

Large Titanosaur from Indo-Pakistan Peninsula

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Abstract

Indo-Pakistan subcontinent is lucky to host the smallest, medium and large sized titanosaurian sauropod dinosaurs. *Saraikimasoom* is the smallest sized, and *Gpsaurus* is the medium sized transversely stocky, *Pakisaurus* and *Isisaurus* are the large sized titanosaurs of South Asia. *Pakisaurus balochistani* is a slender type of pakisaurid titanosaurian based on associated vertebral and appendicular skeletons. *Pakisaurus balochistani* includes key elements like transversely thin or narrow tibia and ventrally not reduced tall caudal vertebrae, along with other elements which are significant for cladistic analysis.

Keywords

Large Titanosaur, Latest Maastrichtian, Vitakri Lameta Formation, Indo-Pakistan

1. Introduction

Pakisaurus is included among four recently recognised titanosaurian sauropods from South Asia. *Pakisaurus balochistani* is described here and significant for comparisons, Gondwanan paleobiogeography and evolutionary studies.

2. *Pakisaurus balochistani* Large Titanosaur from Indo-Pakistan

Systematic paleontology of *Pakisaurus balochistani* is as follows. Dinosauria, Saurischia, Sauropoda, Titanosauria, Pakisauridae [1], *Pakisaurus* [1], and *Pakisaurus balochistani* [1] (**Figure 1**). *Pakisaurus balochistani* as a new genus and new species was formally published by Malkani [1]. *Pakisaurus balochistani* holotypic caudal vertebrae [1] and lectotypic vertebral and appendicular elements from South Kinwa 4 holotypic and lectotypic locality (**Figure 1**), and referred fossils from West Bor 2, northern Top Kinwa 16, North Alam 19n, Shalghara 3, Mari Bohri 15, Darwaza 8 and Grut 9 localities are found in the latest Maastrichtian



Figure 1. *Pakisaurus balochistani* fossils. Row 1, Map of Pakistan (black circle) show Kinwa type locality, holotypic caudal vertebrae from Kinwa. Row 2, 3, 4, 5, lectotypic vertebral and appendicular elements from Kinwa. Row 6, referred associated tibia and humerus (photo 1/p 1) and femur (p 2) from west Bor or lower Bor; chevron 2 views (p 3 - p 4). Row 7, referred coracoid (p 1), proximal radius (p 2), ungual (p 3) and osteoderms jaw ramus with diastema type embedded spikes (p 4 - p 5) and dentary symphysis type with teeth like spikes (p 6). Scale, each black or white digit is 1 cm.

(67 - 66 Ma ago) Vitakri Lameta Formation of Fort Munro Group, Barkhan District, Balochistan, central Pakistan. These fossils are housed in the museum of Geological Survey of Pakistan, Quetta. Some fossils from Vitakri Lameta Formation of India are also referred. Genus *Pakisaurus* honour the host country Pakis-

tan, saurus mean lizard. Species named *P. balochistani* honour the host province Balochistan.

2.1. Diagnosis of *Pakisaurus balochistani* Large Titanosaur

Pakisaurus balochistani sharing with Titanosauria as procoelous caudals; forward insertion of neural arches on caudals; prominent olecranon process on ulna and vertebrae lacking hyposphene-hypantrum articulations *Pakisauridae* characters are same as genus and species. *Pakisaurus balochistani* is recognised as more derived lithostrotian titanosaur based on procoelous anterior and middle caudal vertebrae. *Pakisaurus balochistani* is recognised as most derived Poripuch lithostrotian titanosaur based on procoelous anterior, middle and posterior caudal vertebrae. *Pakisaurus balochistani* is characterised by long slender legs and tall tail; narrow, long and recurved teeth with constant thickness from base to tip (except tip); large sized braincase with D-shaped occipital condyle; basal tubera breadth narrower than occipital condyle; caudals are tall quadrangular shape except a few anteriormost caudals which are broad; distal most caudal centrum anterior articular face shape procoelous while posterior face ball is biconvex cone with a horizontal transverse groove in the middle; distal scapula relatively less expanded than *Gspisaurus*; distal scapula with relatively anteroposteriorly long glenoid; distal scapular articular length for coracoid is relatively small (unlike *Isisaurus*); acromian process is narrow; expanded radial condyle exposed on the anterior aspect of distal humerus (unlike *Isisaurus*); femoral shaft, lateral margin shape, proximal one-third deflected medially with wavy style (and not straight as in *Isisaurus*); transversely narrow proximal Tibia with arc shaped lateral fibular condylar ridge ended just below cnemial crest; and osteoderms spikes on ramus.

2.2. Description of *Pakisaurus balochistani* Large Titanosaur

Teeth are narrow, long and recurved with constant thickness from base to tip (except tip). Braincase is large sized. Occipital condyle is large and broad and greater part of its convexity faces downward. Thick occipital condyle has broad flat upper surface. Basal tubera breadth is narrower than occipital condyle. Occipital region of skull is flat and distally recurved. Paroccipital processes oriented transversely. Basal tubera are long process, diverging laterally with relatively lower angle than *Gspisaurus* who have high angle basal tubera. Basal tubera directed slightly backwards. Basipterygoid processes diverge somewhat anteriorly and much longer than the basal tubera. Caudals are tall quadrangular shape except a few anteriormost caudals which are broad. Anteriormost caudals neural spine is vertical. Distal most caudal centrum anterior articular face shape procoelous while posterior ball face is biconvex cone with a horizontal transverse groove in mid. Distal scapula relatively less expanded than *Gspisaurus*. Distal scapula has relatively anteroposterior long glenoid. Articular length for coracoid is relatively small (unlike *Isisaurus*). Acromian process of scapula is narrow.

Proximal humerus has prominent lateral process than medial process. Expanded radial condyle exposed on the anterior aspect of distal humerus (unlike *Isisaurus*). Proximal ulna with tri-limbs has prominent olecranon process. Femoral shaft, proximal one-third deflected medially with wavy style (and not straight as in *Isisaurus*). Proximal Tibia is transversely thin bone or narrow (unlike thick lense shape of *Gspisaurus* and thick subcircular shape of *Saraikimasoom*) with arc shaped fibular condylar ridge ending just below the cnemial crest. Posterior process of proximal tibia is about half of total anteroposterior width in *Pakisaurus*, while posterior process is about three quarter 3/4 of the total anteroposterior proximal width of *Isisaurus* tibia. Ratio of anteroposterior width of distal end to anteroposterior width of proximal end is 0.80 in *Pakisaurus* while the ratio of anteroposterior width of distal end to anteroposterior width of proximal end is as low as 0.64 in *Isisaurus*. Osteoderms present, arced ramus with diastema having random false teeth like spikes on ramus and also on base skin which forms diastema on arced ramus and false dentary type symphysis with spikes/spines; and Pedal ungual sickle-shaped, much deeper dorsoventrally than broad transversely.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

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