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First rostrum of carnivorous *Vitakridrinda* (Abelisaurid Theropod Dinosaur) found from the latest Cretaceous Dinosaur Beds (Vitakri) Member of PAB formation, Alam Kali Kakor Locality of Vitakri area, Barkhan District, Balochistan, Pakistan

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Abstract

The finding of rostrum 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 on the surface of rostrum is the synapomorphy of abelisaurids. Many autopomorphies and other different useful characters of this rostrum are described here. The external nares seem to be bounded by the premaxilla only. The palate is well exposed at cross section. This snout is found in the site of previously reported basioccipital condyle articulated with partial braincase and a pair of proximal femur of *Vitakridrinda*. Although fragmentary these three masses associate and belong to one animal. This specimen will facilitate comparisons with the Gondwanan as well as Laurischian forms.

It has bite mark, puncture, teeth impression and the embedded teeth revealing confrontation between *Vitakridrinda* and its combatant belonging to same or different species. The skull parts of this theropod are found with the partial skull of adult/subadult titanosaurs. Its occurrences with adult/subadult titanosaur suggest that the theropod came to the titanosaur animnal for feed subsequent fighting with other theropod cauld cause its death. The discovery of *Vitakridrinda a*belisaurids, alongwith saltasaurids, and baurusuchid from Pakistan broadens the distribution and indicates a close affinity with South America, Madagascar and India of Gondwanaland. These assemblages underscore many taxonomical features useful for paleobiology, paleobiogeography, phylogeny, behaviour like fighting, scavenging, predatory and, interaction among other species.

Keywords: Rostrum of **Vitakridrinda** theropod dinosaur beds (Vitakri) Member of PAB formation.

1. Introduction

Carnosaurian dinosaurs were the largest carnivorous animals to inhabit the land (Molnar, *et al.*, 1990). Theropoda are carnivorous dinosaurs. It is the most differentiated group of saurischian dinosaurs, consisting of a sister group to the Sauropodomorpha. Theropoda was originally erected by Marsh (1881) to include all the known Triassic dinosaurs, and the Jurassic and Cretaceous carnivorous dinosaurs. Huene (1914) divided the theropods into carnosaurs and coelurosaurs on the basis of size. The large were called carnosaurs and the small ones coelurosaurs. Bonaparte *et al*, (1990) placed *Abelisaurus*, *Carnotaurus* and *Indosuchas* in the same family, Abelisauridae.

Later on, Huene (1914) proposed an alternative classification of the saurischia and distinguished the coelurosauria. Subsequently Huene (1920) erected carnosauria for large carnivores and coelurosauria for small carnivores. Romer (1956) used the terms as large theropods and small theropods. Gauthier (1986) included the "birds and all saurischians that are

closer to the birds than they are to sauropodomrphs" within the Theropoda.

Theropoda is divided into primitive Theropoda and Neotheropoda. Neotheropoda is divided into coelophysoidea, ceratosauria and tetanurae. Abelisauroidea is the major clade of Ceratosauria, further subdivided into Noasauridae and Abelisauridae (Sereno, *et al.*, in review). Tetanurae is divided into carnosauria and coelurosauria. Carnosauria ended in to strart of early Late Cretaceous. Coelurosauria consists of tyranosaurids. Tyranosaurids are additionally characterized by incisor like nipping teeth in the premaxilla, by extremely powerfull jaws and lateral teeth (which unlike those of typical theropods, are relatively thick side to side), and extremely reduced forelimb with only two claws. Large size of tyranosaurids is due to ending of carnosauria and diet problem (bone and flesh)(Tom R., Holtz, Jr. 2000).

The Theropoda shares with the Sauropodomorpha several derived characters (Gauthier 1986): the reduced maxillary process of the premaxilla, invasion of the temporal musculature onto the caudodorsal surface of the frontal, the neck forming at least 33 percent the length of the presacral vertebral column, placement of the postzygapophyses more laterally than the prezygapophyses, accessory hyposphene-hypantrum articulations between the trunk vertebrae, the manus 40 percent or more of the combined length of the humerus and radius, and the pollerx more robust than other manual digits, the former bearing a large ungula. The Theropoda is a monophyletic group characterized by members having an antorbital fossa, fusion of the vomers rostrally, an expanded and ventrally concave ectopterygoid. The presacral verrterbrae are pleurocoelous, and the sacrum includes at least five vertebrae. The manus has a reduced or absent metacarpal and digit V and/ or IV. The penultimate manual phalanges are elongate; the unguals are enlarged, curved, and transversely compressed. The illium has somewhat elongate preacetabular process and pronounced brevis fossa (Osmolska, 1990).

Well preserved skulls are known for *Allosaurus fragilis, Nanotyrannus lencensis, Alberytosaurus libratus, Daspletosaurus torosus, Tarbosaurus bataar, and Tyranosaurus rex* (Osborn 1912, Madsen 1976, Gilmore 1946, Lambe, 1917, Russell 1970, Maleev 1974). Other taxa are represented by less complete skulls *(Alectrosaurus olseni and Alioramus remotus;* Perle 1977; Kurzanov 1976). Most cranial elements are known from isolated and articulated bones. The palate has been described and illustrated for *Tyranosaurus rex, Daspletrosaurus torosus* and *Allosaurus fragilis* (Osborn, 1912, Russel, 1970; Madsen 1976). Braincases are not well known but have been described for *Acrocanthosaurus atokensis, Allosaurus fragilis, Carcharodontosaurus saharicus, Chilantaisaurus maortuensis, piantnitzkysaurus floresti,Tarbosaurus bataar, and Tyranosaurus rex* (Stovall and Langston 1950, Madsen 1976, Stromer,193; Hu, 1964, Bonaparte 1985, Maleev,1974, Osborn 1912). More descriptive work is needed for an understanding of both palatal and braincase structure in carnosaurus. Hereby the author describes the presently discovered rostrum which has well preserved palatal processes.

Theropoda has global occurrences while tyranosaurids have Laurischian affinity and abelisaurids have Gondwanan affinity. Abelisauroid predators have been recorded almost exclusively from South America, India and Madagascar, a distribution thought to document persistent land connections exclusive of Africa. Discovery of horned dinosaur predatory dinosaur *Carnotaurus sastrei* (Bonaparte, 1985; Bonaparte *et al.,* 1990) and close relatives (Bonaparte and Novas, 1985; Bonaparte and Powel, 1980) in rocks of Late Cretaceous (Maastrichtian) age in Argentina brought to light a new group of dinosaurs now recognized as Abelisauroids. Similar–age fossils from India and Madagascar were linked to this group.

Huene and Matley (1933) described 4 families of carnosauria from India. Sereno, *et al.,* (2004) proposed the Pan-Gondwana model (Scotese, 2001) on the basis of finding of Abelisauroids in the Niger, in which three narrow, probably intermittent passages connected major Gondwanan landmasses during the early

Cretaceous and disconnected at the end of early Cretaceous while the Africa first model (Sampson *et al.*, 1998; Hay *et al.*, 1999) show separation in early duration of early Cretaceous.

The presence of the eleven named species from the Lameta Formation of India actually represent at least three large bodied theropod *(Rajasaurus, Indosuchas, Indosaurus)* and a fourth, small bodied theropod (*Laevisuchas*) (Wilson, *et al.*, 2003). But recently from Pakistan, Malkani (2004) reported one species *Vitakridrinda* of large bodied theropod. However the finding of rostrum of ***Vitakridrinda*** large bodied abelisaurid theropod dinosaur is the first from Pakistan. However there are some evidences of another species of large bodied abelisaurid theropod from Pakistan based on morphology of vertebrae, one small bodied may be noasaurid theropod and an avian theropod. The discovery of abelisaurids, saltasaurids, and baurusuchid from Pakistan broadens the distribution of saltasaurids, abelisaurid and baurusuchid, indicating close affinity with South America, Madagascar and India of Gondwanaland. This specimen will facilitate comparisons with the Gondwanan as well as Laurischian forms. These assemblages underscore many taxonomical features which may be useful for phylogeny, paleobiogeography, behaviors like fighting, scavenging, predatory and interaction among other species.

The associated biomas community of presently described carnivorous theropod is mentioned as following. After first discovery, uptill now round about three thousand fragmentary bones/pieces of bones/fossils have been collected by author from the terrestrial strata of Latest Cretaceous (Maestrichtian) Dinosaur beds/Vitakri member of uppoer part of Pab Formation from Central Sulaioman foldbelt. Pakistani titanosaurs tails tell five tails. Three genus and species (*Pakisaurus balochistani, Sulaimanisaurus gingerichi and Khetranisaurus barkhani)* of herbivorous Pakisaurid=Titanosaurid, and two genus and species (*Marisaurus jeffi and Balochisaurus malkani)* of herbivorous Saltasaurids titanosaurian sauropod dinosaurs are erected (Malkani, 2004). One genus and species (*Pabwehshi pakistanensis)* of Mesoeucrocodylia was discovered by me and reported by Wilson, Malkani and Gingerich (2001), and Malkani (2004b). In addition to this, a partial skull (Malkani, 2003a) along with nearby findings of some cervicals, dorsals, caudals and appendicular elements (Malkani, in process) of *Marisaurus*, four armor bones (Malkani, 2003b), and one braincase (Wilson, Malkani and Gingerich,2005) of Pakistani titanosaurian sauropod have been reported. Presently new discoveries like a Rostrum of *balochisaurus*, an atlas-axis complex, an overlapping dentary teeth(partial), and many cervical, dorsal and caudal vertebrae, and appendicular elements of Pakistani titanosaurian sauropod saurishian dinosaurs (Malkani, in process) are made. One genus and species (*Brohisaurus kirthari*) of Late Jurassic Titanosauria have been discovered from Kirthar foldbelt, Pakistan (Malkani, 2003c, Malkani, 2004c).

2. History of dinosaur discoveries in Pakistan

The first ever discovery of dinosaurs from Pakistan was made by the author during early (2000) from the Latest Cretaceous Dinosaur beds/Vitakri member of Pab Formation in Vitakri area, Barkhan District, Balochistan. A fossil of distal femur of titanosaurian sauropod dinosaur was collected but was first reported by Malkani and Anwar (2000). Professor Philip D. Gingerich, University of Michigan visited the location in late 2000 and about 100 bones/pieces of bones of dinosaur Vitakri locality number one were sent to Museum of Paleontology, University of Michigan, USA for sample preparation. The author collected further 1500 bones/pieces of bones from 25 different localities in the Sulaiman foldbelt, administratively located in the areas of Barkhan, Kohlu, Dera Bugti, and Dera Ghazi Khan districts of Balochistan and Punjab provinces during early 2001. Dr Jaffery A Wilson, Museum of Paleontology, University of Michigan, USA visited the GSP museum during March, 2001 and Dr. David A. Krauss of Bostan College, USA visited the GSP museum and Vitakri locality during middle of 2001 for dinosaur project. The second time dinosaur fossils were reported by Malkani, Wilson and Gingerich, in (2001). About 1200 bones/ pieces

were collected in the middle of (2001), from Sulaiman foldbelt and 20 pieces of bones of Late Jurassic/Early Cretaceous dinosaur were collected Kirthar foldbelt. Malkani, (2003a,b,c, 2004a) again reported Dinosaurs fossils from the Sulaiman fodbelt areas. Two cranial specimens were collected during early (2005). A good number of bones/fossils have been observed and located in situ at Vitakri and Fort Munro regions of Sulaiman foldbelt during field studies. These are left untouched for detailed field studies, proper excavation, preparation of specimen and laboratory studies to describe this fauna. These localities of archosaurs are easy for excavation due to soft mud/clay host rocks to find the articulated skeleton of these exceptional animals.

Late Cretaceous Park and are enriched by bones/fossils.

3. Geological and stratigraphic setting

Newly discovered rostrum of *Vitakridrinda* has been found from Vitakri area, Barkhan District, Balochistan, Pakistan (Figure-1). The study area of Sulaiman fold belt is located in the Central part of Pakistan. The Latest Cretaceous (Maestrichtian) dinosaurs are hosted by the Pab Formation of Sulaiman fold belt. In Vitakri area, the Late Cretaceous Pab Formation has been divided in to three members like Lower Dhaola member, middle Kali member and upper Vitakri member/Dinosaur beds. The Latest Cretaceous sediments in the study area underwent considerable tectonic deformation during the

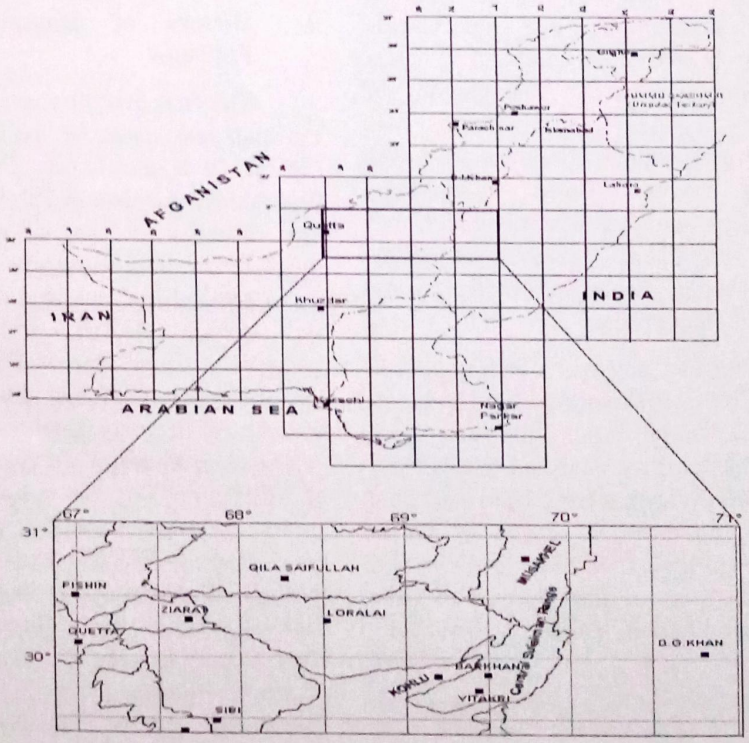

Figure 1. Index map of Pakistan showing the Vitakri locality, which is the host of newly discovered rostrum of *Vitakridrinda sulaimani*, an Abelisaurid theropod dinosaur.

As a whole the Vitakri and vicinity areas seem to be graveyard of terrestrial ecosystems of Vitakri

collision of Asian and Indo-Pakistan continental plates that commenced in the Late Cenozoic. As a

result dinosaur beds along with other formations have been folded.

The Sulaiman foldbelt consists of sedimentary rocks ranging in age from Jurassic to Recent (Figure-2). The rocks comprising of shale, limestone, sandstone, siltstone, marl and conglomerate in different lithological units in ascending order as; Jurassic Sulaiman group representing Spingwar, Loralai and Chiltan formations, Cretaceous Parh group representing Sember, Goru and Parh formations, newly proposed Fort Munro group representing Mughal Kot, Fort
Munro and Pab formations; Paleocene Ranikot Group representing Khadro, Rakhi Gaj and Dungan
Munro and Pab formations; Paleocene Ranikot Group representing Khadro, Rakhi Gaj and Dunganformations; Eocene Ghazij Group represents Shaheed Ghat, Toi, Drug and Baska formations; (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, Fig.-2).

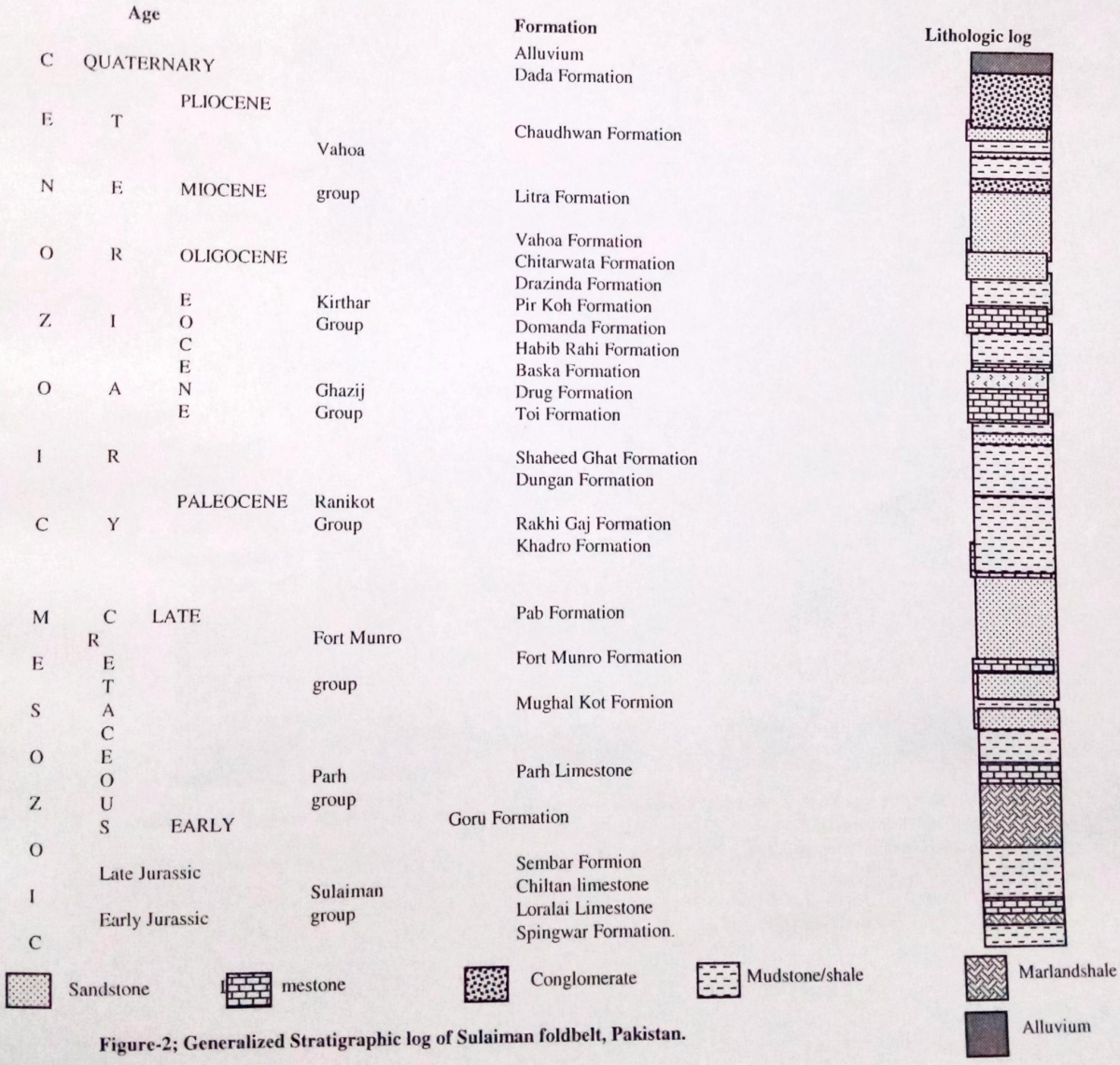

Figure-2; Generalized Stratigraphic log of Sulaiman foldbelt, Pakistan.

4. Materials and methods

Presently a rostrum of ***Vitakridrinda*** abelisaurid theropod dinosaur (MSM-155-19) have been discovered by the author for the first time in Pakistan and reported here. It is found from the Latest Cretaceous Dinosaur beds/Vitakri member of upper part of Pab Formation in Alam Kali Kakor locality of Vitakri area (Figure-1 and 7),

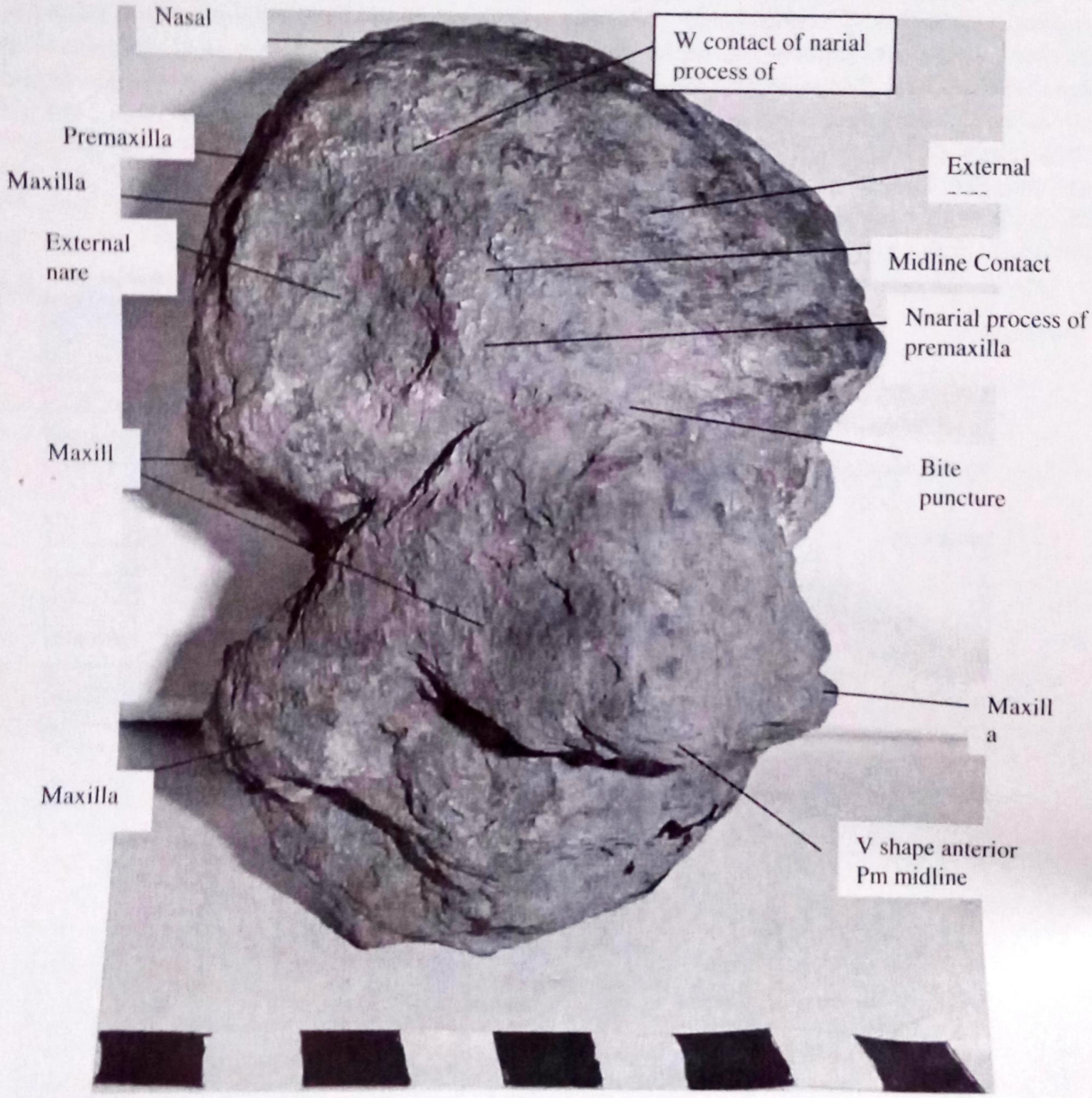

Figure 3. Anterior View of rostrum of *Vitakridrinda*, a carnivorous abelisaurid theropod dinosaur from Vitakri area, Barkhan District, Balochistan, Pakistan Specimen No; MSM-155-19c.
Scale is in centimeter (cm). Every black digit is 1 cm.

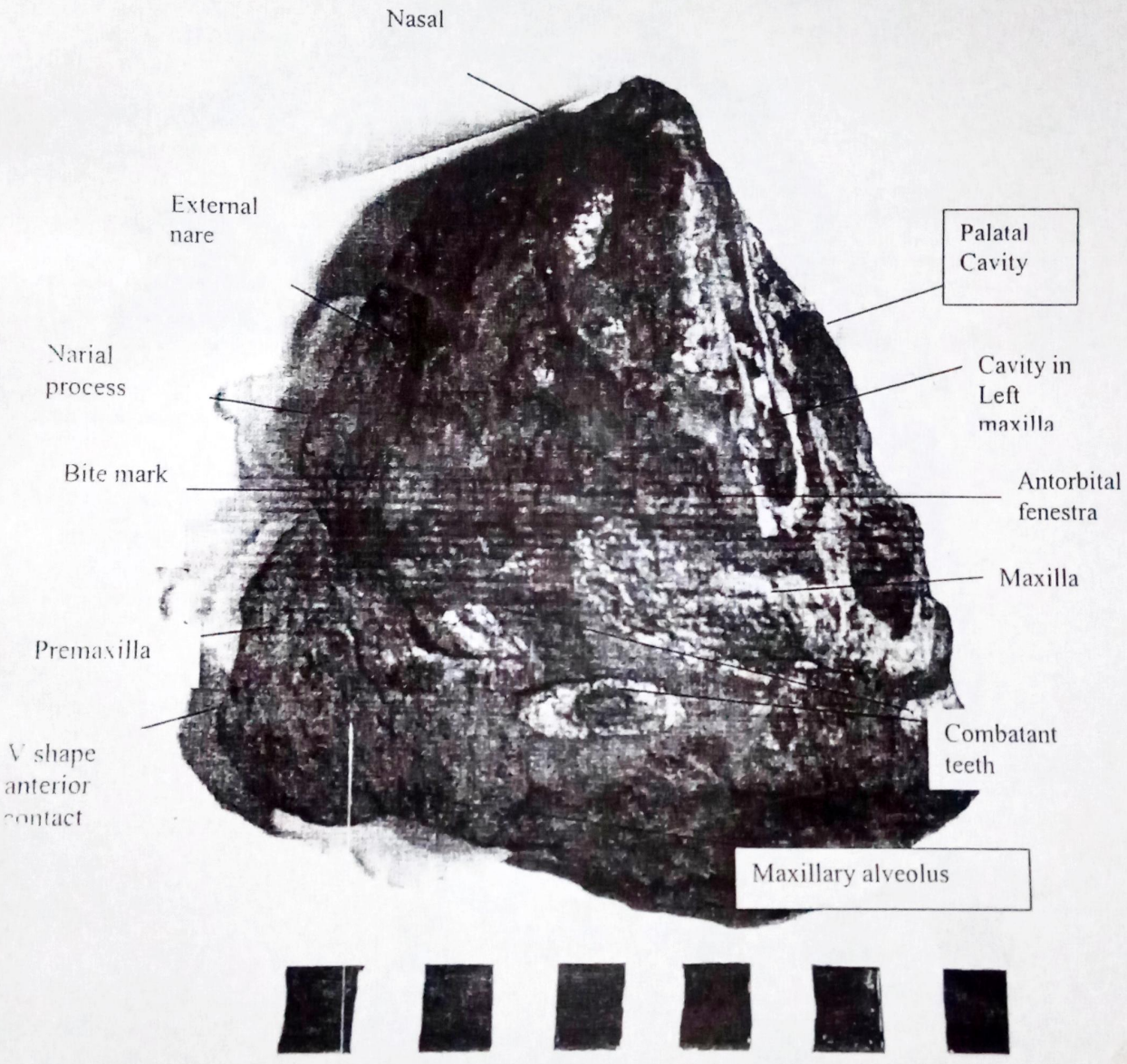

Figure 4 Left lateral View of rostrum of *Vitakridrinda*, a carnivorous abelisaurid theropod dinosaur from Vitakri area, Barkhan District, Balochistan, Pakistan. Specimen No; MSM-155-19c.
Scale is in centimeter (cm). Every black digit is 1 cm.

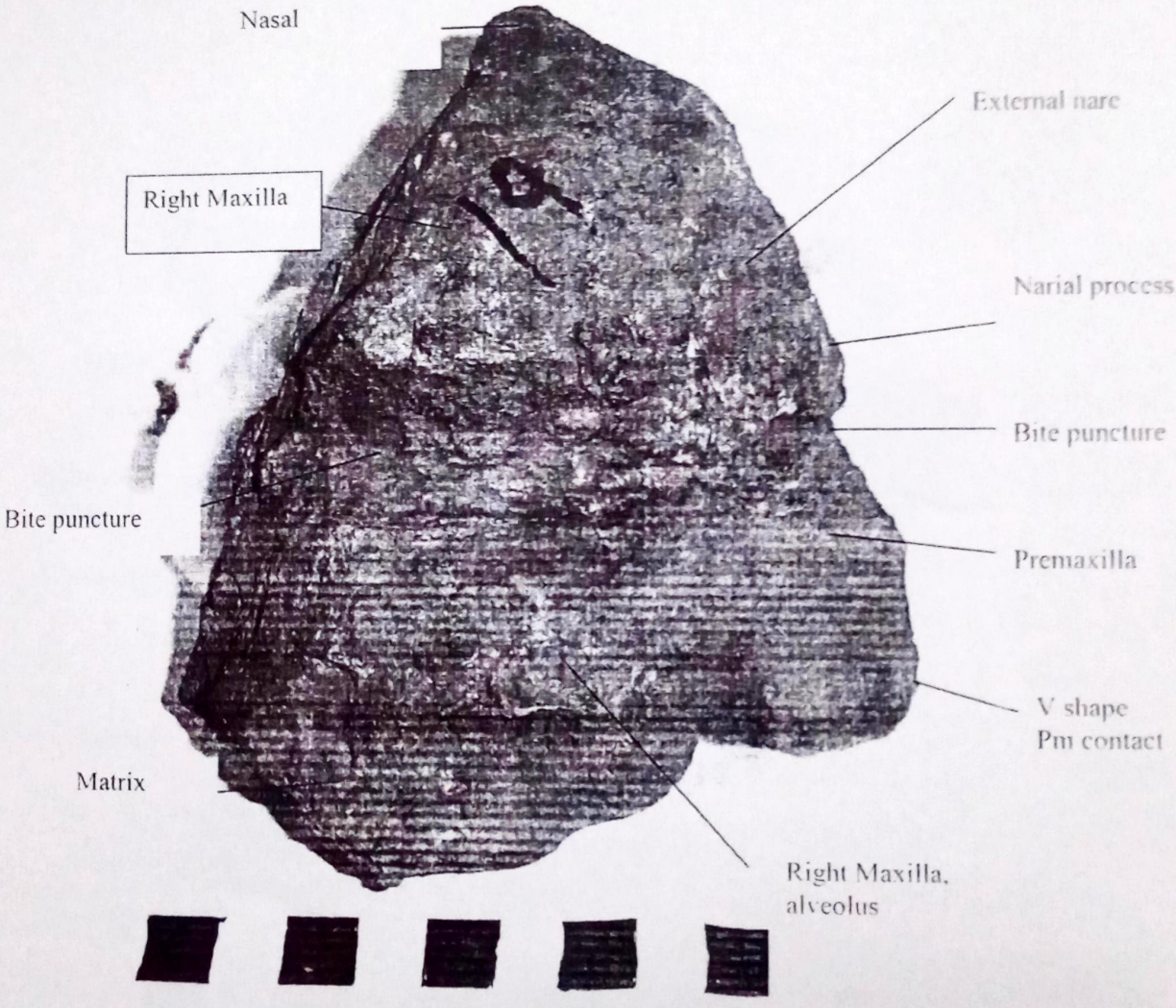

Figure 5.Right lateral View of rostrum of *Vitakridrinda*, a carnivorous abelisaurid theropod dinosaur from Vitakri area, Barkhan District, Balochistan, Pakistan. Specimen No; MSM-155-19c.
Scale is in centimeter (cm). Every black digit is 1 cm.

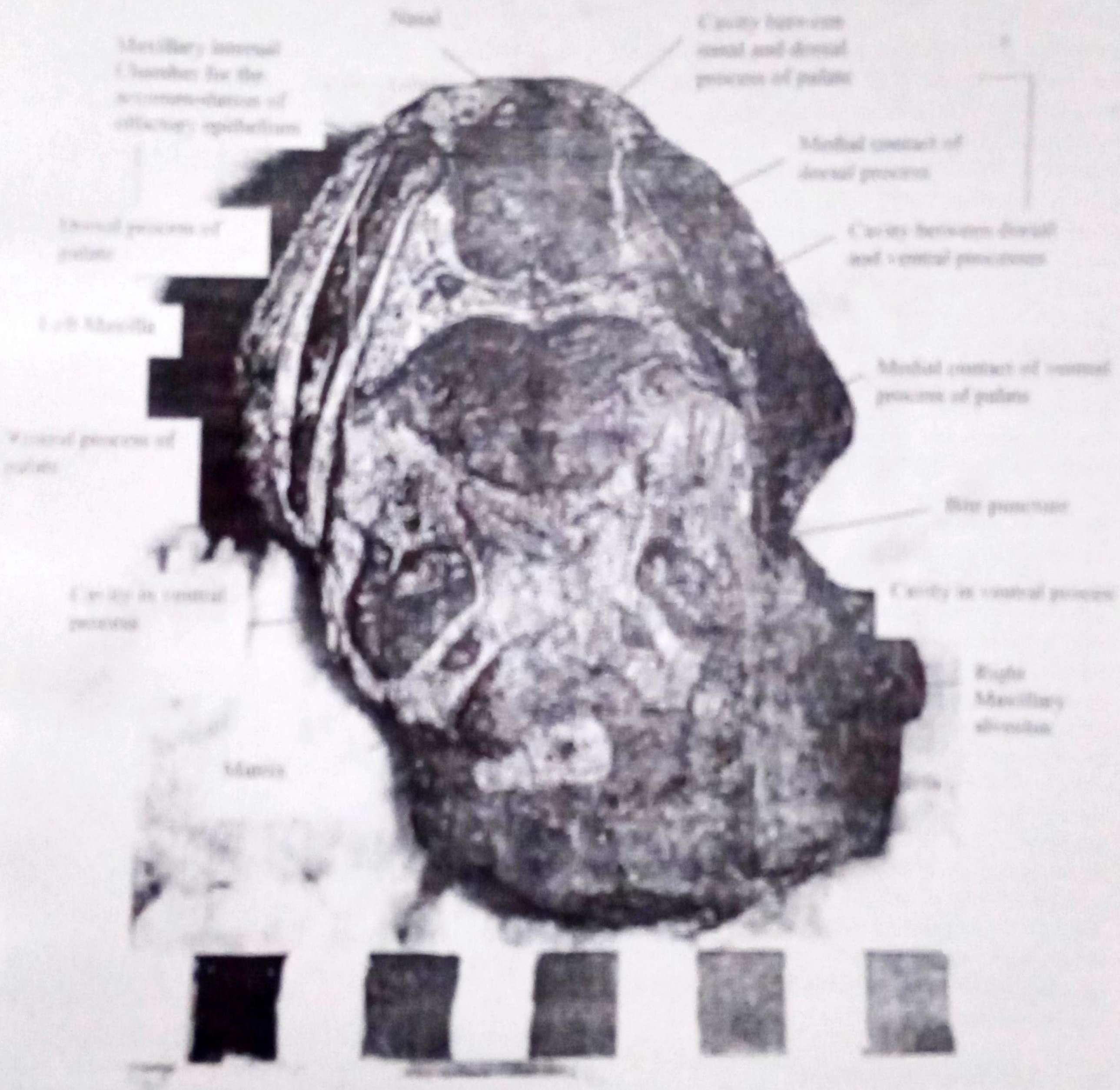

Figure 6 *Posterior View of rostrum of Vitakridrin, a carnivorous abelisaurid theropod dinosaur from Vitakri area, Barkhan District, Balochistan, Pakistan.* Specimen No. MSM-155-19i.
Scale is in centimeter (cm). Every black digit is 1 cm.

Barkhan District, Balochistan, Pakistan. This snout (Figure 3-6) is found in the site of previously reported (Malkani, 2004a,d) basioccipital condyle articulated with partial braincase and a pair of proximal femur of *Vitakridrinda*. All of these fossils of *Vitakridrinda* are found as fragmentary but field evidence and bone association show residual fragments with no transportation. The host horizon is the red muds/clays rich horizon of Vitakri member/Dinosaur beds (upper member) of Late Cretaceous Pab Formation. Discovered cranial parts are found mainly as two masses on same locality. The first mass consists of a basioccipital condyle articulated with partial braincase consisting of paraoccipital process (Malkani-2004d). The second mass consists of a newly collected rostrum preserving the articulated premaxilla along with narial, dorsolateral and lateral processes; external naris; partial nasal, palate and maxilla, which is described here. Both of these specimens are mostly covered by red, brown and black matrix. The third mass coinsists of a pair of proximal partial femur (left and right). Although fragmentary but all these three masses seems to be associated and belong to one animal. The reasons is that the locality is same i. e., the basioccipital condyle articulated with braincase is found 50m apart from rostrum and a pair of proximal femur is 100m apart from basioccipital condyle and 150m apart from rostrum. The second reason is that a pair of proximal femur (left and right) show association. The third reason is that relative sizes of bones/fossils are same, representing adult animal. The fourth materials are vertebrae, which belong to other localities but relative size show adult/sub adult animals. The traditional methodology for paleontological investigations applying descriptive, comparative and interpretive aspects.

6. Systematic paleontology

Dinosauria Owen, 1842
Saurischia Seeley,1887
Theropda Marsh, 1881
Ceratosauria Marsh, 1884
Abelisauridae, Bonaparte & Novas, 1985
Vitakridrinda, Malkani, 2004 (a, d)
Vitakridrinda sulaimani, Malkani,2004 (a,d)

Holotype; MSM-59-19,MSM-60-19,MSM-61-19 and MSM-62-19. A pair of left and right proximal femur; Basioccipital condyle along with partial braincase and a tooth (Malkani, 2004d). The holotype specimens are housed in the Museum of the Geological Survey of Pakistan, Quetta. Newly collected rostrum belongs to the above mentioned locality and included as holotype assemblage of *Vitakridrinda* (MSM-155-19; Figure-3,4,5,6).

Referred specimens; MSM-53-2, MSM-54-2, MSM-55-2, MSM-56-1, MSM-57-3, and MSM-58-15; Four fragmentary caudal vertebrae and two possible dorsal vertebrae (Malkani, 2004d).

Horizon and locality; Holotype specimens are collected from Vitakri locality 19 and referred specimens are collected from Vitakri localities 1, 2, 3 and Mari Bohri locality 15. The holotype horizon is the Vitakri member/ Dinosaur beds of upper part of Late Cretaceous Pab Formation and holotype locality is the Alam Kali Kakor locality (Figure 7) of Vitakri area of Central Sulaiman Range, Barkhan District, Balochistan, Pakistan (Malkani, 2004d).

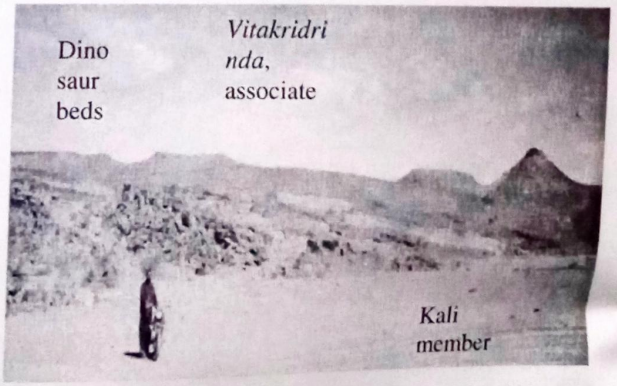

Figure 7. Alam Kali Kakor locality producing assoc ***Vitakridrinda***abelisaurid theropod dinosaur,Vitakri area Balochistan, Pakistan. (For scale please see the man with moto

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 assemblages 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).

7. Description of a rostrum of *vitakridrinda* (theropod dinosaur) from pakistan

First rostrum of ***Vitakridrinda*** belongs to large bodied theropod consists of articulated premaxilla along with 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 pleisomorphies of theropods. The ornamentation like pits and grooves on the surface of rostrum is the synapomorpy of abelisaurids. This rostrum represents many autopomorphies and other different useful characters. The external nares seems to be bounded by the premaxilla only. The short **premaxilla** is subrectangular in lateral view and triangular in anterior view. Its body and dorsal process together form the external naris, and its caudal process contact the nasal and maxilla. On the outer surface it has ornamentation like numerous pits and grooves (Figure3,4). On inner side it is not known and will clear after sample preparation. The anterolateral process is about 4cm long, while the anterior premaxilla along with narial process is 8.5cm long. The separation of posteroventral margins of premaxilla fellows is 4cm. The contact of narial process with the nasal is W shape. The external nares are subcircular having about 2.5cm dia measured on the top where it is filled by matrix (Fig.3). Below the external nares the premaxilla is inset than nasal and maxilla. The midline contact is well exposed in the narial process and feeble on the nasal. Some alveoli without preserved teeth are observed. Minimum anterior width of narial process in the external nare region is 1.2cm. Both the fellows of the premaxilla meet anteriorly with V shape (Figure-3, 4, 5).

The **maxilla** is a large triangular element. The maxilla houses several internal chambers. The major two found in specimen open both rostrally and caudally and may have accommodated olfactory epithelium. The thickness of this chamber varies from 3mm to 7mm and it is 5.5cm long measured on the left maxilla at the posterior broken surface (Figure. 3, 4, 5). Maxilla dorsally is connected with nasal, anteriorly and anterodorsally with premaxilla; and medially with palatal processes. Maxilla have also ornamentation like pitted surface. The preserved lateral process of maxilla is 6cm long and dorsal process is about 9cm long. The rostrum also represents bite mark and puncture (along with combatant teeth and their impression) on the lower side of snout, just below the transversely oriented midline along profile of exposed premaxilla and maxilla. The teeth of combatant are also fixed in the puncture(For detail please see in discussion). One alveolus representing D shape to subcircular asymmetric morphology. Antorbital fenestra is found however it can be clear after sample preparation (Figure-3, 4, 5).

The elongate **nasals** are medially fused. The nasal has feeble rugose mid line contact seems to be tightly fused (Figure-3). The nasal width is about 4cm straight measurements at broken section. Its dorsal circumference is about 4.5cm wide. The thickness of nasal plate is about 7mm to 1cm. The nasal surface represents groove and pitting. The nasal bears two arc shape slight fracture and groove which are parallel to sub parallel. Their arc is convexing backward and forming concave towards anterior. These arcs seem like imbrication.

The **Palate** exposed at about 4cm back of the anterior contact with narial process of premaxilla. It has a long maxillary contact with maxilla representing plate shape contact. Bone texture is spongy and pitted. There are two processess of palate such as dorsal and ventral

processes (Figure-6). The dorsal process is tetraradiate shape probably projecting medially to contact the vomer and ptyerygoid. The ventral process is also tetraradiate that contact the maxilla and possibly with jugal, by a medially open excavation. The ventral process is more robust than dorsal process. Both processes are also internally excavated and are spongy and have internal chambers. Medially the dorsal and ventral processes of palatal are symmetrically vault shaped on both ventral and dorsal sides. The two major cavities are exposed at the nasal sections which is 4.5cm back of W contact with narial process of premaxilla. There are two major cavities in the palatine. The dorsal cavity is rectangular shape with transverse width 2.3cm and dorsoventral height is 2.7cm. It is symmetrical but due to bite mark it is slightly tilted. On the lower side it seems to be divided medially. The other cavity between the dorsal and ventral processes of palatine is subrectangular and more wide than upper cavity and have wings also. The transverse width is about 4.5cm and dorsoventral height is 2.5cm. It is again symmetrical. It is filled by matrix. The ventral process has a pair of left and right cavities with 1.8 and 1.5cm dia respectively, slightly intruded by thin spike of bone on the dorsal part representing same morphology but also tilted by bite. Medioventral to each cavity another smaller cavity of eye shape found well. Three smaller cavities are well exposed on the dorsal of left side cavity. The section of one fellow of dorsal process is triradiate. All radiation radiate from the point in the mid of upper part of maxilla. The dorsal radiation 1.8cm long running parallel to maxilla meet with joint of maxilla and nasal. It is becoming very thin upward decreasing up to 2mm. The ventral radiation 1.8cm long also goes parallel to maxilla and meets with the dorsal radiation of ventral process. It is also thinning downward and gradually taper at or near the dorsal end of dorsal radiation of ventral process. The median radiation goes to the median of chamber to meet its with fellow. Its thickness is first decreasing and then increasing to the mid central junction with fellow. The dorsal process is 1cm thick in the middle centre junction while its minimum dorsoventral height is 7mm. It is contacted with maxilla and nasal also. The section of one fellow of ventral process of palatal is also triradiate. All radiation radiate from the point in the mid of lower part of maxilla. The dorsal radiation 2.4cm long running parallel to maxilla meet with the ventral radiation of dorsal process. It is thinning upward to the joint. The thick ventral radiation goes also parallel to maxilla and tapers at 1.8cm. The median radiation goes to the median of chamber to meet with its fellow. Its thickness is decreasing toward the mid central junction with fellow (Fig. 6). The contact of dorsal process on the left side seems to be from the ventral process. It may be due to bite. The ventral process is transversely 6cm and 2.3cm height in the middle and about 4.5cm long contact with maxilla (Fig-3, 4, 5). The lower and upper side of processes form the arc/arcs. On the left side a fossa representing matrix filled may be preantorbital antorbital fossa and fenestra (Fig4).

Unfortunately the teeth on the premaxilla and maxilla are not preserved. One asymmetrical alveolus in the right maxilla is exposed having antero-posterior length 2cm and maximum width is 1.25cm. matching near about D shape. The two/three possible teeth of combatant are fixed on the line of bite and puncture, having anteroposterior length 2.25cm and transverse width 1cm, while the other is anteroposteriorly length 1.4 m and transverse width 7mm. The third tooth nature is which is found in matrix 1.7cm and width is 7mm. thick in the one side may be posterior side (Fig. 3, 4, 5). The rostrum is also partially weathered. The teeth are eroded away. This rostrum may have anterior dentaries because that portion is mostly covered by matrix. The combatant teeth are also suboval to oval. The large teeth are oval and relatively small show suboval nature (Fig. 4). Isolated teeth D shape and crown length and width ratio is low. Crocodilian teeth are circular to subcircular with striated teeth while the teeth of theropod are oval. The narial fossa is mostly covered by matrix and represent reaching anteriorly inclined downward. Rostrum is compressed and deep. The anterior portions of tooth rows forming V shape joint. Anterior snout V shape, not U shape. One tooth embedded in the matrix along with other bones, found in the same site with the rostrum. This tooth is compressed laterally. Tooth crown is extremely low and the ratio of the

crown height to rostro-caudal width is about 1 to 1.5. Tooth anteroposterior breadth is 2.2cm, labial to lingual depth is about 1.3cm. 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 (Malkani, 2004d).

There are impressions of **bite** on the snout which are represented by the puncture, groove, gash, on right side and teeth implantation on left side and also there are teeth of another combatant theropod on the snout of this theropod. The puncture is great on right side and also representing teeth impressions. The preserved length and width is about 9cm and 2.5cm respectively, widening on the back and thinning a forward. The puncture is trending anteroposteriorly, located in the lower half and just below the boundary of half.

8. Discussion

Theropod lineage leading to birds (Aves) display some of the features that helped investigators establish the dinosaurian origin of birds-including in the order of their evolution, three functional toes, a three finger hand and a half moon shaped wrist bone. Archaeopteryx (150 million years old) the oldest known birds also show some new traits such as a claw on the back toes that curves toward the claws on the other toes. As later birds evolved, many features underwent change. Notably the fingers fused together, the simple tail became a pygostyle composed of fused vertebrae, and the back toe dropped enabling birds'feet to grasp tree limbs firmly (Kelvin and Chiappe, 2000).

The theropod belongs to bipedal movements while Sauropod belongs to quadrupedal movements. Further among Sauropod it is narrow guage and wide gauge. Abelisaurs are known from Gondwanaland. Two theropod dinosaurs as *Indosuchas* and *Indosaurus* are known from India. The *Indosuchas* has a crest on the fronto parietal region like *tyrannosaurus.* Walker (1964) separated *Indosuchas* from *Indosaurus* at familial level. He stressed that the narrow fronto-parietal crest in *Indosuchas* is like that of *tyrannosaurus.* However *Indosuchas* is less advanced, as the median frontal ridge is not narrow, and the prefrontals are more widely separated. Thus he suggests that Indosuchas is a *Tyranosaurus.* Huene distinguished two types of femur and tibia in the Indian allosaurid collection, one type being stouter and the other more slender. Walker believes that the slenderer variety may belong to *Indosaurus*, the stouter type of *Indosuchas.* Huene hinted that on account of inconsiderable thickness of this maxilla, it could belong to *Indosuchas.* Four premaxillary tooth are characteristics of *Tyranosaurus*, thus established their allocation to *Indosuchas.* Two type of dentaries like shallow curvature (*Indosaurus*) and greater curvature (*Indosuchas*) of the anterior region of dentary or from the jaw ramus to symphysis. Huene found two types of basioccipitals. In one the exoccipital forms the floor of foramin magnum *(Indosaurus)* and in other the exoccipitals are excluded from the floor of the foramin magnum (*Indosuchas).* It thus appears from the above discussions, that there are two carnosaurs present in the Lameta Formaton; one is *Indosasurus matley*, a megalosaur; the other is *Indosuchas raptorius*, a tyranosaur. According to Chatterjee, S. and Rudra, D. K. 1996, *Indosuchas* is referred as abelisaurids. The tooth character of Pakistani theropod tele with the *Indosuchas* and consequently with abelisaurids. Unfortunately the post cranial elements of *Abelisaurus* are unknown. Pakistani form is matching with the Indian theropod on the basis of hollow thin walled stout hindlimb bone resemble with *Carnatosaurus* and *Indosuchas*, Spherical elevated inturned head with a distinct neck, tooth crown extremely low, the ratio of crown height to rostrocaudal width is low 1.5 with *Indosuchas.*

The disjunt distribution of the titanosasurids-abelisaurids assemblage in South America, India and Europe is interesting in the context of drifting continents in Late Cretaceous time. Paleontological evidence suggests that the India and Eurasia collision took place during this time, facilitating the migration of northern fauna to India (Chatterjee, 1992, Jaeger, *et al.*, 1989; Prasad, *et al.*, 1994).

Isolation between the northern and southern continents produced dramatically different distributions among dinosaurs. In contrast to northen hemisphere, the dominant herbivore in the late Cretaceous of India and South America were titanosaurids rather than ornithischian, where as the large predators were abelisasurids instead of *Tyranosaurus* (Chatterjee and Rudra, 1996).

Fossil vertebrates of Late Cretaceous age on southern continents are of particular interest because of the dynamic paleography of the period. During the Cretaceous, Gondwana broke apart into 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). This uncertainty is compounded by the relative scarcity of diagnostic Cretaceous vertebrate fossiols, whose relationships could offer evidence of prior geographic connections. Among southern landmasses, Cretaceous vertebrates are best documented on South America. This is largely a result of intensive investigations of strata in Argentina over the last 30 years(summarised in Bonaparte, 1978, 1996).

Sulaiman foldbelt of Pakistan is famous for Cenozoic vertebrate (Gingerich *et al.*, 2001) and new dinosaur discoveries from the Latest Cretaceous strata increase the temporal variation of its vertebrate fauna.

There are impressions of bite on the newly collected snout of which are represented by the puncture, groove, gash, on right side and teeth implantation on left side and also there are teeth of another combatant theropod on the snout of this theropod. Here is a brief description about fighting and gregarious behaviour because these features are also found in Pakistani theropod.

Tanke is a leading authority on paleopathology the study of ancient injuries and disease. He has detected a unique pattern of bite marks among theropods, the group of carnivorous dinosaurs that encompasses *T.rex* and other tyrannosaurs. These bite mark consist of gouges and punctures on the sides of the snout, on the sides and bottom of the jaws, and occasionally on the top and back of the skull. Interpreting these wounds, Tanke and Currie reconstructed how these dinosaurs fought. They believe that the animals faced off, but primarily gnawed at one another with one side of their complement of massive teeth rather than snapping from the front. The workers also surmised that the jaw-gripping behavior accounts for peculiar bite marks found on the sides of tyrannosaur teeth. The bite pattern implies that the combatants maintained their heads at the same level throughout a confrontation. Based on magnitude of some of the fossils wounds, *T.rex* clearly showed little reserve, and sometime inflicted severe damage to its conspecific foe. One tyrannosaur studied by Tanke and Currie supports a souvenier tooth, embedded in its own jaw, perhaps left by a fellow combatant. The usual subjects-food, mates, and territory may have prompted the vigorous disagreements among tyrannosaurs. Whatever the motivation behind the fighting, the fossil record demonstrates that the behavior was repeated throughout a tyrannosaur' life. Injuries among younger individuals seem to have been more common, possibly because a juvenile was subject to attack by members of his or her own age group, as well as by large adults. Nevertheless, the fossil records may also be misleading, and simply contains more evidence of injuries in young *T.rex*. Nonlethal injuries to adults would have eventually healed, destroying the evidence. Juvenile were more likely to die from adult-inflicted injuries, and they carried those wounds to the grave. From the fossil records it is not clear that theropod were predator (like Hawk) or scavenger (likeVulture) (Erickson, 2000).

Skeletal assemblages of multiple individuals shine a light on the interaction among many species. Trace fossils reveal activities through physical evidence, such as bite mark in bones and wear patterns in teeth. Also of great value trace fossils are coprolites, fossilized feces. The coprolite "smoking gun" of carnivores contains remains of a herbivore suggesting proof of species interaction. *Tyraranosaurus* are usually depicted as solitary, as was certainly the case in *Jurassic Park*. A discovery was made during the excavation of "Sue" the largest and

most complete fossil T. rex ever found. Sue is perhaps as famous for her $ 8.36-million auction price following ownership boggling as for her paleontological status (see "No bones about it," News and Analysis, Scietific American, December, 1997). Remains of second adult, a juvenile, and an infant T. rex were later found in Sue' quarry. Researcher from the American Museum of Natural History in New York City working in Alberta, Canada, found a bone bed- a deposit with fossils of many individuals-holding at least nine of close relatives, albertosaurs. All of these suggest gregarious behavior i. e., it were social and not solo (Erickson, 2000).

The skull parts of *Vitakridrinda sulaimani* are found with the partial skull of adult/subadult titanosaurs (Malkani, 2003a). Its occurrences with adult/subadult titanosaur suggest that the theropod has come to the titanosaur animnal to eat. And subsequent fighting with titanosaur or other theropod may cause his death.

There are two type of head orientation in theropod, one is declined head and other is elevated frontal head. In *Vitakridrinda* elevated inturned frontal head is interpreted. Carnosaur has V shaped extensor groove comparable to depth to the flexor sulcus between the distal condyles of femur.

The present finding of a rostrum in the site of previously collected occipital condyle along with partial braincase (Malkani, 2004d) have strengthen the discovery. The theropopd skull along with braincase is significant. However it's other findings of a pair of proximal femur about 200m apart toward southwest also suggest carrying the skull here by other theropods or the transfer of leg bone by other theropod animals. The size of rostrum matches with the size of found leg bone. Recently one new genus and species of saurischian theropod abelisaurs based on hollow proximal femur (a pair), braincase and vertebrae as *vitakridrinda sulaimani* is erected (Malkani, 2004). The present discovery will be useful for generic-level comparisons and phylogenetic resolution, and Indo-Pakistan will enter in hypothesis of Gondwanan dinosaur biogeography. First and new discoveries by author from Vitakri and its vicinity areas of Pakistan have proved a well developed Vitakri Cretaceous Park for terrestrial ecosystem.

9. Conclusions

The eleven named species from the Lameta Formation of India actually represent at least three large bodied theropod *(Rajasaurus, Indosuchas, Indosaurus*) and a fourth, small bodied theropod (*Laevisuchas).* But recently from Pakistan, (Malkani 2004) reported one genus and species *vitakridrinda sulaimani* of large bodied theropod abelisaur based on hollow proximal femur (a pair, left and right), braincase and vertebrae. However the finding of rostrum of ***Vitakridrinda*** large bodied theropod dinosaur is the first from Pakistan

The first rostrum of *Vitakridrinda* from Pakistan will provide the facility of comparison along with other abelisauid and tyranosaurids from other landmasses.

First rostrum have bite mark, puncture, teeth impression and also embedded teeth can reveal the story of confrontation between *Vitakridrinda* and its combatant.

The present finding of a rostrum of *Vitakridrinda* in the site of previously collected occipital condyle articulated with partial braincase and also nearby finding of a pair (left and right) of proximal femur (Malkani, 2004) have strengthened the discovery and are significant producing useful characters for speciation and correlation. The size of rostrum matches with the size of braincase and proximal femur.

The author discovered a variety of dinosaurs from the Latest Cretaceous Vitakri member/Dinosaur beds of Pab Formation of Pakistan mainly as residual surface finds with some in situ fossils. The Mesozoic archosaur fauna although represented by fragmentary materials, include very large Sauropods, coelurosaurs and carnosaurs theropods, and mesoeucrocodilians. All of these terrestrial ecosystems of Sulaiman Latest Cretaceous Park

are found in the red muds/clays rich horizon of Vitakri member/Dinosaur beds (upper member) of Late Cretaceous Pab Formation in the central Sulaiman foldbelt. The environment and vertebrate assemblages of Sulaiman foldbelt Cretaceous Park show a model of medium to large bodied titanosaurids and saltasurids, and theropods habitat along with the possible earlier mammals on the over bank fluvio-lacustrine environments, crocodile habitat in the rivers and lakes, and walking and flying birds on land and air.

The discovery of saltasaurids, abelisaurid and baurusuchid from Pakistan broadens the distribution of saltasaurids, abelisaurid and baurusuchid, and indicate close affinity with South America of Gondwanaland. So far the Late Cretaceous (Maestrichtian) 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 research like paleobiogeographic reconstruction, phylogeny, tephonomy, depositional environments and KT boundary.

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