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Biodiversity of Saurischian Dinosaurs from the Latest Cretaceous Park of Pakistan

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From first fossil to about three thousand fossilized bones/ pieces of bones of dinosaurs have been collected by me from the Latest Cretaceous (70-65 million years before) Vitakri member/Dinosaur beds of upper part of Pab Formation, Barkhan, Dera Bugti, Kohlu and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan. The studies of collected caudal centra, femora, and tibiae show the number of taxa of dinosaurs, although most of the bones were fragmented but are well preserved. Most of the bones are found on or just near the in situ deposition in the overbank red muds. The down ward transportation after the exposure is very small and a few metre only. At many localities most of the bones are found together representing their association. Many localities deserve excavation for exploration of articulated bodies of these exceptional large animals.Titanosaurian synopomorphies are observed as procoelous caudals, forward insertion of neural arches on caudals; a prominent olecranon process on ulna; pneumatic/spongy texture of illia, cervical and dorsal vertebrae; and external nares retracted backward. Two families of sauropod Titanosauria as Pakisaurids (Titanosaurids) and Balochisaurids (Saltasaurids) are identified on the basis of morphology of caudals, femora and tibiae. Late Jurassic limb fossils represent one genus and species *Brohisaurus kirthari* of Pakisaurids (Titanosaurids). Latest Cretaceous caudal vertebrae represent three genus and species *Pakisaurus balochistani, Sulaimanisaurus gingerichi* and *Khetranisaurus barkhani* of Pakisaurids (Titanosaurids); and two genus and species *Marisaurus jeffi* and *Balochisaurus,* of Balochisaurids (Saltasaurids). One genus and species *Vitakridrinda sulaimani* of Latest Cretaceous Abelisaurids theropod dinosaur is established on the basis of partial skull, some vertebrae and a pair of proximal femora.So far the Late Cretaceous Lameta Formation of India has served as the sole source of information on Cretaceous vertebrates of Indo-Pakistan sub-continent and their remains are inadequate for assessing generic-level affinities but the new discoveries from Pakistan have produced a large number of well preserved fossils and are useful for paleobiogeographic reconstruction and phylogeny.

Key words: Biodiversity, 5 titanosaurs, 1 abelisaur, dinosaurs, late Cretaceous Park, Pakistan.

Introduction

Sauropods were the largest terrestrial vertebrate (Figure 23b) and dominant mega herbivorous group throughout 140 million years of the Mesozoic, constituting approximately one-fourth of known dinosaur genera. Titanosaurs comprise nearly half of all known sauropod genera and were the only sauropod lineage to survive to the end of the Cretaceous.

The Titanosauria are regarded as the most advanced of the sauropod dinosaurs. Restricted to the Cretaceous, they were first recorded from central India (Hislop, 1864; Falconer, 1868; Lydekker, 1877, 1879). In 1841 Richard Owen described the scattered remains of first Sauropod known to science as Cetiosaurus or whale lizard. Since that time abundant Sauropod remains have been discovered on every continent except Antarctica. Sauropods constitute a major proportion of the large herbivores in most continental faunas of Jurassic and Cretaceous age (Wilson and Sereno, 1998). Gingerich, et al. (2001) reported tertiary mammals like whale from Pakistan but dinosaur discoveries from Pakistan are first and new.

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The Titanosauria are regarded as the most advanced of the sauropod dinosaurs. Restricted to the Cretaceous, they were first recorded from central India (Hislop, 1864; Falconer, 1868; Lydekker, 1877, 1879). In 1841 Richard Owen described the scattered remains of first Sauropod known to science as Cetiosaurus or whale lizard. Since that time abundant Sauropod remains have been discovered on every continent except Antarctica. Sauropods constitute a major proportion of the large herbivores in most continental faunas of Jurassic and Cretaceous age (Wilson and Sereno, 1998). Gingerich, et al. (2001) reported tertiary mammals like whale from Pakistan but dinosaur discoveries from Pakistan are first and new.

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Barkhan, Dera Bugti, Kohlu and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan. First time in Pakistan I found a fossil of distal femur of titanosaurian sauropod dinosaur during early 2000, at the start of new millennium, and first time published in December 2000 from Geological Survey of Pakistan (Malkani and Anwar, 2000). Professor Philip D. Gingerich of Michigan University congratulated the GSP for this first ever dinosaur discovery from Pakistan and requested to DG, GSP for the visit of dinosaur locality. During late 2000, Gingerich visited Pakistan for previously running project of Eocene whale. On his visit to Vitakri dinosaur locality, I showed him the in-situ fragmentary bones. About 100 bones/pieces of bones of Sangiali Kali Kakor locality/Dinosaur Locality (DL-1) are sent to Museum of Paleontology, University of Michigan, USA.

I collected further 1500 bones/pieces of bones from 25 localities in Sulaiman foldbelt, administratively located in the areas of Barkhan, Kohlu, Dera Bugti, and Dera Ghazi Khan districts, Balochistan and Punjab Provinces during early 2001. Dr Jeffery A Wilson, from Museum of Paleontology, University of Michigan, USA visited the GSP museum during March, 2001 to see the collection by author whereas Dr. David A. Krauss of Boston College, USA visited the GSP museum and Vitakri locality during mid of 2001. For the second time the research on dinosaur fossils are published in September, 2001 from Journal of Vertebrate Paleontology, USA (Malkani, Wilson and Gingerich, 2001). Research on a rostrum and anterior dentaries of mesueucrocodylia discovered by me, which is first diagnostic from Indo-Pakistan subcontinent, have been published in December, 2001 from Museum of Paleontology, University of Michigan, USA (Wilson, Malkani and Gingerich, 2001). I collected additional 1200 bones/ pieces of bones during mid of 2001, from Sulaiman fold and thrust belt.

During 2003 the research on the discovery of partial skull of *Marisaurus* (Malkani, 2003a), armour bones of Titanosauria (Malkani, 2003b), and Late Jurassic dinosaur (Malkani, 2003c) have been published from Centre of Excellence, University of Peshawar. During 2004 the research on taxonomy of Late Cretaceous collected fossils (Malkani, 2004a,b,c) are presented on the occasion of fifth Pakistan Geological Congress, Islamabad. Malkani (2005a) reported a comprehensive report on Saurishian dinosaurs from the Late Cretaceous of Pakistan. Malkani (2005b) reported a new *Marisaurus* from Alam Kali Kakor Locality of Vitakri area. Wilson, Malkani and Gingerich, (2005) have reported a braincase of titanosaurian sauropod discovered by me from Top Kinwa Kali Kakor locality of Vitakri area, Barkhan District, Balochistan. Malkani (2006a-g) reported diversity of Saurischian dinosaurs (abstract); lithofacies and lateral extension of Latest Cretaceous Dinosaur beds from Sulaiman foldbelt; discovery of a Rostrum of *Balochisaurus* Titanosauria; discovery of an Atlas-axis complex of Titanosauria; cervicodorsal, dorsal and sacral vertebrae of Titanosauria; first Rostrum of Carnivorous Vitakridrinda (Abelisaurids Theropod dinosaur); and findings of Appendicular assemblages of Latest Cretaceous titanosaurian sauropod dinosaurs.

Further more the research papers are in review on the finding of trackways of sauropod dinosaurs confronted by a theropod found from the Middle Jurassic Samanasuk Limestone of Pakistan; wide gauge locomotion argued from skeletal morphology of Late Cretaceous Pakistani Titanosauria; localities of dinosaurs from the Late Cretaceous Pakistan; confrontation scenario between two theropod dinosaurs argued from the discovery of a rostrum of *Vitakridrinda*; and paleobiogeography of titanosaurian and abelisaurian dinosaurs from Pakistan. Biodiversity of saurischian dinosaurs from the latest Cretaceous Park of Pakistan are presented here.

Geological and Stratigraphical Setting

The study area of Sulaiman fold belt is located in the Central part of Pakistan (Fig.1). Latest Cretaceous (Maestrichtian) dinosaurs are hosted by the Pab Formation of Sulaiman fold belt. The Cretaceous Sediments in the study area underwent considerable tectonic deformation during the collision of Asian and Indo-Pakistan continental plates that commenced in the Middle to Early Late Cenozoic. As a result dinosaur beds along with other formations have been folded and thrusted. The lateral extension of dinosaur beds of the Pab formation have been observed in the major four anticlinoriums generally trending NNE to SSW however the western part of Dhaola and Mari Bohr anticlines trend E-W forming lobate belts. The four major anticlinorium (Figure 4) are; 1. Vitakri-Mari Bohri anticlinorium 2. Dhaola anticlinorium 3. Phulali anticlinorium 4. Fort Munro anticlinorium.

The Sulaiman foldbelt consists of sedimentary rocks ranging in age from Jurassic to Recent (Fig. 2,3). The sedimentary rocks consist of shale, limestone sandstone, siltstone, marl and conglomerate and are divided into different lithostratigraphic units in ascending order. These are the Jurassic Sulaiman group representing Spingwar, Loralai and Chiltan formations Cretaceous Parh group representing Sember, Goru and Parh formations, the newly proposed Fort Munro group representing Mughal Kot, Fort Munro and Pab formations; Paleocene Ranikot Group representing Khadro, Rakhi Gaj and Dungan formations; Eocene Ghazij Group represents Shaheed Ghat, Toi, Drug and Baska formations; the newly proposed Kirthar group represents Habib Rahi, Domanda, Pir Koh and

Drazinda formations, Oligocene-Pliocene Vahoa (newly proposed) group represents Chitarwata, Vahoa, Litra and Chaudhwan formations, Pleistocene Dada Formation, Subrecent and Recent fluvial, eolian and colluvial deposits (Malkani, 2004c, 2006b).

Materials and Methods

The data presented here have been deduced from the discovered and collected (about 3000) fossilized bones/ pieces of bones of Saurischian dinosaurs by me from the late Cretaceous Park of Pakistan, and research papers on these assemblages. The traditional methodologies for paleontological investigations as descriptive, comparative and interpretive aspects have been used.

Fossils and Characters Scoring

The fossil remains are found in the Dinosaur beds/ Vitakri member of upper part of Pab Formation, partly as scattered and partly together. Most of these bones are found on the host red clay horizons. The clays are soft and easily erodeable than the overlying and underlying resistant sandstone beds. The petrification processes of fossils show the enrichment of irons and increase of hardness. Replacement level of Jurassic dinosaur fossils found from Khuzdar area, are more than the Late Cretaceous dinosaur fossils found from Barkhan area. Some bones are broken and dispersed which may be due to scavenging animals, bacterial action, and weathering effect. Most of the bones are well preserved, which show the rapid burial shortly after the death of animals. The paleoenvironments of Dinosaur beds is deduced as meandering river and overbank deposits which may cause some transportation of bones. The associations of crocodiles with the dinosaurs show the aquatic and over bank environments at the time of deposition. The fossils are direct evidence where as their foot prints are indirect evidence of life in the past.

The first ever collected materials of Late Cretaceous Titanosaurs from southern part of central Sulaiman Range include cranial part as partial skulls, braincase, fragments of dentary rami, axial elements as partial atlas-axis complex, cervical, dorsal and caudal vertebrae, ribs and chevron; and appendicular elements as pectoral limbs partial scapula, humerus, ulna, radius and meta carpals; pelvis girdle as partial illium, pubis, ischium, femur, tibia, fibula and meta- tarsals and ungual. Along with these elements dermal armor bones, fragments of coprolite were also collected. The Late Jurassic material includes the partial cross section of femur/ humerus, ribs, meta carpals/metatarsals, neural spine and vertebral lamina and proximal fibula, may belong to titanosauria; a foot print of sauropods on middle Jurassic limestone; and a impression of solution weathering or backbone i.e., vertebrae and alongwith ribs of marine dinosaurs in middle Jurassic Chiltan limestone from Khuzdar area. The Cretaceous archosaurs remains from Khuzdar area are, one half of egg of dinosaurs or crocodiles, distal neural spine or rib of dinosaurs, ribs of crocodile, possible shape of cross section of leg of carnivore dinosaur due to hollowed nature.

The character observed in Pakistani Titanosaurs are: procoelous anterior, middle and posterior caudals (Fig. 5-12); deep to broad haemal canals; plate like distal ischia; dorsal vertebrae lacking hyposphen-hypantrum articulations, anterior (without anteriormost) and middle caudal centra have ventral longitudinal groove/hollow (Fig. 5-12): in one species (*Khetranisaurus*) possibly no ventral groove in caudals; procoelous cone shaped caudal centra (Fig. 5-12); in two cases the first caudal is biconvex (Fig. 5-12); anteroposteriorly elongate cervical parapophyses; posterior dorsal neural arches with parapophyses above the level of prezygapophyses; two types of chevron such as anteroposteriorly compressed distal caudal chevron and laterally compressed distal caudal chevrons; cervical centra broader than long; atlantal intercentrum, occipital facet shape expanded anteroventrally in lateral view, anteroposterior length of dorsal aspect shorter than that of ventral aspect; cervical and dorsal centra are opisthocoelous; neural spine is single, not bifid; external nares retracted backward having synapomorphy of Macronaria; posterolateral processes of premaxilla and lateral processes of maxilla shape with mid line contact (Fig. 21a,b); palatine lateral ramus, rod shape narrow maxillary contact (Fig. 21a); U shaped anterior portion of tooth rows (Fig. 21a,b); tooth crowns, narrow; tooth crowns orientation, aligned along jaw axis, crowns do not overlap (Fig. 21a,b); tooth crowns cross sectional shape, subcyliderical/subrounded to subelliptical; wrinkled enamel surface texture (Fig. 21a,b); marginal tooth denticles absent; premaxillary teeth, 4; maxillary teeth, possibly 13 (Fig. 21b) ; dentary teeth number seems to be fewer or less than 17; presacral and sacral bone texture, spongy with large open internal cell; presacral centra having pleurocoels (pneumatopores); cervical pleurocoel, simple, not divided; anterior caudal centra, pleurocoel absent; anterior caudal centra, length approximately same; anterior caudals transverse processes, proximal depth, shallow / deep, extending from centrum to neural arch; anterior caudals transverse processes, two type, shape, triangular, tapering distally,/ winglike not tapering distally; dorsal ribs, proximal part spongy and distal massive; chevron seems to be simple, without crus; scapular blade, distal portion expanded; humerus, having low deltopectoral crest; humerus shaft cross section shape, elliptical; Ulnar proximal condyle shape, triradiate (Fig. 20a,b); ulna, prominent olecranon process (Fig. 20a,b); radial distal condyle shape, subractangular, flattened posteriorly and articulating in front of ulna; radius distal breadth is twice midshaft breadth; radius distal condyle orientation, beveled approximately 20 degree proximolaterally; illium Pubis peduncle size small; ischial distal shaft, shape blade like, medial and lateral depth are subequal; ischial distal shaft, cross sectional shape, flat nearly coplanar; elliptical femoral shaft; femoral shaft, proximal one third deflected medially (Fig. 16b); femoral distal condyles, two types, subequal and tibial much broader than fibular (Fig. 17a,b); Tibial proximal condyles (Fig-18a,b), two types, one type shape narrow, long axis anteroposterior, second type expanded transversely, condyle subcircular; tibial cnemial crest, orientation, projecting laterally; Tibial distal breadth, approximately 125% and more than twice midshaft breadth;Tibial distal posteroventral process, two type (Fig.21a), size, broad transversely, covering posterior fossa of astragalus, shortened transversely, posterior fossa of astragalus visible posteriorly; fibula, proximal tibial scar, well marked and deepening anteriorly (Fig.19b); fibular distal condyle, size, expanded transversely more than twice midshaft breadth; spongy/pneumatic cavities in illia, atlas-axis coplex, cervical, dorsal and sacral vertebrae; osteoderms and armour (four types) bones; and pieces of coprolites are found.

SYSTEMATIC PALEONTOLOGY

Dinosauria Owen 1842
Order Saurischia Seeley 1888
Infraorder Sauropoda Marsh 1878
Titanosauria Bonaparte & Coria 1993

Family **Pakisauridae**
(Titanosauridae)
Lydekker 1885
Genus and Species
Pakisaurus balochistani
Malkani 2004a
Sulaimanisaurus gingerichi
Malkani 2004a
Khetranisaurus barkhani
Malkani 2004a

Balochisauridae
(Saltasauridae)
Powell 1992

Marisaurus
Malkani 2003a
Balochisaurus
Malkani 2004a

Theropoda
Abelisauria
Abelisauridae
Bonaparte & Novas 1985

Vitakridrinda sulaimani
Malkani 2004a

Titanosaurian Sauropoda

1, Pakisaurus balochistani Malkani 2004a

Holotype; MSM-11-4 to MSM-14-4, Four fragmentary but seem associated caudal vertebrae (Figure (Fig.) 5-8). The holotype specimens are housed in the Museum of the Geological Survey of Pakistan, Quetta..

Referred specimens; MSM-15-15, MSM-16-2 and MSM-17-16. Three fragmentary caudal vertebrae (Fig.5-8).

Horizon and locality; Holotype specimens are collected from Kinwa Kali Kakor locality of Vitakri area (Dinosaur locality number/DL-4, Figure 7, 9), and referred specimens are collected from Bor Kali Kakor locality (DL-2), Mari Bohri locality (DL-15), Top Kinwa Kali Kakor locality (DL-16) of Vitakri area, Barkhan district, Balochistan. These specimens are housed at the Museum of Geological Survey of Pakistan, Quetta. The host horizon of dinosaurs is the Vitakri member/ Dinosaur beds of upper part of Pab Formation of central Sulaiman foldbelt, Barkhan, Dera Bugti and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan (Fig. 1-4, 22a,b).

Age; Vredenburg (1908) reported *Orbitoides (Lepidorbitoides) minor* of early Maestrichtian age from the lower part of the Pab Formation in Rakhi Nala. Williams (1959) recorded a mixed benthonic-pelagic assemblage of foraminifers of Maestrichtian age from the type locality (Pab Range). Hunting Survey Corporation (1961) reported two collections, one of them of "Senonian-Maestrichtian" ages. On the basis of these data, a Maestrichtian age is assigned to the Pab Formation (Fatmi, 1977). Thus age of the dinosaur beds is the Late Cretaceous (Maastrichtian).

Etymology; *Paki,* from Pakistan, which is the country of origin; ***saurus*** means reptiles. The species epithet ***balochistani*** refers to the province of origin as Balochistan.

Diagnosis; A medium to large sized dinosaur sharing with the **Titanosauria**; as procoelous caudals, forward insertion of neural arches on caudals and a prominent olecranon process on ulna. **Pakisaurids/Titanosaurids** represents the long, flat sided to slightly concave, and tall/squarish/transversely greater width than ventrodorsal width of anterior caudals (except some anteriormost caudals) and mid-caudals; the ratio of mid-dorsal width to mid-ventral width of mid and posterior caudals is about 1; slender femora; narrow elongated anteroposteriorly proximal tibiae; elongated lateral (anteroposterior) width (5^{th} night lunar shape) of distal tibiae; and mid-mediolateral width is less than mid-anteroposterior width of distal tibiae. ***Pakisaurus balochistani*** based on long, tall, lateral upper half (just below the transverse process) flat sided of anterior caudals which are without ventral groove and chevron ridges; long, tall, flat sided mid-caudals having a ventral groove bounded by chevron facets; long, tall, flat sided posterior caudals which are without ventral groove and chevron ridges; the ratio of mid-dorsal width to mid-ventral width of mid and posterior caudals is about 1, lateral surfaces on ventral view are partially visible in the anterior caudals and not visible in the mid and posterior caudals;

Description; Total seven caudals are collected. All the caudal vertebrae are procoelous. Both the height and length of the caudals generally reduce from proximal to distal caudals, however height reduce more than the length. The width and height of anterior rim are greater than the posterior articular rim of caudal centra (Table 1). Anterior concavity is deep and well rounded. The posterior convexity are strongly pronounced cone like and tall rectangular. Transverse diameter is less than the vertical diameter. The anteriormost caudals are without ventral grooves, lateral surfaces are not compressed; in the following anterior most caudal, anterior caudal have started posterior chevron facets and sides are flat; In the mid caudals, the chevron facets on the posterior rim are located on a raised prominent ridge; but the chevron facets on the anterior rims are located on comparatively very low, faint ridges and sides are slightly compressed. Mid caudals are slightly waisted. On the distal caudal the chevrons are very low and faint. It indicates it is increasing up to mid and then it become decreasing. The lateral compressing is directly proportional to the occurrences of chevron facets. The neural arches are hosted on the anterior portion of centra. Prominent rib facets occur at the junction of the centrum and the neural arch in the proximal caudals only. Detail discussions will be mentioned in the fore coming volume.

2, Sulaimanisaurus gingerichi, Malkani, 2004a

Holotype; MSM-17-4 to MSM-22-4, Seven fragmentary but seem associated caudal vertebrae (Fig. 5-8). The holotype specimens are housed in the Museum of the Geological Survey of Pakistan, Quetta.

Referred specimens; MSM-23-3 fragmentary caudal vertebra, MSM-24-15, MSM-25-15 and MSM-26-15, three fragmentary but seem associated caudal vertebrae (Fig. 5-8). These specimens are housed at the Museum of Geological Survey of Pakistan, Quetta.

Horizon and locality; Holotype specimens are collected from Kinwa Kali Kakor locality (DL- 4) of Vitakri area, and referred specimens are collected from Shalghara Kali Kakor locality (DL-3), and Mari Bohri locality (DL-15) of Vitakri area, Barkhan district, Balochistan. The host horizon of dinosaurs is the Vitakri member/ Dinosaur beds of upper part of Pab Formation of central Sulaiman foldbelt, Barkhan, Kohlu, Dera Bugti and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan (Fig. 1-4, 22a,b).

Age; Age of the dinosaur beds is the Late Cretaceous (Maastrichtian) after Fatmi (1977).

Etymology; ***Sulaimani,*** from Sulaiman foldbelt, which is the host mountain range for Latest Cretaceous dinosaurs; ***saurus*** means reptiles. The species specific epithet ***gingerichi,*** honoring the Professor Dr Philip D. Gingerich, Museum of Paleontology, University of Michigan, USA for verifying the ideas of author regarding first dinosaurs from Pakistan.

Diagnosis; ***Sulaimanisaurus gingerichi*** based on long, squarish anterior caudals (without some anteriormost caudals) without chevron ridges and ventral groove; long, squarish mid-caudals having a ventral groove bounded by anterior faint and posterior well developed chevron ridges; the ratio of mid-dorsal width to mid-ventral width of mid and posterior caudals is about 1; lateral surfaces on ventral view are clearly observed in the anterior caudals and slightly observed in mid and posterior caudals.

Description; Total eleven caudals are collected. All the caudal vertebrae are procoelous. Neural arch is located on the anterior portion of caudals centrum. Both the height and length of the caudals generally reduce from proximal to distal caudals, however height reduce more than the length. The width and height of anterior rim are greater than the posterior articular rim of caudal centra (Table 2a, 2b). Anterior concavity is deep and well rounded. The posterior convexities are strongly pronounced cone like and square shape. Transverse diameter is approximately equal to the vertical diameters. The anteriormost caudals are without ventral grooves, lateral surfaces are not compressed; in the following anterior most caudal, anterior caudal have started posterior chevron facets and side are flat; In the mid caudals, the chevron facets on the posterior rim are located on a raised prominent ridge; but the chevron facets on the anterior rims are located on comparatively very low, faint ridges and sides are slightly compressed. On the distal caudal the chevrons are very low and faint. It indicates it is increasing up to mid and then it become decreasing. The lateral compressing is directly proportional to the occurrences of chevron facets. Prominent rib facets occur at the junction of the centrum and the neural arch in the proximal caudals only. In the mid and distal caudals the lateral surfaces are swollen at the junction of centrum and the neural arch. All caudals are waisted, except some anteriormost caudals.

3, Khetranisaurus barkhani, Malkani, 2004a

Holotype; MSM-27-4, one fragmentary caudal vertebra (Fig 5-8). The holotype specimen is housed in the Museum of the Geological Survey of Pakistan, Quetta..

Referred specimens; MSM-28-4, one fragmentary caudal vertebra (Fig 5-8). This specimen is housed at the Museum of Geological Survey of Pakistan, Quetta.

Horizon and locality; Holotype and referred specimens are collected from Kinwa Kali Kakor locality (DL-4) of Vitakri area, Barkhan District, Balochistan. The host horizon of dinosaurs is the Vitakri member/ Dinosaur beds of upper part of Pab Formation of central Sulaiman foldbelt, Barkhan, Kohlu, Dera Bugti and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan (Fig. 1-4, 22a,b).

Age; Age of the dinosaur beds is the Late Cretaceous (Maastrichtian) after Fatmi (1977).

Etymology; *Khetrani,* honoring the Khetran tribe of Barkhan district; ***saurus*** means reptiles. The species specific epithet ***barkhani,*** honoring the Barkhan which is the host District of dinosaurs.

Diagnosis; *Khetranisaurus barkhani* based on long, mid-transversely greater width than mid-ventrodorsal height and no chevron ridges (may be eroded) of anterior caudals; perpendicular ventral and lateral surfaces, a ventral groove of elongated oval/hexagonal shape bounded by wall between the chevron facets depressions, a transverse ventral median ridge formed due to chevron facets depressions and disconnected by oval groove, and a small resistant tubera is found on the ventral margin of anterior articular rim of anterior/mid-caudals just on the front of oval groove; no chevron ridges, a faint ventral groove of elongated oval shape of posterior caudals; the ratio of mid-dorsal width to mid-ventral width of mid and posterior caudals is slightly less than 1; and lateral surfaces on ventral view are not observed in mid and posterior caudals due to mid-ventral greater width than mid-dorsal width.

Description; Total two caudals are collected. Both the caudal vertebrae are procoelous. Another one caudal like the holotype specimen is left in the field locality. The width and height of anterior rim are greater than the posterior articular rim of caudal centra (Table 3). Anterior concavity is deep and well rounded. The posterior convexities are strongly pronounced, cone like. Transverse diameter is slightly greater/ approximately equal to the vertical diameters. In the anterior/mid caudals, the chevron facets are located but broken showing central elongated oval surface, surrounded by wall. In the anterior view it shows a rounded circular tube. The neural arches are hosted on the anterior portion of centra. Prominent rib facets occur at the junction of the centrum and the neural arch in the proximal/mid caudals only. In the caudal the lateral surfaces are swollen at the junction of centrum and the neural arch.

4, Balochisaurus, Malkani, 2004a

Holotype; MSM-43-15 to MSM-48-15; One biconvex first caudal and six fragmentary but seems to be associated caudal vertebrae (Fig. 9-12). The holotype specimens are housed in the Museum of the Geological Survey of Pakistan, Quetta.

Referred specimens; MSM-142-4 a partial rostrum (Fig. 21b), MSM-49-16, one fragmentary caudal vertebra; MSM-50-4, MSM-51-4, two but seems to associated caudal vertebrae; and MSM-52-9, one fragmentary caudal vertebra (Fig. 9-12). These specimens are housed at the Museum of Geological Survey of Pakistan, Quetta.

Horizon and locality; Holotype specimens are collected from Mari Bohri locality (DL-15) of Vitakri area, and referred specimens are collected from Top Kinwa Kali Kakor locality (DL-16) and Kinwa Kali Kakor locality (DL-4) of Vitakri area; and Grut-Gambrak locality (DL-9) of Nahar Kot area, Barkhan District, Balochistan, Pakistan. The host horizon of dinosaurs is the Vitakri member/ Dinosaur beds of upper part of Pab Formation of central Sulaiman foldbelt, Barkhan, Kohlu, Dera Bugti and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan (Fig. 1-4, 22a,b).

Age; Age of the dinosaur beds is the Late Cretaceous (Maastrichtian) after Fatmi (1977).

Etymology; *Balochi,* honoring the Baloch tribes of Pakistan, as they host the Kachi Bohri locality from Central Sulaiman Range; ***saurus*** means reptiles.

Diagnosis; *Balochisaurus and Marisaurus* share with the **Balochisaurids/Saltasaurids** as the the ratio of mid-dorsal width to mid-ventral width of mid and posterior caudals is greater than 1.25 (or round about 1.5 and 2); first biconvex caudal centrum; short and heavy anterior and middle caudals; robust femora; thick transversely proximal tibiae; narrow lateral (anteroposterior) width of distal (elongated oval shape) tibiae; and mid-mediolateral width is greater than mid-anteroposterior width of distal tibiae.

Balochisaurus malkani based on first biconvex caudal centrum; short, heavy and narrow well developed ventral groove due to well developed anterior and posterior chevron facets of anterior caudals (may be except anteriormost caudals); the ratio of mid-dorsal width to mid-ventral width of anterior caudals (may be except anteriormost caudals) and mid caudals is around 2 or more; lateral surfaces on ventral view are clearly observed in the anterior and mid caudals due to mid-dorsal width highly greater than ventral width; robust transversely proximal tibiae; and narrow (elongated oval shape) of distal tibiae (mid width is highly greater than mid antero-th).

; Total eleven caudals are collected. First convex and other ten caudal vertebrae are . Both the height and length of the caudals reduce from proximal to distal caudals. The height of anterior rim are greater than the articular rim of caudal centra (Table 5a,5b). concavity is deep and well rounded. The convexity are strongly pronounced, cone like re shape. Transverse diameter is equal to the diameters in anterior and mid caudals. The most caudals are without ventral grooves and ssed lateral surfaces; in the following anterior caudal, anterior caudal have started posterior n facets and sides are laterally compressed; In d caudals, the chevron facets on the posterior rim cated on a raised prominent ridge; but the chevron on the anterior rims are located on comparatively low, faint ridges and sides are compressed. The l compressing is directly proportional to the rences of chevron facets. Prominent rib facets r at the junction of the centrum and the neural arch e proximal caudals only. Neural arch is located on anterior portion of centrum. The ventral mid width ghly less than the upper mid width i.e., the lateral aces are visible on ventral view. All caudals are l waisted, except some anteriormost caudals.The o is only in mid caudals not in anterior caudals.

RTIAL SKULL OF *BALOCHISAURUS*; The anosauria are regarded as the most advanced of the ropod dinosaurs. Restricted to the Cretaceous, they re first recorded from central India. Titanosaurs mprise nearly half of all known sauropod genera and re the only sauropod lineage to survive to the end of e Cretaceous. Their postcrania are found worldwide, ut their skulls are exceptionally rare. But now Pakistan as entered into list of most important titanosauria in e world due to present discoveries. First rostrum (Fig. 21b) of juvenile ***Balochisaurus*** titanosaurian sauropod dinosaur has been discovered for the first time in Pakistan, from the Latest Cretaceous Dinosaur beds of upper part of Pab Formation in Kinwa Kali Kakor Locality (Fig. 22a,b) of Vitakri area, Barkhan district, Balochistan, Pakistan. This rostrum includes articulated upper and lower jaws consisting of premaxilla, maxilla, palate, dentary and teeth. Rostrum is excavated from in situ red muds/clays of Vitakri member of upper part of Pab Formation and it can be expected to find remaining carcase (Malkani, 2006c).

So far full teeth row of titanosauria are not found in the world but new discovery have advantage to overcome this enigma. Now dental formula can be known. This rostrum belongs to juvenile (based on relatively small size) titanosaurian dinosaur and nearby finding of some post cranial elements of adult titanosaur represent the parental relations an as parental care relation or it may belong to patriarch/matriarch. It is possible that the further excavation at this site can recover remaining preserved carcase of this species and with his/her parents or patriarch/matriarch. Dentary behavior is basal and anteroventral margin shape is gently rounded. Dentary symphyses and the shape of anterior portions of tooth rows in upper jaws is broadly arched forming U shape. The tooth crowns seem to be straight with slight recurving behavior. Tooth crowns do not overlap. Tooth crown cross-sectional shape at mid crown is subcircular. The enamel surface texture is wrinkled. A tooth slenderness index is 3. Due to dearth of cranial data from other known *Titanosaurus* in the world, this new *Balochisaurus* has great potential to clarify high and low level phylogeny. This first time discovery of a rostrum *Balochisaurus* will accommodate the missing link. Present discovery will be useful for knowing dental formula, correlation; higher and lower level phylogenetic resolution, and biogeographic link with other Gondwanan and Laurasian countries (Malkani, 2006c).

5, Marisaurus, Malkani, 2003a ; ***Marisaurus jeffi,*** Malkani, 2004a

Holotype; MSM-7-15 and MSM-29-15 to MSM-33-15: One biconvex first caudal and five fragmentary but seems associated caudal vertebrae (Fig 9-12). The holotype specimens are housed in the Museum of the Geological Survey of Pakistan, Quetta, except biconvex first caudal which have been sent for sample preparation to Dr Jeffery A. Wilson, Museum of Paleontology, University of Michigan, USA.

Referred specimens; MSM-79-19 partial skull (Fig. 23a); MSM-107-19 to MSM-109-19 three associated cervical vertebrae; MSM-110-19 to MSM-112-19 three associated dorsal vertebrae; MSM-113-19 to MSM-117-19 five associated caudal vertebrae; MSM-118-19 distal femur; and MSM-119-19 proximal tibia; MSM-34-16, MSM-35-16 two fragmentary but seems to be associated caudal vertebrae; MSM-36-4 to MSM- 39-4 and MSM-39 (a)-4 five fragmentary but seems to be associated caudal vertebrae; MSM-40-8 one fragmentary caudal vertebra; and MSM-41-2 and MSM-42-2 two fragmentary but seems to be associated caudal vertebrae (Fig 9-12). These specimens are housed at the Museum of Geological Survey of Pakistan, Quetta.

Horizon and locality; Holotype specimens are collected from Mari Bohri locality (DL-15) of Vitakri area and referred specimens are collected from Bor Kali Kakor locality (DL-2), Top Kinwa Kali Kakor locality (DL-4), and Top Kinwa Kali Kakor locality (DL-16) of Vitakri area; and Darwaza-Gumbrak locality (DL-8) of Nahar Kot area, Barkhan District, Balochistan, Pakistan. The host horizon of dinosaurs is the Vitakri member/ Dinosaur beds of upper part of Pab Formation of central Sulaiman foldbelt, Barkhan, Kohlu, Dera Bugti and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan (Fig. 1-4, 22a,b).

Age; Age of the dinosaur beds is the Late Cretaceous (Maastrichtian) after Fatmi (1977).

Etymology; ***Mari,*** honoring the Mari tribes Bohri locality from Central Sulaiman Range; ***saurus*** means reptiles. The species specific epithet ***jeffi,*** honoring the Dr Jeffery A. Wilson, Museum of Paleontology, University of Michigan, USA for verifying the ideas of author regarding first biconvex caudal of Saltasaurids dinosaur from Pakistan.

Diagnosis; ***Marisaurus jeffi*** based on also first biconvex caudal centrum; short, heavy and broad ventral groove on posterior parts of anterior caudals (except some anteriormost caudals) due to well developed posterior chevron facets; short, heavy and broad ventral groove of mid-caudals due to well developed posterior and faint anterior chevron facets; the ratio of mid-dorsal width to mid-ventral width of anterior caudals (except some anteriormost caudals), and mid-caudals is around 1.5; lateral surfaces on ventral view are clearly observed in the anterior and mid caudals due to mid-dorsal width greater than ventral width; robust femora; thick transversely proximal tibiae; and narrow lateral width (elongated oval shape) of distal tibiae (mid-mediolateral width is greater than mid-anteroposterior width);

Description; Total fifteen caudals are collected. First caudal is biconvex. All the caudal vertebrae are procoelous. Both the height and length of the caudals generally reduce from proximal to distal caudals. Height reduces more than length. The width and height of anterior rim are greater than the posterior articular rim of caudal centra (Table 4a,4b,4c). Anterior concavity is deep and well rounded. The posterior convexity is strongly pronounced, cone like and slightly tall rectangular. Transverse diameter is slightly less than less than the vertical diameters in anterior caudals but in distal caudals seem to be subequal. The anterior most caudals are without ventral grooves and compressed lateral surfaces; in the following anterior most caudal, anterior caudal have started posterior chevron facets and sides are laterally compressed; In the mid caudals, the chevron facets on the posterior rim are located on a raised prominent ridge; but the chevron facets on the anterior rims are located on comparatively very low, faint ridges, may be due larger circumference of anterior articular rings and sides are slightly compressed. On the distal caudal the chevrons are very low and faint. It indicates it is increasing up to mid and then it become decreasing. The lateral compressing is directly proportional to the occurrences of chevron facets. Prominent rib facets occur at the junction of the centrum and the neural arch in the proximal caudals and may be in proximal mid caudals only. Neural arch is located on the anterior portion of centrum. The ventral mid width is less than the upper mid width i.e., lateral surfaces are visible on ventral view. All caudals are waisted, except some anteriormost caudals. The ratio of mid-dorsal width to mid-ventral width of only mid caudals is used for all species determination.

NEW *MARISAURUS*; Associated assemblages of new ***Marisaurus*** titanosaurian sauropod dinosaur have been collected from Latest Cretaceous Vitakri member/Dinosaur beds of upper part of Pab Formation, Alam Kali Kakor locality of Vitakri area, Barkhan district, Balochistan, Pakistan. New ***Marisaurus*** (Titanosauria, Sauropoda, Dinosauria) includes 3 cervicals, 3 dorsals, and 5 caudals vertebrae along with appendicular elements as distal femur and proximal tibia. One specimen which is mostly covered by matrix may belongs to occipetal condyle and posterior skull or may belongs to part of vertebra, found associated. All these materials have been collected as from one locality within a diameter of about 10 meters and seem to be associated and belong to adult animal. The nearby finding and nature of matrix tells about the one animal. The cervicals are broad and long, and dorsals are broad and short. Both the cervical and dorsal vertebrae represent spongy/pneumatic cavities on broken surfaces. Caudals matches with the *Marisaurus* with correlation of the ratio of mid dorsal width to mid ventral width about 1.5 and that is the reason for reffering. The distal femur and proximal tibia matches with the saltasaurids family. So these strengthen the caudals assignment to *Marisaurus.* A partial skull (Fig. 21a) of *Marisaurus* Malkani, 2003a is also found 50 meter apart downward from this axial and appendicular fossils locality. The size of skull matches with the appendicular and axial fossils but matrix is different. The remaining preserved carcase may be found on excavation. The present discovery is very significant in the world due to finding of associated nature of cranial, axial and appendicular elements (Malkani, 2005b).

The Titanosauria, the last surviving group of giant Sauropod dinosaurs, attained a near global distribution by the close of the Cretaceous period (65 million years ago). With the few exception of new discoveries in Argentina, Madagascar, and Mongolia, most titanosaurs are known only from fragmentary post cranial skeletons and rare isolated skull elements. Titanosaurs comprise nearly half of all known sauropod genera and were the only sauropod lineage to survive to the end of the Cretaceous. Their postcrania are found worldwide, but their skulls are exceptionally rare. Cranial material is known from only ten Titanosaurs and is limited to isolated elements and fragmentary braincases. In fact, no titanosaur described or illustrated, and very few instances of direct association of skulls and postcrania have been documented. This nagging lack of association has left even the most basic skeletal morphology of the clade controversial and has precluded detailed study of the higher and lower level phylogeny of the group. But now Pakistan has entered into list due to present discoveries of associated cranial, post cranial like axial and appendicular elements of ***Marisaurus*** (Malkani, 2005b).

Abelisaurian Theropoda

Theropod derives it name from thero mean beast and poda mean feet/leg. Theropoda are carnivorous.

1, Vitakridrinda sulaimani, Malkani, 2004a

Holotype; MSM-155-19 a rostrum (Fig. 13);. MSM-59-19, MSM-60-19 A pair of left and right proximal femur (Fig. 7-10, 16a), MSM-61-19 Basioccipital condyle alongwith partial braincase (Fig. 14b, 15a,b) and MSM-62-19 a tooth (Fig. 16a). The holotype specimens are housed in the Museum of the Geological Survey of Pakistan, Quetta.

Referred specimens; MSM-53-2, MSM-54-2, MSM-55-2, three fragmentary may be dorsal or caudal vertebrae; MSM-56-1, one caudal vertebra; MSM-57-3, one caudal vertebra, and MSM-58-15, one caudal vertebra. (Fig.5-8). These specimens are housed at the Museum of Geological Survey of Pakistan, Quetta.

Horizon and locality; Holotype specimens are collected from Alam Kali Kakor locality (DL-19) of Vitakri area, and referred specimens are collected from Sangiali Kali Kakor locality (DL-1), Bor Kali Kakor locality (DL-2), Shalghara Kali Kakor locality.(DL-3), and Mari Bohri locality (DL-15) of Vitakri area, Barkhan District, Balochistan. The host horizon of dinosaurs is the Vitakri member/ Dinosaur beds of upper part of Pab Formation of central Sulaiman foldbelt, Barkhan, Kohlu, Dera Bugti and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan (Fig. 1-4, 22a,b).

Age; Age of the dinosaur beds is the Late Cretaceous (Maastrichtian) after Fatmi (1977).

Etymology; ***Vitakri,*** honoring the dinosaurs' type locality; ***drinda*** Urdu and Seraiki word means beast. The species specific epithet ***sulaimani,*** after the name of Sulaiman foldbelt which acts as a Cretaceous park for terrestrial ecosystem.

Diagnosis; One genus and species of Abelisaurids Theropod dinosaur ***Vitakridrinda sulaimani*** is diagnosed on the basis of an rostrum, thick and long basioccipital condyle articulated with posterior braincase; a pair of proximal femora having greater trochanter, eroded inturned head with joint (only joint are found in both left and right proximal femur), and hollow and thick peripheral bone of cross section; amphicoelous vertebrae, laterally compressed tooth, having low crown and extremely low ratio of crown height and rostro-caudal width.

Description; The tooth is compressed laterally. Tooth crown is extremely low and the ratio of the crown height to rostro-caudal width is about 1-1.5.Tooth anteroposterior breadth is 2.2 cm, labial to lingual depth is about 1.3 cm. tooth is found embedded in matrix so possible length seems to be low like 2.2 cm as broad, this is interpreted due to seeing the decreasing tooth anteroposterior breadth. The cross sectional shape of tooth is D shape and slightly asymmetrical (Fig-17a).

The basioccipital condyle length is about 8 cm, width is 7.6cm and height is 6.6 cm. this condyle is articulated with posterior braincase but mostly covered by matrix. The anterior view of preserved braincase shows paroccipital process going to be down on the edges and basipterygoid processes/rami are close to each other forming high angles from the vertical line forming close v shape. The approximate length of paroccipital process is about 4.8 cm and depth is about 3 cm. the ventrodorsal height of basipterygoid processes is about 4 cm. Basioccipetal condyle is to much thick (Fig. 14b,15a,b) comparatively with the other Pakistani titanosaur's basioccipital condyles.

Total two dorsals and four caudals are collected (Fig. 5-8; Table 6). The vertebrae are procoelous, slightly waisted and lack pleurocoel. The neural arches are found on the anterior of caudal centra like titanosaurs from Pakistan. The caudal centra are tall and thin comparatively dorsal centra which are cylindrical. On dorsal centra the neural arches cover the most of the whole length (Fig. 5-8).

Pair of proximal femur having cross section showing the bones are hollow, thick walled stout. The proximal femur show inturned head with a distinct neck. Greater trochanter is well developed and lesser trochanter may be missing or may be lower from the level of preserved bones. The anteroposterior and transverse diameter of the hollow of the femur bone is about 5 and 5.5 cm respectively. The thickness of peripheral bone is also variable and it is 1 cm on the ventral side and thicker just below the inturned head and it is 2.5 cm thick. The femoral cross section just below the inturned head is slightly eccentric/elliptical having the anteroposterior and transverse maximum width as 7.5 and 9.5 cm respectively.

The finding of rostrum (Fig. 13) of ***Vitakridrinda*** theropod dinosaur is the first one from Pakistan. It is found from the the Latest Cretaceous Dinosaur beds/Vitakri member of upper part of Pab Formation in Alam Kali Kakor locality of Vitakri region, Barkhan District, Balochistan, Pakistan. The newly discovered rostrum consists of articulated premaxilla alongwith narial, dorsolateral and lateral processes; external naris; partial nasal, palate and maxilla. The subterminal rostrocaudally subcircular nares, V shape of anterior snout and teeth characters representing pleisiomorphies of theropods. The ornamentation like pits and grooves

Pakistan. The host horizon of dinosaurs is the Vitakri member/ Dinosaur beds of upper part of Pab Formation of central Sulaiman foldbelt, Barkhan, Kohlu, Dera Bugti and Dera Ghazi Khan districts, Balochistan and Punjab provinces, Pakistan (Fig. 1-4, 22a,b).

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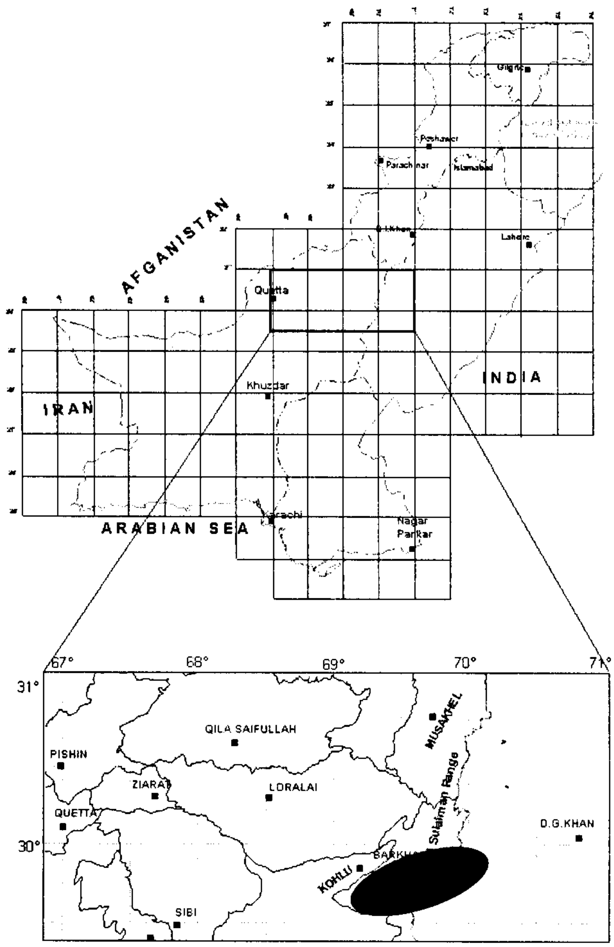


Figure 1. Balck Oval represents the finding of dinosaur fossils From Dinosaur beds/ Vitakrimember of upper part of PabFormation, Latest Cretaceous Park of Sulaiman foldbelt, Pakistan.

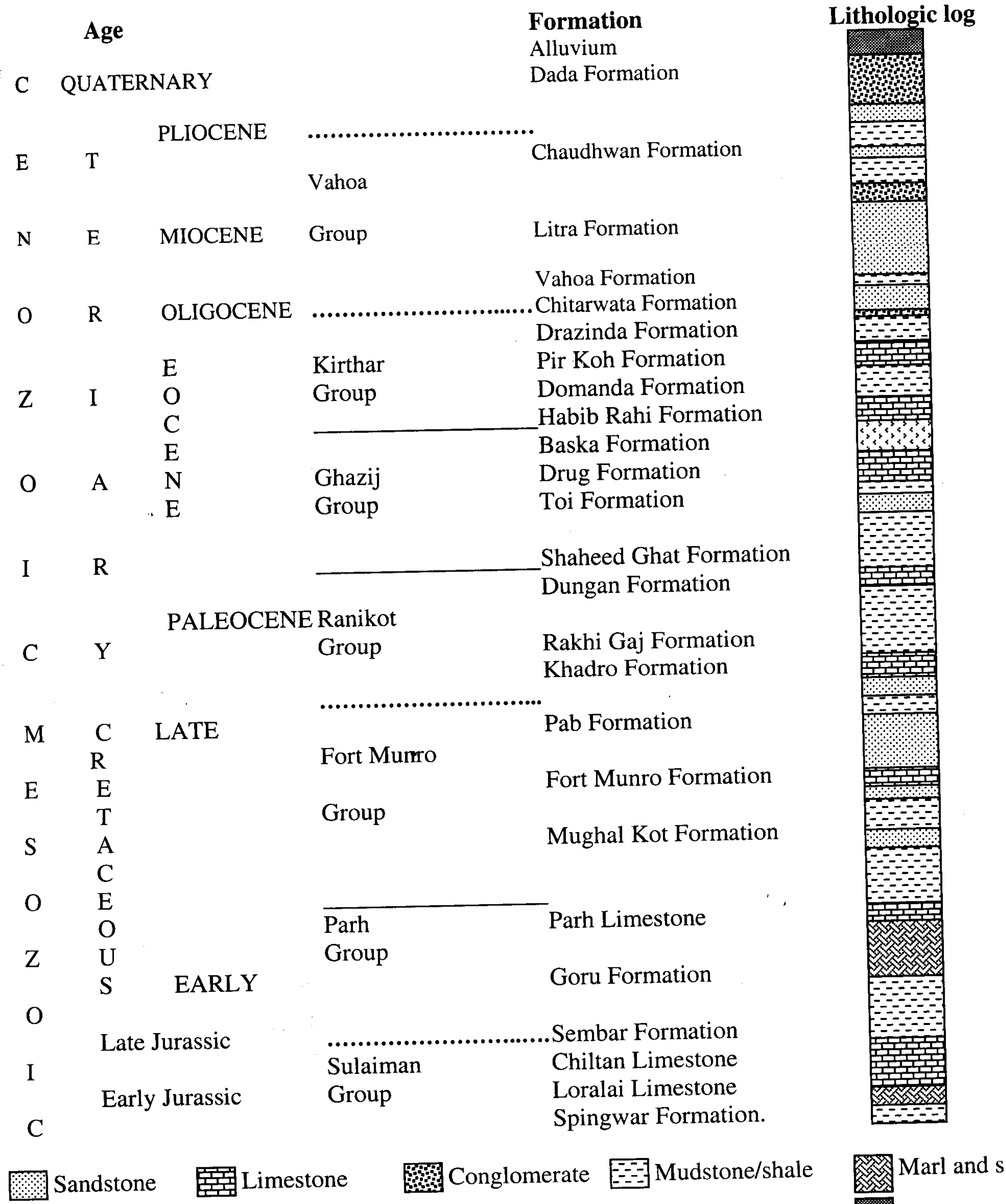
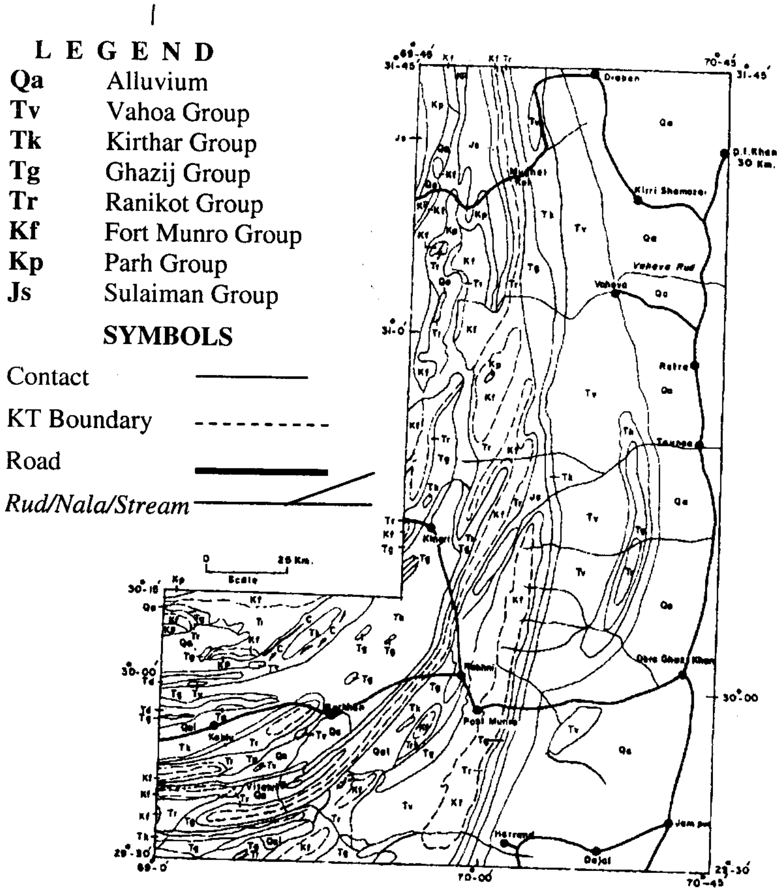


Fig. 2. Generalized Stratigraphic succession of Sulaiman foldbelt, Pakistan.



Geology by: M. Sadiq Malkani

Figure 3. Preliminary Geological Map of part of Sulaiman foldbelt, Pakistan.

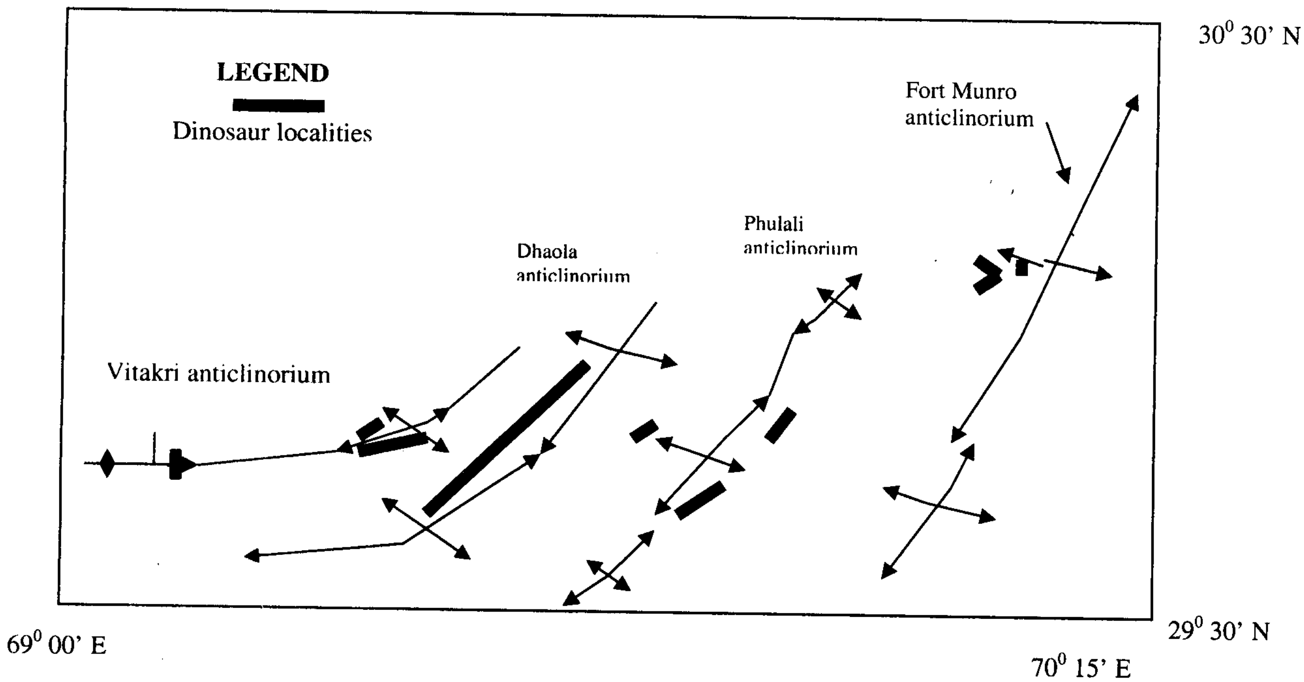


Figure 4. Map showing the Latest Cretaceous Dinosaur localities in major four main anticlinorium of central Sulaiman foldbelt, Barkhan, Dera Bugti and Kohlu distriucts of Balochistan province; and Dera Ghazi Khan and Rajan Pur districts of Punjab province, Pakistan.

Figure 5.First (top) row: MSM-11-4, MSM-12-4, MSM-13-4, MSM-14-4, MSM-15-15, MSM-16-2, MSM-17-16,
Pakisaurus balochistani Malkani 2004a, caudal vertebrae, dorsolateral view.
Second row; MSM-17-4, MSM-18-4, MSM-19-4, MSM-20-4, MSM-21-4, MSM-21(a)-4, MSM-22-4, *Sulaimanisaurus gingerichi*, Malkani, 2004a; caudal vertebrae, dorsolateral view.
Third row; MSM-23-15, MSM-24-15, MSM-25-15, MSM-26-15,
Sulaimanisaurus gingerichi Malkani 2004a, caudal vertebrae, dorsolateral view;
MSM-27-4, MSM-28-1, *Khetrainsaurus barkhani* Malkani 2004a, caudal vertebrae dorsolateral view.
Fourth (lower) row; MSM-53-2, MSM-54-2; *Vitakridrinda Sulaimani* Malkani 2004a, dorsal/caudal vertebrae, dorsolateral view;
MSM-55-2, MSM-56-1, MSM-57-3, MSM-58-15, *Vitakridrinda sulaimani* Malkani 2004a, caudal/dorsal vertebrae, dorsolateral view;
MSM-59-19, MSM-60-19, *Vitakridrinda sulaimani* Malkani 2004a, a pair of proximal femur, medioanterior view.
Sample numbers started in every row from left to right. Sample number MSM represents the collector, followed by sample number and at the end is locality numbers. For example the first sample in top row is MSM-11-4 which represents MSM as collector, 11 is a sample numbers and 4 is a dinosaur locality number 4.
Scale. Each black and white digit is 1 cm.

Figure 6.First (top) row: MSM-11-4, MSM-12-4, MSM-13-4, MSM-14-4, MSM-15-15, MSM-16-2, MSM-17-16,
Pakisaurus balochistani Malkani 2004a, caudal vertebrae, anterodorsal view.
Second row; MSM-17-4, MSM-18-4, MSM-19-4, MSM-20-4, MSM-21-4, MSM-21(a)-4, MSM-22-4, *Sulaimanisaurus gingerichi*, Malkani, 2004a; caudal vertebrae, anterodorsal view.
Third row; MSM-23-15, MSM-24-15, MSM-25-15, MSM-26-15,
Sulaimanisaurus gingerichi Malkani 2004a, caudal vertebrae, anterodorsal view;
MSM-27-4, MSM-28-1, *Khetrainsaurus barkhani* Malkani 2004a, caudal vertebrae, anterodorsal view.
Fourth (lower) row; MSM-53-2, MSM-54-2; *Vitakridrinda Sulaimani* Malkani 2004a, dorsal/caudal vertebrae, anterodorsal view;
MSM-55-2, MSM-56-1, MSM-57-3, MSM-58-15, *Vitakridrinda sulaimani* Malkani 2004a, caudal/dorsal vertebrae, anterodorsal view;
MSM-59-19, MSM-60-19, *Vitakridrinda sulaimani* Malkani 2004a, a pair of proximal femur, posterior view.
Scale. Each black and white digit is 1 cm.

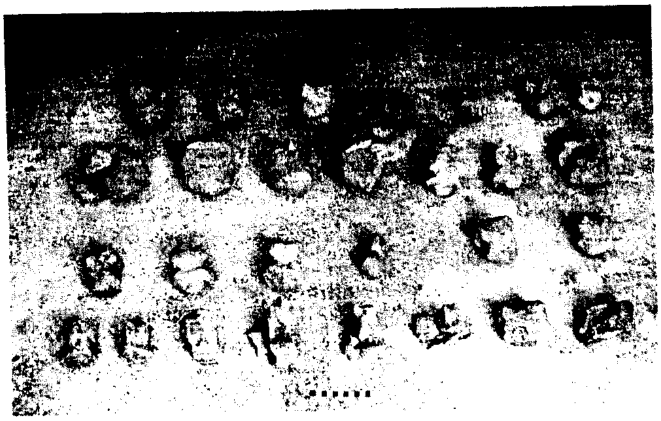


Figure 7.First (top) row: MSM-11-4, MSM-12-4, MSM-13-4, MSM-14-4, MSM-15-15, MSM-16-2, MSM-17-16, *Pakisaurus balochistani* Malkani 2004a, caudal vertebrae, posterodorsal view.
Second row; MSM-17-4, MSM-18-4, MSM-19-4, MSM-20-4, MSM-21-4, MSM-21(a)-4, MSM-22-4, *Sulaimanisaurus gingerichi*, Malkani, 2004a; caudal vertebrae, posterodorsal view.
Third row; MSM-23-15, MSM-24-15, MSM-25-15, MSM-26-15, *Sulaimanisaurus gingerichi* Malkani 2004a, caudal vertebrae, posterodorsal view; MSM-27-4, MSM-28-1, *Khetrainsaurus barkhani* Malkani 2004a, caudal vertebrae, posterodorsal view.
Fourth (lower) row; MSM-53-2, MSM-54-2; *Vitakridrinda Sulaimani* Malkani 2004a, dorsal/caudal vertebrae, posterodorsal view;
MSM-55-2, MSM-56-1, MSM-57-3, MSM-58-15, *Vitakridrinda sulaimani* Malkani 2004a, caudal/dorsal vertebrae, posterodorsal view;
MSM-59-19, MSM-60-19, *Vitakridrinda sulaimani* Malkani 2004a, a pair of proximal femur (right and left), shaft cross-sectional interior view.
Scale. Each black and white digit is 1 cm.

Figure 8.First (top) row: MSM-11-4, MSM-12-4, MSM-13-4, MSM-14-4, MSM-15-15, MSM-16-2, MSM-17-16, *Pakisaurus balochistani* Malkani 2004a, caudal vertebrae, posteroventral view.
Second row; MSM-17-4, MSM-18-4, MSM-19-4, MSM-20-4, MSM-21-4, MSM-21(a)-4, MSM-22-4, *Sulaimanisaurus gingerichi*, Malkani, 2004a; caudal vertebrae, posteroventral view.
Third row; MSM-23-15, MSM-24-15, MSM-25-15, MSM-26-15, *Sulaimanisaurus gingerichi* Malkani 2004a, caudal vertebrae, posteroventral view view; MSM-27-4, MSM-28-1, *Khetrainsaurus barkhani* Malkani 2004a, caudal vertebrae, posteroventral view.
Fourth (lower) row; MSM-53-2, MSM-54-2; *Vitakridrinda Sulaimani* Malkani 2004a, dorsal/caudal vertebrae, posteroventral view;
MSM-55-2, MSM-56-1, MSM-57-3, MSM-58-15, *Vitakridrinda sulaimani* Malkani 2004a, caudal/dorsal vertebrae, posteroventral view;
MSM-59-19, MSM-60-19, *Vitakridrinda sulaimani* Malkani 2004a, a pair of proximal femur, posterior view.
Scale. Each black and white digit is 1 cm.

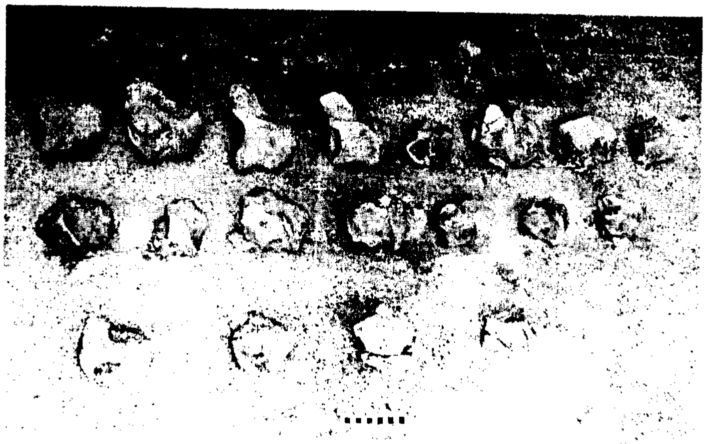


Figure 9.First (top) row:
MSM-29-15, MSM-30-15, MSM-31-15, MSM-32-15, MSM-33-15, MSM-34-16, MSM-35-16, *Marisaurus jeffi* Malkani 2004a, caudal vertebrae, dorsolateral view.
Second row;
MSM-36-4, MSM-37-4, MSM-38-4, MSM-39-4, MSM-39(a)-4, MSM-40-4, MSM-41-2, MSM-42-2, *Marisaurus jeffi* Malkani 2004a, caudal vertebrae, dorsolateral view.
Third row;
MSM-43-15; *Balochisaurus* Malkani 2004(a), first biconvex caudal vertebrae, dorsolateral view; MSM-44-15, MSM-44(a)-15, MSM-45-15, MSM-46-15, MSM-47-15, MSM-48-15, *Balochisaurus* Malkani 2004a, caudal vertebrae, dorsolateral view.
Fourth (lower) row;
MSM-49-16, MSM-50-4, MSM-51-4, MSM-52-9, *Balochisaurus* Malkani 2004a, Caudal vertebrae, dorsolateral view.
Scale. Each black and white digit is 1 cm.

Figure 10.First (top) row:
MSM-29-15, MSM-30-15, MSM-31-15, MSM-32-15, MSM-33-15, MSM-34-16, MSM-35-16, *Marisaurus jeffi* Malkani 2004a, caudal vertebrae, anterodorsal view.
Second row;
MSM-36-4, MSM-37-4, MSM-38-4, MSM-39-4, MSM-39(a)-4, MSM-40-4, MSM-41-2, MSM-42-2, *Marisaurus jeffi* Malkani 2004a, caudal vertebrae, anterodorsal view.
Third row;
MSM-43-15; *Balochisaurus* Malkani 2004(a), first biconvex caudal vertebrae, anterodorsal view; MSM-44-15, MSM-44(a)-15, MSM-45-15, MSM-46-15, MSM-47-15, MSM-48-15, *Balochisaurus* Malkani 2004a, caudal vertebrae, anterodorsal view.
Fourth (lower) row;
MSM-49-16, MSM-50-4, MSM-51-4, MSM-52-9, *Balochisaurus* Malkani 2004a, Caudal vertebrae, anterodorsal view.
Scale. Each black and white digit is 1 cm.

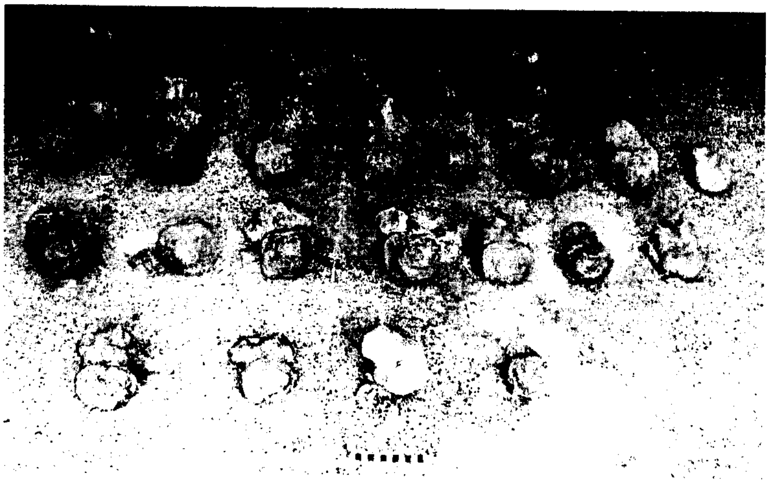


Figure 11.First (top) row:
MSM-29-15, MSM-30-15, MSM-31-15, MSM-32-15, MSM-33-15, MSM-34-16, MSM-35-16, *Marisaurus jeffi* Malkani 2004a, caudal vertebrae, posterodorsal view.
Second row;
MSM-36-4, MSM-37-4, MSM-38-4, MSM-39-4, MSM-39(a)-4, MSM-40-4, MSM-41-2, MSM-42-2, *Marisaurus jeffi* Malkani 2004a, caudal vertebrae, posterodorsal view.
Third row;
MSM-43-15; *Balochisaurus* Malkani 2004(a), first biconvex caudal vertebrae, posterodorsal view;MSM-44-15, MSM-44(a)-15, MSM-45-15, MSM-46-15, MSM-47-15, MSM-48-15, *Balochisaurus* Malkani 2004a, caudal vertebrae, posterodorsal view.
Fourth (lower) row;
MSM-49-16, MSM-50-4, MSM-51-4, MSM-52-9, *Balochisaurus* Malkani 2004a, Caudal vertebrae, posterodorsal view.
Scale. Each black and white digit is 1 cm.

Figure 12.First (top) row:
MSM-29-15, MSM-30-15, MSM-31-15, MSM-32-15, MSM-33-15, MSM-34-16, MSM-35-16, *Marisaurus jeffi* Malkani 2004a, caudal vertebrae, posteroventral view.
Second row;
MSM-36-4, MSM-37-4, MSM-38-4, MSM-39-4, MSM-39(a)-4, MSM-40-4, MSM-41-2, MSM-42-2, *Marisaurus jeffi* Malkani 2004a, caudal vertebrae, posteroventral view.
Third row;
MSM-43-15; *Balochisaurus* Malkani 2004(a), first biconvex caudal vertebrae, posteroventral view; MSM-44-15, MSM-44(a)-15, MSM-45-15, MSM-46-15, MSM-47-15, MSM-48-15, *Balochisaurus* Malkani 2004a, caudal vertebrae, posteroventral view.
Fourth (lower) row;
MSM-49-16, MSM-50-4, MSM-51-4, MSM-52-9, *Balochisaurus* Malkani 2004a, Caudal vertebrae, posteroventral view.
Scale. Each black and white digit is 1 cm.

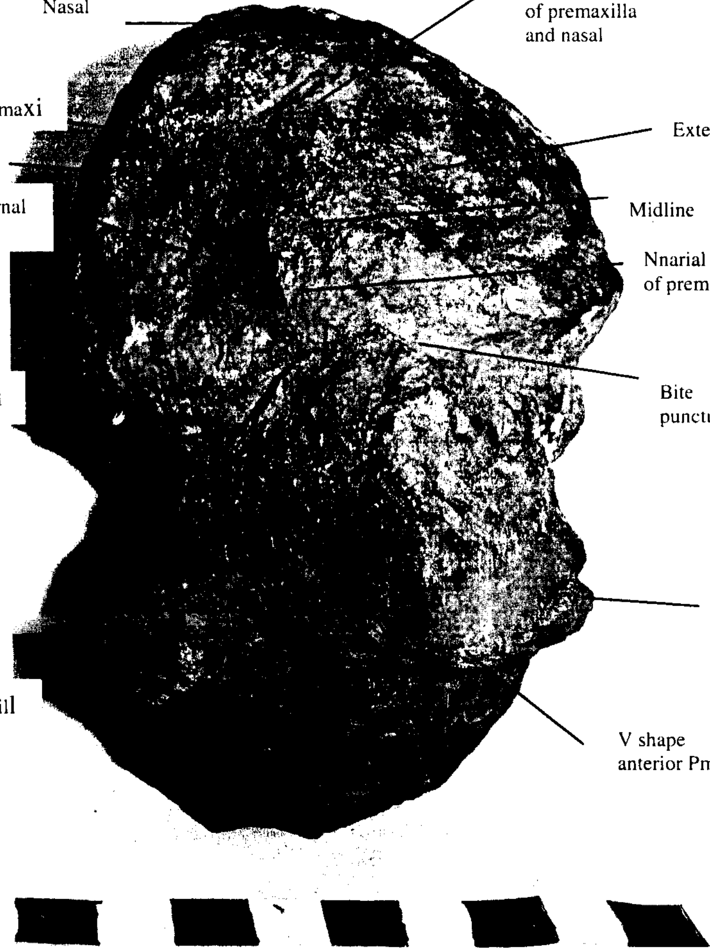


Figure 13. Anterior View of rostrum of *Vitakridrinda*, a carnivorous abelisaurid theropod dinosaur from Vitakri area, Barkhan District, Balochistan, Pakistan Specimen No; MSM-155-19c.

Figure 14a. MSM-59-19, MSM-60-19, *Vitakridrinda sulaimani* Malkani 2004a, a pair of proximal femur, shaft cross-sectional interior view.

Scale. Each black and white digit is 1 cm.

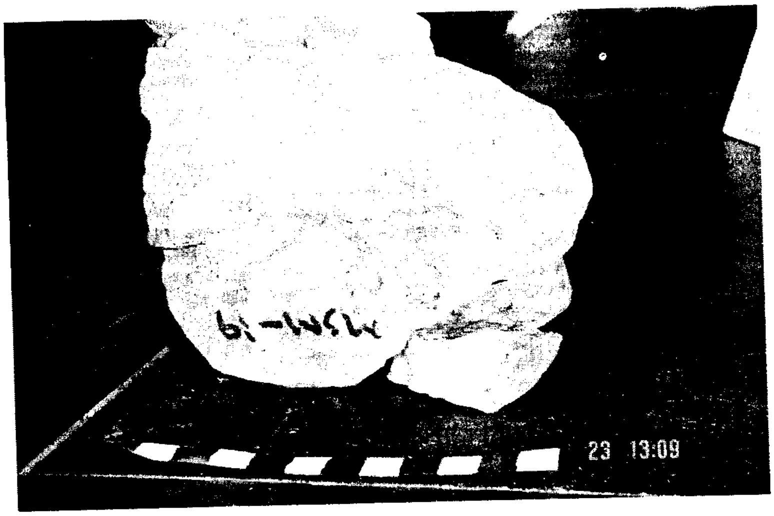


Figure 14b. MSM-62-19, *Vitakridrinda sulaimani* Malkani 2004a, braincase, anterior view.
Scale. Each black and white digit is 1 cm.

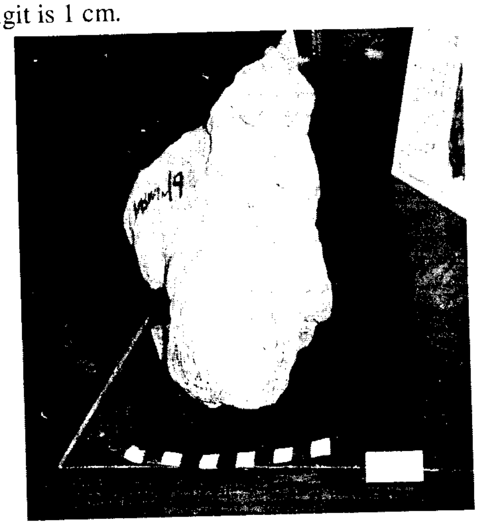


Figure15a. *Vitakridrinda sulaimani* Malkani 2004a, Occipital condyle articulated with partial braincase, posterior view.
Scale. Each black and white digit is 1 cm.

Figure 15b. *Vitakridrinda sulaimani* Malkani 2004a, Occipital condyle articulated with partial braincase, lateral view.
Scale. Each black and white digit is 1 cm.

Figure 16a. *Vitakridrinda sulaimani* Malkani 2004a tooth crown, internal view of base.
Scale. Each black and white digit is 1 cm.

Figure 16b. MSM-69-2, Proximal femur of Pakistani Titanosauria, showing upper one third deflected medially telling morphology of wide gauge trackways.
Scale. Each black and white digit is 1 cm.

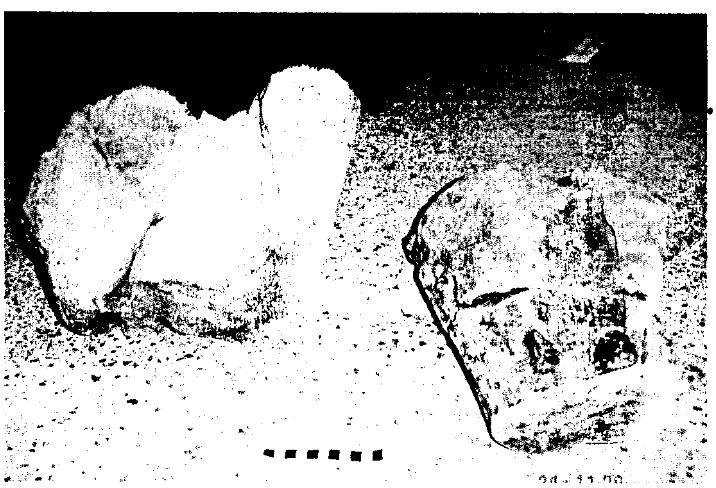


Figure 17a. MSM-70-15, MSM-71-15, two types (stocky and slender) distal femora of Pakistani Titanosauria, posterior view. **Scale.** Each black and white digit is 1 cm.

Figure 17b. MSM-70-15, MSM-71-15, two types (stocky and slender) distal femora of Pakistani Titanosauria, distal view. **Scale.** Each black and white digit is 1 cm.

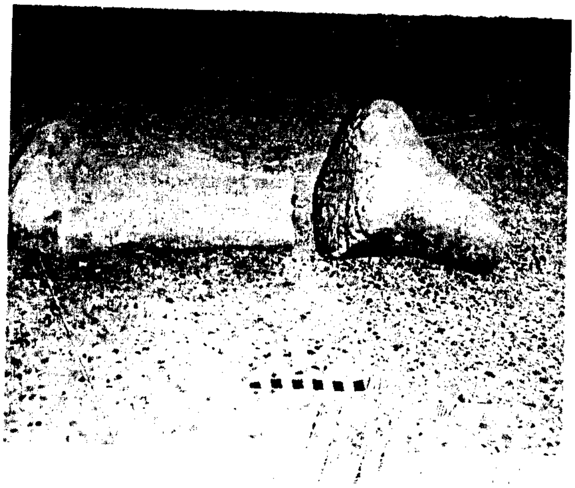


Figure 18a. MSM-72-2, MSM-73-16, two types of proximal tibia, (subcircular and elongated antero-posteriorly proximal exposure) of PakistaniTitanosauria, posterior view.
Scale. Each black and white digit is 1 cm.

Figure 18b. MSM-72-2, MSM-73-16, two types of proximal tibia, (subcircular and Elongated antero-posteriorly proximal exposure) of PakistaniTitanosauria, proximal view.
Scale. Each black and white digit is 1 cm.

Figure 19a. MSM-74-16, MSM-75-9, two types of distal tibia, relative greater Transverse width (distal view oval shape); and less transverse width (distal view, 6th night lunar shape) of Pakistani Titanosauria, distal view.

Scale. Each black and white digit is 1 cm.

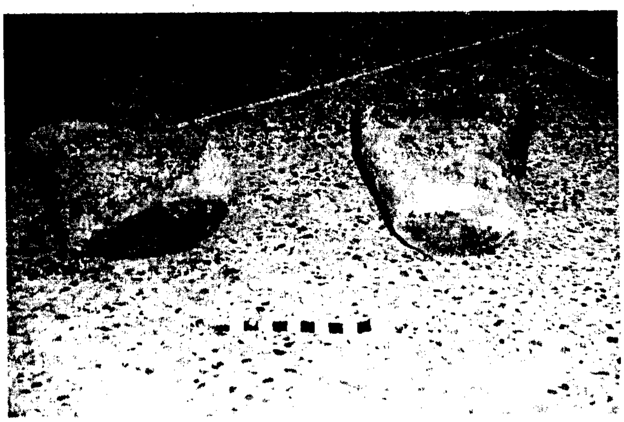


Figure 19b. MSM-76-16, MSM-77-16, a pair (left and right) of proximal fibulae of Pakistani Titanosauria, ventromedial/internal view.

Scale. Each black and white digit is 1 cm.

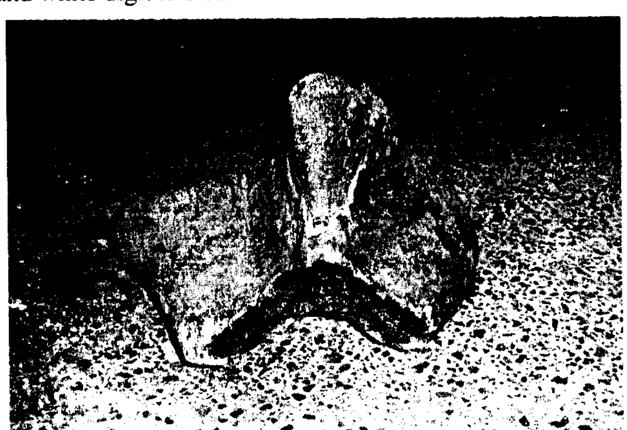


Figure 20a. MSM-78-15, Proximal left ulna of PakistaniTitanosauria, lateroventral/internal view.
Scale. Each black and white digit is 1 cm.

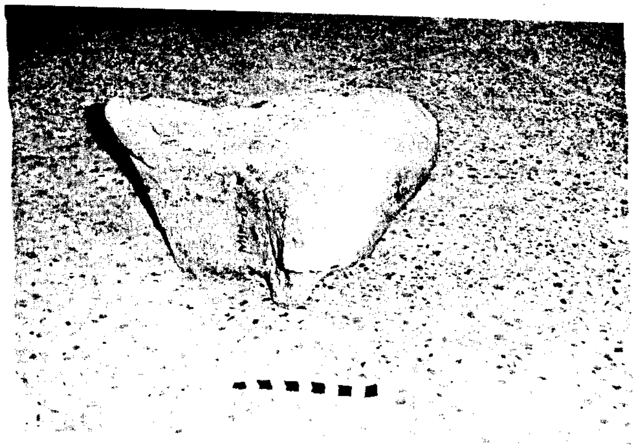
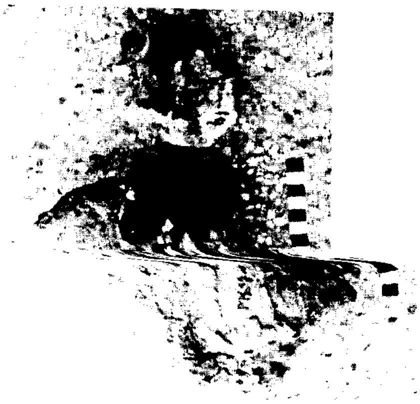


Figure 20b. MSM-78-15, Proximal left ulna of PakistaniTitanosauria, lateroventral/internal view.
Scale. Each black and white digit is 1 cm.



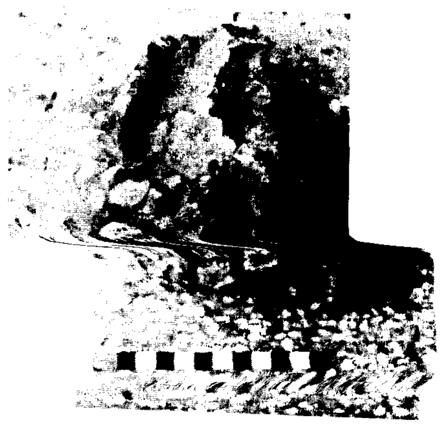


Figure 21a. Left side, Upper photograph; [illegible]. *Posterior vomerine, fused palatine and pterygoid of Marisaurus*, anterovent. view.
Left side,Lower photograph; MSM-79-19. Anterior skull and articulated dentary of *Marisaurus*, anterovent. vie
Right side photograph; MSM-79-19. Anterior skull and articulated dentary of *Marisaurus,* interior view of skul
the level of about posterior maxilla.
Scale. Each black and white digit is 1 cm.

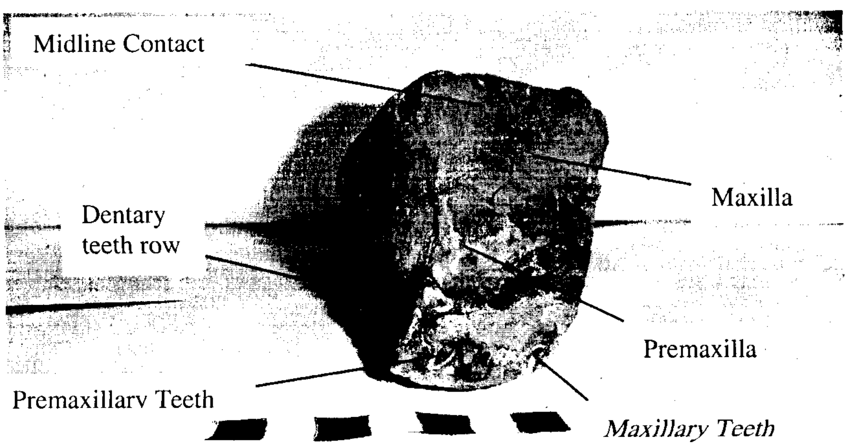


Figure 21b. Anterior view of rostrum articulated with mandible of ***Balochisaurus,*** a herbivorous Titanosaurian Sauropod dinosaur uncovered from Vitakri area,Barkhan District, Balochistan, Pakistan. Specimen no. MSM-1
Scale. Each black and white digit is 1 cm.

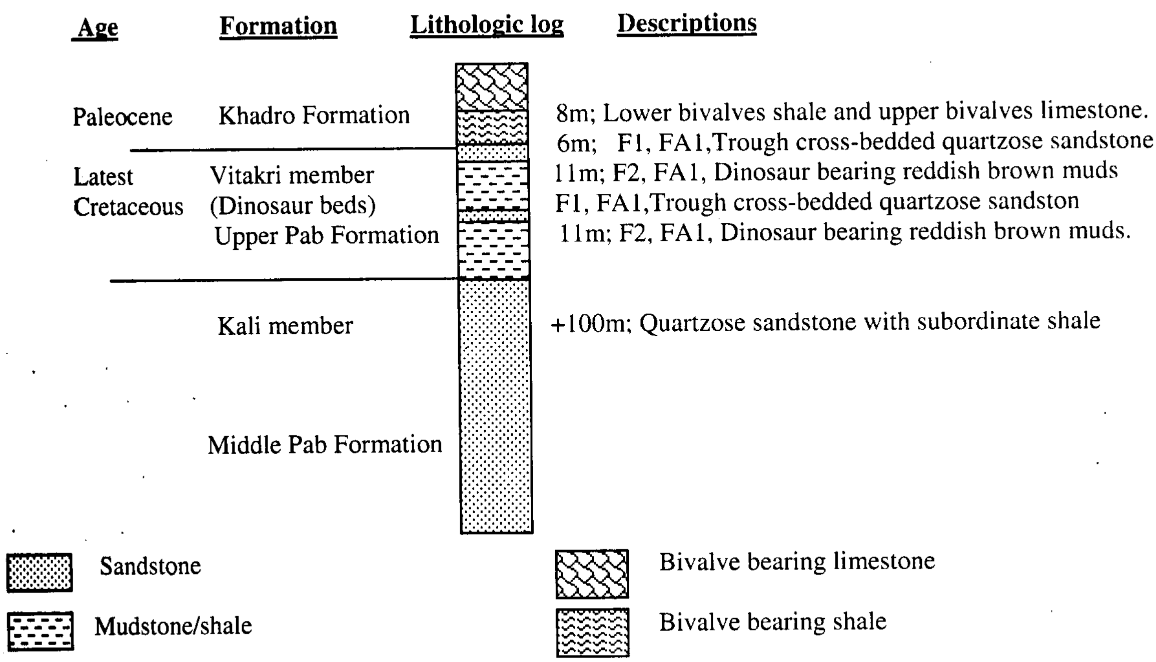


Figure 22a: Lithologic section through the Latest Cretaceous Dinosaur beds/Vitakri member of Pab Formation of Kinwa Kali Kakor locality of Vitakri area, Barkhan District, Balochistan, Pakistan. (69^0 23' 09'' E, 29^0 40' 57'' N). Figure not to the scale.

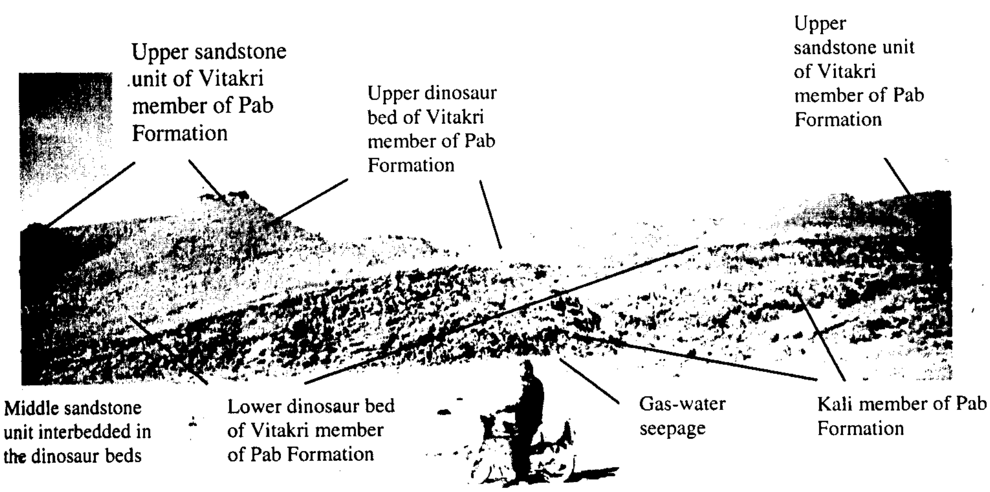


Figure 22b. Photograph of middle Kali member and upper Vitakri member/dinosaur beds of Latest Cretaceous (Maestrichtian) Pab Formation from Kinwa Kali Kakor Locality of Vitakri area, Barkhan District, Balochistan, Pakistan.For scale please see the man on motorcycle.

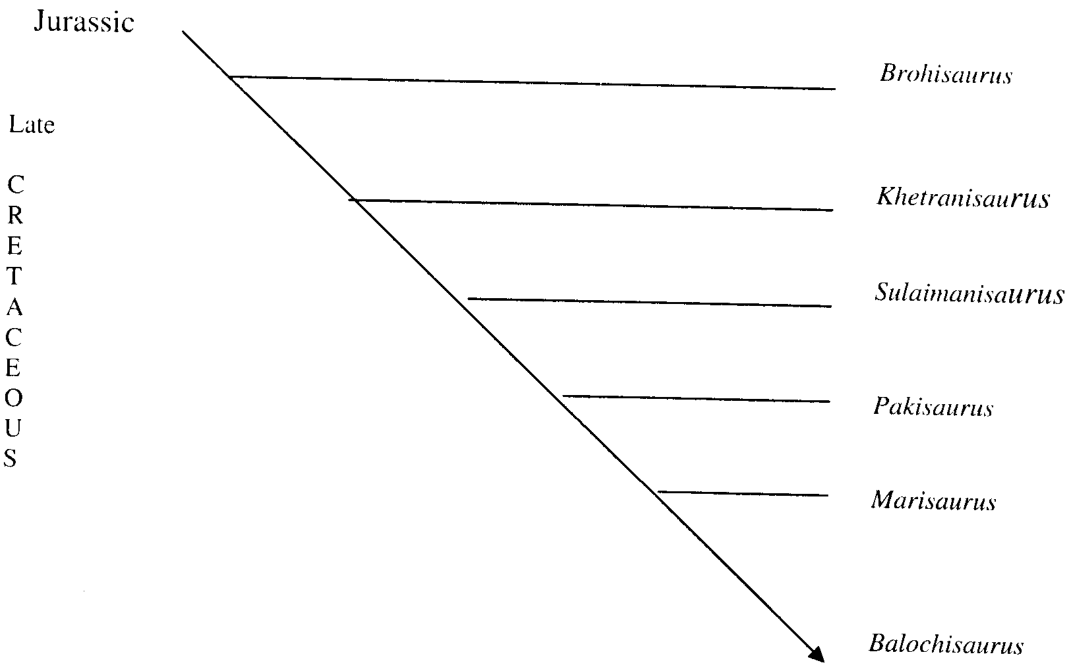


Figure 23a. Tentative phylogeny of Pakistani sauropod dinosaurs based on caudal morphology and age.

Figure 23b. Herbivorous titanosaurian sauropod dinosaurs' herd defending to the carnivorous theropod dinosaurs. (after Clark, R. 2003).

Table 1. The measurements of centra of ***Pakisaurus***

	MSM-11-4	**MSM-12-4**	**MSM-13-4**	**MSM-14-4**	**MSM-15-15**	**MSM-16-2**	**MSM-17-16**
Length without articular cone	8.7	10.6	9.9	-	9.0	10.0	7.0
Length with articular cone	13.6	14.6	13.0	-	11.7	12.5	9.6
Length from lowest cone of anterior chevron facet to posterior chevron facet	-	5.6	5.5	6.4	5.2	-	-
Proximal height without chevron	-	-	10.1	-	7.0	8.1	-
Proximal height with chevron ridge	-	-	10.2	-	-	-	-
Distal height without chevron ridge	-	9.3	7.8	8.2	6.7	7.0	-
Distal height with chevron ridge	-	9.9	9.3	9.6	7.7	-	-
Proximal transverse width	-	-	-	-	-	-	-
Distal transverse width	-	-	7.8	7.8	6.3	6.3	-
Middle transverse width above	-	6.0	6.0	5.7	4.7	4.3	5.0
Middle transverse width below	-	5.8	5.6	5.0	4.5	3.8	5.0
Middle transverse width between ventral ridges	-	-	3.6	3.3	2.8	-	-
Ratio of mid transverse width above and below	-	1.03	1.07	1.14	1.04	1.13	1.00

Table 2a. The measurements of centra of ***Sulaimanisaurus***

	MSM-17-4	**MSM-18-4**	**MSM-19-4**	**MSM-20-4**	**MSM-21-4**	**MSM-21(a)-4**	**MSM-22-4**
Length without articular cone	8.2	7.6	8.3	8.4	-	9.6	9.7
Length with articular cone	13.6	13.0	13.0	13.0	-	13.0	14.7
Length from lowest cone of anterior chevron facet to posterior chevron facet	-	5.0	-	4.3	-	5.3	5.5
Proximal height without chevron ridge	-	10.6	-	10.0	-	8.6	-
Proximal height with chevron ridge	-	11.3	-	10.1	-	9.0	-
Distal height without chevron ridge	10.2	9.6	9.6	9.1	-	7.4	-
Distal height with chevron ridge	-	9.7	-	9.2	-	8.3	-
Proximal transverse width	-	13.0	-	-	-	-	-
Distal transverse width	12.0	11.2	10.1	9.6	-	8.4	-
Middle transverse width above	-	9.0	9.0	9.1	6.6	5.8	-
Middle transverse width below	-	6.7	6.7	6.5	6.6	5.2	-
Middle transverse width between ventral ridges	-	-	-	4.0	2.8	3.4	-
Ratio of mid transverse width above and below	-	1.34	1.34	1.40	1.00	1.11	-

Table 2b. The measurements of centra of ***Sulaimanisaurus***

	MSM-23-3	MSM-24-15	MSM-25-15	MSM-26-15
Length without articular cone	9.0	9.3	9.2	9.2
Length with articular cone	12.0	12.5	12.4	11.7
Length from lowest cone of anterior chevron facet to posterior chevron facet	5.2	-	-	-
Proximal height without chevron ridge	-	8.3	7.4	-
Proximal height with chevron ridge	-	9.3	-	-
Distal height without chevron ridge	-	7.8	7.1	-
Distal height with chevron ridge	-	8.0	-	-
Proximal transverse width	-	-	-	-
Distal transverse width	-	8.5	-	-
Middle transverse width above	-	5.5	5.5	3.8
Middle transverse width below	-	5.1	5.1	3.3
Middle transverse width between ventral ridges	-	3.5	3.5	2.3
Ratio of mid transverse width above and below	-	1.08	1.08	1.15

Table 3. The measurements of centra of ***Khetranisaurus***

	MSM-27-4	MSM-28-4
Length without articular cone	8.1	-
Length with articular cone	12.0	-
Length from lowest cone of anterior chevron facet to posterior chevron facet	-	-
Proximal height without chevron ridge	7.5	-
Proximal height with chevron ridge	-	-
Distal height without chevron ridge	-	6.0
Distal height with chevron ridge	-	-
Proximal transverse width	-	7.5
Distal transverse width	-	8.0
Middle transverse width above	6.3	6.3
Middle transverse width below	7.3	7.0
Middle transverse width between ventral ridges	-	-
Ratio of mid transverse width above and below	0.86	0.90

Table 4a. The measurements of centra of ***Marisaurus***

	MSM-29-15	**MSM-30-15**	**MSM-31-15**	**MSM-32-15**	**MSM-33-15**	**MSM-34-16**
Length without articular cone	9.5	8.2	9.0	8.5	9.0	10.0
Length with articular cone	15.0	12.0	12.0	12.0	13.0	15.5
Length from lowest cone of anterior chevron facet to posterior chevron facet	-	-	-	-	4.1	-
Proximal height without chevron ridge	14.2	-	-	-	-	-
Proximal height with chevron ridge	-	-	-	-	-	-
Distal height without chevron ridge	13.5	9.8	9.5	-	-	10.6
Distal height with chevron ridge	-	11.4	10.7	-	-	12.0
Proximal transverse width	16.2	-	-	-	10.5	-
Distal transverse width	14.0	9.0	8.6	-	9.7	10.6
Middle transverse width above	14.0	8.5	8.6	11.1	-	8.4
Middle transverse width below	9.0	6.3	5.7	8.0	6.2	6.5
Middle transverse width between ventral ridges	7.0	5.0	4.0	-	4.5	-
Ratio of mid transverse width above and below	1.55	1.35	1.50	1.38	-	1.29

Table 4b. The measurements of centra of ***Marisaurus***

	MSM-35-16	**MSM-36-4**	**MSM-37-4**	**MSM-38-4**	**MSM-39-4**	**MSM-39(a)-4**
Length without articular cone	9.7	10.2	13.0	11.0	10.0	-
Length with articular cone	13.0	17.0	18.0	15.5	15.0	-
Length from lowest cone of anterior chevron facet to posterior chevron facet	-	-	6.4	6.6	6.6	-
Proximal height without chevron ridge	-	12.2	13.0	12.8	12.5	-
Proximal height with chevron ridge	-	-	13.5	-	-	-
Distal height without chevron ridge	9.5	12.0	11.4	11.4	9.9	8.8
Distal height with chevron ridge	-	-	13.0	11.7	11.0	9.9
Proximal transverse width	-	15.5	14.0	14.0	-	-
Distal transverse width	9.9	15.0	11.6	10.7	10.5	9.2
Middle transverse width above	8.6	14.0	10.0	10.0	9.9	8.4
Middle transverse width below	6.0	10.0	7.0	8.0	6.0	5.9
Middle transverse width between ventral ridges	-	8.0	5.6	6.6	4.0	4.3
Ratio of mid transverse width above and below	1.43	1.40	1.42	1.25	1.65	1.42

Table 4c. The measurements of centra of ***Marisaurus***

	MSM-40-8	MSM-41-2	MSM-42-2
Length without articular cone	9.6	10.8	6.6
Length with articular cone	16.0	15.0	10.3
Length from lowest cone of anterior chevron facet to posterior chevron facet	-	-	-
Proximal height without chevron ridge	-	-	-
Proximal height with chevron ridg	-	-	-
Distal height without chevron ridge	11.5	9.5	7.1
Distal height with chevron ridge	12.0	10.2	-
Proximal transverse width	-	-	-
Distal transverse width	14.0	10.6	9.5
Middle transverse width above	12.0	10.1	8.5
Middle transverse width below	9.0	7.0	-
Middle transverse width between ventral ridges	7.5	5.0	-
Ratio of mid transverse width above and below	1.33	1.44	-

Table 5a. The measurements of centra of ***Balochisaurus***

	MSM-44-15	MSM-44(a)-15	MSM-45-15	MSM-46-15	MSM-47-15	MSM-48-15
Length without articular cone	8.0	8.5	9.5	8.5	8.4	9.0
Length with articular cone	12.0	13.0	14.5	12.5	12.3	13.0
Length from lowest cone of anterior chevron facet to posterior chevron facet	4.1	-	-	3.2	3.0	-
Proximal height without chevron ridge	-	-	-	-	-	-
Proximal height with chevron ridge	-	-	-	-	-	-
Distal height without chevron ridge	10.0	9.5	9.6	7.7	7.3	6.9
Distal height with chevron ridge	10.9	10.5	10.7	9.2	8.7	8.4
Proximal transverse width	-	11.5	-	-	-	9.5
Distal transverse width	11.7	10.6	11.1	10.3	9.7	8.7
Middle transverse width above	9.5	8.9	9.4	9.1	8.7	7.4
Middle transverse width below	4.5	4.5	4.7	5.0	4.6	4.7
Middle transverse width between ventral ridges	2.4	2.3	3.0	3.2	3.0	3.0
Ratio of mid transverse width above and below	2.11	1.97	2.00	1.82	1.89	1.57

Table 5b. The measurements of centra of ***Balochisaurus***

	MSM-49-16	MSM-50-4	MSM-51-4	MSM-52-9
Length without articular cone	8.9	7.6	8.3	8.0
Length with articular cone	14.0	1.6	12.0	8.3
Length from lowest cone of anterior chevron facet to posterior chevron facet	-	4.2	-	-
Proximal height without chevron ridge	-	8.0	-	-
Proximal height with chevron ridge	-	8.9	-	-
Distal height without chevron ridge	8.7	7.5	8.1	8.3
Distal height with chevron ridge	-	9.2	9.1	9.1
Proximal transverse width	-	9.3	-	-
Distal transverse width	9.8	9.1	9.7	8.7
Middle transverse width above	8.7	8.1	8.7	-
Middle transverse width below	-	4.0	4.5	-
Middle transverse width between ventral ridges	-	2.5	2.8	-
Ratio of mid transverse width above and below	-	2.02	1.93	-

Table 6. The measurements of centra of ***Vitakridrinda***

	MSM-53-2	MSM-54-2	MSM-55-2	MSM-56-1	MSM-57-3	MSM-58-15
...th	-	-	8.7	-	7.3	7.9
...th	6.4	-	5.5	3.5	6.6	5.6
...ht	7.5	8.2	6.4	5.7	5.7	5.8

Phylogeny of Pakistani Titanosaurs

In 1841 Richard Owen described the scattered remains of the first Sauropod known to science as Cetiosaurus or whale lizard. Since that time abundant Sauropods remains have been discovered on every continent except Antarctica. Sauropods constitute a major proportion of the large herbivores in most continental faunas of Jurassic and Cretaceous age (Wilson and Sereno, 1998). Sauropoda is among the most diverse and widespread dinosaur lineages, having attained a near global distribution by the middle Jurassic that was built on throughout the Cretaceous. These gigantic herbivores are characterized by numerous skeletal specializations that accrued over a 140 million year history. The diversification of Titanosauria during the Cretaceous and origin of the Sauropod body plan during the Late Triassic remains frontiers for future studies (Wilson, 2002). Neosauropoda is composed of two lineages, Macronaria and Diplodocoidea. Macronarians are characterized by a substantial number of appendicular synapomorphies that may be involved in the acquisition of a novel wide gauge locomotory style in Titanosaurs. Diplodocoids in contrast are known from comparably fewer taxa whose relationships are based on predominantly cranial and axial features (Wilson, 2002). On the basis of narrow crown peg/pencil, circular to sub-circular/sub-cylinder teeth morphology, the Pakistani Titanosaurs relate to the diplodocoids- titanosaurs lineage. Because the Camarasurids-Brachiosaurids lineage has broad spatulate teeth crowns, therefore they can not be correlated with the Pakistani Titanosaurs on the bases of this character. On the other hand on the basis of medial deflection of proximal one third of femur, the Pakistani titanosaurs resemble to the Brachiosaurids. Retraction of nares backward in two Pakistani Titanosaurs is clear but its level is unknown. The spongy texture of sacral and presacral vertebrae shows synopomorphies with the somphospyndalous sauropods.

Pakistani sauropods of Middle Jurassic age represent narrow gauge movements (by ichnofossils; Malkani, in review), while the Late Cretaceous titanosaurs (by morphology) represent wide gauge trackways (Malkani, in review), are known more than 25 localities (Malkani, in reviews) in the Sulaiman foldbelt.

Till to date, from Pakistan one species ***Malasaurus Mianwali*** of middle Jurassic sauropod based on only ichnofossils is tentatively erected, one species of Late Jurassic Tianosaurian dinosaurs ***Brohisaurus kirthari*** Malkani 2003c is based on fragmentary limb pieces and five species ***Pakisaurus balochistani, Sulaimanisaurus gingerichi, Khetranisaurus barkhani, Marisaurus jeffi***, and ***Balochisaurus*** of Late Cretaceous Titanosaurs are diagnosed on the basis of caudal vertebrae. Due to temporal variation and narrow gauge locomotion, the ***Malasaurus*** (Middle Jurassic) is assumed to be most primitive in Pakistani forms. Then there is the possibility of ***Brohisaurus*** (Late Jurassic).

Major differentiating character in Late Cretaceous Titanosaurs is the ratio of mid width above and below of caudal centra. Titanosaurids family having basal character show this ratio round about 1 and Saltasaurids having more advanced characters show this ratio 1.5 and 2 or more. *Khetranisaurus* show less than 1 and seems to be very primitive and other two genera such as *sulaimanisaurus* and *Pakisaurus* show round about 1 and seems to be primitive originated from Khetranisaurus. *Marisaurus* of Saltasaurids family show 1.5 and may be originated from *Pakisaurus* and other genera of saltasaurids namely *Balochisaurus* may be originated from primitive saltasaurids as *Marisaurus*. There are three possible thoughts in this regard. These are:

1 Two lineages

1a, *Malasaurus-Brohisaurus-Khetranisaurus-Pakisaurus-Marisaurus;*

1b, *Malasaurus-Brohisaurus-Khetranisaurus-Sulaimanisaurus-Balochisaurus.*

2, one lineage; *Malasaurus-Brohisaurus-Khetranisaurus-Sulaimanisaurus-Pakisaurus-Marisaurus-Balochisaurus* (Fig. 23a).

3, Two lineages 3a, *Malasaurus-Brohisaurus-Khetranisaurus-Sulaimanisaurus-Pakisaurus.*

3b, *Malasaurus-Brohisaurus-Khetranisaurus-Marisaurus-Balochisaurus.*

Paleobiogeographic Implications

Continental vertebrates are restricted in their geographic distribution by marine and oceanic barriers, which affect all forms, except the birds (Hallam 1973). Occasionally these barriers break totally or partially and the faunas disperse outside the area of original distribution in diverse forms. These bridges, 'land bridges' or 'corridors', allow the free circulation of faunas in both directions (Powell, 2003). There also exists 'filter bridges' which are similar to those which are mentioned above, with the difference that climatic or other factors exist which filter or permit the passage of some elected forms. The 'sweepstake routes' permit migration to cross marine barriers, by the medium of 'natural raft' (Simpson 1940).

Isolation between the northern and southern continents produced dramatically different distribution among dinosaurs. In contrast to northern hemisphere, the dominant herbivores in the late cretaceous of India and South America were titanosaurids rather than ornithischians, whereas the large predators were abelisaurids instead of tyrannosaurs. Titanosaurian sauropod dinosaurs from all the continents are: *Alamosaurus* from North America; *Titanosaurus, Aelosaurus, Saltasaurus, Neuquensaurus, Microcoelus, Antarctosaurus, Argyrosaurus, Epachthosaurus, Pellegrinisaurus, Clasmodosaurus,* and *Campylodoniscus* from South America; *Titanosaurus, Lirainosaurus, Aplelosaurus, Hapselosaurus* from Europe; *Aegyptosaurus, Malawisaurus, Rapetosaurus,* and *Titanosaurus* from Africa; *Titanosaurus, Antarctosaurus* and *Laplatosaurus* from India; *Marisaurus, Balochisaurus, Pakisaurus, Sulaimanisaurus,* and *Khetranisaurus* from Pakistan; Opisthocoeliucaudia, Nemegtosaurus, and *Quaesitosaurus* from Mongolia. So the occurrence of Titanosauria in all the continents represents global distribution (Malkani, in review).

Fossil vertebrates of Late Cretaceous age on southern continents are of particular interest because of the dynamic paleogeography of this period. During the Cretaceous, Gondwana broke apart in to separate landmasses, isolating once-contiguous terrestrial faunas. Timing, sequence, and degree of isolation among these landmasses, however remain controversial (Smith, et al., 1994; Hay, et al., 1999; Maisey, 2000; Cracraft, 2001). Indo-Pakistan initially connected with the southern hemisphere of Pangea. The Pangea by its breakup during early to middle Mesozoic, divided into Laurasia and Gondwana. Indo-Pakistan alongwith Madagascar were interlocked with the Gondwanan landmasses of Africa, South America, Australia, Antarctica and Madagascar during most of the Mesozoic, drifted northward during the Cretaceous or early Tertiary to collide with Laurasian landmasses during middle Tertiary. Indo-Pakistan thus appears to have experienced a 100-million-year period of isolation during a 9,000-kilometer migration across the equator and Tethy Sea that can be expected to have influenced the character of its native biota. Fossils from this period of biogeographic isolation were relatively scarce. Thus far, the Late Cretaceous (Maastrichtian) Lameta Formation of India has served as the sole source of information on Cretaceous vertebrates of the Indo-Pakistan sub-continent and their remains are inadequate for assessing generic-level affinities (Wilson, Malkani and Gingerich, 2001). But the recent discoveries of dinosaurs by author include a variety of large vertebrate from the Mesozioc of Pakistan. Most of these assemblages show close resemblance to India, Madagascar and South America and these are best fit to the model of Hay, (1999). These discoveries of Jurassic and Cretaceous Arhosaurian reptiles from Pakistan provide a vantage point and act as a milestone for assessing paleobiogeography and phylogeny.

Examination of fossil records indicates that at the end of the Early Cretaceous, the best adapted and potentially adapted family of sauropod was the Titanosauridae. They flourished in the Late Cretaceous and survived after all the other sauropods had become extinct. After the break up of Gondwanaland, the isolation of the titanosaurids in Indo-Pakistan during much of the Late Cretaceous, without competition from other herbivorous dinosaurs, resulted in a diversification into two families with a total of 5 genera.

Recent discoveries by me include a variety of large vertebrate that indicate the first Late Jurassic Titanosaurs(one species), first Late Cretaceous herbivorous Titanosaurs (five species) and carnivorous Abelisaurs(one species) Dinosaurs and Pabwehshi a *Baurusuchids* (Mesoeucrocoreptilia) fossils, have broadened their distribution and provide a vantage point and act as a milestone for assessing paleobiogeography and phylogeny. Europe, and North America. But its resemblance of some skull and especially teeth characters with Mongolian-Chinese forms like *Nemegtosaurus* and *Quaesitosaurus* are encouraging to say the Titanosauria as a Global/Pangean distribution. The findings of *Vitakridrinda*- an Abelisaurids from Pakistan broaden their spatial distribution and matches with the Gondwanan linkage theory.

The discovery of Saltasaurids, Abelisaurids, and Baurusuchids from Pakistan broadens their distribution and may prove the close affinity with India, Madagascar and South America. Pakistani Titanosauria shows some affinity with the Late Cretaceous fauna of Europe, and North America. But its esemblance of some skull and especially teeth characters with Mongolian. Chinese forms like *Nemegtosaurus* and *Quaesitosaurus* are encouraging to say the Titanosauria as a Global/Pangean distribution. The findings of *Vitakridrinda* an Abelisaurids from Pakistan broaden their spatial distribution and matches with the Gondwanan linkage theory.

Conclusions

Two families of sauropod Titanosauria as Pakisaurids/ Titanosaurids and Balochisaurids/Saltasaurids are identified on the basis of morphology of caudals, femora and tibiae. Three genus and species of Late Cretaceous Titanosaurids are ***Pakisaurus balochistani, Sulaimanisaurus gingerichi*** and ***Khetranisaurus barkhani;*** two genus and species of Late Cretaceous Saltasaurids are ***Marisaurus jeffi*** and ***Balochisaurus,*** which are erected on the basis of morphology of caudal vertebrae. One genus and species of Abelisaurids Theropod dinosaur ***Vitakridrinda sulaimani*** is erected.

The Late Cretaceous (Maastrichtian) Lameta Formation of India has served as the sole source of information on Cretaceous vertebrates of the Indo-Pakistan sub-continent and their remains are inadequate for assessing generic-level affinities but the new discoveries from Pakistan have produced a large number of well preserved fossils and are useful for paleobiogeographic reconstruction and phylogeny. Many localities deserve excavation for exploration of articulated bodies of these exceptional large animals. The discovery of Saltasaurids and Abelisaurids from

Pakistan broadens the distribution of Saltasaurids, and Abelisaurids and may prove the close affinity with India, South America and Madagascar. The findings of *Vitakridrinda*- an Abelisaurids from Pakistan matches with the Gondwanan linkage theory. Pakistani Titanosauria also represents some correlation with Mongolian forms on skull characters. It verifies the Pangean or global distribution

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