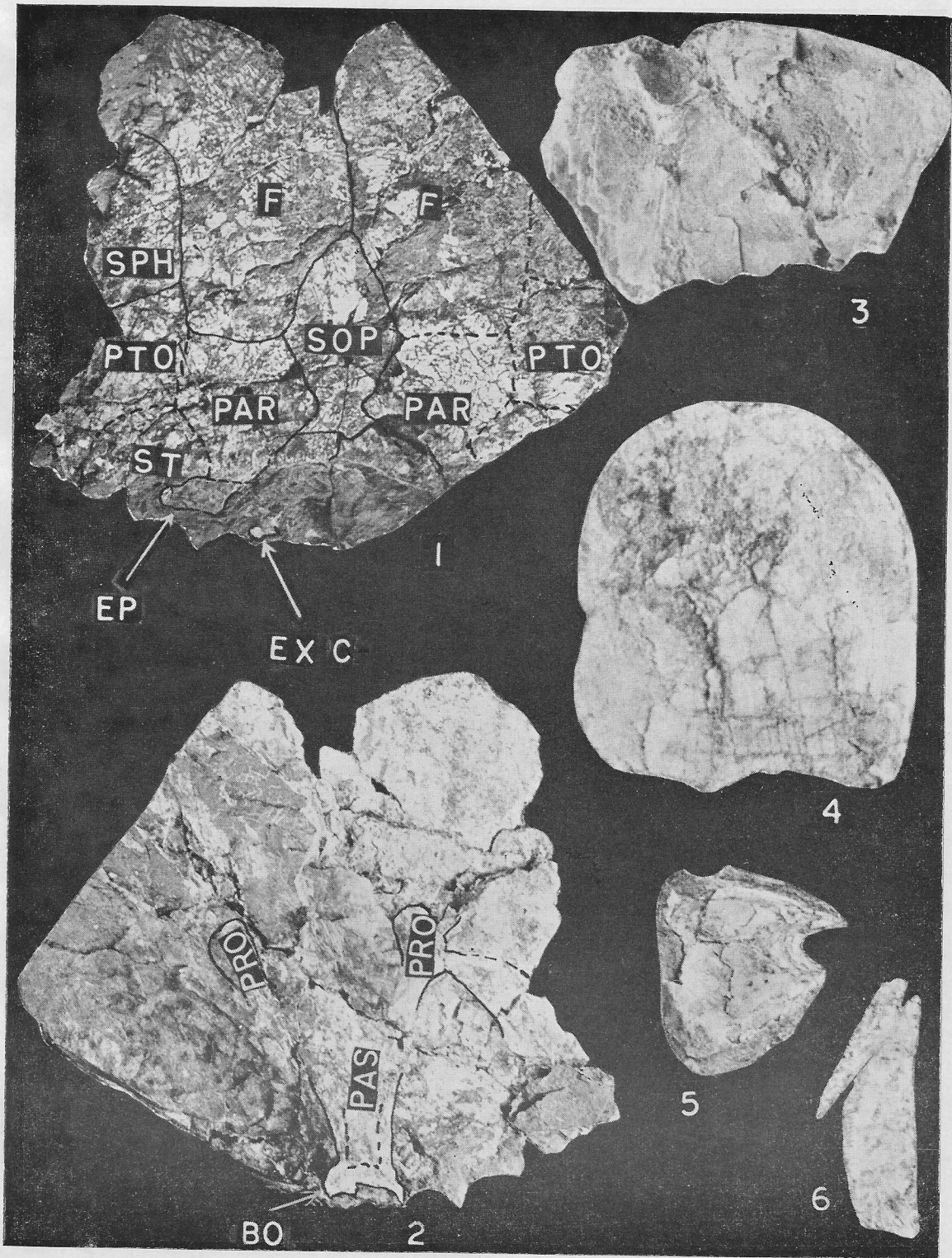
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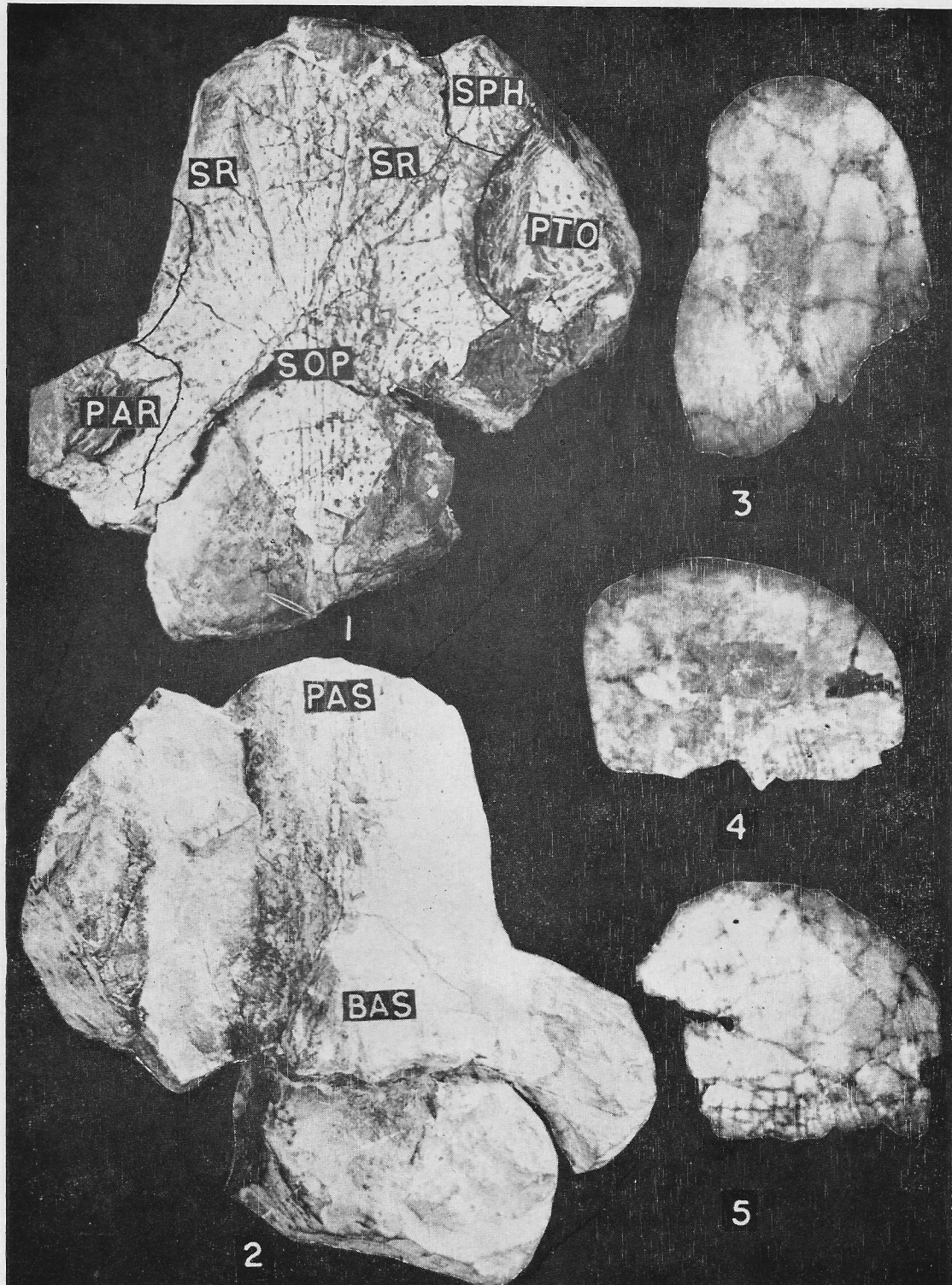
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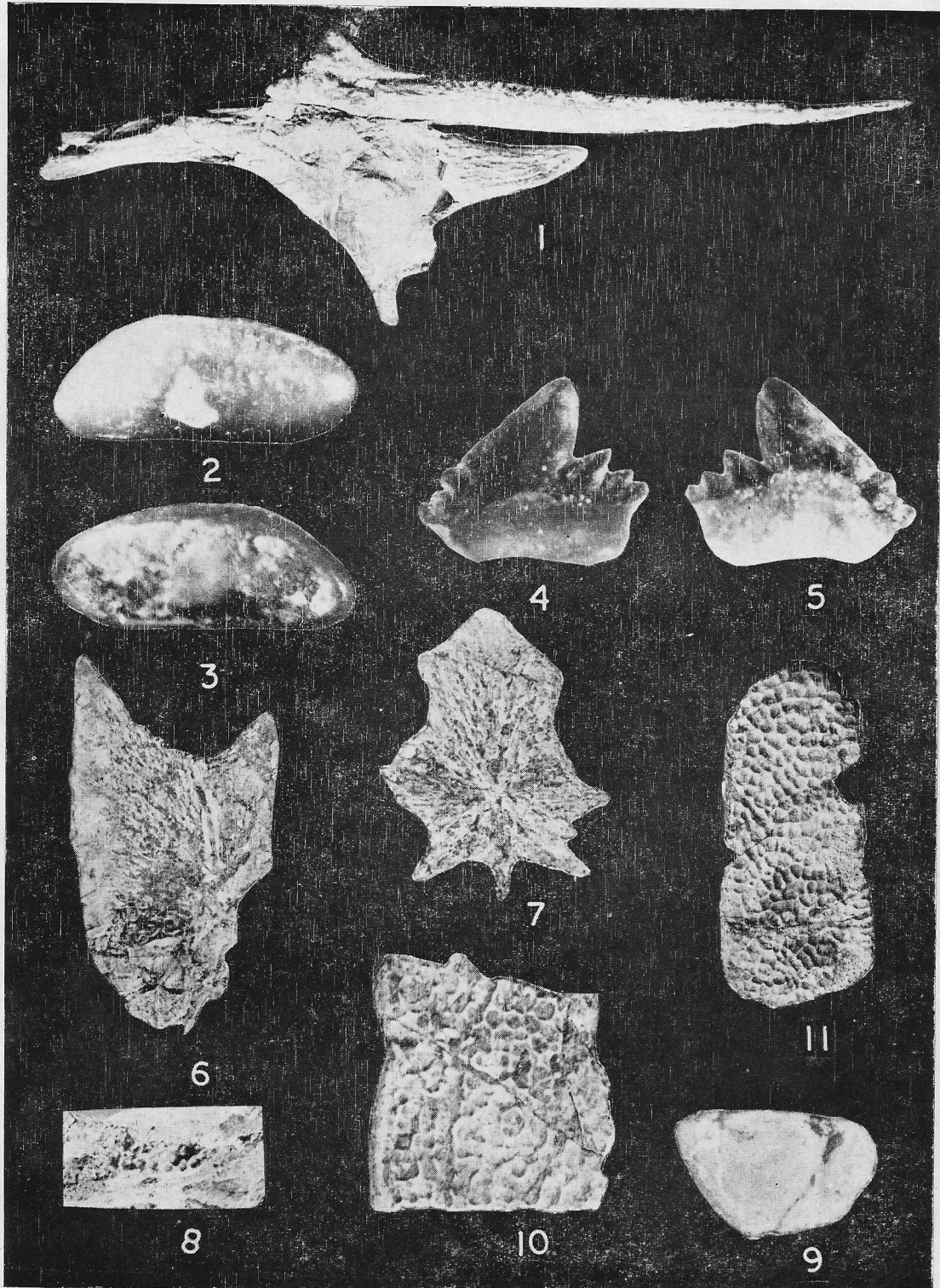
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EXPLANATION OF PLATE 1

- 1-4. *Ophicephalus lydekkeri* sp. nov.; 1 & 2. Holotype, L.U.V.P. 15103, nearly complete skull; 1—Dorsal view, 2—Ventral view, Both $\times 1.27$, 3—Paratype, L.U.V.P. 15104, left operculum $\times 3$, 4—Paratype, L.U.V.P. 15105, scale $\times 4$.
5. *Scorpaena* sp., L.U.V.P. 15106, right operculum $\times 1.75$.
6. *Polydactylus* sp., L.U.V.P. 15108, upper limb of preoperculum with a small anterior portion of operculum $\times 1.6$.







ABBREVIATIONS

BO—Basioccipital; EP—Epiotic; EXC—Exoccipital condyle; F—Frontal; PAR—Parietal; PAS—Parasphenoid; PRO—Prootic; PTO—Pterotic; SOP—Supraoccipital; SPH—Sphenotic; ST—Supra-temporal.

EXPLANATION OF PLATE 2

1. & 2. *Arius* sp., L.U.V.P. 15102, posterior part of the skull; 1—Dorsal view, 2—Ventral view, Both $\times 1.6$.
3. Cf. *Nandus*, L.U.V.P. 15114, scale $\times 5.5$
4. Cf. *Epinephelus*, L.U.V.P. 15115, scale $\times 5.5$
5. *Polycanthus* sp., L.U.V.P. 15113, scale $\times 5$.

ABBREVIATIONS

BAS—Basisphenoid; SR—Sensory groove and others are the same as used in Plate 1.

EXPLANATION OF PLATE 3

1. *Arius sahnii* sp. nov.; Holotype, L.U.V.P. 15101, right half of the pectoral girdle with a complete pectoral spine $\times 1$.
2. & 3. *Coelodus* sp., L.U.V.P. 15107, isolated tooth of principal series of splenial dentition; 1—Occlusal view, 2—Basal view. Both $\times 20$.
4. & 5. *Notidanus primigenius*, L.U.V.P. 15117, isolated tooth; 4—External view, 5—Internal view. Both $\times 12.6$
- 6-9. Unassignable siluroid material; 6—L.U.V.P. 15111, articular, 7—L.U.V.P. 15109, supraoccipital, 8—L.U.V.P. 15110, dentary, 9—L.U.V.P. 15112, Operculum $\times 2.5$. Figures 6, 7, 8 are of natural size.
10. *Hemichelys* cf. *H. warthi*, L.U.V.P. 15119, nearly complete marginal costal plate of carapace $\times 1$.
11. *Trionyx* sp., L.U.V.P. 15118, slightly broken part of the costal carapace plate $\times 1.5$.