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A RECORD OF MICROVERTEBRATE FAUNA FROM THE INTERTRAPPEAN BEDS OF NASKAL, ANDHRA PRADESH

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ABSTRACT

A rich microvertebrate fauna, represented by the fishes: *Igdabatis*, *Lepisosteus*, *Phareodus*, *Apateodus*, otoliths; anurans, turtles, anguimorph lizards, snakes, crocodiles and mammals, is reported from the intertrappean beds of Naskal, Rangareddi District, Andhra Pradesh. This fauna occurs in association with pulmonate gastropods, ostracodes, and charophytes. No peninsular Indian intertrappean sequence has so far yielded a microvertebrate assemblage as diverse as the present one. One of the most significant findings from this locality is the presence of primitive mammalian remains. The mammals, represented by dental and post-cranial elements, have been assigned to a new genus and species *Deccanolestes hislopi*. *D. hislopi*, the first Cretaceous mammal from India, is not only important from biostratigraphic point of view, but also significant from palaeobiogeographic point of view as it shows affinities to the Late Cretaceous North American genus *Cimolestes*. The microvertebrate fauna, particularly fishes and mammals suggest a terminal Cretaceous age and a fluvio-lacustrine condition of deposition for the intertrappean beds of Naskal.

INTRODUCTION

Recent researches, suggesting Deccan volcanism as a possible cause for mass extinctions at Cretaceous/Tertiary boundary (Officer *et al.*, 1987; Courtillot *et al.*, 1988; Mclean, 1988, etc.), necessitated the study of sedimentary beds intercalating the Deccan volcanic flows (infra-and intertrappean beds) and their biotic assemblages in order to have a clear picture of events taking place at the time of Deccan volcanic eruption. The infra and intertrappean beds had remained unexplored for a long time after the initial studies by Hislop (1860), Woodward (1908), and Hora (1938). It is only in the last 7 years, they have been extensively studied along the eastern margin of the Deccan Traps for their microfaunal and floral content with emphasis on microvertebrates (Sahni *et al.*, 1982; Jain and Sahni, 1983; Sahni, 1983, 1984; Bhatia and Rana, 1984; Gayet *et al.*, 1984; Prasad *et al.*, 1986; Prasad and Sahni, 1987; Vianey-Liaud *et al.*, 1987). These studies have yielded rich microvertebrates and other microfossils. But the biota was not as diverse and interesting as the one recovered from the present locality. The microvertebrate assemblage from the intertrappean beds of Naskal includes fishes, frogs, lizards, snakes, turtles, crocodiles and mammals. Besides the microvertebrates, a large number of gastropods, pelecypods, ostracodes and charophytes has also been recovered.

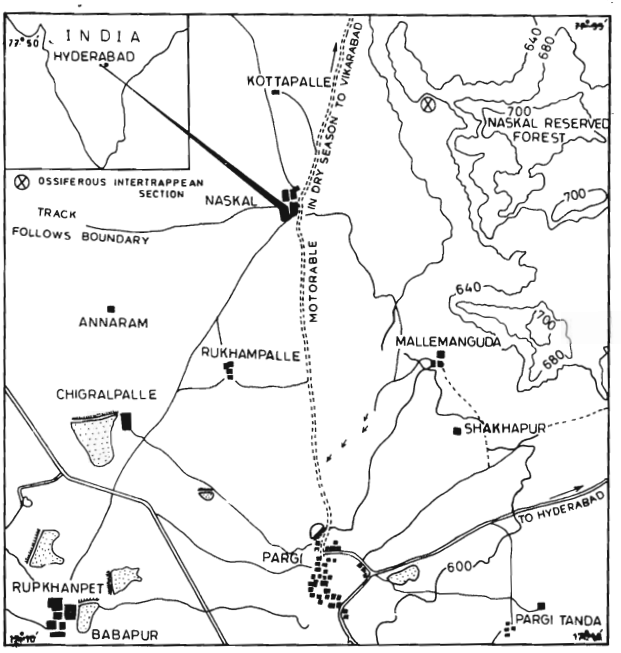

Fig. 1. Map showing the location of ossiferous section

The field area under investigation is situated about 70 km west of Hyderabad city and 2 km NE of the village Naskal in Pargi Taluq, Rangareddi District, Andhra Pradesh (Fig. 1). The area is covered by flat-topped Deccan Trap hills which are intercalated

at many places with sedimentary beds. The intertrappean beds of Naskal were initially studied by Dutt (1975), who reported the occurrence of gastropods and fish teeth in these beds. The sedimentary beds are thin having a thickness of less than 1 m and are mainly constituted by marls. At the collecting site, they are found sandwiched between the volcanic flows No.3 and 4 and can be divided into five litho-units. The basal sedimentary unit is a soft, greyish-white marl containing ostracodes only. Overlying the basal bed is a soft yellow marl yielding a rich ostracode assemblage. A thin pinkish-grey, hard and finely laminated marl enriched with ostracodes, gastropods and charophytes occurs conformably overlying the ostracod bearing yellow marl. This unit is overlain by a pinkish-white sandy marl strewn with concretionary calcareous material. The microvertebrate fauna was recovered from this bed. The topmost unit is lithologically similar to the underlying beds, but is white in colour, and consolidated containing numerous scales of *Lepisosteus indicus* (Fig. 2). Sahni (1984) has shown that there is considerable facies variation in the infra- and intertrappean sequences extending from the mouth of Godavari delta to near the source of its tributary, namely Pranhita, in Central India. The intertrappean beds of Naskal with their predominantly freshwater component represent a fluvio-lacustrine facies.

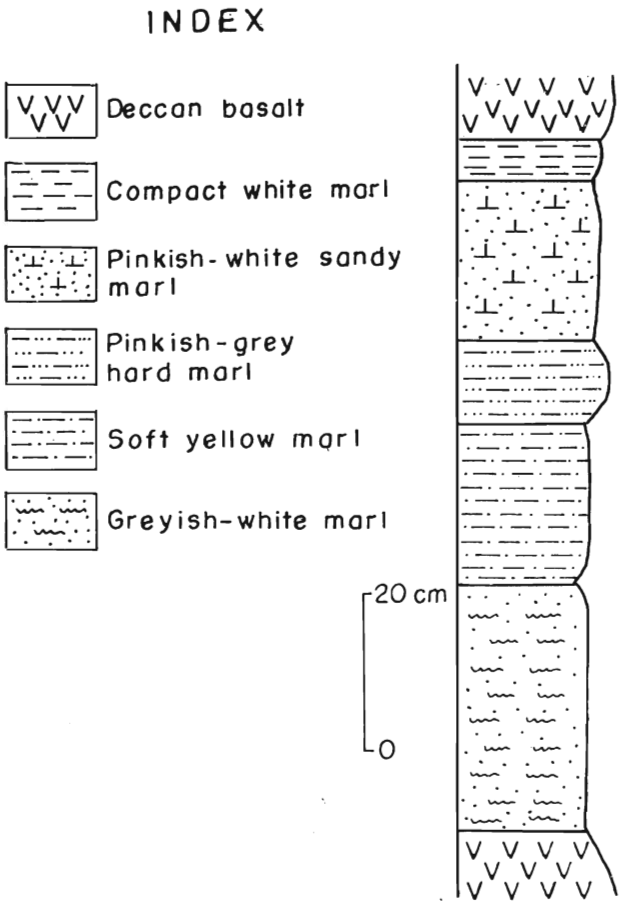

Fig. 2. Measured stratigraphic column of the intertrappean sequence

SYSTEMATIC PALAEONTOLOGY

Class Chondrichthyes
Order Batoidea
Family Myliobatidae

Igdabatis sp.
(Plate I — 1)

There are two isolated, rolled teeth in the Naskal intertrappean fauna, referable to the genus *Igdabatis* sp. Crown of the teeth is trapezoidal in shape, ornamented with polygonal pits. Anterior face of the crown is convex in outline, whereas the posterior face is projecting inwards in the middle part. Occlusal surface of the crown is flat except for the anterior margin which is slanting towards the anterior face. Posterior face of the crown extends in the form of a lip enclosing a broad 'U' shaped depression in between. The anterior face overhangs the root. The root is rhombic in outline. Since the root is worn, it is difficult to comment on the nature of root lobes, whether they are monofid or bifid. Similar types of teeth are also known from the intertrappean beds of Asifabad and Nagpur and the intratrappean beds of Marepalli and Timsanpalli and were referred to the marginal series of *Igdabatis*.

Class Osteichthyes
Order Semionotiformes
Family Semionotidae

Lepisosteus indicus WOODWARD, 1908
(Plate I — 2-7)

Twenty five isolated scales represent the genus *Lepisosteus*. Although similar scales were reported earlier from the infra- and intertrappean beds of Central India, the present forms are much larger in size (2 to 3 cm). The scales vary in shape from oval, rectangular to rhombic depending on their position on the body. Rhombic scales belonging to lateral line of the body are the largest of all the scales. They have a flat external surface covered by an enamelloid layer known as ganoine. However, the ganoine is absent

on the peg of scales. Internal layer of the scales is more or less convex with an obliquely arranged ridge. Dorsal ridge scales are oval in outline, whereas the caudal scales are rectangular in shape. External surface of the caudal scales is characterised by variable number of fusiform or cylindrical ganoine ridges.

Order Osteoglossiformes
Family Osteoglossidae

Phareodus sp.
(Plate I — 8-21)

Numerous isolated scale plates, teeth, premaxillae and dental plates represent the genus *Phareodus*. The scale plates are quadrangular, rhombic or polygonal in shape. Based on external ornamentation the scale plates are divided into two morphotypes. In morphotype I, the scale plates have an external surface ornamented with fine, granular tubercles arranged either irregularly or in regular concentric lines. In morphotype II, the scale plates are relatively large with coarse, widely separated tubercles on the external surface. Internal surface of all scale plates has a concave depression bordered by a raised rim with distinct growth line. The internal surface is generally smooth in scale plates of morphotype I, whereas in those of morphotype II, it is ornamented with widely spaced, coarse tubercles with a central pore.

The teeth are conical in outline with a slight curvature and spherical basal section. Surface of the teeth is smooth and unlike in *Apateodus* and *Lepisostus* they are not laterally compressed. The apical part is very short, while the basal part is 3 to 5 times greater than apical part. In addition to the isolated teeth, there are a large number of dental plates with different sets of teeth and 3 premaxillae in the present collection.

Family Osteoglossidae

Osteoglossidarum deccanensis RANA, 1988
(Plate I — 23)

Two right sagittae represent *O. deccanensis* Rana, 1988. Sagittae are worn and sub-globular in outline with a broad posterior part and a narrow anterior part. Maximum height is in the middle part. Dorsal border is undulating, ventral border is oblique rounded and the posterior border is rounded. Ostial border is oblique straight and the rostrum is broken. Outer surface is slightly concave, while the inner surface is convex. The sulcus is centrally placed on the inner suface, elongated, shallow, and runs parallel to the dorsal border. Sulcus opens anteriorly and terminates at the posterior border. Ostium and cauda are not differentiable. Ostium flattens anteriorly, antirostrum is represented by a small ridge. Cauda is posteriorly rounded and elliptical in outline. Crista superior and crista inferior are indistinct.

Osteoglossidarum intertrappus RANA, 1988
(Plate I — 22)

Seven sagittae of the present collection are referable to *O. intertrappus*. The sagittae are narrow in the anterior part and broad in the posterior part. Greatest height in the mid-posterior region. Sagittae are sub-rhombic in shape with an angular dorsal border, angularly curved ventral border, and a rounded but acute posterior border. Ostial border is oblique straight. Dorsal area is small, shallow and sub-elliptical in outline. Inner surface is slightly convex or flat, outer surface is flat but with a shallow depression in the anterior middle part. All borders are smooth. On the internal surface , the sulcus is long, shallow, curved parallel to the dorsal and ostial borders. Sulcus opens anteriorly and terminates near the posterior margin with a downward bend. Cauda and ostium are distinguished by the obtusely curved crista superior and crista inferior. Cauda is elliptical in outline, while the ostium is oblique straight. Rostrum is pointed and narrows anteriorly. Angular antero-dorsal border marks the antirostrum. Excisura is not distinct.

Family Notopteridae

Notopteridarum nolfi RANA, 1988
(Plate I — 24)

There are seven sagittae in the Naskal microvertebrate fauna with morphological features identical to *N. nolfi*. The sagittae are sub-rectangular in outline with an undulatingly straight dorsal border, undulating and curved posterior border, and a ventral border obliquely curved posteriorly and straight anteriorly. Anteriorly, the sagittae have a characteristic long cylindrical projection. Ostial border is nearly straight and long. Outer surface is flat or slightly convex, internal surface is flat. Junction of the anterior and posterior parts of the sagitta is characterised by a shallow, elongated depression at medio-ventral side. Sulcus is very shallow, elongated, opening ostial and closes at a considerable distance from the posterior border. Ostium is broad anteriorly and narrows down posteriorly. Ostium is long and extends to the outer surface of the sagitta. Cauda is long and elliptical to oval in outline. Sulcus is very thin near the junction of cauda and ostium. Crista superior and crista inferior

are feebly developed. Rostrum is slightly broken. Antirostrum and excisura are marked at the junction of ostial and dorsal borders.

Order Salmoniformes
Family Enchodontidae

Apateodus striatus WOODWARD, 1901
(Plate I — 26-28)

There are ten isolated, worn teeth which can be referred to *Apateodus striatus*. The teeth have a spear-shaped apical part and a cylindrical basal part. Basal part is ornamented with longitudinal striations, whereas the apical part is smooth. The point where the apical and basal parts meet is slightly bulging outwards. The teeth have blunt but acute crown tips and a flange-like lateral edges which are sometimes interrupted in the middle part.

Order Periciformes
Suborder Perocoidei
Family Serranidae

Dapalis sp.
(Plate I — 25)

Sagittae sub-circular in shape with a broad posterior part and a narrow anterior part. Dorsal border is undulating, curved, ventral border is circular in outline, posterior border is undulating and vertical. Dorsal area is shallow and elliptical. Ventral area is pronounced. External surface is flattened and the inner surface is convex. Sulcus is long, opens ostially and terminates near the postero-ventral side. Ostium is smaller than cauda, triangular in shape, ostial border is diagonally straight and curved. Cauda is long, moderately deep, posteriorly curved downwards. Rostrum is acutely pointed but blunt, antirostum and excisura are curved. Crista superior and crista inferior are well developed. These morphological features are similar to those of *Dapalis* sp. described by Rana (1988)

Incertae sedis
(Plate I — 29-32)

In association with the above described fish fauna a large number of isolated vertebrae, spines, cranial fragments and pelvic bones was also recovered. The available information does not allow any comment on their taxonomic position.

Class Amphibia
Order Anura

Anura indet
(Plate II — 1-9)

A few fragmentary maxillae, humeri, ilia, vertebrae and phalanges represent the amphibians. The maxillae are small with narrow dental ridges. Teeth are not preserved and only dental sockets are present, varying in number from 7 to 9. Tooth-bearing surface is comparatively broader than the dental ridges. Dentalgutter is deep. Dorsal surface, in one of the maxillae, is characterised by a single foraman (Plate II — 1-2). Humeri are fragmentary in nature. Only the distal end of humeri consisting of a large spherical condyle surrounded by two epicondyles is preserved. The external epicondyle is attached to the condyle, whereas the internal epicondyle is detached from it. A small depression fossa cubitus ventralis is present around the condyle towards the proximal side (Plate II — 6-7). Generally the ilium is constituted by an anterior part formed of a long cylindrical bone and a short posterior part which bears the anterior part of acetabulum. In the present collection, only the posterior part of the ilium with a spherical depression at the posterior end is preserved (Plate II — 5). In addition to these, there are also a number of isolated phalanges (Plate II — 8-9), a possible Atlas. Plate II — 3) and Caudal vertebrae (Plate II — 4). Fragmentary nature of the material hinders their taxonomic determinations.

Class Reptilia
Order Chelonia
Chelonia Indet

One neural plate and a large number of taxonomically indeterminable carapace fragments are the only representatives of the order Chelonia in the present collection.

Order Squamata
Suborder Lacertilia
Infraorder Anguimorpha
Family Anguidae

Gen. et sp. indet
(Plate II — 12a-b, 14a-c)

In the present collection, lizards are represented by ten isolated vertebrae and a few dental elements. The dorsal vertebrae are broader at the anterior and posterior ends and are narrow in the middle. Neural spine is in the form of a linear ridge and is slightly raised in the posterior region. Zygosphene is arched and fused with the dorsally pointed prezygapophyses. Synapophyses are rounded. Neural canal is

subtriangular in outline. Cotyle is elliptical in shape, shallow and is fused with the prezygapophyses. Zygantrum is projecting postero-medially. A central opening is present in the zygantrum. Postzygapophyses are pointing downwards. Condyle is also elliptical in shape and is smaller than cotyle. Lateral and subcentral foramina are not distinct. Similarly, the ventral keel is not distinct. In these morphological features, the present specimens compare well with anguimorph lizards. Besides the dorsal vertebrae, a few caudal vertebrae are also known (Plate II — 12).

Lacertilia indet.
(Plate II — 10-11, 13)

There is a single well preserved left dentary and a few fragmentary maxillae which can be referred to the order Lacertilia. The dentary is elongated with a blunt anterior end (partly broken) and a broad posterior end. Dorsal surface of the dentary bears row of teeth and tooth sockets. In all, there are seven preserved pleurodont teeth and four tooth sockets. Teeth are cylindrical and have spherical openings at the broken tips. The teeth extend slightly beyond the tooth bearing surface dorsally. Tooth bearing surface is separated from the splenial by means of narrow and convex dental ridge. Splenial is a bone lodged in the groove on the inner side of the dentary. Outer surface of the dentary bears four foramina for mandibular nerves and a mental foramen.

In another jaw fragment distinctly different from the one described above, the teeth are rather acrodont in nature, four in number, cylindrical in shape, slightly slanting towards the anterior side. On the outer surface of the jaw, one dental foramen is seen.

Order Serpentes (Ophidia)
Family Boidae
Subfamily Madtsoiinae

Gen. et sp. indet
(Plate III — 1 a-c)

Five trunk vertebrae are referred to the subfamily Madtsoiinae. The vertebrae are procoelous in nature. Neural spine is not distinct. Zygosphene is slightly raised above the dorsal surface and appears to be in a straight line in the anterior view. Zygosphene is not fused with prezygapophyses. Prezygapophyses are dorsally pointed and are diverging away from the centre. Synapophyses are slightly broken. Neural canal is sub-circular in outline. Cotyle is spherical in shape. In the posterior region, zygantrum is slightly broken. Condyle is oval in shape and is smaller than cotyle. Postzygapophyses are pointing ventrally. A lateral foramen is present on either side of the neural arch. On the ventral surface, haemal keel is present. A sub-central foramen is present on either side of the haemal keel.

Order Crocodylia
Family Alligatoridae

Gen. et. sp. indet
(Plate III — 2-4)

There are 25 isolated teeth in the present collection. The teeth are of two morphological types. One type is represented by elongated, conical, and slightly curved teeth. Surface of these teeth is characterised by longitudinal wrinkles or corrugations (Plate III —2-3). Second type is represented by large, bulbous teeth whose surface is also ornamented with longitudinal wrinkles (Plate III — 4). Both types of teeth are laterally compressed. In basal section, elongated teeth exhibit a round to elliptical cross section, whereas the bulbous teeth have an elliptical cross section. The first type probably belongs to the anterior part, while the second type represents the posterior part of the jaw. Similar type of teeth are known to occur in crocodiles belonging to the family Alligatoridae (Buffetaut, 1985).

Class Mammalia
Order Insectivora
Family Palaeoryctidae

Deccanolestes hislopi Prasad and Sahni, 1988
(Plate III — 5-7)

Mammalian remains from the Naskal intertrappean beds are represented by four well preserved right upper molars and a right lower premolar. Right upper molar (RM^1) has a transverse and triangular occlusal view. Paracone is the highest cusp, being taller than the metacone. The para-and metacones are conical cusps with their lingual walls steeply sloping and connate basally. Paracone and metacone are joined by postparacrista and premetacrista respectively. A transversely oriented preparacrista joins the paracone to the stylocone (stylar cusp B) which is highest and most prominent cusp in the stylar region. Parastyle(stylar cusp A) is small and distinct, situated basal to stylocone. The stylar shelf becomes narrower posteriorly terminating in small metastyle (stylar cusp E). A well developed ectoflexus divides the stylar region into a slightly larger anterior and somewhat smaller posterior part. An obliquely curving postmetacrista joins the metastyle to the metacone. Paraconule is distinct and about the same size as the slightly eroded metaconule. A short lingual ridge descends

from the paracone towards the postparaconular crista intersecting the base of paracone anteriorly. Preparaconular crista dips basally towards the small low lying parastyle. Premetaconuar crista is short and not well developed. Postmetaconular crista extends postero-labially towards the weakly developed metastyle. Protocone is moderately low, weakly developed cusp. Its apex trends anteriorly and dorsally. Pre-and postprotocristae are well defined and distinct. Both pre-and postprotoconular cingula are absent (Plate III — 5 a-d).

Right upper molar RM^3 is comparable in morphology to RM^1. The striking features of this tooth is its extremely well developed parastylar area, wide stylar region, relative dominance of paracone in relation to metacone, transverse nature and small size of the tooth. A shallow ectoflexus divides the stylar shelf into a much larger labially projecting anterior part and a smaller posterior part in which the stylar cusps are not at all prominent. The conules are low but well developed. The paraconule is winged and extends much farther lingually than the metaconule. Protocone is asymmetrically situated with respect to the coronal geometry and slightly shifted anteriorly (Plate III — 6 a-c).

The premolar is a lower right P_3. It consists of a high lingually situated, well developed protoconid somewhat broken apically, separated from the posterior cusps by a deep talonoid. The posterior cusp, of which, the postero-labial is the most prominent, occur near the base of the prominent protoconid. It is difficult to determine whether a short anterior cingulum is actually present as this part of the tooth is highly worn. There are two ridges connecting the protoconid to the posterior cusps, one curving down along the lingual margin of the tooth and the other extending labially half way down the talonoid (Plate III — 7 a-b).

Transverse upper molars, wide stylar shelves, high piercing cusps, absence of pre-and postcingula are some of the morphological features which suggest a palaeoryctid affinity. A close similarity exists between the present forms and the Late Cretaceous North American genus *Cimolestes*, in which the teeth have a broad stylar shelf, small stylar cusps, high connate paracone and metacone, well developed conules, generally lack of pre-and postcingula, if present of small size. In *Kennalestes*, a Late Cretaceous Mongolian genus similar characters are observed, but the presence of pre-and postcingula separates it from *Deccanolestes*.

DISCUSSION

Among the intertrappean fauna of Naskal, fishes and mammals are significant from biostratigraphic point of view. The remaining groups like amphibians, turtles, lizards, snakes, and crocodiles are yet to be studied in detail. Nevertheless, the available information points towards a terminal Cretaceous age for these beds. The fishes are mainly represented by *Igdabatis* sp., *Lepisosteus indicus*, *Phareodus* sp., *Osteoglossidarum deccanensis*, *O. intertrappus*, *Notopteridarum nolfi*, *Apateodus striatus*, and *Dapalis* sp. (probably by *Pycnodus lametae* and *Stephanodus libycus* also, the specimens are lost subsequently during the preparation of the material). Of these, three genera are most important in determining the age of the beds. *Igdabatis*, *Lepisosteus indicus* and *Apateodus striatus* are typical Maestrichtian genara. All the three forms have extensively been reported from the Late Cretaceous Lameta sediments of Jabalpur (Courtillot *et al.*, 1986; Tripathi, 1986), Pisdura (Jain and Sahni, 1983), its equivalents near Marepalli and Timsanpalli (Prasad and Singh, in press) and the latest Cretaceous intertrappean beds of Asifabad (Prasad and Sahni, 1987) and Nagpur (Rana, 1984), The other evidence for a terminal Cretaceous age comes from the primitive Mesozoic mammal, *Deccanolestes hislopi*, which shows close affinities to the North American Late Cretaceous genus *Cimolestes*. Moreover, recently, one more mammalian tooth with morphological features similar to those of family Docodontidae has been recovered from the same horizon. This is a primitive family whose members have so far been known only upto Late Jurassic. Investigations are in progress to find additional material so that a proper taxonomic asignment of the new tooth can be made. Palaeomagnetic and radiometric studies of the Naskal basalts are also in progress. A clear picture regarding the age of the beds will come out when these studies are completed and also the taxonomic position of the associated microfossils such as ostracodes and charophytes is worked out. Preliminary palaeomagnetic results have shown a reversed polarity interval probably 29 R (Prof. J.J. Jaegar pers. comm.) which embodies the Cretaceous/Tertiary boundary.

Although Naskal intertrappean fauna and flora is more or less similar to that of Nagpur and Asifabad, most of the marine elements particularly batoid fishes are conspicuous by their absence. On the contrary, there is a predominance of freshwater and terrestrial elements such as the fishes: *Lepisosteus*, *Phareodus*, *Osteoglossidarum*, *Notopteridarum*, *Dapalis*,

amphibians, turtles, lizards, snakes, crocodiles, mammals, gastropods, ostracodes and charophytes suggesting a fluvio-lacustrine condition of deposition for the Naskal intertrappean beds.

Chatterjee and Hotton (1986) discussed at length the affinities of Indian fauna and flora from the Permian to Tertiary and argued that the biotic assemblages are non-endemic in nature, a majority of them supporting a Laurasian connections. They were also of the opinion that in the Cretaceous, India was not far removed from the present position, lying in between Somalia and Asia separated by a narrow epicontinental Tethys. But this hypothesis fails to explain the presence of cosmopolitan fishes and Gondwanic elements such as snakes and dinosaurs, in the Cretaceous of India.

The primitive mammal *Deccanolestes hislopi* from the Naskal intertrappean beds confirms the Laurasian connection for the Indian plate during the Late Cretaceous times, previously suggested by the presence of pelobatid frogs (Sahni *et al.*, 1982) and a recent find of charophyte genus *Nemegtichara* (Prof. S.B.Bhatia pers. comm.). The morphological affinities of *D. hislopi* to the North American genus *Cimolestes* and the Mongolian genus *Kennalestes* have already been discussed. Sahni *et al.* (1982) based on the occurrence of Laurasian pelobatid frogs in the Late Cretaceous of India, favoured a land connection between India and Eurasia through Iran-Afghan plate. Since the palaeomagnetic data shows that India was in a farther southern position at about 29°S, such a land connection seems to be unrealistic. An intense search for additional mammalian and other fossil material of Laurasian affinity, a careful analysis of their taxonomic position and affinities, and an accurate identification of geotectonic elements along the northern margin of India plate can only help in tracing the dispersal routes between India and Laurasia.

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REFERENCES

BHATIA, S.B. & RANA R.S. 1984. Palaeogeographic implictions of the charophyta and ostracodes of the intertrappean beds of peninsular India. *Mem. Geol. Soc. France.* 147.

BUFFETAUT, E. 1985. Les crocodiliens de 1'Docene inferieru de dirmall (Brabant, Belgique). *Bull. Soc. Belge Geol.* **94**(1): 51-59.

CHATTERJEE, S. & HOTTON, N. 1986. The Paleoposition of India. *Jour. Southeast Asian Earth Sci.* **1**(3): 145-189.

COURTILLOT, V., BESSE, J., VANAMME, D., MONTIGNY, R., JAEGER, J.J. & CAPPETTA, H. 1986. Deccan flood basalts at the Cretaceous Tertiary boundary? *Earth Planet. Sci. Lett.* **80**: 361-374.

COURTILLOT, V., FERAUD, G., MALUSKI,H., VANAMME, D., MOREAU, M.G. & BESSE,J. 1988. Deccan flood basalts and the Cretaceous/Tertiary boundary. *Nature* **333**: 843-846.

DUTT, N.V.S. 1975. Decan Traps of the Western part of Hyderabad District, Andhra Pradesh. *Rec. Geol. Surv. India,* **106**(2): 126-141.

GAYET, M., RAGE, J.C. & RANA, R.S. 1984. Nouvelles ichthyofaune et herpetofaune de Gitti Khadan, le plus ancient gisement connudu Deccan (Cretace/Palaeocene) a microvertebres. Implications Paleogeographiques. *Mem. Geol. Soc. France, N.S.* **147**: 55-65.

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. 1983.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. & 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.

MCLEAN, D.M. 1988. K-T transition into chaos. *Jour. Geol. Education.* **36**: 237-243.

OFFICER, C.B., HALLAM, A., DRAKE, C.L. & DEVINE, J.D. 1987. Late Cretaceous and paroxysmal Cretaceous/Tertiary extinctions. *Nature.* **326**(6109): 143-149.

PRASAD, G.V.R. & SAHNI, A. & GUPTA, V.J. 1986. Fossil asemblages from infra-and intertrappean beds of Asifabad, Andhra Pradesh and their geological implictions. *Geoscience Journal.* **7**: 163-180.

PRASAD, G.V.R. & SAHNI, A. 1987. Coastal-plain microvertebrate assemblge from the terminal Cretaceous of Asifabad, peninsular India. *Jour. Pal. Soc. India.* **32**: 5-19.

PRASAD, G.C.R. & SINGH, V. (in press). Microvertebrate fauna from the infratrappean beds of Rangareddi District, A.P.: Biostraitgraphic significance. Communicated to *Indi. Jour. Earth. Sci.*

RANA, R.S. 1984. Microvertebrate Palaeontology and biostratigraphy of the infra-and intertrappean beds of Nagpur, Maharashtra. Unpublished Ph.D. thesis, Panjab University, Chandigarh.

SAHNI, A. 1983. Upper Cretaceous Palaeobiogeography of the peninsular India and the Cretaceous-Palaeocene transition: The vertebrate evidence. *Indian Association of Palynostratiqraphers Symposium, Birbal Sahni Institute of Palaeobotany,* Lucknow: 128-140.

SAHNI, A. 1984. Upper Cretaceous - Early Palaeogene Palaeobiogeography of India based on terrestrial vertebrate faunas. *Mem. Soc. Geol. France. N.S.* **147**: 125-137.

SAHNI, A., KUMAR, K., HARTENBERGER, J.L., JAEGER, J.J., RAGE, J.C., SUDRE, J. & VIANEY-LIAUD, M. 1982. Microvertebres mouveaux des Trapps du Decan (Inde) kise en evidence d'une viie de communication terrestre probable entre la Laurasie et 1' Inde a la limite Cretace-Tertiaire, *Bull. Soc. Geol. France. 7,* **24**(5-6): 1093-1099.

TRIPATHI, A. 1986. Biostratigraphy, palaeoecology and dinosaur egg shell ultrastructure of the Lameta Formation of Jabalpur. Unpublished M.Phi. dissertation, Panjab University, Chandigarh.

VIANEY-LIAUD, M., JAIN, S.L. & SAHNI, A. 1987. Dinosaur egg shells from the Late Cretaceous intertrappen and Lameta formations (Deccan India). *Jour. Vert. Paleont.* **7**: 408-424.

WOODWARD, A.S. 1908. On some fish remains from the Lameta beds at Dongargaon, Central Province. *Mem. Geol. Srv. India, Pal. Indica (N.S.).* **3**(3): 1-6.

EXPLANATION OF PLATES

PLATE I

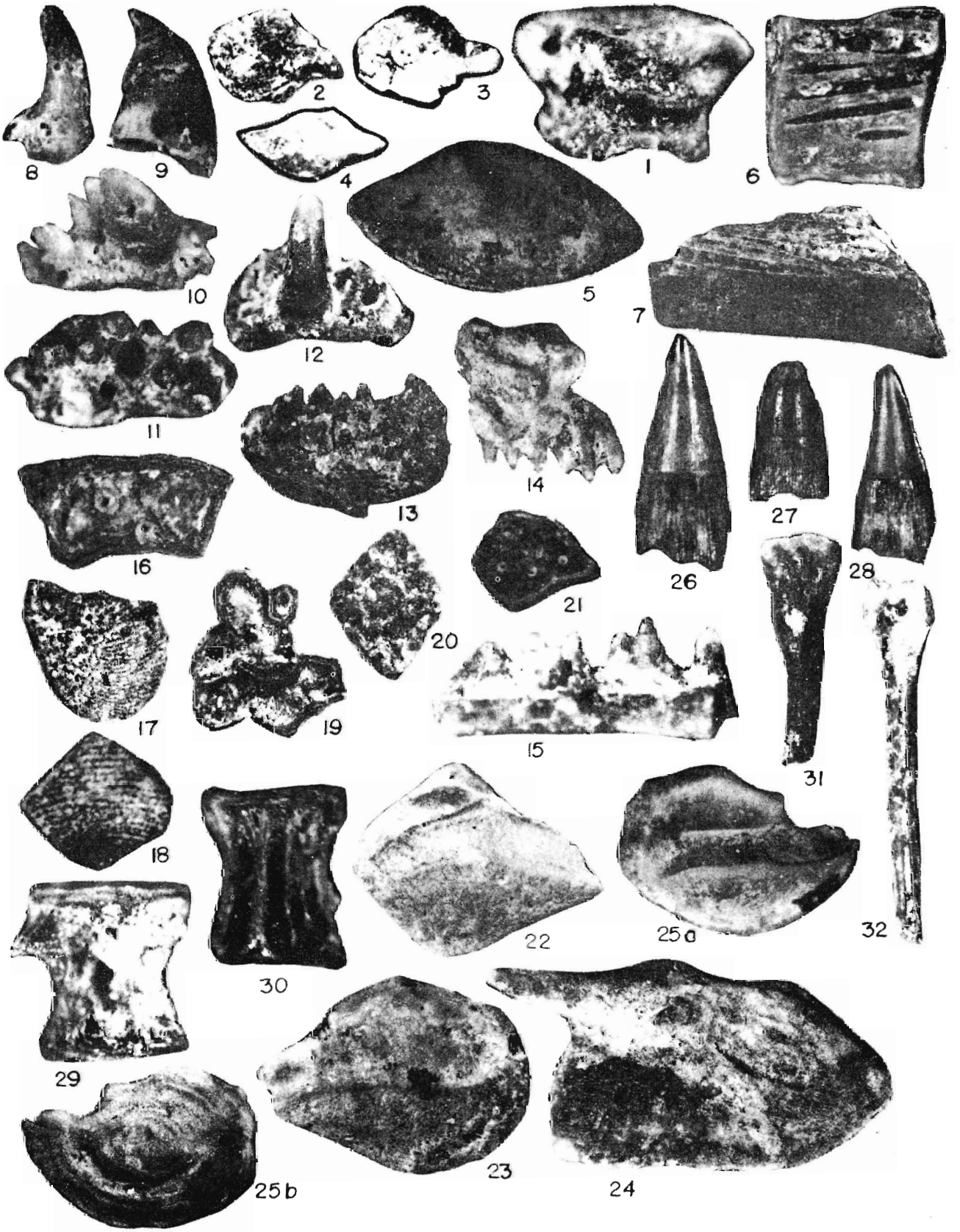
1, tooth of *Igdabatis* sp., posterior view x 28; 2-7, scales of *Lepisosteus indicus*, 2, external view x 1; 3, external view x 1; 4 internal view x 1; 5, internal view x 18; 6, external view x 17; 7, external view x 9; 8-21, teeth, dental plates, premaxilla and scale plates of Phareodus sp., 8, lateral view (tooth) x 23; 9, latera view (tooth) x 23; 10, lateral view (dental plate) x 21; 11, occlusal view (dental plate) x 24; 12, lateral view (dental plate) 18; 13, occlusalview (dental plate) x 20; 14, lateral view (premaxilla) x 17, 15, lateral view (dental plate) x 25; 16, inner surface (scale plate) x 29; 17, external surface (scale plate) x 23; 18, external surface (scale plate) x 28; 19, internal surface (mosaic of scale plates) x 20; 20, external surface (scalle plate) x 20; 21, internal surface (scale plate) x 17; 22. otolith of *Osteogossidarum intertrappus*, internal view x 20; 23, otolith of *O. deccanensis*, internal view x 16; 24, otolith of *Notopteridarum nolfi*, internal view x 17; 25, otolith of *Dapalis* sp., 25a, internal view x 21, 25b, external view x 21; 26-28, teeth of *Apateodus striatus*, 26, lateral view x 23; 27, lateral view x 19; 24, lateral view x 23; 29-32, incertae sedir, 29, vertebra x 14; 30, vertebra x 16; 31, pelvic bone x 15; 32, spine x 19.

PLATE II

1-7, Anura indet., 1, ventral view of maxilla x 23; 2, ventral view of maxilla x 23; 3, ? Atlas x 16; 4, caudalvertebra, 4a, dorsal view x 31; 4b, ventral view x 31; 5 ilium, external view x 9; 6, humerus, ventral view x 24; 7, humerus, ventral view x 23; 8-9, phalanges, 8, lateral view x 15; 9, lateral view x 14; 10-12, Lacertilia indet., 10a, left dentary, dorsal view x 14; 10b, ventral view x 14; 11, maxilla, 11a, dorsal view x 21; 11b, ventral view x 21; 12, caudal vertebra, 12a, ventral view, x 22; 12b, dorsal view x 22; 13, maxilla, ventral view x 31; 14, dorsal vertebra of Anguidae gen. et sp. indet., 14a, ventral view x 18; 14b, anterior view x 18; 14c, dorsal view x 18.

PLATE III

1, vertebra of *Madtsoiinae* gen. et sp. indet., 1a, dorsal view x 23; 1b, ventral view x 23; 1c, anterior view x 23; 2-4, teeth of *Alligatoride* gen. et sp. indet., 2, lateral view x 7; 3, lateral view x 8; 4, lateral view x 10; 5-7, teeth of *Deccanolestes hislopi*, 5, right upper moar M^1, 5a, occlusal view x 31; 5b, posterior view x 31; 5c, anterior view x 31, 5d, labial view x 31; 6, right upper molar M^3, 6a, posterior view x 40; 6b, anterior view x 40; 6c, occlusal view x 40; 7, right lower premolar P_3, 7a, lingual view x 43; 7b, labial view x 43.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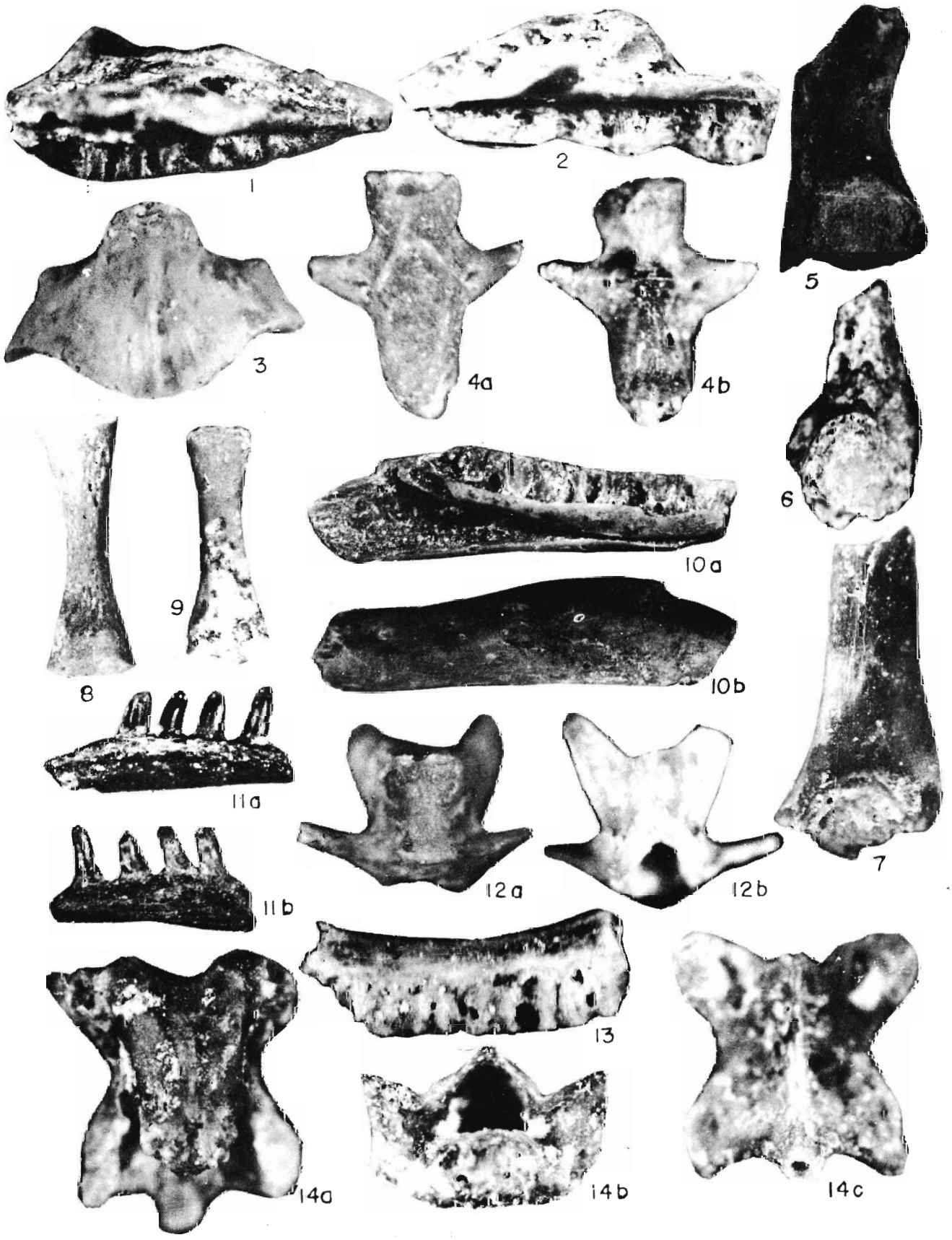
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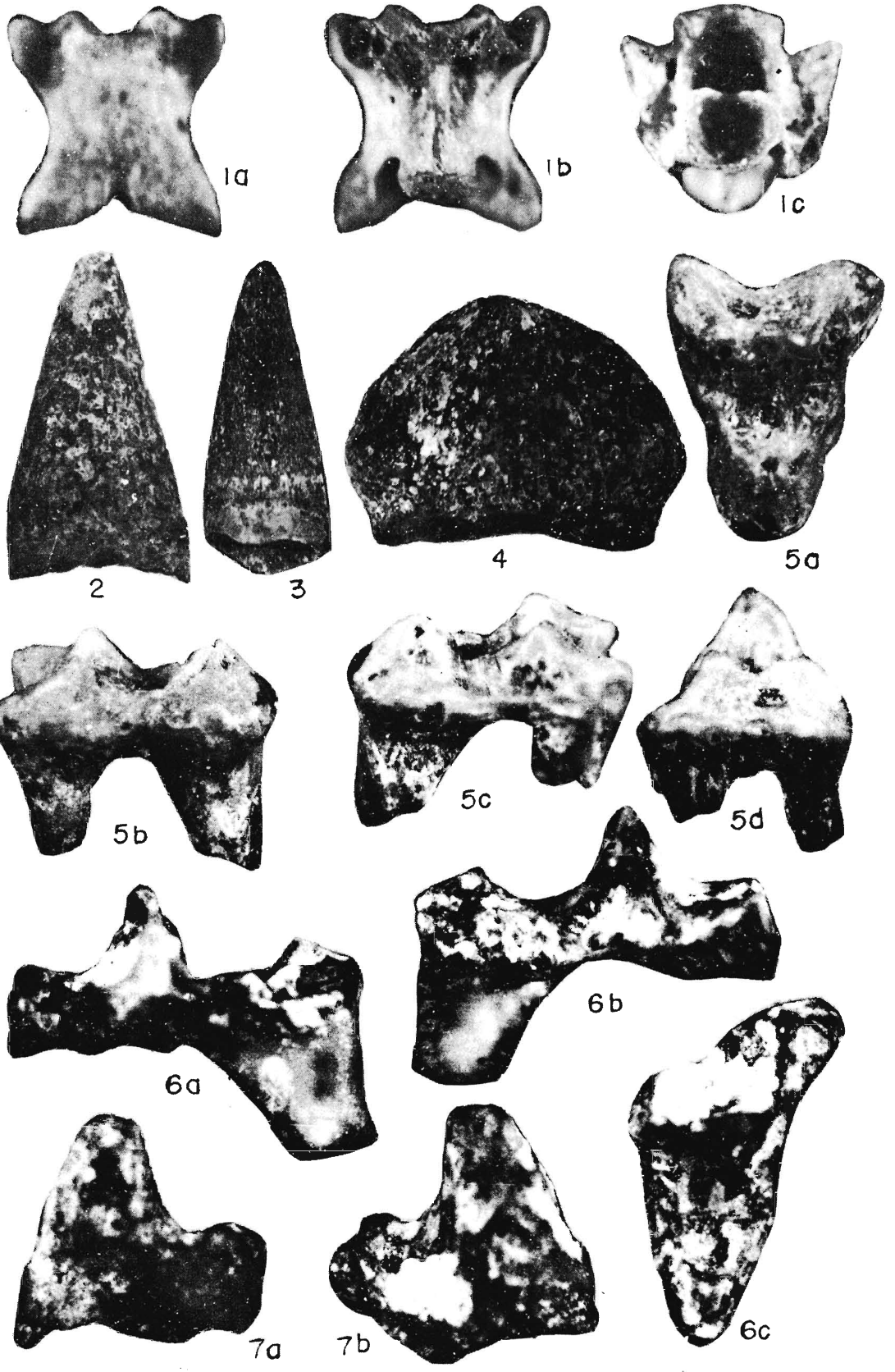
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