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COASTAL-PLAIN MICROVERTEBRATE ASSEMBLAGE FROM THE TERMINAL CRETACEOUS OF ASIFABAD, PENINSULAR INDIA.

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ABSTRACT

A microvertebrate assemblage consisting of 21 genera and 26 species of fish, frogs, lizards, snakes, crocodiles and dinosaurs is described from the Infra — and Intertrappean Beds of Asifabad, Adilabad District, Andhra Pradesh (India). The fauna consists of an admixture of marine and freshwater assemblages thereby suggesting a coastal-plain condition of deposition for these beds. The biotic assemblages show close affinities to those of Holarctic and Gondeanaland continents and are in favour of a Late Cretaceous and Late Cretaceous to Early Palaeocene ages for the infra — and intertrappean beds respectively.

INTRODUCTION

The Deccan volcanic activity covering a time span of Late Mesozoic-Early Tertiary period represents the largest volume of continental basalts on the earth's surface and has been major topic for many geological investigations among which palaeomagnetic, radiometric and palaeontological studies figure invariably. From the palaeontological point of view, the sedimentary beds lying below (infratrappean) and in between (interptrappean) the Deccan volcanic flows are very important as they are fossiliferous. the infra-and intertrappean beds have a wide geographical distribution in central as well as western India. Among these, the Rajahmundry, Bombay and Nagpur Intertrappeans have been extensively studied and have yielded a distinct suite of vertebrates, invertebrates and plants fossils. These strata provide data on transitional Late Mesozoic-Early Tertiary faunal and floral distribution of the Indian plate just prior to and during the Deccan volcanism.

In comparison to the Infra – and Intertrappean Beds of southeastern, western and central India, those of Asifabad have remained virtually unstudied. King (1881) who worked out the geology of Pranhita-Godavari Valley in detail, made only a passing reference of the Asifabad Infra – and Intertrappean Beds. The only fossil record from the beds is that of Rao and Yadagiri (1981), who recorded the presence of a limb bone of a sauropod dinosaur and a few ostracodes, pelecypods, and charophytes in these beds. No systematic study of the fossils from this area has occurred owing to the inaccessibility of the fossil bearing localities and poor exposures. Because a major part of the area is covered by dense forest and it is very difficult to locate good fossiliferous sections.

The geological succession of the area was given for the first time by King (1881) and was subsequently modified by Jain *et al.* (1964), Sengupta (1966) and Kutty (1969). According to King (1881) the basement rocks in this area are mainly Archaean gneisses which are overlain by the Pakhal Series of Cuddapah System and Sullavai Sandstone of the Kamool Series respectively. These rock types are in turn overlain by the Gondwana Group which consists of the Lower Gondwana formations, viz., Talchir, Barakar and Kamthi, and the Upper Gondwana formations, viz., Yerrapalli, Bhimaram, Maleri, Dharmaram, Kota and Gangapur (Jain *et al.*, 1964; Sengupta, 1966 and Kutty, 1969). Overlying the Gondwana Group of rocks, are the Deccan Trap flows with their intercalated sedimentary beds (infra – and intertrappean). Older (Middle to Late Pleistocene) and Recent alluvial deposits blanket the plains surrounding the hill ranges.

The work on Asifabad Infra – and Intertrappeans was initiated in 1982 as an intergral part of G.V.R. Prasad's Ph.D. thesis with an objective of documenting the palaeontological data in relationship to the palaeogeography of the supposedly drifting island subcontinent. Detailed investigations were carried out during the field seasons of 1982-1985, during which more than 3 tons of matrix was screen washed from five fossiliferous sections. Four of the five collecting sites are intertrappean in position, while the fifth one is infratrappean in position (Fig. 1). The infratrappean stratigraphic section is exposed south of the village Mankiguda (19° 24' 15" : 79° 14' 40") and is composed of red and white marls and yields a fauna that includes taxa referable to *Lepidotes, Belonostomus, Eomuraena* and *Enchodus*. A few cycloid and ctenoid scales referable to Pristolepidae gen. et sp. indet. are also present.

The intertrappean sections are exposed 2.5 km south and 3 km SW of the village Ada (19° 25' : 79° 15'), and 1 km south and 3.5 km SW of the village Kothari (19° 24' 30" : 79° 11' 50"). Lithologically they are mainly constituted by quartz, oolitic and lithic arenites, and lithic wackes. A major part of the present collection of microvertebrates has been recovered from the stream

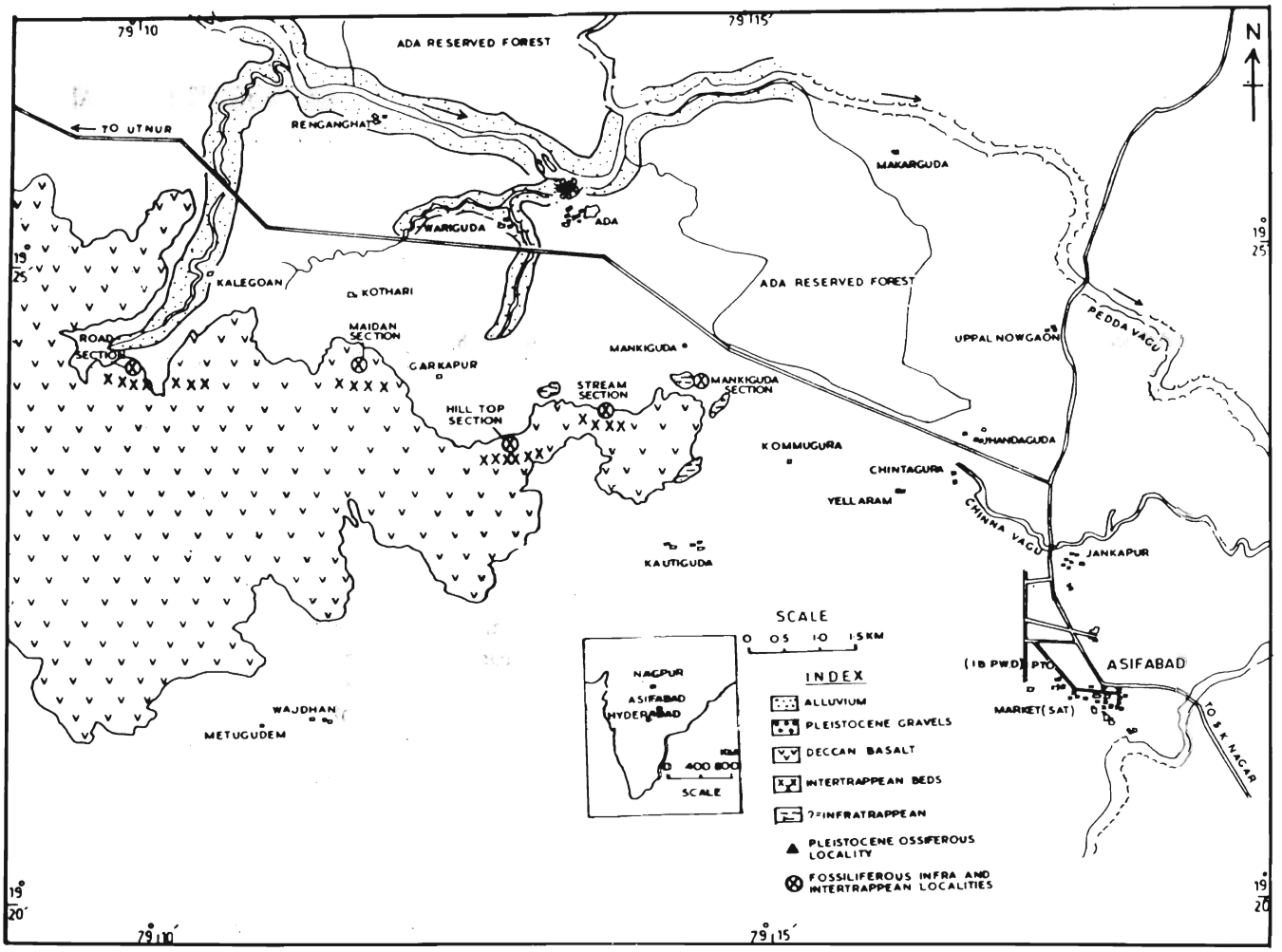

Fig. 1. Location map of the ossiferous horizons

section exposed 2.5 km south of the village Ada. Microvertebrate assemblages recovered from the intertrappean sections include fishes: *Orthacodus, Raja, Coupatezia, Rhombodus, Igdabatis, Lepidotes, Lepisosteus, Pycnodus, Belonostomous, Phareodus, Apateodus, Enchodus,* Pristolepidae gen. et sp. indet., *Pseudoegertonia, Stephanodus, Eotrigonodon, Indotrigonodon, Palaeolabrus;* frogs: Anura indet.; Lizards: Lacertilia indet.; snakes: Boidae gen. et sp. indet; crocodiles: Crocodylidae gen. et sp. indet.; dinosaurs: Megalosauridae gen. et sp. indet., egg shell fragments (Sahni *et al.*, 1984); foraminifers: Nonionidae, Nodosariidae, Textulariidae; molluscs: *Unio, Paludina, Hydrobia, Physa;* ostracodes: *Paracypretta, Mongolianella, Candoniella, Cyprois, Metacypris;* chrophytes· *Platychara, Microchara, Peckichara* (Table 1)

SYSTEMATIC PALAEONTOLOGY

Class Chondrichthyes
Order Selachii
Family Orthacodontidae

Orthacodus longidens AGASSIZ, 1843
(Plate III–14-16)

These are four teeth in the Asifabad fauna which are referable to *Orthacodus longidens.* The teeth are isolated, small in size (1.1 – 1.6 mm in height), slender, slightly bent and laterally compressed with sharp cutting edges.

Table. 1. Late Cretaceous vertebrates of Asifabad.

Formation	Infratrappean	Intertrappean			
Localities / Taxa	Mankiguda section	Stream section of Ada	Hill top section of Ada	Maidan section of Kothari	Road section of Kothari
Orthacodus longidens		×			
Raja sp. indet.		×			
Coupatezia woutersi		×			
Rhombodus cf. *R. levis*		×			
Rhombodus sp. indet		x			
Igdabatis sigmodon		×			
Lepidotes sp.	×	×			
Lepisosteus indicus		×		×	

Pycnodus lametae		×		×
Pycnodus cf. *P. praecursor*		×		
Pycnodus sp.		×		×
Belonostomus cf. *B. cinctus*	×	×		
Eomuraena cf. *E. saggittidens*	×			
Phareodus sp.		×		×
Apateodus striatus		×		
Enchodus sp. indet.	×	×		
Stephanodus libycus		×		×
Stephanodus sp.		×		
Eotrigonodon indicus		×		×
Eotrigonodon wardhaensis		×		
Indotrigonodon ovatus		×		
Palaeolabrus dormaalensis		×		
Anura indet.		×		×
Lacertilia indet.				×
Boidae gen. et sp. indet.		×		×
Crocodylidae gen. et sp. indet.		×	×	
Megalosauridae gen. et sp. indet.		×		

Teeth with the above morphological features have also been reported from the Cretaceous of Japan (Goto, 1977). The genus *Orthacodus* is known from the Early Jurassic-Eocene of Europe, Late Jurassic of Africa, Late Cretaceous of North America (Romer, 1966).

Order Batoidea
Family Rajidae BONAPARTE, 1831
Raja sp.
(Plate I — 1-6)

The genus *Raja* is represented by many isolated well preserved teeth ranging in size from 0.5 – 0.9 mm. Crown is wider than long, elliptical or subrounded with a transverse ridge in some of the teeth, while it is oval in shape with flat occlusal surface in others. In Plate I-3 and 4 have a triangular occlusal surface with a centrally elevated platform. A median uvula is present on the posterior lip. Anterior and posterior lips are convex in outline. Root is bifurcated into two roughly triangular lobes by a narrow root canal.

The genus *Raja* has long been known from the Phosphate Beds of Tunisia and Algeria (Priem, 1909), Morocco (Arambourg, 1952), Eocene of Belgium (Winkler, 1874; Leriche, 1905), Cretaceous Phosphate Beds of Rutbah, Iraq (Signeux, 1959) and from the Thanetian of Niger (Cappetta, 1972). However, *Raja praealba* of Arambourg (1952) and *Raja duponti* of Leriche (1905) have been reclassified by Cappetta (1983) as belonging to the families Dasyatidae and Gymnuridae on the basis of dental histology. The present specimens do not exhibit similar morphology of previously described species.

Family Dasyatidae
Coupatezia woutersi CAPPETTA, 1982
(Plate I — 8)

A complete and well preserved tooth is the only specimen in the Asifabad fauna representing *Coupatezia woutersi*. The tooth is 2.2 mm in height and consists of a well marked acutely pointed cusp in the medio-posterior region of the posterior crown face and belongs to the antero-lateral series. The medio-posterior cusp together with the wrinkled anterior face of the crown imparts an heart-shape to the crown. On the posterior face below the cusp a slight bulge in the form of a ridge can be seen extending from the cusp to the lower margin of the posterior lip.

Cappetta (1982) based on the dental histology and morphology revised the systematic position of *Cestracion duponti* or *Raja duponti* of Winkler (1874), Leriche (1905, 1906), Casier (1946) and Arambourg (1952). He placed the teeth described by Winkler (1874) in a new genus *Jacquhermania* of the family Gymnuridae and those of the Leriche (*Cestracion duponti* 1905, 1906) to a new genus and species *Coupatezia woutersi* belonging to the family Dasyatidae.

The genus *Coupatezia* is known from the Maestrichtian of Morocco, Holland, Ypresian and Bruxellian of Belgium, Auversian of Paris Basin, Thanetian and Ypresian of Morocco and Thanetian of Niger (Cappetta, 1982).

Rhombodus cf. *R. levis* CAPPETTA & CASE, 1975
(Plate I — 9-11)

Four teeth in the Asifabad fauna seem to have affinities to *R. levis* described by Cappetta and Case (1975) from the Monmouth group (Campanian-Maestrichtian) of New Jersey in having diamond-shaped crown, smooth occlusal surface, and the height of the crown less than that of root. But the 'U' shaped transverse groove conspicuous on the posterior lip of the Asifabad forms is not distinct in the New Jersey specimens.

Rhombodus sp. indet.
(Plate I — 13-18)

In addition to *Rhombodus* cf. *R. levis*, there are different types of teeth belonging to the genus *Rhombodus*. These teeth are morphologically different from *R. binkhorsti, R. bondoni, R. meridionalis* and *R. microdon* known from the Maestrichtian of Morocco (Arambourg, 1952). The tooth represented by Pl. I — 12 is similar to *Rhombodus*? sp. indet. of Herman (1973; Pl. 13, Fig. 8) in having rectangular, high and long coarsely wrinkled crowns, anterior and posterior faces of the crown overhanging the root, root with roughly same shape as that of crown and divided into two slender, elongated root lobes.

Similarly the tooth shown in Pl. I — 14 is identical to *Rhombodus*? sp. indet. described by Herman (1973, Pl. 13, Fig. 7 d) from the Cretaceous and Palaeocene of Belgium with diamond-shaped crown ornamented with pits on the posterior face root separated from the crown by smooth, convex, slender ridge, smooth

anterior and posterior faces, convex diamond-shaped basal root divided into two unequal triangular lobes.

Family Myliobatidae
Igdabatis sigmodon CAPPETTA, 1972
(Plate II — 3)

There are three teeth in the Asifabad fauna, which are similar to *Igdabatis sigmodon*. The teeth are slightly arched in a transverse plane giving a sigmoidal shape as seen in *I. sigmodon* (Cappetta, 1972). Teeth are 3-4 times wider than long. Thickness of the crown is maximm in the middle part and minimum at the lateral ends. Occlusal surface exhibits numerous hexagonal and polygonal pits. Root is divided into many alternative grooves and ridges.

In addition to the above teeth, there is a large number of teeth in the present collection with identical occlusal ornamentation as in *I. sigmodon* but with roots divided into two, three, four lobes and even without any divisions (Pl. I — 19; Pl. II — 1-2 and 4). These teeth probably belong to the same species, the difference in shape and root divisions is being due to positional variation on the jaw.

I. sigmodon was first reported by Cappetta (1972) from the Maestrichtian Mount Igdamn of Niger. Similar teeth have also been reported by Jain and Sahni (1983) from the Late Cretaceous Lameta Formation of Pisdura. Though the Asifabad teeth exhibit identical morphological features, they are not as highly sigmoidal as those of Mount Igdamn, rather they are more close to those of the Lameta Formation of Pisdura.

Class Osteichthys
Order Semionotiformes
Family Semionotidae
Lepidotes sp.
(Plate II — 5-7)

Fifteen teeth in the Asifabad fauna are referable to *Lepidotes*. The teeth are small (0.5-0.7 mm), conical, styliform and dome-shaped. Teeth have a circular hase which is crumpled at the margins. In some cases the crown is divided into two chambers by two ring-like sutures. Some teeth exhibit a slight depression at the apex which Jain (1983) considers as the characterstic feature of newly erupted tooth.

Family Lepisosteidae
Lepisosteus indicus WOODWARD, 1908
(Plate II — 8-10)

The present collection comprises 15 teeth and 10 scales referable to the fish *Lepisosteus indicus*. External teeth are small in size while the internal teeth are large in size. Teeth are conical in shape with well differentiated basal and apical parts. Base of the tooth is cylindrical in shape and is ornamented by numerous fine vertical striations.

Scales vary in shape from oval to rhombic. The internal layer is thick and consists of ridge like feature in the middle of the scale, oriented parallel or obliquely to the long axis. External ganoine layer exhibits well marked boundaries surrounded by a distinct peripheral layer.

Both the scales and teeth in the Asifabad collection have close affinities to *Lepisosteus indicus* described by Woodward (1980a) from the Late Cretaceous Lameta Formation of Dongargaon, Central India. Some scales resemble the specimens reported from the Intertrappean Beds of Paharsingha (Hora, 1938).

Order *Pycnodontiformes*
Family Pycnodontidae
Pycnodus lametae WOODWARD, 1908
(Plate II — 11-15)

Ten teeth in the present collection are referred to *Pycnodus lametae* described by Woodward (1908a) from the Upper Cretaceous Lameta Formation of Dongargaon, Central India in having elliptical or oval crowns in the median teeth and circular crowns in lateral teeth with coarsely tuberculated concave occlusal surfaces and coarsely crenulated margins.

Pycnodus cf. *P. praecursor* DARTEVELLE & CASIER, 1949
(Plate II — 16-18)

Five isolated teeth in the Asifabad fauna are tentatively referred to *P. praecursor* based on external morphological features. Median teeth are generally oval or elliptical in shape while the lateral teeth are triangular or circular in shape. Occlusal surface is flat smooth. In comparison to *Pycnodus* cf. *P. praecursor* described by Cappetta (1972) and Kumar (1983) from the Cretaceous-Tertiary formations of Niger and Eocene Subathu Formation of Himachal Pradesh, India respectively, the teeth are very small in size (1.0-2.5 mm in width).

Pycnodus sp.
(Plate II — 19-22)

Pycnodus sp. is represented in the present collection by 20 isolated teeth. These teeth are transversely elongated and consists of two transverse ridges on the anterior and posterior sides of the crown. Transverse ridges are crenulated in some specimens while they are smooth in others.

Teeth with similar morphological features are known from the Late Cretaceous-Early Palaeocene Takli Formation of Nagpur (Rana, 1984), Late Cretaceous Lameta Formation of Pisdura (Jain pers. comm.) and the Eocene Subthu Formation of Jammu and Kashmir, India (Kumar, 1983).

Order Aspidorhynchiformes
Family Aspidorhynchidae

Belonostomus cf. *B. cinctus* AGASSIZ, 1837
(Plate I! — 1a-1c)

There are four isolated teeth and two fragmentary scales which are referable to *B. cinctus*. Teeth are small, slender, conical in shape. In basal section, teeth are circular in outline. Basal part is four times greater in height than the apical part. Teeth are feebly ornamented by coarse vertical striations at the base. Apical part of the tooth is capped by a sharp point of smooth, translucent enamel.

Scales are elongated and thin. Inner surface is flat and smooth. External surface is ornamented by thick, dark, smooth ganoine in the form of transverse ridges. These ridges are discountinuous and are disposed in the direction of the long axis of the scale.

Teeth and scales with similar features are known from the Turonian Stage of the English Chalk (Woodward, 1908b).

Besides the above teeth and scales there are three robust scales (Pl. III — 2 & 3) in the Asifabad fauna, whose external surface is ornamented by elongated, elliptical ridges of smooth ganoine, inflated in the middle part and pinched at the ends. Almost similar type of scales have been described by Rana (1984) from the Late Cretaceous-Early Palaeocene Takli Formation of Nagpur as *Belonostomus* sp.

Order Anguilliformes
Family Muraenidae
Eomuraena cf. *E. sagittidens* CASIER, 1967
(Plate III — 4-6)

Isolated complete teeth referable to *Emuraena sagittidens* are present in hundreds in the Asifabad fauna. Teeth are slender and elongated with a spear-like apex. Surface of the tooth is smooth and is formed of dark brown enamelloid. Basal part of the tooth is higher than the apical part. Teeth are laterally compressed and in the transverse section, the bas eis elliptical in form. Lateral edges of the apical part are as sharp as a blade. Enamel in the apical part is translucent. Lateral edges are inflated at the suture where the apical and basal parts meet.

In addition to the shape of the tooth, Asifabad specimens are identical to those of *E.sagittidens* described by Casier (1967a) from the Lower Eocene Beds of Katharinenhof-Fehmarn Island, Germany, in leghth ratio of the apical and basal parts.

Order *Osteoglossiformes*
Family Osteoglossidae
Phareodus sp.
(Plate III — 7-11)

In the present collection, *Phareodus* is represented by nearly 25 scales. These scales are tetragonal, rhombic and polygonal in outline. External surface of each scale is ornamented by fine tubercles. Inner surface of the scale is a concave basin, borders of which are elevated to form a finely crenulated rim. Inner and outer surface of the rim are characterised by fine lammellae. Isolated coarse tubercles are also present on the inner surface of some scales.

The genus *Phareodus* is known from the Palaeocene of Australia, Early Eocene of Pakistan (Gayet and Meunier, 1983), Late Cretaceous of Bolivia (De Muizon *et al.*, 1983) and from the Late Cretaceous-Early Palaeocene Takli Formation of Nagpur (Rana, 1984), Central India. The present forms resemble closely those of the Pakistan and Nagpur. Similar type of scales have also been recovered from the Late Cretaceous Lameta Formation of Jabalpur and Eocene Subathu Formation of Jammu and Kashmir (Vertebrate Palaeontology Laboratory (VPL), Department of Geology, Panjab University, Chandigarh, work in progress).

Order Salmoniformes
Family Enchodontidae
Apateodus striatus WOODWARD, 1901
(Plate III — 12-13)

120 teeth in the Asifabad collection can be referred to *Apateodus striatus* of the English Chalk (Woodward, 1902) based on the following morphological features. These teeth are complete and lanceolate in shape. Each tooth is constituted by a subcylindrical base ornamented with fine vertical striations. Junction of the apical and basal parts is marked by a slight bulge and is the place where the vertical striations of the basal part disappear. Height of the apical part is greater than that of the basal part. Apex of the crown is blunt. Apical part is laterally flattened and compress. d. Lateral edges are sharp, forming a flange which passes from one side of the teeth to the other side over the summit. In some cases this flange is interrupted in the mid height of one of the two edges of the apical part.

Enchodus sp. indet.
(Plate III — 17-20)

Two distinct types of teeth that differ from *Enchodus ferox* in the external morphology are present in the Asifabad collection.

In Pl. III — 17 and 18 are elongated teeth characteristically in the form of a hook with more or less pronounced sigmoidal curvature. Whereas in Pl. III — 19 and 20 have conical outlines, gentle curvature and smooth surfaces. In these teeth, basal part is covered by dull enamelloid whereas the apical part is made up of glossy translucent enamel and is in the form of a conical cap.

Order Tetraodontiformes
Family Trigonodontidae
Stephanodus libycus DAMES, 1883
(Plate III — 21-23)

20 isolated pharyngeal teeth in the Asifabad fauna appear to belong to *Stephanodus libycus*. The teeth consists of a basal peduncle and an upper crown which is in the form of an open hook and is covered with thick transparent enamel. Crown consists of two prominent cusps: hook-shaped terminal cusp and secondary cusp situated at the base of the terminal cusp. Teeth are compressed laterally. In most of the teeth, a roughly triangular shelf-like structure is present on the posterior side of the crown.

Earlier records of *Stephanodus libycus* include from the Late Cretaceous of Nigeria (White, 1934), Libya, Zaire, Israel, Tunisia and Niger (Cappetta, 1972), Morocco (Arambourg, 1952), Late Cretaceous-Early Palaeocene Takli formation of Nagpur (Rana, 1984), Late Cretaceous Lameta Formation of Pisdura (Jain and Sahni, 1983) Central India, and Lower Eocene Subathu Formation of Jammu and Kashmir, India (Kumar, 1983). Asifabad teeth are identical to those of Niger and Central India.

Stephanodus sp.
(Plate IV — 1a-c)

A single oral tooth is referable to *Stephanodus* sp. only the corwn part of the tooth is preserved. It has a width of 2 mm and a height of 1.5 mm. Crown is covered with thick transparent shiny enamel. Oral edge of the crown is crenulated and convex in outline. The crenulated oral edge consists of five denticles each on either side of the median large denticle. These denticles are very prominent with corresponding fine ridges which are distinctly visible in the apical part of the crown and become less distinct near the base. The anterior face of the crown is convex and the posterior face is concave. In occlusal view, the oral edge is in the shape of a 'S'. In the basal section the crown is elliptical in outline and is much thicker with bulging inner and outer faces.

Oral teeth of *Stephanodus libycus* are known from the Maestrichtian Mount Igdamn of Niger (Cappetta, 1972), Phosphate Beds of Morocco (Arambourg, 1952) and Rutbah, Iraq (Signeux, 1959). Inthe specimens of Rutbah and Morocco there are five denticles on the crown. The denticles are widely spaced in Moroccan specimens. While in the Niger specimens there are ten denticles which are more or less pointed. The Asifabad tooth is comparatively smaller in size and differ from the oral teeth of other localities in having 11 denticles which are short, robust and blunt, and the 'S' like curvature of the oral edge. In all probability the tooth may belong to a new species but the erection of a new species on the basis of single specimen is not possible unless the type material of the oral teeth is not looked in.

Eotrigodon indicus
(Plate III — 24-26)

At least 5 pharyngeal teeth and 7 oral teeth represent *Eotrigonodon indicus* in the Asifabad fauna. Morphologically pharyngeal teeth resemble *S. libycus* but unlike in *S. libucus* the terminal cusp is slightly curved and in some cases, it is almost straight (Pl. III, 24). The secondary cusps are connected to the terminal cusp by a semicircular shelf-like structure and in comparison to *S. libycus* the basal peduncle is more broader in *E. indicus*.

Oral teeth are subrectangular or ovoid in shape (Pl. III, 25-26). External and internal surfaces are arched and depressed respectively. Cutting edges are smooth and sharp. In most of the specimens, root is broken. Anterior end of the tooth projects upwards and the height of the tooth is maximum in this part. Generally, posterior end of the tooth is curved whereas the anterior end is nearly straight.

E. indicus is also known from the Lower Eocene Subathu Formation of Himachal Pradesh, India (Kumar, 1983). Teeth with identical morphology are known from the Eocene Intertrappean Beds of Rajahmundry (Bhalla, 1974) as *E. jonesi*.

Eotrigonodon wardhaensis JAIN & SAHNI, 1983
(Plate III — 27)

There are 5 isolated, oral teeth in the Asifabad fauna belonging to *E. wardhaensis*. The teeth are rectangular in shape. They consist of an external convex and internal concave surfaces. Oral edge is sharp and in some eroded specimens it is crenulated. Base of the crown is slightly narrower than the upper part. These teeth are larger in size (2.8-3.0 mm in width) in comparison to *E. indicus*.

The Asifabad specimens are closely related in their external morphology to *E. wardhaensis* described by Jain and Sahni (1983) from the Late Cretaceous Lameta Formation of Pisdura, Central India.

Indotrigonodon ovatus JAIN & SAHNI, 1983
(Plate III — 28)

Three fragmentary oral teeth are referred to *Indotrigonodon ovatus* reported by Jain and Sahni (1983) from the Late Cretaceous Lameta Formation of Pisdura, Central India. The teeth are suboval at the base and gradually become wider occlusally. This gives a roughly oval shape to the teeth. Crowns consist of transparent enamel and their surfaces are ornamented with very fine vertical striations.

Teleostei Incertae Sedis ESTES, 1976
Family Palaeolabridae ESTES, 1969
Palaeolabrus dormaalensis CASIER, 1967
(Plate III — 29)

Two isolated dermopalatine teeth are referred to *Palaeolabrus dormaalensis* based on the styliform shape,

the presence of a small pointed enamelloid tip raised above the crown surface, and numerous fine vertical striations in the base. Teeth vary in diameter from 0.5 to 0.7 mm. Peripheral borders of the teeth are inflated and convex in outline.

The genus *Palaeolabrus* was first described by Casier (1967b) from the Late Palaeocene-Early Eocene Dormaal deposits of Belgium (*Palaeolabrus dormaalensis*). Estes (1969) reported *P. montanensis* from the Late Cretaceous Hell Creek Formation, a species that differs in having a flat and slightly depressed apical tip below the crown surface. Whereas in *P. dormaalensis*, the apical tip is raised above the crown surface.

Class Amphibia
Order Anura
Incertae Sedis

There are two types of fragmentary maxillae in the Asifabad fauna. In the first type the dental ridges are narrow, smooth, cylindrical in shape, dental gutter is deep, teeth are pleurodont in nature, lateral surfaces are smooth without any sculpturing (Pl. IV — 3, 5 and 7). These morphological features are comparable to certain extent to discoglossid B type of Sahni (1972) reported from the Late Cretaceous Judith River Formation of Montana.

In the second type, the maxillae consists of broad convex dental ridge, shallow dental gutter, smooth labial surface. Breadth of the dental ridge and the tooth bearing surface are nearly equal (Pl. IV — 2, 4 and 6). These forms are differentiated from first type in the shape of the dental ridge and its breadth. Maxillae having identical features have also been reported from the Late Cretaceous-Early Palaeocene Takli Formation of Nagpur, Central India (Rana, 1984). The Nagpur specimens have been referred to the family Pelobatidae. It is premature to say anything about their systematic position at this stage as the material is fragmentary in nature.

In addition to the maxillae a single scapula and a urostyle are also present. The scapula (Pl. IV — 9) shows affinities to pelobatid frogs while the urostyle (Pl. IV — 8) is related to hylids.

Class Reptilia
Order Squamata
Lacertilia indet.
(Plate IV — 10)

A single fragmentary dentary referable to the lizards occur in the Asifabad fauna. The dentary is small, fragile and poorly preserved. Lower margin of the dentary is slightly curved, a similar curvature of the tooth bearing border gives a boat- shape to the dentary. Labial side of the deniary is smooth, slightly convex with a single mental formen just behind the only well preserved tooth. The tooth is cylindrical in shape and is compressed linguolabially. It is slightly swollen and elevated at the crown end. Tip of the crown is spherical in shape with a central cavity. Tooth and teeth sockets project one fifth of their length out of the parapet of the dentary. Parapet is in a straight line. Dental ridge is broken.

The above morphological features compare favourably to an indeterminate genus of the family Anguidae described by Sullivan (1982) from the Middle Palaeocene Swain Quary Fort Union Formation, Carbon Country, Wyoming.

Family Boidae
gen. & sp. indet.
(Plate IV — 14a-b)

There are five incomplete vertebrae in the Asifabad which can be referred to the family Boidae. The vertebrae are proceolous in nature, broader anteriorly and posteriorly narrow. The neural arch is completely broken and only a cast of the neural canal is visible. The condyle is well developed and set off from the centrum by a neck. It is inclined somewhat dorsally at an angle similar to that of cotyle which is facing ventrally. Cotyle is rounded and has a diameter greater than that of the neural canal. The prezygapophyses are low relative to the height of neural canal. The facets of the prezygapophyses are spread out at angle of 30° and are slightly facing dorsally. The postzygapophyses are broken, but from the broken part it is evident that they are slanting outwards. Ventrally a median ridge present which is prominent posteriorly. These features demonstrate the ophidian nature of the Asifabad specimens. Similar vertebrae have also been described from the Late Cretaceous Lameta Formation of Pisdura (Jain & Sahni, 1983) and the Late Cretaceous-Early Palaeocene Takli Formation of Nagpur (Rana, 1984) under the family Boidae.

Order Crocodilia
Family Crocodylidae
gen. & sp. indet.
(Plate IV — 11-13)

Two types of crocodilian teeth are identified in the Asifabad fauna, the ones having fluted surfaces and circular cross sections and the others that are laterally flattened with smooth surfaces. Teeth are conical in shape with a broad base. Apices of the teeth are blunt.

In surface fluting, the teeth resemble pristichampsine teeth described from the Middle Eocene Subathu Formation of Jammu and Kashmir (Sahni *et al.*, 1978) but there are no serrations on the lateral edges which is a characteristic feature of pristichampsine teeth. Teeth with smooth surfaces resemble those of the Late Cretaceous-Early Palaeocene Takli Formation of Nagpur (Rana, 1984).

Order Saurischia

Family Megalosauridae
gen. & sp. indet.
(Plate IV — 15)

There is a fragmentary tooth in the Asifabad fauna which is comparable to a megalosaurian tooth. The tooth is broken vertically into two halves. The preserved half does indicate that the tooth is sub-triangular in shape, slightly bent with a broad base and a tapering blunt apex. The enamel is broken in the apical part. The tooth fragment is robust and laterally compressed. The compressed lateral edge exhibits very coarse serrations. The serrations are short, blunt and are oriented at right angles fo the axis of the tooth. The tooth measures to 5.5 mm in height.

The compressed nature of the tooth with coarse serrations are observed in megalosaurids as well as thecodontosaurids such as *Massospondylus rawesi* reported from the Late Cretaceous-Early Palaeocene Takli Formation of Nagpur (Lydekker, 1890). But in the megalosaurids the serrations on the lateral edges are short and at right angles to the axis of the tooth whereas in thecondontosaurids the serrations are long, slender and directed obliquely to the axis of tooth. Moreover in thecodontosaurids the serrations are observed all along the anterior border but they are not usually present on the lower part of this border in megalosaurids. This feature is not observable in the Asifabad specimen as the tooth is fragmentary in nature. However the short, blunt serrations oriented at right angles to the lateral compressed border are certainly in favour of their affinity to megalosaurids rather than to thecodontosaurids. But the fragmentary nature of the tooth does not allow its identification beyond the family level.

Order Chelonia

Many carapace fragments are suggestive of the presence of turtles in the Asifabad fauna. The size of the fragments vary from 0.5 to 1.5 cms.

Class Mammalia

There are a few isolated phalanges in the present collection questionably referable to mammals. Further studies are necessary to establish taxonomic position of these phalanges.

CONCLUSIONS

Previously widely varying views have been expressed regarding the age of the Deccan Traps. This was mainly due to the absence of an objective analysis of the fossil assemblages recovered from the sedimentary beds underlying (= infratrappean or Lameta Formation) and overlying (= intertrappean) the Deccan Trap flows. A majority of the earlier workers were of the opinion that the Central Indian intertrappeans are essentially Tertiary in aspect (Hislop, 1860; Sahni, 1934; Prakash, 1960). Their observations were based mainly on the frashwater molluscs, charophytes and mega plant fossils. So far, no attempt has been made to study systematically the microfossil assemblages (including vertebrates, invertebrates and plants) of the infra – and intertrappean beds widely distributed along the eastern margins of the main mass of Decan Traps. It was only in 1908 that Woodward reported *Eoserranus, Clupea, Lepisosteus* and *Pycnodus* from the Lameta Formation of Dongargaon. Later on in 1938 Hora described some fish scales from the Intertrappean Beds of Deothan and Kheri. After the initial investigations carried out by Woodward (1908a) and Hora (1938), there was a marked paucity in the microvertebrate studies.

The present work is the only detailed study on the microvertebrate assemblages of Peninsular Indian Intertrappeans and revealed the presence of many taxa previously not recorded from the Indian subcontinent. Many of the marine fishes such as *Raja, Coupatezia, Rhombodus, Igdabatis, Belonostomus, Stephanodus* etc. present in the Asifabad fauna are widely distributed in the Cretaceous-Tertiary formations of Morocco, Niger, Nigeria, Zaire, Egypt, Iraq, Libya, Belgium, England and U.S.A. Frogs and lizards exhibit an holoarctic distribution (U.S.A.). The freshwater or non-marine fishes represented by *Lepidotes, Lepisosteus* and *Phareodus* are cosmopolitan in distribution (Fig. 2). In its constitution, Asifabad fauna is very much identical at generic and familial level to that of the Late Cretaceous El Molino Formation of Southcentral Bolivia. The forms most common to both the formations include *Lepidotes*, Lepisosteidae, Pycnodontidae, Aspidorhynchidae, *Phareodus, Enchodus*, Eotrigonodontidae and booid snakes (De Muizon *et al.*, 1983). Dinosaurs are represented in the El Molino Formation by track ways while at Asifabad they are known by dental elements, limb bones and possible egg shell fragments. The Asifabad fauna is strickingly similar to the fauna of Latest Cretaceous Lameta Formation of Pisdura and also share some elements with the Eocene Subathu Formation of Himachal pradesh and Jammu and Kashmir.

The presence of an admixture of marine and non-marine faunal assemblages in the Asifabad Infra – and Intertrappean Beds is indicative of the existence of coastal-plain conditions in this area during the Late Cretaceous-Early Palaeocene Period. This reconstructed environment is similar to the one suggested for the Takli Formation of Nagpur except of course for the definite presence of forminifers at Asifabad which would suggest a greater marine influence.

Based on the faunal affinities to other known Cretaceous formations of India and abroad and their temporal ranges, a Late Cretaceous and Late Cretaceous-Early Palaeocene ages have been proposed for the Infra – and Intertrappean Beds of Asifabad respec-

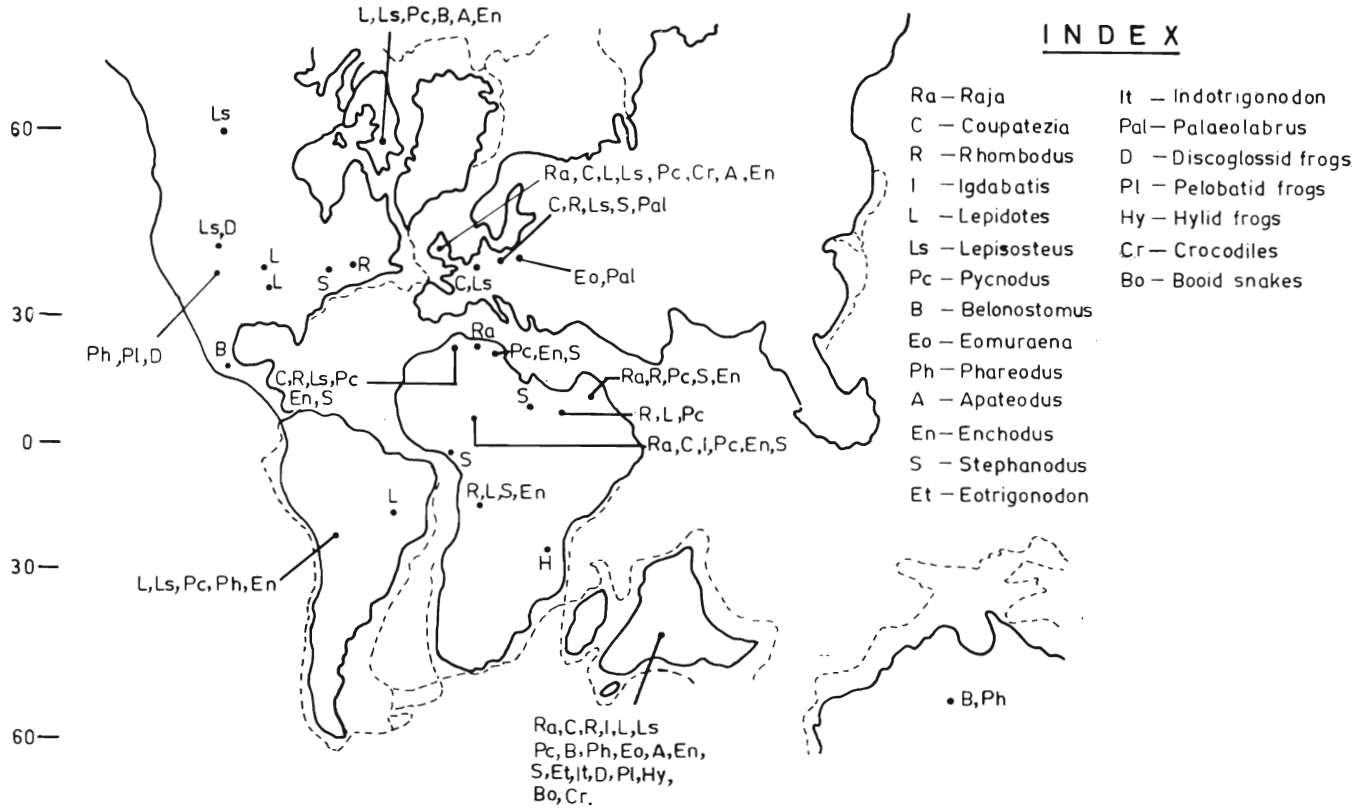

Fig. 2. Global distribution on Asifabad fauna (late Cretaceous-Eocene).

tively. One of the important findings in this connection is the presence of dinosaurian remains in the Asifabad fauna as dinosaurs are believed to have become extinct by the end of Cretaceous.

The present study revealed little faunal dissimilarities between the infra – and intertrappean beds thereby suggesting a short time span for the eruption of first and second basaltic flows. Thus the lower age limit of the first basaltic flow overlying the infratrappean is considered to range in between Late Cretaceous-latest Cretaceous whereas the flow overlying the intertrappean beds is considered to be Late Cretaceous-Early Palaeocene in age.

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REFERENCES

ARAMBOURG, C. 1952. Les vertebres fossiles des gisements de phosphates (Maroc-Algerie-Tunisie). *Service geologique Maroc Notes et Memories.* **92**: 1-132.

BHALLA, S.N. 1974. On the occurrence of *Eotrigonodon* in the Eocene of Rajahmundry, Andhra Pradesh. *Jour Geol. Soc. India.* **15**(3): 335-337.

CAPPETTA, H. 1972. Les poissons Cretaces et tertiaries du bassin des Iullemeden (Republique du Niger). *Palaeovertebrata.* **5**(5): 179-251.

CAPPETTA, H. 1982. Revision de *Cestracion duponti* Winkler, 1874 (Selachii, Batomorphii) du Bruxellien de Woluwe-Saint-Lambert (Eocene Moyen de Belgique). *Meded. Werkgr. Tert. Kwart. Geol.* **19**(4): 113-125.

CAPPETTA, H. 1983. Additions a la faune de seleciens fossiles du Maroc. 2: Revision de *Raja praealba* Arambourg, 1952, espece de l'ypresien des Ouled Abdoun. *Tertiary Research.* **5**(1): 1-8.

CAPPETTA, H. & CASE, G.R. 1975. Contribution a l' etude des selaciens du groupe Monmouth (Campanien-Maestrichtien) du New Jersey. *Palaeontographica Abstract* A. **151** (1-3): 1-46.

CASIER, E. 1946. La faune ichthyologique de l'Ypresien de la Belgique. *Mem. Mus. royale Hist. Nat. Belgique.* **104**: 1-267.

CASSIER, E. 1967a. Poissons de l' Eocene inferieur de Katharinenhof-Fehmarn (Schleswig-Holstein). *Bull. Inst. royale Sci. Nat. Belgique.* **43**(25): 1-23.

CASSIER, E. 1967b. Le Landenien de Dormaal (Brabant) et sa faune ichthyologique. *Mem. Inst. royale Sci. Belgique.* **156**: 1-66.

DE MUIZON, C., GAYET, M., LAVENUE, A., MARSHALL, L.G.,

SIGE, B. & VILLAROEL, C. 1983. Late Cretaceous Vertebrates including mammales from Tiupampa, Southcentral Bolivia. *Geobios.* **16**(16): 747-753.

ESTES, R. 1969. Two new Late Cretaceous fishes from Montana and Wyoming. *Breviora.* **335**: 1-15.

FOWLER, H.W. 1911. A description of the fossil fish remains of the Cretaceous, Eocene and Miocene formations of New Jersey. *Bull. Geol. Surv. New Jersey.* **4**: 1-191.

GALTON, P.M. 1983. The cranial anatomy of *Dryosaurus,* a hypsilophodontid dinosaur from the upper jurassic of North America and East Africa, with a review of hypsilophodontids from the Upper Jurassic of North America. *Geologica et Palaeontologica.* **17**:207-243.

GAYET, M. 1982. Nouvelle extension geographique et stratigraphique du genre *Lepidotes. Compte Rendu Academic Sciences,* Paris. **294**(2): 1387-1390.

GAYET, M. & MEUNIER, F.J. 1983. Ecailles actuelles et fossiles d' Osteoglossiformes (Pisces, Teleostei). *Compte Rendu Academie Sciences,* Paris. **297**(2): 867-870.

GOTO, M. 1977. Cretaceous fossil elasmobranchs from Japan (First Report). *Bull. Mizunami Fossil Mus.* **4**: 119-138.

HERMAN, J. 1973. Les selaciens des terrains neocretaces et paleocene de Balgique et des contrees limitrophes. Elements d' une biostratigraphie intercontinentale. These doctorat Dactylographiee (non publiee): 1-598.

HISLOP, S. 1860. On the Tertiary deposits, associated with trap rock, in the East Indies. *Quart. Jour. Geol. Soc. London.* **16**: 154-189.

HORA, S.L. 1938. On some fossil fish scales from the intertrappean beds at Deothan and Kheri, Central Provinces. *Rec. Geol. Surv. India.* **73**(2): 267-294.

JAIN, S.L. 1983. A review of the genus *Lepidotes* (Actinopterygii: Semionotiformes) with special reference to the species from Kota Formation (Lower Jurassic) India. *Jour. Pal. Soc. India.* **28**: 7-42.

JAIN, S.L., ROBINSON, P.L. & ROYCHOWDHURY, T.K. 1964. A new vertebrate fauna from the Triassic of the Deccan India. *Quart. Jour. Goel. Soc. London.* **120**(1): 115-124.

JAIN, S.L. & SAHNI, A. 1983. Some Upper Cretaceous vertebrates from Central India and their palaeogeographic implications. *Indian Association of Palynostratigraphers Symposium, Birbal Sahni Institute of Palaeobotany,* Lucknow: 66-83.

KING W. 1881. The geology of the Pranhita-Godavari Valley. *Mem. Goel. Surv. India.* **18**(3): 151-300.

KUMAR, K. 1983. Palaeontological and palaeohistological investigations of Subathu vertebrates from Jammu and Kashmir and Himachal pradesh. Unpublished Ph.D. Thesis, Panjab University, Chandigarh: 1-438.

KUTTY, T.S. 1969. Some contributions to the stratigraphy of the upper Gondwana formations of the Pranhita-Godavari Valley, Central India. *Jour. Geol. Soc. India.* **10**(1): 33-48.

LERCHE, M. 1905. Les poissons tetiaires de la Belgique II. Les Poissons eocenes. *Mem Mus. royale Hist. nat. Belgique* **3**(11): 49-228.

LERICHE, M. 1906, Contribution a l'etude des poisson fosiles du Nord de la France et des regions voisines. *Mem. Soc. goel. Nord.* **5**: 1-430.

PRAKASH, U. 1960. A survey of Deccan intertrappean flora of India. *Jour. Pal.* **35**(5): 1027-1040.

PRIEM, F. 1909. Note sur des poissons fossiles des phosphates de Tunisie et d'Algerie. *Bull. Soc. geol. France.* **4**: 315-327.

RAGE, J.C. 1974. Les batraciens des gisements Quaternaires Europeens determination osteologique. Extrait du *Bull. Mensuel Soc. Linn. Lyon.* **8**: 276-279.

RANA, R.S. 1984. Microvertebrate palaeontology and biostratigraphy of the Infra – and Intertrappean Beds of Nagpur, Maharashtra. Unpublished Ph.D. thesis, Panjab University, Chandigarh:

RAO, B.R.J. & YADAGIRI, P. 1981. Cretaceous intertrappean beds from Andhra Pradesh and their stratigraphic significance. In: Deccan volcanism and related basalt provinces in other parts of the world (Eds. K.U. Subha Rao & R.N. Sukeshwala) *Geol. Soc. India Mem.* **3**: 287-291.

ROMER, A.S. 1966. *Vertebrate Palaeontology.* The University of Chicago Press, Chicago and London. 468 p.

SAHNI, A. 1972. The vertebrate fauna of the Judith River Formation, Montana. *Bull. Amer. Mus. Nat. Hist.* **147**(6): 323-412.

SAHNI, A., SRIVASTAVA, M.C & D'SOUZA, R. 1978. Eocene Ziphodont Crocodilia from Northwestern India. *Geobios.* **11**(5): 779-785.

SAHNI, B. 1934. The Deccan Traps: Are they Cretaceous or Tertiary? *Current Science.* **3**(4): 134-136.

SENGUPTA, S. 1966. Palaeocurrents and depositional environments of the Gondwana rocks around Bheemaram — a preliminary study. *Bull. Geol. Soc. India.* **3**(1): 5-8.

SIGNEUX, J. 1959. Poissons et reptiles du Maestrichtien et de l'Eocene inferieur des environs de Rutbah (Irak). In: Contributions a la stratigraphie et a la Paleontologie du Cretace et du Nummultique de la marge NW de la Peninsula Arabique par C. Arambourg, L. dubertret, J. Signeux et J. Sornay. *Notes* et *Mem. Moyen Orient.* **7**: 233-251.

SULLIVAN, R.M. 1982. Fossil lizards from Swain Quarry "Fort Union Formation", Middle Palaeocene (Torrejonian), Carbon County, Wyoming. *Jour. Pal.* **56**(4): 996-1010.

WHITE, E I. 1934. Fossil fishes of Sokoto Province. *Bull. Geol. Surv. Nigeria.* **14**: 1-78.

WINKLER, T.C. 1874. Deuxieme memoire sur les dents de poissons fossiles du terrain bruxellien. *Arch. Mus. Teyler.* **4**(1): 16-48.

WOODWARD, A.S. 1902. Fossil fishes of the English Chalk. *Palaeontographic Society* volume for 1902: 37-38.

WOODWARD, A.S. 1908a. On some fish remains from the Lameta Beds of Dongargaon, Central Province. *Mem. Geol. Surv. India, pal. Ind.* (New Series). **3**(3): 1-6.

WOODWARD, A.S. 1908b. The fissil fishes of the English Chalk, *Palaeontographic Society* volume for 1911: 142-143.

EXPLANATION OF PLATES

PLATE I

1-7, teeth of *Raja* sp., 1, posterior view X 58; 2, lateral view X 60; 3, posterior view X 70; 4, posterior view X 68; 5, posterior view X 50; 6, posterior view X 60; 7, posterior view X 62; 8, isolated tooth of *Coupatezia woutersi,* 8a, occlusal view X 21; 8b, anterior view X 21; 8c, posterior view X 21; 9-11, teeth of *Rhombodus* cf. *R. levis,* 9, posterior view X 11; 10, posterior view X 10; 11, occlusal view X 23; 12-18, teeth of *Rhombodus* sp. indet.; 12, lateral view X 10; 13a, anterior view X 14; 13b, posterior view 14; 14a, posterior view X 10; 14b, occlusal view X 10; 15, occlusal view X 18; 16, occlusal view X 11; 17a, anterior view X

17; 17b, posterior view X 17; 18, posterior view X 16; 19, tooth of *Igdabatis sigmodon;* 19a, occlusal view X 19; 19b, basal view X 19.

PLATE II

1-4, teeth of *Igdabatis sigmodon;* 1a, anterior view X 29; 1b, bassal view X 29; 2, posterior view X 46; 3a, basal view X 19; 3b, occlusal view X 19; 4a, occlusal view X 16; 4b, bassal view X 16; 5-7, teeth of *Lepidotes* sp.; 5, lateral view X 55; 6, lateral view X 62; 7, lateral view X 33; 8-10, teeth and scale of *Lepisosteus indicus;* 8, lateral view (tooth) X 24; 9, lateral view (tooth) X 4; 10, external view (scale) X 24; 11-15, teeth of *Pycnodus lametae,* 11, occlusal view X to; occluds, bore X 12; 13, occlusal view X 32; 14, occlusal view X 48; 15, occlusal view X 32; 16-18, teeth of *Pycnodus* cf. *P. praecursor;* 16, occlusal view X 25; 17, occlusal view X 33; 18, occlusal view X 31; 19-22, teeth of *Pycnodus* sp. 19, occlusal view X 16; 20, occlusal view X 78; 21, occlusal view X 24; 22, occlusal view X 8.

PLATE III

1, teeth and scale of Belonostomus cf. *B. cinctus,* 1a, external view (scale) X 30; 1b, lateral view (tooth) X 19; 1c, lateral view (tooth) X 13; 2-3, scales of *Belonostomus* sp., 2, external view X 40;) 3, external view X 41; 4-6, teeth of *Eomuraena* cf. *E. sagittidens;* 4, lateral view X 16; 5, lateral view X 15; 6, lateral view X 15; 7-11, scales of *Phareodus* sp.; 7, external view X 31; 8, external view X 58; 11, internal ivew X 25; 12-13, teeth of *Apateodus striatus;* 12, lateral view X 13; 13, lateral view X 15; 14-16, teeth of *Orthacodus longidens;* 14, lateral view X 16; 15, lateral view X 17; 16, lateral view X 20; 17-20, teeth of *Enchodus* sp. indet., 17, lateral view X 15; 18, lateral view X 20; 29, lateral view X 26; 20, lateral view X 45; 21-23, pharyngeal teeth of *Stephanodus libycus,* 21, lateral view X 35; 22, lateral view X 13; 23, lateral view X 23, 24-26, teeth of *Eotrigonodon indicus,* 24, lateral view (pharyugeal tooth) X 14; 25, internal view (oral tooth) X 35; 26, internal view (oral tooth) X 35; 27, oral tooth of *Eotrigonodon wardhaensis,* external view X 19; 28, oral tooth of *Indotrigonodon ovatus,* internal view X 24; 29, dermopalatine tooth of *Palaeolabrus dormaalensis,* occlusal view X 78.

PLATE IV

1, *Stephanodus* sp. la, external view X 23; 1b, internal view X 23; 1c, occlusal view X 23; 2-7, macillae of Anura Incretae Sedis, 2, lingual view X 68; 3, lingual view X 47; 4, lingual view X 29, 5, lingual view X 39; 6, lingual view X 40; 7, lingual view X 39, 6, lingual view X 40; 7, lingual view X 55; 8-9, Anura Incertae Sedis, 8, urostyle ventral view X 12; 9, scapula X 14; 10, Lacertilia indet., lingual view X 35; 11-13, Crocodylidae gen. et sp. indet., 11, lateral veiw X 18; 12, lateral view X 23; 13, lateral view X 21; 14, Boidae gen. et sp. indet., 14a, dorsal view X 11; 14b, ventral view X 11; 15, Megalosauridae gen. et sp. indet., lateral view X 11.


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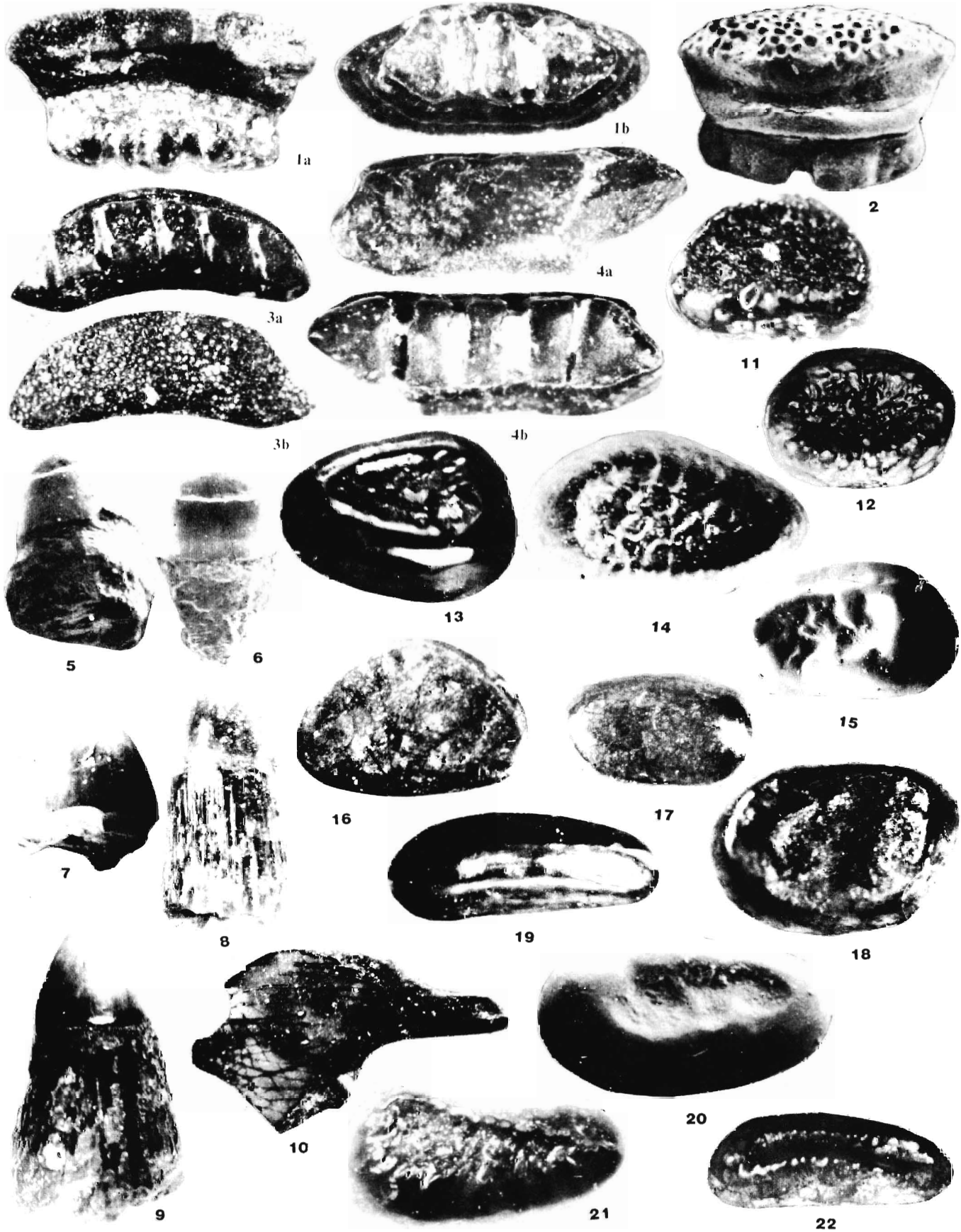
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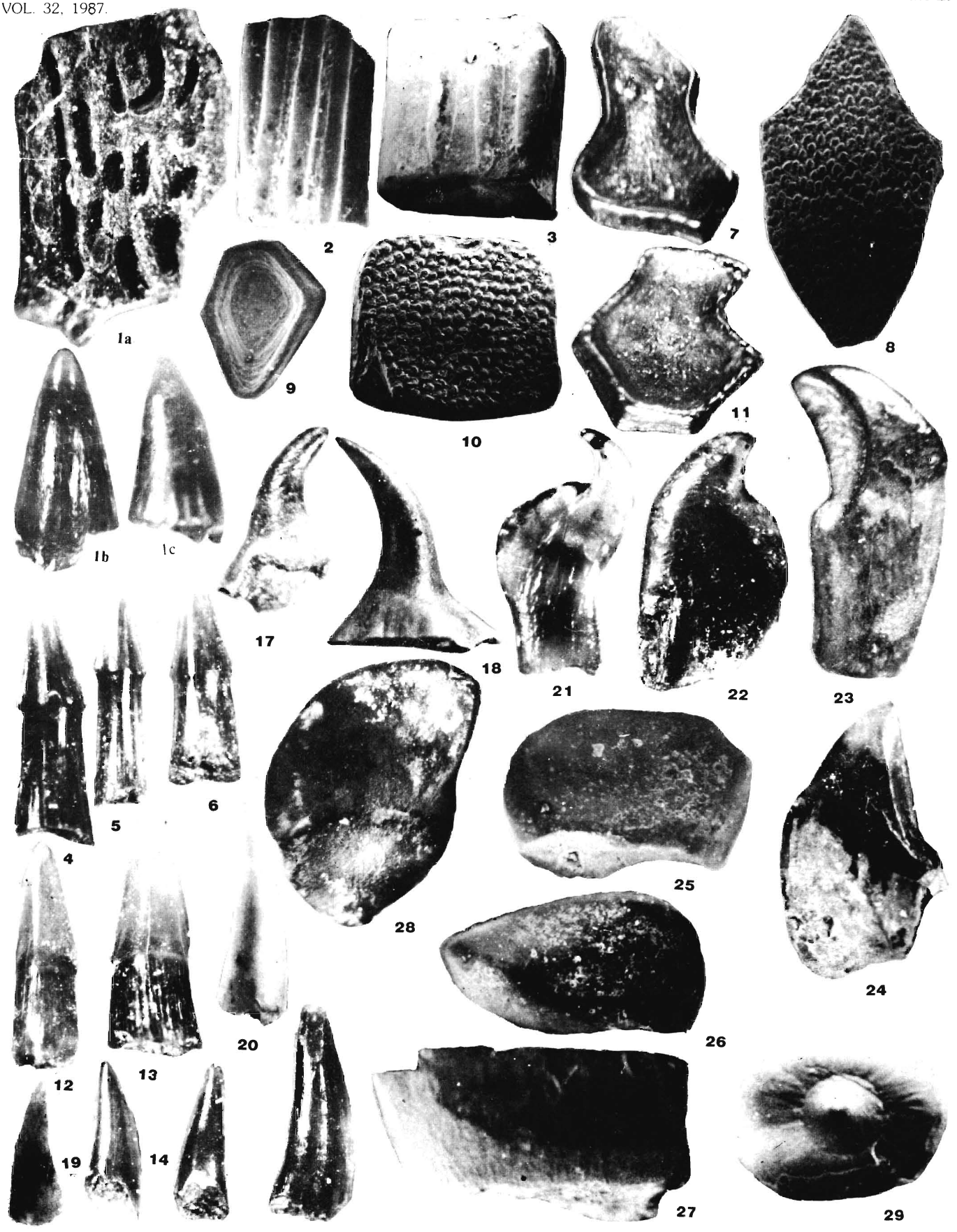
Plate III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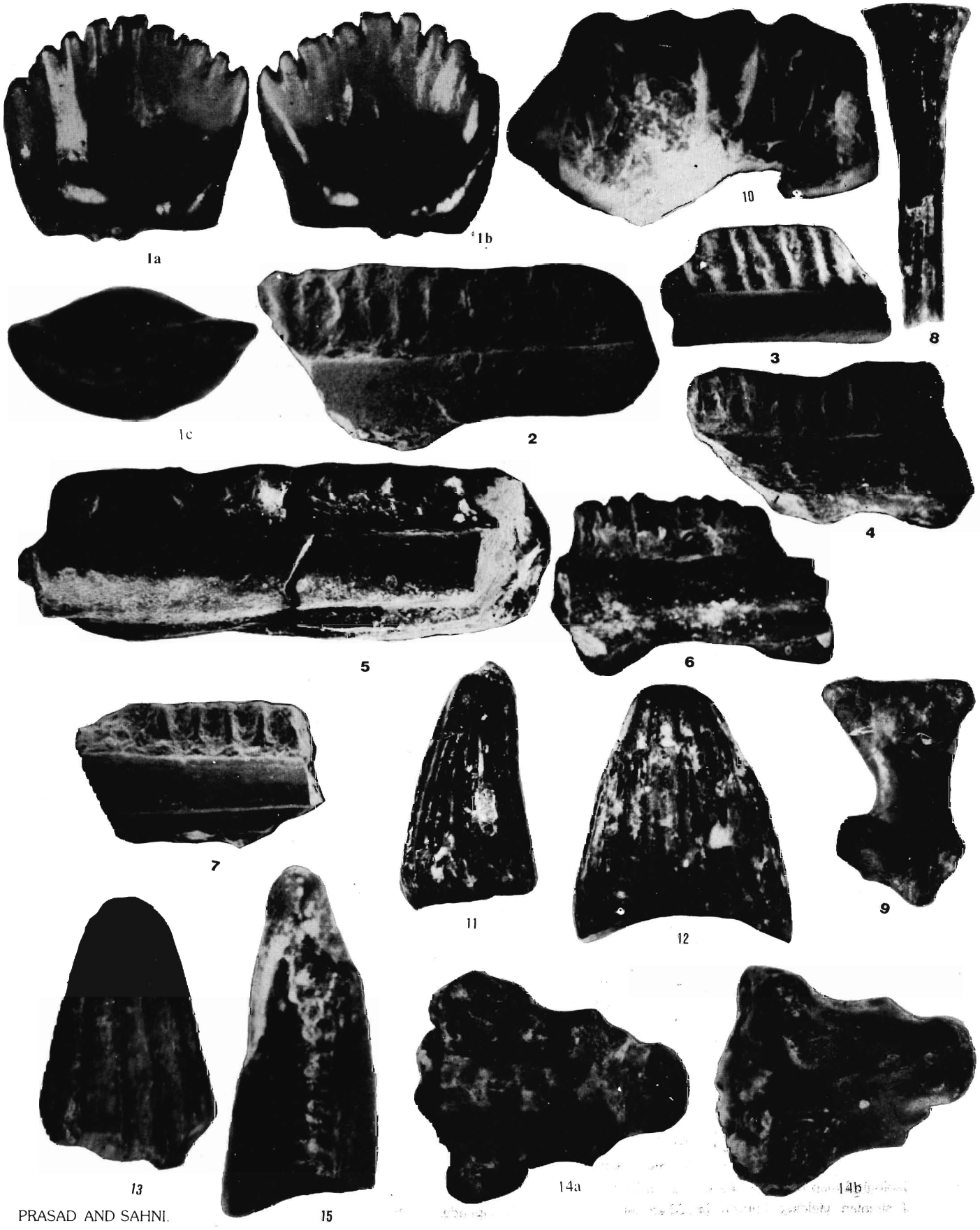
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