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Vertebrate faunas from the Indian Gondwana Sequence

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In the thick pile of continental sediments of the Gondwana Sequence of India, the vertebrate-bearing horizons occur at nine stratigraphic levels; three of these are in the Palaeozoic and six in the Mesozoic. A vertebrate sequence covering the period from Upper Permian to Lower Jurassic is now known from the Indian Gondwana Formations. A brief review of the vertebrate faunas with their stratigraphic and palaeogeographic significance has been presented.

Key-words—Vertebrate fauna, Gondwana stratigraphy, Palaeogeography, Permian, Lower Jurassic (India).

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सारॉंश

भारतीय गोंडवाना अनुक्रम से रीढ़धारी जन्तुजात

पी० पी० सत्संगी

भारतीय गोंडवाना अनुक्रम की मोटी सतह वाले अवसादों में नौ विभिन्न स्तरिकीय तलों में रीढ़धारी-धारक संस्तर मिलते हैं। इनमें तीन पुराजीवी कल्प के तथा शेष छः मध्यजीवी कल्प के हैं। भारतीय गोंडवाना शैल-समूहों से अब उपरि परमी से अधरि जुराई तक विस्तृत रीढ़धारी जन्तुओं से युक्त एक अनुक्रम ज्ञात है। रीढ़धारी जन्तुजातों के स्तरिकीय एवं पुराभौगोलिक महत्व की संक्षिप्त विवेचना भी प्रस्तुत की गई है।

IN the last three decades new continental faunas have been discovered and well-preserved and more complete specimens of already known faunas have been brought to light in the Gondwana Sequence of India. It has helped in determining the age of the bed containing them and their stratigraphic correlation.

In the Palaeozoic Gondwana the vertebrate fossil horizons have been found to occur at three stratigraphic levels, viz. (i) Lower Permian Mamal Formation (Vihi Bed) of Kashmir, (ii) Upper Permian stratigraphic unit from Pranhita-Godavari Valley, considered as equivalent of Motur Formation of Satpura Basin, and (iii) Late Permian basal beds of the Kamthi from Pranhita-Godavari Valley and its equivalent the Raniganj Formation of Damodar Valley and South Rewa Basin and Bijori Formation of Satpura Basin (Table 1).

In the Mesozoic sequence six stratigraphic levels have been recognised. The Triassic horizons are: (i) Lower Triassic Panchet Formation of Raniganj and South Karanpura coalfields and its equivalent the Mangli Bed of Wardha Basin, (ii) Middle Triassic Yerrapalli Formation of Pranhita Godavari Valley and Denwa Bed of Satpura, (iii) ?late Middle Triassic Bhimaram Sandstone, (iv) Early Late Triassic Maleri Formation of Pranhita-Godavari Valley and its equivalent Tiki Formation of South Rewa Basin, and (v) Late Triassic Dharmaram Formation of Pranhita-Godavari Valley (Table 2). The Lower Jurassic fauna is known from the Kota Formation of Pranhita-Godavari Valley.

Concepts, limits and extension of the Indian Gondwana
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Table 1—Correlation of Permian Gondwana formations of India

Age	*Area*	*Damodar Valley*	*Narmada Valley (Satpura Basin)*	*Son-Mahanadi Valley*	*Wardha-Pranhita-Godavari-Valley*	*Kashmir*
Late		Raniganj Formation*	Bijori Formation*	Kamthi Formation*	Kamthi Formation*	
Upper		Barren Measures/ Ironstone Shale	Motur Formation	—?—	Motur Formation*	
Lower		Barakar Formation Karharbari Formation	Barakar Formation Karharbari Formation	Barakar Formation Karharbari Formation*	Barakar Formation	Mamal Formation* Panjal Volcanics Nishatbagh Formation
		Talchir Formation	Talchir Formation		Talchir Formation	Agglomeratic slate

*Indicates vertebrate bearing horizons

PALAEOZOIC VERTEBRATE FAUNA

Lower Permian Fauna

The oldest horizon from which vertebrates have been reported from the Indian Gondwana formations is the Gondwana plant bed of Kashmir, commonly known as 'Gangamopteris bed' (Hayden, 1907). The first plant bed with Gondwana flora and vertebrates was discovered by Noetling (1902) at Risin in Vihi District. Later, plant beds were discovered at a number of places at different stratigraphic positions. Kapoor (1977) who examined the stratigraphic position of these plant beds observed that they occur at two stratigraphic levels: (i) at the base of the Panjal Trap, and (ii) overlying the Panjal Trap. The vertebrates have been found at widely scattered localities but in all the localities the vertebrate-bearing plant bed overlies the Panjal Trap. At Risin, from which most of the vertebrate fossils have come from, the Mamal Formation (Vihi Bed) (Singh *et al.*, 1982) directly underlies the marine Zewan Formation.

The vertebrates known from Mamal Formation of Kashmir include fishes and labyrinthodont amphibians. Woodward (*in* Seward & Woodward, 1905) identified species of palaeoniscoid genus *Amblypterus, A. kashmiriensis, A. symmetricus* and *Amblypterus* sp. from Risin. Gupta *et al.* (1978) described a new species, *Gardenerichthys tewarii* from the same locality. *G. tewarii* bears close resemblance to *G. latus* (= *Amblypterus latus*) known from Lower Permian of Saar Basin, Germany. It also shows affinity with the fishes described by Woodward but Gupta *et al.* (1978) are of the opinion that the fishes may not belong to *Amblypterus*. Gupta (1971) had recorded another fish *Phlyctaenichthys pectinatus* from Apharwat but no details of the same is available. *Phlyctaenichthys* is a genus of Redfelidae which are common in Triassic; the genus is reported from Middle Triassic of Australia (Romer, 1966, p. 353).

It may be pointed out that the fusiform palaeoniscoids though exhibit similarity in general appearance, yet vary considerably in structural details. The main diagnostic character of these primitive actinopterygians is the structure of the cheek, particularly in the suspensorium of the jaw apparatus which undergoes modification during evolution (Gardiner, 1963). In most of the specimens studied by Woodward, the skull region is either crushed or missing. It hardly needs emphasis that the revision of the fishes of the Mamal Formation is much desired in the light of the recent advances in the study of primitive actinopterygians.

The amphibians reported from the Mamal Formation are the rhachitomous labyrinthodonts. Amongst the long snouted forms two species of *Archaegosaurus, A. ornatus* Woodward (1905) and *A. kashmiriensis* Tewari (1962) are known. Romer (1947) considers the assignment of these Kashmir forms to *Archegosaurus* as uncertain since both the snout and the post-orbital regions are less elongated than the European form and the lateral lines are more conspicuous. It may be pointed out that the long snout is generally attributed to piscivorous habit and the lateral line grooves are related to aquatic habit of the animal. The relatively less elongated snout and conspicuous lateral lines in Kashmir specimens may be due to ecological factors (Tewari, 1962) and this possibility cannot be entirely ruled out.

Associated with these archeosaurids are eryopsids, *Actinodon risinensis* Wadia & Swinton (1928) and *Lyspipterygium deterrai* Branson (1935). The former is known from Risin and the latter from Zewan. Branson (1935) pointed out the possibility of *Lyspipterygium deterrai* being generically, if not specifically, identical with *Actinodon risinensis*. The comparison between the two is not possible because *Actinodon risinensis* is known from the skull roof alone and *Lyspipterygium deterrai* mainly by the palatal aspect of the skull, and only a part of the inter-orbital region of the skull roof is preserved.

Table 2—Correlation of the Triassic Gondwana formations

Age	*Area*	*Damodar Valley*	*Narmada Valley (Satpura Basin)*	*Son-Mahanadi Valley*	*Wardha-Pranhita Godavari Valley*
				Parsora Formation	Dharamaram Formation*
Upper			Bagra Conglomerate	Tiki Formation*	Maleri Formation*
Middle		Mahadeva Formation (Supra Panchet)	Denwa Bed*	? Mahadeva Formation*	Bhimaram Sandstone*
					Yerrapalli Formation*
Lower		Panchet Formation*	Pachmarhi Sandstone	Nidpur Bed	Mangli Bed*/ Kamthi Formation*

*Indicataes vertebrate bearing horizons.

Verma (1962) reported another labyrinthodont from Marahoma which he found to be similar to *Chelydosaurus* known from the Lower Permian of Bohemia. He referred it to a new species *Chelydosaurus marahomensis*. The specimen is far too incomplete for specific determination.

The vertebrate fauna akin to that of Mamal Formation is not known from any other part of Gondwanaland. It shows distinct European affinity. The labyrinthodont, *Archegosaurus* and *Actinodon* are common in the Lower Permian of Saar Basin in Germany and Autun Coal Basin of France. The palaeoniscoid fishes are also common in Permian of Europe and North America; *Garderinicthys* is known from the Lower Permian of Saar Basin in Germany. The vertebrate fauna from the Mamal Formation on the whole, indicates a Lower Permian age (Chakravarty, 1968). On the basis of the overlying marine Zewan beds and the underlying Agglomeratic Slates, the age of the Mamal Formation has been suggested as early Artinskian to Early Kungurian (Kapoor, 1977).

The presence of this fauna with strong European affinity at the northern fringe of India, in Kashmir, signifies infiltration from Laurasia. This is also supported by the presence of floral elements of northern affinity in plant beds of Kashmir (Kapoor, 1969; Srivastava & Kapoor, 1969).

The Mamal Formation is considered to be deposited near the coast as lagoonal, if not coastal deposit (Kapoor & Nakazawa, 1973). It is not improbable that the migration of the fauna from North might have taken place through isthmus links or dense archipelago in Kashmir region (Sahni, 1926; Wadia, 1938) or through development of island in the Tethyan region as suggested by Nakazawa *et al.* (1975).

Upper Permian Fauna

The next higher stratigraphic level in the Gondwana Sequence from which fossil vertebrates have been known is from a lithological unit in between the Kamthi and Barakar formations in northern part of Pranhita-Godavari Valley. It has lithological resemblance with the Motur Formation of Satpura Basin. The fauna is essentially a dicynodont assemblage in which a captorhinomorph reptile (Kutty, 1972) is also present. The dicynodonts include endothiodontids in which a species of the genus *Endothiodon* has been recognised. Another skull has been found to show affinities to *Cistecephalus*.

The presence of *Endothiodon* in association with *Cisticephalus* makes the fauna directly correlatable with *Cistecephalus* zones of Kitching (1977). It is difficult to compare the fauna with *Tropidostoma-Endothiodon* Assemblage Zone and *Aulacephalodon-Cistecephalus* Assemblage Zone of Keyser and Smith (1979) as details of the reptilian fauna from Pranhita-Godavari Valley is still not known. It may, however, be pointed out that so far both *Tropidostoma* and *Aulacephalodon* are known only from Africa. *Endothiodon* is reported from three Gondwana continents, i.e., from Rio do Rasto Formation of Parana Basin of Brazil, Beaufort Group of South Africa and Motur Formation of Pranhita-Godavari Valley. *Cistecephalus* is known from Madumabisa mudstone of the Luanzwa Valley in Zambia and Pranhita-Godavari Valley; a closely related genus *Kawingasaurus* is recorded from Kawinga Series of Ruhuku in Tanzania (Keyser, 1980). The two assemblage zones, the *Tropidostoma-Endothiodon* Assemblage Zone and the *Aulacephalodon-Cistecephalus* Assemblage Zone, are correlated with the *Cistecephalus* zone of Kitching (Keyser, 1980).

The association of the captorhinomorph reptile with the dicynodonts assemblage of Pranhita-Godavari Valley is significant as captorhinomorphs are mainly distributed in the Lower Permian of Europe and North America. The only exception is Nigeria (Taquet, 1969), where it is recorded from beds equivalent to *Endothiodon* and *Cistecephalus*

zones. The Nigerian *Moradisaurus* is a large form while the Indian form is very small.

Late Permian Fauna

From the succeeding stratigraphic units, namely, the Bijori Formation of Satpura Basin and the Raniganj Formation of Sidhi District, South Rewa Basin, labyrinthodont amphibians are recorded. Both the formations have yielded typical Raniganj flora suggesting a Late Permian age. A few scales of palaeoniscoid fishes have been noted from the Raniganj Formation of Raniganj Coalfield (Mukherjee & Ghosh, 1973).

The Bijori labyrinthodont is known by a skull and part of skeleton which was named as *Gondwanosaurus bijoriensis* (Lydekker, 1885). The form is apparently close to capitosaurs but could be best classified among the neorhachitomes. Romer (1966, p. 363) has preferred to group it under Benthosuchidae and assigned it an Eotriassic age.

The other labyrinthodont amphibian collected from the Raniganj Formation near Marhwas, Sidhi District, Madhya Pradesh, is preserved as a mould showing impression of the skull roof in which eye orbits are conspicuous. Tripathi (1962a) has identified it as a new species of *Rhinesuchus, R. wadiai*. The comparison of *R. wadiai* with *Gondwanasaurus bijoriensis* is not possible as the bones of the skull roof in the Bijori specimen are not preserved. Rhinesuchid labyrinthodonts are known from the Permian of East and South Africa.

Recently a reptile has been found within the sandstone of the Kamthi Formation near Jaipuram in Pranhita-Godavari Valley (GSI News, Coal Wing, January 1986). The animal is represented by a medium-size dicynodon skeleton in which the skull, though present, is not well-preserved. It is not improbable that the form represents a daptocephalid dicynodon. The presence of dicynodont, in the Kamthi Formation overlying the *Endothiodon*-bearing Motur Formation points to the possibility of the presence of the reptilian fauna of the *Deptocephalus* Zone of the Karoo Sequence in the basal part of the Kamthi Formation of Pranhita-Godavari Valley.

TRIASSIC VERTEBRATE FAUNA

Lower Triassic Fauna

The Triassic vertebrate fauna is known from the Panchet Formation of Raniganj and North Karanpura coalfields and its equivalent the Mangli Formation of Wardha Basin.

The Panchet vertebrate fauna has been studied by several workers (Huxley, 1865; Lydekker, 1885; Das Gupta, 1922, 1928; Von Huene & Sahni, 1958; Tripathi, 1962b, 1969; Tripathi & Satsangi, 1963; Satsangi, 1964). Brief reviews of the fauna have been made earlier by von Huene (1942), Chatterjee and Roy Chowdhury (1974) and Satsangi (1987).

The Panchet fauna is predominated by therapsid dicynodont genus, *Lystrosaurus*, alongwith the carnivorous cynodont reptile *Thrinaxodon*, the thecodont reptile, *Chasmatosaurus*, and a cotylosaurian reptile showing affinities with *Procolophon*. Associated with the reptiles are the labvrinthodont amphibians represented by brachiopod, lydekkerinid, early capitosaurid, and trematosaurid amphibians. The fishes are represented by palaeoniscoid referred to *Amblypterus* (White: *in* Gee, 1932, p. 59).

The labyrinthodont amphibians in the Panchet fauna vary from short-faced triangular brachyopid forms to elongated long snouted trematosaurid amphibians.

The short-faced labyrinthodont *Indobrachyops panchetensis* was considered to be a brachiopid by von Huene and Sahni (1958); Welles and Estes (1969) and Cosgriff (1969) excluded *Indobrachyops* from brachyopidae on the consideration that the posterior portion of the quadrate bone is almost in line with the occipital condyles, a character which is not found in brachiopods. They pointed out that the *Indobrachyops* lacks the arched palate, broad pterygoid and ectopterygoid tusks of true brachiopids and it may represent a capitosaurid amphibian. Cosgriff and Zowiskic (1979) have grouped it in rhytidosteoidea under a separate family Indobrachyopidae.

A true brachyopid, *Brachyops laticeps*, is however, known from Mangli Bed (Owen, 1855; Broom, 1915; Watson, 1956; Welles & Estes, 1969) which is correlated with Panchet Formation (Fox, 1931). This correlation is also supported by the conchostracans.

Tripathi (1969) recognised new forms of labyrinthodont amphibians in the Panchet fauna showing affinity with Russian neorhachitome genus *Benthosuchus* and the Spitsbergen form *Lyrocephalus*. He also identified a new species of *Lydekkerina*, a rhinesuchid labyrinthodont, commonly known from the *Lystrosaurus* zone of South Africa.

The trematosaurid amphibian *Gonioglyptus* recorded from the Panchet Formation of Raniganj Coalfield (Huxley, 1865; Tripathi, 1969) is also known from the Lower Triassic *Prinolobus* Bed of Salt Range (von Huene, 1920). A specimen of the skull figured by Tripathi (1969, pl. 11, figs 4, 5) represents the anterior part of the skull of *Gonioglyptus*. Comparing it in association with the

skull fragments described by Huxley (1865) and von Huene (1920), it gives a fair idea of the elongated snout of *Gonioglyptus* which shows close similarity to *Aphaneramma* known from the Early Triassic.

The most dominant, abundant and characteristic fossil of the Panchet fauna is *Lystrosaurus*. It is known by atleast four species namely, *L. murrayi, L. platyceps, L. maccaigi* and *L. rajurkari* (Tripathi & Satsangi, 1963; Colbert, 1974). The first three species are common in South Africa, Antarctica and India. *Lystrosaurus* is also known from China (Yuan-Young, 1934) and probably from Indo-China (Cluver, 1971).

The other associated therapsid is the carnivorous cynodont reptile *Thrinoxodon* very much similar to *Thrinoxodon liorhinus* known from the Lower Triassic *Lystrosaurus* zone of South Africa and Fremouw Formation of Antarctica (Satsangi, 1987). The Panchet cynodont is represented by a single specimen of a well-preserved skull with attached lower jaw. The sutures of the bones on the skull roof are not fused completely and the animal appears to be an young individual. The snout region of the skull is relatively long and slender as compared to *Thrinoxodon liorhinus*. The Antarctic forms of *Thrinoxodon* are large and robust.

The other common reptile in the Panchet fauna is the thecodont *Chasmatosaurus* (von Huene, 1942; Hughes, 1963; Satsangi, 1964). It is represented by a single species, *Chasmatosaurus indicus* von Huene. The association of *Chasmatosaurus* with *Lystrosaurus* has been known from the *Lystrosaurus* zone of South Africa, Fremouw Formation of Antarctica and Thungushan Formation of Sinkiang and Wuhsiang beds of Shansi in China (Young, 1958). A cotylosaurian reptile referable to procolophnid is also recorded in the Panchet fauna (Tripathi, 1962b) but the details are not known.

The presence of the dominant dicynodont genus *Lystrosaurus* in the Panchet Formation in association with *Thrinoxodon* and *Chasmatosaurus* makes it directly correlatable with the Lower Triassic *Lystrosaurus* zone of the Karoo Sequence of South Africa and the Fremouw Formation of the Beacon Group of Antarctica. The presence of atleast three common species of *Lystrosaurus* in Africa, Antarctica and India strongly supports closer land connection among these continents forming continuous landmass as part of Gondwanaland during Early Triassic. The occurrence of *Lystrosaurus* in China and also probably in Indo-China indicates the possibility of these areas being part of the Gondwanaland (Colbert, 1974). *Lystrosaurus*, though adopted to semiaquatic habitat, was essentially a denizen of land. It was incapable of crossing large sea and therefore its presence in China and Indo-China could be explained either by accepting these areas to be part of Gondwanaland or assuming a long migration route from Africa to Laurasia through Spanish-Moroccan region and then to further east into China (Colbert, 1974).

Middle Triassic Fauna

In the Pranhita-Godavari Valley all the stratigraphic units of the Gondwana Sequence overlying the Kamthi Formation have yielded vertebrates. The vertebrate fauna equivalent to the Lower Triassic Panchet fauna has so far not been recorded from Pranhita-Godavari Valley. The earliest undoubted Triassic horizon is the Yerrapalli Formation.

The Yerrapalli fauna, distinct from the Maleri fauna, was discovered by Jain *et al.* (1964). It consists of fishes, the *Saurichthys* (Jain, 1984) and the dipnoan, *Ceratodus*. The labyrinthodont amphibians are represented by the capitosaurid *Parotosaurus rajareddyi* (Roy Chowdhury, 1970a) and a brachyopid. The reptiles are the rhynchosaur, *Mesodapedon kuttyi* (Chatterjee, 1980), a triracodontid cynodont and the dicynodonts *Wadiasaurus indicus* and *Rechnisaurus cristarhynchus* (Roy Chowdhury, 1970b). Two archeosaurs and a prolacertid similar to *Tanystrophèus* have also been recorded.

The Yerrapalli stahlekeriid dicynodont *Rechnisaurus* is comparable to *Dinodontosaurus* from the Middle Triassic of South America (Colbert, 1984) and Middle Triassic Natware Formation of Zambia (Roy Chowdhury 1970a, b; Crozier, 1970; Cox, 1969). The rhynchosaur *Mesodapedon* is close to the form reported from the Middle Triassic Manda Formation of Tanzania (Chatterjee, 1980).

The capitosaurid *Parotosaurus rajareddeyi* has been shown to be more advanced than typical Lower Triassic forms like *P. nasutus* from Bunter of Germany and *P. haughtoni* from the *Cynognathus* zone of South Africa. It is more close to *P. pronus* from the Middle Triassic Manda Formation of Tanzania in the nature of the tabular horns (Roy Chowdhury, 1970a, b). The Yerrapalli fauna is closer to Middle Triassic though it contains common form of *Cynognathus* zone fauna like *Saurichthys*.

The other horizon which is now considered equivalent of the Yerrapalli Formation is the Denwa Bed of Satpura Basin where a specimen of a tabular horn of *Parotosaurus* has been recorded by Chatterjee and Roy Chowdhury (1974). The semi-closed nature of the otic notch of the specimen is a character present in the Middle Triassic species of *Parotosaurus*. It is also seen in *P. rajareddyi* known from the Yerrapalli Formation. The Denwa Bed was earlier equated with the Maleri and Tiki formations

on the basis of the presence of *Mastodonsaurus indicus* Lydekker (1885). Chatterjee and Roy Chowdhury (1974) have shown that the identification of *Mastodonsaurus* was based on insufficient diagnostic characters and therefore it should be abandoned.

From Nidpur area in Singrauli Basin fish fragments showing thick ganoid scales have been reported by Ghosh, Singh and Shah (personal communication) from the beds overlying the *Dicroidium* bearing Lower Triassic Nidpur beds. The scales are not the palaeoniscoid type found in the Permian Mamal and Raniganj formations and in the Lower Triassic Panchet Formation.

?Late Middle Triassic Fauna

The Bhimaram Sandstone overlying the early Middle Triassic Yerrapalli Formation and underlying the early Upper Triassic Maleri Formation, is considered to be of ?late Middle Triassic age. The vertebrates recorded from this horizon are labyrinthodont and dicynodont (Kutty, Jain & Roy Chowdhury, 1987, p. 41), the details of which are still not known.

Upper Triassic Fauna

The vertebrate fauna from Maleri Formation of Pranhita-Godavari Valley and its equivalent Tiki Formation of Son-Mahanadi Valley contains some common identical forms. The fishes include the lang fish *Ceratodus* represented by four species (Jain, 1968); a subholostean and the pleurocanth shark, *Xenacanthus indicus* (Jain, 1980). The labyrinthodont amphibian is known by the solitary form *Metoposaurus maleriensis* (Roy Chowdhury, 1965). The reptiles are represented by the cynodont *Exaeretodon statiscae* (Chatterjee, 1982), the protosaurian *Malerisaurus robinsoni* (Chatterjee, 1980), the phytosaur *Parasuchus hislopi* (Chatterjee, 1978) and the rhynchosaur *Paradapedon huxleyi* (Chatterjee, 1974). Besides, the fauna also contains pseudosuchians scutes similar to *Typothorax* and a possible coelurosaurian dinosaur (Jain & Roy Chowdhury, 1987).

The most common forms of the Maleri and Tiki fauna are the metoposaurs, the rhynchosaurs and the phytosaurs. The Maleri amphibian *Metoposaurus* is similar to those known from Germany and is identical with the North American form *Eupelor*. The genus *Metoposaurus* is known from the Upper Triassic beds of North America and Germany, equivalent to Schilfsandstein through Stubensandstein (Roy Chowdhury, 1965).

The rhynchosaur *Paradapedon* was considered as an advance form and grouped with *Hyperodapedon* of Scotland and *Scaponyx* of South America in the sub-family Hyperdapedontinae by Chatterjee (1969). He subdivided the family Rhynchosauridae into three sub-families: the Mesosuchinae, Rhynchosaurinae and Hyperodapedontidae representing three stages of rhynchosaur evolution. These stages are considered characteristic of Lower, Middle and Upper Triassic respectively.

The phytosaur *Parasuchus* is similar to *Palaeorhinus*, a North American form known from the lower part of the Upper Triassic. Chatterjee (1978) on the basis of the evolutionary level of the Maleri phytosaur indicated a Carnian age to the Maleri Formation.

A podokesaurid theropod, *Walkeria maleriensis*, has recently been reported by Chatterjee (1987) which is very similar to *Coelophysis* of North America and *Procansoguathus* of Germany and *Syntarsus* of Zimbabwe and North America. This is the earliest known dinosaur from the Asia.

The Maleri fauna was considered to be of lowermost Upper Triassic age by von Huene (1942) who pointed out the strong relationship of the Maleri Labyrinthodont and phytosaur to the forms of the Northern Hemisphere. Colbert (1958, 1984) also indicated the close affinity of the Maleri fauna with the faunas known from the Keuper of Europe and North America.

Late Triassic Fauna

The fauna from the Dharamaram Formation which overlies the Maleri Formation in Pranhita-Godavari Valley is characterised by an archosaur fauna consisting of prosauropods. These are represented by one large plateosaurid and another archosaurid (Jain & Roy Chowdhury, 1987). The typical members of the Maleri fauna are not present. The fauna has been considered to be Late Norian and Rhaetian in age by Kutty (1969) who compared the changes between Dharamaram and Maleri faunas to be much similar to those seen between Knollenmergel and Rhätsandstein of Germany and their equivalents.

Lower Jurassic Fauna

The Lower Jurassic vertebrate fauna is known from the Kota Formation of the Pranhita-Godavari Valley. It consists of fishes, sauropod dinosaur, pterosaur, crocodiles and mammals. The fishes are represented by seminotids, a coelocanth and pholidophorids. The seminotids are known by three

forms: *Lepidotes deccanensis, Paradapedium egertoni* and *Tetragonolepis oldhami*. These seminotids resemble very much with Liassic marine forms of Europe. *Lepidotes deccanensis* is much similar to *L. elevensis* which is known from the Upper Liassic. *Paradapedium* (Jain, 1973) is closer to *Dapedium* which is reported from Rhaetic to Upper Liassic. The presence of *Pholidophorus* in Kota fauna was first recognised by Satsangi and Shah (1973) and later two species, *P. indicus* and *P. kingii* have been described by Yadagiri and Prasad (1977). Pholidophorid fishes are common in the European Liassic. The coelocanth, *Indocoelocanthus robustus* Jain (1974a) is not known elsewhere. Thus, on the basis of the seminotolid and pholidophorid fishes the age of the Kota Formation is Liassic.

The dinosaurs reported from the Kota Formation are the best known sauropods from the Lower Jurassic anywhere in the world (Jain *et al.*, 1975, 1979; Yadagiri *et al.*, 1979). Two forms of sauropods have been recognised: one is named as *Barapasaurus tagorei* (Jain *et al.*, 1979) which is one of the best known sauropod from the Lower Jurassic and another an unnamed form which is closer to prosauropods (Yadagiri *et al.*, 1979). A pterosaur was noted by Rao and Shah (1963) in the Kota Formation. Jain (1974b) recorded another specimen of pterosaur which he named as *Campyglognathoides indicus*. The genus is also known from the Liassic Hoezmaden deposits of southern Germany (Colbert, 1979).

The crocodilian remains recorded by Owen (1852) have been referred to Teleosauridae (Buffetant, 1979) who has suggested that the Kota crocodiles may represent the earliest member of the group like those known from Chile.

One of the significant addition to the Kota fauna are the Early Jurassic mammals. The record of Mesozoic mammals is extremely poor from the southern continents. The forms discovered by Datta *et al.* (1978) from Kota are referable to symmetrodonts. Datta (1981) described a new form of symmetrodont *Kotatherium haldeni* and later Yadagiri (1984) added two more new forms, *Trishulotherium kotensis* and *Indotherium pranhitai*. Yadagiri (1985) described a new amphidontid symmetrodon, *Nakunodon paikasiensis*, from the Kota Formation. The relationship of the Kota symmetrodonts with other Jurassic mammals is still not clear. Yadagiri (1986) recorded fresh water hybodontid Shark, percoid fishes, urodele and palaeobatid amphibians and sphanodontid and platynoid reptiles from the Kota Formation.

From Gangapur Bed which overlies the Kota Formation in Pranhita-Godavari Valley and is considered to be Lower Cretaceous in age, fish-scales have been reported. No other recognisable vertebrate is known from the Lower Cretaceous sediments.

CONCLUSION

A vertebrate faunal succession covering the period from Upper Permian to Lower Jurassic is now known from the Indian Gondwana. Six of the vertebrate faunas in this succession are well represented and are directly correlatable with similar faunas known elsewhere.

The aquatic and semiaquatic vertebrate fauna known from the Mamal Formation of Kashmir has distinct affinity with the Lower Permian fauna of Europe and North America. The presence of this fauna suggests a close proximity of this part of Gondwanic India to Laurasia in Lower Permian allowing free migration of tetrapods from Laurasia through island connections.

The discovery of characteristic reptilian genera of South African Karoo Sequence in the Indian Gondwana permits direct correlation of this part of the Permian-Triassic Sequence with the well known reptilian biozones: *Endothiodon, Cistecephalus, Daptocephalus* (?) and *Lystrosaurus* zones of the Karoo Sequence. It also points out to the close connection between South Africa and India during Upper Permian and Lower Triassic.

The occurrence of common species of *Lystrosaurus* in South Africa, Antarctica and India provides strong evidence of contiguity of these land masses during Lower Triassic. The presence of *Lystrosaurus* in China and Indo-China (?) supports the idea of these areas being part of Gondwanaland during Lower Triassic.

The dominance of fauna of northern affinity over the southern genera in the Maleri fauna indicates a palaeontological link between India and Laurasia during Upper Triassic time.

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