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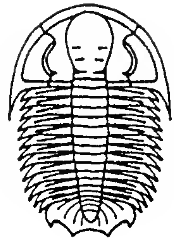

Tropaeum sp., a Cretaceous ammonite from Walsh River, north Queensland.

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EDITORIAL NOTES

HOW LONG CAN THE F.C.A.A. KEEP GOING?

Although in the early days of our existence some doubts were expressed that we would survive for more than a few years, we have managed to publish 39 editions of The Fossil Collector over a period of 13 years. However, obtaining sufficient material to fill each issue, without resorting (with permission) to the wholesale use of articles already published in other magazines, is becoming more and more of a problem. Publication of worthwhile Bulletins over the last year has often depended on the fortuitous arrival of material at the last moment. How long we can continue under in this manner is anyone's guess. Put simply, NO BULLETIN - NO F.C.A.A.!

DEADLINE FOR THE NEXT ISSUE

Material for the next issue should be submitted by 20th April, 1993, unless otherwise arranged with the Editor.

SUBSCRIPTIONS

Subscriptions for the 1993/94 financial year are due on 1st March (renewal form enclosed). Payment before the end of April would be appreciated to avoid the expense of sending out reminder notices. As our current reserves are once again more than adequate for our needs, there will be no increase in annual subscriptions. They remain as follows:-

Surface Mail	
Australia, Papua/New Guinea, New Zealand	$ 7.50
All other countries	$ 9.00
Air Mail	
Papua/New Guinea, New Zealand	$ 10.00
USA, Canada	$ 12.50
UK, Europe	$ 14.00

(All subscriptions quoted in Australian dollars)

RED FACE DEPARTMENT

At the beginning of the Editorial in the last issue (September 1992 - Page 3), we "tried" to correct an error in the previous Bulletin, where we had inadvertently [nice way of saying the Editor can't spell] inserted the letter 'r' in the generic name Nothofagus. In making the correction we succeeded in leaving out the 'h' as well. This second error was kindly brought to our attention by an eminent Tasmanian member who wrote:- "The erratum (page 3) caught my eye. There is an erratum in the erratum! The generic name is not, as you point out Notofargus, but Nothofagus, not as you wrote, Notofagus. The irony is that Notus is the Latin word used for the south wind (as in sirocco), but Nothos (the latinized spelling of the Greek word) means bastard! (which might well be your thought when you write another erratum). So Nothofagus is the bastard beech, whereas Notofagus is the southern beech. We have the illegitimate variety here in Tasmania!"

CONTROL OF FOSSIL COLLECTING

Legislative control of fossil collecing by other than authorised scientists is a topic which is continually being raised in one country or another. In Bulletin 28 (May, 1989) we included details of the Canadian Province of Alberta's Historical Resources Act and its effect on amateur collecting. More recently a bill, which would restrict collecting of vertebrate (and probably associated) fossil remains on public lands, was introduced into the United States Senate (The Paleontological Resources Protection Act: S-3107). As with the Alberta legislation, this has raised a considerable amount of controversy among amateur collectors and commercial

EDITORIAL NOTES (Cont.)

paleontological suppliers. For the moment this piece of legislation has 'died' in the committee stage but may be reintroduced later.

In Australia, as in the United Kingdom, there are currently few restrictions on collecting fossils, however, this may not always be the case. The recent investigations into the illegal export of fossils brought to light the complete lack of knowledge among the public (and I suspect many professionals) of the existence and content of the Protection of Movable Heritage Act, 1986. It is hoped that in the future any proposed ammendments to this Act or additional legislation are given adequate advance publicity to permit public comment. Unlike the United States, this country appears to have a poor record of public involvement in this type of legislation.

On the topic of fossil collecting and conservation, it was extremely refreshing to read a very balanced appraisal by David B. Norman, of the situation in Britain. The "Conclusions" at the end of his paper, Fossil collecting and site conservation in Britain: Are they reconcilable? (Palaeontology, Vol. 35, Part 2, 1992, pp. 247-256.), are reproduced below.

> In most circumstances the collection of fossils from palaeontological sites is to be encouraged, since this activity will, in the long term, promote the science of palaeontology.
>
> There are a small number of instances where the collection of fossils needs to be regulated and monitored, simply because the fossil resources at some sites are limited and their scientific and heritage value is high. These can be considered to be vulnerable sites.
>
> Strategies relating to the management of the palaeontological resource at specimen-rich fossil sites will vary depending on the degree to which the site is subject to erosional (natural or man-induced) forces.
>
> Collecting practice must be encouraged to be of a uniformly high standard through education and example, as befits specimens that are a component of our natural heritage. And there must be encouragement of attitudes which will foster a willingness to ensure that the scientifically most important specimens are not lost to science in the long term.
>
> The price of fossils, established through commercialized fossil collecting, will continue to cause consternation so long as museums and universities are underfunded (and low priority is given to the acquisition of new fossils): a situation that is unlikely to change in the foreseeable future. Undesirable though it may be to put a monetary value upon any aspect of our natural heritage, it has been argued that there are merits in doing so for fossils. The value may be arbitrary, in most instances, but it may provide a way of raising political awareness among policy makers about an otherwise totally underestimated part of our national heritage.

Although dealing with an overseas situation, it is well worth reading the complete paper if you can get to a library that subscribes to this journal.

FINANCES

Statement of finances as at 20th January, 1993:

Carried forward from previous year	$ 1830.69
Add income 1.3.1992 to 20.1.1993	$ 1511.68
	$ 3342.37
Less expenditure 1.3.1992 to 20.1.1993	$ 1427.13
	$ 1915.24
Deduct advance subscriptions	$ 119.50
Balance in hand (excluding cost of this Bulletin)	$ 1795.74

BRIEF COMMENTS ON PREDATION OF THE FOSSIL SAND DOLLAR, FELLASTER INCISA (TATE).

Frank Holmes, 15 Kenbry Road, Heathmont, Victoria, Australia.

Introduction.

The occurrence of the fossil sand dollar Fellaster incisa (Tate, 1893) in the Late Pliocene micaceous sands of the Norwest Bend Formation at Willowbank and Sunnyside Lookout, north of Murray Bridge, South Australia, has been described by Sadler and Pledge (1985). In their "Brief Communication" (p.176) they note some specimens of Fellaster show evidence of a round hole bored into the adapical surface, presumably by a carnivorous gastropod.

A study of twenty specimens collected from the Norwest Bend Formation, south of Sunnyside Lookout in August, 1992, reveals that predation of this species is extremely common at this locality, fifty per cent having at least one clearly visible circular drill hole penetrating the test, while two others have circular indentations interpreted as abandoned attempts at predation.

Specimens were collected from one horizon over a distance of about 200 metres. While it will be necessary to compare a far greater number of specimens than those already collected, to provide totally reliable statistical evidence to the extent of predation and to the 'preferred' position of drill holes on the test, two interesting points emerge from the current study.

1. Predation was not restricted to the adapical (upper) surface, the number of clearly defined drill holes being divided almost equally between adapical and adoral surfaces. However, it should be noted that in the majority of specimens, only one surface could be examined, due to the presence of encrusting matrix (see Table 1).

2. Of the 13 positively identified drill holes (including the two abandoned attempts), only two occur in the outer zone of the test containing the highly concentrated concentric pillars of calcite, an area where successful predation would be extremely difficult, if not impossible (see Fig. 1).

Questions raised by the unusual degree of predation.

Assuming the predator was a carnivorous gastropod, as the size

PREDATION OF FELLASTER INCISA (Cont.)

and regular outline of the circular drill holes suggest, each of the points listed above raise interesting questions.

Firstly: How did predation take place on the adoral (underside) surface of the echinoid?

Sand dollars generally live on shifting sands swept by waves and tidal currents. All burrow to some extent, the depth to which they go to avoid being swept away being generally determined by the strength of the waves, although some species can only survive in sheltered bays (Telford & Mooi, 1987). It is considered virtually impossible for the Fellasters to have been attacked from beneath, consequently, either the predator was capable of turning the echinoid over, or it was already laying with its adoral surface uppermost when attacked. As the first of these possibilities is also considered an extremely unlikely scenario (one which would raise the further question as to what advantage was to be gained by such a manoeuvre, since the thickness of the

Specimen			Visible detail		Predation		
Number	Length	Width	Adapical	Adoral	Adap'l	Adoral	Diam.
1.	40.4	43.8	G	G	nil	nil	
2.	41.6e	45.5e	F	F	nil	1	1.0o
3.	48.0e	51.4e	G	G	nil	nil	
4.	47.2	50.2	G	enc	1	?	1.6
5.	40.9	40.9	G	enc	1*	?	1.3
6.	36.5e	39.0	G	enc	1	?	1.3
7.	34.0	36.2	G	enc	1	?	1.3
8.	36.9	39.4e	F (p.enc)	enc	1?	?	
9.	25.7	27.8	P (p.enc)	enc	1	?	1.0
10.	22.0e	24.0e	enc	enc	?	?	
11	49.2	52.2	enc	G	?	1+2?	1.6
12.	48.7	51.3	enc	G	?	1	2.0
13.	50.1	53.9	enc	G	?	1	1.3
14.	39.3	40.5	enc	F	?	1	1.2
15.	31.0	32.7	P (p.enc)	F	?	2+1?	1.5,1.0
16.	29.7	31.5	P (p.enc)	F	?	nil	
17.	28.0	30.3	enc	enc	?	?	
18.	56.7e	59.7e	G (p.mis)	enc	nil	?	
19.	41.5e	43.5e	G (p.mis)	enc	1*+1?	?	1.0
20.	34.3	36.0e	enc	P (p.mis)	?	?	

TABLE 1. Details of twenty specimens of Fellaster incisa collected from the Norwest Bend Formation, near Murray Bridge, South Australia, including the number, location and size of circular drill holes on each surface of the test. Visible detail: G = good, F = fair, P = poor, p. = part, enc = encrusted, mis = missing. Predation: ? following number = possible, ? = information unavailable due to encrusted surface, * = circular depression not extending through test. All dimensions in millimetres.

test to be drilled is virtually the same above and below the central body cavity); we must assume that the latter alternative is the only plausable answer to the question. Probably the sand dollars were upturned by an abnormal increase in wave action brought about by a sudden storm and were unable to right themselves before being attacked by predatory gastropods. Without a comparative study of the habits of the extant species of the

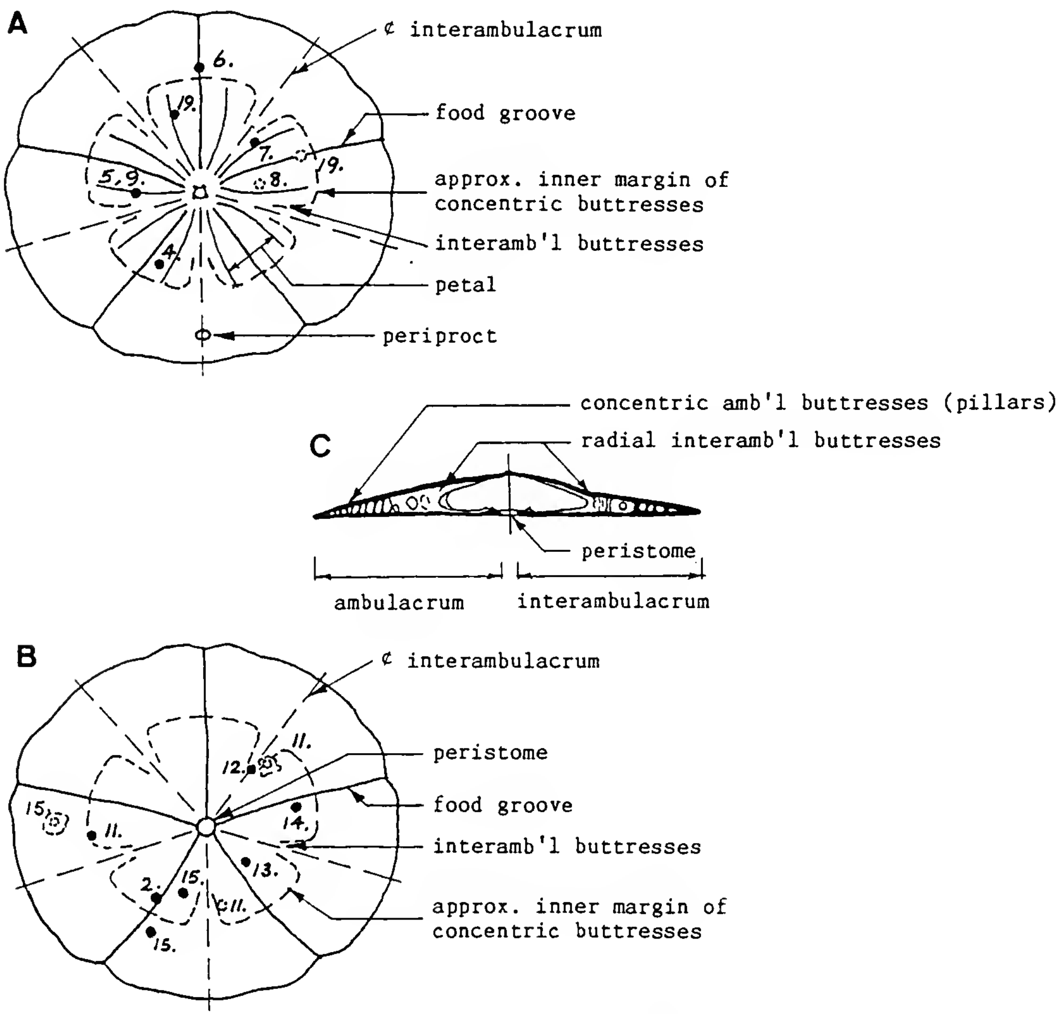

FIGURE 1. A, diagram of adapical surface of Fellaster incisa showing location of drill holes listed in Table 1, in relation to approximate position of central body cavity (shown with broken line). B, diagram of adoral surface showing details as in A. C, cross-section through actual specimen on centre line of ambulacrum (left) and interambulacrum (right). Average thickness of test above and below central body cavity is 0.7 mm.

PREDATION OF FELLASTER INCISA (Cont.)

genus, Fellaster zelandiae (Gray, 1855), or the closely related genus Arachnoides, we have no way of knowing how long it would take the sand dollars to resume their normal living position in the sediment with their adapical surface uppermost, if indeed they belong to a group that can perform this task. Barnes (1980) infers that not all sand dollars can right themselves when turned over. Those species that can, achieve the task by burrowing the anterior end into the sand and gradually elevating the posterior end until eventually the body can be flipped over. It is unfortunate that the percentage of overturned specimens was not recorded during recent collecting, although Sadler and Pledge note a few overturned specimens among those recorded in their 1985 paper.

Secondly: How did the predator target the area of the test above and below the central body cavity, where successful predation of the echinoid's soft parts would be assured? Was it an acquired trait or purely by chance?

Regrettably, it would seem impossible to answer this question without knowing exactly which species of animal was the predator. While, as previously noted, the most likely culprit was a carnivorous gastropod, no fossil remains of gastropods have yet been found in the beds where Fellaster incisa has been collected. As Sadler and Pledge (1985) point out, because of the porous nature of the sediment, it can be presumed that the aragonite shells of any gastropods present would be rapidly dissolved away, unlike the tests of the sand dollars which are composed of the more stable calcite. Even if it can be established that a particular species of gastropod preys on extant sand dollars belonging to the same subfamily (Arachnoidinae), it would require extensive observation of the act of predation under laboratory conditions to establish any consistent strategy and be able to answer the above question with any degree of confidence.

As the extent of predation recorded in Table 1, is considered to be extremely unusual (see later comment), it would seem that successful predation was probably a matter of chance, rather than any acquired (evolutionary) trait developed by continued predation on sand dollars. In the case of predation by naticids, Berg and Nishenko (1975) note that the gastropod or bivalve prey (presumably also echinoid prey) is manipulated in such a way that boring is in the middle of the shell. It would be interesting to see if the scallops (Chlamys cf. antiaustralis), found associated with

Fellaster at Sunnyside Lookout, also show predation by gastropods.

Echinoid predation in general.

Evidence of gastropod predation is comparatively rare in fossil echinoids although extant post-larval echinoids are known to be preyed upon by a wide range of animals including other echinoids, starfish, gastropods, decapod crustaceans, octopuses, fish, birds, otter and man (Moore 1966). Predation will rarely decimate a population and under normal conditions accounts for only a small proportion of deaths (Smith 1984).

Among the gastropods adapted for drilling holes in the shells of prey, though not necessarily echinoids, are genera of the neogastropod Muricidae and the mesogastropod Naticidae. Both families rely on a combination of shell-softening, by secretion of an acid substance and drilling with the radula. However in the former, the gland producing the secretion is situated in the anterior sole of the foot, and in the latter, in the proboscis tip (Barnes 1980).

McNamara (1991) links predation of the heart urchin Lovenia, from the Miocene of southern Australia, with a third family of gastropods, the mesogastropod Cassidae. He also notes that of hundreds of sand dollars of the genus Monostychia he examined, only one had a cassid-cut hole in it.

The final question.

Probably the most important question which has to be addressed, is the reason for the high level of predation in Fellaster.

While the lack of predation in species of Monostychia, referred to by McNamara, may be the result of different environmental conditions and the period of time in which they lived (Early Miocene compared with Late Pliocene), a cursory check of hundreds of partial specimens of Fellaster incisa from the Early Pliocene Jemmys Point Formation, near Lakes Entrance, East Gippsland, Victoria (Museum of Victoria collection), failed to reveal any sign of gastropod predation. Although detail of the lithology of the beds where these latter specimens were collected needs to be determined, some specimens of Fellaster from Nungurner, west of Lakes Entrance, are found in a micaceous sandstone not unlike that found at Sunnyside Lookout.

Before any attempt can be made to answer this question, a

PREDATION OF FELLASTER INCISA (Cont.)

considerable amount of additional collecting and study is required. What little evidence there is at the moment seems to point to a localized phenomenon.

Summary.

A. Specimens of Fellaster incisa collected from the vicinity of Sunnyside Lookout, South Australia, show an abnormally high degree of predation (approx. 50%).

B. Over half of those predated where attacked on the adoral surface.

C. The predator was most likely a carnivorous gastropod.

D. Slightly older specimens of Fellaster from East Gippsland, do not appear to have suffered similar predation.

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WESTERN AUSTRALIA'S CRETACEOUS FLORAS

Stephen McLoughlin and **Lisa Guppy**, Department of Geology, University of Western Australia, Nedlands, W. A., 6009.

Abstract

Early Cretaceous plant macrofossils are recorded from several Western Australian sedimentary basins. The floras, dominated by cycadophytes, conifers, and ferns, are discussed in terms of their age, palaeoclimatic and palaeoenvironmental implications, and their relationship to the contemporaneous fauna.

Distribution of fossil localities

Few studies have been conducted on Western Australia's Cretaceous floras. The Canning Basin's Broome Sandstone (at Broome), Cronin Sandstone (near Lake Disappointment), and Callawa Formations (near Shay Gap) have yielded foliage and wood impressions and casts. White (1961a) compiled a brief report on the Bureau of Mineral Resources' geological survey collections from this basin.

The chiefly marine Carnarvon Basin Cretaceous sequence contains sporadic leaf remains in the Nanutarra Formation near the Ashburton River in the northern part of the Basin. These plants have not been previously studied apart from a list of three genera cited in Cox (1961).

FIGURE 1. Silicified wood with <u>Teredo</u> burrow casts, x 1. Birdrong Sandstone, Kalbarri.

The Perth Basin, similarly, has just a few plant-bearing horizons in the Leederville and Bullsbrook Formations which interfinger with dominantly marine sequences. A small assemblage of plants from the Leederville Formation (formerly Strathalbyn Beds) at Gingin was described by Walkom (1944) and incorrectly dated as Jurassic. Nothing has previously been published on the Bullsbrook floras.

In addition, many Cretaceous marine units in Western Australian basins contain silicified, limonitized, or phosphoritized gymnosperm wood. This wood commonly shows evidence of boring (Fig. 1) presumably produced by bivalves of the family Teredinidae (commonly known as shipworms). The

WESTERN AUSTRALIA'S CRETACEOUS FLORAS (Cont.)

wood is typically poorly preserved consisting of only seasonally banded secondary xylem tissue. Simpson (1912) provisionally assigned Cretaceous Teredo-bored conifer wood from the Dandaragan Sandstone, at Dandaragan, to Cedroxylon. The primary wood, generally essential for species determinations, is rarely preserved. Most of this wood is probably attributable to the dominant Early Cretaceous araucarian and podocarp conifers and is best assigned to the non-commital form genus Araucarioxylon.

Depositional setting

In the Canning Basin, the Broome Sandstone has a deltaic depositional setting and consists of mixed coarse-and fine-grained sediments while the coeval sandstone-dominated Callawa Formation and Cronin Sandstone represent fluvial deposits (Middleton 1990), The Carnarvon Basin's Nanutarra Formation has a fluvial to nearshore marine depositional setting (Hocking 1990). The Leederville Formation of the Perth Basin comprises mixed lithologies and is a shallow marine to paralic unit, whereas the correlative Bullsbrook Formation was deposited under fluvial conditions (Cockbain 1990).

Institutional collections

The principal collection of Western Australian Cretaceous plants resides in the Western Australian Museum (WAM). The small assemblage described by Walkom (1944) together with assorted permineralised wood collections are housed in the Geology Department of the University of Western Australia (UWA). Counterparts of some of Walkom's specimens are lodged with the Australian Museum in Sydney. The Commonwealth Palaeontological Collection housed in the Bureau of Mineral Resources, Canberra, contains limited material from regional geological surveys of the 1950s and 60s.

Composition of the floras

The list of Cretaceous plant macrofossil species from WAM and UWA collections (excluding permineralised woods) is shown in Table 1. Most of these taxa have been described or figured from eastern Australia or other parts of Gondwana and do not require re-examination here. Others are too poorly preserved for accurate identification. A few appear to be new or unusual forms and these are briefly discussed below. A more comprehensive treatment of the fossil flora will be published elsewhere. Figures 2-26 illustrate a variety of taxa from the Western Australian Early Cretaceous floras.

TABLE 1. Distribution of plant fossils in Western Australian Early Cretaceous formations

EARLY CRETACEOUS UNITS/ LOCALITIES PLANT GROUPS	BROOME SANDSTONE	CRONIN SANDSTONE	CALLAWA FORMATION	NANUTARRA FORMATION	LEEDERVILLE FORMATION	BULLSBROOK FORMATION	MT BABBAGE, S. AUST.	KOONWARRA, VICTORIA
LYCOPHYTA								
Isoëtaceae								
Nathorstianella babbagensis (Woodward) Glaessner & Rao 1955	x						◊	
Isoëtites elegans Walkom 1944					x			
PTERIDOPHYTA								
Dipteridaceae								
Hausmannia sp.	xΔ							
Osmundaceae								
Cladophlebis sp. cf. *C. oblonga* Halle 1913	x		Δcf			x	◊	‡
Cladophlebis sp.	Δ							
Phyllopteroides lanceolata (Walkom) Medwell emend. Cantrill & Webb 1987	x	Δ				x		‡
Gleicheniaceae								
Microphyllopteris gleichenioides (Oldham & Morris) Walkom 1919	x							
Incertae sedis								
Adiantites sp.		Δ						
indederminate spatulate leaf/frond	x							
Sphenopteris sp. A	x	Δ?						
Sphenopteris sp. B	x							
PTERIDOSPERMOPHYTA								
Pentoxylales								
Taeniopteris daintreei McCoy 1874	x	Δ			x	x	◊	‡
Bucklandia sp.	xΔ							
Incertae sedis								
Thinnfeldia sp. cf. *T. talbragarensis* Walkom 1921					x	x		‡cf
CYCADOPHYTA								
Nilssonia sp. A				x		x	◊?	
Nilssonia sp. B	x							
Nilssonia sp. C	Δ							
Otozamites bengalensis (Oldham & Morris) Schimper 1870	xΔ	Δ			x		◊	
Ptilophyllum acutifolium Morris 1840	xΔ			x			◊?	
Ptilophyllum boolensis (Douglas) Douglas 1969	x							
PINOPHYTA								
Araucariaceae								
Araucaria sp. A	x		Δ					
Araucaria sp. B	x							
Araucariacean cones and cone scales	x							‡cf
Podocarpaceae								
Rissikia n. sp.	x	Δ			x	x	◊?	
Incertae sedis								
Carpolithes n. sp.						x		
ribbed axes	x							

x This study; Δ White (1961a); ◊ Glaessner & Rao (1955); ‡ Drinnan & Chambers (1986).

WESTERN AUSTRALIA'S CRETACEOUS FLORAS (Cont.)

Two fragmentary Broome Sandstone lycophytes show the small, closely spaced, spirally arranged, leaf cars typical of the South Australian type material of Nathorstianella babbagensis (see Glaessner & Rao, 1955, fig. 1). These short axes may have borne the simple foliage and sporangia represented by Isoetites elegans (See Fig. 12, and Walkom 1944, Figs. 1-5). Isoetites species are known from the Late Triassic to Tertiary of Europe, North America, India and Australia (Ash & Pigg, 1991). They are the likely ancestral stock for the modern quillworts (Isoetes) of which there are six species surviving in the southwest of Western Australia and eight living species in total within Australia (Clifford & Constantine, 1980).

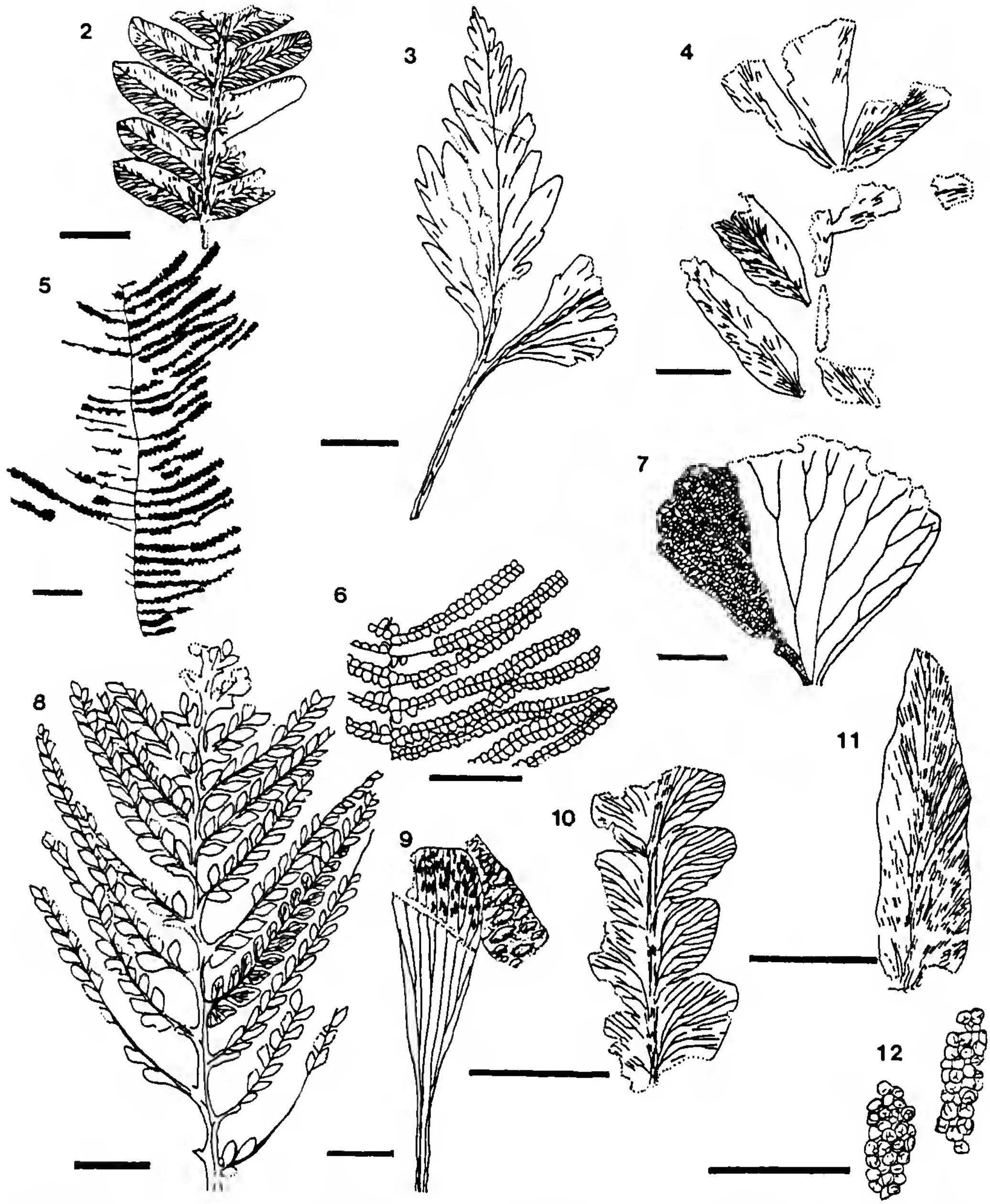
Hausmannia sp. (Fig. 7). This fan-shaped reticulate-veined leaf is similar to several others described from the Australian Mesozoic (e.g., Walkom, 1928). It probably has affinities to the modern fern genus Dipteris of which one species D. conjugata grows in tropical wet sclerophyll forests of northeast Queensland.

Indeterminate spatulate leaf (n. sp.). This spatulate leaf from the Broome Sandstone (Fig. 9) has prominent dichotomous venation suggesting affinities with the ginkgophytes. However, small elliptical sori-like impressions occur between the distal veins indicating a possible relationship to the ferns.

Taeniopteris daintreei (Fig. 18). This is a widespread Late Mesozoic Australian species sometimes described under the name T. spatulata. Taeniopteris-type leaves have been assigned to various cycadophyte and seed-fern groups. T. daintreei was probably the foliage borne by Bucklandia-type axes (Fig. 9) and the species complex probably belonged to the Pentoxylales (Drinnan & Chambers, 1985).

Nilssonia sp. A (Fig. 15), Nilssonia sp. B (Fig. 17), Otozamites bengalensis (Figs. 13, 14), Ptilophyllum acutifolium (Fig. 16), and P. boolensis (Fig. 21) are cycadophyte foliage species. Their remains numerically dominate the WA Cretaceous assemblages. Rissikia n. sp. (Fig. 24). This species probably represents podocarp conifer foliage and is widespread in the WA Cretaceous. The specimens differ from Elatocladus species in not having strongly contracted leaf bases.

Apart from araucarian terminal shoots and foliage (Figs. 22, 26), isolated cone scales (Fig. 20), detached cone impressions, and



FIGURES 2 - 12. Photo line tracings of selected Early Cretaceous plants from the Broome Sandstone (2, 3, 5-9), Bullsbrook Formation (4, 10, 11) and Leederville Formation (12). 2: Cladophlebis sp. cf C. oblonga. 3: Sphenopteris sp. A. 4, 11: Phyllopteroides lanceolata. 5, 6: Microphyllopteris gleichenioides. 7: Hausmannia sp. 8: Sphenopteris sp. B. 9: Indeterminate spatulate frond overlying Bucklandia axis. 10: Thinnfeldia sp. 12: Detached megasporangial clusters of Isoetites elegans. All bar scales = 1 cm. except Fig. 12 (= 5 mm.).

WESTERN AUSTRALIA'S CRETACEOUS FLORAS (Cont.)

seeds (Fig. 25) are preserved in the Broome Sandstone. These plants probably represented the chief arborescent elements of the Early Cretaceous vegetation.

The Western Australian assemblages are very similar and any representational differences are likely to be due to variations in depositional environments and limited sampling rather than any major floristic zonation.

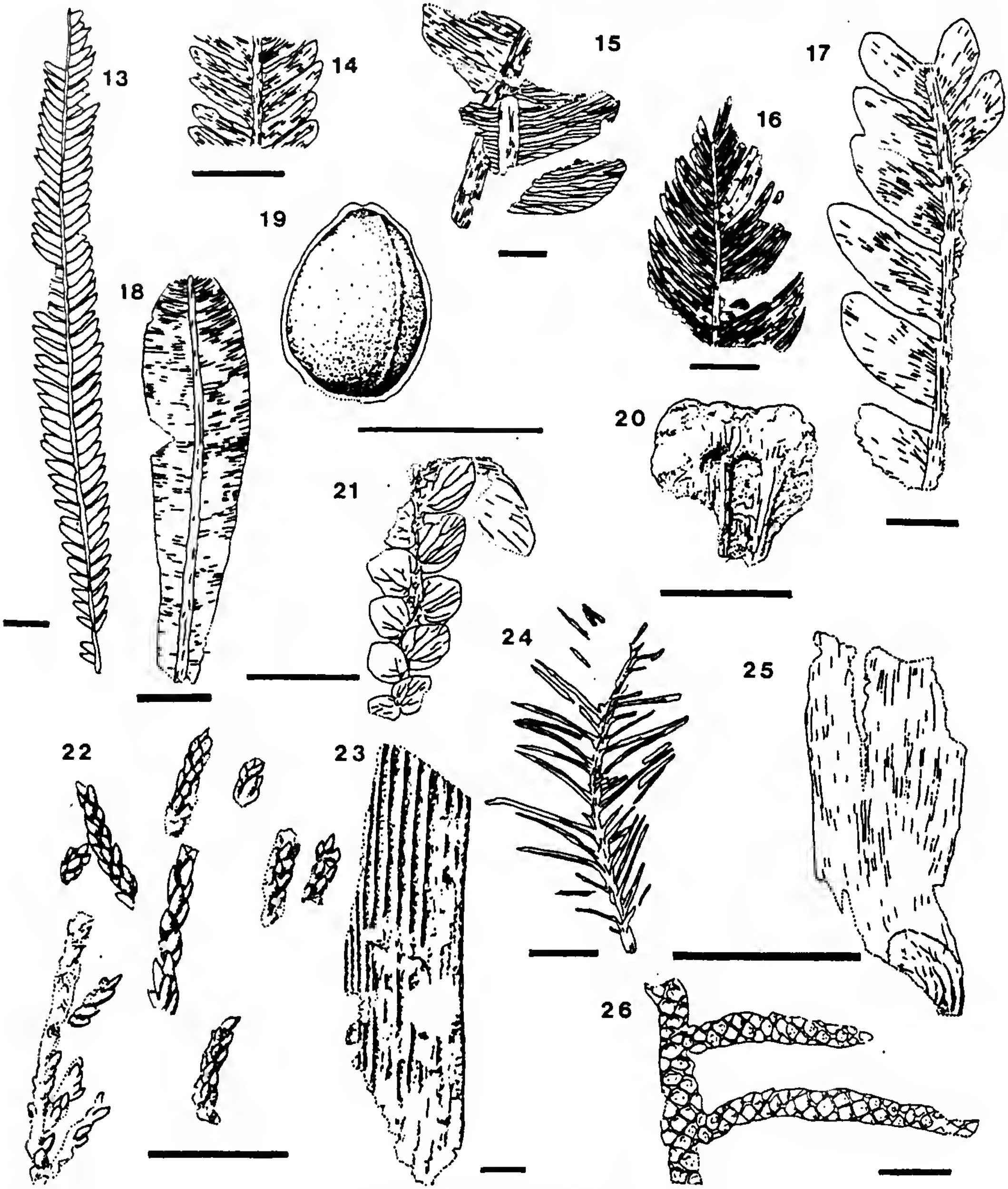
Age of the floras

Late Jurassic and Early Cretaceous floras of Australia (and Gondwana in general) show considerable stratigraphic uniformity. An Early Cretaceous age for the collective WA floras is suggested by the occurrence of Ptyllopteroides lanceolata, Taeniopteris daintreei, an Isoetites species, and abundant pinnate cycadophyte fronds together with the absence of typical Jurassic elements like Sagenopteris, Pachypteris, and Phlebopteris species and Late Cretaceous elements (angiosperms).

The Western Australian assemblages show greatest similarities to Early Cretaceous floras of the Blythesdale Sandstone at Mt. Babbage in South Australia (Glaessner & Rao, 1955),and the Bauhinia Downs flora of the Northern Territory (White, 1961b). At least four key species and perhaps up to seven are shared between the Western Australian and South Australian floras (Table 1). Lesser similarities exist with the Burrum and Styx Coal Measure floras of Queensland (Walkom, 1919) and the Gippsland-Otway floras of Victoria (Douglas, 1969, 1973; Drinnan & Chambers, 1986). Although palaeoclimatic factors limit correlation between the Victorian and WA assemblages, the pre-eminence of pinnate (fishbone-shaped) cycadophyte fronds within the Western Australian floras and the absence of other pteridosperm and ginkgophyte index species suggests closest similarity to Douglas' (1969, 1974) Victorian Neocomian-Barremian (Zone A) assemblages. Correlations with marine sequences and limited palynological studies (Balme in Bozanic 1969a,b; Ingram, 1969), also support a Neocomian (ca. 119-144 million years) age for the floras.

Plant habits

Incomplete preservation and disarticulation of remains inhibits interpretation of the original stature and growth forms of most fossil plants. Nevertheless, some indication of their growth habits and habitat preferences can be gleaned from the presence



FIGURES 13 - 26. Photo line tracings of selected Early Cretaceous plants from the Broome Sandstone (13, 14, 17-18, 20-26), Nanutarra Formation (15, 16) and Bullsbrook Formation (19). 13, 14: Otozamites bengalensis. 15: Nilssonia sp. A. 16: Ptilophyllum acutifolium. 17: Nilssonia sp. B. 18: Taeniopteris daintreei. 19: Carpolithes n. sp. 20: Araucarian cone scale. 21: Ptilophyllum boolensis. 22: Araucaria sp. A. 23: Striate axis. 24: Rissikia n. sp. 25 Conifer seed with wing. 26: Araucaria sp. B. All bar scales = 1 cm. except 19 and 21 (= 5 mm.).

WESTERN AUSTRALIA'S CRETACEOUS FLORAS (Cont.)

of specialised anatomical and morphological features, associations with other environmentally diagnostic plant or animal fossils or sedimentary facies, and comparisons with related or morphologically similar living plants. Fig. 27 shows a speculative reconstruction of a Western Australian Early Cretaceous deltaic setting dominated by arborescent conifers together with shrub-sized cycadophytes and seed ferns and herbaceous ferns and lycophytes.

Relationships with the fauna

The functional anatomy of Cretaceous reptiles (especially dentition) suggests that sauropod and ornithiscian dinosaurs were herbivorous. Though direct evidence of herbivory is not available from the fossil plants, trackways preserved in the Broome Sandstone (Long, 1990) indicate that a number of herbivorous dinosaurs roamed the Western Australian Early Cretaceous lowlands. Though no information about the anatomy or dentition of these dinosaurs is yet available, the size of some of the sauropod footprints (up to 80 cm diameter) suggests that these were creatures of awesome dimensions requiring a large and regular intake of vegetable matter. Like their modern long-necked mammalian counterparts (giraffes), sauropods probably fed chiefly upon arborescent elements of the vegetation; likely food candidates being araucarian and podocarp conifers. On the other hand, some of the Broome trackways appear to belong to smaller bipedal and quadrupedal ornithiscians including possible stegosaurians (Long, 1990). Bipedal ornithiscians and especially quadrupedal stegosaurs, with their relatively short stocky forelimbs and low-slung heads, probably fed chiefly upon the herb- to shrub-sized elements of the flora, notably the cycadophytes, ferns, seed-ferns and lycophytes.

Palaeoclimate and palaeoenvironments

Victorian Early Cretaceous floras include more abundant deciduous ginkgophyte and seed fern species than the Western Australian assemblages reflecting cooler prevailing climates. South Australian and Queensland Early Cretaceous floras from the Eromanga, Maryborough, Styx and Carpentaria basins show intermediate representations of plant groups between the Victorian and Western Australian assemblages. This southeast to northwest gradational pattern was probably latitudinally/climatically controlled. Veevers et al (1991) positioned the Valanginian (132.5 Ma) palaeopole off southern Queensland. However, an alternative pole position southeast of Victoria, as they proposed for other Late Jurassic

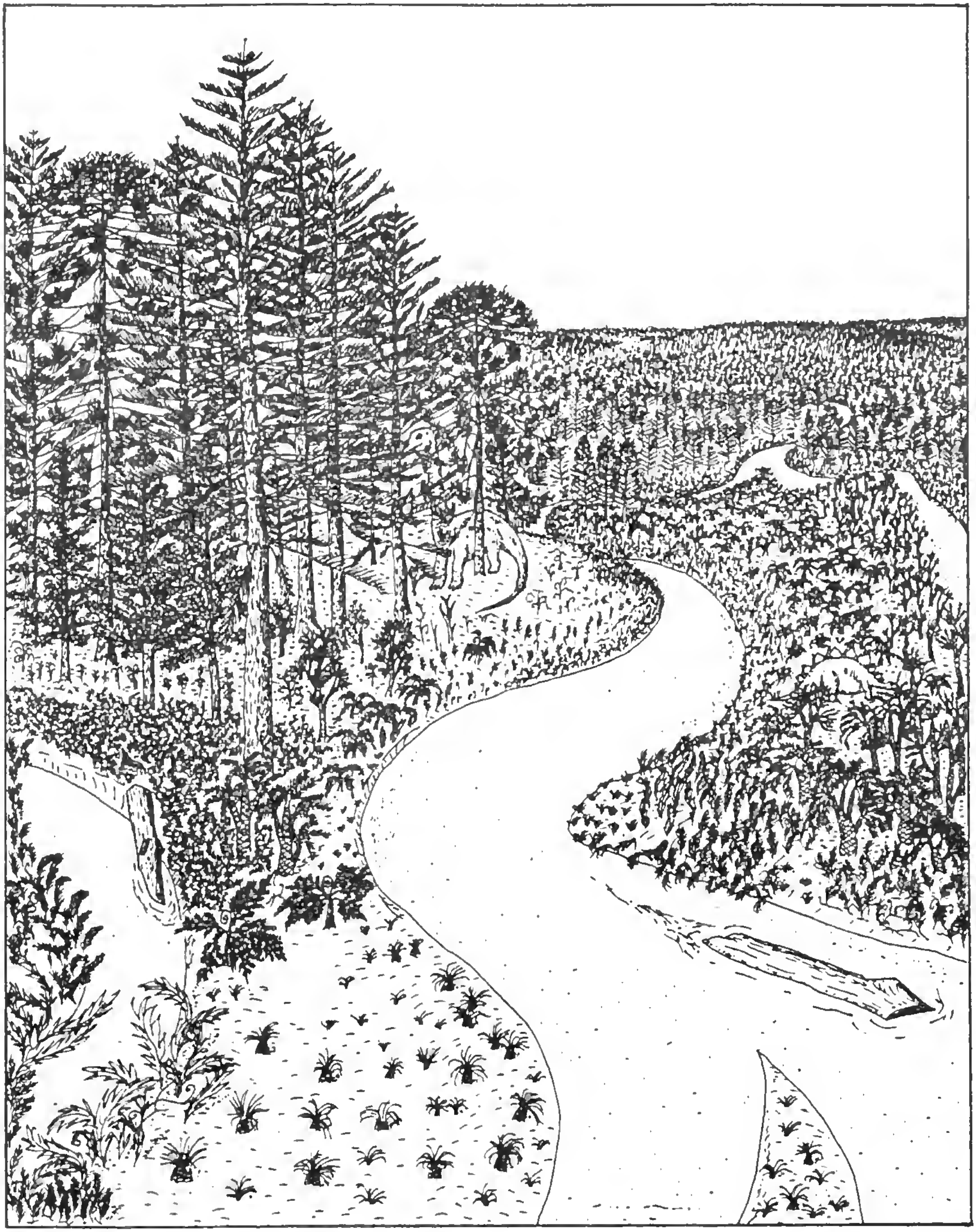


FIGURE 27.
Pictorial reconstruction of Western Australian Early Cretaceous vegetation.

WESTERN AUSTRALIA'S CRETACEOUS FLORAS (Cont.)

and Early Cretaceous epochs, would give palaeolatitudes of about 70°-80° for the Otway and Gippsland Basins, 65°-75° for the Maryborough and Styx Basins, and around 45°-55° for the marginal Western Australian Basins, which would better account for the trans-Australian floristic gradation. Plant communities, nevertheless, thrived at very high latitudes in the Neocomian as global temperatures may have been somewhat higher at that time and no contemporaneous glacial activity is evident in Australia although glendonites and apparent ice-rafted boulders occur in Cretaceous strata in South Australia, the Northern Territory, and Queensland (Frakes & Francis, 1988; Frakes & Krassay, 1992).

Relatively mild conditions are suggested for WA at this time based on the lack of deciduous ginkgophytes together with an abundance of cycadophytes, Pentoxylales, dipteridacean ferns, and araucarian conifers. The diversity of ferns and lycophytes implies relatively wet habitats although the fossils' coastal or deltaic depositional settings may indicate that the plant communities were supported by rheotrophic (groundwater-fed) rather than ombotrophic (rainwater fed) conditions. The deltaic settings probably also allowed mixing of wet lowland and drier hinterland plant debris. The more fluvial Cronin Sandstone yields a higher proportion of gymnosperms (White, 1961a), possibly reflecting a greater input of upland plants.

Conclusions

The largely neglected Western Australian Cretaceous floras fill a significant gap in our knowledge of the distribution of Cretaceous plants. They are also useful for dating terrestrial strata particularly in outcrop where deep weathering prohibits palynological investigations. Each of the Western Australian assemblages is indicative of a Neocomian-Barremian age reflecting a significant pulse of fluvio-deltaic deposition along the western continental margin at that time. The assemblages also provide an insight into the types of plants available as food sources for the large Cretaceous terrestrial herbivores.

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MAKING MICROFOSSIL SLIDES

K. N. Bell, Stony Creek, South Gippsland, Victoria.

Microfossils such as foraminifera, ostracods, fish remains and conodonts and the smaller molluscan species can be easily stored and protected using special microslides. These slides can be difficult (and expensive) to obtain commercially but can be easily made at home with a little care and patience. Whilst plastic slides can be purchased or made, I prefer cardboard ones as there is no static electricity problem which can be troublesome with smaller fossils. A slide protected in a glass topped sleeve is constructed as follows :-

Required are thick cardboard (about 2-3 mm), thin card, stiff paper, glass slides, one or more wad punches or 'Stanley' - type knife and a good paper glue. The thin card should be coloured to provide a background to the fossils - either black or green is normally used.

The steps involved are :

a. Cut thick cardboard to size, usually 25x75 mm.

b. Either punch one or more holes in the cardboard slide; the size and number of holes is an individual preference - I use single, double and triple holed slides with holes about 15 mm in diameter.

c. Cut the thin card to same size as the cardboard slide (25x75 mm).

d. Glue the thin card to base of slide (Fig. A).

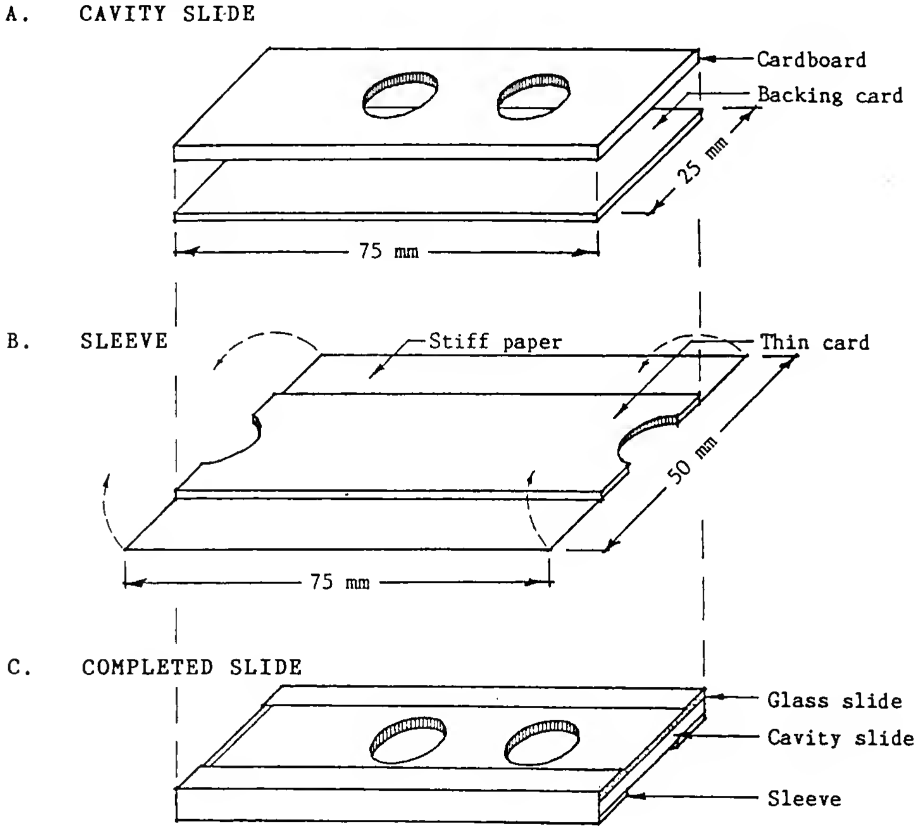
e. Another piece of thin card is cut to size and glued to the stiff paper (Fig. B); the paper is 50x75 mm in size.

f. It is useful to make finger cutouts with the punch as shown in Fig. B.

g. The final assembly consists of placing a clean glass slide on A, placing both on B, folding up the free sides of the stiff paper firmly and glueing to the glass slide (Fig. C).

Various glues can be used; I have found UHU Stic glue and Perkin's paste quite suitable but no doubt many others can be used - all that is required is that the paper/glass join be firm and long lasting. The cavity slide should move smoothly but not loosely in the sleeve. By cutting out the various pieces in bulk firstly, the total time to make a slide is only minutes.

Square or rectangular cavity slides can be made by carefully cutting out with a 'Stanley' - type knife (can you buy rectangular wad punches?). To house thicker specimens, two or more cavity slides can be glued together and then assembled as previously. If you want a numbered grid on the slide, it is possible to draft up a suitable numbered grid pattern and have it reproduced as photographic prints on heavy quality gloss paper. This then takes the place of the backing piece in A.



Specimens can be left free in the cavities or glued down using a thick solution of gum tragacanth to which a few drops of oil of cloves has been added as a fungicide. Specimens once glued down can be easily released by using a damp brush to soften the gum.

Of course, all slides must be fully labelled with locality data, collector, date at least; do not rely on memory. Slides can be stored in small boxes or a small cabinet with sliding trays can easily be constructed from 3-ply, cardboard and staples to any desired size.

No doubt, other variations on these procedures will suggest themselves.

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CONFERENCE ON VOLCANISM AND EARLY TERRESTRIAL BIOTAS

(Organised by The Royal Society of Edinburgh and The National Museum of Scotland - September, 1992)

This conference brought together a diverse group of geologists, geographers, volcanologists and palaeontologists, all in some way involved with the early Carboniferous volcanogenic deposits at East Kirkton, near Bathgate, Scotland. We discovered subsequently that the meeting also attracted a group of NASA scientists interested in the possibility of organisms being preserved in the hot springs of Mars!

East Kirkton is perhaps most famous for producing "Lizzie", the earliest known "reptile", and for the publicity which surrounded this fossil when Stan Wood, a "commercial" collector, offered it for sale on the world market at approximately $300,000. Although funds were raised to allow "Lizzie" (now properly known as Westlothiana lizziae) to remain at The Royal Scottish Museum and several other of Stan Wood's fossils from East Kirkton were bought by British museums, the incident has left the palaeontological community scarred. Resultant problems include the understandable reluctance of museum authorities to allow destructive preparation of such valuable specimens. Most East Kirkton specimens are so called "road kills", i.e., squashed, with rotten bone, so that only removal of the bone allows access to the fine detail preserved in the mould.

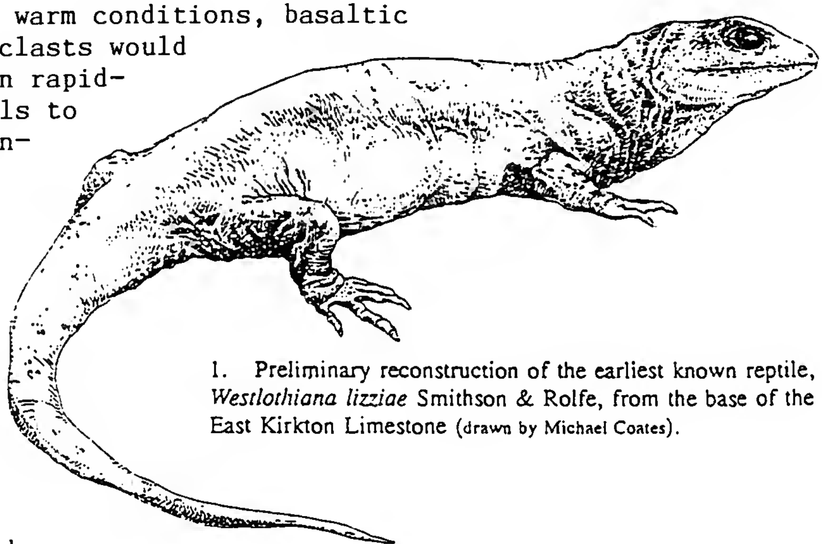
The interest of these deposits lies in their age, as early Carboniferous terrestrial deposits are rare, and in their vulcanogenic nature.

Many of the invertebrate fossils are the earliest proven terrestrial records of their group, including diplopod millipedes, scorpions, and a harvestman spider.

Apart from Westlothiana, the vertebrate fauna includes at least three types of fossil amphibians, providing evidence that several groups of tetrapods were fully terrestrial earlier than previously recognised. Among the most recent discoveries are fish, disproving an earlier theory that the fauna had been killed and preserved by falling into hot springs.

Geologists interpret Britain in the early Carboniferous (Dinantian) as the earliest example of intraplate alkali basaltic volcanism. In the East Kirkton area a variety of habitats for terrestrial biotas would have arisen in association with the volcanic activity. The basaltic cones would have provided areas of relatively high and well drained ground as well as islands emergent during periods of marine incursion. Larvas episodically dammed river valleys giving rise to fresh water lakes and swamps. Crater lakes within tuff rings provided closed environments within which a rich flora and fauna could develop. The hot springs would have occurred within ephemeral geothermal areas.

In these moist, warm conditions, basaltic larvas and pyroclasts would have broken down rapidly yielding soils to be rapidly colonised by plants. Abundant charcoal in the East Kirkton quarry provides evidence not only of afforestation but also of forest fires.



1. Preliminary reconstruction of the earliest known reptile, *Westlothiana lizziae* Smithson & Rolfe, from the base of the East Kirkton Limestone (drawn by Michael Coates).

The richness and diversity of these habitats must have provided an ideal climate for the rapid evolutionary advances found in the East Kirkton biota.

The conference ended with several areas still disputed. Were the tetrapods preserved under marine or fresh water conditions? Were some of the terrestrial fauna trapped by hot springs? If the springs were sufficiently cool to support life, why is there no evidence of aquatic life in the limestones? Why were the smaller tetrapods, like "Lizzie", preserved intact, while larger tetrapods were fragmented? Is the tetanic position of the bodies of these specimens evidence of desiccation or of poisoning? Are the striations present within the orbits of the temnospondyl amphibian really remains of eyelids? And, perhaps most importantly to this vertebrate palaeontologist, is "Lizzie" really an amniote?

Anne Warren, La Trobe University, Melbourne, Australia.

THE JAWS OF DEATH: EVIDENCE FOR PREDATION AND SCAVENGING IN VERTEBRATE FOSSILS

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Professional and amateur palaeontologists alike have often been fascinated by the strange forms of extinct animals. Some of these - like the triangular plates of the dianosaur Stegosaurus, or the morning-star-like tail clubs of the glyptodonts - have been assumed to be for defence against predators. However, in recent years, palaeontological interest has focussed largely on understanding evolutionary (phylogenetic) relationships. This results in a very detailed anatomical kind of palaeontology, producing papers consisting of lists of hordes of anatomical details, but has distracted attention from research on how animals actually lived. Of course, if the popular methodology, cladistics, is as good as its proponents claim then very shortly this work should come to a halt because we will soon understand the relationships of all of the well-known fossil organisms. Further work would be needed only when new taxa are discovered. Whether this has already happened is not clear, but interest among many vertebrate palaeontologists seems to be shifting from evolutionary relationships to understanding how animals lived and died.

Of primary interest, it seems, is how the animals died. After all, this kind of evidence was the last 'impressed' upon the animal, or its body, before it became preserved. Hence it is the most easily found, not being effaced by subsequent events in the beast's life. Furthermore death is one important event by which natural selection is effected, and so evidence for preda-

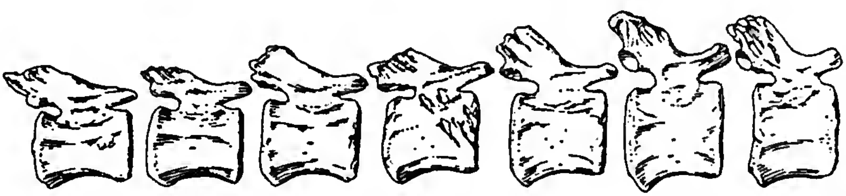

FIGURE 1. Six caudal vertebrae from a specimen of Apatosaurus in the American Museum of Natural History (New York) showing score marks from the teeth of a carnivorous dinosaur. These marks can be seen on the tips of the neural spines of all the vertebrae, except the third from the left, and, additionally, on the body of the third vertebra from the right. These were made whilst feeding on the tail, but whether the apatosaur was killed or only scavenged by the carnivore cannot be determined from the evidence. (From Osborn)

tion in the fossil record illuminates the mechanics of evolution in times long past. It has long been assumed that many features of modern and fossil animals are related to predation, yet with few exceptions, the evidence for this has been scanty, sometimes dubious. I recall how tradition had it that certain Early Cretaceous dinosaur bones bore tooth marks of the small, scavenging mammals that had gnawed on the bones. I had the opportunity to examine these specimens many years ago, while doing preparation myself. I found that a slip of the hand with the chisel could produce convincingly similar marks, and hence cast doubt - at least in my own mind - on this evidence for scavenging.

On the other hand, there was some good evidence for predation, or at least scavenging. A skeleton of the Late Jurassic dinosaur Apatosaurus had scored caudal vertebrae that seemed to have been bitten (Fig. 1). The spacing of the scorings matched those between the teeth of the predator Allosaurus. And furthermore, shed theropod teeth, presumably from Allosaurus, were found with the skeleton.

There was also some spectacular, if rare, evidence of actual predation, that is evidence of attacks that occurred during life. In South Dakota (U.S.A.) the skull of an extinct cat, Nimravus, had been found; the top of this skull had been punctured, leaving a large, slot-like wound (Fig. 2). Probably this was inflicted by one of the canine teeth of the contemporaneous sabrecat, Eusmilus. The Nimravus survived this wound - which had entered the base of the snout, penetrating the frontal sinus and perhaps injuring the olfactory bulb - for the opening had almost completely healed by the time the animal died, presumably from unrelated causes. Oddly enough, considering the foul mouths of modern large cats, the injury didn't become infected.

Still, by and large palaeontologists tended to ignore even such fascinating evidence ... for two reasons. Many palaeontologists had been trained as geologists, and hence were primarily interested in what the fossils could tell them about the rock in which they were preserved; that is about stratigraphic correlation and such, rather than about the lives of the animals themselves. Others were basically taxonomists, interested in describing the remains and working out their evolutionary relationships, and - when that was done - going on to the next specimen. It was the anthropologists, interested in how early humans fared, how they obtained their food, and whether they themselves were obtained as food, that first brought attention to evidence for predation. Scientists

THE JAWS OF DEATH (Cont.)

such as C. K. Brain, in South Africa, and Vance Haynes, in Nevada (U.S.A.), worked in this area. They were curious to know if the evidence often adduced for human hunting actually did indicate hunting by humans, or whether it indicated predation by other animals. Here in Australia, this work was pioneered and pursued not by a professional, but an amateur, Mr. Ian Sobbe. He examined Pleistocene bones from the eastern Darling Downs of Queensland for toothmarks and compared them with bones that had been 'treated' by modern Australian predators, particularly Tasmanian Devils (Sarcophilus).

At about the same time in the U.S.A., interest was generated by Drs. Larry Martin and Bruce Rothschild. They had been examining pathological bones from mosasaurs, Late Cretaceous marine lizards distantly related to goannas. Examining the cross-sections of such bones can sometimes reveal the origin of the pathology; whether it was the result of disease or injury. One fascinating, and badly infected bone had a deeply embedded shark's tooth that had caused the infection. Obviously sharks 80 million years ago were as voracious as their modern descendants - but in this case the prey got away.

Talks at the 1992 Society of Vertebrate Paleontology meetings, in Toronto (Canada), showed that interest in such subjects has now become widespread among palaeontologists, both amateur and professional. Dr. Wade E. Miller, of Brigham Young University in Provo, Utah, discussed the skeleton from an aged (gerontic) individual of the sauropod dinosaur Camarasaurus lewisi. The ilium showed marks indicating that teeth had been dragged along the surface, and possibly removed part of the edge. Jim Kirkwood, from Dinamation, described a sauropod scapula marked by teeth from a quarry in Upper Jurassic rocks near Morrison, Colorado, and Dale A. Winkler, of Southern Methodist University, found

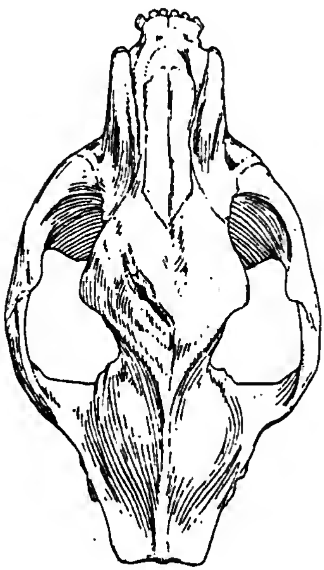

FIGURE 2 (left). The type skull of the Oligocene cat, Nimravus bumpensis, showing a partially healed puncture through the skull roof on the left side. This wound was probably the result of an encounter with the sabrecat Eusmilus. The healing of the wound shows that the wound itself was not fatal, and the Nimravus survived for some time afterward. (From Scott)

tooth marks on the ilium of a juvenile nodosaur from the Early Cretaceous in Texas. Greg Erickson,a graduate student at the University of California at Berkeley, presented a poster session detailing bite marks on Late Cretaceous dinosaur bones from their contemporary predator, Tyrannosaurus rex itself.

Winkler's evidence is most interesting because nodosaurs are armoured dinosaurs, sometimes referred to - by popular science journalists - as walking tanks. Armoured with an almost tortoise-like shell, it seemed obvious that this was protection from attacks by the large carnivorous theropod dinosaurs; yet, considering the mechanics of evolution, there must have been some attacks by theropods. Otherwise it would have been to the benefit of the nodosaurs to abandon producing the armour and divert the metabolic energy saved to producing more eggs, and hence more nodosaurs. After all, that's what evolutionary success is all about. And if there were attacks, there should be evidence for them. Yet so little evidence was evident that it was seriously (I think) suggested that the armour of these dinosaurs served to help heat or cool them during cool or warm weather, respectively. Although it seems very likely that the armour of stegosaurs, with their upstanding triangular plates, did serve to help regulate body temperature, nodosaur armour wasn't so well suited to this.

So Dale Winkler's little nodosaur shows that their armour did have some protective use - or does it? In fact it only suggests, but doesn't prove, that the armour was a defence, because the toothmarks, like those on the camarasaur, might have been made by a scavenger after the little beast was already dead. Nonetheless, at least it does show that the flesh was tasty enough to have been scavenged, and thus that predation was a reasonable explanation for the armour.

However, more spectacular finds were also reported: Mark Norrell, of the American Museum of Natural History in New York City, reported the discovery of a new dromaeosaur skeleton, from Late Cretaceous rock in Mongolia. This animal, with literally paper-thin bones, bore puncture marks from teeth in the roof of its skull. Norrell believed that they were made during the creature's life, and hence really are evidence of predation.

But most significant was the study by Darren H. Tanke, of the Royal Tyrrell Museum in Alberta (Canada), of wounds to some Oligocene artiodactyls, the oreodont Merycoidodon culbertsoni. They

THE JAWS OF DEATH (Cont.)

showed round, depressed fractures, probably punctures by teeth, as well as drag marks from teeth. Some of these wounds had healed, or partially healed. Thus they were indisputably made during life, and must record predation attempts, and not just scavenging. In fact, Tanke reported that one skull has both healed and unhealed punctures piercing the skull roof, and penetrating into the endocranial cavity. The beast had apparently been caught by the head by a predator, perhaps a large cat or bear-dog, then escaped and lived long enough for the punctures at least to start to heal. It was then caught, again by the head, and this time killed. Perhaps the first attack had damaged the beast's brain, so that it was more easily caught later.

So it is clear that close examination of fossils can reveal evidence of both scavenging and predation. This evidence is necessary if we are to understand the role of predation in "designing" protective structures (and behaviours) in prey animals. The role of predators, and their relationships to their prey, can clearly be seen in modern animals. But the long-term implications and results of predation can only be observed in the fossil record. Because the actual attacks cannot be seen by palaeontologists, only careful study of toothmarks and other such evidence on the bones can reveal such attacks and how they were carried out. This is necessary because it is not clear from the form of the teeth alone, that the animals that possessed them were predators and not scavengers. There is a long tradition of debate regarding whether the great theropod dinosaurs such as Allosaurus and Tyrannosaurus, were hunters, or scavengers (not that this distinction was likely to have been of much significance to a hungry theropod). One way to resolve this would be to find injuries, say toothmarks from a theropod, on the bones of another, prey animal, that had healed. This would clearly indicate hunting, not scavenging, and this is what Greg Erickson is doing.

Such work also shows that we cannot rely overly much on reasoning from what is happening now. Christine Janis, at Brown University in Rhode Island (U.S.A.), has argued that among mammals, pursuit predators - those that run down their prey, like African hunting dogs and cheetahs - evolved only recently, in the Pliocene or Pleistocene.

The injuries of fossil bones provide direct evidence, not just supposition, of how prey animals were hunted and attacked. Thus we can glimpse natural selection in action. This leads to better understanding of how prey animals defended themselves or escaped from predation, and hence which individuals survived ("were selected") and which did not. This work illuminates the life-and-death dramas of the deep past that helped set the course of evolution, for both hunter and prey.

IN THE NEWS

FOSSIL FIND PUTS DINOSAURS ON PERTH DOORSTEP

A single fossilised bone found by a young Perth student near Gingin has turned out to be a toe bone from a carnivorous dinosaur such as an allosaurus or the fearsome Tyrannosaurus rex. The bone, about 80 to 90 million years old, was identified in August last year by the curator of vertebrate palaeontology at the Western Australian Museum's Department of Earth and Planetary Sciences, Dr John Long.

Michael Green, 22, a second-year geology student from the University of WA, was searching for sharks' teeth when he found what proved to be an upper toe bone from the fourth toe of a therapod dinosaur, a powerful animal capable of running at 45 km/h when mature and of biting, tearing or kicking its prey to pieces. It was probably a young four to five metre long predator with long sharp teeth and powerful claws, that lived in the Cretaceous when a much colder Australia was still linked to Antarctica and when Perth and Gingin both lay under the ocean which extended up to what is now the escarpment. It was possible that the landscape at that time was cool, temperate and forested as Tasmania is now.

According to Dr Long, the bone might have been part of a carcass swept down a river and into the sea, or it could have been picked up by a scavenging pterosaur and droped into the ocean.

The find means the big area of flat-topped hills around Gingin could be rich in dinosaur fossils. Previously the southermost dinosaur find in Western Australia was made near Geraldton.

Adapted from an article in the West Australian, August 15th, 1992.

NEW ARCHAEOPTERYX FIND

Colin Chidley, a FCAA member, has written to say that late last year he received a letter from a friend in Germany, advising of the discovery at a Solnhofen quarry during August, 1992, of a new specimen of the Jurassic bird Archaeopteryx.

An acquaintance of Colin's German friend was there when the bird was found and helped to save the broken parts. The specimen belongs to a Solnhofen cement company and still needs many weeks of preparation. Value of the fossil is put at 20 million DM (about AUS$ 18,500,000).

There are seven known specimens referred to the genus Archaeopteryx (not including the latest find); the first, identified by Hermann von Meyer in 1860, was a single feather. The most famous specimens are the nearly complete skeleton (lacks head) in the possession of the British Museum (Natural History), London, and one, including the head, in the Humbolt University Museum, Berlin. The other four specimens, including one privately owned, have only been identified in the last forty years, although one skeleton in the Teyler Museum, Haarlem, was reputedly found in 1855.

WESTERN AUSTRALIA PLESIOSAUR DISCOVERY

Early in 1992, geologists Iain Copp and Greg Milner of the University of Western Australia, found part of the fossilised skeleton of a plesiosaur in an eroded gully near Kalbarri.

The plesiosaurs, giant seagoing reptiles which lived at the same time as the dinosaurs, were fearsome creatures which grew to around 13 metres in length. However, the Kalbarri plesiosaur appears to have been a juvenile about 4 m. long. Its likely age has been pinpointed at between 110 and 114 million years old, based on microfossils found in the same bed.

Dr John Long, curator of vertebrate palaeontology at the WA Museum, considers the find particularly exciting because it is the most complete plesiosaur skeleton so far found in WA, being about a third complete. Plesiosaurs evolved into two groups, one with small short heads and long necks and the other with relatively short necks but with proportionately larger heads. Dr Long believes the Kalbarri find is of the rarer short-necked variety. The head is missing, which complicates identification, but the skeleton is complete enough to name and to compare with others from around the world.

Adapted from articles by Brendan Nicholson in the West Australian.

RECENT DISCOVERY OF FOSSIL FISH IN THE LIAS (LOWER JURASSIC) OF GERMANY.

C. M. Chidley, P.O.Box 124, Merrylands, N.S.W., 2160.

Recently, a number of Jurassic fish specimens have been recovered from the Schwarzer Jura (Lias) or Black Lias of Germany during excavations for the new Main-Donau Canal between the townships of Sulzkirchen and Bachhausen north of Nurnberg. The two species found belong to a fauna that can be compared with that of the Talbragar River Fish Bed deposit, New South Wales, Australia. One specimen, a Coccolepis, caused much excitement, as it is the first of its kind to be found in Central Europe.

The two species recovered are as follows:-

Leptolepis coryphaenoides (Fig. 1. - 8.4 cm. long), was found in the Laibstein (Breadstone), 1 km. east of Sulzkirchen. In a recently published book (see note) it is compared with the Australian Jurassic fish Leptolepis talbragarensis (Fig. 2.).


1.

The other specimen, the one that caused great excitement, was Coccolepis liassica (specimen Fig. 3.- 13.5 cm. long), found in the Olschiefer (Oilshale), also 1 km. east of Sulzkirchen.

Note: For further information refer:

Schmidt-Kaler, Tischlinger and Werner, 1992. **Wanderungen in die Erdgeshichte. Sulzkirchen und Sengenthal - zwei beruhmte Fossilfundstellen am Rande der Frankenalb.** Druckerei Braunstein, Munchen, 112p (German).

ASTEROIDS MAY HAVE CAUSED BREAK-UP OF GONDWANALAND

Asteroids slamming into the Earth 250 million years ago might have caused the break-up of an ancient super-continent into the present day land masses.

An Associate Professor of Applied Science at New York University, Professor Michael Rampino, reported during a meeting of the American Geophysics Union that he had found two large basins off Tierra del Fuego at the southern tip of South America which might have been caused by the impact of comets or asteroids millions of years ago. He believes the large impact structures found off Tierra del Fuego are in the right place to have caused the splitting of the super-continent.

The impacts might have fractured the Earth's crust, allowing the subsequent break-up of the ancient super-continent, Gondwanaland, one of two land masses that split to form the present day continents. The different parts of Gondwanaland drifted apart to form South America, Africa, India, Australia and Antarctica. The other continents were formed from the super-continent Laurasia.

ASTEROIDS MAY HAVE CAUSED THE BREAK-UP OF GONDWANALAND (Cont.)

Professor Rampino said he had identified two circular bedrock basins, 320 km. and 200 km. in diameter on the Falklands Plateau. The smaller basin is outlined by the circular Gulf of San Jorge in southern Argentina. These large basins have the form and structure expected of craters produced by the impact of comets or asteroids 9 km. to 19 km. in diameter.

The rocks in regions of South America, West Antarctica and South Africa - which would have been within 960 km. of the centres of the basins before the break-up of Gondwana - showed evidence of having suffered an intense disturbance about 250 million years ago. The period when the basins were believed to have been formed was marked by the most severe mass extinction of life in the geological record when 96 per cent of all species were lost.

Based on a Reuters report from San Francisco, December, 1992.

IN THE NEWS (Cont.)

The F.C.A.A. is indebted to the Palaeontological Association (U.K.) for permission to reprint the following selected abstracts from their Christmas Meeting.
These abstracts were first published in Palaeontology Newsletter No. 16, Autumn 1992.

PERMIAN AND TRIASSIC FOSSIL FORESTS FROM ALLAN HILLS, ANTARCTICA.

Jane Francis, Earth Sciences, University of Leeds.

Petrified conifer wood is abundant in Permian and Triassic sediments at Allan Hills in the Transantarctic Mountains, Antarctica. The wood is preserved as large logs, up to 21 m long, and tree stumps in a sequence of sandstones, silt stones and coals. The sediments represent a forested coal swamp environment through which large rivers meandered. The migrating rivers disturbed the trees, washing soil from around the tree stumps and causing some trees to be washed into the rivers, later to be trapped on point bars.

Glossopteris leaves and Vertebraria rootlets are also common in these sediments, the rootlets preserved in their growth positions in siltstones beneath the coals. The dimensions of the petrified wood indicates that the forest was composed of large forest trees, even though the palaeolatitude during the early Permian was about 80°S. Growth rings in the wood are wide, indicative of favourable conditions during the growing season. However, the presence of glacially-striated, ice-transported boulders in the same sediments indicates that the climate of this region was at least seasonally cold.

THE FIRST DAY OF THE TRIASSIC

Paul Wignall, Earth Sciences, University of Leeds.

The Permo-Triassic mass extinction was the worst calamity in the history of life. The nature of the event and its origin are poorly understood and there is currently little consensus amongst those studying the subject. When taken at face value, the fossil record appears to show a gradually declining diversity throughout the latest Permian and this has led many to a protracted extinction event spread over several million years. This is probably an artifact due to the rarity of latest Permian strata. In those regions where latest marine Permian is preserved there is an increase in diversity up to the topmost Permian. This is seen in western China where reefs thrive to the boundary and in the Dolomites where quantified diversity analysis of foraminiferal faunas reveals little change until the boundary is reached.

In most complete sections the Permo-Triassic mass extinction appears to have occurred within the space of a bedding plane or at most a few decimeters implying a catastrophic event. This is associated with a spectacularly rapid basal Triassic (Griesbachian) transgression and the spread of deep water dysaerobic or anaerobic deposition. Only in Salt Range of Pakistan, and similar southern Tethyan locations, did shallow water deposition persist into the Triassic and it is noteworthy that these are the last localities where the typical Palaeozoic high level tiered communities persist; these too eventually succumbed as deep water conditions were established over vast areas in the mid Griesbachian.

GREAT MOMENTS IN INSECT EVOLUTION

Ed. A. Jarzembowski, Postgraduate Research Institute for Sedimentology, University of Reading & Town Hall, Brighton.

Insects are the most diverse class of living organisms, but the geological occurrence of insects is sometimes presumed to be too poor to merit mention. In fact, over 1,080 families in some 40 orders have a fossil record.

Primitively wingless insects (hexapods) first appear in the Lower Devonian and no 'intermediates' are known with Crustacea/Myriapoda.

Winged insects appear suddenly in the latest Early Carboniferous. They were the first animals to develop powered flight and the success of this adaptation is reflected in the Recent fauna in which 99% of species belong to winged or primitively winged groups. Over 80% of these insects undergo complete metamorphosis and such holometabolous insects had radiated by the Early Permian.

Following the Permo-Triassic extinctions, insects took on a more modern aspect with social groups and fleas appearing in the Lower Cretaceous as well as the oldest insect bearing amber. Beetles emerged as a major group by the end of the Mesozoic and moths and butterflies radiated later in the Tertiary. The rise of the angiosperm flowering plants was probably the biggest upheaval in the insect world in the last 100 million years (but will probably pale into insignificance compared with the mass extinction forecast during the next century).

PTEROSAUR WINGS: THE FINAL SOLUTION?

David M. Unwin, Department of Geology, University of Bristol, Queen's Rd, Bristol, BS8 1RJ.

Pterosaurs are now generally accepted to have been true flapping fliers, but a fierce debate still continues over the extent and structure of their wings. "Narrow, stiff wings" and "extensive, floppy wings" represent either end of a broad spectrum of ideas. Resolution of this debate has been hampered by: (1) the difficulty of interpreting remains; (2) a tendency to generalise from a few or even single specimens; and (3) failure to separate ideas on wing shape from those concerning wing structure.

Combined evidence from fossilised soft tissues, impressions, osteology, arthrology, PTEROSAUR WINGS: THE FINAL SOLUTION (Cont.)

taphonomic studies, biomechanics and phylogenetic analysis lead to the conclusion that many pterosaurs had rather extensive wings which attached to the hind limbs as far as the ankle. In early pterosaurs a uropatagium was stretched between the hind limbs and manipulated by the fifth toe.

The wing membrane was a complex, multi-layer structure containing blood vessels, muscle and thin fibres which, at high magnifications, appear to be bundles of very fine fibrils. Proximally the membrane was relatively pliable, but became much stiffer toward the wing tip. In flight the shape of the wing was controlled by the fore limbs, hind limbs and movements within the membrane itself.

ANIMAL, VEGETABLE AND MINERAL STUDIES ON A LATE DEVONIAN BLACK SHALE FROM SOUTH AFRICA

Norton Hiller, Rhodes University, Grahamstown, South Africa.

A new fossil locality in the Witteberg Group (Devonian) in the eastern Cape Province of South Africa has yielded a variety of fish and plant remains. The fossils were recovered from a carbonaceous shale interbedded with the typical quartzose sandstones of the Witpoort Formation. The rocks are interpreted as having been deposited in a marginal marine setting, with the black shale representing a back-barrier lagoon or a marsh. The fossils appear as white, mineralised compressions in which organic tissues are represented by a mixture of kaolinite and a metamorphic mica. As a result, preservation is rather poor.

The fish fauna includes, a dipnoan, a chondrichthyan, an acanthodian, and three placoderms that make up a distinctive Late Devonian assemblage comprising a phyllolepid, a groenlandaspid, and a species of the antiarch Bothriolepis. This assemblage is well known from Australia, Antarctica, and Euramerica but the occurrence described here is the first recorded from west Gondwana. The plant remains include an intriguing mixture of apparently primitive forms, such as the Cooksonia -like genus Dutoitia, and more advanced types, like the progymnosperm Archaeopteris which is recorded for the first time from South Africa. In addition, there are numerous specimens that cannot be assigned with confidence to any major plant group.

LETTERS TO THE EDITOR

"Talbragar Fish Beds"

Dear Editor,

I wonder if a few comments on the Lake of Talbragar, Fish and Flora beds would be of interest. It comes within my research interests in the Mesozoic of eastern Australia. These were prompted by the interesting article from C. M. Chidley in The Fossil Collector (September 1992 - page 17). I have no knowledge of the Liaoning Province Fish beds of China.

Firstly, within 30 kilometers of the Talbragar site there is evidence of igneous activity which could have supplied tuff to the sediments and devitrification would provide soluable silica for silification. Only six kilometers from Leadville, about 30 kilometers from Talbragar, there are exposures of the Boggabri Volcanics of Rhyolite and Andesite. These are Permo/Carboniferous in age but nearer in time and widely evident to the north and east are the Garrawilla Volcanics giving Dolerite, Basalt, Trachyte Tuff and Breccias. And most sediments in the area contain more or less iron. The Garrawilla Volcanics are very Early Jurassic while the Talbragar Beds belong to the Ukebung Formation, late Early Jurassic. These could surely be a source to supply sediments of ferruginous, siliceous cherts and shales for Talbragar. The specimens I have studied have varied from hard, ferruginous cherts to soft shales.

Secondly, the relationship of the freshwater lake deposits. These freshwater lakes were a dominant feature of the inland Australian landscape from the Late Triassic through the Jurassic to the Early Cretaceous when a marine transgression took over the inland basin area. Vast quantities of sediment deposited in these inland basins formed the Great Artesian Basin of today. Although eastern Australia was then in far southern latitudes, precipitation must have been very high and subsequent erosion on a very active scale. The Permian Hunter Bowen Orogeny would have given highlands to the southeast and the coast was much further east than now. To maintain the great fresh water lakes the rivers would have been flowing inland at that time. I am sure it would be normal for there to have been smaller freshwater lakes around the margins of the larger lake areas from time to time. Talbragar would have been one of these, the time length of its existence is a subject for further study.

I find it difficult to agree with some of Mr. Chidley's conclusions about the deposition of sediments at Talbragar, because the majority of specimens which I have seen have been of very fine sediments deposited in thin, parallel strata of even thickness. These could only have formed from a succession of deposits from sediment laden relatively quiet water, without sufficient momentum to carry fine sediments any further. There are specimens showing slight signs of minor turbulence in the strata, but neither the fish nor the flora are much disturbed. Further there are many complete, possibly deciduous, shoots of Agathis, complete even to the basal scale leaves. I also have several small but complete fern fronds. That Sahnia, the pollen organs of Pentoxylon, have been found there would argue for gentle transport of these fragile specimens. The age of any ash falls is prior to the age of the Talbragar Beds so, in the warm, long, wet summers, the surrounding landscape was probably well clothed in vegetation and heavy showers could wash the flora in from the forest floors. Was there sufficient sediment to overwhelm the fish or did they die of starvation during the long dark months of winter? They are often co-fossilised with the vegetation. As there are layers of fossils, parallel and a centimeter or more of sediment apart it would seem that the fish were killed periodically and buried rapidly and completely with the associated flora.

I note with considerable interest the comment about the absence of any pollen in samples so far from Talbragar. In view of the wide dispersal of pollen and its durability as a fossil, there are clearly many questions yet to answer.

References

Geological information - 1:500.000 Geological Map of Coonamble, published by the Geological Survey of New South Wales.

White, M. E., (1981). Revision of the Talbragar Fish Bed Flora (Jurassic) of New South Wales. Records of the Australian Museum 33: 695-721.

White, M. E., (1986). The Greening of Gondwana. Reed Books Pty Ltd, Frenchs Forest, New South Wales, 256p.

Other coments are based on studies of specimens in the writer's personal collection.

Sheila Bennetts, R.S.D., Verney Road, Shepparton, Victoria. 12/10/1992.

BOOKS AND BOOK REVIEWS

TREATISE ON INVERTEBRATE PALEONTOLOGY, PART R, Arthropoda 4, volumes 3 & 4, Hexapoda (1992). The Geological Society of America, Inc., Boulder, Colorado and The University of Kansas, Lawrence, Kansas, 677p. (ISBN 0-8137-3019-8). Price US$87.50.

These long awaited volumes cover the superclass Hexapoda and complete the original Part R, Arthropoda 4, the first two volumes of which were published in 1969. Within the superclass Hexapoda, four classes are recognized: the Collembola, Protura, Diplura, and Insecta. It is with the latter of these, the class Insecta, that the bulk of these two volumes is concerned.

The class Insecta is by far the largest of all existing classes of animals. Because of problems of preservation, however, only a small fraction of the total number of species of insects, both living and extinct, is represented in the fossil record. At this time, insects are unknown in deposits older than the Upper Carboniferous, but the presence of eleven orders in these rocks indicates that the class had a long, prior evolutionary history.

This two-volume set presents diagnoses of more than 5000 genera of fossil insects, 1195 of which are illustrated. Type species are indicated for all extinct genera. These volumes also include a carefully compiled bibliography of well over 2400 titles, documenting everything from the higher taxa down to the type species. A stratigraphic chart shows the geological ranges of the 777 families in the superclass. This landmark publication will be a useful reference tool for paleontologists and entomologists, as well as for zoologists in general.

The Treatise on Invertebrate Paleontology is distributed by The **Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140, U.S.A.** [telephone (303)447-2020, fax 303-447-1133].

FOSSILS (Collins Eyewitness Handbook Series) by Cyril Walker and David Ward. Published in Australia (1992) by Collins Angus and Robertson Publishers Pty Limited, a division of Harper Collins Publishers (Australia) Pty Limited, Pymble, N.S.W., 320p. Recommended retail price - hardcover AUS$29.95 [ISBN 07322 0122 5]

This visual guide to over 500 fossil genera from around the world should not be confused with the book of similar title by P. D. Taylor, issued in the Collins Eyewitness Guide Series.

Introductory pages give brief but useful information on what constitutes a fossil; modes of preservation; where to look; fossil collecting, including details of equipment to take on field trips; and preparing your collection. It also includes an easy to read geological time chart; an 8 page fossil identification key; and an annotated example of a typical page explaining how the book works.

The book is divided into three parts: invertebrates, vertebrates, and plants. Within these major divisions, the main groups of fossils are introduced. Using the genus as a starting point for identification, usually a typical or relatively common species is illustrated with identifying features clearly highlighted. A written description of the main characteristics of the genus is followed by information on habitat and general remarks about the animal or plant. Boxes show the Order, Family, informal name, geological range distribution and frequency of occurrence. One very pleasing feature is the inclusion of a small drawing showing a reconstruction of of the fossil species, as it would have appeared when alive. It is a pity one or two of these reconstructions do not match the orientation of the specimen in the photographs (anterior - posterior reversed).

The handbook is intended to assist the collector by illustrating a broad range of fossils, from those likely to be found to some of the more spectacular but less common. Although fossils were chosen from the collection of The British Museum (Natural History), London, they are not restricted to specimens from the United Kingdom, but cover material from all over the world, including Australia. While 19 of the genera are illustrated by Australian species, many more with a world wide distribution are to be found in this continent.

By and large, reproduction of the photographs by Colin Keata are excellent, however, as is often the case, there are a few illustrations where little colour contrast exists between the specimen and matrix, making recognition a little difficult. Unfortunately, whether due to insufficient proof reading or a failure to check the accuracy of Museum labels, there are occasional spelling errors and superseded taxonomical names etc. Nevertheless, as an inexpensive guide for the novice, it compares more than favourably with similar books produced in the last decade, the boxed format accommodating each illustrated genus being particularly pleasing and easy to comprehend.

Comments by Frank Holmes.

A GUIDE TO THE FOSSILS OF THE ALBANY REGION by K. J. McNamara. Department of Earth and Planetary Sciences, Western Australian Museum, Perth, 1992, 12p. Australian price $3-50 + 50c postage & packing (see enclosed order form).

This booklet tells the story of the marine and plant life that lived around Albany 40 million years ago, based on the fossilised remains of sea urchins, starfish, sea lilies, brachiopods, bivalves, bryozoans, crabs, sharks, nautiloids, gastropods, sponges and plants. Containing 36 line drawings of fossils, this booklet is designed to assist both amateur and professional geologists to identify their fossils.

A GUIDE TO THE FOSSILS OF THE NEWMARRACARRA LIMESTONE BY K. J. McNamara and K. Brimmell. Department of Earth and Planetary Sciences, Western Australian Museum, Perth, 12p. Australian price $3.50 + 50c postage & packing (see enclosed order form).

In the hills surrounding Geraldton in W.A. occur the only extensive marine Jurassic deposits in Australia. This booklet describes and illustrates with 39 photos, 27 species of ammonites, bivalves gastropods, brachiopods, echinoids and belemnites. As with the other two booklets in this series, it is designed to assist both amateur and professional geologists to identify their fossils.

OVERSEAS COLLECTOR WISHES TO EXCHANGE FOSSILS

Michael Reagin, 3108 E. Lee Street, Pensacola, Florida 32503, USA., wishes to acquire Cenozoic marine fossils from Australia, New Zealand and other countries in the South Pacific and Asia. Has Tertiary shells and echinoids from the Eocene through Pliocene of the southeastern U.S. as exchange.