THE STRATIGRAPHIC PALYNOLOGY
OF
ATHENE # 1,
GIPPSLAND BASIN.

for: PHILLIPS AUSTRALIAN OIL COMPANY.

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ATHENE # 1

SUMMARY OF STRATIGRAPHIC PALYNOLOGY.

DEPTH (m)	SPORE POLLEN ZONE	DINOFLAGELLATE ZONE	AGE	PALEOENVIRONMENT
2756 - 2760	*P. tuberculatus*	?	Early Oligocene	marine to marginal marine
2765 - 2780	Lower *N. asperus*	?	Mid Eocene	
2786.5 - 2838.5	*M. diversus*	?	Early Eocene	
2879.5		*I. druggii*		non marine to marginal marine
2904.5	*T. longus*	?	Maastrichtian	
2904.5 - 3258.5				non marine
3302.5 - 3382.5	*T. lilliei*		Campanian	

A. SIDEWALL CORES.

SPORES and POLLEN

The spores and pollen identified are listed in Table 1 and the ranges of diagnostic species are shown on Figure 1. The species in Table 1 are grouped into three categories:-

1) Spores, mostly from ferns and their allies.
2) Gymnosperm pollen: pines e.g. hoop pine, Huon pine etc. These would have been mostly forest trees. Their relatives are found today in forests of Tasmania, New Zealand, New Caledonia and New Guinea. Only a few grow on the Australian Mainland and they are restricted to rainforests and the wetter climates.
3) Angiosperm pollen: flowering plants. These may have been trees or shrubs.

An assessment of the abundance of plant tissue debris is included in Table 1. Plant tissue debris is abundant in non marine swamps but less so in fresh water lakes. Plant tissue debris is not abundant in marine environments unless the location is close to a river outlet. However, other factors are involved with the abundance of plant tissue debris, e.g. preservation. Poor preservation may destroy or render unrecognisable much of the plant tissue debris.

The ranges of diagnostic species and zonation follows Stover & Partridge (1973, 1982) as ammended by Partridge (1976). Some modification has been made in the light of experience and they are explained in the text.

Experience has shown that subsequent publications on the same period extend the ranges of some diagnostic species. This is seen especially for the Early and Middle Cretaceous where three groups of authors have published on this time range. For this reason, if the ranges of some species fall slightly outside of those given in the references, then it is not considered serious. Sometimes there is conflicting evidence, and the method adopted then is to add up all the pros and cons before making a decision. Even with this approach, some assemblages remain problematical and it requires independant evidence to resolve these difficulties.

<u>1. *T. lilliei* Zone, Campanian, 3302.5-3382.5m.</u>

Triporopollenites sectilis and *Latrobosporites amplus* are found in the oldest sample. Both of these species first appear at the base of the *T. lilliei* Zone. Other species which first appear in the *T. lilliei* Zone are found in other samples, viz. *Latrobosporites ohaiensis*, *Lygistepollenites balmei* and *Nothofagidites endurus*. There are no species present which first appear in the overlying zone.

<u>2. *T. longus* Zone, Maastrichtian, 2904.5-3258.5m.</u>

The *T. longus* and *T. lilliei* Zones are generally similar with only a few species appearing at the base of the *T. longus* Zone. Of these few species, only *Proteacidites angulatus* is found regularly in these assemblages and it extends down to 3258.5m. One questionable specimen of *Dilwynites granulatus*, which also first appears at the base of the *T. longus* Zone, is found at 3113.5m.

Experience with Helios and Hermes has shown that the *T. longus* Zone extends above the *I. druggii* dinoflagellate Zone (discussed further below) and into the Paleocene. However, in Athene # 1, the *T. longus* Zone stops at the *I. druggii* Zone, hence is Maastrichtian here. Thus relative to Helios and Hermes the upper part of the *T. longus* Zone is absent in Athene.

<u>3. *M. diversus* Zone, Early Eocene, 2786.5-2838.5m.</u>

The lowermost assemblage here contains no pollen whatsoever, but the dinoflagellates (discussed further below) indicate an age compatible with the *M. diversus* Zone. In the other assemblages, *Ischyosporites gremius*, *Cupanieidites orthoteichus* and *Nothofagidites emarcidus* first appear at the base of the *M. diversus* Zone. *Australopollis obscurus* terminates its range at the top of the *L. balmei* Zone, but experience has shown that it is a frequent transgressor into the *M. diversus* Zone; contrary to published range charts. There are no species present which first appear in the overlying *P. asperopolus* Zone.

The *M. diversus* Zone has been divided into lower, middle and upper, but the diagnosis of this subdivision has not been published, hence is unknown. Consequently, it is not possible to place these assemblages into a subdivision of the *M. diversus* Zone.

4. Lower *N. asperus* Zone, Mid-late Eocene, 2765-2780m.

These assemblages all have abundant *Nothofagidites* species, and this is a feature of this zone. *Nothofagidites asperus, N. vansteenisii* and *N. falcata* first appear at the base of the Lower *N. asperus* Zone. There are no species present whose ranges terminate in the underlying *P. asperopolus* Zone.

Originally, the Lower and Upper *N. asperus* Zones were described (Stover & Partridge, 1973). Subsequently, the Middle *N. asperus* Zone has been named but not described, so its diagnostic features are unknown and it is not used here. However, the Lower *N. asperus* Zone in the original sense, and used here, probably includes both the subsequent lower and middle subdivisions.

5. *P. tuberculatus* Zone, Early Oligocene - Mid Miocene, 2756-2760m.

Cyatheacidites annulatus is present and it first appears at the base of the *P. tuberculatus* Zone. *Proteacidites tuberculatus* is also present but it first appears at the base of the Upper *N. asperus* Zone. There are no species present which first appear in the younger zone above.

DINOFLAGELLATES

The dinoflagellates identified are listed on Table 1 and the ranges of diagnostic species shown on Figure 2. Precise ranges are known for only the diagnostic species. Although ranges for the other species are not documented, the age of the type specimen is usually available, and is used as supporting evidence.

Dinoflagellate zones have been named in Partridge (1976) and Stover et al (1979) but they have not been described, so the diagnostic features of the zones are not known. One assumption of the diagnosis is that the species after which the zone is named is common therein. Another possible assumption is that the presence of the nominate species indicates the zone until the next nominate species of the zone above it appears. It should be noted that the ranges of these species usually extend beyond the zone. As with the spores and pollen, experience may show that the ranges require modification. Some modifications have been adopted in this report and they are explained on next page.

1. 2904.5m.

Here, there are two crumpled dinoflagellates which cannot be identified reliably, hence they are listed as unidentified species on Table 1. However, one of them has the type of spines seen on *Apectodinium homomorphum*. From evidence in Helios and Hermes, an informal "*Apectodinium* spp. Assemblage" has been recognised below the *I. druggii* Zone. Although the evidence in Athene is not conclusive, it suggests that the same pattern exists here.

2. *I. druggii* Zone, Late Maastrichtian-Early Paleocene, 2879.5m.

Only two specimens of *I. druggii* have been found here.

Originally, Partridge (1976) placed the *I. druggii* Zone completely within the Maastrichtian, the top of the zone being coeval with the top of the Cretaceous. Stover et al (1979) follow this scheme. However, in New Zealand, *I. druggii* occurs both below and above unconformable contact between late Maastrichtian and early-mid Paleocene in a single, well documented outcrop section (Strong, 1977, Wilson, 1978). Moreover, *I. druggii* occurs in the type Danian of Denmark (Wilson, 1978).

Figure 2 has been modified in the light of this evidence.

3. 2756-2786.5m.

Dinoflagellates occur throughout this interval. Unfortunately, none of the named zones can be recognised, even if both of the assumptions of diagnosis (discussed above) are adopted. Considered in conjunction with the spore pollen zones, however, the dinoflagellates are in good agreement.

a) *M. diversus* Zone, Early Eocene, 2786.5-2838.5m.
   Glaphyrocysta retiintexta occurs here, within its range. Other dinoflagellates are compatible with this age, e.g. *Achomosphaera crassipellis, Leiosphaera scrobiculata*. Others are long ranging, e.g. *Spiniferites ramosus*.

b) Lower *N. asperus* Zone, Mid-late Eocene, 2765-2780m.
   Systematophora placacantha and *Areosphaeridium capricornum* (although a poor specimen in this case) both occur within their ranges here. Others are compatible with a mid-late Eocene age, e.g. *Deflandrea leptodermata, Impagidinium dispertitum* and *Phthanoperidinium eocenicum*.

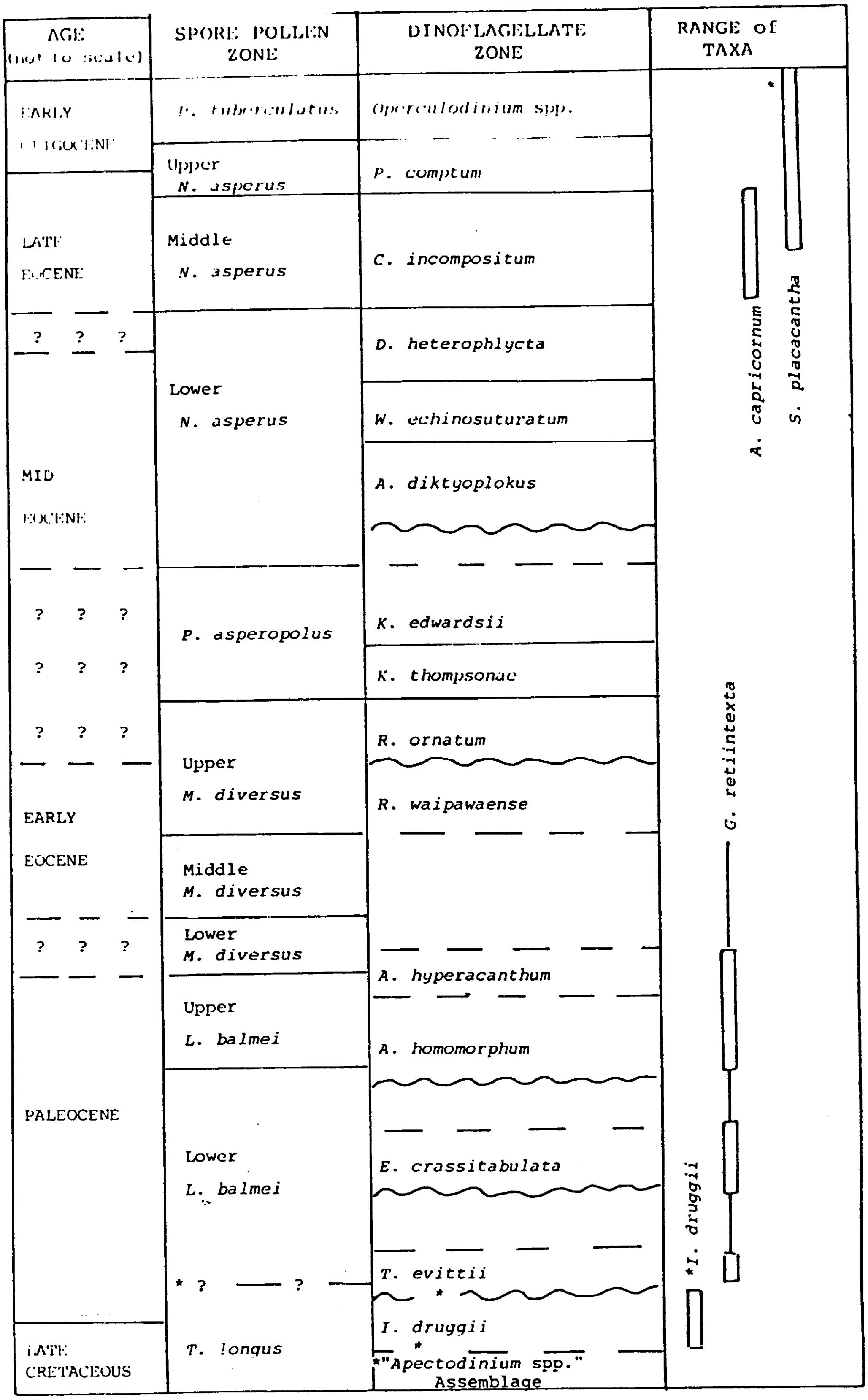

FIGURE 2: ATHENE # 1 DINOFLAGELLATE RANGE CHART BASED on STOVER et al (1979) & PARTRIDGE (1976), with modifications marked*. For further explanation, see text.

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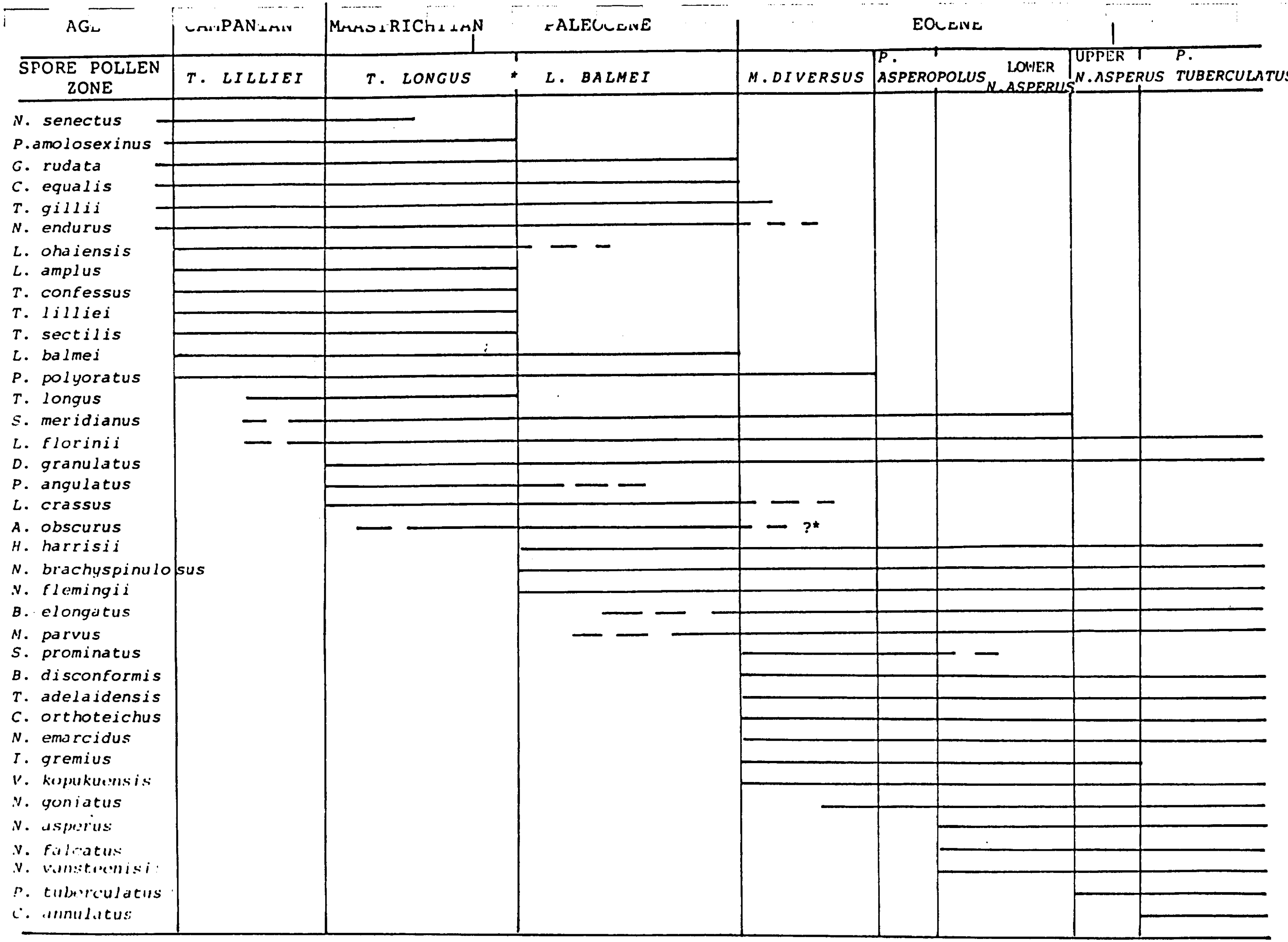

FIGURE 1: ATHENE # 1 SPORE POLLEN RANGE CHART.
Based on STOVER & PARTRIDGE (1973, 1982) and PARTRIDGE (1976), with modifications marked*. For further explanation, see text.

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c) *P. tuberculatus* Zone, Early Oligocene-Mid Miocene, 2756-2760m.

Operculodinium centrocarpum is the most common dinoflagellate in 2760m, hence would agree with the *Operculodinium* spp. Zone named in Partridge (1976). However, *Operculodinium* sp. is the most common dinoflagellate in 2770m, in the Lower *N. asperus* Zone, so it is doubtful whether this feature is reliable for the diagnosis of an Early Oligocene zone. *O. centrocarpum* is also very abundant in the Early Miocene of the Murray Basin (Martin, unpubl.) and it is one of the most common dinoflagellates found in surface marine sediments today (Wall et al, 1979), which casts further doubt on the usefulness of an *Operculodinium* spp. Zone as diagnostic of the Early Oligocene.

PALEOECOLOGY.

Table 1 lists the abundance of spores, pollen, dinoflagellates and plant tissue debris. As discussed previously, plant tissue debris originates from land plants, hence is more abundant in non marine deposition. However, with poor preservation, it may be destroyed, so the lack of plant tissue debris is not necessarily indicative of marine conditions.

1. 2904.5-3084m.

There are no dinoflagellates here and plant tissue debris is fairly abundant in most assemblages, thus indicating non-marine conditions.

2. 2879.5-2904.5m.

A few dinoflagellates are found here. The abundance of plant tissue debris, spores and pollen is low. These assemblages are non marine to marginal marine.

3. 2756-2838.5m.

Dinoflagellates are consistently present, although the abundance fluctuates. The spore pollen content is low in most samples with an occasional good assemblage. Plant tissue debris is low to a trace occurrence in most samples. These assemblages are marine to marginal marine.

B. CUTTINGS.

Cutting samples labelled 3110m were examined but the results are spurious. This depth falls within the *T. longus* Zone, sidewall cored interval, but no species diagnostic of this zone were identified in the cuttings. This happens also with some sidewall cores within this zone. Only species which range through both the *T. longus* and *L. balmei* Zones, together with Eocene contaminants have been identified. These samples also contained dinoflagellates and foraminifera, whilst no marine indicators were found in the sidewall cores spanning this interval. Thus the cuttings were heavily contaminated and it is impossible to deduce the true age from the cuttings at 3110m.

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SIDEWALL CORES Depth in metres	SPORE/POLLEN ZONE	DINOFLAGELLATE ZONE	AGE
2756.0	*P. tuberculatus*	?	Early Oligocene
2760.0			
2765.0			
2770.0	Lower *N. asperus*	?	Mid Eocene
2773.5			
2775.5			
2778.5			
2780.0			
2786.5			
2788.5	*N. diversus*	?	Early Eocene
2838.5			
2879.5			
2904.5	*T. longus*	*I. druggii* / ?	Maastrichtian
3103.5			
3108.0			
3113.5			
3231.0			
3258.5			
3302.5			
3315.0			
3320.0	*T. lilliei*		Campanian
3363.5			
3375.0			
3382.5			

Species columns (occurrences marked + in the chart):

Aequitriradites sp. 1*
Baculatisporites comaumensis 1
Ceratosporites equalis 1
Cicatricosisporites australiensis 1
Cyathea paleospora 9
Cyathidites annulatus 3
Cyathidites australis 1
C. minor 1
Gleicheniidites cf *G. circinidites* 1
Ischyosporites gremius 3
Laevigatosporites ovatus 1
Latrobosporites amplus 3
L. crassus 3
L. ohaiensis 3
Leptolepidites verrucatus 1*
Lycopodiumsporites spp 1
Polypodiidites sp
Stereisporites cf *S. antiquasporites* 1
Verrucosisporites kopukuensis 3

GYMNOSPERM POLLEN
Araucariacites australis 1
Dacrycarpites australiensis 10
Ginkgocycadophytus nitidus 1
Lygistepollenites balmei 3
L. florinii 3
Microcachryidites antarctus 1
Phyllocladidites mawsonii 3
Podocarpidites spp.
Podosporites microsaccatus 1

ANGIOSPERM POLLEN
Australopollis obscurus 3
Banksieaeidites elongatus 3
Cupanieidites orthoteichus 3
Dilwynites granulatus 3
Gambierina rudata 3
Haloragacidites canacomyricoides 4
H. harrisii 3
Myrtaceidites parvus 9
Nothofagidites asperus 3
N. brachyspinulosus 3
N. deminutus 3
N. emarcidus 3
N. endurus 3
N. falcatus 3
N. flemingii 3
N. goniatus 3
N. senectus 3
N. vansteenisii 3
Periporopollenites polyoratus 3
Proteacidites amolosexinus 3
P. angulatus 3
P. ivanhoensis 9
P. scaboratus 2
P. tuberculatus 3
Proteacidites spp.
Simplicepollis meridianus 3
Spinizonocolpites prominatus 3
Tricolpites confessus 3
T. gillii 3
T. longus 3
T. waiparensis 7
Tricolporites adelaidensis 4
T. lilliei 3
Triorites minor 2
Triporopollenites sectilis 3
Undescribed tricolpates/tricolporates

DINOFLAGELLATES
Achomosphaera crassipellis 6
Areolinga sp.
Areosphaeridium capricornum 6
Cannosphaeropsis cf *C. densiradiata* 5
Cleistosphaeridium sp.
Cordosphaeridium inodes 5
Deflandrea cf *C. leptodermata* 5
Deflandrea sp.
Glaphyrocysta retiintexta 6
Glaphyrocysta sp.
Heterosphaeridium heteracanthum 5
Hystrichokolpoma sp.
Hystrichosphaeridium cf *H. tubiferum* 5
Hystrichosphaeridium sp.
Impagidinium dispertitum 6
Isabelidinium druggii 5
Leiosphaera scrobiculata 8
Lingulodinium machaerophorum 5
Operculodinium centrocarpum 5
Operculodinium sp.
Phthanoperidinium eocenicum 5
Spiniferites ramosus 5
Spiniferites sp.
Systematophora placacantha 6
No. of unidentified dinoflagellates

Spore-pollen abundance
Dinoflagellate abundance
Plant tissue debris abundance
Preservation

BARREN SAMPLES:
2940.5
3084.0

Reference to Species:
1 Dettmann, 1963
2 Dettmann & Playford, 1968
3 Stover & Partridge, 1973
4 Stover & Partridge, 1982
5 Lentin & Williams, 1977
6 Stover & Evitt, 1978
7 Couper, 1960
8 Deflandre & Cookson, 1955
9 Martin, 1973
10 Cookson & Pike, 1953

*Reworked Early Cretaceous
?Identification probable but specimens poorly preserved or broken

Key to assessment of abundance and preservation:
♦ good, above average
o average
+ poor, below average
z exceedingly poor, trace occurrence

TABLE 1: SPORES, POLLEN AND DINOFLAGELLATES IDENTIFIED IN ATHENE # 1.

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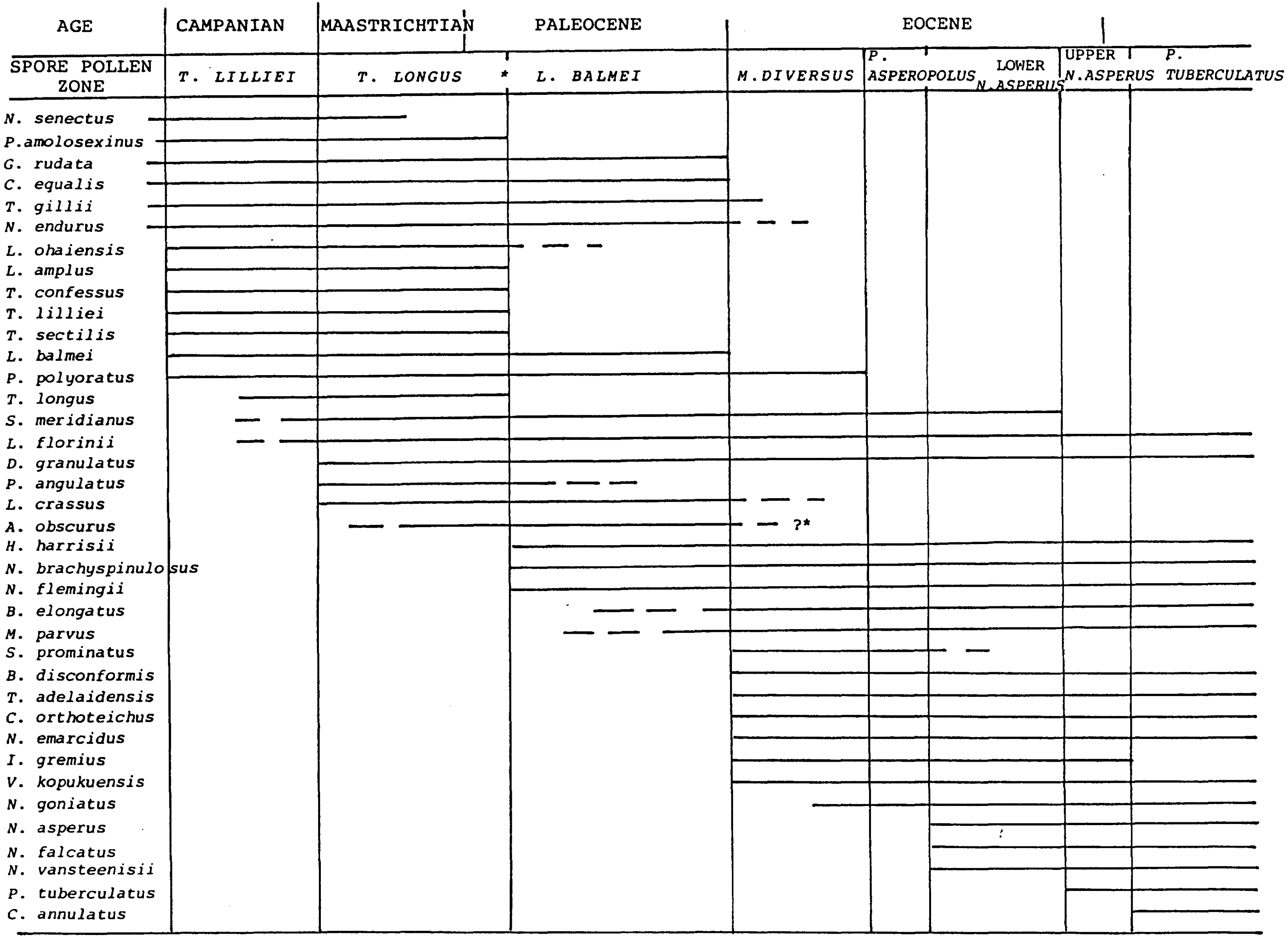

FIGURE 1: ATHENE # 1 SPORE POLLEN RANGE CHART.
Based on STOVER & PARTRIDGE (1973, 1982) and PARTRIDGE (1976), with modifications marked*. For further explanation, see text.

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