Continental Drift and a Strange Fossil Reptile

A. W. Crompton

It has recently been reported in the New York Times that a group of scientists, including Dr. E. H. Colbert of The American Museum of Natural History, discovered the remains of a reptile by the name of *Lystrosaurus* in sedimentary rocks approximately 225 million years old on the Antarctic continent. This discovery is extremely important because it is the best biological evidence we have supporting the now widely accepted theory that the relative positions of the continents have changed dramatically during the last 200 million years.

The documentation of the steps involved in the evolution of the earliest mammals from the cold-blooded reptiles is best preserved in the extensive sedimentary rocks that were deposited over most of the southern tip of Africa and the adjoining continents somewhere between 240 and 195 million years ago. Perhaps the most common fossil of these sedimentary rocks is the aberrant reptile *Lystrosaurus,* so common in fact that it has to a large extent been ignored by scientists studying the fossil faunas of those times. However, now that it has leaped into prominence it deserves a closer look.

Lystrosaurus was a stocky animal with short legs, large head and short tail. The adults were anywhere from 2 to 5 feet in length (Fig. 1). Juvenile forms ranging from 6 to 9 inches in length have recently been discovered in South Africa. A drawing of the skull as it would appear in side view is shown in Figure 2.

Remains of *Lystrosaurus* have also been discovered in fair abundance in India. Because it was certainly not a free-swimming animal, migration from Africa to the Arctic continent across what is now the South Atlantic Ocean appears to be out of the question. Geologically speaking, *Lystrosaurus* apparently survived for only a relatively short period of time. It is unlikely that conditions for the survival of this animal would have been present in India, South Africa and the Antarctic simultaneously if the continents were in their present positions. A more reasonable way to explain the occurrence of *Lystrosaurus* on the Antarctic continent is to assume that Africa, India, and the Antarctic together with South America and Australia once formed part of a super-continent (Gondwanaland) (Fig. 3) which started to break up about 200 million years ago. This view is supported by numerous other lines of geological evidence, especially sea-floor spreading and plate tectonics, both of which have had such a profound effect upon our understanding of geological processes.

The concept of continental drift is not new, but before the geophysical evidence was available, the theory was not entirely convincing. Prior to discovery of *Lystrosaurus* on the Antarctic continent, the biological evidence suggesting continental drift could be interpreted in several ways. For example, the animals that lived in South America and South Africa about 200 million years ago were very similar; this is in sharp contrast to the present. But it could be argued that the similarity did not necessarily result from the close proximity of South America and Africa. If the

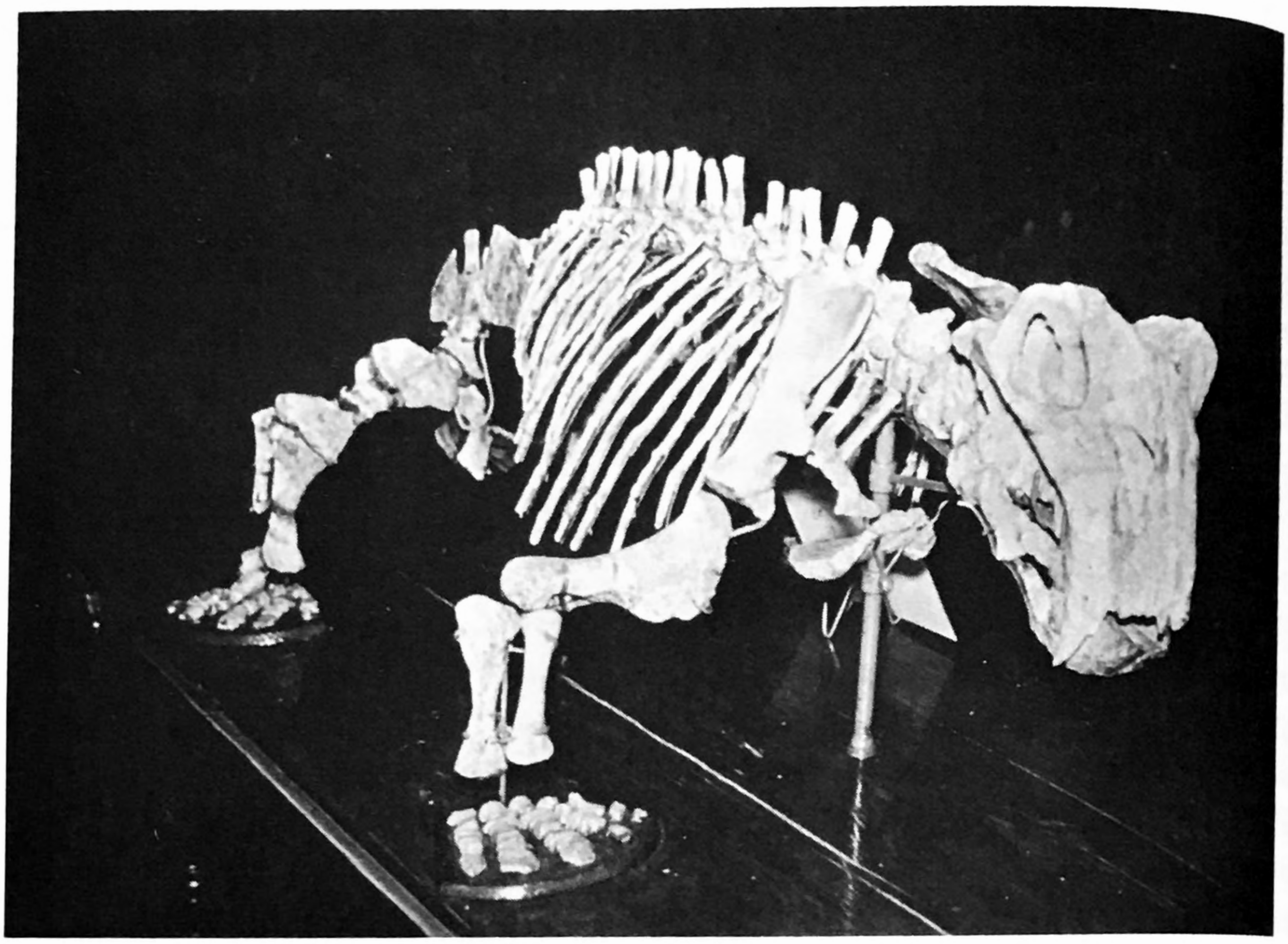

Fig. 1. Skeleton of *Lystrosaurus.*

continents were in their present position and if substantial bridges existed between South America and North America (Isthmus of Panama) and between North America and Asia (Bering Strait) and Asia and Africa, and if the climatic conditions at that time were more uniform across the entire globe and less zonal than they are today, then animals that lived at that time could well have had a worldwide distribution. (These bridges are perfectly reasonable and are known to have been crossed by animals during the last 70 million years). In such a case, the similarities between the 200 million year old fossil faunas of Africa and South America would be expected. However, short of proposing a mythical bridge between Africa and the Antarctic, a worldwide distribution would not have been expected to include the Antarctic. This is why *Lystrosaurus* is so important.

The most striking feature of *Lystrosaurus* was its adaption for feeding. The teeth, with the exception of two large tusks in the upper jaw, were lost and replaced by a horny beak on both upper and lower jaws. Horn does not usually fossilize; hence is not seen in the pictures. Apparently the edges of the horny beak were extremely sharp and formed an efficient shearing mechanism not unlike a turtle's beak, but there was an added peculiarity to the masticatory apparatus of *Lystrosaurus:* as the jaw closed, it was at the same time drawn backward (Fig. 4). This backward movement increased the efficiency of the shearing action, and at the same time food was shoveled into the mouth. *Lystrosaurus* was only capable of shearing food; grinding as we know it in modern herbivorous mammals was out of the question. The beak worked rather like a chaff-cutter; the function of the large tusks seemed to have been to help guide the lower jaw rather than to provide effective weapons for either offense or defense.

Numerous species of *Lystrosaurus* have been described, and the differences among them are mainly the length of the snout, the position of the eyes, and the position of the eyes and nostrils. The long snout, the eyes near the top of the skull, and the high position of the nasal opening suggests that it was adapted for feeding on reed-like plants which grew in shallow water on flood plains that were presumably subjected to periodic flooding. The terrestrial fauna associated with *Lystrosaurus* was apparently very limited both in diversity and numbers. It consisted of small insectivorous to carnivorous mammal-like reptiles (see J. A. Hopson, *Discovery* 2(2): 25–33), small lizard-like herbivores, a few lizard-like forms and one or two genera of medium to large carnivorous reptiles. The latter are important because they are the earliest representatives of the group from which the later dinosaurs, flying reptiles, crocodiles and birds arose. *Lystrosaurus* was the dominant element of the fauna and the only terrestrial vertebrate herbivore of any significance. If the fauna of which *Lystrosaurus* formed a part were limited to small geographic areas, this restricted animal life would not be unexpected. The remarkable fact is that the sediments containing abundant remains of *Lystrosaurus*

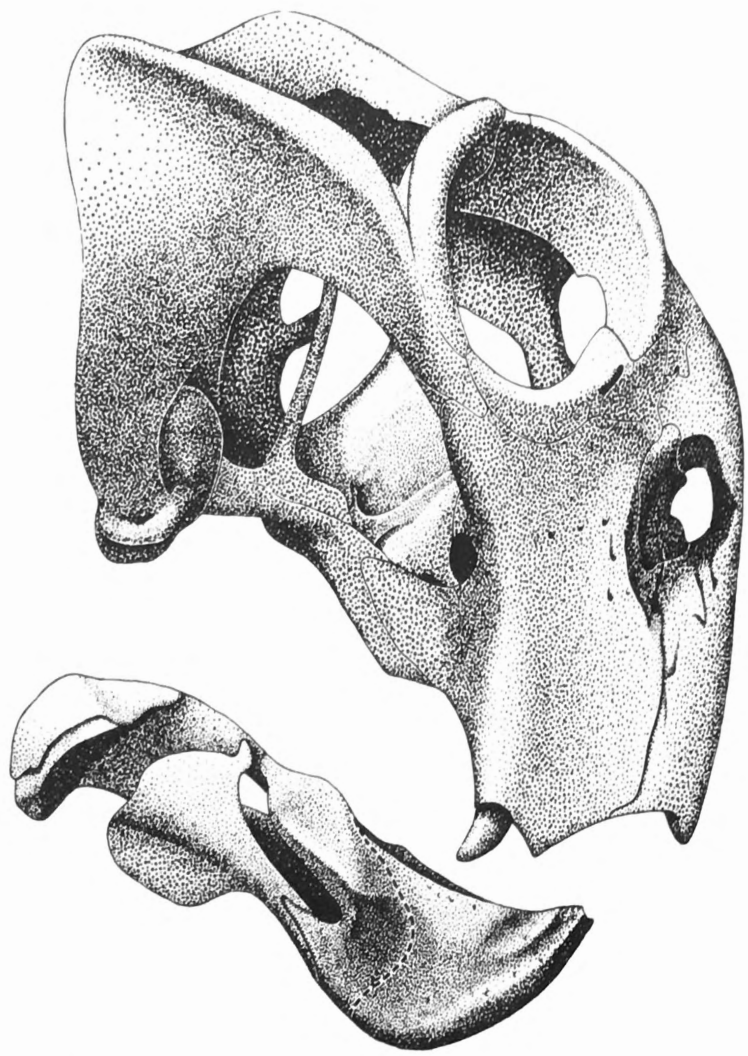

Fig. 2. Skull of *Lystrosaurus* in side view.

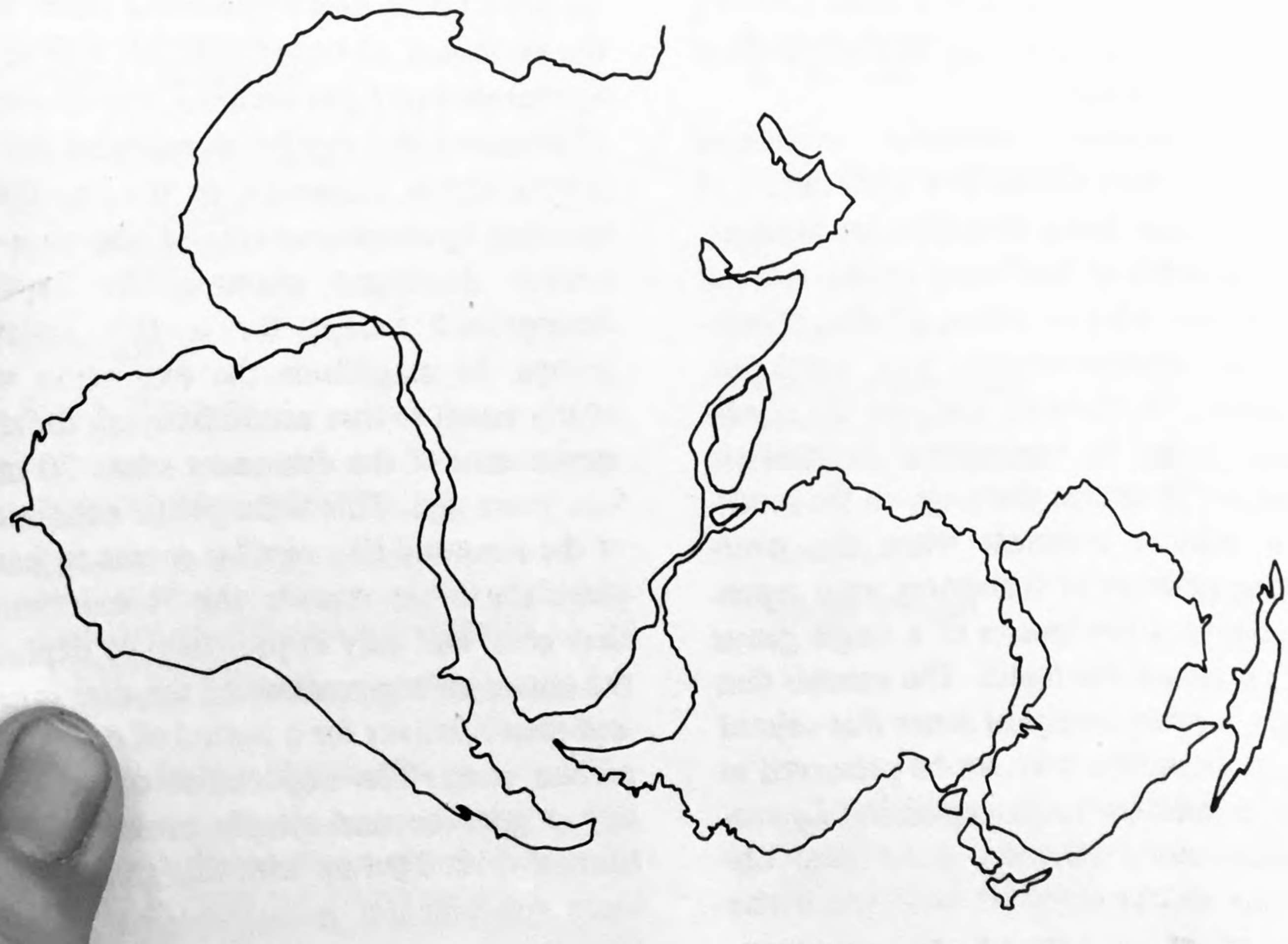

Fig. 3. The position of present-day continents in Gondwanaland.

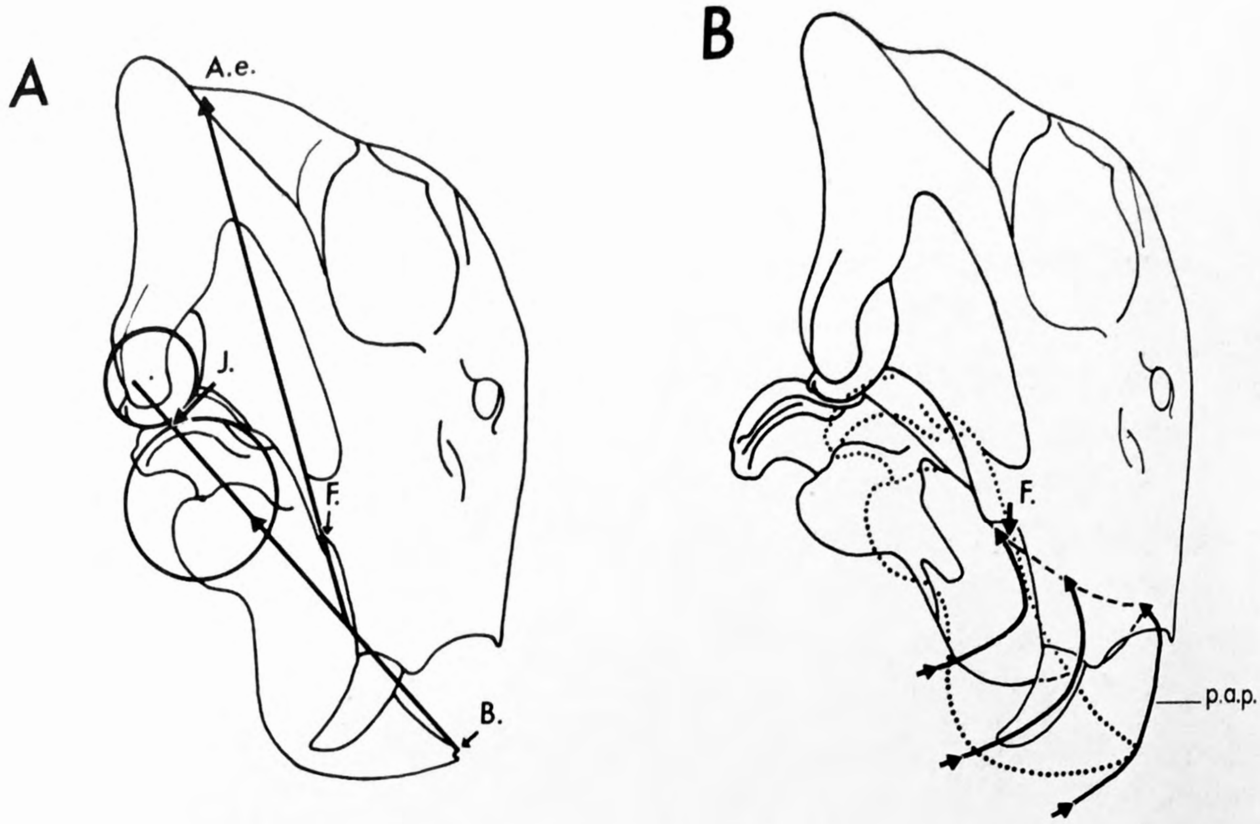

Fig. 4. Lystrosaurus. A, lateral view of the skull to illustrate the traction line of the adductor externus (A.e.), the radii of the arcs of the articular surface forming the jaw joint and the functional axis of the lower jaw (JB). B, movement of the lower jaw from complete protraction to complete retraction.

extend across hundreds of thousands of square miles of southern Africa, and we now know that these sediments extend into India and the Antarctic and may turn up in South America and Australia as well. It is difficult to explain why a fauna covering such a large geographical area would show so little diversity.

Contemporary terrestrial vertebrate faunas usually consist of a wide variety of herbivorous forms. Consider, for example, the diversity of herbivores on the African continent today — zebras, giraffes, rhinoceroses, hippopotamuses, pigs, antelopes, rodents, etc. Contrast this with the conditions during the beginning of the Triassic period 225 million years ago on the southern African continent when the overriding majority of herbivores were represented by a few species of a single genus of a mammal-like reptile. The animals that lived in other ecological zones that existed at the same time may not be preserved in the sedimentary rocks containing *Lystrosaurus,* and a sampling error must obviously also be involved, but even if this is taken into account, environmental conditions that existed over extensive geographical areas at that time must have greatly narrowed the variation of terrestrial herbivorous vertebrates.

The widespread environmental conditions that favored *Lystrosaurus* and its associated fauna had a profound effect upon the evolution of terrestrial life. Before the appearance of *Lystrosaurus,* a wide variety of mammal-like reptiles dominated the terrestrial scene. However, as the conditions favoring *Lystrosaurus* spread, the once extensive dominant mammal-like reptiles disappeared except for a few isolated groups. In magnitude the extinction was nearly equal to that accompanying the disappearance of the dinosaurs some 70 million years ago. This widespread extinction of the mammal-like reptiles seems to have given the other reptiles the "break" that they need and may in part help to explain the commanding position of the dinosaurs and their relatives for a period of over 100 million years. The importance of *Lystrosaurus* goes beyond simply proving continental drift. Tied up with this animal are some fundamental paleoecological problems that have broad biological and geological implications.