

birds. The stimulating effect of song of one male on the singing of other males is well known both from natural observations and from play-back experiments^{9,10}. The increase in song B in dense populations after the first of June may result from the fixation of territorial boundaries and the resulting relative decline in situations of territorial interaction and situations where a male is on "uncertain" ground.

Observations of the contexts of the two song types, and particularly of the situations in which switching from one to the other occurs, suggest that the song types represent segments of a motivational continuum. This would suggest in turn that their function is rather similar. The function of territorial displays is to defend an area without resorting to physical encounters. The existence of more than one territorial display (such as different song types) allows the recipients to determine the activities and emotional state of the displaying males more precisely from a distance and to discriminate more finely in their responses. This would mean, for example, that there would be no reason to chase and fight to determine the position of a neighbouring male's territorial boundary.

At the same time there is nothing in such a situation to prevent both song types serving another function in mate attraction and pair-bond formation and maintenance, for the meanings of the displays depend on the classes of recipients.

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Phytogeographical Classification of Mesozoic Floras and their Bearing on Continental Drift

ALTHOUGH much palaeobotanical work has focused on Palaeozoic plant geography there have been few attempts to classify Mesozoic taphofloras. The Jurassic flora was thought to be uniform all over the world though Oswald Heer showed that the Siberian Jurassic vegetation (contrary to the contemporaneous European vegetation) had been dominated by the *Ginkgo* allies¹. Nathorst referred to the Mesozoic flora of Siberia and Arctic islands as "Phoenicopsis flora", and Prynada proposed the designation "Siberian" or "Phoenicopsis" flora for this type of Mesozoic vegetation. Vakhrameev^{2,3} coined the term "Indo-European floristic province" for the rest of Eurasian taphofloras of this age, uniting two floristic regions (India and Europe) of rather different aspect. I propose the following phytogeographical classification.

First, the Arctomesozoic or *Phoenicopsis* flora include the Siberian province of Prynada, Alaska, western Canada⁴ and

western Greenland⁵. One of the dominant genera of this flora was *Phoenicopsis*, a gymnospermous plant of Czekanowskian affinities. *Phoenicopsis* flora is supposed to be approximately equivalent to the temperate forest zone.

Second, there are the Madromesozoic or *Cycadeoidea* flora. The richest localities of *Cycadeoidea* and its allies (Monanthesia, but not the leptocaul bennettites which are widespread in all geofloras) are confined to the Black Hills of Dakota, the Freezeout Hills of Wyoming and north-western New Mexico^{6,7} not far from the area where Axelrod established his Madrotertiary flora⁸. The *Cycadeoidea* flora is well represented also in the European Jurassic and after considerable interval appears in India, Mongolia and Japan⁹. It is absent in the *Phoenicopsis* zone. The difference between these two zones seems to be vegetational as well as floristic. The Madromesozoic zone probably comprised the treeless areas of profuse growth of small pachycaul plants exposed to pronounced aridity, although most of the region was covered with conifer forests.

Third, there is the Notomesozoic or *Pentaxylon* flora. The *Pentaxylales* had been described from the Indian localities. They were identified in some southern hemisphere taphofloras, but never in the northern hemisphere apart from India. Their status in the southern floras was analogous to that of Czekanowskiales in the northern floras. Thus, the strong southern affinity of the Mesozoic Indian flora is evident.

The classification proposed here is relevant to the theory of continental drift. The fossil floras of peninsular India retained their southern affinity up to the Eocene¹⁰. The change of floristic composition of this area coincides with its supposed collision with Asia as the result of either anticlockwise rotation or the strike-slip along the transform faults¹¹. Thus, the palaeofloristic evidence agrees with the plate tectonic version of Indian plate history.



Fig. 1 Scheme of the Mesozoic geofloras.

Reservations must be made as to the other implications of continental drift. Some authors are inclined to explain all disjunct distributions, for example, distribution of the Proteaceae and other angiosperm groups, as the consequence of predrift (Triassic) arrangement of the southern continents¹². Such suggestions do not agree with the fossil record. No angiosperms were found in the southern taphofloras until the end of the Early Cretaceous. The similarities demonstrated between the Palaeozoic *Glossopteris* floras of Gondwana persist after the breakup in the post-drift late Mesozoic floras of this region. It seems that the floristic continuum was not greatly affected by the first stages of expansion due to successful migrations across the land bridges and/or "stepping stones". The Gondwana concept is not necessary for the explanation of all floristic connexions of the southern continents.

According to the plate tectonic theory, the lithosphere is consumed in the trenches bordering the Pacific Ocean, the consumption being superior to the crust accretion along the Pacific ridges. If the Atlantic Ocean is expanding, "it is axiomatic that another major ocean (Pacific) is contracting"¹³. If we accept this we might presume that the floras on opposite sides of the Pacific ocean have been more dissimilar in the Palaeozoic than they were in fact¹⁴. The *Cycadeoidea* flora is represented on both Asiatic and American margins of the

Pacific Ocean. There is a considerable gap in the fossil record of Cycadeoidea between Europe and Central Eastern Asia and the Cycadeoideas from Mongolia and Japan are probably of American origin. Migration across the Bering land bridge is excluded because the northern parts of Asia and America were occupied by the Arctomesozoic flora.

There is a striking parallel between the distribution of Cycadeoidea and horned dinosaurs, the latter being represented only in Mongolia and western North America¹⁵. According to Colbert, the horned dinosaurs crossed the Pacific Ocean but were incapable of surmounting the Lance Sea—a narrow strip of water. Migration along the Bering bridge is also doubtful because of climatic barrier.

These facts enable us to suggest the migration route across the Mesozoic Pacific Ocean at middle latitudes. This means a much narrower, not wider Pacific. It follows that the Pacific as well as Atlantic area was expanding at the end of Mesozoic time, the difference being probably not in the amount or crust accretion but in the arrangement of rise systems. While the true mid-ocean rise was active in the Atlantic Ocean, the asymmetrical seafloor spreading (half cell stile of spreading) took place along the margins of Pacific¹³.

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Revised Radiocarbon Chronology for the Stone Age in South Africa

SEVERAL radiocarbon dates have recently become available which necessitate a rather drastic revision of the chronology of the Stone Age south of the Limpopo River¹. An important consequence of the new time scale is that there is now strong evidence to suggest a very early appearance of *Homo sapiens* in Africa—considerably earlier than in the Middle East and Europe. It thus seems possible to envisage the continent of Africa as the area where much of modern man's early evolutionary development took place.

The first radiocarbon time scale for southern Africa was proposed in 1959 by J. D. Clark², who estimated that the Middle Stone Age (MSA) lasted from 38,000 BC to 6,000 BC, and that the Later Stone Age (LSA) postdated 6,000 BC. The only major subsequent modification of this scheme has been the shifting of the LSA/MSA interface back to about 10,000 BC³. When radiocarbon dates of greater than 50,000 years

were obtained for the MSA^{4,5}, however, the validity of the prevailing chronology was doubted, and these doubts have recently been confirmed by readings of earlier than 20,000 BC for LSA aggregates at three widely separated localities.

We have here, purely for present purposes, introduced various new terms, which are identified by means of quotation marks.

The LSA is usually defined in terms of the presence of flakes with plain striking platforms, partly produced by means of a punch technique⁶. The most consistent artefact classes are various convex scraper types, scaled pieces and bone points. Our analysis of the stratigraphic and dating evidence indicates that it is possible to subdivide the LSA into two major temporal phases, namely an "Early LSA" and a "Late LSA", equated typologically with the Upper Palaeolithic and Mesolithic of Western Europe, respectively.

The MSA, on the other hand, is distinguished by the occurrence of flakes with faceted butts, and the consistent, but not necessarily dominating, presence of flake points shaped either by convergent dorsal flaking or by lateral trimming⁶. Stratigraphic evidence provides proof that the MSA may be envisaged as an unbroken linear development, within which a number of temporal phases can be isolated on arbitrary typological grounds. It may in this way be separated into a "full MSA", representing the MSA proper, and a "final MSA", which would correspond with the now abandoned Second Intermediate.

The following sites have provided key dates for the "Early LSA" and the "final MSA" in South Africa:

(1) Rose Cottage Cave, near Ladybrand in the Orange Free State. At this locality three Wilton levels are successively underlain by a Pre-Wilton stratum, 1.5 m of beige sand containing for the most part a sparse and even older "Early LSA" aggregate and 3.0 m of "final MSA" ascribed to the Magosian^{7,8}. The pertinent dates^{4,5,9} are:

Pta-211	RC	1.35 m base Pre-Wilton	27,480 ± 520 BC
GrN-5300	RC	1.46 m top beige sand	23,690 ± 220 BC
Pta-354	RC	3.25 m base beige sand	> 39,000 BC
Pta-213	RC	3.33 m top Upper Magosian	> 48,250 BC
Pta-214	RC	3.78 m Upper Magosian	> 42,500 BC
SR-116	RC	3.78 m Upper Magosian	> 48,000 BC

These results show clearly that the "Early LSA" must have existed well before 27,500 BC.

(2) Heuningsneskrans Shelter, near Ohrigstad, in the Transvaal. Here 6.4 m of "Early LSA" deposit rest directly on bedrock and underlie surface Iron Age. The basal stratum yielded the following dates⁹:

Pta-114	Hnk.	1.56 m top Stratum 1	8,480 ± 150 BC
Pta-100	Hnk.	2.27 m upper Stratum 1	11,150 ± 110 BC
Pta-101	Hnk.	4.39 m middle Stratum 1	22,680 ± 300 BC

The apparently linear rate of accumulation, when extrapolated, gives a date of about 32,000 BC for the base of Stratum 1.

(3) Border Cave, near Ingwavuma, in Natal. The 1970/71 excavations at this site revealed an "Early LSA" white ash stratum up to 30 cm thick, lying between Iron Age and MSA layers towards the centre of the cave, and elsewhere a "final MSA" of Epi-Pietersburg type overlies the "full MSA"¹⁰. Dates for these levels are:

Pta-422 Ingw.	1.0 m top First White Ash	34,850 ± 1,000 BC
Pta-433 Ingw.	1.1 m middle First White Ash	34,150 ± 900 BC
Pta-424 Ingw.	1.2 m base First White Ash	33,750 ± 1,100 BC
Pta-459 Ingw.	0.4 m base Epi-Pietersburg	> 46,300 BC

(4) Montagu Cave, near Montagu, in the Cape. Here Wilton (Layer 1) is underlain in turn by up to 1.5 m of grey sand containing "final MSA" of Howieson's Poort aspect (Layer 2), and by two Acheulian levels separated by sterile red sand (Layers 3–5). Layer 2 was subdivided into an upper part, with seven surfaces represented by increased artefact