DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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DISCOVERY OF LEPIDOCYCLINA (FORAMINIFERIDA) IN THE EUCLA BASIN

GEOLOGICAL SURVEY

by

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REGIONAL GEOLOGY

and

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BIOSTRATIGRAPHY

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DISCOVERY OF LEPIDOCYCLINA (FORAMINIFERIDA) IN THE EUCLA BASIN

by

M.C. Benbow and J.M. Lindsay

(for proposed Quarterly Note)

ABSTRACT

The large, extinct, benthonic foraminifera Lepidocyclina, with "tropical" affinities, has been found at two localities in Nullarbor Limestone outcropping on the eastern margin of the Eucla Basin. The species is apparently the usual, variable, South Australian species L. howchini Chapman and Crespin. At Seven Mile Swamps, the L. howchini zone is only about 0.2 m thick. Specimens here are rare and small, only 1-2 mm in diameter. At Lake Tallacootra, 70 km to the northwest, the zone is about 1 m thick and specimens are rare to frequent, 1-11 mm diameter, the larger individuals being microspheric, others megalospheric. At both localities the zone is within a metre or two of the local base of Nullarbor Limestone, and is more bryozoal than usual for the formation. There is no reason to doubt that the zone here is a time-correlative of the L. howchini zone in the St Vincent and Murray Basins, representing a regional transgressive/warm water-mass/climatic episode of early Middle Miocene age.

INTRODUCTION

The large (up to centimetre-size), extinct, benthonic foraminifer Lepidocyclina howchini, with "tropical" affinities, is known to occur in South Australia within a relatively thin zone in lower Morgan Limestone of the Murray Basin (Ludbrook, 1957, 1961; Lindsay and Giles, 1973), and in upper Port Willunga

Formation and Melton Limestone of the St Vincent Basin and associated smaller peripheral marine basins (Glaessner, 1953; Ludbrook, 1963; Lindsay, 1969, 1970). The zone is interpreted to represent a regional episode involving transgression, warm water-mass, and climatic optimum (Lindsay, 1976; McGowran, 1979, 1986). This event is now dated early Middle Miocene on the basis of associated Praeorbulina glomerosa curva (Blow) in the Murray Basin (Lindsay and Giles, 1973; compare Berggren, Kent, Flynn and Van Couvering, 1985, fig. 6). For many years it has appeared anomalous that Lepidocyclina was not found in the Eucla Basin, the more so because the large benthonic foraminifer Flosculinella, also with "tropical" affinities, has long been known from the Nullarbor Limestone (Crespin, 1956), and the lower part of this formation had a microfauna which seemed to be at about the stratigraphic level of the L. howchini zone as known elsewhere in South Australia (Lindsay and Harris, 1975, p. 38; McGowran, 1979, fig. 5).

We now report Lepidocyclina, apparently the usual, variable, South Australian species L. howchini, from outcropping basal Nullarbor Limestone at the eastern margin of the Eucla Basin near the Ooldea Range, at Lake Tallacootra and Seven Mile Swamps (Fig. 1). The discovery was made by MCB and corroborated by JML in thin section of material collected from Seven Mile Swamps. Several natural sections of small Lepidocyclina were also recognised on broken rock surfaces. Larger, more frequent and obvious individuals have since been observed by us in outcrop at Lake Tallacootra and in thin section (Photos 1-3). At both localities, unlike the case in the St Vincent and Murray basins, the limestone is too tightly cemented to allow sufficient disaggregation for the release of any whole individuals of Lepidocyclina.

SETTING, LITHOLOGY, FACIES, AND MIROFAUNAL NOTES

Around the eastern margin of the Nullarbor Plain and the sand-covered Bunda Plateau adjacent to the Ooldea Range, there are scattered outcrops of Nullarbor Limestone, particularly in the vicinity of playa lakes such as Ifould Lake, Lake Tallacootra, Chundie Swamps and Seven Mile Swamps (Fig. 1).

These represent marginal limits of the formation, which here overlies unconformably, rocks ranging in age from Archaean/Early Proterozoic of the Gawler Craton, to Eocene Pidinga Formation of the Eucla Basin.

Seven Mile Swamps

Outcrops are scattered and low-lying on the floor of the western side of the main playa lake, and in the adjacent sand-covered country. Lepidocyclina has been found very sparsely in outcrop at the extreme southwestern corner of the lake (SADME photo locality 1/61/1118), where the limestone appears to overlie black ferruginised sandstone. Local drilling by exploration companies indicates that Nullarbor Limestone overlies black, carbonaceous, Eocene Pidinga Formation, and sands of possible Eocene age.

At Seven Mile Swamps Lepidocyclina is only known to occur in a 20 cm-thick bed at lake floor level. The lithology of this bed is coarse-grained, quartzose sandy limestone, coloured brown, orange, and darker brown to purplish where ferruginised. Also present are large, plant-like bryozoal fragments, and locally prominent echinoids. The rock is partly decomposed and leached due to its position in the lake floor. This "basal" limestone fines upwards to a fine, even-grained, indurated, recystallised limestone which outcrops up to 2 m above the lake floor around the margin.

Texturally, the Lepidocyclina-bearing limestone is a skeletal packstone, skeletal remains being largely derived from bryozoans and echinoids, with comparatively minor contributions from algae and foraminifera. Lepidocyclina is rare and small in this lithology, only 1-2 mm in diameter, and all megalospheric. Associated foraminifera include Amphistegina lessoni d'Orbigny, Operculina victoriensis Chapman and Parr, and Marginopora vertebralis Blainville, and occasional Gypsina howchini Chapman and Austrotrillina howchini (Schlumberger).

Lake Tallacootra

Nullarbor Limestone here is exposed along the northwestern margin, in the lake floor, and adhering to the top and sides of local crystalline basement highs. Lepidocyclina has been

observed at a very localised site near the head of an east-(lakeward) draining creek, on the dissected margin of the Nullarbor Plain (SADME photo locality 4/136/2227). The zone is about one metre thick, with the acme in the lower part, and is only about 1.5 m above the local base of Nullarbor Limestone where it transgresses nearby onto gneissic bedrock with noticeable relief. The outcrop is relatively very elevated, for this area, occurring some 10-20 m above outcrops in the lake floor. The base of the formation is not exposed here, but may be seen about 100 m downstream, where limestone overlies a thin, transgressive, basal lag, a clay-sand-grit, on weathered bedrock.

The Lepidocyclina-bearing limestone is indurated, and pale grey, brown, or off-white in colour. It is quartzose and variably sandy, becoming in part a calcareous, medium-grained, well sorted sandstone. Algal nodules and crusts up to 20-30 mm across are common. Thin-section examination of the limestone reveals much textural variation. In one large thin section (Photo 1) micrite mud, variably sandy packstone and floatstone to micritic sandstone, can all be observed, with sandy packstone predominating. Terrigenous sand, mostly quartz, is largely medium-grained and well rounded, while the skeletal clasts are coarse-grained. The predominant skeletal remains are bryozoal: in the packstone they may constitute up to 30% of the sediment. At least four forms are represented. Algae are the next most prominent skeletal-derived clasts, locally forming up to 25% of the sediment in a floatstone texture. Bioerosion and boring of the algal nodules is common, and cavities and primary voids are infilled with sediment and/or calcite cement. Geopetal fabrics are common. Echinoid grains are a minor constituent.

Foraminifera include miliolid, agglutinated and encrusting forms (together generally less than 5.0-7.5% of the sediment). Austrotrillina, Marginopora, Amphistegina and Operculina are present. Lepidocyclina has a diameter ranging from 1 to 11 mm, a vertical section compressed to inflated, and a marginal flange narrow to wide and prominent. The larger, compressed specimens with minute embryonic apparatus and notable marginal flange, are microspheric (Photo 2) (Lindsay and Giles, 1973), in contrast to the smaller, megalospheric individuals with prominent embryonic apparatus (Photo 3).

DISCUSSION

Reasons why Lepidocyclina has not been found previously in the Eucla Basin may include: accidents of sampling in reconnaissance work, recrystallised limestone lithologies, and possible restriction to a particular marginal setting. Lepidocyclina also may not have been discovered earlier, since it occurs in a bryozoal facies. Only that part of the formation at Head of the Bight (lower two-thirds) has been previously described as being bryozoal (Ludbrook, 1958) although recent work now indicates bryozoal facies to be widespread (Benbow, in prep.). However this facies has limited accessible exposure.

The Lepidocyclina-bearing bryozoal facies has a foraminiferal fauna distinctly younger than that of the Oligocene to Early Miocene Abrakurrie Limestone which is also notably bryozoal (Lowry, 1970; Lindsay and Harris, 1975), and there is no doubt that the newly-discovered Lepidocyclina zone should be assigned to Nullarbor Limestone rather than to Abrakurrie Limestone. Only two possible identifications of Abrakurrie Limestone have been made in this eastern marginal sector of the Eucla Basin. Fossiliferous gravelly quartzose sand and calcarenite a few metres thick, penetrated in company drilling 6 km west of Seven Mile Swamps, was identified recently as possibly a late phase of Abrakurrie Limestone (suggested as one of three alternatives, the others being: an early phase of Nullarbor Limestone, or a new intermediate unit). However the microfauna contains Sherbornina cuneimarginata Wade, and is of Longfordian, Early Miocene age (Lindsay, 1987). It is distinctly older than the Lepidocyclina zone reported here. An earlier tentative identification of silcrete-replaced (?)Abrakurrie Limestone equivalent (or basal Nullarbor Limestone) at Chundie Swamps (Fig. 1) by Firman (1983) lacked any faunal data.

The environment of deposition of this Lepidocyclina-bearing, bryozoal-rich facies, may have been a bryozoal or seagrass meadow, situated one or two kilometres offshore at Lake Tallacootra, and perhaps five to ten kilometres offshore at Seven Mile Swamps. The textural variation and very micritic nature of the limestones at Lake Tallacootra, suggests a baffling medium which would have diminished current and wave energy and allowed

micritic mud to accumulate. Whether the bryozoans were epibionts on seagrass as is the case today at Shark Bay, for example (Davies, 1970), is unknown. Certainly some display flattened areas, suggesting attachment surfaces. In thin section and sediment residues however, bryozoans have been observed encrusting mineral grains, other bryozoans, and other organisms including algae, so attachment-like surfaces do not necessarily imply attachment to seagrass.

If there was a bryozoal or seagrass baffle, larger foraminifera such as Lepidocyclina and Marginopora may have lived attached. Marginopora is often attached today, as noted for example by Carrigy (1956), Davies (1970), and Murray (1973). Chaproniere (1975, p. 56) concluded that Lepidocyclina (Nephrolepidina), e.g. L. howchini, "probably was able to live on a variety of substrates but was confined to shallow waters (possibly less than 12 m deep), similar to the modern representatives of Marginopora", and preferring, but not restricted to, seagrass associations. The presence of red algal nodules indicates areas of less baffle protection, where nodules could roll about and grow under the influence of waves or currents.

The age of the South Australian Lepidocyclina episode, in international terms, is indicated by common association with the First Appearance Datum of planktonic foraminifer Praeorbulina glomerosa curva (Blow) in the Murray Basin (Lindsay and Giles, 1973). Despite some authors' continuing preference for the first appearance of Orbulina itself, in the Orbulina bioseries, as marker for the Early/Middle Miocene boundary (e.g. Jenkins and Srinivasan, 1985), the Neogene time scale adopted as standard for the recently concluded Decade of North American Geology indicates the first appearance of Praeorbulina glomerosa as the marker for this boundary (Berggren, Kent, Flynn and Van Couvering, 1985, fig. 6; see also Palmer, 1983). Similarly, Berggren, Kent and Van Couvering (1985, p. 227) noted that "the lower-middle Miocene boundary (=base of the Langhian Stage) is biostratigraphically correlated with the FAD of Praeorbulina glomerosa curva which is associated with Chron C5CN1 .... and which has an estimated age of 16.5 Ma". This is within the lower part of Zone N.8. Haq et al. (1987, fig. 2) have adopted essentially the same time scale,

with base P. glomerosa Zone, base Langhian Stage, and Early/Middle Miocene boundary all at 16.2 Ma. Hence the L. howchini zone in the western Murray Basin is dated earliest Middle Miocene, about 16 Ma. The planktonic record is poor at this level in the St Vincent Basin, where L. howchini is not accompanied by any members of the P. glomerosa complex (Lindsay, 1969, figs. 5, 6), while in the eastern Eucla Basin no planktonic foraminifera have been recognised yet in the L. howchini zone; however, the reasonable assumption continues to be made that the South Australian Lepidocyclina episode was virtually isochronous, so it is dated earliest Middle Miocene, about 16 Ma. This correlates neatly with the transgressive phase of the major global eustatic peak in Third Order Cycle 2.3 (Haq et al., 1987, fig. 2). Transgression onto local crystalline basement highs is apparent at Lake Tallacootra.

The presence of large benthonic foraminifera of "tropical" affinities, including Lepidocyclina, in marine sediments of the southern Australian region, is a result of relatively short-lived expansion of the low-latitude warm-water belt (McGowran, 1979). Lepidocyclina of Early to Middle Miocene age is known from the Gippsland and Otway basins (summarised in Abele et al., 1976), northwestern Tasmania (Quilty, 1972), the Murray and St Vincent basins, and now the eastern Eucla Basin, indicating the widespread nature of this warm-water circulation along southern Australia, especially at the early Middle Miocene acme. It is reasonable to assume that there was a connection with the Lepidocyclina facies of the Perth and Carnarvon basins (Chaproniere, 1980) but it is not yet proven.

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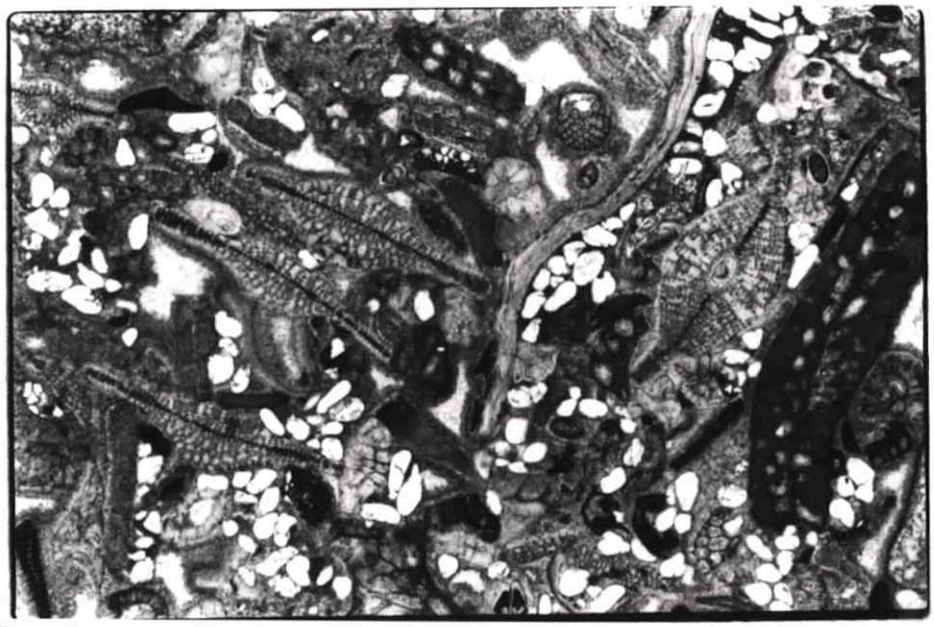


Lepidocyclina-bearing, sandy micritic skeletal limestone (packstone to floatstone) with local areas of micritic sandstone. Both microspheric and megalospheric forms of Lepidocyclina may be present. Also apparent are skeletal fragments of bryozoans and echinoids, Marginopora vertebralis (lower left hand corner) and other foraminifera. Field of view is 10.5 x 7.0 mm. Average size of Lepidocyclina is 3 mm.

(Lake Tallacootra, 5335 RS 27)

PHOTO 2

Microspheric form of Lepidocyclina (8.9 mm long). Texture is locally a micritic sandstone to sandy (micritic) mudstone with minor skeletal grains (including fragmentary Lepidocyclina)

(Lake Tallacootra, 5335 RS 26)

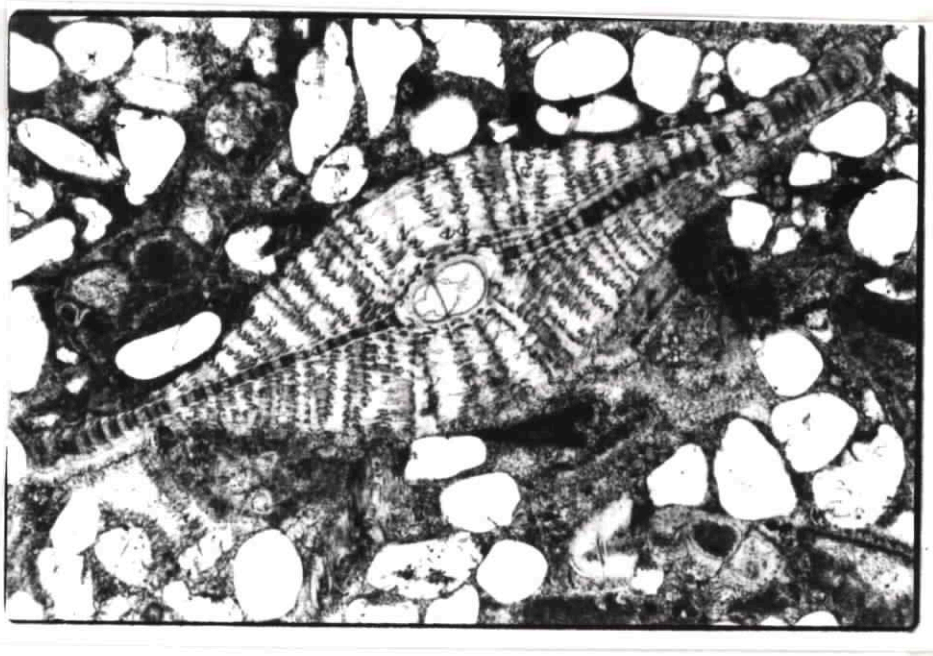
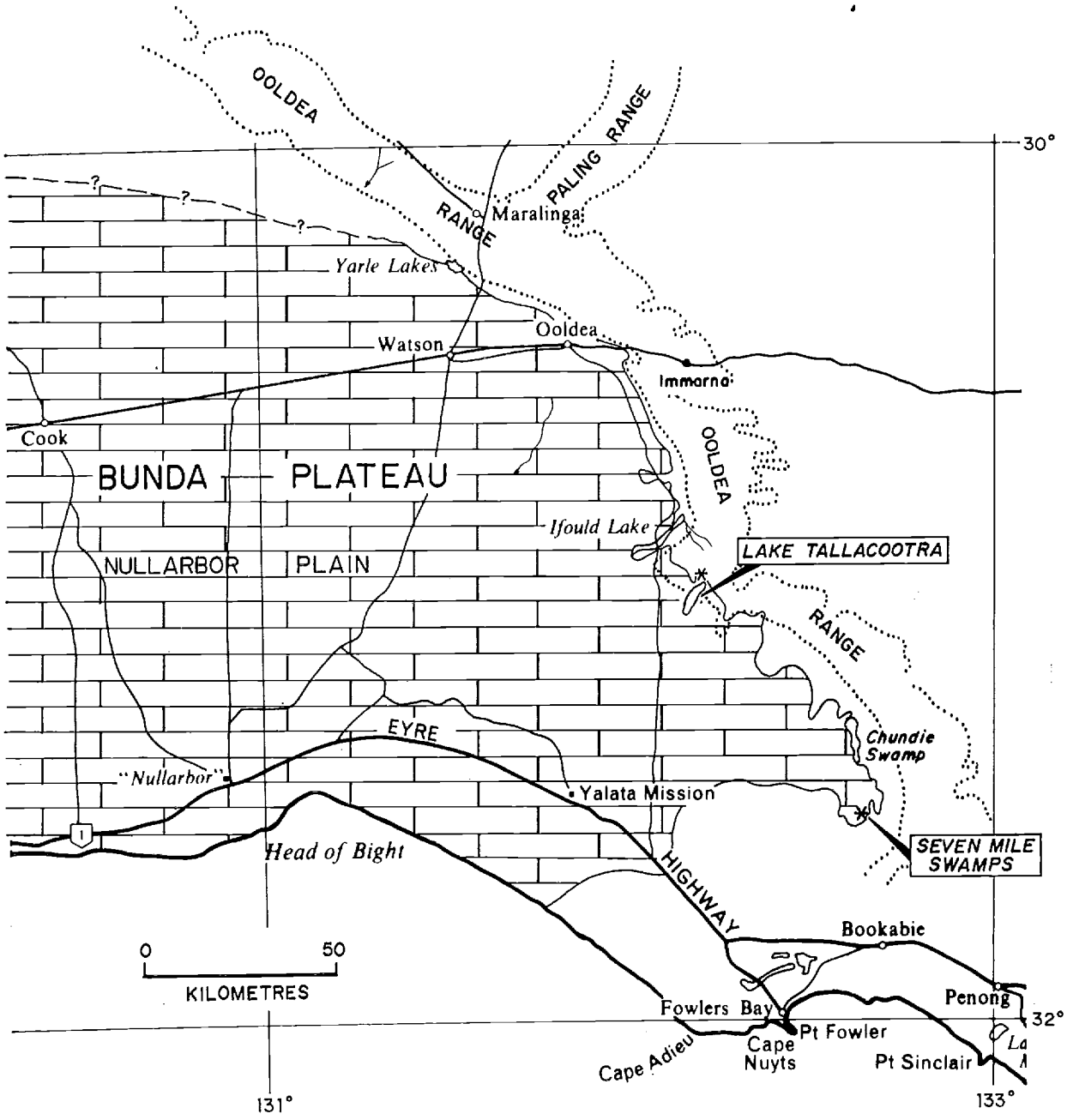


PHOTO 3

Megalospheric form of Lepidocyclina (4.15 mm long). Texture is similar to Photo 2.

(Lake Tallacootra, 5335 RS 25)



Nullarbor Limestone (known limit)

* *'Lepidocyclina'* occurrence

(Modified from Benbow, in prep.)

Fig. 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED M.C.B.	C.D.O. DATE
DISTRIBUTION OF NULLARBOR LIMESTONE, EASTERN EUCLA BASIN SHOWING OCCURRENCES OF LEPIDOCYCLINA	DRAWN A.F.	SCALE As shown
	DATE	PLAN NUMBER S19734
	CHECKED	

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