For the first time, skeletal remains of an armoured dinosaur (Ornithischia: Ankylosauria) were found in the red clay bed of the Kota Formation, Pranhita-Godavari Valley, Andhra Pradesh. The bed occurs 2 m below the marker limestone unit of the Kota Formation. The collection includes parts of skull, 30 specimens of body armour, vertebrae and parts of girdle bones. The characteristics of armour plates, skull and teeth indicate that these fossils belong to ankylosauria. The ankylosaurs are less known from the Lower Jurassic period. The detailed studies of the present material are likely to throw light on the evolutionary history of these dinosaurs.

The dinosaurian fauna from the Lower Jurassic Kota Formation of the Pranhita-Godavari Valley is well known through the occurrence of early sauropods, Barapasaurus tagorei (Jain et al. 1975, 1979) and Kotasaurus yamanpalliensis (Yadagiri, 1988, 2001). During the present investigation, skeletal remains of ankylosaur were collected for the first time from red clay bed of Kota Formation. The site is about one kilometer south of Bodepalli village and about 30 km northeast of Bellampally, a coal-mining town (Fig.1). Whereas most of the fossils in the collection were found lying on the surface, a few including the parts of skull and armour plates were recovered by shallow trenching. In addition, one complete turtle shell, fragments of carapaces, and a skull were also collected from the red clay bed.

The Kota Formation comprises mainly pale brown
Plate I. Skeletal parts of Ankylosaurian dinosaur. Parts of skull, maxilla in lateral (a) and ventral (b) views; mandibles in lateral (c) and dorsal (d) views; enlarged view of an anterior tooth showing the denticles (e); body armour (f-j); dorsal vertebra in lateral view (k), caudal vertebrae in lateral view (l) and scapula (m) with incomplete glenoid. The scale bar measures 1 mm in fig.e and 30 mm in all others.
sandstones and grits, red clays and a prominent limestone unit. The red clay bed, which has yielded armoured dinosaur, occurs 2 m below the marker limestone unit. The Kota vertebrates represented by semionotid fishes, flying reptiles, sauropod dinosaurs, crocodiles turtles and early mammals, are indicative of aquatic, terrestrial and arboreal habitat. The fauna indicates a Lower Jurassic age for the Kota Formation (Jain, 1973; Yadagiri and Prasad, 1977).

Description: Both the lower and upper parts of the skull are filled up with hard matrix. The anterior part of the skull appears to be narrow and elongated. The teeth are small, crowns are leaf shaped and laterally compressed. The anterior and posterior edges are gently curved with broad bases. The anterior and posterior edges are closely placed (Plate 1, fig.e), which are characteristic feature of the ankylosaurid. The skull does not show sutures and its surface has pitted ornamentation. The symmetry of two mandibles is clearly seen. Both the mandibles are closely placed (Plate 1, figs.a-d) due to compression.

The body armour plates are flat and have varying heights with broad bases. The anterior and posterior edges are smoothly curved to a pointed summit. Based on the size and shape of the bases, they are classified into four types. In type A (Plate 1, fig.f) the plate is flat and broad at the base. The ventral keel is present anteriorly which runs diagonally to the posterior edge. The plate measures 175 mm by height, 130 mm by base length and 80 mm by base width. In type B (Plate 1, fig.i) plates, the anterior edge is incurved with broadly rounded posterior edge. The base has two distinct areas of dermal attachment, a prominent medial anterior process and lateral posterior process. A ridge separates both the areas. The overall height of the plate is 157 mm, of the base, the length is 102 mm and width is 18 mm. In type C (Plate 1, fig.j) the base is narrow, gently arched with a depression in the central part. In type D (Plate 1, fig.g,h) the base is large in size compared to the height of the spine.

The centrum of dorsal vertebra (Plate 1, fig.k) is platycoelous and elongated. The centrum measures 65 mm in length, 55 mm in height and 60 mm in width. The centrum of the caudal vertebrae (Plate 1, fig.l) are short and amphicoelous. They have a strong longitudinal keel in ventral part.

The total length of the scapula is 200 mm, width of the shaft is 100 mm and width at glenoid is 120 mm (Plate 1, fig.m), the shaft is plano-convex in shape and takes a gradual curvature.

Remarks: Ankylosaurs were short-limbed, four-legged armoured dinosaurs. The most prominent armour of scutes, have keeled or unkeeled plates of bone embedded in the skin. The origin of ankylosaurs is not well understood, because globally only a few specimens are known from the Early and Middle Jurassic, during which period ankylosaurs first appeared and diversified. They first appeared in the Early Jurassic (about 200 m.y.) as relatively smaller forms not more than 2 m in length. It is known that Scutellosaurus, from the Lower Jurassic Kayenta Formation of North America, shielded its dorsal body surface with rows of keeled ossicles that were embedded in the skin (Colbert, 1981). True ankylosaurs are known from the Middle Jurassic and include Sacrolestes from England and Tianchiasaurus from China (Carpenter, 1997). These genera are represented by fragmentary remains. The discovery of armoured dinosaur from the Lower Jurassic Kota Formation assumes importance in this context. Detailed osteological studies are envisaged for understanding the origin and evolution of ankylosaurs.

Acknowledgement: We are thankful to Dr. N. Chattopadhyay, Deputy Director General, Geological Survey of India, Southern Region, for extending facilities to carry out the field and laboratory studies. Thanks are due to Shri Robert Prasad for photographs.

References


(Received: 9 October 2001; Revised form accepted: 4 January 2002)