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LATE CRETACEOUS-PALAEOCENE CROCODILIANS FROM THE DECCAN TRAP-ASSOCIATED SEDIMENTARY SEQUENCES OF PENINSULAR INDIA

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ABSTRACT

Numerous isolated crocodilian teeth are described from the Deccan Trap associated sedimentary successions (Late Cretaceous-Palaeocene) of the peninsular India. These are represented by *Allognathosuchus* sp., *Asiatosuchus* sp., *Brachychampsa* sp., cf. *Bottosaurus* sp., *Thoracosaurus* sp., *Crocodylus* sp. and Dyrosauridae gen. et sp. indet. Except the dyrosaurid and *Crocodylus*, all other genera are being reported for the first time from the Indian subcontinent. These are indicative of freshwater-lacustrine environment of deposition with proximity of seawater. *Allognathosuchus* and *Asiatosuchus* suggest a Paleocene age while *Brachychampsa* indicates a Late Cretaceous age.

Key words : Crocodilians, Deccan Trap associated sedimentary sucessions, Peninsular India, Cretaceous-Palaeocene.

INTRODUCTION

The Deccan Trap-associated sedimentary successions (Infra- and Intertrappean beds or equivalents, the Lameta and Takli formations respectively) of the peninsular India have a wide geographical distribution in central, western and central south India. These sedimentary beds are found in thick (Infratrappean) and thin lens-shaped (Intertrappeans) scattered patches. They have a variable lithology in each locality. The Infratrappean beds are generally considered fluvio-lacustrine coastal plain deposits (Mohabey and Udhoji, 1993; Mohabey, Udhoji and Verma, 1993 and Tandon, Sood, Andrews and Dennis, 1995). The Intertrappeans are generally considered to have been formed by a sudden blocking of the drainage system after the eruption of Deccan basalt, resulting in the formation of small and large enclosed basins, separated by interfluvial divides (Rana, 1990). These sedimentary sequences are highly fossiliferous and yield diverse fauna and flora (Hislop and Hunter, 1855; Hora, 1938; Sahni, Kumar, Hartenberger, Jaeger, Rage, Sudre and Vianey-Liaud, 1982; Sahni, Rana and Prasad, 1987; Jain and Sahni, 1983; Bhatia and Rana, 1984; Gayet, Rage and Rana, 1984; Sahni, 1984; Rana, 1984, 1987, 1988, 1990, 1996; Prasad and Sahni; 1988; Sahni and Bajpai, 1988; Rana and Sahni, 1989; Bhatia *et al.*, 1990a, 1990b, 1996; Prasad and Rage, 1991; Rage and Prasad, 1992; Mohabey and Udhoji, 1993; Mohabey *et al.*, 1993 and Prasad and Cappetta, 1993). In the recent years, the Infra and Intertrappean beds have attracted the attention of geoscientists for studies on their age (Cretaceous-Tertiary boundary problem), initiation and duration of Deccan lava eruption, origin, migration and dispersal route of the fauna and flora, the palaeoenvironment, palaeoecology and the vertebrate fauna, especially mammals.

The palaeomagnetic, geochronological and palaeontological analysis of Deccan basaltic lava and the associated sedimentaries suggests that the age of the Deccan traps is 66.8 my. and the duration of the Deccan volcanism is not more than 1 my. (Besse *et al.*, 1986; Courtillot *et al.*, 1986, 1988; Jaeger, Courtillot and Topponnier, 1989; Sahni and Bajpai, 1988, 1991). However, 6-7 my duration of the Deccan lava eruption has been suggested by Venkatesan, Pande and Gopalan (1993) on the basis of the bottom section of Deccan basalt flow, which is close to 67 my, while the upper sections indicate an age 62.3 ± 2.4 my in the Western Ghats. The data also suggests that the volcanic eruptions influenced K/T events and that these may not be catastrophic events.

The Infra and Intertrappean vertebrates comprise diverse taxa such as fish (marine and non-marine), pelobatid and discoglossid frogs, anguid lizards, alligatorine crocodiles and palaeoryctid mammals. Most of these faunal elements are of the

Laurasian affinity having a wide distribution in Cretaceous-Tertiary successions of Laurasian continents. However, the identifications of the Infra and Intertrappean taxa especially those with Laurasian affinities have been questioned by Asher (1995); Mckenna (1995) and Thewissen and Mckenna (1992) due to the fragmentary nature of fossil material.

Rich fossil assemblages have been documented from the Deccan associated sedimentary sequences but until recently, there was no detailed report of crocodilian fauna except for vertebrae and isolated teeth (Rana, 1987, 1990) and *Crocodylus* sp. (Rana, 1984; Gayet *et al.*, 1984; Sahni *et al.*, 1987). In the present paper, seven species of crocodiles are described from Rangapur, Nagpur, Kamareddi, Naskal (Intertrappean beds), Pisdura, and Marepalli (Infratrappean beds) areas of Maharashtra and Andhra Pradesh (fig. 1). *Crocodylus* sp. is present in all the localities, while rest of the genera are recognized only from Marepalli, Rangapur and Naskal localities.

In the present paper, the classification by Romer (1966) is followed.

Abbreviations

IFTV/M/Cr- Infratrappean Vertebrate/Marepalli/ Crocodile, Catalogue number.

IFTV/P/Cr- Infratrappean Vertebrate/Pisdura/ Crocodile, Catalogue number.

ITV/N/Cr- Intertrappean Vertebrate/Nagpur/ Crocodile, Catalogue number.

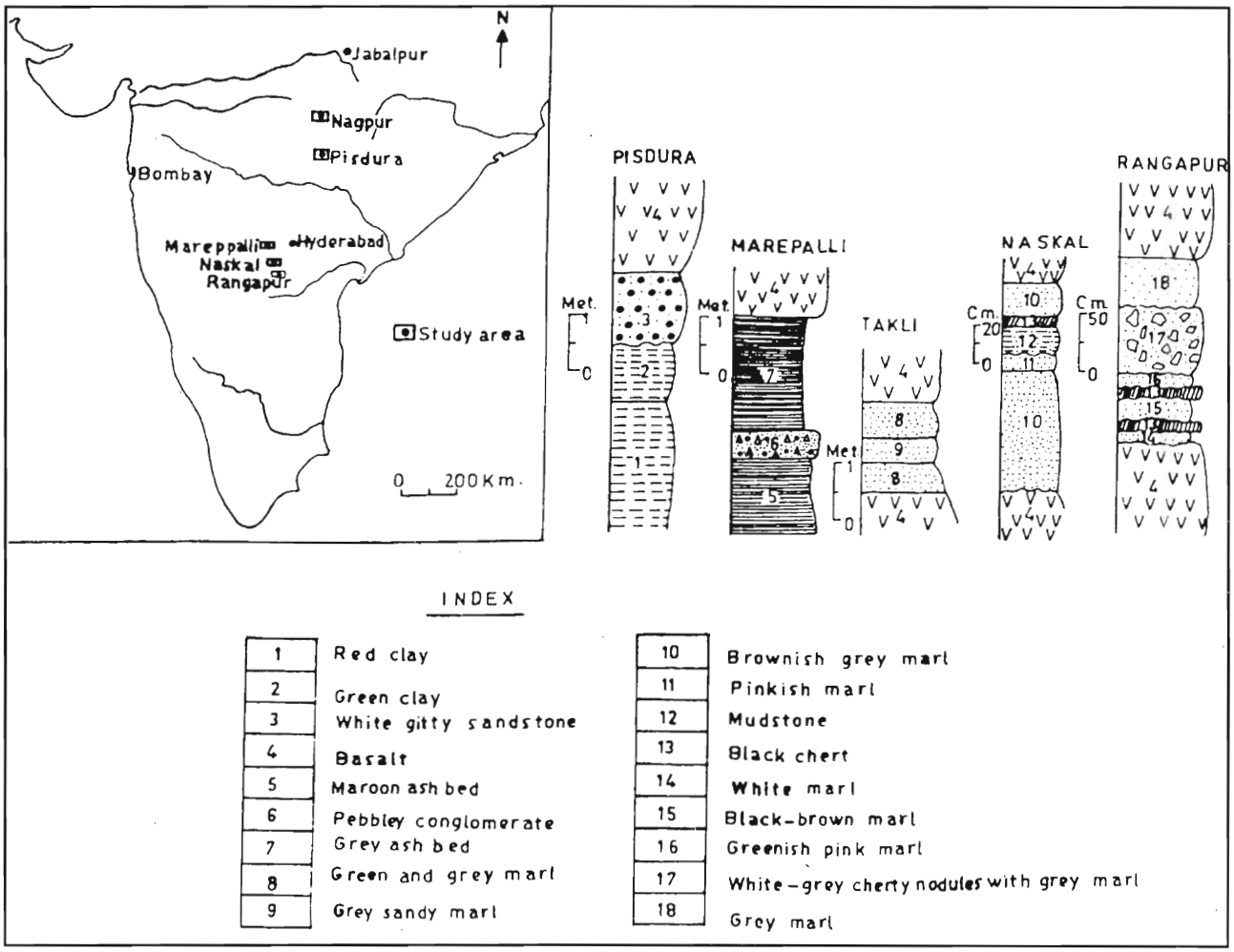

Fig.1. Location map and lithologic sections of the investigated Infra- and Intertrappean localities of peninsular India.

ITV/R/Cr- Intertrappean Vertebrate/Rangapur/ Crocodile, Catalogue number.

ITV/Ns/Cr- Intertrappean Vertebrate/Naskal/ Crocodile, Catalogue number.

SYSTEMATIC PALAEONTOLOGY

Subclass **Archosauria**

Order **Crocodilia** Gmelin, 1788

Suborder **Mesosuchia** Huxley, 1875

Family **Dyrosauridae** De Stefano, 1903

Gen. et. sp. indet.
(Pl. I, figs. 1-5; Pl. III, figs. 1-3)

Material : Fifteen isolated teeth (IFT/M/Cr-901 t0 915).

Horizon and Locality : Pebbly conglomeratic horizon of the Infratrappean beds, Marepalli, Rangareddi District, Andhra Pradesh.

Description : Teeth are long, cylindrical in shape, pointed, slightly curved; apex smooth, partly broken in some specimens (Pl. I fig. 2). The enamel surface is ornamented by dense ribs or striations, about 10 to 12 per mm.

Remarks : The teeth have close resemblance with the teeth of *Atlantosuchus coupatezi,* known from the Cretaceous -Tertiary sequences of Morocco (Buffetaut and Wouters, 1979). However, because of lack of comparative material, the present specimens are assigned to Dyrosauridae gen. et. sp. indet. In India, the dyrosaurids were earlier reported from the Infratrappean beds of Ausupalli area, Rangareddi District, Andhra Pradesh on the basis of isolated vertebrae (Rana, 1987). Additional material is needed for a definitive identification.

Suborder **Eusuchia** Huxley, 1875

Family **Crocodylidae** Cuvier, 1807

Subfamily **Alligatorinae** Steel, 1973

Genus ***Allognathosuchus*** Mook, 1921

Allognathosuchus sp.
(Pl. I, figs. 6-12; Pl. III, figs.4, 6-18, 20)

Material : Forty posterior teeth (ITV/R/Cr-1 to 25 and ITV/Ns/Cr-301 to 315), seventy median teeth (ITV/R/Cr-26 to 70 and ITV/Ns/Cr-316 to 350) and thirty-five anterior teeth (ITV/R/Cr-71 to 90 and ITV/Ns/Cr-351-365).

Horizon and Locality : Black brown marl and white grey marl beds of Rangapur Intertrappeans and brownish grey marl of Naskal Intertrappean beds of Rangareddi District, Andhra Pradesh.

Description : The teeth are represented by three different morphological types viz. posterior, median and anterior. The posterior crushing teeth, characterized by their small size (2 to 8 mm in width and 1 to 4 mm in height), are typically bulbous or button shaped with a low, wrinkled crown sharply separated from the root. The teeth are bluntly rounded and do not appear striated. They are somewhat laterally compressed, showing the presence of weak carinae, extending from apex to base, and laterally symmetrical and swollen at the gingival margin. Their elliptical basal part seems trilobate. The median teeth are subtriangular and labio-lingually compressed with pointed apices, wrinkled ornamentation and prominent carinae. Their crown and root are separated by a constriction on the gingival margin and their base is bilobate. The anterior teeth or premaxillary teeth are conical with globular base showing carinae-bearing pointed apices.

Remarks : The teeth (posterior, median and anterior) of *Allognathosuchus* sp. have close morphological resemblance with the teeth of *Hassiacosuchus kayi,* known from the Eocene of Wyoming (Mook, 1941, pl. XXV and shown in fig. 1 and Pl. III, fig. 5) and with the isolated teeth of *Allognathosuchus woutersi* from the Lower Eocene of Dormaal, Belgium (Buffetaut, 1985, figs. I to R). However, a few teeth of *A. woutersi* have much better developed roots. It is possible that the roots of present teeth are not fully preserved. The present specimens have been assigned to *Allognathosuchus* sp. because Romer (1966) considered *Allognathosuchus and Hassiacosuchus* as synonymous.

The anterior conical teeth of the present species also resemble the teeth of *Bottosaurus* sp., known from the Lower Cretaceous of Australia but are smaller in size. Earlier, Rana (1989) had included these teeth in Alligatorinae gen. et. sp. indet. because of similarities of the posterior teeth with the isolated teeth of alligatorines from the Upper Cretaceous of

Austria, southern France and Transylvania (Buffetaut, 1980). The posterior teeth also have morphological resemblance with the teeth of *Bernissartia* sp. known from Belgium, Spain and France (Buffetaut and Ford, 1979; Sanz *et al.*, 1984).

Genus ***Asiatosuchus*** Mook, 1940

Asiatosuchus sp.
(Pl. I, fig. 13; Pl. II, figs. 1, 2; Pl. III, figs.19, 21; Pl. IV, figs.1-2)

Material : Three isolated teeth (ITV/R/Cr- 91 and 92 and ITV/Ns/Cr- 366).

Horizon and Locality : Black brown marl of Rangapur Intertrappean beds and brownish grey marl of Naskal Intertrappean beds, Rangareddi District, Andhra Pradesh.

Description : The teeth are robust and labio-lingually compressed with elevated crown, rounded apical region, and a dull enamelloid cover. The crown has two curved or inclined thick carinae having bulge granules, which look like serrations. The enamelloid is dull, covered on most part by many irregular and very fine folds, and wrinkles, which appear to be distorted by the granules at the apex. The apical facet is prominent. The root is well preserved in all the specimens. It is hollow, smooth and separated from the crown by a faintly developed constriction at the crown- root junction.

Remarks : The present teeth have close morphological resemblance with the posterior teeth of *Asiatosuchus* sp., reported from the Paleocene of Belgium (Buffetaut, 1985 figs. S - U) but the present teeth have slightly smaller root and less prominent carinae granules. *Asiatosuchus* sp. is being reported for the first time from the Indian subcontinent. The genus is also known from Eocene of Mongolia, Paleocene of China and Middle Eocene of North America (Berg, 1966, 1970).

Genus ***Brachychampsa*** Gilmore, 1911

Brachychampsa sp.
(Pl. II, figs. 3-9; Pl. IV, figs. 3, 5-8)

Material : Five anterior and five posterior teeth (IFTV/M/Cr-916 to 925).

Horizon and Locality : Pebbly conglomeratic horizon of the Infratrappean beds of Marepalli, Rangareddi District, Andhra Pradesh.

Description : Size-wise the teeth of the present species are the largest in the collection and belong to different positions of the jaw. The teeth are well-differentiated into crown and root by the notches on the lateral side at the root - crown junction. The crown is high, labio-lingually compressed and smooth. It is leaf or chisel shaped with a pointed apex. The carinae are prominent between the apex and the root - crown junction. The crown has a very thin coat of shiny enamelloid. The root is not preserved in most of the present specimens, except in one (Pl. II, fig. 6; Pl. IV fig. 5) which has a slightly broken root that is deep, rounded, smooth and hollow.

The anterior teeth are the largest (length 17 mm; width 9mm), robust, conical in shape and flattened with prominent carinae. The surface is smooth and has a thin layer of enamelloid. The root is broken, but well separated from the crown by a slight constriction.

The posterior teeth are smaller (5 mm), and slightly compressed with a smooth surface covered by thin shiny enamelloid, The apex has a rounded facet from where the prominent carinae are developed. The basal part of the root is elliptical and hollow.

Remarks : The present teeth have close morphological affinities with *Brachychampsa montana* and *Brachychampsa* sp. described by Carpenter (1979) and Carpenter and Lindsey (1980) from the Late Cretaceous, Lance and Laramie formations of the North America and with Recent Alligatorine teeth from the North America (Westergaard and Ferguson 1987). See Pl. III, fig. 4. The posterior teeth have some morphological affinities with *B. montana* described and figured by Mook (1911) from the Late Cretaceous, Hell Creek beds of Montana, North America. The present teeth differ from those of *Alloganthosuchus* sp. and *Asiatosuchus* sp. from the Naskal and Rangapur Intertrappean localities in having smooth crown surface, laterally compressed shape and larger size.

cf. *Bottosaurus* sp.
(Pl. II, figs. 10-11; Pl. IV, figs. 16-19)

Material : Nearly one hundred isolated teeth (IFTV/M/Cr- 991 to 1091).

Horizon and Locality : Pebbly conglomeratic bed of Marepalli Infratrappean bed of Rangareddi District, Andhra Pradesh.

Description : The teeth show a large variation in size (2 to 8 mm in height). They either belong to individuals of different age groups or to different positions in the jaw. Their basal part is globular or bulbous and apical part is narrow and pointed. The crown surface has a very thin and shiny enamelloid cover, with fine or coarse vertical striations from apex to base. The root is not well preserved, but at the root - crown junction there is a slight constriction. The carinae are absent.

Remarks : Similar type of teeth with jaw fragment are known from the Lower Cretaceous Lightning Ridge of New South Wales (Molnar, 1980, figs. F and G). The posterior teeth of *Brachychampsa montana* have similar morphology but they have prominent carinae (Gilmore, 1911). Similar type of teeth have been recovered from the Rangapur and Naskal Intertrappean beds but due to their very small size, they have been assigned to anterior teeth of *Alloganthosuchus* sp. More material is needed for definite identification.

Thoracosaurus sp.

(Pl. II, figs. 12-13; Pl. IV, figs. 10-12, 15)

Material : Nearly two hundred isolated teeth (ITV/R/Cr- 93 to 150, ITV/Ns/Cr- 326 to 380 and ITV/M/Cr- 926 to 990).

Horizon and Locality : Black brown marl bed and white grey marl bed of Rangapur Intertrappeans; brownish grey marl bed of Naskal Intertrappeans and pebbly conglomeratic bed of Infratrappean bed of Marepalli, Rangareddi District Andhra Pradesh.

Description : The teeth vary in height from 2 to 10 mm. They are conical, slightly curved or straight with fine and coarse vertical striations on a dull enamelloid cover. The anterior and posterior carinae are well developed and non-serrated. The root is not preserved.

Remarks : Similar type of teeth have been described as *Thoracosaurus* from the Late Cretaceous Hell Greek Formation of Montana (Estes and Berberian, 1970), Lance Formation of Eastern Wyoming (Breithaupt, 1982) Fruitland Formation of New Mexico (Armstrong-Ziegler, 1980) and the Late Cretaceous of Europe (Buffetaut, 1979). However, the present teeth are considerably smaller in size.

Crocodylus sp.

(Pl. II, figs. 14-15; Pl. IV figs. 9-13, 14)

Material : Over two hundred isolated teeth (IFTV/M/Cr- 1092-1120, IFTV/P/Cr-300-3020, ITV/R/Cr-151-200, ITV/Ns/Cr-381-400, and ITV/N/Cr-4000-4080).

Horizon and Localities: All investigated Infra and Intertrappean localities of peninsular India.

Remarks: There are many isolated teeth, which are conical, straight, labio-lingually compressed having prominent non-serrated carinae, and smooth surface. The root is not preserved in any of the specimens. As no other significant features are noticed, they are described under *Crocodylus* sp.

DISCUSSION

Seven taxa of crocodiles viz., Dyrosauridae gen. et. sp. indet. *Allognathosuchus* sp., *Asiatosuchus* sp., *Brachychampsa* sp., cf. *Bottosaurus* sp., *Thoracosaurus* sp. and *Crocodylus* sp. have been described on the basis of isolated teeth from the Infra-and Intertrappean beds of the peninsular India. Of these, four genera viz. *Brachychampsa* sp., *Allognathosuchus* sp., *Asiatosuchus* sp. and *Bottosaurus* sp. belong to the Subfamily Alligatorinae (Family Crocodylidae). The alligatorines range from Middle Cretaceous to Recent. The Dyrosauridae gen. et. sp. indet and alligatorines were earlier reported on the basis of vertebrae and isolated teeth from the Infratrappean and Intertrappean beds of the peninsular India (Rana, 1987, 1989). The *Crocodylus* sp. is a common taxon in all Infra and Intertrappean localities of the peninsular India.

The documented stratigraphic range of dyrosaurids is from Maastrichtian to Priabonian. They are known mainly from Africa, eastern seaboard of North and South America, Pakistan and Myanmar (Buffetaut, 1976, 1978). In Africa, the dyrosaurids attained their maximum diversification

during the Palaeocene (Buffetaut, 1978). Their complete record from Maastrichtian to middle Eocene is known from Africa. The record of dyrosaurids from the North and South America suggests that they did not survive the Cretaceous - Tertiary transition in these continents. The finding of dyrosaurid vertebrae from the Pondaung Formation of Myanmar indicates that they survived at least till late Eocene time in the southern Asia. The report of dyrosaurid elements in *Cardita beaumonti* beds of Pakistan suggests a littoral marine environment (Buffetaut, 1978). However, the finds from the Eocene of Pakistan and Pondaung Formation, Myanmar indicate a freshwater environment. In the Infratrappean beds of Marepalli, the dyrosaurids occur in association with marine and non-marine fauna indicating a marine influence and a coastal environment. A coastal environment for Infratrappeans is also supported by Buffetaut's (1978) view who interpreted that the adult dyrosaurids spent most of their time in littoral marine waters but laid their eggs inland near the stream banks. It can also be interpreted that the primitive dyrosaurids were marine, while those from the Eocene of the Eastern Tethyan region were freshwater.

The second dominant group of crocodiles in the collection is represented by alligatorines (Crocodylidae) which occur in both Infra- and Intertrappean beds of Marepalli, Naskal and Rangapur areas of the Rangareddi District, Andhra Pradesh. In the Infratrappean beds, typical Late Cretaceous elements *viz., Brachychampsa* sp. and *Bottosaurus* sp. have been reported while *Allognathosuchus* sp. and *Asiatosuchus* sp. are reported from the Intertrappean beds of Naskal and Rangapur. Some isolated teeth, which look like those of *Bottosaurus sp.* and are found in the Intertrappean beds of Rangapur and Naskal, probably represent the anterior teeth of *Allognathosuchus* (Gilmore, 1911; Molnar, 1980). So it can be said that *Bottosaurus* sp. is probably absent in the Intertrappean beds. Both *Allognathosuchus* and *Asiatosuchus* are known from the Palaeogene of North America, Europe and China (Mook, 1921, 1941, 1960; Case, 1925; Simpson, 1930; Weitzel, 1935; Young, 1964; Berg, 1966; Buffetaut, 1978, 1979, 1985,).

It is inferred that the Infra- and Intertrappean alligators were primary eaters of fish, amphibians, reptiles, mammals, molluscs and crustaceans, because they had a broad snout and short bulbous posterior teeth, as in the modern alligators, which feed mostly on turtles and molluscs (Neill, 1971). The modern alligators are primarily freshwater, and thrive mostly in lagoonal and shallow lakes rather than in streams. The occurrence of alligators in the Deccan trap-associated sediments of the peninsular India suggests that during the Late Cretaceous and early Tertiary times, there were several small shallow lakes formed by the palaeosea in the peninsular India and later these were joined with rivers and the deposition became probably lagoonal. *Thoracosaurus* sp., an aquatic form known from the Late Cretaceous to early Tertiary of North America, Europe and Asia, was probably better adapted to a coastal habitat. The dietary niches are similar to those of the existing crocodilian fauna.

The overall analysis of the crocodilian fauna, recovered from the Infra and Intertrappean beds of the peninsular India suggests that these beds were deposited in a fluvio-lacustrine to coastal plain environment connected by sea. The presence of *Brachychampsa* sp., dinosaurs and *Lepidotes* sp. in the Infratrappean beds of Marepalli suggest a Late Cretaceous age while the presence of *Allognathosuchus, Asiatosuchus* and absence of dinosaurs and *Lepidotes* in the Naskal and Rangapur Intertrappean beds indicates a Palaeocene age for these beds.

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REFERENCES

Armstrong-Ziegler, J. 1980. Amphibia and Reptilia from the Campanian of New Mexico. *Fieldiana Geol. n.s. no.* **4**: 1- 39.

Asher, R.J. 1995. Diversity in the acetabular region of the Discoglossid (Anura) ilium : palaeontological implications. *Jour. Vert. Palaeont.*, **15** : 16-17.

Asher, R. J. and Krause, D. W. 1994. The first pre-Holocene (Cretaceous) record of anura from Madagascar. *Jour. Vert. Palaeont.* **14**: 1-15.

Berg, D.E. 1966. Die Krokodile, insbesondere dem *Asiatosuchus* und aff. Sebecus ?, aus dem Eozam von Messel bei Darmstadt/Hessen. *Abh. Hess. L. Bodenforsch.* **52** : 1-105.

Berg, D.E. 1970. Characteristic crocodiles of the Paleocene in Europe. *Paleont. Inst. Mainz. Saarstr.* **21** : 73-75.

Besse, J., Buffetaut, E. Cappetta, H., Courtillot. V., Jaeger, J. J., Montigny, R., Rana, R. S., Sahni, A., Vandamme, D. and Vianey-Liaud, M. 1986. The Deccan Traps (India) and Cretaceous-Tertiary boundary events, p. 365-370. In : *Lect. Notes Earth Sci.* (Ed. O. Walliser).

Bhatia, S.B. and Rana, R. S. 1984. Palaeogeographic implications of the charophyta and ostracoda of the Intertrappean beds of peninsular India. *Mem. Geol. Soc. France, N.S.* **147** : 2935.

Bhatia, S. B., Prasad, G.V.R. and Rana, R.S. 1990a. Deccan volcanism, a Late Cretaceous event; conclusive evidence of ostracodes. *In: Sahni A. and Jolly, A (Eds)*, : 47-49.

Bhatia, S. B., Revelian, J. and Rana, R.S. 1990b. Charophyta from the Deccan Intertrappean beds near Rangapur, Andhra Pradesh, India. *Paleobot.* 37 (3): 316- 323.

Bhatia, S. B., Prasad, G.V.R. and Rana R.S. 1996. Maastrichtian non-marine ostracodes from peninsular India: Palaeobiogeographic and age implications. *Mem. Geol. Soc. India*, **37**: 297-311.

Breithaupt, B. H. 1982. Palaeontology and palaeoecology of the Lance Formation (Maestrichtian), east flankof Rock Springs Uplift, Sweetwater County, Wyoming. *Contrib. Geol. Univ. Wyoming*, **21 (2)**: 123-151.

Buffetaut, E. 1976. Sur la repartition geographique hors d'Afrique de Dyrosauridae, crocodiliens mesosuchiens du Cre'tace' terminal et du Pae'ogene. C.R, Acad. Sci. Paris, **283** (D): 487-490.

Buffetaut, E. 1978. Crocodilian remains from the Eocene of Pakistan. *N.Jb. Geol. Palaont. Abh.* **156**(2): 262-283.

Buffetaut, E. 1980. Crocodilians from the continental Upper Cretaceous of Europe: New finds and interpretations. *Mesoz. Verteb. Life*, **1**: 5-14.

Buffetaut, E. 1985. Les crocodiliens de L'Eocene Inferieur de Dormaal (Brabant, Belgique). *Bull. Soc. Geol. Belg.* **94 (1)**: 51-59.

Buffetaut, E. and Ford, R.L.E. 1979. The crocodilian Bernissartia in the Welden of Isle of Wight. *Palaeont.* **22** (4) : 905-912.

Buffetaut, E. and Wouters, G. 1979. *Atlantosuchus coupatezi*, n. g., n. sp., un nouveau dyrosauride (Crocodilia, Mesosuchia) des phosphates Montiens du Maroc. *Bull. Trim. Soc. Geol. Norm. Amis Mus. Havre*, **66 (4)**: 85- 90.

Carpenter, K. 1979. Vertebrate fauna of the Laramie Formation (Maestrichtian), Weld County. Colorado *Contrib. Geol. Univ. Wyoming*, **17**: 37-49.

Carpenter K. and Lindsey, D. 1980. The dentary of Brachychampsa montana, Gilmore (Alligatorinae, Crocodylidae), a Late Cretaceous turtle-eating alligator. *Jour. Pal.* **54** : 1213-1217.

Case E. C. 1925. Note on a new species of the Eocene crocodilian *Allognathosuchus, A. wartheni. Contrib. Mus. Geol. Univ. Michigan*, **2** (5): 93-97

Courtillot, V., Besse, J., Vandamme, D., Montigny, R., Jaeger, J. J. and Cappetta, H. 1986. Deccan flood basalt at the Cretaceous/Tertiary boundary?. *Earth Planetary Sci. Letters.* **80**: 361-374.

Courtillot, V., Feraud, G., Maluski, H.,Vandamme, D., Moreau, M.G. and Besse, J. 1988. Deccan flood basalt and Cretaceous/Tertiary boundary. *Nature*, **333**: 843- 846.

Estes, R. and Berberian, P. 1970. Palaeoecology of Late Cretaceous vertebrate community from Montana. *Breviora*, **343** : 1-35.

Gayet, M. Rage, J. and Rana, R. S. 1984. Nouvelles ichthyofaune et herpetofaune de Gitti Khadan, de plus anciengisement conn du Deccan (Cretace-Paleocene) a microvertebres. Implications paleobiographiques. *Mem. Soc. Geol. France, N.S.* **147**: 55-65.

Gilmore, C.W. 1911. A new fossil Alligator from the Hell Creek Beds of Montana. *Proc. U.S.A. Nat. Mus.* 41: 297-302.

Hislop, S. and Hunter, R. 1855. On the geology and fossil of the neighbourhood of Nagpur, Central India. *Quart. Jour. Geol. Soc. London.* **16**: 345-383.

Hora, S. L. 1938. On some fish scales from the Intertrappean beds at Deothan and Kheri, Central Province. *Rec. Geol. Surv. India*, **75**: 267-297.

Jaeger, J. J., Courtillot, V. and Topponnier, 1989. Palaeontological view of the age of the Deccan traps, the Cretaceous/Tertiary boundary and India-Asia collision. *Geology*, **17**: 316-319.

Jain, S. L. and Sahni, A. 1983. Some Upper Cretaceous vertebrates from Central India and their palaeogeographic implications. *Indian Assoc. Palyn. Lucknow*, 66-83.

Mckenna, M.C. 1995. The mobile Indian raft: a reply to Rage and Jaeger. *Systematic Biology*, 44: 265-271.

Mohabey, D.M. and Udhoji, S.G. 1993. Palaeoenvironmental interpretation of Lameta Formation (Late Cretaceous) of Nand area, Nagpur District, Nagpur. *Gond. Geol. Mag.*, **4-5**: 13-22.

Mohabey, D.M., Udhoji, S.G. and Verma, K.K. 1993. Palaeontological and sedimentological observations on non-marine Lameta Formation (Upper Cretaceous) of Maharashtra, India and their palaeontological and Palaeoenvironmental significance. *Palaeogeogr. Palaeoclimatol Palaeoecol.* **105:** 83- 94.

Molnar, R. E. 1980. Procoelous crocodile from Lower Cretaceous of Lightning Ridge, N. S. W., *Mem. Queen. Mus. Brisbane*, **20 (1)**: 65-75.

Mook, C. C. 1911. A new fossil Alligator from the Hell Creek Beds of Montana. *Proc. U.S. Nat. Mus.* 41: 297-302.

Mook, C. C. 1921. *Allognathosuchus*, a new genus of Eocene crocodilians. *Bull. Amer. Mus. Nat. Hist.* 44 (10): 105-110.

Mook, C.C. 1941. A new crocodilian, *Hassiacosuchus kayi*, from the Bridger Eocene beds of Wyoming. *Ann. Carng. Mus.* **28**: 207-221.

Mook, C.C. 1960. *Diplocynodon* remains from the Bridger beds of Wyoming. *Am. Mus. Novit.* 2007: 1-4.

Neill, W. T. 1971. *The last of the Ruling Reptiles, Alligators, Crocodiles.* Columbia Univ. Press, New York.

Prasad, G. V. R. and Cappetta, H. 1993. Late Cretaceous selachians from India and the age of the Deccan Traps. *Paleont.* **36** (10) 161-173.

Prasad, G. V. R. and Rage, J. C. 1991. A discoglossid frog in the latest Cretaceous (Maastrichtian) of India. Further evidence for a terrestrial rout between India and Laurasia in the latest Cretaceous. *C. R. Acad. Sci. Paris, t.* **313**(2): 273-278.

Prasad, G. V. R. and Sahni, A. 1988. First Cretaceous mammal from India. *Nature*, **332**: 638-640.

Rage, J.C. and Prasad, G.V.R. 1992. New snakes from the Late Cretaceous (Maastrichtian) of Naskal, India. *N. Jb. Geol. Palaeont. Abh.* **187**(1): 83-97.

Rana, R.S. 1984. Microvertebrate Palaeontology and biostratigraphy of the Infra and Intertrappean beds of Nagpur, Maharashtra. *Unpublished Ph. D. Thesis, P. U., Chandigarh.*

Rana, R. S. 1987. Dyrosaurid crocodile (Mesosuchia) from the Infratrappean beds of Vikarabad, Andhra Pradesh, India. *Cur. Sci.* **56**: 532-534.

Rana, R. S. 1988. Freshwater fish otoliths from the Deccan trap associated sedimentary (Cretaceous-Tertiary transition) beds of Rangapur, Hyderabad District, Andhra Pradesh, India. *Geobios.* **21 (4)**: 465-493.

Rana, R. S. 1989. Alligatorine teeth from the Rangapur Intertrappean beds of Andhra Pradesh, India: Further evidence of Laurasiatic elements. *Curr, Sci.* **59**(1) 49-51.

Rana, R.S. 1990. Palaeontology and palaeoecology of the Intertrappean (Cretaceous-Tertiary transition) beds of peninsular India. *Jour. Pal. Soc. India*, **35**: 105-120.

Rana, R.S. 1996. Additional fish otoliths from the Deccan trap associated sedimentary beds exposed near Rangapur, Rangareddi District, Andhra Pradesh, India. *Contrb. XV, Indian Colloq. Micropal. Strat. Dehra Dun,* 477-491.

Rana, R.S. and Sahni, A. 1989. Fish otoliths from the Takli Formation (Intertrappean beds) of Nagpur, India. *Geosci. Jour.* **10 (1)**: 145-164.

Romer, A. S. 1966. *Vertebrate Palaeontology*. Chicago Univ. Press.

Sahni, A. 1984. Cretaceous-Palaeocene terrestrial fauna of India. Lack of endemism drifting of Indian Plate. *Sci.* **226**: 441-444.

Sahni, A and Bajpai, S. 1988. Cretaceous-Tertiary boundary events: the fossil vertebrate, palaeomagnetic and radiometric evidence from peninsular India. *Jour. Geol. Soc. India*, **32**: 382-396.

Sahni, A., and Bajpai, S. 1991. Eurasiatic elements in the Upper Cretaceous non-marine biotas of peninsular India. *Cret. Res.* **12**: 177-183.

Sahni, A., Kumar, K., Hartenberger, J.L., Jaeger, J.J., Rage, J.C., Sudre, J. and Vianey-Liaud, M. 1982. Microvertebre nouveau des Traps du Deccan (Inde): mise en evidence d'un voie de communication terrestre probable entre la Laurasie et l'Inde a la limite Cretace-Tertiaire. *Bull. Soc. Geol. Fr.* **14**: 1093-1099.

Sahni, A., Rana, R.S. and Prasad, G.V.R. 1987. New evidence for Palaeobiogeographic Intercontinental Gondwana relationship based on Late Cretaceous-Earliest Palaeocene coastal fauna from the peninsular India. *Amn. Geophy. Union*, 207-218.

Sanz, J.L., Buscalioni, A. Casanovas, M.L. and Santafe, J.V. 1984. The archosaur fauna from the Upper Jurassic/ Lower Cretaceous of Galve (Teruel, Spain). 3rd Symp. Mes. Terr. Ecosy. Edt. Reif. W. E. and Westphal. F. Tubingen. 207-210.

Simpson, G.C. 1930. *Allognathosuchus mooki*, a new crocodile from the Puerco Formation. *Ann. Mus. Novit.* **445** :1-16.

Tandon, S. K., Sood, A., Andrews, J. E. and Dennis, P. F. 1995. Palaeoenvironment of the dinosaurs-bearing Lameta beds (Maastrichtian), Narmada Valley, Central India. *Palaeogeogr., Palaeoclimatol., Palaeoecol.* **117**: 153-184.

Thewissen, J.G.M. and McKenna, M.C. 1992. Palaeogeography of Indo-Pakistan: a response to Briggs, Patterson, and Owen. *Systematic Biology*, **41**: 248-251.

Venkatesean, T.R., Pande, K. and Gopalan, K. 1993. Did Deccan volcanism pre-date the Cretaceous/Tertiary transition?. *Earth Planet. Sci. Lett.* **119**: 181-189.

Weitzel, K. 1935. *Hassiacosuchus haupti* n. g. n. sp., ein durophages Krokodil aus dem Mitteleozan von Messel. *Notizble. Ver. Erdk. U. Hess. Geol. L. Anst.* **5 (16)** : 40-49.

Westergaard, B and Ferguson, M. W. 1987. Development of the dentition in *Alligator mississippiensis*. Later development in the lower jaws of embryos, hatchlings and young juveniles. *Jour. Zool.* **211:** 191-200.

Young, C.C. 1964. New fossil crocodiles from China. *Vertb. Palasi.* **8 (2)**: 189-208.

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EXPLANATION OF PLATES

Plate I

Dyrosauridae gen. et sp. indet

1. Isolated tooth (IFTV/M/Cr- 901), lateral view, X 5.
2. Isolated tooth (IFTV/M/Cr -902), lateral view, X 5.
3. Isolated tooth (IFTV/M/Cr-904), lateral view, X 7.
4. Isolated tooth (IFTV/M/Cr- 905), lateral view, X 5.
5. Isolated tooth (IFTV/M/Cr- 906), lateral view, X 5.

Allognathosuchus sp.

6a. Isolated posterior tooth (ITV/R/Cr-1), apical view, X 10.
6b. Isolated posterior tooth (ITV/R/Cr-1), lateral view, X 10.
6c. Isolated posterior tooth (ITV/R/Cr-1), basal view, X 10.
7. Isolated median tooth (ITV/R/Cr- 26), lateral view, X 4.4.
8. Isolated median tooth (ITV/R/Cr- 27), lateral view, X 5.
9. Isolated median tooth (ITV/Ns/Cr- 316), lateral view, X 6.
10. Isolated anterior tooth (ITV/R/Cr- 71), lateral view, X 4.8.
11. Isolated anterior tooth (ITV/Ns/Cr- 351), lateral view, X 6.5.
12. Isolated anterior tooth (ITV/Ns/Cr- 352), lateral view, X 3.9.

Asiatosuchus sp.

13a. Isolated tooth (ITV/R/Cr- 92), lateral view, X 2.6.
13b. Enlarged view of serrations (ITV/R/Cr- 92), X 7.

Plate II

Asiatosuchus sp.

1. Isolated tooth (ITV/Ns/Cr-366), a and b lateral views, X 10.
2a. Isolated tooth (ITV/R/Cr- 91), lateral view, X 20.
2b. Enlarged view of serrations (ITV/R/Cr- 91), X 25.

Brachychampsa sp.

3. Isolated anterior tooth (IFTV/M/Cr- 916), lateral view, X 4.
4. Isolated posterior tooth (IFT/M/Cr- 922), lateral view, X 5.
5. Isolated posterior tooth (IFTV/M/Cr- 923),lateral view, X 7.
6a. Isolated anterior tooth (IFTV/M/Cr- 917), lateral view, X 4.
6b. Isolated anterior tooth (IFTV/M/Cr- 918), lateral view, X 4.
7. Isolated anterior tooth (IFTV/M/Cr- 919), lateral view, X 4.2.
8. Isolated anterior tooth (IFTV/M/Cr- 920), lateral view, X 15.
9. Isolated anterior tooth (IFTV/M/Cr- 921), lateral view, X 3.2.

cf. *Bottosaurus* sp.

10. Isolated tooth (IFTV/M/Cr-1000), lateral view, X 20.
11. Isolated tooth (IFTV/M/Cr- 1001), lateral view, X 22.

Thoracosaurus sp.

12. Isolated tooth (IFTV/M/Cr- 926), lateral view, X 15.
13. Isolated tooth (IFTV/M/Cr 927), lateral view, X 16.

Crocodylus sp.

14. Isolated tooth (IFTV/M/Cr-1092), lateral view, X 10.
15. Isolated tooth (ITV/R/Cr-151), lateral view, X 18.

Plate III

Bar represents 1.0 mm.

Dyrosauridae gen. et sp. indet.

1. Isolated tooth (IFTV/M/Cr 901), lateral view,
2. Isolated tooth (IFT/M/Cr 902), lateral view,
3. Isolated tooth (IFTV/M/Cr 906), lateral view.

Allognathosuchus sp.

4. Isolated posterior tooth (ITV/R/Cr- 2), a. lateral view, and b. apical view.
6. Isolated posterior tooth (ITV/R/Cr- 3), a. apical view and b. lateral view.
7. Isolated posterior tooth (ITV/Ns/Cr-301), a and d. lateral views, b. basal view and c. apical view.
8. Isolated posterior tooth (ITV/R/Cr-05), a. apical and b. lateral views.
9. Isolated upper median tooth (ITV/R/Cr-26), lateral view
10. Isolated upper median tooth (ITV/R/Cr-28), lateral view
11. Isolated upper median tooth (ITV/Ns/Cr-316), lateral view
12. Isolated lower median tooth (ITV/Ns/Cr-317), a and b lateral views.
13. Isolated lower median tooth (ITV/R/Cr-40), a and b lateral views.
14. Isolated anterior tooth (ITV/R/Cr-71), lateral view
15. Isolated anterior tooth (ITV/R/Cr-74), lateral view
16. Isolated upper median tooth (ITV/R/Cr-27), a lateral and b apical views
17. Isolated anterior tooth (ITV/Ns/Cr-352), lateral view
18. Isolated upper median tooth (ITV/R/Cr-72), a lateral and b apical views
20. Isolated anterior tooth (ITV/Ns/Cr-353), lateral view.

Asiatosuchus sp.

19. Isolated tooth (ITV/Ns/Cr-366), lateral view
21. Isolated tooth (ITV/R/Cr-91), a and b lateral views.

Hassiacosuchus kayi

5. Skull along with the anterior, median and posterior teeth, bar represents 1.0 cm.

Plate IV

Bar represent 1.0 mm.

Asiatosuchus sp.

1. Isolated teeth (ITV/Ns/Cr-366), lateral view.
2. Isolated teeth (ITV/R/Cr-92), a and b lateral views.

Brachychampsa sp.

3. Isolated posterior tooth (IFTV/M/Cr-922), a lateral and b apical views.
5. Isolated posterior tooth (IFTV/M/Cr-917), a, b lateral and c apical views.
6. Isolated posterior tooth IFTV/M/Cr-923), a, b lateral and c apical views.
7. Isolated anterior tooth (IFTV/M/Cr-921), a lateral and b apical views
8. Isolated anterior tooth (IFTV/M/Cr-919), a lateral b apical views
4. Lower jaw of recent *Alligator mississippiensis* from North America.

Crocodylus sp.

9. Isolated tooth (ITV/N/Cr-4000), lateral view
13. Isolated tooth (ITV/Ns/Cr-381), lateral view
14. Isolated tooth (ITV/R/Cr-151), lateral view.

Thoracosaurus sp.

10. Isolated tooth (IFTV/M/Cr- 926), lateral view.
11. Isolated tooth (IFTV/M/Cr-927), lateral view.
12. Isolated tooth (ITV/Ns/Cr- 326), lateral view.
15. Isolated tooth (ITV/R/Cr- 93), lateral view.

Bottosaurus sp.

16. Isolated tooth (IFTV/M/Cr- 991), lateral view.
17. Isolated tooth (IFTV/M/Cr- 992), lateral view.
18. Isolated tooth (IFTV/M/Cr- 993), lateral view.
19. Isolated tooth (IFTV/M/Cr- 994), lateral view.

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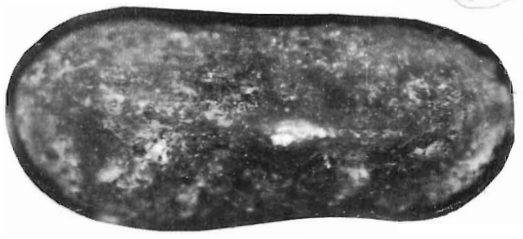

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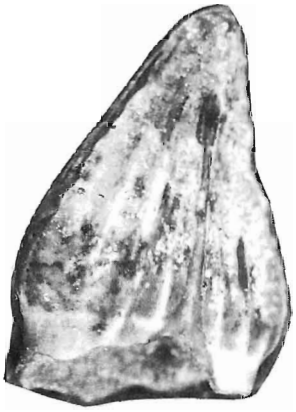

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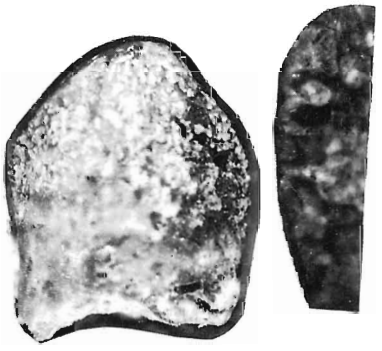

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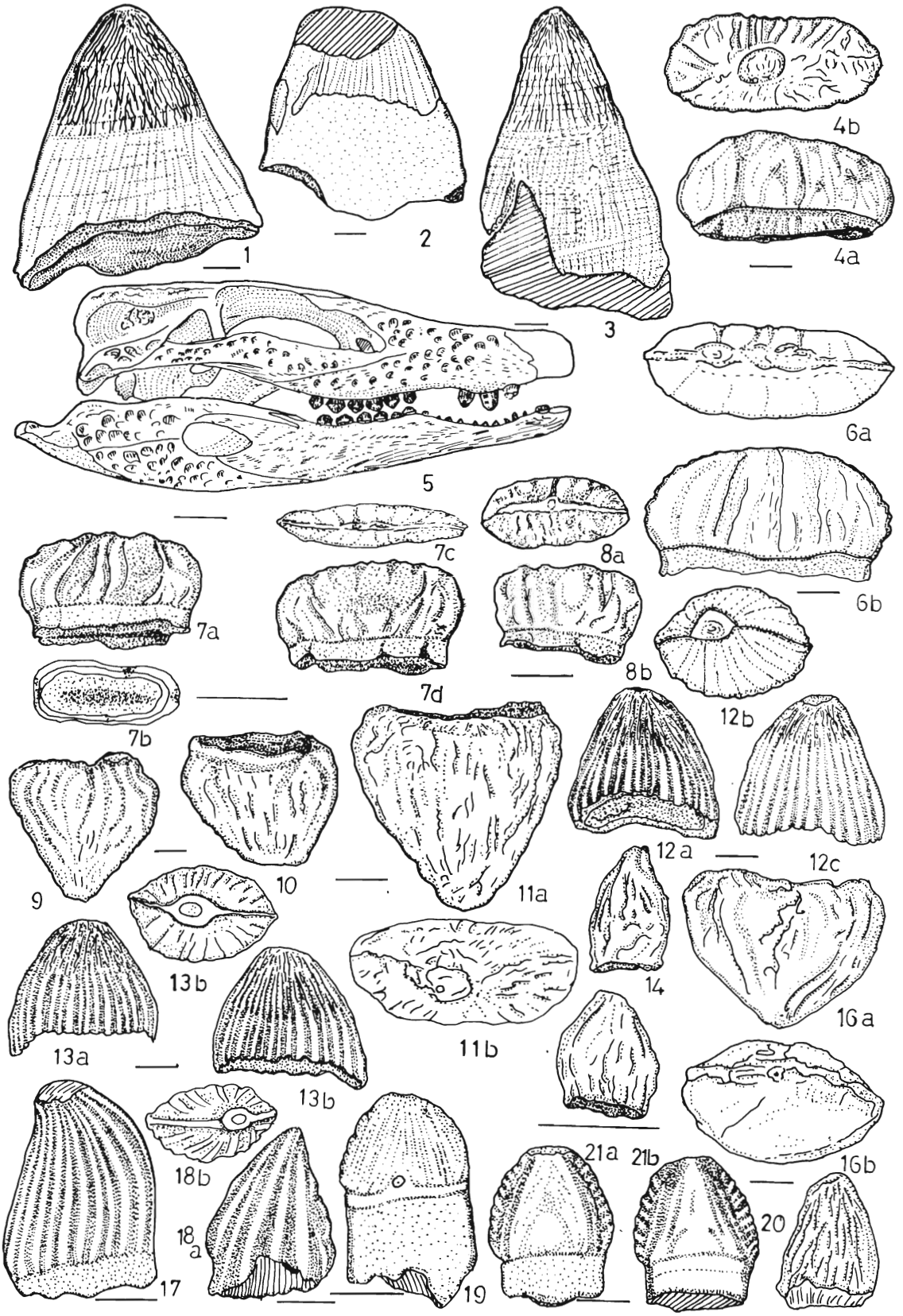
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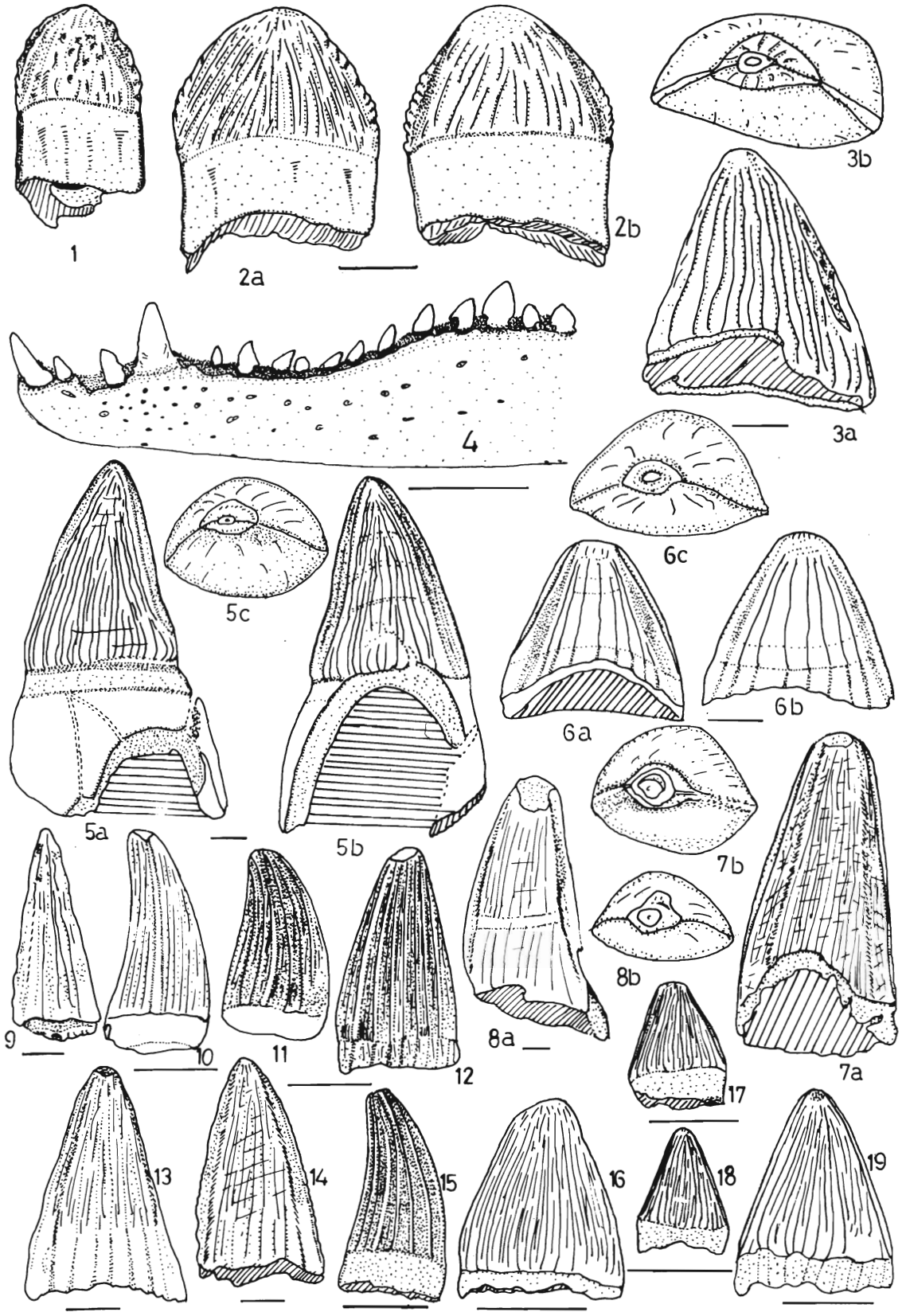
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