India’s first dinosaur, rediscovered

‘Reasoning from analogy at Jubbulpore, where some of the basaltic cappings of the hills had evidently been thrown out of craters long after this surface had been raised above the waters, and become the habitation both of vegetable and animal life, I made the first discovery of fossil remains in the Nerudda valley. I went first to a hill within sight of my house in 1828, and searched exactly between the plateau of basalt that covered it, and the stratum immediately below; and there I found several small trees with roots, trunks, and branches, all entire, and beautifully petrified. They had been only recently uncovered by the washing away of a part of the basaltic plateau. I soon after found some fossil bones of animals.’

—W. H. Sleeman

So begins the history of Indian dinosaur studies. The bones that Sleeman collected from the beds underlying the Deccan Traps at Jabalpur would soon embark on ‘rambles’ of their own. Sleeman sent two fossil bones to G. G. Spilsbury, a civil surgeon, who himself collected a third bone from the same bed. In 1832, Spilsbury sent all three to Calcutta and a second bone from the same bed. In 1832, Spilsbury sent all three to Calcutta and a second bone from the same bed.

By 1862, these bones had held a special place as India’s first recorded dinosaur, discovered only four years after the discovery of the first-named dinosaur Megalosaurus and 14 years before the name ‘Dinosaur’ was coined. Like Megalosaurus and other early-named dinosaurs such as Iguanodon and Cetiosaurus, Titanosaurus was based on limited material whose diagnostic features were eventually made obsolete by the discovery of more complete remains. The first such discoveries were made by Charles Matley and Durgasankar Bhattacharji in the early 1900s (refs 14 and 15). Excavations near the probable location of Sleeman’s original site in Jabalpur produced the braincase and partial skeleton of Antarctosaurus septentrionalis (whose genus name has since been changed to Jainsosaurus), a partial postcranial skeleton of a second, smaller individual of the same genus, as well as many isolated bones. Many of the theropod remains were shipped to London for preparation and description in 1922 and 1925; most of them were returned to India in 1936, along with a plaster cast of the partial hind limb of Jainsosaurus. There is no manifest for this shipment, so it is not known exactly which specimens made the trip to and from London. Barnum Brown visited Bara Simla and made additional collections of theropod and sauropod remains, which are housed at the American Museum of Natural History. More recent excavations elsewhere in India have added to the initial discoveries of Matley and Bhattacharji at Bara Simla and Chhiba Simla (Jabalpur). One of most important was an accumulation of several hundred bones in strata just below a prolific egg-bearing horizon in Rahioli, western India. Another such locality was Dongargaon in central India, some 335 km south of Jabalpur. The Dongargaon locality...
produced the most complete skeleton of an Indian dinosaur, *Indosaurus colberti* (formerly known as ‘Titanosaurus’ colberti), which is known from a braincase, presacral, sacral and caudal vertebrae, girdle bones and limb bones. The more recent discovery of scores of dinosaur bones in Balochistan, Pakistan also represents an important source of information on dinosaurs of the Indian subcontinent.

Beyond its historical and patrimonial significance, what is the relevance of *T. indicus*, if the species was based on limited material, now missing, deemed insufficient to distinguish it from other dinosaurs? The material is relevant for several reasons. First, *Titanosaurus* provided an initial glimpse at, and eventually became the namesake for, the diverse, late-surviving sauropod lineage Titanosauria. Titanosaurs comprise more than 40 genera, which have been recorded from all continental landmasses, including Antarctica. They are morphologically distinctive sauropods with elongate skulls bearing narrow tooth crowns and presacral vertebrae with complex lamination and limbs that were slightly angled outward in a wide-gauge posture. Some titanosaurs even possessed dermal armour that may have functioned as a mineral store that allowed them to survive in stressed environments. In addition, *Titanosaurus* provided the first indications of what Lydekker called a ‘remarkable community of type which undoubtedly exists between the faunas of southern continents of the world’. Recast in today’s mobilist palaeogeographic paradigm, the Indian subcontinent takes on special significance as a large dispersal vector that began the Mesozoic interlocked with other southern landmasses and ended it in isolation prior to docking on Asia sometime in the early Tertiary. Large continental tetrapods like *Titanosaurus* and other dinosaurs can provide insight into India’s relationship with other landmasses, both southern and northern. Last, and perhaps most significantly, inability of the scientific community to access and study *T. indicus* is symptomatic of a larger issue. There are several Indian dinosaur specimens that are currently missing, including both small and large specimens of sauropod and theropod dinosaurs. Notable missing specimens include the partial postcranial skeleton of the stocky-limbed, large theropod *Lametasaurus indicus*, skull materials of both *Indosaurus matleyi* and *Indosuchus raptorius*, parts of *Jainosaurus septentrionalis* and the small noasaurid theropod *Laevisuchus indicus* and many theropod limb bones (Figure 1). The nonavailability of these elements has seriously hindered efforts to understand the evolutionary history of Indian dinosaurs and to decode their palaeobiogeographic connections to other southern landmasses. But are these bones lost, or merely misplaced? Are efforts best directed at retrieving these bones in collections or finding new bones in the field?

The Geological Survey of India (GSI) and the University of Michigan have recently embarked on a programme to recover missing fossil bones in museum collections and to collect new bones from field sites. Efforts at the Indian Museum (Kolkata) and GSI repositories have resulted in the recovery of the misplaced holotypic caudal vertebra of *T. indicus* (Figure 2). The *T. indicus* holotype was stored together with bones of *T. blanfordi* and with Triassic vertebrae of the ‘Lydekker collection’, also presumed missing. The bones were recovered from the vast fossil vertebrate and

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**Figure 1.** Currently missing Indian dinosaur fossils. a, b, Syntypic skull elements of the large theropod *Indosuchus raptorius*. a, Skull roof K20/350 in dorsal view. b, Skull roof and braincase K27/685 in dorsal and left lateral views. c, Holotypic partial skeleton of the large theropod dinosaur *Lametasaurus indicus*, including sacrum in ventrolateral view, right ilium in ventral view (anterior towards bottom), and left tibia in lateral view. d, Holotypic cervical vertebra (K20/614) of the noasaurid *Laevisuchus indicus*. Scale equals 10 cm for (a) and (b), 30 cm for (c) and 5 cm for (d).

**Figure 2.** Rediscovered holotypic caudal vertebra of India’s first dinosaur, *Titanosaurus indicus*, in left lateral view. Roman numerals inked on the bone refer to plate and figure numbers; the other two numbers (GSI ‘2191’, ‘2194’) represent serial numbers as recorded in the Specimen Register of the Curatorial Division, GSI. Scale equals 5 cm.
invertebrate collection of the Curatorial Division of GSI Headquarters at Kolkata. The *T. indicus* caudal vertebra is preserved intact, based on comparisons with drawings by Falconer and Lydekker4,5, save a small portion of its coty lar rim that is now broken. Recovery efforts have also turned up several other bones (Figure 3). The original syntypic caudal vertebrae of *Titanosaurus blanfordi* (one of which later was removed from the type16) were found with the *T. indicus* holotype. The holotypic humerus of *J. septentrionalis* (GSI K27/497) was found in several pieces atop tall display cases in the Siwalik Gallery of the Indian Museum after having gone unnoticed for decades48. One of the holotypic cervical vertebrae of the small theropod *Laeviasuchus indicus* (GSI K20/613)19 was recently found in three separate pieces in unmarked boxes, together with other unnumbered fragments in the Invertebrate Gallery of the Indian Museum. A complete abelisaurid femur (GSI K27/569)19 was found in five pieces in the Siwalik Gallery of the Indian Museum. In that same cabinet, a collection of theropod cranial, caudal, and limb elements collected by Matley but never described was found, along with undescribed rib fragments of the Chhotaborn specimen of *Jainosaurus*39, still in their original wrappings. In each of these instances, the specimen had no accession number—either because it never received one (e.g. *T. indicus*, *T. blanfordi*) or because the number had been separated from it by breakage (e.g. *Laeviasuchus, Jainosaurus*). Recovery of these specimens was more difficult because individual specimens (often fragments), rather than numbers, had to be recognized. In several cases (e.g. *T. indicus*, *T. blanfordi*, *Jainosaurus*), the specimen had been shifted outside the designated collection space, which had been searched repeatedly.

Recovery of *T. indicus* and other misplaced fossils bodes well for retrieval of other important missing specimens, such as *Laemtasaurus indicus*, *Indosaurus matleyi* and *Indosuchus raptorius* (Figure 1). The circumstances associated with the loss of the bones in Figures 2 and 3—no accession number, stored outside the ‘normal’ area—suggest that future rediscoveries may rely on visual recognition of unlabelled specimens that may be stored apart from other collections.

These results emphasize the importance of fossil repositories as secure storage for historical objects that form the basis for scientific research. These objects constitute the primary record of the evolutionary history of Greater India and its past and present connections to other landmasses.

Figure 3. Other rediscovered Indian dinosaur specimens. a, Abelisaurid femur (GSI K27/569) in anterior view. b, Holotypic cervical vertebra of *Laeviasuchus indicus* (GSI K20/613) in left lateral view. c, Cast of *Jainosaurus cf. septentrionalis* hind limb from Chhotaborn38,39, presented by Natural History Museum (London) to Nagpur City Museum1 in 1936. The original specimens are labelled as NHMUK 5903. d, Undescribed saurosaur caudal vertebra from the Matley Collection (GSI K20/612) in right lateral view. e, Holotypic caudal vertebra of *Titanosaurus blanfordi* (GSI 2195) in right lateral view. Scale bar equals 10 cm for (a), 2 cm for (b), 30 cm for (e), 1.5 cm for (d) and 5 cm for (e).

Pilot whale is a carnivorous marine mammal described under the order Cetacea, suborder Odontoceti (toothed whales). Though commonly called as ‘black fish’ or ‘potheads whales’, these mammals are named as ‘pilot whales’ because it was believed that pods were piloted by a leader. They are gregarious and frequently found with other small cetaceans. Pilot whales are one of the largest members of the family Delphinidae. Two extant species of pilot whales reported in the world oceans are long-finned * Globicephala macrorhynchus * (Traill, 1809) and short-finned * Globicephala melas * (Traill, 1809) and * Globicephala macrorhynchus * Gray 1846. General appearance of short- and long-finned whales is similar. However, the fin of the long-finned whales is one-fifth or more of their body length and one-sixth for that of short-finned whales. Short-finned pilot whales have fewer teeth, i.e. 7–9 short, sharply pointed teeth in the front of each tooth row, whereas it is 8–13 for long-finned whales. According to IUCN Red List, both the species are insufficiently known. Pilot whales are found in waters nearly worldwide with long-finned pilot whales living in temperate waters, and short-finned pilot whales living in the tropical and subtropical waters generally in deep offshore areas of Indian, Atlantic and Pacific Oceans. Both the species live in groups of 20–60 individuals or more. The population of * G. macrorhynchus * has been estimated as 150,000 in the eastern tropical Pacific Ocean and about 30,000 in the western Pacific, off the coast of Japan. Normally they prefer the waters in the western Pacific, off the coast of Japan. Normally they prefer the waters in the western Pacific, off the coast of Japan. Normally they prefer the waters in the western Pacific, off the coast of Japan. Normally they prefer the waters in the western Pacific, off the coast of Japan.

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Dhananjay M. Mohabey1 Subashis Sen2 Jeffrey A. Wilson3,4

1Geological Survey of India (Northern Region), Lucknow 226 004, India 2Geological Survey of India (Central Headquarters), Kolkata 700 016, India 3Museum of Paleontology and Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan 48109-1079, USA

*For correspondence. e-mail: wilsonja@umich.edu

Mass stranding of pilot whale * Globicephala macrorhynchus * Gray, 1846 in North Andaman coast

Pilot whale is a carnivorous marine mammal described under the order Cetacea, suborder Odontoceti (toothed whales). Though commonly called as ‘black fish’ or ‘potheads whales’, these mammals are named as ‘pilot whales’ because it was believed that pods were piloted by a leader. They are gregarious and frequently found with other small cetaceans. Pilot whales are one of the largest members of the family Delphinidae. Two extant species of pilot whales reported in the world oceans are long-finned * Globicephala melas * (Traill, 1809) and short-finned * Globicephala macrorhynchus * Gray 1846. General appearance of short- and long-finned whales is similar. However, the fin of the long-finned whales is one-fifth or more of their body length and one-sixth for that of short-finned whales. Short-finned pilot whales have fewer teeth, i.e. 7–9 short, sharply pointed teeth in the front of each tooth row, whereas it is 8–13 for long-finned whales. According to IUCN Red List, both the species are insufficiently known. Pilot whales are found in waters nearly worldwide with long-finned pilot whales living in temperate waters, and short-finned pilot whales living in the tropical and subtropical waters generally in deep offshore areas of Indian, Atlantic and Pacific Oceans. Both the species live in groups of 20–60 individuals or more. The population of * G. macrorhynchus * has been estimated as 150,000 in the eastern tropical Pacific Ocean and about 30,000 in the western Pacific, off the coast of Japan. Normally they prefer the waters of the shelf break and slope. Although they primarily feed on squid, pilot whales consume fishes, including Atlantic cod, Greenland turbot, Atlantic mackerel, Atlantic herring, hake, blue whiting and spiny dogfish. These whales are habituated to migrate seasonally inshore and offshore in response to the dispersal of their prey. Pilot whales are often