Scientific Reports in Life Sciences 6 (3):61-85

DOI: https://doi.org/10.5281/zenodo.16895340

A review of the fossil records of dinosaurs of the Late Jurassic–Early Cretaceous from present-day Pakistan

Hans-Volker Karl[1], Amtyaz Safi[2*], Gottfried Tichy[3]

[1]Department of Prehistory and Early History, Friedrich Schiller University, Löbdergraben 24a, 07743 Jena, Germany. ORCID: 0000-0003-1924-522X
[2]Department of Zoology, Diwan Dayaram Jethmal (D.J.) Sindh Government Science College, Dr. Ziauddin Ahmed Road, Karachi 74200, Pakistan. ORCID: 0000-0002-4484-3224
[3]Department of Geography and Geology, Paris Lodron University of Salzburg, Hellbrunnerstrasse 34, 5020 Salzburg, Austria
**Email: amtyaz.safi@gmail.com*

Received: 14 January 2025 / Revised: 07 March 2025/ Accepted: 10 March 2025/ Published online: 20 August 2025.
How to cite: Karl, H.-V., Safi, A., & Tichy, G. (2025). A review of the fossil records of dinosaurs of the Late Jurassic–Early Cretaceous from present-day Pakistan, Scientific Reports in Life Sciences 6(3), 61-85. **DOI:** https://doi.org/10.5281/zenodo.16895340

Abstract

Recent geological and paleontological studies in Pakistan have discovered fossils of various prehistoric biota, including dinosaurs. Pakistan is rich in paleontological evidence from the Mesozoic era, especially traces and tracks from the Late Jurassic to Early Cretaceous. These prehistoric fossils are important for paleo-biogeographic studies because these Mesozoic faunae show significant paleo-biogeographic connections with Gondwana, as most dinosaurs such as titanosaur sauropods, carnivorous abelisaurids, and theropods are closely associated with Gondwana (Southern hemisphere), in contrast to the Cenozoic shows close relationships with the Eurasian biota. About 400 fossil bones have been found in the upper shale layer of the true Maastrichtian Vitakri Formation, which is the base of the titanosaur group. Pakistan is a unique country, where 15 species of titanosaurs were discovered in a small area at the Sangyali site of Vitakri Dome (Barkhan district of Baluchistan). The first fossil of a dinosaur was reported in 2000, while the last dinosaur (*Imrankhanshaheen)* was reported in August 2024 from Pakistan. This investigation corresponds to the fossils of about 3000 Saurischian dinosaurs and some footprints and trackways of these Mesozoic dinosaurs. So far, 45 taxa are known; most were discovered, collected, scientifically documented, and published by Muhammad Sadiq Malkani, the former director of the Geological Survey of Pakistan.

Keywords: Dinosaurs, Fossil records, Pakistan, Prehistory, Review

Introduction

The entire mass of the Earth was concentrated on a C-shaped supercontinent called Pangea. The Indian subcontinent was a part of Gondwana, south of Pangaea. In the Late Cretaceous, as the Indian plate moved across the Tethys Sea to form the Indian Ocean and most of the other continents, the Indian subcontinent was still a large landmass. The Paleocene epoch followed the explosion. The separation of India from Madagascar began 88 million years ago, and complete separation occurred at the end of the Maastrichtian. This process is thought to have been the formation of the Deccan Traps. Soon after, the continents rushed northwards until contact was made with Asia 55 million years ago (Klaus et al., 2016) (Figure 1). The Mesozoic was a very important era on an evolutionary and paleontologically basis for the dominancy of terrestrial vertebrate fauna; In addition to the occurrence of large explosions, which made very significant climate changes caused by heat and cold have also caused drastic faunal turnovers it acted as a major biological extinction (Rögl, 1999; Böhme, 2003; Karl et al., 2021, 2024). Dinosaurs are a diverse group of reptiles belonging to the sub-class Dinosauria that first appeared on Earth during the Triassic Period, between 243 and 233.23 million years ago (mya). They became the dominant land vertebrates after the Triassic-Jurassic extinction event (201.3 million years ago), and their dominance continued throughout the Jurassic and Cretaceous periods. The fossil record shows that birds were feathered dinosaurs that evolved from early theropod dinosaurs of the late Jurassic period and survived the approximately 66-million-year extinction event of the Cretaceous-Paleogene period (Mathew et al., 2018). The first dinosaur fossils were discovered in the 19th century; Sir Richard Owen used the term "dinosaur" (meaning "terrible lizard") in 1842 to refer to fossils of "Great fossil lizards" (Brett-Surman et al., 2012). The effects of the Deccan Trap volcanism are thought to have caused mass extinctions, particularly devastating and wiping out almost all terrestrial vertebrate lineages on the continent. (Karanth & Praveen, 2021). The Indus Valley (part of Gondwana) of Pakistan is important for discovering dinosaurs and other Mesozoic terrestrial and marine Formations and biota. The Indus Basin encompasses Mesozoic and Cenozoic oceanic and continental sequences (Malkani 2010a) (Figs. 2 and 3). Dinosaurs were first recorded in 2000 in Pakistan, and Pakistan appeared on the world dinosaur map for the first time. All the fossils found so far are housed in the Museum of Geological Survey of Pakistan (GSP), Quetta, Pakistan, except for some fossils sent to the University of Michigan, USA, for preparation. The Vitakri region of Pakistan is considered a paradise for dinosaurs due to its rich fossil collection.

The mass screen-washing method of paleontological examination is used to study amphibians (frogs), reptiles (snakes, lizards, turtles, dinosaurs, and crocodiles etc.), mammals, birds, and fishes, etc. (Malkani, 2015a & b; Malkani & Ge, 2016). The first titanosaur or early titanosaur of the Sembar Formation from the Kirthar Range in Pakistan. Since then, about 3000 fossils have been collected in the two layers of red mud (alternating two rock layers) of the fluvial Vitakri Formation (Latest Cretaceous) distributed in Vitakri-Mari Bohri, Dhaola-Andari, Phulai-Pikal-Siah Koh, and Fort Munro-Takht Sulaiman anticlinoria (Malkani, 2006) of Sulaiman Basin. The Super Indus Basin is further divided into the uppermost/northernmost Indus (Khyber-Hazara-Kashmir), upper /north Indus (Kohat and Potwar), middle/central Indus (Sulaiman), and lower/south Indus (Kirthar) basins (Malkani, 2015c). The Vitakri region of Pakistan is considered a heaven for dinosaurs due to the abundance of fossils (Malkani, 2013), due to its rich fossilized bones. Vitakri Formation's red mud hosts the latest Cretaceous dinosaurs in Pakistan's Sulaiman (Middle Indus) Basin. The Vitakri Formation with the dinosaur bones is well exposed in the Vitakri and Fort Munro eastern Sulaiman fold belt, also exposed in the Ziarat District as Ziarat laterite/Vitakri Formation in western Sulaiman and Sor Tangi area in Zhob District as Sor Tangi Laterite/Vitakri Formation in western Indus Suture. According to dinosaur fossils and stratigraphic position, the age is considered as the latest Maastrichtian or latest Cretaceous (66 mya). The Vitakri Formation hosts numerous late Cretaceous dinosaurs, crocodiles, and pterosaurs of Pakistan. It constitutes a graveyard due to its richness of fossil bones, due to the Cretaceous-Tertiary extinction (Malkani, 2015b). Pieces of evidence of dinosaurs in Pakistan are found in the Indus basin, which is divided into the Upper Indus (Kohat and Potwar), Middle Indus (Sulaiman), and Lower Indus (Kirthar) basins. Titanosaurid/early titanosaur sauropod remains have been found in the Late Jurassic Sambhar Formation, and sauropod tracks have been found in the Middle Jurassic Chiltan Limestone of the Indus River. Several smaller theropods and a larger titanosaur, *Sagittarius*, are reported along with several footprints in the upper (Kohat and Potwar) basins, and a group in the Barochichno-type Middle Jurassic Samanasuk limestone was recorded from the Mianwali, Punjab. The Middle Indus (Sulaiman) Basin provides the latest Cretaceous titanosaur sauropod fossils, including abelisaurids and tetrasaurian theropods, mesocrocodiles, pterosaurs, and titanosaur sauropod bones. Pakistan is relatively rich in footprints/trackways and Late Cretaceous fossils as compared to its neighbor India (Malkani, 2015a & b; Malkani & Ge, 2016). The revised stratigraphy of the Kirthar (Lower Indus) basin shows mostly the same lithological units of the

Suleiman basin during the Mesozoic, but varies in Cenozoic strata (Malkani 2019a), e.g., Paleocene represents the Ranikot Group. Khadro, Bara, and Lakhra developed the Upper Neocene Manchar Group/Vihowa Group (Malkani, 2024a). Sulayman Basin produced Maastricht *Pashtunosaurus* Ornithopaonia (Malkani, 2021a), *Dgkhansauroperus marri* Sauropaonia (Malkani, 2003), and *Anmolpakhiperus alleni* Pteropaonia (Malkani, 2021a). Kirthar Basin gives Jurassic *Chiltansaroperus nicki* Sauropaonia (Malkani, 2021b). Titanosaurs and theropods were found in the Vitakri Formation (Fig. 2) in many localities, which are shown in Figures 2 & 3 of Malkani (2021a, 2021b). All these fossils are housed in the Geological Survey of Pakistan (GSP), Saryab Road, Quetta, Pakistan. Some fossils are unique in the world, some are unique in Asia, and some are unique in the Indo-Pak subcontinent (Malkani, 2015a & c). These different bones and their locations should be preserved by creating new tourist and international tourist areas for the development of the Pakistani state, and also be useful for world science. All these data can solve the sub- and super-phylogenies, paleo-biogeographic connections, tectonic evolution, and geodynamics of the Indo-Pak subcontinent that separated from Madagascar (more than 6000 km) and migrated. The rest of the Gondwana Plateau crosses the equatorial line from the South. It collides with Asia and the northern hemisphere in the north. The upper, middle, and lower Indus are important areas for the strata for dinosaur discovery from the Jurassic-Cretaceous (Figure 2). These basins were folded and faulted due to Cenozoic and late Mesozoic tectonics (Malkani, 2015b).

Figure 1. The World map during the Late Jurassic-Early Cretaceous, Gondwana began breaking up, eventually pushing Africa and India north across the Tethys and opening up the Indian Ocean (Courtesy: Pierre Dèzes, 1999).

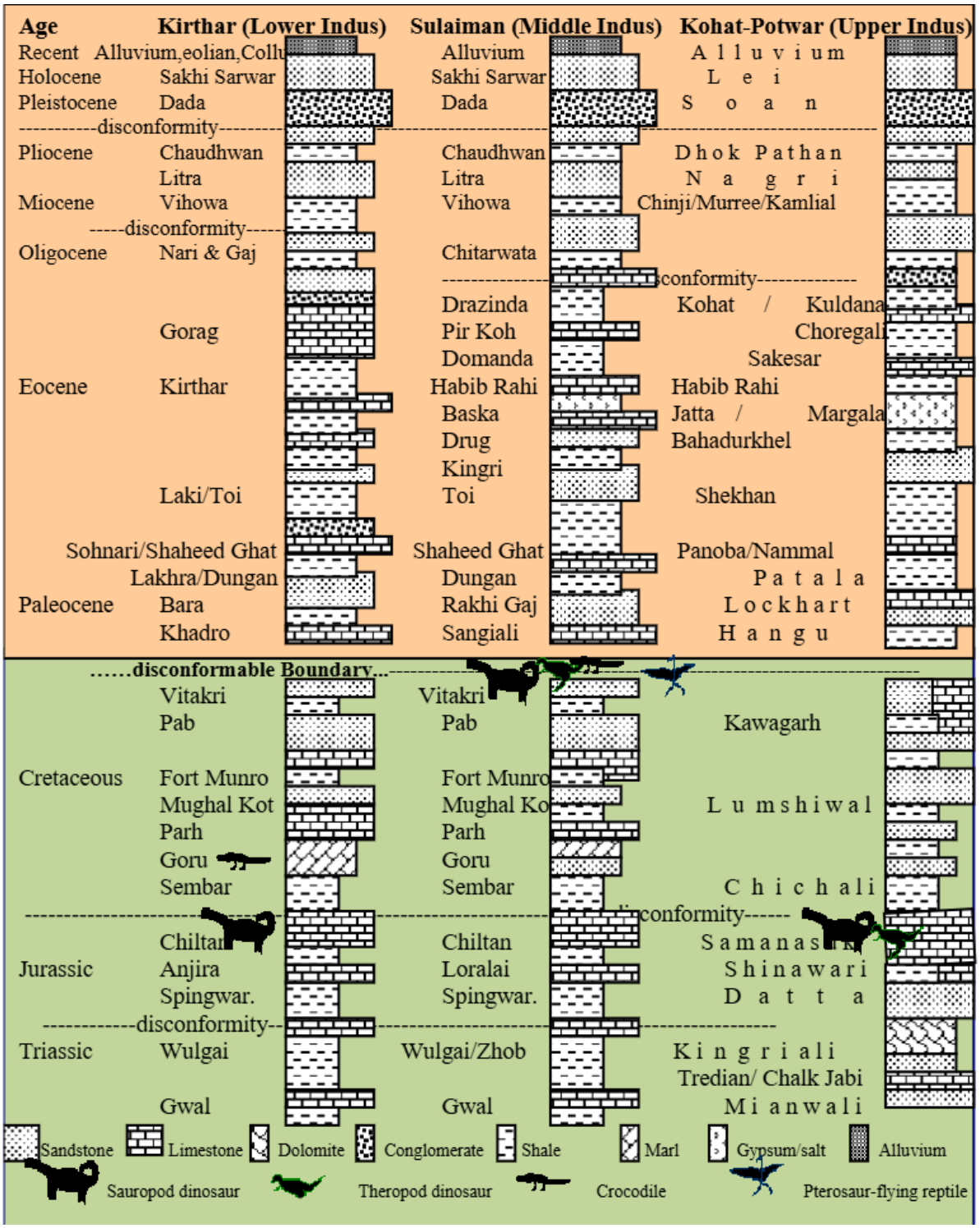

Figure 2. Litho-stratigraphic Correlation of Lower Indus (Kirthar), Middle Indus (Sulaiman), and Upper Indus (Kohat-Potwar) Basins of Pakistan (Courtesy: Malkani, 2015)

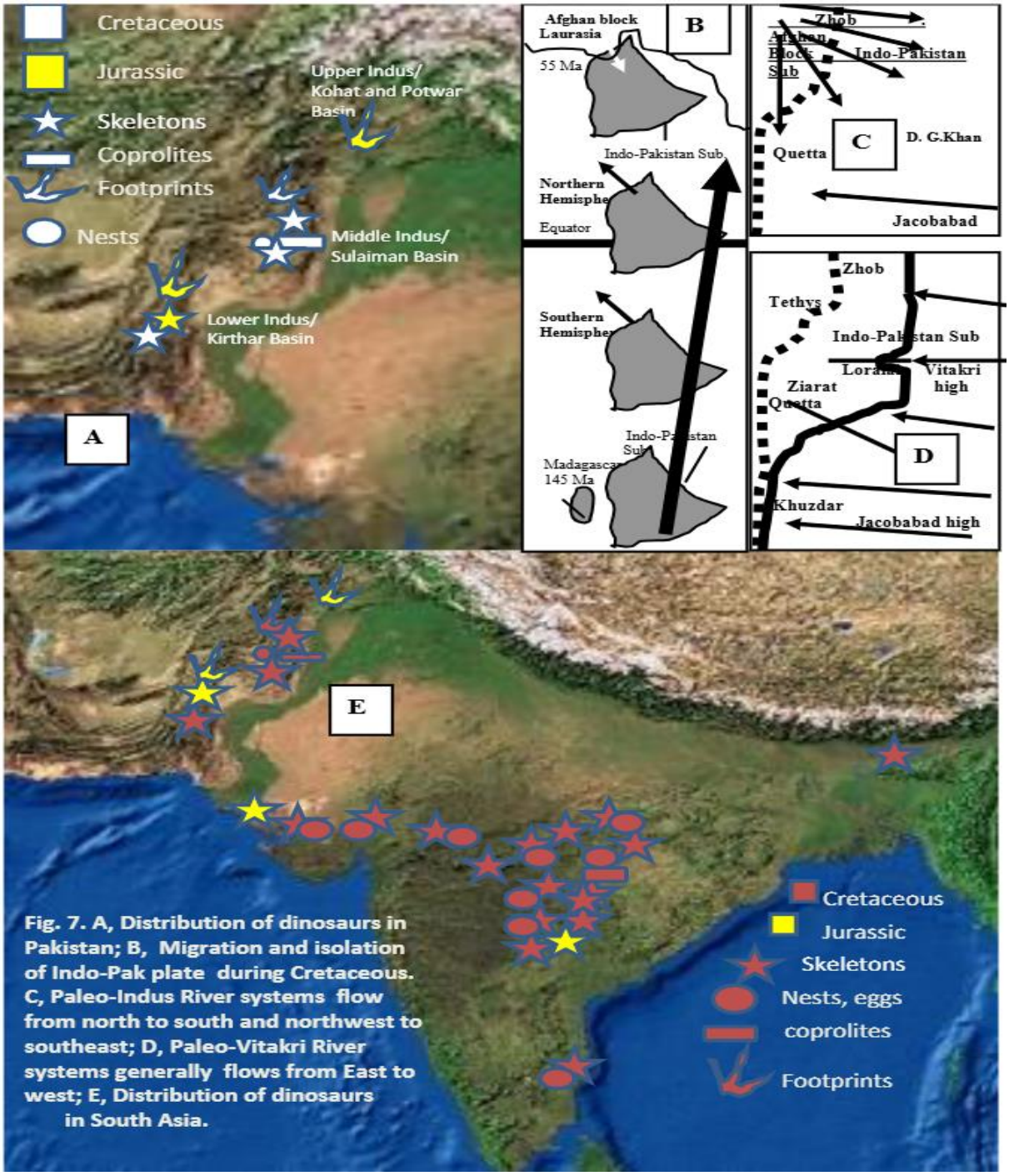

Figure 3. **A**, Distribution of dinosaurs in Pakistan; **B,** Migration, and isolation of the Indo-Pak plate during the Cretaceous. **C,** Paleo-Indus River systems flow from north to south and northwest to southeast; **D**, Paleo-Vitakri River systems generally flow from East to west; **E,** Distribution of dinosaurs in South Asia (Courtesy: Malkani, 2015)

Dinosaurian fauna of Pakistan and their distributions

The Baluchistan province of Pakistan is known for its rich Mesozoic fossil beds. Baluchistan's dry and rugged terrain and geological history make it a region rich in dinosaur fossils in South Asia. Ongoing research continues to uncover important new dinosaur specimens in this country. Information about dinosaurs in Pakistan has just begun to emerge after their first discovery by M. Sadiq Malkani in 2000 (Malkani, 2003). These dinosaurs and their terrestrial communities and ecosystems are also found in the latest Maastrichtian (66 mya) Vitakri Formation on land. Table 1 summarizes recent discoveries (Series 1-26). Twenty-six dinosaur taxa have been discovered so far in Pakistan. Twenty-one of these dinosaur taxa are based on fossils, and 5 are based on tracks/ foot imprints. Note that it includes recent changes based on discoveries. Serial 1 is a titanosauriform sauropod found in the Late Jurassic-Early Cretaceous Sembar Shale. M. Sadiq Malkani of the Geological Survey of Pakistan discovered *Brohisaurus*. *Brohisaurus* was based on poorly recognized vertebral and appendicular bones. *Brohisaurus* was formally described in 2003. Its updated information is available in Malkani (2021a, 2023a). Series 2-16 are discoveries of titanosauropods from the Vitakri Formation of the Cretaceous Period (Latest Maastrichtian), and their formal descriptions were made by Malkani (2021a & b, 2022, 2023b, 2024a). Serials 17-20 are Abelisaurian theropod dinosaurs found in the Vitakri formation, and their updated information is available in Malkani (2024a). The four Abelisaurian theropods from Pakistan, namely *Vitakridrinda, Vitakrisaurus*, and *Shansaraiki* arranged in the family Vitakrisauridae and *Saraikisaurus* of Noasauridae. The basic information of these medium-large-bodied abelisaurian theropod dinosaurs is found in Table 1 (2023a). The first carnivorous theropod dinosaur bones from Pakistan were discovered in 2001, in Baluchistan, Malkani (2023a). The habitat of *Vitakridrinda, Vitakrisaurus, Shansaraiki, and Saraikisaurus* was terrestrial. Three Pakistani theropods were among the largest theropods or land carnivores on earth, and one was among the smallest noasaurid theropods. Serials 21-26 are Mesozoic dinosaur ichno taxa formally described in Malkani (2021b; Malkani 2023a). *Malakhelisauroperus* and *Pashtosauroperus* are arranged in the group Ornithopaonia. *Dgkhansauroperus* and *Chiltansauroperus* are arranged in the group Sauropaonia. Large-sized theropod *Samanadrindoperus* and small-sized theropod *Himalayadrindoperus* are arranged in a group, Theropaonia. The first small footprint of *Chiltansauroperus* was discovered in 2002 in the Kirthar fold belt. The first dinosaur trackways from Pakistan were found in 2006 in Malakhel, Mianwali (Punjab), and reported in 2007 by

Malkani. *Malakhelisauroperus* and *Samanadrindoperus* footprints were among the largest/biggest footprints on Earth. *Samanadrindoperus* Theropaonia was the largest predator, or among the biggest predators, on Earth. The existence and enrichment of 15 titanosaur taxa in a few kilometers of area of Pakistan is the first in the World. *Brohisaurus* is the only Jurassic dinosaur in Pakistan. 15 titanosaur taxa were found in the Late Cretaceous. All the dinosaur fossils were found in the Balochistan Province of Pakistan. Ichno taxa of dinosaurs were found in North Punjab, South Punjab, and Balochistan. *Pakisaurus balochistani* is the first titanosaur dinosaur reported (in 2004) from Pakistan, while *Imrankhanshaheen masoombushrai* is the last titanosaur reported (Malkani, 2024a) from Pakistan. All dinosaurs in the Vitakrı Formation were found below the Cretaceous-Paleogene boundary 66 million years ago (end of the Cretaceous Period).

Table 1. List of dinosaur taxa from present-day Pakistan

Group	Family	Taxa
Titanosauriform		*1. Brohisaurus kirthari, Malkani (2003)*
Poripuchia (Titanosaurian Sauropods)	Gspsauridae	2. *Gspsaurus pakistani, Malkani (2014a)* 3. *Maojandino alami, Malkani (2015a)* 4. *Ikqaumishan smqureshi, Malkani (2023b)* 5. *Imrankhanshaheen masoombushrai, Malkani (2024a)* *6. Isisaurus colberti,* Jain and Bandyopadhyay *(1997)*
	Saraikimasoomidae	7. *Saraikimasoom vitakri, Malkani (2014a)* 8. *Nicksaurus razashahi, Malkani (2015a)*
	Balochisauridae	9. *Balochisaurus malkani, Malkani (2004)* 10. *Qaikshaheen masoomniazi (Malkani, 2024, 2023b)* 11. *Marisaurus jeffi, Malkani (2004)*
	Pakisauridae	12. *Pakisaurus balochistani, Malkani (2004)* 13. *Khanazeem saraikistani Malkani (2022)* 14. *Imrankhanhero zilefatmi (Malkani, (2024, 2023b)* 15. *Sulaimanisaurus gingerichi, Malkani (2004)* 16. *Khetranisaurus barkhani, Malkani (2004)*
Theropodous dinosaurs	Vitakrisauridae	17. *Vitakridrinda sulaimani, Malkani (20064)* 18. *Vitakrisaurus Ssaraiki, Malkani (2010)* 19. *Shansaraiki insafi, Malkani (2022)*
	Noasauridae	*20. Saraikisauris minhui,* Malkani (2013)
Ichno taxa of dinosaurs	Ornithopaonia	*21. Malakhelisauroperus mianwali,* Malkani (2021a) *22. Pashtosauroperus zhobi,* Malkani (2021a)
	Sauropaonia	*23. Chiltansauroperus nicki,* Malkani (2021a) *24. Dgkhansauroperus, maarri* Malkani (2021) Malkani et al. (2018)
	Theropaonia	*25. Samanadrindaoperus surghari,* Malkani (20142021a) *26. Himalayadrindaoperus potwari,* Malkani et al. (2018) Malkani, (2021a)

Titanosauria sauropods (Herbivorous dinosaurs) from the Jurassic-Cretaceous periods:

1. *Brohisaurus kirthari,* Malkani 2003 (Fig. 4): A Titanosaur or early titanosaur-like sauropods found in the lowermost part of the Late Jurassic Sambhar Formation of the Sun Chaku region of the Kalkh region of the Kirthar Range are based on some little-known postcranials (Malkani 2003). Only one bone is referred to here from the Lakha Kach Charo Zidi site. The genus of sauropods was herbivorous and existed during the late Jurassic period. Fossils of another larger species, Brohisaurus, with a long neck, have been found in the Kirthar Mountain. Its name means "Brohi lizard" and refers to the “Brohi” people who are living in the area.

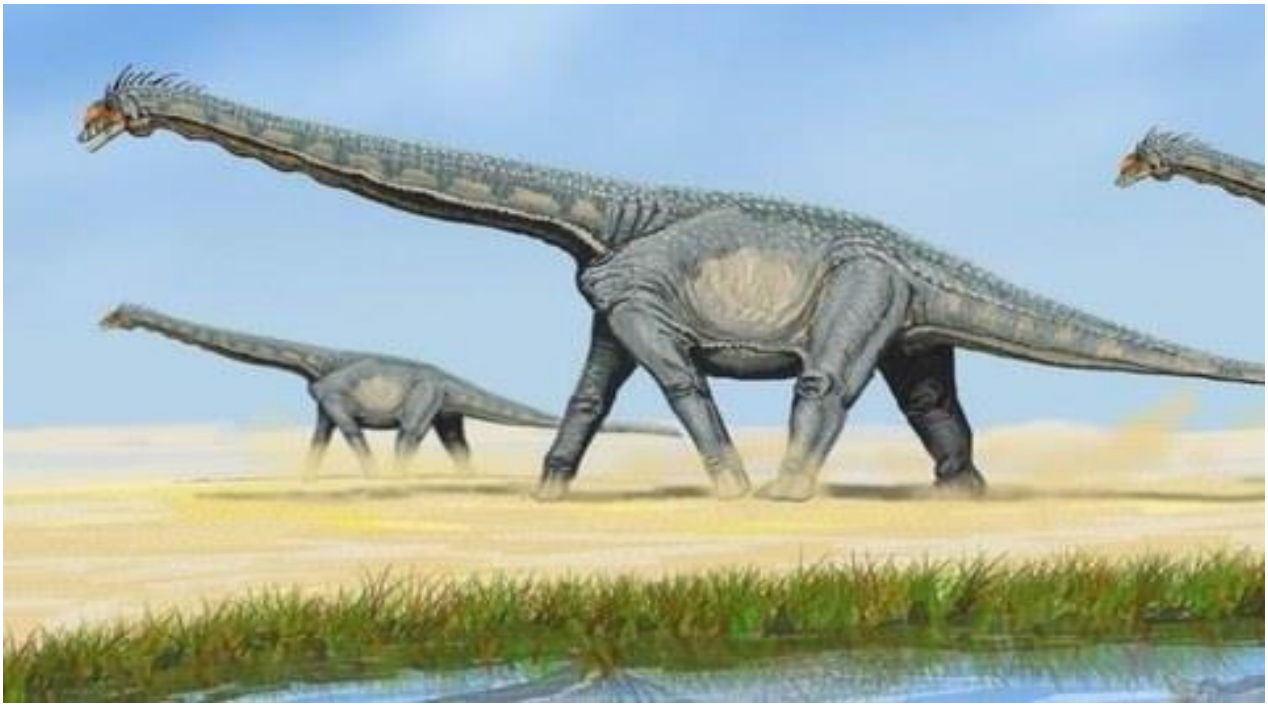

Figure 4. An artistic image of *Brohisaurus kirthari,* Malkani 2003 (Courtesy: Bashir Ahmad)

2. G*spsaurus pakistani* Malkani 2014: (Fig. 7): A large Gspsaurus titanosaur sauropod was found in the form of a complete skull from the red mud of the Vitakri Formation at the Alam Kali Kakor site of the Vitakri region (Malkani 2014a, 2015a, b). *Gspsaurus* is a titanosaurian sauropod dinosaur from the Late Cretaceous Vitakri Member of the Pab Formation of Sulaiman Basin of Pakistan (Malkani, 2023b). The referred holotype MSM-79-19 and another holotype, “MSM-80-19,” were discovered in 2001 and contain partial skulls including the rostrum.

3. *Maojandino alami*, Malkani 2015: *Maojandino* is a new taxon of titanosaurid sauropods from the Late Cretaceous of Pakistan during the Maastrichtian stage. It is a large Balochsaurid titanosaur-like sauropod dinosaur (Malkani 2015a). The neck is thick, broad, and long, the tail is short, and the body is heavy and stocky. Based on the holotype material, the fossils include 6 cervical vertebrae, 4 dorsal vertebrae, and 10 caudal vertebrae, as well as part of the left femur, part of the left and right tibia, and part of the radius and a pair of ends of the scapula, part of the sternal plate or iliac bone, some neural arch and laminae covered partially by yellow-brown muds, etc. The holotypic materials were collected from Alam Kali, Kakor locality of Vitakri area.

4. *Imrankhanshaheen masoombushrai:* A new genus and new species *Imrankhanshaheen* (meaning "Imran Khan - like a Hawk"), and the species is *masoombushrai,* meaning "innocent Bushra", showing respect and honor to the great Imran Khan and his wife, who were politically victimized and are housed in prisons. Malkani (2024a) described the genus *Titanosaurus* from the Late Cretaceous (Maastricht) Vitakri Formation of Pakistan. The holotype includes a braincase, vertebrae, a humerus, ulnae, a radius, metacarpals, a tibia, fibulae, ribs, girdle bones, and osteoderms.

5. *Isisaurus* (Fig. 5): It is named after the “Indian Statistical Institute”; this species belongs to the titanosaur dinosaur from the Late Cretaceous Lametta Formation of India and the Pab Formation of Pakistan. One species of the genus is *Isisaurus colberti*. The type specimen of *Isisaurus colberti,* ISI R 335/1-65, was first described and named *Titanosaurus colberti* by Jain et al. in 1997. A cranium referred to this species is known from the Pab Formation of Pakistan, which is the same in age as the Lameta Formation (Wilson et al., 2011; Hussam et al., 2011).

Figure 5. An artistic image of *Isisaurus colberti* (Courtesy: Ansh Saxena)

6. Ikqaumishan: *Ikqaumishan* (meaning 'Imran Khan, the national honor') is a species of titanosaur dinosaur from the Vitakri Formation from the Late Cretaceous (Maastrichtian) Vitakri Formation of Pakistan, described by Malkani (2023a). The assigned fossil material includes many humeri. Caudal vertebrae and osteoderms were found in the Vitakri Formation and referred to this taxon as *Ikqaumishan*. The referred type of species is *Ikqaumishan smqureshi* (Malkani, 2024a).

7. Saraikimasoom vitakri, Malkani 2014 (Fig. 7): A Gspsaurid titanosaurian sauropod, based on an almost complete skull (Malkani , 2014a , 2015a. *Saraikimasoom* (meaning 'Innocent one' from Saraiki belt) is a species of titanosaur dinosaur from the Vitakri Formation from the Late Cretaceous in Pakistan. The type species, *Saraikimasoom vitakri*, was described by Sadiq Malkhani in 2015. He is the leader and pioneer in dinosaur discoveries from Pakistan; he described more than two dozen dinosaur taxa such as *Gspsaurus*, *Nicksaurus,* and *Maojandino* (Malkani, 2023a, b).

***8. Nicksaurus razashahi*, Malkani 2015** (Fig. 7): This species of Titanosaurian sauropod was discovered in Kinwa, North locality of the Vitakri area, from the Late Cretaceous red muds of the Vitakri Formation of the Sulaiman Basin, Pakistan. The holotype is based on a pair of femora, a pair of stocky distal tibiae, partial humerus parts, proximal radius, five teeth in the jaw ramus, teeth, skull fragments, chevron, cervical, dorsal, and caudal centra (Malkani, 2014a, 2015a, b). This dinosaur shared a common habitat with other sauropod dinosaur taxa like *Khetranisaurus, Sulaimanisaurus, Pakisaurus, Gspsaurus, Saraikimasoom,* and *Maojandino*. The referred species is *Nicksaurus razashahi* (Malkani, 2019).

***9. Marisaurus jeffi*, Malkani 2004 (Fig. 6):** This species was described by Malkani in 2004 as *M. jeffi,* and it is based on caudal vertebrae, found in the Maastrichtian Age, Vitakri area of the Pab Formation. Much additional material, including a partial skull, many vertebrae, and a few hind limb bones, was referred to this genus. This species, along with *Sulaimanisaurus,* was assigned to the Balochisauridae family and was used as a synonym of Saltasauridae (Malkani, 2006; Malkani , 2008a, b, 2010c, 2014a, 2015a; Wilson et al., 2005). It lived in the Cretaceous period. Six fossils have been recorded from Baluchistan/Pakistan. *Marisaurus* (meaning "Mari lizard", for the Mari tribe of Pakistan) is a taxon of titanosaurian sauropod from the Late Cretaceous of Baluchistan, Pakistan.

Figure 6. An artistic image of *Marisaurus jeffi*, Malkani 2004 (Courtesy: Bashir Ahmad)

***10. Balochisaurus malkani*, Malkani 2004 (Fig. 7):** A Balochisaurid titanosaurian sauropod based on seven tail vertebrae found in the Maastrichtian-age of the Vitakri member of the Pab Formation, with an additional partial skull assigned to it. *Balochisaurus* was assigned to the family Balochisauridae along with *Marisaurus* (Malkani, 2006). Four specimens were discovered in Pakistan by the Geological Survey of Pakistan. *Balochisaurus* (meaning "Balochi lizard", for the Baluchistan province.

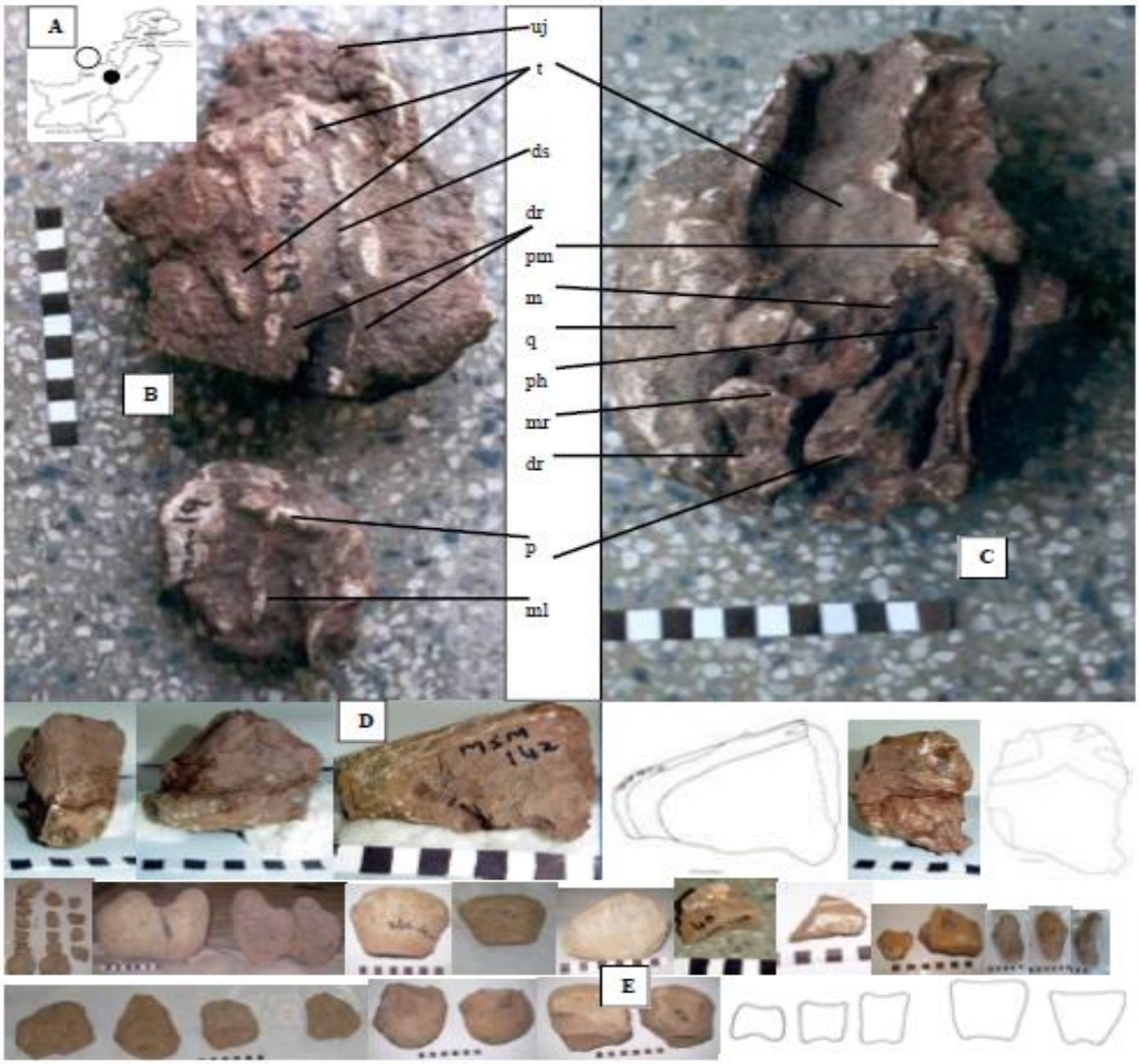

Figure 7. Map of Pakistan showing new ichnotype site by a white circle and bone fossil localities by black circle and (A), MSM-79-19 and MSM-80-19 (holotype skull) in ventral (B) and posterior (C) fossil of *Gspsaurus pakistani* from "Alam Kali Kakor" of Vitakri Formation (D) Holotype skull (MSM-142-4) in anterior, lateral, ventral and posterior views of *Saraikimasoom vitakri* from Kinwa locality of Vitakri area, (E) Upper row and initial half of lower row include holotypic associated axial and limb elements of *Nicksaurus razashahi* from Kinwa north locality of Vitakri Formation. The 1st column of the upper row (MSM-190-4n), 2nd column (MSM-346-4n), and (MSM-345-4n) a pair of the distal tibia, (MSM-378-4n and MSM-270-4n) femur fragments, (MSM-192-4n) distal portion of a femur, 3rd column (MSM-380-4n), (MSM-377-4n, MSM-379-4n, and MSM-438-4n) humerus segments, (MSM-190-4n and MSM-192-4n) ventral view of a pair of distal femora, and (MSM-344-4n) proximal portion of radius in 3 different views, and (MSM-138-4n) five teeth in mandible rami in two different views, (MSM-315-4n and MSM-314-4n) Cranium and tooth fragments in the matrix, (MSM-313-4n) chevron in three different views, Lower row (MSM-212-4n) cervical/dorsal centrum, (MSM-381-4n, MSM-382-4n, and MSM-383-4n) cervical centra, (MSM-347-4n and MSM-348-4n) caudal vertebrae in postero-dorsal and antero-ventral views, and line drawing 1st three centra (Pakisauridae) and last two centra (Balochisauridae) titanosaurian

sauropods. Each black or white digit is 1cm. Abbreviations: ml-midline contact, mr-maxillary ramus, p-palatal reverse v shape, ph-palatal dorsal hook v type, t-teeth, uj-upper jaw, dr-dentary rami, ds-dentary symphysis (Courtesy: Malkani, 2015).

11. Qaikshaheen: *Qaikshaheen* (means an abbreviation of 'Qaed in Urdu, meaning ' Leader), Imran Khan, and Shaheen means 'Hawk'; it means honor, love, and devotion for the great Imran Khan, the former Prime Minister, Cricketer, and Social worker. It is a taxon of titanosaur dinosaur from the Vitakri Formation in Pakistan is a new genus of titanosaurian dinosaurs from the Late Cretaceous (Maastrichtian) Vitakri Formation of Pakistan described by Malkani (2023a). The referred type of species is *Qaikshaheen masoomniazi* (Malkani, 2024a).

***12. Khetranisaurus barkhani*, Malkani 2004 (Fig. 8):** A Pakisaurid titanosaurian sauropod based on one holotypic vertebra collected from mid-Kinwa Formation and one attributed caudal from Sangiali (Malkani, 2006), and three attributed caudal from Bor, Mari Bohri, and Grut Gambrak localities (Malkani, 2009). It lived in the same era as others, and only one specimen of this species has been found in Baluchistan. *Khetranisaurus* (Khetran lizard) is a taxon of titanosaurian sauropod from the Late Cretaceous of Baluchistan, Pakistan. The proposed species is "*K. barkhani*" (Malkani, 2006), and it is based on a tail vertebra, found in the Maastrichtian-age Vitakri Member of the Pab Formation. It was assigned to "Pakisauridae" (Synonym is Titanosauridae), along with *Pakisaurus and Sulaimanisaurus* (Malkani, 2009).

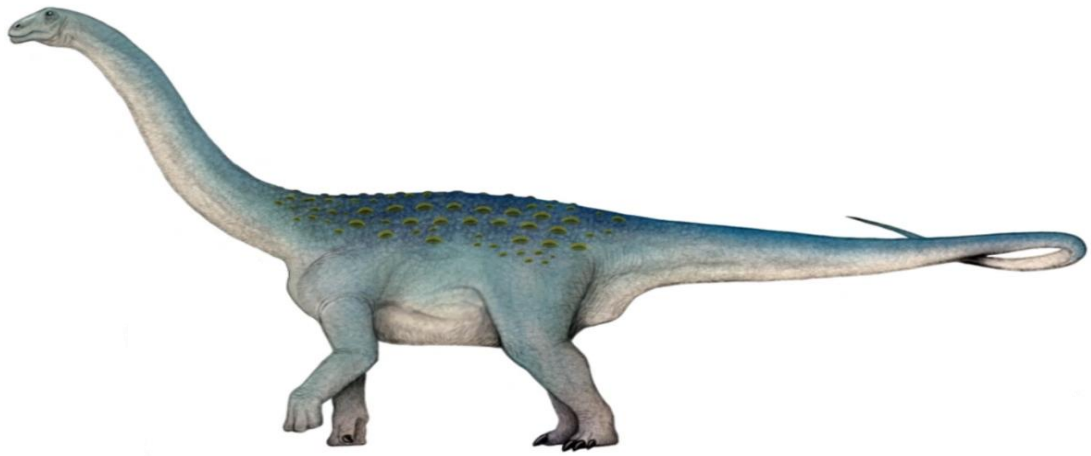

Figure 8. An artistic image of *Khetranisaurus barkhani*, Malkani 2004 (Courtesy: Bashir Ahmad)

13. *Sulaimanisaurus gingerichi,* Malkani 2004: A Pakisaurid titanosaurian sauropod based on seven fragmentary but associated caudal vertebrae collected from Kinwa locality (Malkani, 2006). *Sulaimanisaurus* was an herbivore and like other sauropods. Three different specimens have been discovered, including those from Baluchistan. *Sulaimanisaurus* (Sulaiman lizard), of the Sulaiman fold belt, is a taxon of titanosaurian sauropod from the Late Cretaceous of Baluchistan. The proposed species is *S. gingerichi*, described by M. Sadiq Malkani in 2006. It is considered to be related to *Pakisaurus* and *Khetranisaurus* in the family Pakisauridae.

14. *Pakisaurus balochistani*, Malkani 2004 (Fig. 9): A pakisaurid titanosaurian sauropod based on four associated tall caudal centra (Malkani, 2006) related to many surface finds of postcranial skeletons. All fossils are collected from the latest Cretaceous Vitakri Formation in different localities in the Vitakri area, Barkhan district of Baluchistan (Malkani 2008a, 2010a, 2014a, 2015a). The proposed species is *P. balochistani*, and it was named by M. Sadiq Malkani in 2006. A femur discovered in the Lameta Formation of India in 2023 was assigned to *Pakisaurus.* Another specimen *Anokhadino mirliaquati,* was synonymized with *Pakisaurus balochistani* by Malkhani (2019).

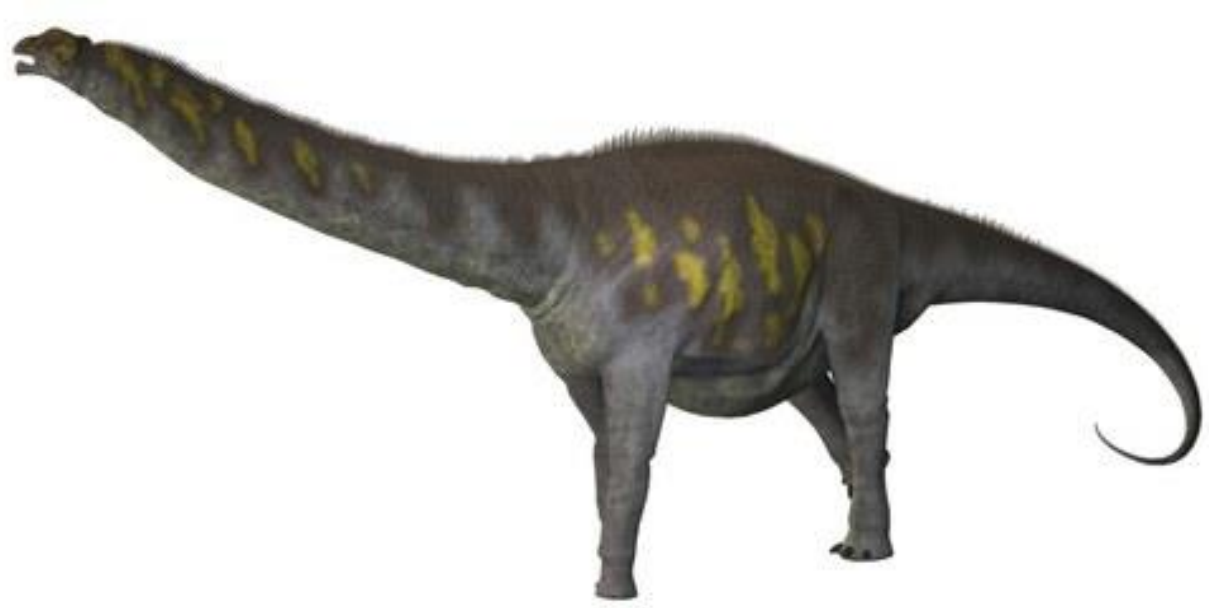

Figure 9. An artistic image of *Pakisaurus balochistani*, Malkani 2004 (Courtesy of: Bashir Ahmad)

15. *Imrankhanhero:* *Imrankhanhero* (meaning 'Imran Khan a hero' honor and love for the great Imran Khan, former Prime minister of Pakistan, a social activist, and a legendary cricketer) is a

new taxon of titanosaur dinosaur from the Vitakri Formation in Pakistan is a new genus of titanosaurian dinosaurs from the Late Cretaceous (Maastrichtian) Vitakri Formation of Pakistan described by Malkani (2023a). A humerus, a femur, fibulae, a tibia, a metatarsal, and caudal vertebrae are the fossil materials found in the Vitakri Formation and referred to as *Imrankhanhero zilefatmi* (Malkani, 2024b).

16. *Khanazeem:* *Khanazeem* (meaning 'The great Khan' shows honor and love for the great Imran Khan, Former Prime Minister of Pakistan, Imran Khan. It is a new genus of titanosaurian sauropod from the Late Cretaceous Vitakri Formation of Pakistan. A dentary with teeth, caudal vertebrae, femora, humeri, and tibiae in the form of a partial skeleton as a holotype. The intended type species is *Khanazeem saraikistani*, which Malkani first reported and described (2022; 2024a).

Theropods (Carnivorous dinosaurs) from the late Cretaceous Vitakri Formation

17. *Vitakridrinda sulaimani,* Malkani 2006 (Fig. 10): It lived in the Cretaceous period and was a large-sized carnivorous belisaurian theropod dinosaur, which is based on partial snout and braincase, and was originally referred to as the holotype; additional vertebrae may also belong to this genus. Thomas Holtz considered a possible length of 6 meters (19.7 feet) for this species (Holtz, 2012). (Malkani 2006a , 2014b). This is also called the "Pakistani T. rex"; the *Vitakridarinda* was an 8-meter-long carnivore that scavenged the Pab Formation in Baluchistan, Pakistan. *Vitakridrinda* is a genus of abelisaurid theropod dinosaur from the Late Cretaceous of Baluchistan, Pakistan.

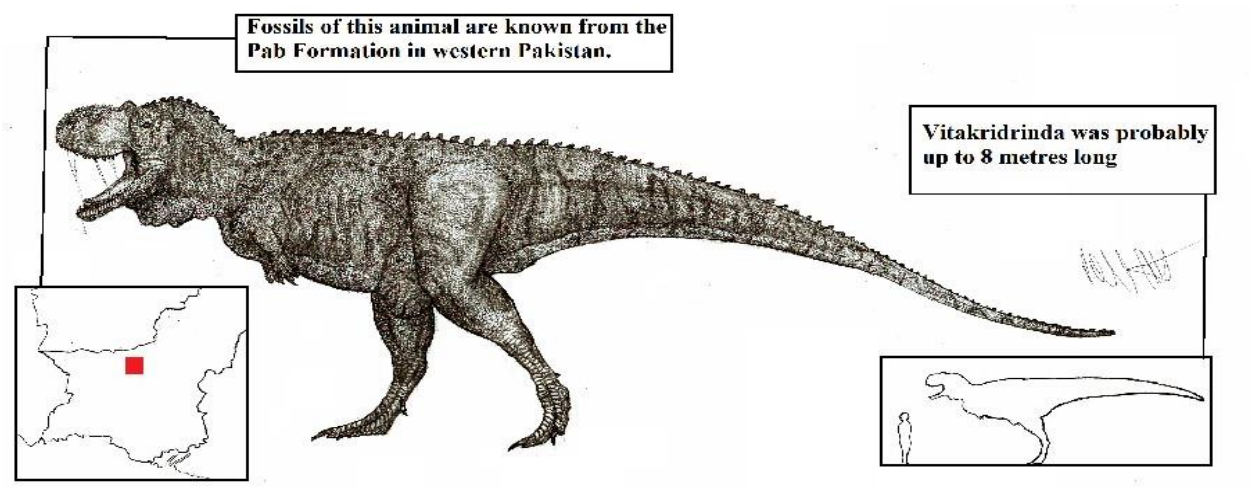

Figure 10. An artistic image of *Vitakridrinda sulaimani* Malkani, 2006 (Courtesy: Robinson Kuuz, 2013)

18. *Vitakrisaurus Saraiki,* Malkani 2010 (Fig. 11): It is a small, carnivorous, non-lizard theropod of the family Vitakrisauridae, derived from the red flood muds of the Late Cretaceous Vitakri Formation of Kali Kakar in the Vitakri district, from which separate animals have been collected (Malkani, 2010b). It resembles the famous Velociraptor and was present in the late Cretaceous period. The *Vitakrisaurus* is a carnivorous genus of noasaurid theropod dinosaurs. The holotype specimen, MSM-303-2, is a right foot with a three-toed shape and phalanges. The genus *Vitakri* refers to the Vitakri genus of the Pab Formation, and the specific name "Saurus", meaning "reptile" in Greek. The specific name honors the Saraiki people, who primarily live in southern Punjab, south of KPK, and north of Sindh. Most of the dinosaur taxa are named by Muhammad Sadiq Malkani. Some authors consider *Vitakrisaurus* to be the same animal as *Vitakridrinda (*Malkani, 2017, 2021b).

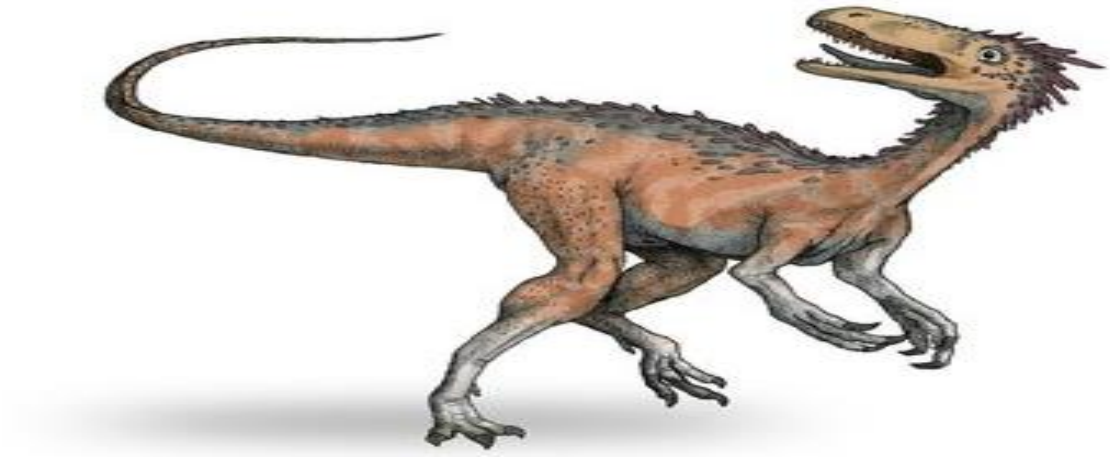

Figure 11. An artistic image of *Vitakrisaurus Saraiki,* Malkani 2010 (Courtesy: Bashir Ahmad)

19. *Shansaraiki:* *Shansaraiki* (meaning Respect and honor of Saraiki peoples) is a new genus and new species of a theropod that was probably an abelisauroid. The holotype was found in the Shalghara locality of the Late Cretaceous period, Vitakri Formation of Pakistan, and the holotype consists of GSP/ MSM-140-3 (symphysis), GSP/MSM-5-3 (mid-ramus with partial tooth bases), and GSP/MSM-57-3 (dorsal vertebrae). However, they may belong to separate specimens as they were found apart from each other's localities. The intended type species is *Shansaraiki insafi,* which was first mentioned by Malkani (2022).

Noasauridae

20. *Saraikisauris minhui,* Malkani (2013): A new small theropod dinosaur (Bellisauridae: Noasauridae) has been discovered in the latest Maastrichtian Vitakli Formation in Pakistan. The

piece of evidence is in the form of a bone dentary ramus articulated with transversely compressed partial teeth of *Saraikisaurus minhui* found from the latest Cretaceous (latest Maastrichtian) Vitakri Formation of Baluchistan Province, Pakistan. The transversely compressed leaf-like teeth and pre-dentary occurrence are among the main features of ornithischians (Malkani, 2024b). The posterior teeth were removed (most of the teeth were destroyed), and the ramus of *Saraikisaurus minhui* may have had prerotational or destroyed prerotational bones and may belong to the order Ornithischia. *Saraikisaurus minhui* from Pakistan also shows resemblance and is supported by a breakage line or suture preserved in *Masiakasaurus knopfleri* from Madagascar (Sampson et al. 2001; Carrano et al. 2002.

Ornithopaonia

Three pieces of evidence of partial trackways, footprints, and some bones of Ornithopoda (a herd of at least 3 individuals) were discovered:

21. *Malakhelisauroperus* *(Malakhelisaurus, Malakhelpodus):* The first evidence is the footprints and partial trackways of dinosaurs found in the Middle-Late Jurassic Samanasuk Limestone in Baroach Nala, Malakhel area of Mianwali District of Punjab, Pakistan. This is a large-bodied *Malakhelisauroperus mianwali* Malkani 2021b Ornithopaonia (most probably ornithischian or maybe titanosauriforms sauropod) which is obliquely confronted by the largest solitary *Samanadrindoperus surghari* Malkani 2021b large Theropaonia (belongs to theropod). Mannion et al. (2013) concluded that the Baroach Nala Malakhel trackways (according to Lockley 1991 and P.L. Falkingham, pers. comm in 2012 with Mannion) as three-toed ornithopods (Malkani, 2024b).

22. *Pashtosauroperus* *(Pashtosaurus, Pashtopodus):* The second piece of evidence is the footprints and partial trackways of dinosaurs found from the Late Cretaceous (Maastrichtian) Sor Member of Pab Formation in Sor Muzghai locality of Musafarpur area of Qila Saifullah District, Balochistan Province, Pakistan. Footprints and partial trackways of large-bodied *Pashtosauroperus zhobi* Malkani 2021b, Ornithopoda, found on the sandstone bed of Pab Formation. Prof. Dr. P.L. Falkingham identified the tritoedpes identity as large ornithischians that may be *Hadrosaurs* or *Stegosaurs;* however, he identified that the manus may belong to titanosaurs. Detailed descriptions and comparisons of this species can be seen in Malkani (2017) and Malkani (2024b.

Sauropaonia:

The following two species of Sauropod are evident from footprints:

23. *Chiltansauroperus* *(Chiltanpaer): Chiltansauroperus nicki* footprint from the Late Jurassic of Pakistan. Slender digits and unguals characterize it. Its central claw points forward, while its first and second claws point inward, and its fourth and fifth claws point outward. This is a new Sauropodaonia/ new ichnotaxon; named *Chiltansauroperus nicki, Chiltansauroperus nicki* new ichnogenus, and a new ichnospecies. Its holotype is in the form of a footprint, GSP/MSM-1067-K, which is housed in the Museum of the Geological Survey of Pakistan, Quetta. Its type locality is Madan Jhukur locality (latitude 28˚15'03" N; longitude 67˚06'12" E) of Moola area of Khuzdar district, Baluchistan. Its horizon is Chiltan limestone. Its age is late Jurassic. Genus *Chiltan* honors the host Chiltan limestone, "*sauro*", Greek for a lizard, and *"per*", Saraiki/Urdu for a foot. Species *nicki* honors British Journalist "Mr. Nicholas Allen" (Nick Allen) who helped a lot with the preservation of the ichno site and fossils (Malkani, 2021a).

24. *Dgkhansauroperus* *(Dgkhansaurus, Dgkhanpodus: Dgkhansauroperus maarri* Footprint from the Latest Cretaceous of Pakistan. This Sauropaonia is a new ichnotaxon: "*sauro*", Greek for reptile, "paon", Urdu/Saraiki for feet. *Dgkhansauroperus maarri,* new ichnogenus and new ichnospecies. Genus *Dgkhan* honors the host division Dera Ghazi Khan, and Species *marri* honors the host from the "Marri" tribe of Baluchistan in Marri Peak (Malkani, 2021a).

Theropaonia

25. *Samanadrinda surghari* (Fig. 12): A large-bodied beast resembling the T-Rex but with smaller teeth was discovered in 2006 and named in 2014 by Malkani. The name "Samana" is the geological Formation of the site at which it was discovered. "*Darinda*" means beast in Urdu, and "*Surghari"* is dedicated to the Sur ghar (Red Mountain in Pushto) range, which hosts the area, Middle Jurassic Samana Suk Formation.

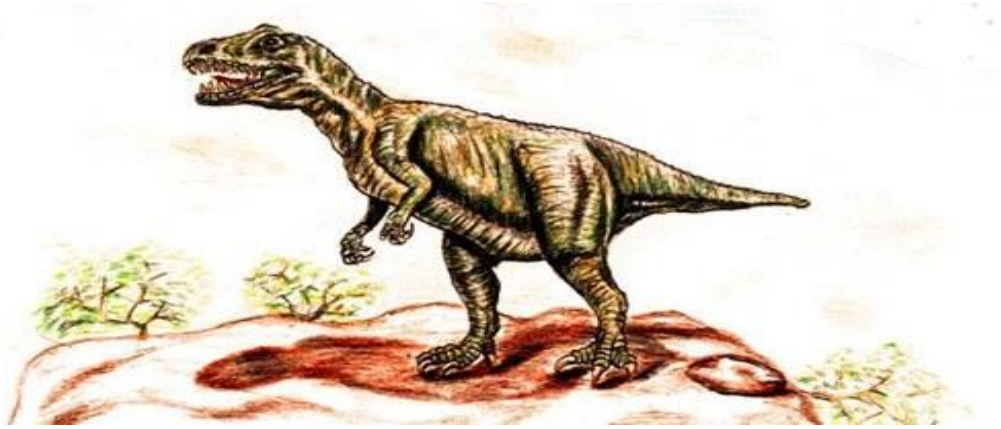

Figure 12. An Artistic image of *Samanadrinda surghari* (Courtesy: Asim Mirza)

26. *Himalayadrindoperus* *(Himalayadrinda, Himalayapodus): Himalayadrindoperus potwari* Trackways from the Late Jurassic of Pakistan. Theropaonia's new ichno taxon has a slender tridactyle/tri-digit overlap with Theropaonia. *Himalayadrindoperus potwari,* new ichnogenus and new ichnospecies. Its age is the latest Jurassic. Etymology: Genus Himalaya honors the Himalayan Mountain, "*Darinda*", Saraiki/Urdu for beast, and "*per*" in Saraiki/Urdu for foot or footmark. *Himalayadrindoperus* has a high divarication angle of slender digits II-IV = c. 70˚-90˚ with medial deflection of claws. It is differentiated from other theropodous footprints by having a high divarication angle (Malkani et al*.,* 2018; Malkani, 2021a).

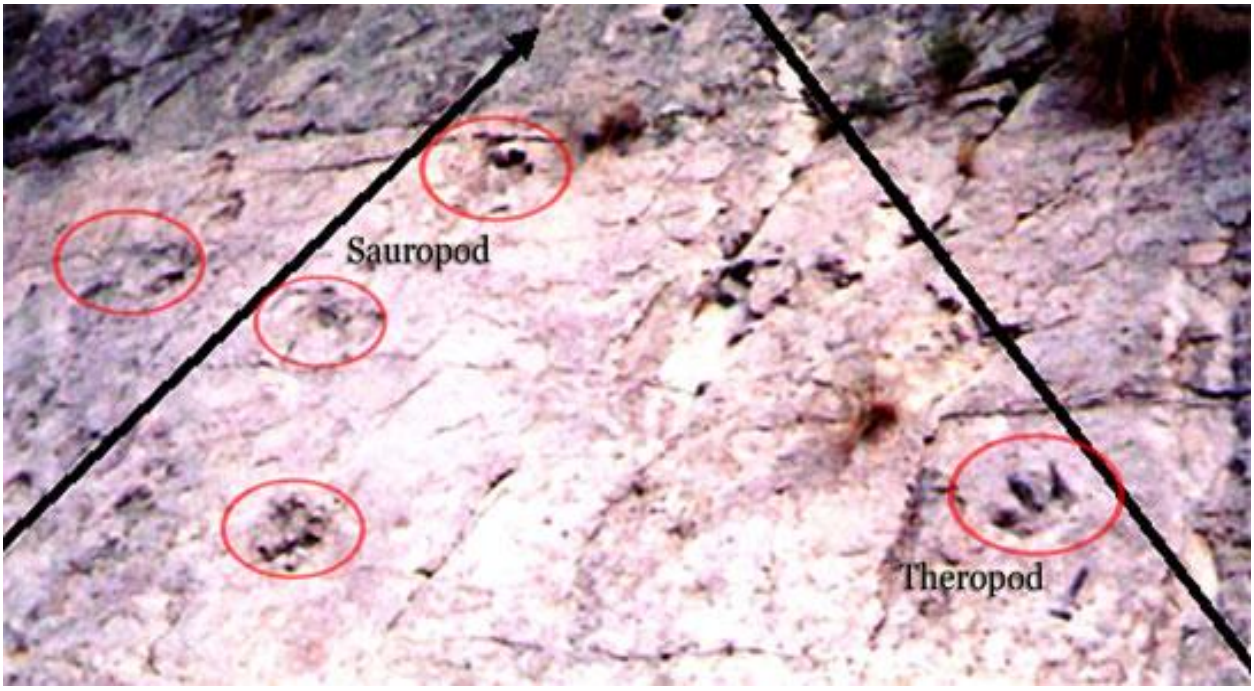

Figure 13. A photo of the footprints and trackways of dinosaurs (Courtesy: Malkani).

Conclusion

Sufficient and significant collections of fossils of titanosaurs have been collected so far, about 25 years after the first dinosaur was discovered in Pakistan. Some complete and some nearly complete titanosaur sauropod limb bones from Pakistan, and some complete bones from India, are sufficient for comparison. Although complete fossil skeletons are rare in Pakistan, many fossils (Out of 400 documented fossil bones recorded) with many comparisons and tests are enough for the basis for more than two dozen dinosaurian species, viz, *Saraikimasoom* is based on the snout, *Gspsaurus, Imrankhanshaheen, Nicksauru, Pakisaurus,* and *Khanazeem* are based on cranial, vertebral, and

appendicular bones. *Balochisaurus, Qaikshaheen, Marisaurus, Maojandino, Ikqaumishan,* and *Imrankhanhero* are based on vertebral and appendicular skeletal segments. *Sulaimanisaurus* and *Khetranisaurus* are based on tail vertebrae only. Most of these taxa have skeletal elements for comparison with each other. 1 titanosaur, 15 titanosaur, and 4 theropod dinosaur groups have been recorded in Pakistan to date. The exposures of the Vitakri Formation in the Vitakri dome proved a graveyard that yielded a large number of bone assemblages and also hosted numerous skeletal fragments and their assemblages. Despite the lack of a direct impact, many isolated fossils are found at the surface, but the lack of repetition, consistency, and overall morphological coherence suggests that the evidence is not directed at their direct organization. Many of these assemblages became the source of holotypes for most titanosaur sauropods and vitasaurid theropods. Many of these assemblages became the source of holotypes for most titanosaurian sauropods and vitasaurid theropods. Some vertebrae align some assemblages and are partially embedded in mud. Other collections are consistent with holotypes and taxa. Each combination generally occurs within a small area (approximately 10- 20 m2). Many sites are suitable for excavation. The true age of the fossiliferous Maastricht Vitakri Formation, bounded by the Maastricht and the early Paleocene Formations, has been determined. The titanosaurs of Pakistan are closely related to titanosaurs of Australia, Africa (Madagascar, Malawi, and Egypt), and South America (Argentina), and more distantly related to titanosaurs of Europe and South America. While far from European and South American titanosaurs. *Saraikimasoom vitakri* snout shows some relation with Mongolian (Asian) nemegtosaurids, while slender titanosaurs *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* show close relation with Egyptian (African) titanosaurs. Despite its V-shaped tooth row, *Gspsaurus* of Pakistan was the last of the titanosaurs. Fossils collected from Pakistan have important and comprehensive diagnostic features that can be used in phylogenetic analysis, including updated and expanded characters of titanosaur fossils, Indo-Pakistan plate palaeo-biogeography, and K-Pg extinction. Further work for Paleo-Biogeographic and paleo-phylogenetic analyses of these Pakistani dinosaurs should be done soon to know a clearer and more accurate position of these dinosaurs.

Authors' contributions

Hans-Volker Karl: Conceptualization (equal); supervision; project administration; formal analysis (equal); investigation (equal); methodology (equal); resources (equal); software (equal);

validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal).

Amtyaz Safi: Conceptualization (equal); project administration; Formal analysis (equal); investigation (equal); software (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal).

Gottfried Tichy: Conceptualization (equal); formal analysis (equal); investigation (equal); methodology (equal); resources (equal); software (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal).

All authors approved the final manuscript.

Acknowledgments

The authors would like to thank Prof. Dr. Zafar Farooqui (Head, Department of Zoology, Government Degree Science College, Nishtar Road, Karachi) and Prof. Dr. M. Usman Ali Hashmi (Head of Zoology Department at Government Dehli Science College, Hussainabad, Karachi) for their valuable suggestions and insightful comments on the earlier draft of this article. We should not forget Muhammad Sadiq Malkani (Former Director, The Geological Survey of Pakistan, AJK, Muzaffarabad, Pakistan), whose extensive research and investigations in Pakistan were a source of inspiration and a baseline for the compilation of this review article. We would also like to thank him for his valuable comments and suggestions that helped us improve this article.

Conflict of interest statement: The authors declare no conflicts of interest regarding the publication of this paper.

References

Böhme, M. (2003). The Miocene climatic optimum: Evidence from ectothermic vertebrates of Central Europe. Palaeogeography, Palaeoclimatology, Palaeoecology, 195, 389–401. https://doi.org/10.1016/S0031-0182(03)00367-5

Brett-Surman, M. K., Holtz, T. R., & Farlow, J. O. (2012). The complete dinosaur (p. 25). Indiana University Press. ISBN 978-0-253-00849-7

Carrano, M. T., Sampson, S. D., & Forster, C. A. (2002). The osteology of Masiakasaurus knopfleri, a small abelisauroid (Dinosauria: Theropoda) from the Late Cretaceous of Madagascar. Journal of Vertebrate Paleontology, 22(3), 510–534.

Holtz, T. R. (2012). Dinosaurs: The most complete, up-to-date encyclopedia for dinosaur lovers of all ages [PDF].

Hussam, Z., Pol, D., Carvalho, A. B., Nascimento, P. M., Riccomini, C., Larson, P., Juarez-Valieri, R., Pires-Domingues, R., da Silva, N. J., de Almeida Campos, D., & Sereno, P. (Ed.). (2011).

A complete skull of an Early Cretaceous sauropod and the evolution of advanced titanosaurians. PLOS ONE, 6(2), e16663. https://doi.org/10.1371/journal.pone.0016663

Jain, S. L., & Bandyopadhyay, S. (1997). New titanosaurid (Dinosauria: Sauropoda) from the Late Cretaceous of Central India. Journal of Vertebrate Paleontology, 17(1), 114.

Karanth, K. P. (2021). Dispersal vs. vicariance: The origin of India's extant tetrapod fauna. Frontiers of Biogeography, 13(1). https://doi.org/10.21425/F5FBG48678

Karl, H.-V., Safi, A., & Staesche, U. (2021). New findings of Neogene tortoises Titanochelon kayadibiensis sp. nov. and Protestudo bessarabica (Riabinin, 1918) (Testudinidae) from the Miocene of western Turkey, with a review of fossil turtles of Turkey. SPC Journal of Environmental Sciences, 3(1), 1–9.

Karl, H.-V., Safi, A., & Tichy, G. (2024). Review of fossil records of prehistoric reptiles, their distribution, and paleo-biogeographic evolution in Pakistan. Scientific Reports in Life Sciences, 5(3), 1–23. https://doi.org/10.5281/zenodo.13771832

Klaus, S., Morley, R., Plath, M., et al. (2016). Biotic interchange between the Indian subcontinent and mainland Asia through time. Nature Communications, 7, 12132. https://doi.org/10.1038/ncomms12132

Lockley, M. (1991). Tracking dinosaurs: A new look at an ancient world (238 pp.). Cambridge University Press. Available at https://www.researchgate.net/publication/248685949 (Accessed August 28, 2024).

Malkani, M. S. (2003). First Jurassic dinosaur fossils found from Kirthar Range, Khuzdar District, Balochistan, Pakistan. Geological Bulletin, University of Peshawar, 36, 73–83.

Malkani, M. S. (2004). Stratigraphy and economic potential of Sulaiman, Kirthar and Makran-Siahan ranges, Pakistan. *Fifth Pakistan Geological Congress*, Islamabad, Abstract Volume, 14–15 April 2004.

Malkani, M. S. (2006). Biodiversity of saurischian dinosaurs from the latest Cretaceous Park of Pakistan. Journal of Applied and Emerging Sciences, 1(3), 108–140.

Malkani, M. S. (2007). Trackways evidence of sauropod dinosaurs confronted by a theropod in the Middle Jurassic Samana Suk Limestone of Pakistan. Sindh University Research Journal: Science Series, 39(1), 1–14.

Malkani, M. S. (2008). Marisaurus (Balochisauridae, Titanosauria) remains from the latest Cretaceous of Pakistan. Sindh University Research Journal: Science Series, 40(2), 55–78.

Malkani, M. S. (2009). New Balochisaurus (Balochisauridae, Titanosauria, Sauropoda) and Vitakridrinda (Theropoda) remains from Pakistan. Sindh University Research Journal: Science Series, 41(2), 65–92.

Malkani, M. S. (2010a). New Pakisaurus (Pakisauridae, Titanosauria, Sauropoda) remains and Cretaceous–Tertiary boundary from Pakistan. Sindh University Research Journal: Science Series, 42(1), 39–64.

Malkani, M. S. (2010b). Osteoderms of Pakisauridae and Balochisauridae (Titanosauria, Sauropoda, Dinosauria) in Pakistan. Journal of Earth Science, 21(Special Issue 3), 198–203. https://doi.org/10.1007/s12583-010-0212-z

Malkani, M. S. (2013). New pterosaur from the latest Cretaceous terrestrial strata of Pakistan. In Abstract Book of the 9th International Symposium on the Cretaceous System, Ankara, Turkey, 62.

Malkani, M. S. (2014a). Titanosaurian sauropod dinosaurs from the latest Cretaceous of Pakistan. In Abstract Volume of the 2nd Symposium of International Geoscience Program 608, Tokyo, Japan, 108–111.

Malkani, M. S. (2014b). Theropod dinosaurs and mesoeucrocodiles from the Terminal Cretaceous of Pakistan. In Abstract Volume of the 2nd Symposium of International Geoscience Program 608, Tokyo, Japan, 169–172.

Malkani, M. S. (2015a). Titanosaurian sauropod dinosaurs from Pakistan. In Y. Zhang (Ed.), Abstract volume of the 12th Symposium on Mesozoic Terrestrial Ecosystems and IGCP 608, Shenyang, China, 93–98.

Malkani, M. S. (2015b). Terrestrial mesoeucrocodiles from the Cretaceous of Pakistan. In Y. Zhang (Ed.), Abstract volume of the 12th Symposium on Mesozoic Terrestrial Ecosystems and IGCP 608, Shenyang, China, 242–246.

Malkani, M. S. (2015c). Dinosaurs, mesoeucrocodiles, pterosaurs, new fauna, and flora from Pakistan. Geological Survey of Pakistan, Information Release 823, 1–32.

Malkani, M. S., & Ge, S. (2016). Fossil biotas from Pakistan with a focus on dinosaur distributions and discussion on the paleobiogeographic evolution of the Indo-Pak Peninsula. Global Geology, 19(4), 230–240.

Malkani, M. S. (2017). Titanosaurian sauropod and abelisaurian theropod dinosaurs and mesoeucrocodiles from Pakistan: A review. In Abstract Volume of the 5th Symposium of IGCP 632, Flagstaff, Arizona, 12.

Malkani, M. S., Somro, N., & Arif, S. J. (2018). A new pes footprint of sauropod dinosaur discovered from the latest Cretaceous of Pakistan. ResearchGate, 1 p.

Malkani, M. S. (2019). Recently discovered beasts, baluchithere, rhinoceros, horses, sea cow, proboscidean, eucrocodile, pterosaurs, plesiosaur, fishes, invertebrates, and wood fossils, tracks and trackways of dinosaurs from Pakistan; Comparison of the recognized four titanosaur taxa of Indo-Pakistan with Madagascar. Open Journal of Geology, 9, 919–955. https://doi.org/10.4236/ojg.2019.912098

Malkani, M. S. (2021a). Formal description of Mesozoic and Cenozoic biotas found in Pakistan. Open Journal of Geology, 11, 411–455.

Malkani, M. S. (2021b). Jurassic–Cretaceous and Cretaceous–Paleogene transitions and Mesozoic vertebrates from Pakistan. Open Journal of Geology, 11, 275–318.

Malkani, M. S. (2022). Plate boundary and structural geology of Balochistan and Indus basins through field observations on Chaman transform fault and western Indus suture (Pakistan): Dinosaurs from Pakistan with attributed bones and key features; Titanosaurs from India with updated assessment on Jainosaurus. Open Journal of Geology, 12, 1032–1079. https://doi.org/10.4236/ojg.2022.1211049

Malkani, M. S. (2023a). Geology and mineral deposits of Saraikistan (South Punjab, Koh

Sulaiman Range) of Pakistan: A tabular review of recently discovered biotas from Pakistan and paleobiogeographic link: Phylogeny and hypodigm of poripuchian titanosaurs from Indo-Pakistan. Open Journal of Geology, 13, 900–958. https://doi.org/10.4236/ojg.2023.138040

Malkani, M. S. (2023b). A glance at the mineral deposits and stratigraphic sequential variations and structures in different Indus basins (Pakistan): New titanosaurian sauropod dinosaurs from the latest Maastrichtian Vitakri Formation of Pakistan. Open Journal of Geology, 13, 1069–1138. https://doi.org/10.4236/ojg.2023.1310046

Malkani, M. S. (2024a). New data on coal, gypsum, iron, and silica sand deposits and geochemical exploration (Pakistan): Revision of 25 years' history of dinosaur discoveries from Pakistan. Open Journal of Geology, 14, 431–511. https://doi.org/10.4236/ojg.2024.143020

Malkani, M. S. (2024b). First ornithischian dinosaurs from Pakistan: Some evidence. ResearchGate. https://www.researchgate.net/publication/First_ornithischian_dinosaurs_from_Pakistan (Accessed August 13, 2024).

Mannion, P. D., Upchurch, P., Barnes, R. N., & Mateus, O. (2013). Osteology of the Late Jurassic Portuguese sauropod dinosaur Lusotitan atalaiensis (Macronaria) and the evolutionary history of basal titanosauriforms. Zoological Journal of the Linnean Society, 168, 98–206.

Baron, M. G., & Williams, M. E. (2018). A re-evaluation of the enigmatic dinosauriform Caseosaurus crosbyensis from the Late Triassic of Texas, USA and its implications for early dinosaur evolution. Acta Palaeontologica Polonica, 63. https://doi.org/10.4202/app.00372.2017

Rögl, F. (1999). Mediterranean and Paratethys: Facts and hypotheses of an Oligocene to Miocene paleogeography (short overview). Geologica Carpathica, 50, 330–349.

Sampson, S. D., Carrano, M. T., & Forster, C. A. (2001). A bizarre predatory dinosaur from the Late Cretaceous of Madagascar. Nature, 409(6819), 504–506.

Wilson, J. A., Malkani, M. S., & Gingerich, P. D. (2005). A sauropod braincase from the Pab Formation (Upper Cretaceous, Maastrichtian) of Baluchistan, Pakistan. Gondwana Geological Magazine, Special Volume 8, 101–109.

Wilson, J. A., Barrett, P. M., & Carrano, M. T. (2011). An associated partial skeleton of Jainosaurus cf. septentrionalis (Dinosauria: Sauropoda) from the Late Cretaceous of Chhota Simla, Central India. Palaeontology, 54(5), 981–998.

Online sources

Fandom. (n.d.). Dinosaurs of Pakistan. In *Fossil Wiki*. Retrieved August 28, 2024, from https://fossil.fandom.com/wiki/Dinosaurs_of_Pakistan

Pakiscience. (2023). Rare dinosaur fossils in Pakistan. *Pakiscience*. https://pakiscience.pk/archives/2946

Dawn. (2011, April 2). Rare dinosaur footprints in Pakistan. Dawn News. https://www.dawn.com/news/617762/rare-dinosaur-footprints-in-pakistan