CHARTS OUT OF PRINT.

A PRELIMINARY REVIEW OF THE BIOSTRATIGRAPHY OF THE UPPERMOST PERMIAN, TRIASSIC AND LOWERMOST JURASSIC OF GONDWANALAND

by

H. M. Anderson and J. M. Anderson.

CONTENTS

A. INTRODUCTION

B. RADIOMETRIC AGES, STANDARD STAGES AND AMMONOID ZONES OF THE UPPER PERMIAN, TRIASSIC AND LOWER JURASSIC OF THE WORLD.

C. CHARTS 1–22

- (a) *Tetrapod Vertebrate Palaeontology* (charts 1–5)
  - Chart 1 The vertebrate fauna of the Cistecephalus, Lystrosaurus and Cynognathus zones of the Beaufort 'Group', Karroo Basin, South Africa, with notes on the invertebrate fauna, microflora, macroflora and geology of these zones.
  - Chart 2 The vertebrate fauna of the Molteno, Red Beds and Cave Sandstone 'Formations' of the Stormberg 'Group', Karroo Basin, S. Africa, with notes on the invertebrate fauna, microflora, macroflora and geology of these formations.
  - Chart 3 The vertebrate fauna of the Triassic of S. America, India and the Ntawere and Manda 'Formations' of southern Africa.
  - Chart 4 The uppermost Permian, Triassic and lowermost Jurassic vertebrate faunas of the Northern Hemisphere countries (excluding India) and of the remainder of the Gondwana faunas not covered in charts 1, 2 and 3.
  - Chart 5 Uppermost Permian, Triassic and lowermost Jurassic tetrapod vertebrate evolution chart of the world.
- (b) *Microflora* (charts 6–8)
  - Chart 6 Microfloral range chart for the uppermost Permian and lower half of the Triassic of the Sydney Basin, eastern Australia.
  - Chart 7 Microfloral range chart of the uppermost Permian, Triassic and Lower Jurassic of the Bowen, Clarence-Moreton & Surat Basins of Queensland, eastern Australia.
  - Chart 8 Microfloral range chart of the Upper Permian and the lower half of the Triassic of the Salt Range and Trans-Indus Ranges of W. Pakistan.
- (c) *Macroflora* (charts 9–12)
  - Chart 9 Diagramatic key to the genus *Dicroidium*.
  - Chart 10 Macrofloral range chart of the uppermost Permian and Triassic of the Sydney Basin and the Clarence-Moreton Basin of eastern Australia.
  - Chart 11 Macrofloral lists of the Triassic of the Karroo Basin, South Africa (i.e. of the Upper Cynognathus zone and of the Molteno).
  - Chart 12 Macrofloral lists of all described and listed floras of the Triassic of southern South America.
- (d) *Geology and General Palaeontology* (charts 13–20)
  - Chart 13 Western Australia (Perth, Canning and Carnarvon Basins).
  - Chart 14 South Australia, Tasmania and Victoria.
  - Chart 15 Bowen, Galilee and Cooper Basins, eastern Australia.
  - Chart 16 Sydney Basin, eastern Australia.
  - Chart 17 Clarence-Moreton Basin, eastern Australia.
  - Chart 18 Southern South America.
  - Chart 19 India.
  - Chart 20 Antarctica, Southern Africa (excluding the Karroo Basin) and Madagascar.
- (e) *General* (charts 21–22)
  - Chart 21 Correlation chart of the uppermost Permian, Triassic and lowermost Jurassic 'formations' of Gondwanaland.
  - Chart 22 Map of the Gondwana continents showing the known distribution of the Triassic (including uppermost Permian and lowermost Jurassic) outcrop and subcrop. The known Permian basins are also given.

D. GENERAL DISCUSSION AND CONCLUSIONS.
  1. The present state of classification and nomenclature of the animal and plant life of the Gondwana Triassic.
  2. The present state of accuracy of interbasinal correlations within Gondwanaland and of the tie up with the Standard Stages and ammonoid zones of the Northern Hemisphere.
  3. Discussion regarding the diversity and relative abundances of the tetrapod vertebrates and the vascular plants in Gondwanaland during the Triassic.
    (a) Diversity of fauna and flora in the world today (given here as a basis for comparison).
    (b) Introductory notes on the diversity of the tetrapod vertebrates and the vascular plants of the Gondwana Triassic.
    (c) The tetrapod fauna of the Lystrosaurus zone of South Africa and its supposed equivalents; the Fremouw Fm. of Antarctica and the Panchet Fm of India.
    (d) Brief consideration of the presently known diversity of the tetrapod fauna of the Gondwana Triassic as a whole.
    (e) The macroflora and microflora of the Molteno 'Formation' of South Africa and its supposed equivalents elsewhere in Gondwanaland.
    (f) Brief consideration of the macroflora and microflora of the Gondwana Triassic as a whole.
  4. Discussion concerning the possibility of arriving at a reasonable estimate of the evolution of the tetrapod vertebrates and the vascular plants in Gondwanaland during the Triassic.
  5. The relationship between the evolutionary patterns of the tetrapod vertebrates and the vascular plants of the Gondwana Triassic.

E. ACKNOWLEDGEMENTS.
F. BIBLIOGRAPHY.
G. NOTES ADDED AT PROOF STAGE.

A. INTRODUCTION

This review paper was born out of a desire to visualize in some detail the picture of the evolving Gondwana Triassic landscape and the story of life and ecology upon it; a desire to provide a general setting in which to view the details of the work in which we are actively involved at the present—the macroflora (H.M.A.) and microflora (J.M.A.) of the Molteno 'Formation' of the Karroo Basin of South Africa.

The need to superimpose all the available information regarding lithology, tectonics, animal and plant life of the Triassic of Gondwanaland is recognised and attempted.

It is also recognised that any such attempted review will on publication already be out of date and inaccurate. Firstly, it is virtually impossible to gather together all the mass of relevant literature. Secondly, a large amount of information lies dormant either for indefinite periods in mining and oil company files, in unpublished theses and simply in the unpublished ideas and accumulated knowledge of individual persons; or for shorter periods in the hands of editors and publishers.

We hope, however, that in presenting this review it will catalyze its own obsolescence.

We have chosen to present the review in the form of charts. This we have done for two chief reasons.

1. Far more information can be presented in far less space.
2. The information can be presented more clearly and succinctly and is easily referred to. Vagueness, blanketing the unknown or unsure facts, is avoided.

The format which we would theoretically have liked to follow in this review is presented below and is followed by a very brief résume of what we have actually managed to do.

Theoretically desired format.

I. Reconstruction of Gondwanaland (on a global scale with its relationship to the Northern landmass shown) including the known Triassic outcrop and subcrop in detail, the areas of Phanerozoic deposition and orogenesis, the stable Precambrian basement areas, the possible lines of Palaeolatitude and possible climatic belts.

Although only the Triassic (or what it is supposed to encompass at the time) should be plotted on the distribution map, it would be desirable to include a study of the uppermost Permian and lowermost Jurassic beds in the following sections, for obvious reasons. Firstly, it is not at all clear just where the lower and upper Triassic boundary fits in the various Gondwana 'basins'. Secondly, it is desirable to know just what happens at these boundaries, whether any particularly dramatic events occur or whether in fact there is simply a normal continuum of change.

II. Each Triassic Basin (or remnant basin) discussed and/or illustrated in turn under the following headings:

(a) Breakdown into groups, formations and members.
(b) Isopach map; cross sections.
(c) Post-depositional folding, faulting, intrusions, erosion and possible original extent of deposits.
(d) Account of the underlying and overlying strata.

(e) Range charts (as opposed to evolution charts, as they refer only to a restricted area and restricted time intervals) for the different animal and plant groups where a sufficient number of productive 'formations' renders this meaningful.

(f) Each 'formation' elaborated on fully under the following headings:
  (1) Isopach map, facies map, cross sections.
  (2) Detailed lithological and structural account.
  (3) Detailed palaeontological account of—
    Vertebrates;
    Invertebrates;
    Macroflora;
    Microflora;
    Trace fossils
  giving full classified lists of all species (or types) present, their relative abundance, peculiarities of distribution, preservation and lithological matrix.
  (4) Possible conditions of deposition (physiographic and climatic).

III. Evolution charts (to the same scale as the range charts—see IIe—and correlated as accurately as possible with the Standard Northern Hemisphere Stages and ammonoid zones) for the vertebrates, invertebrates, macroflora and microflora.

IV. Correlation chart (to the same scale as the evolution charts and again tied in as accurately as possible with the Standard Northern Hemisphere Stages and ammonoid zones) incorporating all known 'basins' and 'formations'; with the predominant palaeontological and lithological characteristics of each 'formation' included in code form.

V. Appendix giving all available absolute dates and palaeomagnetic data (with critical assessments of their derivation, validity and usefulness) used in compiling correlation charts and reconstructions of Gondwanaland.

VI. An account of the Standard Stages and Ammonoid Zones established for the Triassic of the N. Hemisphere, and on which all worldwide correlations of Triassic strata should be based.

Brief résumé of format followed in this review.

Due to the lack of a great deal of necessary information, some in the published literature but unavailable to us; some lying dormant in literature unavailable to the public at large; some investigated but not yet put to paper; and a good proportion not yet investigated at all; the format followed in this review falls far short of that just proposed, but which should, with concerted effort be possible in the not too distant future. Further difficulties are the very obvious lack of standardization at present of the use of the geological terms—group, formation and member; and of the nomenclature applied to the families, genera and species of the various animal and plant groups.

For the sake of clarity we have indicated below the coverage of the present review in the same order as that of the proposed format, but it must be noted that it is not in the order in which this review is actually presented (see contents).

I. A composite map of the Gondwana continents (chart 22) but not a detailed reconstruction of Gondwanaland, has been compiled. (New Zealand, New Guinea and the northern halves of South America and Africa are not included in this composite map, nor are they considered in the review). On it we have plotted the known Triassic (including in some cases the uppermost Permian and lowermost Jurassic) outcrop and subcrop, and named all the particular 'basins', boreholes, and palaeontological localities mentioned in the charts. The underlying 'Permian' basins (where possible) are also included. Since we have not attempted a reconstruction of Gondwanaland, we have also not given the possible lines of latitude and the climatic belts of the Triassic.

(We refer the reader here to Robinson (1971) who provides the most comprehensive attempt, known to us, to reconstruct the Triassic world with its lines of latitude.)

II. We have attempted in varying degrees to discuss each Gondwana Triassic 'basin' as indicated in the proposed format, but fall far short of the ideal, especially on the geological side. (Charts 1—20, excluding 5 and 9.)

III. It is at present only possible to attempt an evolution chart for the tetrapod vertebrates (chart 5). This we have done considering the whole world.

IV. A correlation chart (chart 21) to the same scale as the evolution and range charts and matched as accurately as possible with the Standard Stages and ammonoid zones of the N. Hemisphere, has been compiled. This chart covers the majority of the 'Triassic' basins indicated in the distribution map and incorporates the 'formations' of the Triassic as well as those possibly or probably belonging to the uppermost Permian and lowermost Jurassic. The predominant palaeontological characteristics for each 'formation' are included in code form.

V. The known absolute dates relevant to the Upper Permian, Triassic and Lower Jurassic of the world are discussed and their present usefulness in the compilation of a Triassic timescale and in correlations is assessed.

Since we have not attempted a reconstruction of Gondwanaland, it has not been of use to review the relevant available palaeomagnetic data.

VI. A discussion on the Standard Stages and ammonoid zones of the Upper Permian, Triassic and Lower Jurassic is presented.

B. RADIOMETRIC AGES, STANDARD STAGES AND BIOSTRATIGRAPHICAL UNITS (ZONES) ESTABLISHED FOR THE UPPER PERMIAN, TRIASSIC AND LOWER JURASSIC OF THE WORLD

REFERENCES:

Radiometric ages

Upper Permian—Smith 1964
Triassic—Tozer 1964
Lower Jurassic—Howarth 1964
} in "Geological Society Phanerozoic time-scale 1964".

Standard stages and biostratigraphical units

Upper Permian—Ruzhentsev & Sarÿcheva 1965 (Translation by Brown 1968).
Triassic—Tozer 1967; Silberling & Tozer 1968.
Lower Jurassic—Arkell 1956.
Correlation of old zones of Spath (1934) and new zones of Tozer (1967) for the Lower Triassic—Balme (1968).

RADIOMETRIC AGES ESTABLISHED FOR THE UPPER PERMIAN, TRIASSIC AND LOWER JURASSIC.

A. **Upper Permian.** Smith (in "Geological Society Phanerozoic time-scale 1964")

1. The Permian-Triassic boundary

"Most of the available isotopic dates which can be related to the age of the Permian-Triassic transition are from the New England intrusive complex of eastern Australia. The rocks of this complex yield isotopic ages ranging from 225 to 253 m.yrs. . . . and are progressively younger northwards. They cut sparsely fossiliferous beds thought to range in age up to Artinskian or early Kungurian, but are generally believed . . . to have been associated in time with the Hunter-Bowen orogeny. An early phase of this orogeny took place at the end of Upper Marine (low-mid to mid-Kungurian) deposition, and the isotopic age of the earliest of the New England granites is consistent with intrusion at this time. Later phases occurred in mid-Newcastle (= upper stage of Upper Coal Measures) time, but the main compression undoubtedly followed deposition of the highest Newcastle beds (? mid to late Tatarian), as evidenced by the widespread non-sequence and local unconformity between these beds and the overlying continental beds of the Lower Narrabeen Series (low-mid to mid-Bunter). Since the Lower Narrabeen Series was subjected to only minor epeirogenic movements and does not appear to have been affected by plutonic activity, it appears likely that even the youngest of dated rocks—The Stanthorpe Granite and Carpenter's Gully molybdenite . . . with isotopic ages of 225 m.yrs.—are pre-early-Bunter. The most likely time of intrusion of these bodies is thought to be during or immediately following the main phase of the Hunter-Bowen orogeny which . . . took place at the end of the Permian Period. This is therefore tentatively placed at 225 m.yrs."

2. The Kazanian-Tatarian boundary

"No available age-determinations bear directly on the age of this boundary, which can thus be estimated only by interpolation. In the type-area, the Kazanian stage is represented by a complex series of marine and semi-continental deposits in which three or four major cycles of sedimentation are separated by non-sequences or unconformities. By contrast, the Tatarian stage of the type-area is represented by only a few hundred feet of continental beds and may have been relatively brief. An age of 230 m. yrs. is tentatively suggested for this boundary."

3. The Kungurian-Kazanian boundary (i.e. the base of the Kazanian stage)

"The age of this boundary can only indirectly be inferred from a single isotopic age determination—that of 241 m.yrs. on sylvine from the Verkhnekamensk Formation, Solikamsk, U.S.S.R. The sylvine is about high-mid-Kungurian, and provides the only isotopic age directly referable to the adopted standard sequence. Analysis of both K-Ar and Ca-K ratios of a sample of allegedly unrecrystallized sylvine . . . gave concordant results, and because of this the authors consider the isotopic age to be accurate. Kulp (1961, p.1110) however, believes that the calculated age should probably be regarded as minimal because of the readiness of sylvine to recrystallize, and in view of this an age of about 240 m.yrs. is suggested for the Kungurian-Kazanian boundary."

B. **Triassic.** Tozer (in "Geological Society Phanerozoic time-scale 1964") See Table I

"Little information is available that can be used with confidence to construct a Triassic time-scale. The base of the system is variously dated in the range 220 to 238 m.yrs., the age of the boundary with the Jurassic is also uncertain, but may be placed at about 190 to 200 m.yrs. Apart from a Russian determination giving a minimum age of 200 m.yrs. for the Middle Triassic, the only radiometric data available are for the Upper Triassic."

Only 3 dates within the Triassic are available.

It is clear that the Triassic and its stages are in fact very poorly dated. The ages used in our various charts are those presented, (as the best present estimates) in the summary of the ages presently available in the "Geological Society Phanerozoic time-scale 1964".

C. **Lower Jurassic.** Howarth (in "Geological Society Phanerozoic time-scale 1964") See Table II

For the Lower Jurassic only four reasonably reliable radiometric dates (all based on biotite; K-Ar) are available.

Because of the anomaly of the 193 m.yrs. date for the Palisade sill, (see Triassic ages) which occurs within the Upper Triassic, being younger than the Hotailuh botholith (194 m.yrs.) which is supposedly close to the Triassic-Jurassic boundary, a best estimate of 190—195 m.yrs. is given for the Triassic-Jurassic boundary.

TABLE I. RADIOMETRIC AGES FOR THE TRIASSIC.

Palisade sill (Intrudes Stockton Fm. of Newark Group)	New Jersey – U.S.A.	Middle to Upper Norian (see chart 5)	193 m.yrs.
Chinle Fm. (ores) (Petrified Forest M. Pitchblende ore)	Colorado Plateau – U.S.A.	± Mid-Norian (see chart 5)	Many dates ranging from 20 m.yrs.–218 m.yrs.
Mt. Yatyrgvart (? rock type)	Russia	?	200 m.yrs.

TABLE II RADIOMETRIC AGES FOR THE LOWER JURASSIC.

Takteetna intrusion	Alaska	probably near the Bajocian-Toarcian boundary.–Howarth 1964	170 m.yrs.
Topley intrusion	British Columbia – Canada.	of uncertain stratigraphic position. Both these intrusions may fit anywhere within the L. Jurassic, though the top of the L. Jurassic is favoured for the Topley intrusion.–Howarth 1964	179 m.yrs.
Billiton granite	Indonesia		181 m.yrs.
Hotailuh batholith	British Columbia – Canada	fairly accurately placed as being close to the Triassic-Jurassic boundary.–Howarth 1964	194 m.yrs.

TABLE III. STANDARD STAGES AND AMMONOID ZONES OF THE UPPER PERMIAN.

Stages & ages presented in "Geological Society Phanerozoic time-scale 1964"	presently accepted standard stages. (As presented in Ruzhentsev & Sarȳcheva 1965)	Substages	Ammonite zones.
225 m.yrs (top) Tatarian (continental beds) 230 m.yrs. (base)	Dzhulfian		*Cyclolobus*
Kazanian (endemic marine fauna not useful for correlations) 240 m.yrs. (base).	Guadalupian	Capitanian	*Timorites*
		Wardian	*Waagenoceras*

D. Conclusions regarding the radiometric ages available

It is clear that very little in the way of absolute radiometric ages are available for the Upper Permian, Triassic and Lower Jurassic, and certainly none that are accurately tied in with the standard marine sections.

On our various range charts we have included the Triassic as occupying 32½ m.yrs. (from 225–192½ m.yrs.), based on the best evidence available. Although this gives us a convenient working basis for the time being, not too much reliance must be placed on it.

STANDARD STAGES AND BIOSTRATIGRAPHICAL UNITS (ZONES) FOR THE UPPER PERMIAN, TRIASSIC AND LOWER JURASSIC.

A. Upper Permian. Ruzhentsev & Sarȳcheva (1965). (Translation by Brown, 1968)

The Tatarian and Kazanian of the Russian Platform (W. of Urals) and Southern Urals used in the "Geological Society Phanerozoic time-scale 1964" as the standard stages for the Upper Permian are considered unsuitable by Ruzhentsev & Sarȳcheva 1965. This is because the Tatarian is of continental origin, and the Kazanian has an endemic marine fauna, and neither are practical for intercontinental correlations.

The type sections of the Dzhulfian stage occur in Nakhichevan, on the left bank of the Araks River, S. of the Caucasus Mountains, between The Black and Caspian Seas (i.e. Trans-Caucasia). Although the ammonoid assemblages of this stage are most diversified and best represented in Trans-Caucasia, corresponding assemblages are also found in The Salt Range (W. Pakistan), Himalayas, New Caledonia (Pacific island E. of Australia), Greenland and Madagascar. The zone fossil *Cyclolobus* is widespread.

The Guadalupian type section occurs in W. Texas in the Guadalupe and Glass Mountains. These sections abound in fossils, including ammonoids. In Mexico the fauna is even more abundant and well preserved. In The Glass Mountains the stage is sub-divided into the two sub-stages, Capitanian and Wardian, with the zone fossils being *Timorites* and *Waagenoceras* respectively.

The resolving power of the Upper Permian (with a duration on present estimates of 15 m.yrs.) ammonoid zones is only of the order of 5 m.yrs. in comparison with that of ± 1 m.yrs. for the Triassic and Jurassic.

B. Triassic. Tozer (1967); Silberling and Tozer (1968)

"In Alpine Europe, the classical region for the study of the Marine Triassic, only a dozen or so distinct ammonoid faunas are represented, and all but one of these are in the Middle and Upper Triassic. Moreover, few of the zones characterized by these faunas are in contiguous succession, and some of them, because of the stratigraphic and structural complexity of this region, are not in directly determinable sequence. Attempts to fill out the zonal succession of the Triassic, as known from the Alpine region, began as long ago as 1895, when Mojsisovics, Waagen and Diener added to it ammonoid zones from the older parts of the Triassic in the Salt Range and Himalayas of the Indian region.

"A recent 'standard' ammonoid zonation for the Triassic is that included in the correlation chart of Triassic formations in North America (Reeside and others, 1957) and in the Treatise on Invertebrate Paleontology (Arkell and others, 1957, p. 1124); it incorporates a similar mixture of Alpine, Salt Range and Himalayan zones and adds to these still other Lower and Middle Triassic zones from Asia Minor, Timor, and N. America. This composite scheme, comprising 30 Triassic zones, suggests a number of successive distinct ammonoid faunas expectable in the Triassic and indicates the usage made of the various stage and series names, but it does not constitute a standard of comparison that is objectively applicable to any one region. Rather, it is more in the nature of a listing of ammonoid faunas from various places in the world in what was believed to be their order of age.

"The marine Triassic rocks of western and arctic North America are well endowed with ammonoid faunas, which at one place or another represent nearly every part of Triassic time. Provincialism among North American faunas is in some cases great enough to warrant separate zonal designation of roughly correlative strata in different parts of the region, but in general the lateral continuity of faunas is good enough so that the many local sections preserving parts of the faunal sequence can be pieced together in an overlapping fashion into a sequential framework . . . . At present, about 35 distinct biostratigraphic units of demonstrably different age can be recognised on the basis of ammonoid faunas in the Triassic of North America, and some of these units combine still more refined local faunal sequences. Hence, using current estimates of the duration in years of the Triassic System, the average resolving power of the zonal units is 1.0 to 1.5 m.yrs., though the actual time span of the individual units is of course probably widely variable." (Silberling & Tozer 1968).

It is added that changes and additions to the scheme are expected and that it is presented mainly as a temporary standard to which reference can be made.

"The faunal succession of the Triassic in north-eastern British Columbia and in the Arctic Islands of Canada complement one another and together form by far the most complete sequence of Triassic ammonoid faunas known from any one region. Because of its importance, Tozer (1967) has prepared a fully documented summary of present knowledge regarding this succession and has established a standard sequence of Canadian Triassic ammonoid zones." (Silberling & Tozer 1968).

It is this standard sequence presented by Tozer (1967) for the Triassic of Western and Arctic Canada which we have incorporated in our various range charts.

N.B. Although Silberling & Tozer (1968) suggest that the average resolving power of the Triassic ammonoid zones is between 1.0 and 1.5 m.yrs. (see above) it would appear that from the best estimate at present of the duration of Triassic (i.e. 32½ m.yrs.) this resolving power is in fact very close to 1 m.yrs.

C. Lower Jurassic—Arkell (1956)

The standard stages and biostratigraphical units (zones) for the Jurassic, based on ammonoids, are derived from N.W. Europe (England, France and to a lesser extent Germany). The zones for the upper half of the Jurassic System are based on the English Sequence, and the lower half predominantly on the French Sequence. The scheme involving 58 ammonoid zones (Lower Jurassic—17; Middle Jurassic—21; Upper Jurassic—20) first devised in 1850 has remained essentially the same since that date. The ammonoid zones of the Jurassic, which on current estimates occupied 56½ m.yrs. are thus on average resolved to a little under 1 million years each, which is very much the same as for the Triassic.

D. GENERAL DISCUSSION AND CONCLUSIONS

We do not intend to give here a summary of the information contained in each of the 22 charts. Their direct perusal by the reader will be far more worth while. Instead we intend simply to expand on some interesting points of discussion that come to light.

(*N.B.* Wherever we mention Triassic, the uppermost Permian and lowermost Jurassic must be considered under discussion as well.)

If one is eventually to construct a reasonably detailed and accurate evolving picture of the landscape and life of the Gondwana Triassic, there are two related prerequisites which need to be lifted to a level of some degree of sophistication—

1. The classification and nomenclature of the animals and plants of the Gondwana Triassic.
2. The interbasinal correlation of the Geological strata (groups, formations and members) and the correlation of these strata with those of the Northern Hemisphere.

1. The present state of classification and nomenclature of the animal and plant life of the Gondwana Triassic.

Fish and invertebrates are found very rarely in the Triassic of Gondwanaland. They have been cursorily treated in the charts, and are not discussed here. Non-vascular plants are included in the macrofloral and microfloral charts, but are otherwise ignored.

(a) *Tetrapod Vertebrates* (refer to charts 1–5)

The creation of a very large number of artificial species and genera in the past has greatly hindered progress in the understanding of the diversity, natural relationships, evolution and ecology of the tetrapods of the Triassic of Gondwanaland. However, taxonomic reviews in the last decade or so have rectified the position to a point where it has been possible to attempt to compile an evolutionary and relative abundance chart involving all described genera of tetrapods for the Triassic of the whole world. (See chart 5.) Very much more collecting and revision work is necessary, however, before any such chart can be regarded as truly reliable. At present it merely presents a good initial impression of the major events that occurred.

(b) *Macroflora* (refer to charts 9–12, 19, 20)

The state of nomenclature of the fossil leaves found in Gondwana Triassic beds is very confusing. Generic names for a fair number of commonly found types have become fairly standard, but very poorly circumscribed specific designations are still far too freely used. It is therefore not possible at present to attempt to compile a general evolutionary and relative abundance chart for the Gondwana Triassic plants. The presentation of lists of all standing genera and species (within the best classification available) for each particular plant bearing 'formation' is all that can be presently given. In the case of the Sydney and Clarence-Moreton basins of Australia (see chart 10) a sufficient number of productive 'formations' occur, to present the assemblage lists in the form of a range chart. No relative abundances could be included.

(c) *Microflora* (spores and pollen grains of vascular plants) (Refer to charts 6–8)

Here the situation is in some respects better and some respects worse than in the case of the macroflora. In Australia where most of the work to date has been done a reasonable degree of uniformity of useage of generic and specific names has been arrived at and it is possible to draw up range charts (including general indications of relative abundances) for the Sydney Basin and for the Queensland basins (see charts 6 and 7). A range chart has also been drawn up for the Salt Range (W. Pakistan) (see chart 8). A fairly high degree of conformance of results exists between these 3 charts. The few Triassic spore/pollen assemblages that have been described from other Gondwana areas are very similar to those of Australia and the Salt Range. The generic and specific names that have been applied to the forms described, however, are very different. As a result direct comparisons of the microfloras via assemblage lists are largely impossible to assess.

2. The present state of accuracy of interbasinal correlations within Gondwanaland and of the tie up with the Standard Stages and ammonoid zones of the Northern Hemisphere.

(Refer to chart 21 which is based on a consideration of all palaeontological and other information presently available.)

The continued accumulation of new information will almost certainly necessitate several significant and many minor changes in the correlation chart we have attempted to compile. The results of work in the following areas will be particularly valuable in this regard.

(i) Comprehensive collecting and taxonomic revision of the animal and plant groups.
(ii) Rigorous mapping and definition of geological 'groups' and 'formations'.
(iii) Recognition of 'formation' contacts (transitional, non-depositional or erosional).
(iv) The meaning and significance of the magnitude of the faunal and floral breaks encountered.
(v) Rates of deposition enabling more accurate plotting of the various 'formations' within the available time scale.
(vi) Radiometric age dating of inter or intra 'formational' igneous events.

In view of the lack of marine strata, other than in the Lower Triassic of W. Australia, Madagascar and the Salt Range, direct correlations with the N. Hemisphere Standard Stages and ammonoid zones are very difficult.

Roundabout correlation via tetrapod vertebrates and microfloras is the present basis of the tie in of the Gondwana and N. Hemisphere 'formations'. With improved knowledge of world Triassic tetrapod faunas and floras these correlations will become very much more reliable.

3. Discussion regarding the diversity and relative abundances of the tetrapod vertebrates and the vascular plants in Gondwanaland during the Triassic.

(a) *Diversity of fauna and flora in the world today* (given here as a basis for comparison)

Invertebrates	(Barnes 1963). ± 1 000 000 species. (i.e. ± 95% of total animal species).
Vertebrates	(Carrington 1962). ± 40 000 species.
Fish	>20 000 species
Amphibians	± 1 500 species (frogs, toads, salamanders, Apoda)
Reptiles	± 6 000 species (snakes, lizards, turtles, crocodiles, Tuatara)
Birds	± 8 500 species
Mammals	± 5 000 species

Flora (Vascular plants only)
(Foster & Gifford 1959; de Wit 1966; Phillips 1951).

	families	genera	species
Psilopsida	1	2	4
Lycophyta	3	4	± 900
Sphenophyta	1	1	± 30
Filicophyta	11-21	± 300	± 10 000
Cycodophyta	1	9	± 80
Ginkgophyta	1	1	1
Coniferophyta	7	53	± 500
Gnetales	3	3	± 80
Angiosperms	250-350	± 10 000	± 200 000

It would be very valuable to present a fairly detailed account of the distribution and natural habitat of the above mentioned plants and animals. An estimation could then be arrived at, of what number of these might reasonably be expected to be fossilised. This quite obviously cannot be done here. We merely present the above figures to give an impression of the very great diversity of plants and animals today. In the plant kingdom, the Angiosperms, comprising the bulk of today's flora, were not yet in existence during the Triassic (or not in the depositional areas at any rate). On the other hand, the seed ferns, predominant in the Triassic depositional areas, are now extinct.

(b) *Introductory notes on the diversity of the tetrapod vertebrates and the vascular plants of the Gondwana Triassic*
(See figures provided above)

In comparison with the continental fauna and flora of today, that of the Gondwana Triassic *appears* to have been extremely limited in diversification. Before such a conclusion is justifiable, however, we must consider what proportion of the total plant and animal life might have been preserved.

In the first instance, we are dealing only, or very predominantly so, with the life of the depositional areas, i.e. the lowland plains and the adjacent deltaic areas and in fewer instances, inland plains. Only very rarely are sediments with included plant and animal remains preserved in the hilly terrain of the upland areas. In considering the tetrapod vertebrates of the Triassic of the whole world only one such hill fauna is known, the ± mid-Norian fissure fillings of the Bristol Channel area, England (see chart 4). These fissures occurred in the hilly Carboniferous Limestone country of the time.

Present knowledge is such that it is not possible to assess what proportion of the animal and plant species occupying the Gondwana depositional basins of any particular period during the Triassic would actually have been preserved. Nor is it yet possible to determine how accurately the relative abundances of the fossils collected reflect the true proportions of the various forms living at the time.

These assessments will only be possible when far more detailed work has been accomplished (for each fossiliferous 'formation' within each Gondwana Triassic basin) regarding the following:

1. The subtleties of the depositional environment.
2. The details of lithology and sedimentological structures associated with the plant and animal remains.
3. The particular characteristics regarding the association of species, their relative abundance and their attitude, completeness and state of preservation at each fossiliferous locality.
4. Precisely where in the depositional areas of today fossiliferous accumulation of similar character occur.

In order to give an indication of the diversity and relative abundance of the presently known species of Gondwana Triassic tetrapod vertebrates and vascular plants, we will consider in some detail what are probably the best known tetrapod bearing and plant bearing 'formations' and their supposed equivalents, respectively.

(c) *The tetrapod fauna of the Lystrosaurus zone of South Africa (see chart 1) and its supposed equivalents; the Fremouw Fm. of Antarctica (see chart 4) and the Panchet Fm. of India (see chart 3)*

THE LYSTROSAURUS ZONE OF S. AFRICA (see chart 1). The information contained below is based on Kitching (1968) and amplified by recent discussions with him. (Kitching pers. comm. 1971). See acknowledgements.

TABLE IV. THE TETRAPOD VERTEBRATES OF THE LYSTROSAURUS ZONE OF SOUTH AFRICA.

Reptiles	No. of species	No. of specimens	Size and general appearance	
Lystrosaurus	± 6 *	abundant	young–medium grown hippopotamus	Amphibious herbivore
Procolophon	1	common	large lizard	terrestrial herbivore (or insectivore)
Myosaurus	1	8	mouse	Terrestrial herbivore
Owenetta	1	1	lizard–small leguaan	terrestrial carnivores & insectivores
Prolacerta	1	5		
Scaloposaurids	a few	± 8		
Galesaurids	a few	± 40		
Proterosuchus	1	± 9	large leguaan–small crocodile	amphibious carnivore
Moschorhinus	1	± 12	squat leopard	terrestrial carnivore
Amphibians				
Lydekkerina	1	common	skull length ± 5–10 cm	aquatic insectivore
Uranocentrodon	1	several	skull length ± 50 cm	aquatic carnivore (? piscivore)

Fish–None yet found.

*** This figure of ± 6 species was based on Kitching's personal opinion (per. comm. 1971) and Cluver (in press) 1971. (See chart 1) We have since received Cluver's paper in which he has now decided on retaining 9 species of *Lystrosaurus.***

Refer to chart 22 for distribution of *Lystrosaurus* zone. The outcrop of the zone ('formation') is quite clearly the most extensive of any Gondwana Triassic 'formation'. It occupies most of the outcrop area indicated outside the broken line on the map, i.e. below the Molteno 'Fm.'. (The *Cynognathus* zone is of restricted distribution occurring only in the southern half of the Triassic exposure between the *Lystrosaurus* zone and the Molteno 'Fm.'). The existing remnant of the *Lystrosaurus* zone measures about 600 km x 300 km. The depositional area of the beds of this zone probably originally extended over the entire Karroo Basin indicated on the map, i.e. a vast plain roughly equivalent in area to the largest lowland river basins of today, e.g. the Amazon, Congo or Mississippi.

The *Lystrosaurus* zone fauna described here is based on some 1–2 000 specimens (it must be noted that of the more common forms–*Lystrosaurus, Procolophon* and *Lydekkerina*–only the better material has been retained) collected from 89 localities scattered throughout the outcrop area. The first descriptions of elements of this fauna are over 100 years old, but the most systematic collections have been made by James Kitching over the last 15 years or so. "Even so, most areas around the outcrop have not been thoroughly combed as yet." (Kitching pers. comm. 1971).

Lystrosaurus

By far the most abundant form. Found at nearly all the localities around the outcrop. Usually found complete in the northern half of the outcrop where several animals are often found in close proximity to one another, and as skulls and scattered postcranial bones in the southern half.

Procolophon

Occurs at many localities widespread in the southern areas of the outcrop sometimes as complete well preserved specimens in mudstones and siltstones and sometimes as fragmentary material in mud-pellet conglomerates at or near the base of sandstone lenses. Occurs more rarely in the northern area from only a few localities and here always as fragmentary material in mud-pellet conglomerates at the base of sandstone lenses. Where good material has been collected in the south, whole colonies of animals appear to have been overwhelmed by mud. As many as 6 specimens may be found in a single horizon within an area of 2 sq. yards. In the mud-pellet conglomerates, in north and south, the fragmentary material is abundant and many animals are represented at any particular locality.

Myosaurus

All eight known specimens have been collected from an area 12 ft. x 12 ft. at a single locality–Harrismith Dongas–at the north end of the outcrop. The skulls were well preserved, but most of the skeletal material was missing.

Owenetta sp.

The single specimen, from the *Lystrosaurus* zone found to date is an almost complete animal and derives from a locality near Bethulie in the mid-western part of the outcrop.

Prolacerta

The five specimens, mostly complete animals, have been collected from widely scattered localities around the outcrop.

Scalopsaurids

The specimens have mostly been found from widely scattered localities along the southern portion of the outcrop. A single specimen has been found in the Orange Free State in the north-western part of the outcrop. Some of the specimens are complete skulls and skeletons and some only skulls.

Galesaurids

Galesaurus—one specimen from near Middelburg in the south-west and one from near Bulwer in the north-east. Skulls only.

Glochinodontoides—Two specimens from Harrismith in the north and one from near Bethulie in the mid-west. Skulls only.

Micrictodon—one specimen from Harrismith in the north.

Nanictosaurus—one specimen from near Graaff-Reinet in the south-west. Skull only.

Notictosaurus—Six specimens have been found to date, all from the south-west portion of the outcrop. One specimen was found near Graaff-Reinet and the other five from two localities near Burghersdorp. Four of these (complete specimens of an adult and three immature animals) derive from a single block from one of the two localities.

Nythosaurus—One specimen from near Smithfield in the mid-west. Skull only.

Platycraniellus—One specimen from near Harrismith in the north and one from near Bethulie in the mid-west.

Thrinaxodon—± 30 specimens, nearly all complete, have been found to date. About half the specimens have come from a single locality at Harrismith in the north and the other half from the farm Newcastle (on Oliviershoek Pass) about 25 miles to the south of Harrismith. Two specimens have been found from near Bethulie in the mid-west. At the two main localities *Thrinaxodon* is found very closely associated with *Lystrosaurus* and *Lydekkerina*. In assessing the distribution patterns of the Galesaurids it must be noted that taxonomic revision of the group is urgently needed and that some of the genera at least will certainly become synonymous with *Thrinaxodon*.

Proterosuchus

The ± 9 specimens have been found at localities scattered widely throughout the outcrop. Portions of the postcrania occurred with some of the specimens.

Moschorhinus

The ± 12 specimens have been found at localities scattered widely throughout the outcrop. Most specimens consist of isolated complete skulls. In only one case was the complete animal found.

Lydekkerina

The numerous specimens have been collected from only two localities i.e. Harrismith (in the north) and from the farm Newcastle (on Oliviershoek Pass), about 25 miles to the south of Harrismith. These are the same two localities at which *Thrinaxodon* is commonly found. All specimens are complete and often found very closely associated with *Lystrosaurus* and *Thrinaxodon.*

Uranocentrodon

All the specimens (which are complete and well preserved) have been found at a single locality near Senekal in the north-west. All occurred in a single horizon with specimens of *Lystrosaurus* occurring in horizons immediately above and below.

THE FREMOUW 'FORMATION' OF ANTARCTICA (see charts 4 and 22)

The information contained below is drawn directly from the results of James Kitching's recent collecting trip (1970/71 season). (Colbert et al 1971.) Earlier collections consist of very fragmentary material and add nothing to the overall picture.

Lystrosaurus—The most prominent form but not overwhelmingly so as in South Africa. Skulls and scattered skeletal elements are found separately.

Procolophon—Several specimens, all complete with skulls and skeletons.

Small anomodonts—Three specimens, 1 complete and two with skulls and parts of the skeleton.

Thrinaxodon—Several specimens all complete.

Prolacerta-like forms—± Four specimens, all complete.

Lydekkerina—Much fragmentary material. Only one skull (more or less complete) has been found.

The faunal assemblage known to date is clearly very similar indeed to that of the *Lystrosaurus* zone. The only elements not common with the *Lystrosaurus* zone forms are the small anomodonts. Preparation of all the specimens is still necessary before detailed comparisons can be made.

The specimens have been collected from a number of localities from an outcrop area far smaller than that of the South African outcrop (see chart 22).

THE PANCHET 'FORMATION' OF INDIA (see charts 3 and 22)

The fauna is very poorly known as yet. (For reference see chart 3.)

Lystrosaurus —	Predominant (± 24 skulls and skeletons)
Procolophon	Very little material to date
Proterosuchus	
Brachyops	
Indobrachyops	

Other than in the case of *Brachyops* and *Indobrachyops*, which are amphibians unrelated to the two forms known from South Africa, the fauna could well have been derived from any single locality in the *Lystrosaurus* zone.

CONCLUDING REMARKS ON THE FAUNA OF THE LYSTROSAURUS ZONE AND ITS EQUIVALENTS

(1) The faunal assemblages from the Fremouw and Panchet 'formations' are still very poorly known but are clearly closely related in overall characteristics and age to that of the *Lystrosaurus* zone.

(2) Although the *Lystrosaurus* zone faunal assemblage is the best known of any tetrapod-bearing Triassic 'formation' (including uppermost Permian and lowermost Jurassic) it is still, according to Kitching (pers. comm. 1971), far from comprehensively studied. Most areas of the outcrop have only received sparse attention. From the very small number of specimens known of the more rare elements and the very restricted presently known distribution of certain forms (particularly *Uranocentrodon*) it is clear that there remain significant gaps in our knowledge of the fauna.

(3) Very little detailed geological study of the *Lystrosaurus* zone has been undertaken and it is not yet possible therefore to assess the subtleties of the depositional environment.

(4) The attitudes and state of preservation of the various faunal elements of the *Lystrosaurus* zone, and their relationships one to another as seen in the field offer certain clues to the environment and overall characteristics of the fauna, e.g. the very close association of complete specimens of *Lystrosaurus* and *Lydekkerina* at both localities at which *Lydekkerina* occurs suggests that these forms were overwhelmed by silt and mud perhaps whilst going about their daily business in the flooded flood plain of a meandering river system. It is possible that the elements found more rarely at these localities were actually equally common but that since their natural habitat is not aquatic or amphibious as with *Lystrosaurus* and *Lydekkerina* they are less commonly the victims of mud floods.

It is obvious that once detailed notes are made regarding the sediments and structures directly associated with the animal remains that it will be possible to draw conclusions of the above nature with more confidence. With a great number of localities studied in this way the reconstruction of a good overall picture of the depositional environment should be possible.

(5) In a reconstruction of Gondwanaland the three 'formations' discussed above lie at the apices of a triangle whose sides are very roughly 2–3 000 miles long. (The distances obviously vary according to the different suggested possible Gondwanaland reconstructions.) If we assume the reconstruction of the Upper Permian world, with lines of latitude included, as given in Robinson (1971) (the most comprehensive attempt known to us to date) to be roughly correct we arrive at the following latitudes for the three 'formations'—

Lystrosaurus zone (± 60–65°S)
Fremouw 'Fm'. (± 80°S)
Panchet 'Fm'. (± 65°S)

We might thus envisage a considerable continental area spanning some 20° of latitude (the latitude values might be incorrect) whose depositional basins *appear* to have supported a fauna very limited in diversity and dominated throughout by *Lystrosaurus.*

(6) The presently known tetrapod fauna of the *Lystrosaurus* zone numbers ± 20 species, that of the *Lystrosaurus* zone plus its equivalents, the Panchet and Fremouw 'Formations', ± 23 species. With more comprehensive collecting the total tally might possibly reach twice this figure. What proportion of the total fauna inhabiting the depositional basins of Gondwanaland during *Lystrosaurus* zone times does this represent? How many species left no trace of their existence? We cannot at present attempt to answer these questions.

(d) *Brief consideration of the presently known diversity of the tetrapod fauna of the Gondwana Triassic as a whole (see charts 1–5)*

TABLE V. THE TETRAPOD FAUNAS OF THE BEST KNOWN PRODUCTIVE GONDWANA "TRIASSIC FORMATIONS"

			Total Species	Amphibian Species	Reptile Species	Mammal Species
? lowermost Jurassic		Cave Sandstones	10	—	10	—
Triassic	U. Norian—Rhaetian	Red Beds	15	—	13	2
	L–M. Norian	Ischigualasto Fm	15	1	14	—
	Anisian	Manda Beds	15	1	14	—
	Scythian	Cynognathus zone	30	8	22	—
? uppermost Permian		Lystrosaurus zone	20	2	18	—

In the above table we have selected a succession of Gondwana Triassic tetrapod-bearing 'formations' giving rough counts of the number of species of tetrapods presently known from each. The numbers are based on what are considered to be valid natural species. The 'formations' chosen are those bearing the 'richest' and best known faunal assemblages of all tetrapod-bearing Gondwana Triassic 'formations'. In the case of the 4 South African 'formations' the presently known assemblages are the result of a considerable (although by no means comprehensive) amount of collecting over a number of decades. The Manda and Ischigualasto 'Fm.' collections are more limited.

(e) *The macroflora and microflora of the Molteno 'Formation' of South Africa and its supposed equivalents elsewhere in Gondwanaland.*

THE MACROFLORA (VASCULAR PLANTS) OF THE MOLTENO 'FORMATION' OF S. AFRICA

Refer to chart 11 for a fairly detailed account of this flora and its peculiarities of distribution according to the 21 localities (from which more or less comprehensive collections have been made) scattered around the outcrop (see chart 22).

After detailed consideration of the ± 3 350 selected specimens of leaves (and sphenophyte stems) collected from these 21 localities we estimate the presence of ± 87 reasonably clearly definable 'species'. As can be seen in the case of *Dicroidium* (see diagrammatic key on chart 9) the delineation of 'species' is by no means always easy. However, in most of the other genera the task is simpler. (One of us (H.M.A.) is at present preparing a comprehensively illustrated account of the Molteno Flora, which should be published in 1972.)

With further detailed collecting from the presently known localities and many more, resulting as it should in the discovery of the very rare elements of the flora, our estimate is that the eventual number of 'species' will not exceed 125.

THE MACROFLORA (VASCULAR PLANTS) OF THE IPSWICH 'GROUP' OF E. AUSTRALIA

Refer to chart 10 for an account of the flora.

The total number of leaf species (including sphenophyte stems) presently valid in the literature on the Ipswich 'Group' (including the Esk flora) is approximately 80. The Ipswich flora forming the bulk of this total, was last revised in 1947 by Jones and de Jersey. The revision was, for that time, very comprehensive. The Esk flora was last dealt with by Walkom in 1928. With further detailed collecting and revision we presume that the total flora will roughly match that of the Molteno in diversity of 'species'.

At least half, and probably a lot more, (it is not possible to judge accurately from the literature available) of the Ipswich flora is common with that of the Molteno.

THE MACROFLORA (VASCULAR PLANTS) OF THE 'FORMATIONS' IN ARGENTINA AND BRAZIL PRESUMED TO BE EQUIVALENTS OF THE MOLTENO (see chart 12)

With the limited knowledge presently available, it is of course very difficult to assess (as is suggested on the correlation chart–chart 21) whether all the plant-bearing 'formations' of Argentina and Brazil are in fact of the same age. Nor is it really possible at present, to assess how closely in age they match the Molteno. There is, however, no good evidence to suggest that the above mentioned South American and South African 'formations' are not equivalent in age and for the present this is the best assumption. Considering the apparent widespread similarities of conditions in the depositional basins of Gondwanaland at any one time (based on many independent lines of evidence, e.g. the discussion just held on the *Lystrosaurus* zone and its equivalents) this conclusion appears justified.

The total number of species of leaves (and sphenophyte stems) presently standing in the literature for all the Argentina and Brazil 'formations' is approximately 140 (see chart 12). It is assumed once again that; with revision and further comprehensive collecting, the number of 'species' will probably roughly match that of the Molteno. It is extremely difficult to judge just how many species are in common with the Molteno and/or Ipswich floras since a great many have been inadequately described and illustrated to date. However, it appears that well over half of the Molteno 'species' occur in S. America.

CONCLUDING REMARKS ON THE MACROFLORA OF THE MOLTENO AND ITS SUPPOSED EQUIVALENTS

(1) Excellent floras, undescribed as yet but obviously closely comparable to those of the Molteno, Ipswich and S. American 'formations', occur in many other Gondwana basins.

(2) Comprehensive collections of the flora from all plant-bearing Molteno age 'formations', and their description in the light of extensive taxonomic revision is necessary.

(3) We can at present only make a very rough estimate of the total number of vascular plant 'species' that were preserved in all Gondwana depositional basins during Molteno times. Considering what we presently know it is difficult to imagine that the number will exceed 200.

(4) What proportion of the species of vascular plants actually growing in the depositional basins during Molteno times does the preserved flora represent? Again, as in the case of the *Lystrosaurus* zone and its equivalents, very limited geological detail is known concerning the 'formations' in question. No attempts have been made to give detailed accounts of the lithology and sedimentary structures or the peculiarities of leaf associations and relative abundances in the various horizons or portions of an horizon within the section at any particular fossil locality. In other

words no attempts have been made to assess the details of the original growing and depositional conditions at and nearby the plant localities.

Until this is done and until the overall depositional regime of each 'formation' is known, we can hardly hope to assess with confidence the proportion of the total plant species, of the basins, that might have been preserved. Nor can we hope to be really aware of the true relative abundances of the species involved.

THE MICROFLORA (VASCULAR PLANTS) OF THE MOLTENO AND ITS SUPPOSED EQUIVALENTS

(1) The Molteno 'Formation' figures are based on the detailed study of numerous samples from many Molteno localities made by one of us (JMA.) over the past few years. The microflora, which has received no attention in the available literature to date, will be published along with the macroflora in 1972.

(2) The Potrerillos 'Formation' figures are based on our estimations of the number of 'forms' present, based on the photographic plates in Jain (1968). Jain described 54 genera and 95 species from about 20 samples from a single exposure (covering about 160 m of strata). Considering only consistently recognisible, distinct basic 'forms' (i.e. not including as distinct the various abnormalities, or the different stages of dehiscence, splitting, opening and folding) we consider that only ± 34 'forms' are present.

(3) The Ipswich 'Group' figures are based on de Jersey (1962 and 1970b) (see chart 7).

(4) Microfloras of supposed equivalent age to the three 'formations' just mentioned have been very briefly described, or merely mentioned, in the literature from many other Gondwana basins (see chart 21). No details for the purposes of this discussion can be gleaned from these references, however.

(5) In considering microfloras we can only legitimately talk of distinct morphological 'forms' rather than 'species'. This holds particularly for the non-striate disaccate pollen grains presumed to derive mainly from *Dicroidium*; and the *Cycadopites*-type pollen grains presumed (by comparison with modern day forms) to be the predominant pollen-type of the Cycads and Ginkgos. The morphological possibilities are limited to such an extent in these two pollen groups that, in the case of the Molteno microflora only 7 and 4 distinct 'forms' can be recognised respectively. In comparison, in the Molteno macroflora, 25 reasonably distinct *Dicroidium* 'species' and 19 Cycad + Ginkgo 'species' can be recognised (see charts 9 and 11). In total only some 64 spore and pollen 'forms' can be recognised as compared to approximately 87 leaf 'species'.

(6) Although microfloral assemblages represent predominantly the plants growing in the immediate or close vicinity, contamination of the flora can be expected to be effected by the influx by wind or water of spore and pollen types derived from plants growing outside the depositional basin.

(7) In both the Potrerillos and Ipswich microfloras about ¾ of the 'forms' are clearly closely comparable with 'forms' from the Molteno.

(8) Considering the number of recognisable 'forms' presently known and taking into account the great similarities between microfloras in the different areas of Gondwanaland, the total microflora of the Molteno and its equivalents might be

TABLE VI. THE MICROFLORA (VASCULAR PLANTS) OF THE MOLTENO AND ITS SUPPOSED EQUIVALENTS

Microfloral groups (with possible and/or probable parent plant groups)	**Approximate No. of 'forms'**		
	Molteno 'Fm'; S. Africa	Potrerillos 'Fm'; Cacheuta Basin; S. America	Ipswich 'Grp'; E. Australia
Trilete & monolete cavate spores of probable lycophyte origin	2	3	4
Other trilete and monolete spores (Sphenophyta, Filicophyta and additional Lycophyta).	35	13	25
Striate disaccate pollen grains (possibly Glossopteris but perhaps of other gymnospermous origin).	2	3	–
Non-striate disaccate pollen grains (mainly *Dicroidium* but also probably including other gymnospermous plants).	7	7	(Several)
Cycadopites and other miscellaneous gymnospermous pollen grains.	5	4	1
Alete forms (possibly including both spores and pollen grains).	13	4	5
Total	64	34	35 + ?

expected eventually to approach 125 distinct 'forms'.

(f) *Brief consideration of the macroflora and microflora of the Gondwana Triassic as a whole.*

(1) The Molteno and supposed equivalent 'formations' are by far the most productive as regards macrofloral (leaf) remains. Only in E. Australia (see chart 21) does there exist a reasonable scatter of plant-bearing 'formations' through the rest of the Triassic. It appears that it is from this region that most of the story of Gondwana Triassic macrofloras will have to be told.

Other than from the Ipswich 'Group' very little systematic description of E. Australian floras has, however, so far been undertaken. Townrow (pers. comm. 1969) has over the past ten years or so made extensive collections of many of the floras under question, but has not, as yet, published the results of most of his labours.

(2) As with the macroflora we have to turn to E. Australia for the most complete succession of good spore and pollen-bearing Triassic 'formations'. The bulk of our present knowledge of Gondwana Triassic microfloras is based on work done in Australia (see charts 6 and 7).

4. Discussion concerning the possibility of arriving at a reasonable estimate of the evolution of the tetrapod vertebrates and the vascular plants in Gondwanaland during the Triassic.

(1) We can at best only hope to discuss that part of the evolutionary story which took place in the lowland areas. How much disjointing of the story will have been effected by the arrival of new elements from the upland areas, unknown previously in the lowland areas, and not evolved from any of the forms occurring there, will only become evident with much more precise work.

(2) A study of the correlation chart (chart 21) will give some indication of what periods of Triassic time are represented by strata bearing tetrapod vertebrates, macrofloras and microfloras. It must be clearly noted, however, that the correlation chart is based on present evidence, and we feel that it will look significantly different on revision in years to come.

(3) As a consequence of the faunas and floras being so constant from one depositional area to another it is theoretically possible to compile the evolutionary story by making use of all the available information from all the 'formations' no matter in which basin or country they occur.

(4) In this way tetrapod-bearing 'Formations' can be pieced together to occupy most of the Triassic succession; Microflora-bearing 'formations' occur through most of the Triassic excluding the Norian; Macroflora-bearing 'formations' offer much the same overall coverage as do the microfloras, but in a more restricted sense.

5. The relationship between the evolutionary patterns of the tetrapod vertebrates and the vascular plants of the Gondwana Triassic (see charts 5 and 6–8).

That a very definite relationship between the evolutionary patterns of the plants and tetrapods exists, is clearly shown by comparing the tetrapod evolution chart (chart 5) and the microfloral range charts (charts 6–8). Extensive, major floral and faunal changes occur roughly simultaneously at 3 levels within the period covered by this review; (a) somewhere near the top of the Permian (but below the *Lystrosaurus* zone and its equivalents); (b) somewhere within the upper half of the Scythian; and (c) somewhere near the base of Rhaetian. Precisely how rapidly these changes occurred and whether the plant changes preceded the vertebrate changes or vice versa, or whether they occurred virtually concurrently cannot be assessed at present.

E. ACKNOWLEDGEMENTS

We would like to thank Arthur Cruickshank, James Kitching and Chris Gow, members of the Bernard Price Institute for Palaeontological Research, without whose willing help the compilation of the vertebrate lists for southern Africa would not have been possible.

Arthur Cruickshank helped considerably in the recommendation of literature and with general guidance and criticism throughout.

James Kitching deserves a special debt of gratitude. He is at present working on the enormous task of compiling full comprehensive lists of all reptiles found from each known fossil locality from the Beaufort Beds (upper half of the Permian and lower half of the Triassic) of South Africa. This study involves some 10 000 recognisable specimens (predominantly housed in S. Africa) from 5–600 localities. He will be presenting, therefore, an extremely detailed account of the reptile life of the several faunal zones of the Beaufort beds. He has been perfectly willing to impart to us any information we wished to have. We would also like to thank him for letting us incorporate the results of his very recent (1970/71 season) and highly successful collecting trip to Antarctica (see reptile list on chart 4 and localities on chart 22) even though our review will possibly appear before his own published account.

Chris Gow helped with the compilation of the vertebrate lists and qualifying notes for the Red Beds and Cave Sandstones of South Africa—see chart 2. Much of the information contained in this chart is unpublished and is based on his own personal knowledge.

We would also like to acknowledge with thanks the following persons—Hugh Allsop, Basil Balme, Peter Barrett, Joseph Bonaparte, André Keyser, Frederico Lange, Christian Mendrez, Edgar Riek, John Townrow, Alick Walker, Hans Welkae, with whom fruitful discussions have been held,

from which certain information has been drawn.

Marcia Orelowitz compiled the bibliography as part of the requirements for her Diploma in Librarianship (Witwatersrand University). For her work and ever cheerful presence we thank her most deeply.

Janet Cronjé helped enormously in drawing up the charts. A great deal of the art work including the map (chart 22), the tetrapod evolution chart (chart 5) and the microfloral range charts (charts 6–8) is hers. Her artistic soul has helped us to endure.

Anna Benecke, busy on her Ph.D. thesis, stopped to help us with corrections and tidying up.

The manuscript for the written part of this review and the bibliography were typed by Eileen Barrett, Pat Sharland and Sue McCarthy.

F. BIBLIOGRAPHY

Includes only the literature (including maps, personal communications and letters) referred to directly in the compilation of this review.

AMARAL, S., CORDANI, U.S., KAWASHITA, R. and REYNOLDS, J. H., 1966. Potassium-argon dates of basaltic rocks from southern Brazil. *Geochim. Cosmochim. Acta* 30 (2): 159-189.

AMOS, A. J. and ROCHA-CAMPOS, A. C., 1970. A review on South American Gondwana geology 1967–1969. In: *Proc. 2nd I.U.G.S. symposium on Gondwana Stratigraphy and Palaeontology, Cape Town and Johannesburg,* ed. by S. H. Haughton. Pretoria, C.S.I.R.

ANTEVS, E., 1913. Results of Dr. E. Möjberg's Swedish scientific expeditions to Australia 1910–1913. V. Some Mesozoic plants. *K. svenska Vetensk-Akad. Handl.* 52 (5): 1–6.

——————— 1914. Die Gattungen *Thinnfeldia,* Ett. und *Dicroidium,* Goth. *K. svenska Vetensk-Akad. Handl.* 51 (6) 1–71.

APPLEBY, R. M., CHARIG, A. J., COX, C. B., KERMACK, K. A. and TARLO, L. B. H., 1967. Reptilia. In: *The Fossil Record: A symposium with documentation*; ed. by W. B. Harland, et al. London, Geological society of London. pp. 695-731.

ARBER, E. A. N., 1917. The earlier Mesozoic floras of New Zealand. *Palaeont. Bull., Wellington* 6: 1-80.

ARCHANGELSKY, S., 1967. Estudio de la Formacion Baquero Cretacico inferior de Santa Cruz, Argentina. *Revta Mus. La Plata Palaeontologia.* 5: 63-171.

——————— 1968. Studies on Triassic Fossil plants from Argentina. IV: The leaf genus *Dicroidium* and its possible relation to *Rhexoxylon* stems. *Palaeontology* 11 (4): 500-512.

ARKELL, W. J., 1956. *Jurassic geology of the world.* Edinburgh, Oliver and Boyd. 806 p. plates, illus.

ATTRIDGE, J., 1963. The Upper Triassic Karroo deposits and fauna of Southern Rhodesia. *S. Afr. J. Sci.* 59 (5): 242-247.

AUSTRALIAN INSTITUTE OF MINING AND METALLURGY, Annual Conference. 1962 Excursion No. 11: The Ipswich coalfield. Chart on stratigraphic succession.

BALASUNDARAM, M. S., GHOSH, P. K. and DUTTA, P. K., 1970. Panchet sedimentation and origin of Red Beds. In: *2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*: ed. by S. H. Haughton. Pretoria, C.S.I.R.

BALME, B. E., 1963. Plant microfossils from the Lower Triassic of Western Australia. *Palaeontology* 6 (1): 12-40.

——————— 1968. The Permian-Triassic boundary in Australia. *Special publications of the Geological society of Australia* 2: 99–112.

——————— 1969. The Triassic system in Western Australia. *Australian Petroleum Exploration Association Journal* 9: 67-78.

BALME, B. E., 1969. (pers. comm.) Department of Geology, University of Western Australia.

——————— 1970. Palynology of the Permian and Triassic strata in the Salt Range and Surghar Range, West Pakistan. *Univ. Kans. Dept. Geol. Sp. publ.* 4: 305-453.

BANKS, M. R., 1967. Correlation chart for the Triassic system in Australia. In: *Gondwana stratigraphy, 1st I.U.G.S. symposium, Buenos Aires.* Paris, Unesco, 1969. p. 478-481.

BARNES, R. D., 1963. *Invertebrate Zoology,* W. B. Saunders Company, Philadelphia/London. 632 p. illus.

BARRETT, P. J., 1970. Stratigraphy and paleogeography of the Beacon supergroup in the Trans-antarctic mountains, Antarctica. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg;* ed. by S. H. Haughton. Pretoria, C.S.I.R.

BARRETT, P. J., 1970. (pers. comm.) Department of Geology, Victoria University of Wellington, New Zealand.

BARTHOLOMAI, A. and HOWIE, A., 1970. Vertebrate fauna from the Lower Trias of Australia. *Nature, Lond.* 225, (5237): 1063.

BELL, S., HARRINGTON, H. J. and McKELLAR, I.C., 1956. Lower Mesozoic plant fossils from Black Jacks, Waitaki river, South Cantebury. *Trans. R. Soc. N.Z.* 83, (4): 663-672.

BELTRÃO, R., 1965. Paleontologia de Santa Maria e São Pedro do Sul, Rio Grande do Sul, Brazil. *Bolm. Inst. Ciências Naturais Univ. Santa Maria* 2: 1–156.

BESAIRIE, H., 1960. Monographie geologique de Madagascar. Tananarive: Service géologique, 166p. illus. maps, tabs.

——————— 1967. Progres dans l'étude du Gondwana de Madagascar de 1960 à 1966. In: *I.U.G.S. Reviews prepared for the first symposium on Gondwana stratigraphy.* Haarlem, Netherlands, I.U.G.S. secretariat, 1967. pp. 197–200.

BEUKES, N. J., 1970. Stratigraphy and sedimentology of the Cave Sandstone stage, Karroo system. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*; ed. by S. H. Haughton. Pretoria, C.S.I.R.

BHARADWAJ, D. C. and SHRIVASTAVA, S. C., 1969. A Triassic mioflora from India. *Palaeontographica* Abt. B.125 (4-6): 119-149.

BONAPARTE, J. F., 1970. Annotated list of the South American Triassic tetrapods. In. *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*; ed. by S. H. Haughton. Pretoria, C.S.I.R.

BONAPARTE, J. F., 1970. (pers. comm.) Fund–Instituto M. Lillo, Universidad Nacional de Tucumán-Consejo Nacional de Investigaciones Cientificas y Técnicas, Argentina.

BONAPARTE, J. F., PASCUAL, R. and STIPANICIC, P. N., 1967. Geology of the Upper Paleozoic and Triassic continental formations of Cerro Bola-Ischigualasto-Talampayo-Gualo basin (San Juan and La Rioja provinces). In: *1st International symposium on Gondwana stratigraphy and palaeontology. Guidebook no. 2.* Excursion la. Argentina, Asociacion geologica Argentina. 18p.

BOND, G., 1965. Some new fossil localities in the Karroo system of Rhodesia. *Arnoldis (Rhodesia)* 2 (11): 1-4.

——————— 1967. A review of Karroo sedimentation and lithology in Southern Rhodesia. In: *I.U.G.S. Reviews prepared for the first symposium on Gondwana* *stratigraphy*. Haarlem, Netherlands, I.U.G.S. secretariat, 1967, pp. 173-195.

BONETTI, M. I. R., 1966. Consideraciones sobre algunos representantes de la familia *Corystospermaceae*. *Ameghiniana* 4 (10) 389-395.

——— 1968a. Communicación sobre algunas representantes de la familia *Corystospermaceae*. *Actas III as Jorn. Geol. Arg.* 1: 249-250;

——— 1968b. Las especies del género *Pseudoctenis* en la flora Triasica de Barreal (San Juan). *Ameghiniana* 5 (10): 433-446.

BONETTI, M. I. R. and HERBST, R., 1964. Dos especies de *Dictyophyllum* del Triasico de Paso Flores, Provincia de Neuquén, Argentina. *Ameghiniana* 3 (9): 273-278.

BORTOLUZZI, C. A. and BARBERENA, M. C., 1967. The Santa Maria beds in Rio Grande do Sul (Brazil). In: *Problems in Brazilian Gondwana geology: Brazilian contribution to the 1st International symposium on the Gondwana stratigraphy and palaeontology*; ed. by J. J. Bigarella, R. D. Becker and J. D. Pinto. Brazil, Conselho nacional de Pesquisas. pp. 169-195.

BOTHA, B. J. V., 1968. The stratigraphy of the Red Beds stage, Karroo system, at Elliot, C.P. *Trans. geol. Soc. S. Afr.* 71 (1): 101-117.

BOUREAU, E., (ed.) 1970. Plan du Traité. In: *Traite de Paleobotanique*. 4 iv. Paris, Masson.

BRANAGAN, D. F., (in Packham) 1969. Fauna and flora. *J. geol. Soc. Aust.* 16 (1): The Geology of New South Wales: 415-417.

BRETT, D. W., 1968. Studies on Triassic fossil plants from Argentina. III: The trunk of *Rhexoxylon. Palaeontology* 2 (2): 236-245.

BUCHAN, S. H., CHALLINOR, A., HARLAND, W. B. and PARKER, J. R., 1965. The Triassic stratigraphy of Swalbad. *Skr. norsk. Polasinst. 135.*

BURGES, N. A., 1935. Additions to our knowledge of the flora of the Narrabeen stage of the Hawkesbury series in New South Wales. *Proc. Linn. Soc. N.S.W.* 60: 257-264.

BUTLER, P.M. et al., 1967. Chapter 30, Mammalia. In: *The Fossil Record: A symposium with documentation*; ed. by W. B. Harland et al. London, Geological society of London. pp. 763-787.

CARPENTIER, A., 1935. Etudes paleobotaniques sur le groupe de la Sakoa et le groupe de la Sakamena (Madagascar). *Annls. geol. Serv. Mines Madagascar* 5: 1-32.

——— 1936. Additions a l'étude de la flore du groupe de la Sakamena (Madagascar). *Annls. géol. Serv. Mines. Madagascar* 6: 1-12.

CARRUTHERS, W., 1872. Notes on fossil plants from Queensland, Australia. *Q. Jl geol. Soc. Lond.* 28: 350-359.

CARRINGTON, R., 1962. The Mammals ed. by Editors of Life and text by R. Carrington. Time Inc. 192p. illus.

CHALONER, W. G., 1969. Triassic spores and pollen. In: Tschuoy, R. H. and Scott, R. A., *eds. Aspects of palynology: an introduction to plant microfossils in time.* New York, Wiley-Inter-science. pp. 291-309.

CHAPMAN, F. and COOKSON, I. C., 1926. A revision of the "Sweet" collection of Triassic plant remains from Leigh's Creek, South Australia. *Trans. R. Soc. S. Aust.* 1: 163-178.

CHATERJI, G. C. and GHOSH, P. K., 1967. Tectonic frame-work of the peninsular Gondwanas of India. In: *Gondwana Stratigraphy, 1st I.U.G.S. symposium, Buenos Aires.* Paris, Unesco, 1969. pp. 923-924.

CHATTERJEE, S., 1969. Rhynchosaurs in time and space. *Proc. geol. Soc.* 1658: 203-208.

CHERNIN, S. and CRUICKSHANK, A. R. I., 1970. A Capitosaurid amphibian from the Upper Luangwa Valley, Zambia. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*; ed. by S. H. Haughton. Pretoria, C.S.I.R.

CLUVER, M. A., 1971. The cranial morphology of the dicynodont genus *Lystrosaurus. Ann. S. Afr. Mus.* 56 (5): 155-274.

COLBERT, E. H., 1970. Antarctic Gondwana tetrapods. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*; ed. by S. H. Haughton. Pretoria, C.S.I.R.

COLBERT, E. H. and GREGORY, J. T., 1957. Correlation of continental Triassic sediments by vertebrate fossils. *Bull. geol. Soc. Am.* 68: 1456-1467.

COLBERT, E. H., KITCHING, J. W. and ELLIOT, O. H. (in press), 1971. Stratigraphy and palaeontology of the McGregor glacier area, Antarctica (provisional title). *Science, N.Y.*

COX, C. B., 1964. On the palate, dentition, and classification of the fossil reptile, *Endothiodon* and related genera. *Am. Mus. Novlt.* no. 2171: 1-25.

——— 1969. Two new Dicynodonts from the Triassic Ntawere formation, Zambia. *Bull. Br. Mus. nat. Hist. Geology* 17 (6): 255-294.

CROMPTON, A. W., 1955. On some Triassic cynodonts from Tanganyika. *Proc. zool. Soc. Lond.* 125 (3 and 4): 617-669.

——— 1958. The cranial morphology of a new genus and species of Ictidosaurian. *Proc. zool. Soc. Lond.* 130 (2): 183-216.

——— 1963. On the lower jaw of *Diarthrognathus* and the origin of the mammalian lower jaw. *Proc. zool. Soc. Lond.* 140 (4): 697-753.

——— 1964. A preliminary description of a new mammal from the Upper Triassic of South Africa. *Proc. zool. Soc. Lond.* 142 (3) 441-452.

CROMPTON, A. W. and JENKINS, F. A., 1968. Molar occlusion in late Triassic mammals. *Biol. Rev.* 43: 427-458.

CROZIER, E. A., 1970. Preliminary report of two Triassic Dicynodonts from Zambia. *Palaeont. afr.* 13, 39-45.

CRUICKSHANK, A. R. I., 1967. A new Dicynodont genus from Tanzania (Tanganyika). *Proc. zool. Soc. Lond.* 153: 163-208.

——— 1970. Taxonomy of the Triassic anomodont genus *Kannemeyeria. Palaeont. afr.* 13, 47-55.

——— 1971. (In press) The proterosuchian thecodonts. In: Joysey K. A. and Kemp, T. S. *eds. Studies in vertebrate evolution: essays presented to Dr. F. R. Parrington*, Edinburgh, Oliver & Boyd.

CRUICKSHANK, A. R. I., 1971. (pers. comm.) Bernard Price Institute for Palaeontological Research, Witwatersrand University, Johannesburg.

CURRAN, M. J., 1884. On some Fossil Plants from Dubbo, New South Wales. *Proc. Linn. Soc. N.S.W.* 9: 250-254.

DE JERSEY, N. J., 1962. Triassic spores and pollen grains from the Ipswich Coalfield. *Publs geol. Surv. Qd.* 307: 1-18.

——— 1964. Triassic spores and pollen grains from the Bundamba Group. *Publs geol. Surv. Qd.* 321: 1-21.

——— 1968. Triassic spores and pollen grains from the Clematis Sandstone. *Publs geol. Surv. Qd.* 338 (Pal. pap. No. 14) pp. 1-41.

——— 1970a. Early Triassic miospores from the Rewan Formation. *Publs geol. Surv. Qd.* 345 (Pal. pap. no. 19) pp. 1-29.

——— 1970b. Triassic miospores from the Blackstone Formation, Aberdare Conglomerate and Raceview Formation. *Publs. geol. Surv. Qd.* 348 (Pal. pap. No. 22) pp. 1-41.

DE JERSEY, N. J. and HAMILTON, M., 1967. Triassic spores and pollen grains from the Moolayember Formation. *Publs geol. Surv. Qd.* 336 (Pal. pap. no. 10) pp. 1-61.

——— 1969. Triassic microfloras from the Wandoan Formation. *Rep. geol. Surv. Qd.* 31: 1-30.

DELANEY, P. J. V. and GONI, J. C., 1964. Correlation of Gondwanic rocks of Uruguay and Rio Grande do Sul, Brazil. In: *International geological congress. Report of* *the twenty-second session, India. Part 9. Gondwanas.* Calcutta, R. K. Sundaram, 1964, pp. 111-122.

DETTMANN, M. E., 1961. Lower Mesozoic megaspores from Tasmania and South Australia. *Micropaleontology* 7 (1): 71-86.

DE WIT, H. C. D., 1966. The Higher Plants I, Thames and Hudson, London. 335p. illus.

DICKINS, J. M., 1969. Geological history of the Bowen basin. In: *Geological society of Australia, field conference, 6th Queensland, 1969. Mineral resources of Central Queensland.* Queensland, Geological society of Australia. pp. 13-16.

DOUGLAS, J. S., 1969. The Mesozoic floras of Victoria. Parts 1 and 2. *Mem. geol. Surv. Vict.* 28: 1-310.

DRYSDALL, A. R. and KITCHING, J. W., 1963. A re-examination of the Karroo succession and fossil localities of part of the Upper Luangwa Valley. Northern Rhodesia. *Memoir of the geological survey,* no. 1, 62p.

DUN, W. S., 1909. Notes on fossil plants from Lower Mesozoic strata, Benolong, Dubbo district. *Rec. geol. Surv. N.S.W.* 8 (4): 311-317.

——— 1910. Notes on some fossil plants from the roof of the coal seam in the Sydney Harbour Colliery. *J. Proc. R. Soc. N.S.W.* 44: 615-619.

——— 1911. Note on the occurrence of *Taeniopteris* in the roof of the coal seam in the Sydney Harbour Colliery. *J. Proc. R. Soc. N.S.W.* 45: 554-555.

DU TOIT, A. L., 1927. The fossil flora of the Upper Karroo beds. *Ann. S. Afr. Mus.* 22 (2): 289-420.

——— 1932. Some fossil plants from the Karroo system of South Africa. *Ann. S. Afr. Mus.* 28 (4): 369-393.

ELLENBERGER, F., ELLENBERGER, P. and GINSBURG, L., 1967. The appearance and evolution of dinosaurs in the Trias and Lias: a comparison between South African Upper Karroo and Western Europe based on vertebrate footprints. In: *Gondwana stratigraphy, 1st I.U.G.S. sumposium, Buenos Aires.* Paris, Unesco, 1969. pp. 333-354.

ELLIOT, D. H., 1970. Mesozoic volcanic rocks of the Beardmore glacier area, Antarctica. In: *Proc. 2nd I.U.G.S. symposium on Godńdwana stratigraphy and palaeontology, Cape Town and Johannesburg:* ed. by S. H. Haughton. Pretoria, C.S.I.R.

ELLIOT, D. H., COLLISON, J. W. and POWELL, J. S., 1970. Stratigraphic setting of the Triassic vertebrates of Antarctica. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*: ed. by S. H. Haughton. Pretoria, C.S.I.R. 12p.

EVANS, P. R., 1964. A correlation of some deep wells in the North-Eastern Eromanga Basin, Central Queensland. *Australia Bureau of mineral resources, geology and geophysics. Records: 1964/197* (unpublished report) 12 p.

——— 1966a. Mesozoic stratigraphic palynology in Australia. *Australas. Oil Gas J..* 12 (6): 58-63.

——— 1966b. Palynological studies in the Longreach, Jericho, Galilee, Tambo, Eddstone and Taroom 1: 250 000 Sheet areas, Queensland. *Australia Bureau of mineral resources, geology and geophysics. Records: 1966/61.* (unpublished report). 31 p.

——— 1966c. Palynological comparison of the Cooper and Galilee basins. *Australia Bureau of mineral resources, geology and geophysics. Records: 1966/222,* (unpublished report) 16 p.

——— 1967. Upper Carboniferous and Permian palynological stages and their distribution in Eastern Australia. In: *Gondwana stratigraphy, 1st I.U.G.S. symposium, Buenos Aires.* Paris. Unesco. 1969. pp. 41-54.

FABRE, J. and GREBER, C., 1960. Présence d'un *Dictyophyllum* dans la flore Molteno du Basutoland (Afrique australe). *Bull. Soc. géol. Fr.* 7 (2): 178-182.

FEISTMANTEL, O., 1882. The fossil flora of the Gondwana system: flora of the South Rewah Gondwana Basin. *Mem. geol. Surv. India Palaeont. indica.* Ser. *XII,* 4 (1): 1-52.

——— 1889. Übersichtliche Darstellung der Geologisch-Palaeontologischen Verhältnisse Sud-Afrikas. Th. 1: Die Karroo-Formation und die dieselbe unterlagernden Schichten. *Abh. K. Bohm. Ges. Wiss. Prague* 7 (3): 1-89.

——— 1890. The geological and palaeontological relations of the coal and plant bearing beds of Eastern Australia. *Mem. geol. Surv. N.S.W. (palaeont).* 3: 1-85.

FLORES, G., 1970. Suggested origin of the Mozambique Channel. *Trans. geol. Soc. S. Afr.* 73 (1) 1-16.

FOSSA-MANCINI, E., 1937. La formacion continental de Paso Flores en el Rio Limay. *Notas Mus. La Plata (Geologia)* 2 (3): 89-96.

FOSTER, A. and GIFFORD, E. M., 1959. Comparative morphology of vascular plants. W. H. Freeman and company, San Francisco and London. 555p. illus.

FOURIE, S., 1962. Notes on a new Tritylodontid from the Cave Sandstone of South Africa. *Navors nas. Mus., Bloemfontein* 2 (1): 7-19.

FOX, C. S., 1931. The Gondwana system and related formations. *Mem. geol. Surv. India* 58: 1-241.

FRAKES, L. A. and CROWELL, J. C., 1969. Late Paleozoic glaciation: 1. South America. *Bull. geol. Soc. Am.* 80: 1007-1042.

FRENGUELLI, J., 1941a. *Dicroidium Stelznerianum* (Gein.) n. comb. *Notas Mus. La Plata Palaeontologia* 6 (33): 393-403.

——— 1941b. Sobre *Cycadocarpidium andium.* n. sp. del rético de Cacheuta Mendoza. *Notas Mus. La Plata* Palaeontologia 37: 486-498.

——— 1941c. Algo mas sobre *Cycadocarpidium* del rético de Mendoza. *Notas Mus. La Plata* Palaeontologia 39: 537-544.

——— 1942. Contribuciones al conocimiento de la flora del Gondwana superior en la Argentina. I-X. *Notas Mus. La Plata.* Palaeontologia 7 (42-51): 265-353.

——— 1943a. Contribuciones al conocimiento de la flora del Gondwana superior en la Argentina XI–XIV. *Notas Mus. La Plata* Palaeontologia 8 (57-60): 401-430.

——— 1943b. Resena crítica de los géneros atribuidos a la "Serie de *Thinnfeldia*" *Revta Mus. La Plata* n.s. Palaeontologia 2: 225-342.

——— 1944a. Las especies del género "Zuberia" en la Argentina. *An. Mus. La Plata* n.s. Palaeontologia Sec. B. 1: 1-30.

——— 1944b. Contribuciones al conocimiento de la flora del Gondwana superior en la Argentina. XV–XX. *Notas Mus. La Plata* Palaeontologia 9 (63-68): 271-420.

——— 1944c. Contribuciones al conocimiento de la flora del Gondwana superior en la Argentina. XXI–XXXI. *Notas Mus. La Plata* Palaeontologia 9 (70-80): 479-568.

——— 1946. Contribuciones al conocimiento de la flora del Gondwana superior en la Argentinia. XXXIII. *Notas Mus. La Plata* Palaeontologia 11 (87): 100-127.

——— 1947. El género "*Cladophlebis*" y sus representantes en la Argentina. *An. Mus. La Plata* n.s. Palaeontologia Sec. B. 2: 1-74.

——— 1953. Recientes progresos en el conocimiento de la Geología y la Paleogeografia de Patagonia Basados sobre el estudio de sus Plantes fósiles. *Revta Mus. Uni. Eva Peron Geologiá* 4: 321-341.

FUENZALIDA VILLEGAS, H., 1937. El retico en la costa de Chile central. *Departmento de Mineralogia é Petroleo Ministerio de Fomento, Chile.* pp. 1-11.

GEINITZ, H. B., 1876. Ueber rhätische Pflanzen und Thierreste in den argentinischen Provinzen, La Rioja, San Juan, und Mendoza. *Palaeontographica,* Suppl. 3: 1-14.

GEOLOGICAL SOCIETY OF LONDON, 1964. Phanerozoic time-scale 1964. *Q. Jl geol. Soc. London.* 120s: 260-262.

GHOSH, P. K. and BANDYOPADHYAY, S. K., 1967.

Palaeogeography of India during the Lower Gondwana times. In: *Gondwana stratigraphy, 1st I.U.G.S. symposium, Buenos Aires.* Paris, Unesco, 1969, pp. 523-536.

GHOSH, P. K. and MITRA, N. D., 1970. A review of recent progress in the studies of the Gondwana of India. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*, ed. by S. H. Haughton. Pretoria, C.S.I.R.

GINSBURG, L., 1962. *Likhoelia ellenbergeri*, Tritylodonte du Trias superieur du Basutoland (Afrique du Sud). *Annls. Paleont.* 48, 179-194.

GORDON, M. and BROWN, R. W., 1952. Plantas Triassicas do sol do Brazil. I: Estudos preliminiares. *Notas prelim. Estud. Div. Geol. Miner Bras.* 54: 1-7.

GOTHAN, W., 1925. Sobre restos de plantas fósiles procedentes de la Patagonia. Con un apendice: Plantas réticas de Marayes. (Prov. de San Juan.) *Boln Acad. nac. Cienc. Córdoba* 27: 197-212.

GOUBIN, N., 1965. Description et repartition des principaux pollenites Permiens, Triasiques et Jurassiques des sondages du Bassin de Morondava (Madagascar). *Revue Inst. fr. Pétrole.* 20 (10): 1415-1420.

GOW, C. E., 1971. The morphology and relationships of the Millerosauria. Thesis for M.Sc. (Palaeontology). The University of the Witwatersrand.

GOW, C. E., 1971. (pers. comm.) Bernard Price Institute for Palaeontological Research, Witwatersrand University, Johannesburg.

GREGORY, J. T., 1957. Significance of fossil vertebrates for correlation of late Triassic continental deposits of North America. In: *International geological congress 20th, Mexico. Sec. II. El Mesozoico del Hemisferio occidental y sus Correlaciones Mundiales.* Mexico, Editorial stylo, 1957, pp. 7-25.

HALE, G. E., (In Spry and Banks) 1962. Triassic System. *J. geol. Soc. Aust.* 9 (2): 217-231.

HALSTEAD, L. B., (Tarlo) 1967. Triassic reptiles from the shores of Tethys. *Publs. Syst. Ass.* 7: 103-109.

HALSTEAD, L. B., (Tarlo) 1970. The northern shore of Gondwanaland in Tunisia. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*; ed. by S. H. Haughton. Pretoria, C.S.I.R.

HALSTEAD, L. B. (Tarlo) and STEWART, A. D., 1970. Middle Triassic reptiles from southern Tunisia. *Proc. geol. Soc.* 1662: 19-25.

HARRINGTON, H. J., 1970. Recent advances in the study of the Beacon supergroup in the Trans-antarctica mountains. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*, ed. by S. H. Haughton. Pretoria, C.S.I.R.

HARRIS, W. K. and LUDBROOK, N. H., 1966. Occurrence of Permian sediments in the Eucla basin, South Australia. *Quarterly geological notes.* Geological Survey of South Australia 17: 11-14.

HAUGHTON, S. H., 1925. Investigations in South African fossil reptiles and amphibia. Pt. 13: Descriptive catalogue of the Amphibia of the Karroo system. *Ann. S. Afr. Mus.* 22 (1): 227-261.

——— 1963. *The stratigraphic history of Africa south of the Sahara.* Edinburgh, Oliver and Boyd. 365p.

——— 1969. *Geological history of southern Africa.* Chapt. 13: *Karroo system.* Cape Town, Geological society of South Africa. pp. 348-415.

HAUGHTON, S. H. and BRINK, A. S., 1954. A bibliographical list' of reptilia from the Karroo beds of Africa. *Palaeont. afr.* 2: 1-187.

HAUTHAL, R., 1892. Nota sobre un nuevo género de Filiceos de la Formation Rhetica del Challao. *Revta Mus. La Plata* 4: 221-223.

HELBY, R., 1970. *A biostratigraphy of the late Permian and Triassic of the Sydney Basin.* Unpublished thesis for Ph.D. (Geology). The University of Sydney.

HELBY, R. and MARTIN, A. R. H., 1965. *Cyclostrobus* gen. nov. cones of lycopsidean plants from the Narrabeen group (Triassic) of New South Wales. *Aust. J. Bot.* 13: 389-404.

HELBY, R. J. and McELROY, C. T., 1969. Microfloras from the Devonian and Triassic of the Beacon group. Antarctica. *N.Z. Jl Geol. Geophys.* 12 (2 and 3): 376-382.

HERBST, R., 1963. *Chansitheca argentina* n.sp. del Triasico superior de Santa Cruz, Patagonia. *Ameghiniana* 3 (4): 108-112.

——— 1965. Algunos esporomorfos del Triásico de Argentina. *Ameghiniana* 4 (5): 141-152. Text in Spanish, abstract in English.

HILL, D., 1930. The stratigraphical relationship of the shales about Esk to the sediments of the Ipswich basin, *Proc. R. Soc. Qd.* 41 (14): 162-190.

HIND, M. C. and HELBY, R. J., (In Packham) 1969. The Great Artesian Basin in New South Wales. *J. geol. Soc. Aust.* 16 (1): The geology of New South Wales: 481-497.

HOWIE, A. A., 1970. A new capitosaurid labyrinthodont from East Africa. *Palaeontology* 13 (2): 210-253.

JACOB, K. and JACOB, (MRS.) C., 1950. A preliminary account of the structure of the cuticles of *Dicroidium-Thinnfeldia* fronds from the Mesozoic of Australia. *Proc. natn. Inst. Sci. India* 16: 101-126.

JAIN, R. K., 1968. Middle Triassic pollen grains and spores from Minas de Petroleo beds of the Cacheuta formation (Upper Gondwana), Argentina. *Palaeontographica* Abt. B. 122 (1-3): 1-47.

JAIN, R. K. and DELEVORYAS, T., 1967. A middle Triassic flora of the Cacheuta formation from Minas de Petroleo, Argentina. *Palaeontology* 10 (4): 564-589.

JEKHOWSKY, B. de and GOUBIN, N., 1964. Subsurface palynology in Madagascar: a stratigraphic sketch of the Permian, Triassic and Jurassic of the Morondava basin. *A.A.P.G. publications.* pp. 116-130.

JOHNSON, W., 1960. Exploration for coal, Springfield basin in the Hundred of Cudla-Mudla, Gordon-Cradock district. *Rep. geol. Surv. S. Aust.* 16: 1-62.

JOHNSTON, R. M., 1888. *A systematic account of the geology of Tasmania.* Hobart, Government printer. 408p. plates.

——— 1896. Further contributions to the history of the fossil flora of Tasmania. Part 2. *Pap. Proc. R. Soc. Tasm.* for 1895: 57-63.

JONES, O. A. and DE JERSEY, N. J., 1947. The flora of the Ipswich coal measures—morphology and floral succession. *Pap. Dep. Geol. Univ. Qd.* n.s. 3 (3): 1-88.

KEYSER, A. W., 1969. A re-evaluation of the systematics and morphology of certain Anomodont Therapsida. *Thesis for Ph.D. (Palaeontology).* The University of the Witwatersrand.

——— 1970. Some ecological aspects of the Cistecephalous zone of the Beaufort series of South Africa. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*; ed. S. H. Haughton. Pretoria, C.S.I.R.

——— (in press) Preliminary study of the type area of the *Cistecephalus* zone of the Beaufort series, South Africa and a revision of the Anomodont family, Cistecephalidae. *Trans. geol. Surv. S. Afr.*

KITCHING, J. W., 1957. A new small Stereospondylous Labyrinthodont from the Triassic beds of South Africa. *Palaeont. afr.* 5: 67-82.

——— 1968. On the *Lysirosaurus* zone and its fauna with special reference to some immature Lystrosauridae. *Palaeont. afr.* 9: 61-76.

——— 1970. A short review of the Beaufort zoning in South Africa. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*: ed. by S. H. Haughton. Pretoria, C.S.I.R.

KITCHING, J. W., 1971. (pers. comm.) Bernard Price Institute for Palaeontological Research, Witwatersrand University, Johannesburg.

KREBS, B., 1969. *Ctenosauriscus koeneni* (v. Heune), die

Pseudosuchia und die Buntsandstein-Reptilien. *Eclogae. geol. Helv.* 62 (2): 697-714.

KREMP, G. O. W. and METHVIN, J. G. 1969. Computer Techniques in Palynology-Palaeobotany can stimulate fruitful research on a world scale. In: *J. Sen Memorial Volume*; ed. by H. Santapau et. al Calcutta, J. Sen Memorial Committee and Botanical Society of Bengal. pp. 161-171.

KURTZ, F., 1921. Atlas de plantas fósiles de la República Argentina. *Actas Acad. nac. Cienc. Cordoba* 7 129-158.

KUTTY, T. S. and ROY-CHOWDHURY, T., 1970. The Gondwana sequence of the Pranhita-Godavari valley, India, and its vertebrate faunas. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*: ed. by S. H. Haughton. Pretoria, C.S.I.R.

LACEY, W. S. 1961. Studies in the Karroo floras of Rhodesia and Nyasaland. Pt. 1: A geological account of the plant bearing deposits. *Proc. Trans. Rhod. scient. Ass.* 49 (1): 26-53.

LANGE, F. W., 1970. (pers. comm.) Petróleo Brasileiro S.A. Caixa Postal 809. Rio de Janeiro—Brazil.

LEHMAN, J. P., 1961. Les Stégocéphales du Trias de Madagascar. *Ann. Paléont.* 47: 111-154.

——— 1965. Les progrès récents de la paleontologie vertébrés du Trias au sud de la Méditerranée. *Israel J. Zool.* 14: 173-184.

——— 1966. Nouveaux Stégocéphales de Madagascar. *Ann. Paléont.* 52 (2): 117-139.

LELE, K. M., 1955. Plant fossils from Parsora in the South Rewa Gondwana basin. *Palaeobotanist* 4:23-34.

——— 1961a. Studies in the Indian Middle Gondwana flora. 1: On *Dicroidium* from the South Rewa Gondwana basin. *Palaeobotanist* 10 (1 and 2): 48-68.

———1961b. Studies in the Indian Middle Gondwana flora. 2: Plant fossils from the South Rewa Gondwana basin. *Palaeobotanist* 10 (1 and 2): 69-83.

——— 1962. Studies in the Indian Middle Gondwana flora. 3: Platyspermic seeds and megaspore impressions from the South Rewa Gondwana basin. *Palaeobotanist* 11 (1 and 2): 13-18.

——— 1969. Studies in the Indian middle Gondwana flora. 5: *Parsorophyllum* gen. nov. from the Parsora beds, South Rewa, Gondwana basin. In: *J. Sen Memorial Volume*; ed. by H. Santapau et. al. Calcutta, J. Sen Memorial committee and Botanical society of Bengal. pp. 313-318.

LELE, K. M. and MAITHY, P. K., 1963. Studies in the *Glossopteris* Flora of India—15. Revision of the epidermal structure of *Noeggerathiopsis* Feistmantel. *Palaeobotanist* 12 (1): 7-16.

LOVERING, J. F. and McELROY, C. T., (In Packham) 1969. Wianamatta group. *J. geol. Soc. Aust.* 16 (1): The geology of New South Wales: 417-423.

McCOY, F., 1847. On the fossil botany and zoology of the rocks associated with the coal of Australia. *Ann. Mag. nat. Hist.* 20 (132): 149-157.

McDOUGALL, I., 1963. Potassium-argon age measurements on Dolerite from Antarctica and South Africa. *J. geophys. Res.* 68 (5): 1535-1545.

McDOUGALL, I. and RUEGG, N. R., 1966. Potassium-argon dates of the Serra Geral formation of South America. *Geoch. Cosmoch. Acta* 30: 191-195.

McELROY, C. T., (In Packham) 1969. The Clarence-Moreton Basin in New South Wales. *J. geol. Soc. Aust.* 16 (1): The geology of New South Wales: 457-468.

MALONE, E. J., 1964. Depositional evolution of the Bowen basin. *J. geol. Soc. Aust.* 11 (2): 263-282.

MANTON, W. I., 1968. The origin of associated Basic and Acid rocks in the Lebombo-Nuanetsi igneous province as implied by Strontium isotopes. *J. Petrology* 9 (1): 23-39.

MENDREZ, C., 1971. (pers. comm.) Laboratoire de Paléontologie Museum National Histoire Naturelle, 8 Rue de Buffon. Paris V^e France.

MENENDEZ, C. A., 1951. La flora Mesozoica de la Formación Llantenes (Provincia de Mendoza). *Revta Inst. nac. Invest. Cienc. nat. Mus. argent. Cienc. nat. Bernardino Rivadavia. Ciencias Botanicas* 2 (3): 147-261.

——— 1957. *Asterotheca hilariensis* sp. nov. del Triasico superior de Hilaria, San Juan. *Amefhiniana* 1 (1—2): 25-30.

MÉSIGOS, M. G. and STIPANICIC, P. N., 1967. Geology of Sierra de Barreal San Juan. In: *1st International symposium on Gondwana stratigraphy and palaeontology. Guidebook no. 1.* Excursion 1, pt. 3. Argentina, Asociacion geologica Argentina. 12p.

MORRIS, J., in Strzelecki, Count, 1845. Physical description of New South Wales and van Diemens land. 422 p. London.

NORRIS, G., 1965. Triassic and Jurassic miospores and acritarchs from the Beacon and Ferrar groups, Victoria Land, Antarctica. *N.Z. Jl Geol. Geophys.* 8 (2): 236-277.

OCHEV, V. G., 1966. Stratigraphic outline of continental Triassic deposits on the Russian platform and the Cisuralian region. *Dokl. Akad. Nauk. S.S.S.R.* 171: 84-86.

ÔISHI, S., 1931. On *Fraxinopsis* Wieland and *Yabeiella* Ôishi, gen. nov. *Jap. J. Geol.* Geogr. 8 (4): 259-267.

OLSON, E. C., 1957. Catalogue of localities of Permian and Triassic terrestrial vertebrates of the territories of the U.S.S.R. *J. Geol.* 65 (2): 196-226.

PARKIN, L. W., comp., 1953. The Leigh Creek coalfield. *Bull, geol. Surv. S. Aust.* 31: 1-74.

PHILLIPS, E. P., 1951. The Genera of South African Flowering Plants. Botanical Survey Memoir No. 25. Government Printer, Pretoria.

PINTO, I. D., 1956. Artrópodos da Formacáo Santa Maria (Triassic Superior) do Rio Grande do Sul, com noticias sôbre alguns restos vegetais. *B. Soc. bras. Geol.* 5 (1): 75-94.

PLAYFORD, G., 1965. Plant microfossils from Triassic sediments near Poatina, Tasmania. *J. geol. Soc. Aust.* 12 (2): 173-210.

PLAYFORD, G. and DETTMANN, M. E., 1965. Rhaeto-liassic plant microfossils from the Leigh Creek. coal measures, South Australia. *Senkenberg. leth.* 46 (2 and 3): 127-181.

PLUMSTEAD, E. P., 1962. Fossil floras of Antarctica. *T.A.E. Scientific reports* 9: 1-154.

RAATH, M. A., 1969. A new Coelurosaurian dinosaur from the Forest Sandstone of Rhodesia. *Arnoldia* (Rhodesia) 4 (28): 1-25.

RAGGATT, H. G., (In Packham) 1969. Macroflora and fauna. *J. geol. Soc. Aust.* 16 (1): The geology of New South Wales: 405—407.

RAO, A. R. and LELE, K. M., 1962. On the cuticle of Dicroidium (*Thinnfeldia*) *Sahnii* (Seward) with some observations on the genera *Thinnfeldia* and *Dicroidium*. *Palaeobotanist* 11 (1 and 2): 7-12.

REISER, R. F. and WILLIAMS, A. J., 1969. Palynology of the Lower Jurassic sediments of the northern Surat Basin, Queensland. *Publs geol. Surv. Qd.* 339 (Pal. pap. no. 15) pp. 1-24.

RIEK, E. F., 1971. (In press.) A review of the Palaeozoic and Mesozoic Insects.

RIEK, E. F., 1971. (pers. comm.) Division of Entomology, CSIRO. Black Mountain, Canberra. A.C.T.

ROBINSON, P. L., 1957. The Mesozoic fissures of the Bristol Channel area and their vertebrate faunas. *J. Linn. Soc.* Zoology 43 (291): 260-282.

——— 1967a. Triassic vertebrates from Lowland and Upland, *Sci. Cult.* 33: 169-173.

——— 1967b. The Indian Gondwana formations—a review. In: *I.U.G.S. Reviews prepared for the first symposium on Gondwana stratigraphy.* Haarlem, Netherlands, I.U.G.S. secretariat, 1967. pp. 201-268.

——— 1971. A problem of faunal replacement on Permo-Triassic continents. *Palaeont.* 14 (1): 131-153.

ROMER, A. S., 1947. Review of the Labyrinthodontia. *Bull. Mus. comp. Zool. Harv.* 99 (1): 1-368.

——————— 1966. *Vertebrate palaeontology*; 3rd ed. Chicago, University of Chicago press. 468p. illus.

——————— 1970. Plenary paper on tetrapod vertebrates and Gondwanaland. In: *Proc. 2nd I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg*; ed. by S. H. Haughton. Pretoria, C.S.I.R.

——————— 1971? (In press.) Title unknown, paper on the genera *Gualosuchus* and *Chanarisuchus* family Proterosuchidae from Ischichuca Fm. Argentina.

ROY-CHOWDHURY, T., 1965. A new metoposaurid amphibian from the Upper Triassic Maleri formation of central India. *Phil. Trans. R. Soc.* Ser. B. Biological sciences, 250 (761) 1-52.

——————— 1970a. Two new dicynodonts from the Triassic Yerrapalli formation of Central India. *Palaeontology* 13 (1): 132-144.

——————— 1970b. A new capitosaurid amphibian from the Triassic Yerrapalli formation of the Pranhita-Godavari valley. *J. geol. Soc. India* 11 (2): 155-162.

RUST, I. C., 1959. *On the sedimentation of the Molteno sandstones in the vicinity of Molteno, C.P.* Thesis for M.Sc. (Geology). The University of Stellenbosch.

RUZHENTSEV, V. E. and SARYCHEVA, T. G., 1968. The development and change of marine organisms at the Palaeozoic-Mesozoic boundary. Part 1; translated by D. A. Brown. *Publications of the Australian National University, Department of Geology.* No. 117: 1-137.

RYAN, P. J., 1963. *Petrology, origin and deposition of the Molteno stage in the Indwe area of the north-eastern Cape Province.* 2v. Thesis for M.Sc. (Geology). The University of the Witwatersrand.

SAKSENA, S., 1952a. Correlation of the Gondwanas based on the evidence of plant fossils. *Agar Unv. J. of Research* 1: 1-13.

——————— 1952b. On a new species of *Phyllotheca* (*P. Sahnii*) from the South Rewa Gondwana Basin, Central India, and its comparison with *P. Etheridgei* from the Newcastle series, New South Wales, Australia. *Palaeobotanist* 1: 409-415.

——————— 1954. Reconstruction of the Vegetative branches of *Phyllotheca* Etheridgei Arber and *P. Sahnii* Saksena. *Palaeobotanist* 3: 51-53.

——————— 1955. On two new species of Samaropsis from the South Rewa Gondwana Basin, Central India. *Palaeobotanist* 4: 73-76.

SAKSENA, S., 1958. On a Bryophytic sporophyte-like structure from the Ganjra nalla beds in the South Rewa Gondwana basin, Central India. *J. Palaeont. Soc. India* 3: 149-150.

——————— 1961. On some fossil plants from Karkati, Kamtadand and Parsora, in the South Rewa Gondwana basin, Central India. *Palaeobotanist* 10 (1 and 2): 91-96.

———————1962. On Fossil Flora of Ganjra nalla bed, South Rewa: Part 1. Macrofossils. *Palaeobotanist* 11 (1 and 2): 23-28.

SATSANGI, P. P., 1964. On the occurrence of *Dicroidium* flora in Sidhi district, Madhya Pradesh. *Curr. Sci.* 33 (18): 556-557.

SATSANGI, P. O., CHANDRA, A. and SINGH, G., 1968. Sporological analysis of the Panchet series and its bearing on the Permian-Triassic transition. *Curr. Sci.* 27: 116-117.

SEWARD, A. C. 1903. Fossil floras of Cape Colony. *Ann. S. Afr. Mus.* 4 (1): 1-122.

——————— 1908. On a collection of fossil plants from South Africa. *Q. Jl geol. Soc. Lond.* 64 (253): 83-108.

——————— 1932. On some fossil plants from the Parsora stage, Rewa. *Rec. geol. Surv. India* 66 (2): 235-243.

SEWARD, A. C. and HOLTTUM, R. E., 1921. On a collection of fossil plants from Southern Rhodesia. *Bull. geol. Surv. Sth. Rhod.* 8: 39-45.

SHIRLEY, J., 1898. Additions to the fossil flora of Queensland, mainly from the Ipswich formation, Trias-Jura system. *Bull. geol. Surv. Qd.* 7: 1-25.

SHRIVASTAVA, R. N. and PAWDE, M. B., 1962. Palynological study of Borehole R.O.l. Ondal, West Bengal. *Rec. geol. Surv. India* 91: 369.

SIEDNER, G. and MILLER, J. A., 1968. K-Ar Age determinations on Basaltic rocks from S.W.A. and their bearing on continental drift. *E. and P.S. Letters* 4 (6): 451-458.

SIGOGNEAU, D., 1970. Revision systématique des Gorgonopsiens Sud-Africains. Paris: *Centre national de la recherche* scientifique. 416p. 93 pls. illus.

SILBERLING, N. J. and TOZER, E. T., 1968. Biostratigraphic classification of the marine Triassic in North America. *Spec. Pap. geol. Soc. Am.* 110: 1-63.

SOLMS-LAUBACH, H. and STEINMANN, G., 1899. Das Auftreten und die Flora der rhätischen Kohlenschichten von La Ternera (Chile). In: Steinmann, G.: Beiträge zur Geologie und Palaeontologie von Südamerika VII. *Neues Jb. Miner. Goel. Paläont.* 12: 581-609.

SOTA, E. R. de la and ARCHANGELSKY, S., 1962. Das nuevas especies de *Asterotheca* de la serie Triasica "El Tranquilo" Provincia de Santa Cruz. *Ameghiniana* 2 (7): 113-119.

SPRY, A., (In Spry and Banks) 1962. The Precambrian rocks. *J. geol. Soc. Aust.* 9 (2):107-126.

SRIVASTAVA, S. C., 1969. Two new species of *Glossopteris* from the Triassic of Nidpur, Madhya Pradesh, India. In: *J. Sen Memorial Volume;* ed. by H. Santapau et al. Calcutta, J. Sen. Memorial committee and Botanical society of Bengal. pp. 299-303.

STIPANICIC, P. N., 1956. El sistema Triasico en la Argentina. In: *International geological congress, 20th Mexico. Sec. II El Mesozoico del hemisferio occidental y sus correlaciones* mundiales. Mexico, Editorial stylo, 1957. pp. 73-105.

——————— 1967. Las Sucesiones Triasicas Argentinas. In: *Gondwana stratigraphy, 1st I.U.G.S. symposium, Buenos Aires.* Paris, Unesco, 1969. pp. 1121-1149.

STIPANICIC, P. N. and BONETTI, M.I.R., 1965. Las especies del género "*Saportaea*" del Triasico de Barreal (San Juan). *Revta Mus. argent. Cienc. nat. Bernardina Rivadavia Inst. nac. Invest. Cienc. nat. Paleontologia* 1 (4): 81-114.

——————— 1967. Consideraciones sobre la Cronologia de los Terrenos Triasicos Argentinos. In: *Gondwana stratigraphy, 1st I.U.G.S. symposium, Buenos Aires.* Paris. Unesco, 1969. pp. 1081-1119.

STIPANICIC, P. N., and MENENDEZ, C. A., 1949. Contribución al conocimiento de la flora fósil de Barreal (Provincia de San Juan). 1: Dipteridaceae. *Boln Infs petrol.* 26 (291): 44-73.

STIPANICIC, P. N., RODRIGO, F., BAULIES, O. L. and MARTINEZ, C. G., 1968. Las Formaciones Presenonianas en el Denominado Macizo Nordpatagonico y Regiones Adyacentes. *Revta Asoc. geol. argent.* 23 (2): 67-98.

STOCKLEY, G. M., 1932. The geology of the Ruhuhu coalfields, Tanganyika Territory. *Q. Jl geol. Soc. Lond.* 88: 610-622.

SURANGE, K. R. and LELE, K. M., 1956. Studies in the *Glossopteris* Flora of India–6. Plant fossils from Talchir beds of South Rewa Gondwana Basin. *Palaeobotanist* 5 (1): 82-90.

SZAJNOCHA, L., 1888. Über fossile Pflanzenreste aus Cacheuta in der Argentinischen Republik. *Sber. Akad. Wiss. Wien.* Mathematisch-naturwissenschaftliche Klasse. 97: 219-245.

TARLO, L. B., (See Halstead, L. B.)

TENISON-WOODS, J. E., 1883. On the fossil flora of the coal deposits of Australia. *Proc. Linn. Soc. N.S.W.* 8: 1-131.

THOMAS, H. H., 1933. On some pteridospermous plants from the Mesozoic rocks of South Africa. *Phil. Trans. R. Soc.* Ser. B. Biological sciences, 222: 193-265.

——————— 1952. A *Glossopteris* with whorled leaves. *Palaeobotanist* 1: 435-438.

——— 1955. Mesozoic pteridosperms. *Phytomorphology* 5: 177-185.

——— 1958. *Lidgettonia*, a new type of fertile Glossopteris. *Bull. Br. Mus. nat. Hist. Geology* 3: 179-189.

THULBORN, R. A., 1970. The skull of *Fabrosaurus australis*, a Triassic ornithischian dinosaur. *Palaeontology* 13 (3): 414-432.

TOWNROW, J. A., 1955. On some species of *Phyllotheca. J. Proc. R. Soc. N.S.W.* 89: 39-63.

——— 1956. The genus *Lepidopteris* and its southern hemisphere species. *Avh. norske Vidensk. Akad. Oslo. Mat.–Naturv. Klasse.* 2: 1-28.

——— 1957. On *Dicroidium*, probably a pteridospermous leaf, and other leaves now removed from this genus. *Trans. geol. Soc. S. Afr.* 60: 1-36.

——— 1959. Two Triassic Bryophytes from South Africa. *Jl S. Afr. Bot.* 25: 1-22.

——— 1960. The Peltaspermaceae, a pteridosperm family of Permian and Triassic age. *Palaeontology* 3 (3): 333-361.

——— 1962a. On *Pteruchus*, a microsporophyll of the Corystospermaceae. *Bull. Br. Mus. nat. Hist.* Geology 6 (2): 289-320.

——— 1962b. Note on the type material of *Xylopteris elongata* (Carruthers) Frenguelli. *Pap. Proc. R. Soc. Tasm.* 72 (10): 123-127.

——— (In Spry and Banks) 1962c. Palaeontology (Triassic System). In: *J. geol. Soc. Aust.* 9 (2): 224-231.

——— 1966a. On *Dicroidium odontopteroides* and *D. obtusifolium* in Tasmania. In: *Symposium on floristics and stratigraphy of Gondwanaland, India.* Lucknow, Birbal Sahni institute of palaeobotany, 1964. pp. 128-136.

——— 1966b. On *Lepidopteris madagascariensis* Carpentier (Peltaspermaceae). *J. Proc. R. Soc. N.S.W.* 96: 203-216.

——— 1967a. Fossil plants from Allan and Carapace nunataks and from the Upper Mill and Shackleton glaciers, Antarctica. *N. Z. Jl Geol. Geophys.* 10 (2): 456-473.

——— 1967b. On *Rissikia* and *Mataia* podocarpaceous conifers from the Lower Mesozoic of southern lands. *Pap. Proc. R. Soc. Tasm.* 101: 103-136.

——— 1967c. On *Voltziopsis*, a southern conifer of Lower Triassic age. *Pap. Proc. R. Soc. Tasm.* 101: 173-188.

TOWNROW, J. A., 1969. (pers. comm.) Botany Department, University of Tasmania, Hobart.

TOWNROW, J. A. and JONES, J., 1969. On *Pachypteris pinnata* (Walkom) from Tasmania. *Pap. Proc. R. Soc. Tasm.* 103: 63-67.

TOZER, E. T., 1967. A standard for Triassic time. *Bull. geol. Surv. Can.* 156: 1-103.

TURNER, B. R., 1970. Facies analysis of the Molteno sedimentary cycle. In: *Proc. 2nd. I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg.* ed. by S. H. Haughton. Pretoria, C.S.I.R.

WALKER, A. D., 1961. Triassic reptiles from the Elgin area: *Stagonolepis, Dasygnathus* and their allies. *Phil. Trans. R. Soc.* Ser. B. Biological sciences. 244 (709): 103-204.

——— 1964. Triassic reptiles from the Elgin area: *Ornithosuchus* and the origin of carnosaurs. *Phil. Trans. R. Soc.* Ser. B. Biological sciences 248 (744): 53-134.

——— 1969. The reptile fauna of the "Lower Keuper" sandstone. *Geol. Mag.* 106 (5): 470-476.

——— 1970. A revision of the Jurassic reptile *Hallopus victor* (Marsh), with remarks on the classification of crocodiles. *Phil. Trans. R. Soc.* Ser. B. Biological sciences. 257 (816): 323-372.

——— 1971. (Letter.) Department of Geology, The University Newcastle Upon Tyne, NEI 7 RU. England.

WALKOM, A. B., 1917. Mesozoic floras of Queensland. Pt. 1: The flora of the Ipswich and Walloon series. (c) Filicales, etc. *Publs. geol. Surv. Qd.* 257: 1-67.

——— 1924. On fossil plants from Bellevue, near Esk. *Mem. Qd. Mus.* 8 (1): 77-92.

——— 1925a. Notes on some Tasmanian Mesozoic plants. Pt. 1. *Pap. Proc. R. Soc. Tasm. 1924*: 73-89.

——— 1925b, Fossil plants from the Narrabeen stage of the Hawkesbury series. *Proc. Linn. Soc. N.S.W.* 1 (3): 214-224.

——— 1928. Fossil plants from the Esk district, Queensland. *Proc. Linn. Soc. N.S.W.* 53 (4): 458-468.

WARRINGTON, G., 1967. Correlation of the Keuper series of the Triassic by miospores. *Nature, Lond.* 214 (5095): 1323-1324.

WELKAE, H. J. and ALLSOP, H. L., 1971. (pers. comm.) Bernard Price Institute for Geophysical Research, Witwatersrand University, Johannesburg.

WELLES, S. P. and COSGRIFF, J., 1965. A revision of the labyrinthodont family Capitosauridae and a description of *Parotosaurus peabodyi* n.sp. from the Wupatki member of the Moenkopi formation of Northern Arizona. *Univ. Calif. Publs. geol. Sci.* 54: 1-148.

WHITE, M. E., 1965. Report on 1964 plant fossil collections. *Australia. Bureau of mineral resources, geology and geophysics. Records*: *1965/101.* (Unpublished report). 8p.

——— 1966. Report on 1965 plant fossil collections. *Australia. Bureau of mineral resources, geology and geophysics. Records. 1966/111.* (Unpublished report) 10p.

——— 1969. Report on the 1968 collection of plant fossils from Moolayember and Teviot formations. *Australia. Bureau of mineral resources, geology and geophysics. Records*: *1969/51.* (Unpublished report) 13p.

WOPFNER, H., 1970. Permian paleogeography and depositional environment of the Arctaringa basin, South Australia. In: *Proc. 2nd. I.U.G.S. symposium on Gondwana stratigraphy and palaeontology, Cape Town and Johannesburg;* ed. by S. H. Haughton. Pretoria, C.S.I.R.

YRIGOYEN, M. R., 1967. Geology of the Triassic formations of Northern Mendoza area. In: *1st International symposium on Gondwana stratigraphy and palaeontology. Guidebook no. 1.* Excursion 1, pt. 1. Argentina, Asociacion geologica Argentina. 13p.

ZEILLER, R., 1911. Sur une flore Triasique découverte à Madagascar par M. Perrier de la Bâthie. *C. r. hebd. Séanc. Acad. Sci., Paris.* 153: 230-235.

ZEUNER, F. E., 1960. A Triassic Insect Fauna from the Molteno beds of South Africa. *Int. Kongress Entomologie, Wien.* 1 (1-4): 304-306.

GEOLOGICAL MAPS

AFRICA (Tectonic map) 1968. International tectonic map of Africa. Paris, A.S.G.A. and Unesco. *Scale*: 1:5 000 000.

ANTARCTICA (geology map folio series) 1969–1970. Geological maps of Antarctica. Folio 12; ed. by V. C. Bushnell. American Geographical Society, New York. *Scale*: 23 maps various scales.

AUSTRALIA (Geology map) 1966. Atlas of Australian resources, second series. Canberra, Resources information and development branch. Dept. of national development. *Scale*: 1:6 000 000 or 94.7 miles = 1 inch. Simple conic projection with 2 standard parallels.

BOWEN BASIN (Geology map) 1967. Geological map, Bowen Basin, Queensland. Canberra, Bureau of mineral resources, geology and geophysics. *Scale*: 1:500 000.

CARNARVON BASIN (Western Australia) (Geology map) 196?. Geological map of Carnarvon basin Western Australia. Canberra, Bureau of mineral resources, geology and geophysics. *Scale*: 1:500 000.

INDIA (Geology map) 1949. Geological map of India. Calcutta, Geological survey of India. *Scale*: 1 inch = 96 miles.

INDIA (Geology map) 1962. Geological map of India. Calcutta, Geological survey of India. (Publ. 1963.) *Scale*: 1:5 000 000 or 1 millimetre = 5 kilometres.

MADAGASCAR (Geology map) 1964. Madagascar carte géologique. Tananarive, Service géologique de Madagascar (Publ. 1965.) *Scale*: 1:1 000 000. Projection conforme Laborde.

SOUTH AFRICA (Geology map) 1970. Geological map of the Republic of South Africa and the Kingdoms of Lesotho and Swaziland. Pretoria, Government printer. *Scale*: 1:1 000 000.

SOUTH AMERICA (Geology map) 1964. Carte géologique de l'Amerique du sud. Rio de Janeiro, Impresso sobos auspicios do Conselho nacional de Pesquisas. *Scale*: 1:5 000 000.

SOUTH AUSTRALIA (Geology map) 1953. Geological map South Australia. Adelaide, Geological survey of South Australia. *Scale*: 1 inch = 32 miles.

SOUTHERN RHODESIA (Geology map) 1961. Provisional geological map of Southern Rhodesia, rev. ed. Salisbury, Geological survey office. *Scale*: 1:1 000 000 or 15.78 miles = 1 inch.

TASMANIA (Geology map) 1961. Geological map of Tasmania. Hobart, Geological survey of Tasmania. *Scale*: 1:506 880. Transverse Mercator projection.

WESTERN AUSTRALIA (Geology map) 1966. Geological map of Western Australia. Perth, Geological survey of Western Australia. *Scale*: 1:2 500 000. Regtangular polyconic projection.

G. NOTES ADDED AT PROOF STAGE.

NOTE 1.

Discussion on the radiometric age of the Permian Triassic boundary. (See page 4, left hand column)

WEBB, A. W., 1968. Isotopic age determinations in Queensland and their relation to the geochronological time scale for the Permian. *Spec. Publs. geol. Soc. Aust.* 2: 113-116.

Webb (1968) comments on the age of 225 m.years derived by Smith (1964) for the Permian-Triassic boundary as follows–

"Granites from the New England area of New South Wales had, according to Smith (1964), K-Ar mineral dates ranging from 250 to 225 m.yrs. The younger date was taken to be pre-Narrabeen, and as the Narrabeen was considered to be post-Permian, an age of 225 m.yrs. was suggested as being a close approximation to the Permian-Triassic boundary. However, the granite which gave the 225 m.yrs. date could on stratigraphical evidence, be as young as Early Jurassic."

Webb (1968) arrives at an age of 230-235 m.yrs. for the Permian-Triassic boundary as follows–

"Three distinct periods of granitic emplacement occurred in Queensland within the Permian: 265 m.yrs., 245 m.yrs. and 235 m.yrs. ago. The ages are fairly precisely known because of the large number of analyses made on these rocks." The 235 m.yrs. granitic emplacement was by far the most significant and is presumed associated with an extensive belt of uplift along the Eastern flanks of the Bowen and Sydney Basins. "Contemporaneous with this was the initial down-warping of the Mimosa Syncline and the localising of the main deposition of the Rewan Fm. in this area. If the granite emplacement along this belt of uplift can be correlated with the time of uplift and with the commencement of deposition of the Rewan Fm., [Rewan Fm. deposition is presently regarded as having began in the uppermost Permian–see relevant charts] then the age of the Permian-Triassic boundary must be close to 230-235 m.yrs."

NOTE 2.

Chart 21. Discussion on the radiometric ages of the lavas (and feeders) of the Lower Jurassic.

FITCH, F. J. and MILLER, J. A., 1971. (In Press). Potassium-argon radioages of Karroo volcanic rocks from Lesotho. *Bull. volcan.* 35:

Drakensberg lavas.

Fitch and Miller (1971) present age determinations (K-Ar; whole rock) on 8 Drakensberg lava samples and 8 Karroo dolerite (sills and dykes) samples. All eight lava samples occurred in the lower 1 200′ of the total pile of ± 4 500′ of lavas. The results indicate that this whole thickness (i.e. of 1 200′) is of much the same age, namely 187 ± 9 m.yrs. Of the 8 dolerite samples,

1 gave an age of 186 ± 7 m.yrs.
3 gave ages of 160–162 m.yrs.
4 gave ages of ± 155 m.yrs.

South Lebombo and Bubye/Lower Sabi Coalfields area.

Fitch and Miller (1971), after mathematically re-calculating Manton's (1968) ages get the following results.

	Manton (1968)	**Fitch & Miller (1971)**
8 extrusives	202 ± 14 m.yrs.	191 ± 13 m.yrs.
12 intrusives	177 ± 7 m.yrs.	167 ± 7 m.yrs.
4 extrusives	206 ± 14 m.yrs.	194 ± 12 m.yrs.

NOTE 3.

Chart 19. India. South Rewa Basin–Parsora Beds–Macroflora. Notes and conclusions regarding the flora.

LELE, K. M., 1964. The problem of middle Gondwana in India. *International geological congress. Report of the twenty-second session, India. Part 9, Gondwanas.* Calcutta, R. K. Sundaram, 1964. pp. 181-202.

In writing points (c) and (d) under the above heading we unfortunately (in error) overlooked Lele's 1964 paper.

He tentatively concludes that localities 1–8 belong to the 'Panchet Stage' (= 'Daigaon Stage') and are of Lower Triassic age; that localities 9–16 (and possibly 17–20) belong to the Parsora Stage and are of Middle to Upper Triassic age; and that locality 21 belongs to the Tiki Stage (Lower part) and is of Triassic age.

Our conclusions (given in point 2) are not affected by this reference.

NOTE 4.

Chart 22. See Map of India (Son Valley Basins).

The Triassic outcrop area (including the 'Parsora' etc. plant localities) has been incorrectly located. The area should remain ± the same shape and size as indicated but shifted 2/3 the way across the Permian trough towards the word 'SON'.