EARLY TRIASSIC TETRAPODS AND GONDWANALAND

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INTRODUCTION

The geological revolution of the past decade — a revolution in scientific theory and thought as profound as the biological revolution initiated by Darwin a century ago — involves more than geology. The strictly geological concepts are of great dimensions; being concerned with the fragmentation of vast former continental masses, the drift of continents caused by the movement of tectonic plates across the surface of the globe, the spreading of the sea floor and the descent of the leading edges of plates into deep oceanic trenches, magnetic reversals and the like. But in our preoccupation with such immense physical events we must not lose sight of the fact that these happenings during the course of past earth history have necessarily involved living things. And the theory of continental drift, if it is to be viable, must take cognizance of the relationships and the distributions of plants and animals; there must be reasonable agreement between the theory and what we know about the established facts of paleobiology (and of current biology, as well). In brief, does the theory of continental drift, in its present elaborate and sophisticated form, agree with the past and present distributions of organisms on the world, and conversely, does the theory explain these distributions ?

Perhaps this question has sometimes been given less attention than it deserves, in part because there have been multiple explanations for the distributions of fossil land-living organisms. For example the presence of the early Permian reptile, *Mesosaurus*, in South Africa and in Brazil and nowhere else, was taken by many authorities as strong proof for the former close ligation between Africa and South America. But *Mesosaurus* was obviously an aquatic reptile, so one could argue that perhaps it swam from one continent to the other. This was not a convincing argument, but it could not be ruled out. As another approach, it could be argued that *Mesosaurus* made the journey between South Africa and southern Brazil the long way around — through Africa, across Asia, across a Bering Straits connection, down through North America and across a Panamanian isthmus into South America. Again, this did not seem like a convincing argument, yet it could not be ruled out merely because long distances are involved. Nor could it be ruled out completely by virtue of the fact that no remains of *Mesosaurus* have been found along the presumed route of migration; such absences could be attributed as possibly owing to the accidents of preservation and discovery. And what holds for *Mesosaurus* might be maintained for the fossils of other vertebrates on the various modern continents. Except for Antarctica and Australia, it could be argued that the continents in their present positions are connected by adequate intercontinental bridges (it being recognized, of course, that the present separation of Alaska from Siberia is a temporary relationship of geologically recent origin), and that such may have been the case in past geologic periods.

The discovery within the past three or four years of fossil amphibians and reptiles in Antarctica, however, brings new dimensions into the problem of the past distributions of land-living vertebrates. And it has necessitated the reevaluation of the evidence that has gone before. This will be a prime consideration in the present discussion.

TRIASSIC TETRAPODS IN ANTARCTICA

It so happens that the fossil tetrapods found in Antarctica are of early Triassic age. And this is in many respects fortunate, because the record of Triassic land-living vertebrates extends through the other continental regions, and is frequently abundantly documented. Permian amphibians and reptiles in Antarctica would be useful, too, but perhaps not quite so helpful, because of the lacunae in the Permian record — in South America, for instance. Land-living tetrapods of later ages would also serve, but would not be quite so pertinent, since they would be contained within continental fragments that presumably were drifting apart. So it is especially fortunate that fossils of early Triassic age were found in Antarctica — in a portion of the theoretical Gondwanaland continent just prior to the break-up of this great land mass.

The first inkling of terrestrial vertebrates of significant geological age in Antarctica was the discovery in December, 1967, by Peter Barrett, a New Zealand geologist, of a fragment of a labyrinthodont amphibian jaw. This specimen was found on the slopes of Graphite Peak in the Transantarctic Mountains, near the Beardmore Glacier, and about 500 kilometers from the South Pole. It was found in sandstones belongig to the Fremouw Formation, a rock unit of presumed early age Triassic.

As a result of this discovery, a concerted effort was undertaken, to search out and collect Triassic vertebrates in Antarctica. Two field trips were made to the Transantarctic Mountains, during the austral summers of 1969-1970, and 1970-1971. Numerous fossil remains were collected on both of these trips; first at Coalsack Bluff, about 50 kilometers west of the immense Beardmore Glacier and about twice that distance from Graphite Peak, and subsequently at Shackleton Glacier some 250 kilometers to the east of Coalsack Bluff. All of the fossils were collected in the Fremouw Formation.

The Fremouw Formation is one unit in the Beacon Group, a thick sequence of sediments ranging in age from the Devonian to the Jurassic. These sediments are essentially horizontal throughout most of their exposures, they are intruded by extensive dolerites, and frequently are capped by basalts. Interestingly, similar relationships occur in the Karroo rocks of South Africa. The Fremouw Formation, an alternation of sandstones, mudstones and shales, cut by dolerites, rests upon the Permian Buckley Formation below, composed of dark shales and coals with abundant local deposits of the Gondwana plant, *Glossopteris*. Above the Fremouw Formation are other Triassic sediments, first the Falla Formation, and on top of that the Prebble Formation. Above the Beacon sequence are the Kirkpatrick Basalts, of Jurassic age. The intrusive Ferrar dolerites also are of Jurassic age. Fossil wood is found in the Fremouw Formation, and in its upper portions, at least, the characteristic southern hemisphere Triassic plant, *Dicroidium*.

The vertebrates of the Fremouw Formation, with which this present paper is especially concerned, are common — one might say, abundant — and belong to a considerable series of genera and species, many of which have as yet to be studied in detail. There are small and large labyrinthodont amphibians, including the new genera, *Cryobatrachus* and *Austrobrachyops*, related to the South African forms, *Lydekkerina* and *Batrachosuchus*, respectively.

The reptiles show considerable variety. Perhaps the most significant form is the genus *Lystrosaurus*, recognized at an early stage in the first season of collecting, and found rather abundantly preserved. Moreover, it seems almost certain that at least two species, *Lystrosaurus murrayi* and *Lystrosaurus curvatus* are in Antarctica. *Lystrosaurus* is a rather highly specialized dicynodont, one of the therapsid reptiles, showing modifications for living in an environment of rivers, lakes and swamps. One might compare it in a vague way with a modern mammalian hippopotamus. It seems almost certain that *Lystrosaurus* was an herbivore.

Along with *Lystrosaurus* in Antarctica is the small, carnivorous cynodont therapsid, *Thrinaxodon*, known from a considerable series of partially articulated specimens. Other cynodonts may be in the fauna, but this has as yet to be determined. The cynodonts were active predators, fulfilling the roles in their day that wolves and foxes do in modern mammalian faunas. Also present is the cotylosaurian genus, *Procolophon*, a small reptile that was perhaps « lizard-like » in its ecological adaptations.

The presence of "lizard-like" reptiles in the Fremouw Formation is augmented by numerous skeletons and bones of small eosuchian reptiles, probably on the direct evolutionary line leading to the lizards of later ages. Finally, there are bones of thecodont reptiles in the Antarctic sediments, these being characteristic Triassic reptiles from some of which there evolved the dominant reptiles of later Mesozoic times — the dinosaurs, crocodilians and pterosaurs.

Such is the composition (at least in part) of the Fremouw fauna; labyrinthodont amphibians, *Lystrosaurus*, *Thrinaxodon*, *Procolophon*, small eosuchians and thecodonts. In essence this is the so-called *Lystrosaurus* fauna, as abundantly represented in the lowest Triassic sediments of South Africa. Let us therefore look at the classic *Lystrosaurus* fauna in its type locality.

THE *LYSTROSAURUS* FAUNA OF AFRICA

The Karroo System of South Africa is composed of four extensive Series of sedimentary rocks, these being from bottom to top the Dwyka, Ecca, Beaufort and Stormberg, ranging in age from the Carboniferous through the Triassic. The Lower Beaufort beds are of late Permian age, the Middle and Upper Beaufort of early Triassic age, and the Stormberg Series is of late Triassic relationships. The rocks of the Karroo System are exposed in a series of concentric rings in the Great Karroo Basin, with the highlands of Lesotho, dominated by the impressive Drakensbergs, forming a core or center. The sediments are essentially horizontal, and are frequently intruded by dolerites, a situation that as we have seen is characteristic of Antarctica.

The *Lystrosaurus* Zone, composed of shales and sandstones, comprises the Middle Beaufort beds. It overlies the Upper Permian *Cistecephalus* Zone of the Lower Beaufort beds, and is in turn succeeded by the Lower Triassic *Cynognathus* Zone of the Upper Beaufort. (The *Procolophon* Zone, commonly indicated as coming between the *Lystrosaurus* and *Cynognathus* Zones, seems almost certainly a facies of the former.)

Fossils are numerous in the *Lystrosaurus* Zone, and they are composed overwhelmingly of the genus *Lystrosaurus*. Associated with this reptile, the remains of which form fully 85 percent of all fossils recovered from the Zone, are some of the other tetrapods that we have already seen in Antarctica. As in the South Polar continent, labyrinthodont amphibians are present, of which the large genus, *Uranocentrodon (Rhinesuchus)*, and the small form, *Lydekkerina* are characteristic. As for reptiles, more than two dozen species of *Lystrosaurus* have been described; probably six are valid, including *L. murrayi* (the generic type) and *L. curvatus*, both of which are in Antarctica. *Thrinaxodon*, the carnivorous therapsid, is present as it is in Antarctica, and in addition there are some fourteen other genera of theriodonts, or therapsid carnivores, within the fauna. The little lizard-like cotylosaurian, *Procolophon*, as well as a closely related form, *Owenetta* are characteristic of the *Lystrosaurus* fauna in Africa. So are the eosuchian precursors of the true lizards, *Pricea* and *Prolacerta*, although these reptiles do not occur in anything like the abundance with which they do in Antarctica. Finally there are rather large thecodont reptiles, *Chasmatosaurus* or *Proterosuchus*.

The similarities of the *Lystrosaurus* fauna in Antarctica to the type *Lystrosaurus* of Africa are obvious. Making allowances for antarctic materials that as yet have not been studied in detail, the comparisons may be listed as follows.

Lystrosaurus Zone, Africa	Fremouw Formation, Antarctica
Amphibia	Amphibia
Lydekkerina	*Cryobatrachus*
Uranocentrodon	*Austrobrachyops*

Reptilia	Reptilia
Lystrosaurus murrayi	*Lystrosaurus murrayi*
Lystrosaurus curvatus	*Lystrosaurus curvatus*
Lystrosaurus — four other species	
Thrinaxodon	*Thrinaxodon*
Other theriodont genera	Possibly other genera
Procolophon	*Procolophon*
Owenetta	
Pricea	Small eosuchians of comparable size
Prolacerta	
Chasmatosaurus [1]	Thecodonts
Proterosuchus [1]	

At the moment the antarctic fauna does not seem quite as rich as the type *Lystrosaurus* fauna, but one must remember that explorations in the *Lystrosaurus* Zone of Africa have been carried on for a century, while work in Antarctica has occupied two necessarily very short field seasons. Paleontologically speaking, the fossil content of the Triassic in Antarctica has barely been sampled.

Keeping this in mind, it may be seen that the *Lystrosaurus* fauna appears well represented in Antarctica, and essentially similar to its expression in Africa. This means that Africa and Antarctica were sufficiently close during early Triassic time so that the same genera and probably frequently the same species occupied both regions. It means also that the ligation between the two regions was sufficiently broad so that the entire fauna was represented in both regions. In other words, there was not an isthmian link between Africa and Antarctica, because such a narrow connection would have exerted a filter effect, with some faunal elements conspicuously absent in one region that were present in the other. In short, Africa and Antarcticaseemingly formed one large, continuous land mass, across which roamed the animals belonging to a single fauna. The *Lystrosaurus* Zone of Africa and the Fremouw Formation of Antarctica are now the separated fragments of what was once a single faunal range.

LYSTROSAURUS IN ASIA

Lystrosaurus and certain associated reptiles have been known for some time from the Lower Triassic Panchet Formation, as it is exposed in the Raniganj coalfield in peninsular India, about 200 kilometers northwest of Calcutta. The Panchet Formation consists to a large degree of brown and red clays and shales, overlying the coal-bearing Raniganj beds. And although fossils of *Lystrosaurus* have been collected in the Panchet beds for almost a century, it has been particularly owing to the efforts of Indian geologists and paleontologists during the past decade or so that significant collections have been made. As a result of this work, *Lystrosaurus* is known to occur in the Panchet beds in considerable abundance, with the African species, *Lystrosaurus murrayi* quite evident. Two other species in India have been identified as being the same as forms found in Africa, while a fourth new species has been named. It seems evident that *Lystrosaurus* in India is closely related to *Lystrosaurus* in Africa, and as in Africa occurs in almost overwhelming abundance, as compared with the remains of other tetrapods in the Panchet Formation.

The other tetrapods include labyrinthodont amphibians, a procolophonid and thecodonts of the genus *Chasmatosaurus*. So we see a reflection of the African *Lystrosaurus* fauna in India, but not so thoroughly represented as is the case with the *Lystrosaurus* fauna in Antarctica. Nevertheless, the well-attested presence of *Lystrosaurus* in India, and its close affinities to *Lystrosaurus* in Africa, together with some of the other tetrapods that characteristically occur in the *Lystrosaurus* fauna, is in accord with the geological evidence, which would include peninsular India as a part of Gondwanaland,

1. It has been maintained that these two genera are synonymous.

having long connections along the western border of the present peninsula with Africa (to the north of the African-Antarctic ligation) and perhaps along the eastern border with Antarctica and Australia.

If such a former position for peninsular India is postulated, it brings the localities for *Lystrosaurus* in India about as close to southern Africa as the Antarctic localities, in a reconstructed Gondwanaland. And it places *Lystrosaurus* (now occurring in three quite separate continents) within the confines of a single range of quite reasonable dimensions, as based upon our knowledge of the ranges of modern land-living tetrapods.

Lystrosaurus is known from three other regions in Asia; from Indo-China in the vicinity of Luang Prabang, where fragmentary materials have been found, in Shansi in central China, and far to the northwest, in Sinkiang. In China this genus is known from well-preserved and rather complete materials, where in Shansi it is associated with a procolophonid, and in Sinkiang with the thecodont, *Chasmatosaurus*. Several new species of *Lystrosaurus* have been named among the Chinese materials, but it is perhaps significant that *Lystrosaurus murrayi* also has been recognized. [The problem of speciation in *Lystrosaurus* is a vexing one that cannot be discussed at this place. Suffice it to say that far too many species have been described.]

So it is evident that representatives of the *Lystrosaurus* fauna reached far into eastern Asia. On present evidence it would seem that perhaps the fauna is not as fully represented in China as it is elsewhere, but a note of warning concerning negative evidence must be registered. Perhaps the accidents of preservation and of discovery are involved in our restricted view of the *Lystrosaurus* fauna in Asia.

However that may be, the presence of *Lystrosaurus* and some characteristic associated reptiles in China poses certain interesting questions. If China (and Indo-China) were contained within the eastern extremities of Laurasia, as is indicated in many current restorations of the Triassic world, then we must suppose that *Lystrosaurus* and some of its contemporaries made a long migratory trek during early Triassic time — up through Africa, into Laurasia at the frequently postulated connection between northern Africa and Spain, and thence east for many thousands of kilometers to northwestern and central China. Such would have been possible.

In this connection, however, it should be noted that quite recently several geologists and geophysicists have expanded the concept of Gondwanaland, to include a considerable portion of the region now placed in eastern Laurasia. Hurley with his associates have advocated the inclusion of most of China and Korea within Gondwanaland. (Hurley, P. M. et al, 1971, pp. 9-11; Hurley, P. M. 1971, abstract). And working quite independently, Ridd has correlatively proposed that Indo-China was included with the Gondwanaland continent. (Ridd, M. F. 1971, pp. 531-533.) At the present date these are very tentative proposals, but in the light of such suggestions made upon the basis of physical evidence, supplementing the presence of *Lystrosaurus* in China and Indo-China, it seems possible that these new ideas concerning the composition of Gondwanaland may have some validity. Certainly if China and Indo-China are included within Gondwanaland, more or less in the positions suggested by Hurley and his coworkers, and by Ridd, the localities where the *Lystrosaurus* fauna or portions of it have been found, are brought into a logical pattern of distribution.[1]

Up to this point nothing has been said about early Triassic tetrapods in South America and in Australia, which continents are important in the reconstruction of Gondwanaland. The *Lystrosaurus* fauna as yet has not been recognized in either of these continents, possibly the result of the accidents of preservation and discovery. However, in the Lower Triassic Blina shales of western Australia are labyrinthodont amphibians which would appear to be closely related to some of the amphibians found in the Fremouw Formation of Antarctica. It seems reasonable. But more study is necessary to determine this point.

As for South America, even though *Lystrosaurus* is at the present time unknown in this continent, one may suppose that it might be discovered at some future date. In the meantime we do know that there was a close connection between South America and Africa in early Triassic time, not only upon the basis of physical evidence, but also because of the presence in both regions of the *Cynognathus* fauna — a tetrapod assemblage to which we will now turn our attention.

1. Within the past few months (1971), A. R. Crawford has submitted geological evidence for including Tibet, the Tarim Basin and northern China in Gondwanaland.

THE CYNOGNATHUS FAUNA

Mention has been made of the *Cynognathus* Zone in South Africa, the horizon that overlies the *Lystrosaurus* Zone, and that comprises the Upper Beaufort beds within the Karroo System. The name of this particular zone, is, of course, based upon the well-known reptile *Cynognathus*, so characteristic of this level of Karroo sediments. Lithologically, the *Cynognathus* Zone is composed of sandstones, interbedded with red and maroon-colored mudstones and shales. It forms a record of continental sedimentation as do the rocks of the underlying Middle and Lower Beaufort beds, and like the sediments of earlier age, the Upper Beaufort rocks contain an abundant tetrapod fauna in which the therapsid reptiles are dominant. The fossils of the *Cynognathus* Zone would seem to indicate, however, that this was perhaps a more " upland " region than was the case during Middle Beaufort time ; there is not the evidence for such widely spread aquatic or marsh conditions as is offered by the remarkable abundance of the amphibious *Lystrosaurus* in the Middle Beaufort sediments.

However the *Cynognathus* Zone must represent a period of considerable lowland and swamp environment, because of the presence of a varied array of labyrinthodont amphibians, represented by at least eight genera. A number of large genera are present, such as *Capitosaurus*, and *Cyclotosaurus*. A distinctive dicynodont, *Kannemeyeria*, characterizes the *Cynognathus* fauna — this being a rather large reptile, standing perhaps three feet or more in height at the shoulder, and having a somewhat elongated dicynodont-type skull in which the occiput slants toward the rear, and in which the tusks are quite large.

The bulk of the *Cynognathus* Zone reptilian fauna is composed, however, of carnivorous theriodonts, of which about thirty genera have been described. *Cynognathus* itself is an advanced mammal-like reptile, rather wolf-like in its adaptations, a comparison that is heightened by the adaptations in the skull, including a strongly differentiated dentition marked by pointed incisor teeth, a large canine, and cusped cheek teeth. Evidently *Cynognathus* was capable of cutting its food into comparatively small chunks for quick digestion, a fact that would seem to point to a high degree of metabolism — perhaps even some degree of endothermy — in this reptile. This supposition is supported by the well-developed secondary palate and the strong reduction of ribs in the lumbar region, which may be some indication of a diaphragm. Perhaps *Cynognathus* was possessed of hair. Various other cynodonts in the *Cynognathus* fauna, such as *Bauria* and *Diademodon* were almost equally advanced. *Diademodon* had broad cheek teeth, so that one may suppose this reptile to have been rather " bear-like " in its eatings habits, enjoying a catholic diet of meat and vegetation as well.

There are some small procolophonids in the *Cynognathus* fauna, and in addition some small rhynchocephalians. Finally there are thecodonts, so characteristic of most Triassic reptilian assemblages ; a large form, *Erythrosuchus*, and a small, active reptile, *Euparkeria*, which by virtue of its structure and adaptations may well represent an evolutionary stage generally ancestral to the dominant archosaurian reptiles of late Triassic, Jurassic and Cretaceous age.

In summary this fauna may be characterized as an overwhelmingly theriodont assemblage, with *Cynognathus* typical, accompanied by the large, specialized dicynodont, *Kannemeyeria*, by some small procolophonids, some varied thecodonts, and by a considerable array of labyrinthodont amphibians.

Within recent years an impressive series of Triassic sediments has been delineated in South America, particularly in western Argentina. Of particular interest in the present connection are the red sandstones of the Puesto Viejo Formation in the Province of Mendoza. These rocks contain cynodonts and dicynodonts that show close similarities to related reptiles in the *Cynognathus* Zone of Africa. (The Puesto Viejo may be slightly later than the *Cynognathus* zone ; nevertheless the comparisons here being made are valid.) Thus, *Kannemeyeria* is unmistakably present in South America, and in addition a cynodont named *Pascualgnathus*, which may be equated with the broad-toothed cynodonts *Diademodon* and *Trirachodon* of South Africa. As Bonaparte, who described these South American reptiles has said : " *Pascualgnathus* is closer to African genera than to other cynodonts from South America or from other continents ;... and provides new evidence of some type of vinculum between

Africa and South America not detected in the case of other tetrapods from the South American Triassic." (Bonaparte, 1966b, p. 3). It should be added that quite recently *Cynognathus* itself has been found in Argentina.

Thus certain elements of the *Cynognathus* which have been found in Argentina supply the evidence that was lacking (because of the absence of *Lystrosaurus* in South America) for the close relationship between this continent and Africa during early Triassic history. The reliance upon theoretical long migrations through the northern hemisphere and crossing from east to west by way of trans-Bering bridge is made all the more unreal, not only because of the close relationships between *Cynognathus* Zone type reptiles in Argentina and Africa, but also because the evidence of the *Lystrosaurus* fauna in Antarctica, now a completely isolated continent, indicating the former union of that land with Africa, has increased immeasurably the probabilities of similar ligations between other Gondwanaland continental elements. The relationships of the fossils fully corroborate the physical evidence for the elongated junction between South America and Africa.

Rather recent paleontological investigations in peninsular India, in the general area of the confluence of the Godavari and Pranhita rivers, in the state of Andra Pradesh, have revealed a tetrapod fauna in the Lower Triassic Yerrapalli Formation. The materials still await careful study, but preliminary examinations have shown that they consist of labyrinthodont amphibians of capitosaurid relationships, of a dicynodont showing kannemeyerid affinities, of theriodont reptiles and of thecodonts comparable to the genus *Erythrosuchus*. Here again, as in the case of the more ancient *Lystrosaurus* faunal elements in India, close relationships to South Africa are indicated.

A *Cynognathus* Zone type of fauna has come to light during the past few decades in Shansi, China — where, as we have seen, *Lystrosaurus* and some of its contemporaries have been found. The fossils occur in the Ehrmayin Series of Shansi, and to date have revealed a considerable assemblage of tetrapods that may be compared with South African equivalents as follows.

Cynognathus Zone, Africa	Ehrmayin Series, Shansi, China	
Amphibia	Amphibia	
Various labyrinthodonts, including *Capitosaurus*	Capitosaurid	
Reptilia	Reptilia	
Procolophonids	*Neoprocolophon*	
Kannemeyeria	*Sinokannemeyeria*	
	Parakannemeyeria	
	Shansiodon	
Numerous theriodonts, including		
Diademodon	*Sinognathus*	
		Diademodontids
Trirachodon	*Ordosiodon*	
Cynognathus		
Thecodonts	*Chasmatosaurus*	
	Shansisuchus	
	Fenhosuchus	Thecodonts
	Wangisuchus	

As can be seen, the genera described from China are different from those of the African *Cynognathus* Zone, but the relationships are there. *Sinokannemeyeria*, for example, is very close to *Kanne-*

meyeria, and the same holds true for the Chinese and African diademodontids. It should be added that there may be more than one horizon represented in China, which may account for *Chasmatosaurus* in the assemblage.

There are differences, it is true, but allowing for divergent opinions concerning the taxonomic differences or identities of fossils in the two regions, it seems evident that in essence tetrapods of *Cynognathus* Zone relationships are present in China, as was the case with the *Lystrosaurus* fauna. And so, once again African relationships extend outwardly into other continental areas that indicate the former inclusion of these regions in a cohesive Gondwanaland. Whether China was a part of Gondwanaland in early Triassic time is a question that has already been discussed.

CONCLUSION

From the foregoing discussion it is plain that land-living amphibians and reptiles of early Triassic age are widely distributed through those continents which supposedly once formed the single supercontinent of Gondwanaland. The distribution of the *Lystrosaurus* fauna, or elements of it, in South Africa, Antarctica, peninsular India and possibly Australia points to the presence at one time of a single tetrapod fauna ranging over a wide habitat. *Lystrosaurus* and associated reptiles in China and in Indo-China lead to the supposition that these regions, too, may once have been a part of Gondwanaland — a suggestion that has independently been made on geological grounds. Similarly, the distribution of the *Cynognathus* fauna, or tetrapods related to those comprising the *Cynognathus* fauna, in Africa, South America, peninsular India and China parallels the distribution of the *Lystrosaurus* fauna. The occurrences of these several tetrapod assemblages are in accord with the theory of a former Gondwanaland that subsequently was fragmented, its remnants drifting apart to form the continents as we known them. In short, the distributions of tetrapods of early Triassic age are perhaps best explained by the theory of continental drift. These conclusions have been markedly strengthened during the past two years by the discovery of a well-documented *Lystrosaurus* fauna in Antarctica.

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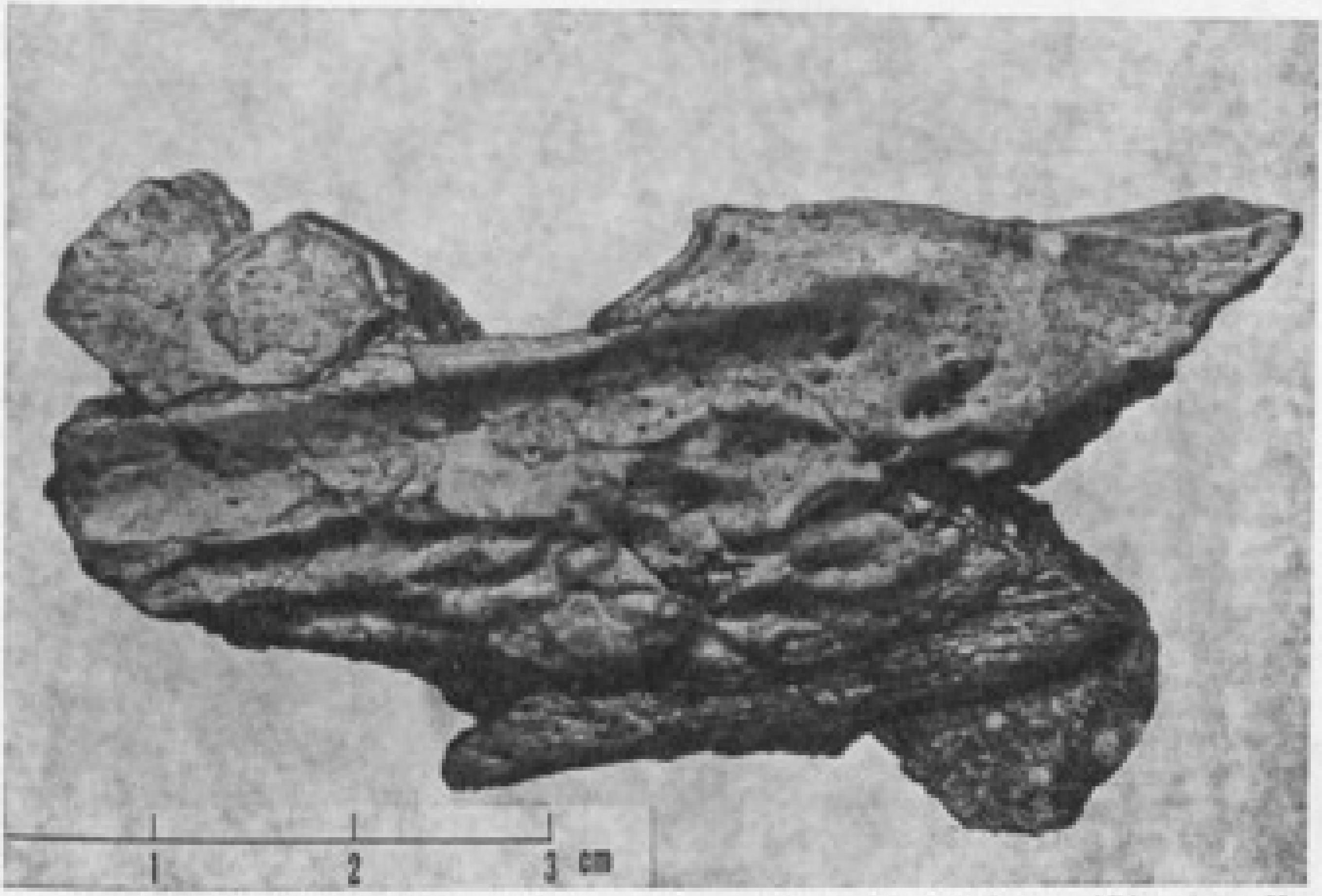

FIG. 1. — External lateral view of a left mandibular ramus fragment from a labyrinthodont amphibian, Amer. Mus. Nat. Hist., No. 9301 ; found in the Fremouw Formation, at Graphite Peak, Transantarctic Mountains, Antarctica. This was the first Triassic tetrapod found in Antarctica, and as such is an historic specimen. It was discovered by Peter J. Barrett, now of Victoria University, Wellington, New Zealand, in December, 1967. Since then two field trips to the Fremouw Formation have collected several hundred specimens of amphibians and reptiles.

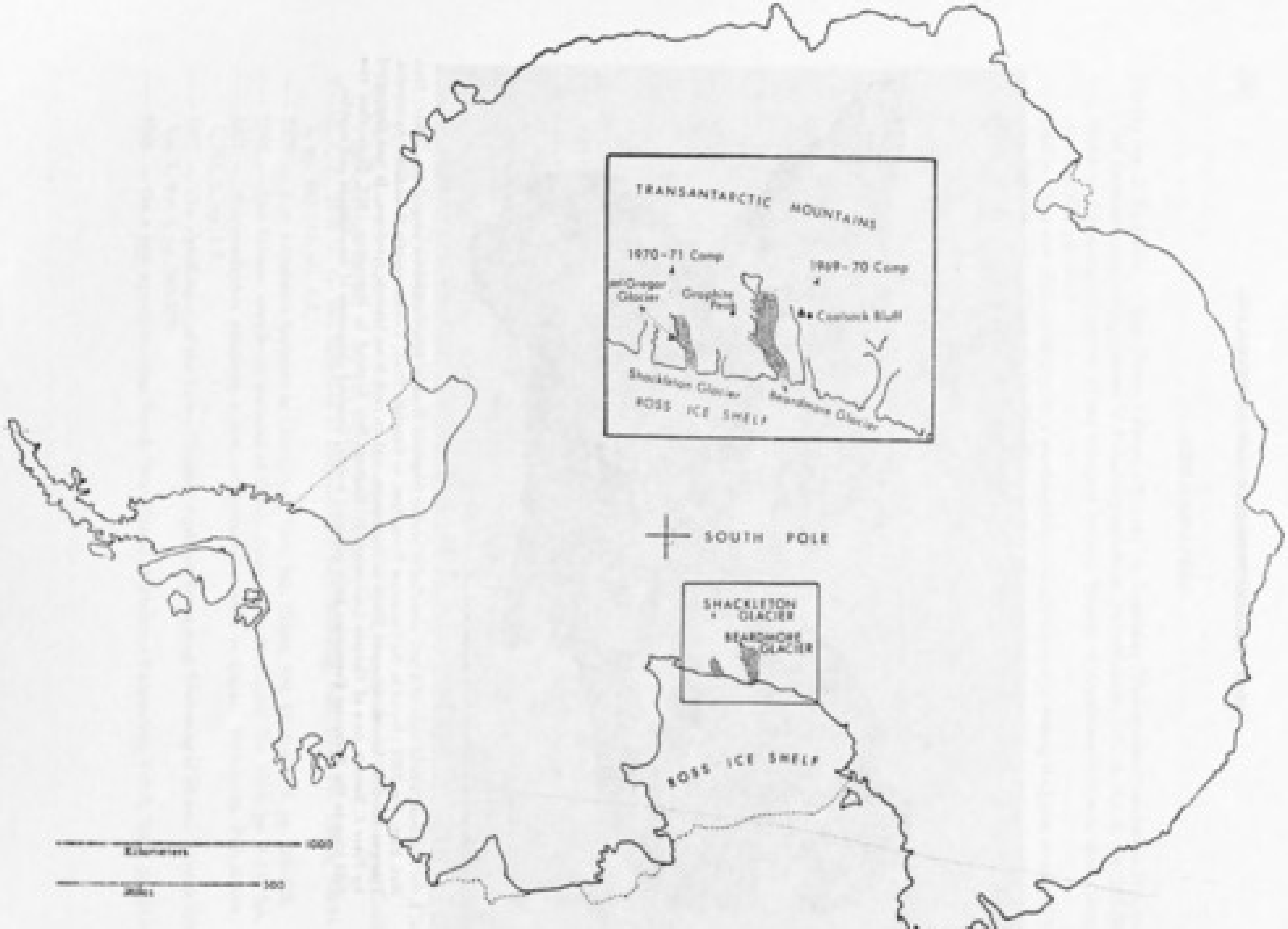

fig 2

Fig. 2. — Map of Antarctica, showing the localities at Coalsack Bluff and McGregor Glacier, in the Transantarctic Mountains, where Lower Triassic amphibians and reptiles were collected in the Fremouw Formation.

FIG. 3. — Characteristic constituents of the Lower Triassic *Lystrosaurus* Fauna of South Africa. A. *Lydekkerina*, a labyrinthodont amphibian, from Romer; B. *Procolophon*, a cotylosaurian reptile, from Watson; C. *Thrinaxodon*, a cynodont reptile, from Brink ; D. and E. *Lystrosaurus*, a dicynodont reptile, D. adapted from Crompton, E. from Broom ; F. *Chasmatosaurus* (or *Proterosuchus*), a thecodont reptile, from Broili and Schroeder ; G. *Prolacerta*, an eosuchian reptile, from Camp. *Lystrosaurus* and *Chasmatosaurus* are found in peninsular India and China. *Lystrosaurus*, *Thrinaxodon*, *Procolophon*, an eosuchian related to *Prolacerta*, and *Cryobatrachus*, a small labyrinthodont similar to *Lydekkerina*, have been found in Antarctica.

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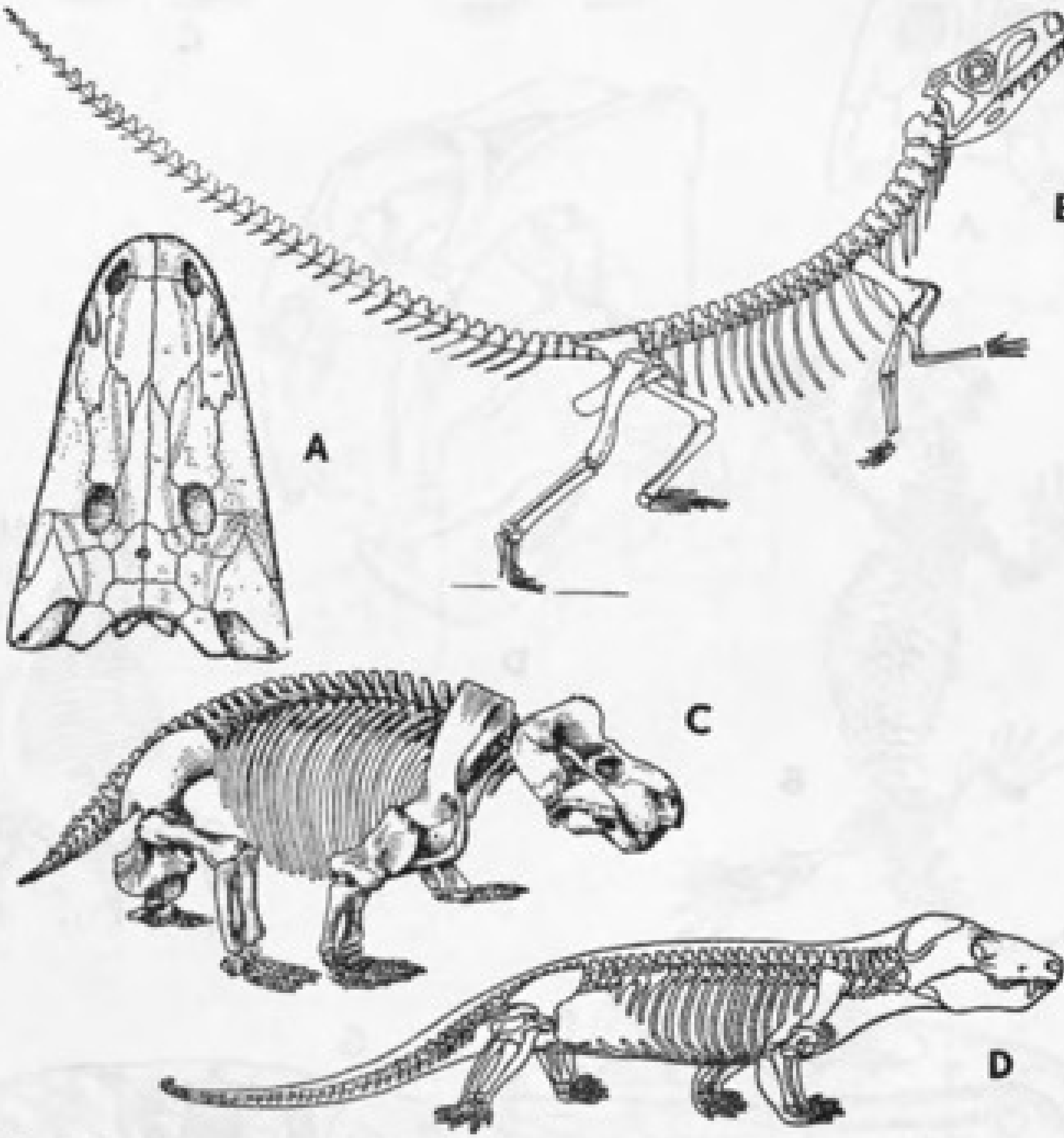

FIG. 4. — Characteristic constituents of the Lower Triassic *Cynognathus* Fauna of South Africa. A. *Capitosaurus*, from Case; B. *Euparkeria*, from Ewer; C. *Kannemeyeria*, from Pearson; D. *Cynognathus*, from Gregory. *Cynognathus* and *Kannemeyeria* have been found in Argentina, and closely related forms in Asia.

FIG. 5. — A reconstruction of Gondwanaland, showing the occurrences of the Lower Triassic *Lystrosaurus* Fauna (circles), and *Cynognathus* Fauna (squares).