1. INTRODUCTION

In the Aydincık area an autochtonous sequence of platform carbonate rocks was deposited, ranging in age from the Liassic to the Aptian. The sequence conformably overlies Upper Triassic basal conglomerates, interbedded with mudstones and sandstones (DEMI. R. ATU, 1984), and is unconformably overlain by Upper Campanian fore-reef carbonate breccia and limestone (TASLI & EREN, 1999).

The biostratigraphy of Jurassic-Cretaceous carbonate sequences of the Central Taurides has been studied by the author since 1997. The present work on the Aydincık profile forms part of the ongoing studies, such as TASLI (2000). The Late Jurassic section is particularly rich in benthic foraminifera belonging to the families Pfenderinidae (Kurnubiinae) and Valvulinidae.

2. LOCATION AND FIELD DESCRIPTION OF THE AYDINCIK PROFILE

The Aydincık Upper Jurassic profile is located about 2 km along the road to Karaseki village west of Aydincık (Içel) town (Fig. 1). It continuously overlies an alternation of dolomite and limestone of late Dogger age (TASLI, 2000) and is about 50 m thick. Its upper limit is marked by the reappearance of entirely dolomitic beds representing the transition between the Jurassic and the Cretaceous, which is easily recognizable in the field because of its morphological difference.

The analyzed section consists of light brown, predominantly thick-bedded limestones. *Cladocoropsis mirabilis* FELIX, although occurring sporadically in the underlying beds (i.e. in the Upper Dogger), is so frequent and abundant that it seems to be lithologically dependent.

3. BIOSTRATIGRAPHY

Stratigraphic distribution of the benthic foraminifera and calcareous algae is shown in Fig. 2. The analyzed...
limestones continuously overlie limestones and dolomites corresponding the underlying biostratigraphic unit, *Paleopfenderina salernitana* cenozone of SARTONI & CRESCENTI (1962) (TASLI, 2000). *Kurnubia palas - tiniensis* HENSON, an index species of the cenozone established by SARTONI & CRESCENTI (1962) in the Apennines, is frequent and locally abundant throughout the sequence. This species is known to occur through the whole Malm of the Mediterranean realm (e.g. VELIĆ, 1977; SEPTFONTAINE, 1980). The presence of *Salpingoporella sellii* (CRESCENTI) (Pl. III, Fig. 10), a dasycladacean alga used as an index species in the Apennines (SARTONI & CRESCENTI (1962) and Dinarides (NIKLER & SOKAČ, 1968; GUŠIĆ et al., 1971; VELIĆ, 1977), indicates the *S. sellii* subzone which corresponds approximately to the lower part of the Malm.

**4. MICROFACIES DEVELOPMENT AND PALAEOENVIRONMENTAL SETTING**

The limestones consist mainly of fossiliferous wackestones and biopeloidal grainstones, with oncoids. Intraclastic grainstones with *Favreina* sp. only occur in the uppermost part of the sequence. The presence of abundant, well preserved *Cladocoropsis mirabilis* FELIX, centimetre-sized oncoids and benthic foraminifera are characteristic for these limestones. Benthic foraminifera are most abundant regarding both the number of species and individuals, whereas calcareous algae are subordinate. Dasycladacean algae are represented by *Salpingoporella annulata* CAROZZI (Pl. III, Fig. 11), which is locally common, and rarely by *Salpingoporella sellii* (CRESCENTI). *Thaumatoporella parovesciculifera* (RAINERI) (Pl. III, Fig. 12) is frequent, but not abun-
Bioclastic fraction is mainly composed of fragments of *Cladocoropsis*, pelecypods and subordinately brachiopods (punctate), ostracods and echinoids. Calcareous sponge spicules are locally abundant. Siliciclastic material is totally absent.

Predominantly dense micrites and abundant oncoids indicate low energy in a sheltered environment and shallow-water conditions. Intraclastic grainstones with *Favreina* sp. in the uppermost part of the sequence indicate high energy conditions, resulting in the development of a regressive facies.

5. SYSTEMATIC DESCRIPTIONS

**Family Nautiloculinidae** LOEBLICH & TAPPAN, 1985

**Genus Nautiloculina** MOHLER, 1938; emend. BRÖNNIMANN, 1967

**Type-species:** *Nautiloculina oolithica* MOHLER, 1938

*Nautiloculina circularis* (SAID & BARAKAT), 1959


1968 *Nautiloculina circularis* (SAID & BARAKAT).- BRÖNNIMANN, p. 64, fig. 3, pl. 1, figs. 1-8, pl. 2, figs. 1-6.

1977 *Nautiloculina oolithica* MOHLER.- VELIĆ, pl. VIII, figs. 7, 8.

1985 *Nautiloculina circularis* (SAID & BARAKAT).- FOURCADE, ARAFA & SIGAL, pl. 3, fig. 4.

**Material**: Twelve random thin-sections with approximately eighty specimens.

**Description and remarks**: This form with lenticular-shaped, involute-planispirally coiled test shows the umbilical fillings and axial depressions. BRÖNNIMANN (1968) distinguishes *N. circularis* from *N. oolithica* MOHLER by the marked subacute periphery, axial depressions, and by the larger size and larger numbers of the whorls in the former. ARNAUD-VANNEAU & PEYBERNES (1978) give a comparison table of the principal characters of the four species of *Nautiloculina* (including the two Cretaceous species). In our material there are specimens which are assignable to the species *N. circularis* and *N. oolithica* (Pl. 1, Fig. 2), with the dominance of the former.

![Fig. 2 Stratigraphic column of the Aydınçık Upper Jurassic section and distribution of benthic foraminifera and other microorganisms.](image-url)
Dimensions: The measurements are from axial sections only (12 specimens). Equatorial and axial diameters vary between 0.55-0.80 mm, and 0.30-0.48 mm, respectively. The ratio of equatorial/axial diameter oscillates around 1.8:1. The inner diameter of proloculus ranges from 0.03 mm to 0.05 mm.

Family Charentiidae LOEBLICH & TAPPAN, 1985
Genus Karaisella KURBATOV, 1971
Type-species: Karaisella uzbekistanica KURBATOV, 1971
Karaisella aff. uzbekistanica KURBATOV, 1971 (Pl. I, Figs. 3-13)

?1968 Haplophragmium cf. suprajurassicum SCHWAGER.- NIKLER & SOKAČ, pl. IX, fig. 7.

Material: Fifteen random thin-sections and ten successive acetate peels with approximately ninety specimens.

Description: Test is free, lenticular shaped, thickened towards the poles, with small axial depressions. Peripheral margin is rounded to subrounded. Septal sutures, observed in equatorial sections (Pl. I, Figs. 6, 7), are slightly depressed. Coiling is planispiral, occasionally streptospiral, and involute, with a tendency to become uncoiled in the later stage (Pl. I, Fig. 12). There are two or at maximum three and a half whorls. The number of chambers in the last whorl is nine to twelve. Chamber interiors are simple. Septa are curved and inclined in the direction of coiling, in continuity with the outer wall. The base of the septum against the previous whorl is thickened and chomata-like (Pl. I, Figs. 8-10). Septal spacing (= height of chamber) and height of the whorls slightly increase during the ontogeny. Megasphere is simple, spherical or slightly ovoid. Aperture is simple and central (Pl. I, Figs. 6, 7). Wall is calcareous microgranular (= finely agglutinated) with a keriothecal structure, occasionally visible only in the last whorl of large specimens (Pl. I, Fig. 11).

Dimensions: Dimensions (in mm) are shown in Table 1.

Remarks: Because of its streptospiral coiling, single areal aperture, and the presence of chomata-like thickening at the base of the septa (Pl. I, Fig. 5), this form is herein assigned to the genus Karaisella KURBATOV, 1971 (in LOEBLICH & TAPPAN, 1988). Karaisella aff. uzbekistanica is a close homeomorph of the Cretaceous genus Charentia NEUMANN, 1965, except its streptospiral coiling. The genus Karaisella was placed in the family Charentiidae by LOEBLICH & TAPPAN (1988) although they note that it did not show a canaliculate wall structure (keriothecal structure of HOTTINGER, 1967). Specimens in the Aydőncõk material do not show a sharp change in the plane of coiling from early to later whorls and subacute periphery as in the type species.

This form is similar to the genera Bulbobilaculites MAYNC, 1952 and Haplophragmium REUSS, 1860 in areal aperture and the streptospiral nature of coiling. However, the wall is distinctly agglutinated and simple in the former genus, and alveolar in the latter. More-

### Table 1

<table>
<thead>
<tr>
<th>Sample No. (AY)</th>
<th>Specimens</th>
<th>Greater equatorial diameter</th>
<th>Axial diameter</th>
<th>Inner diameter of proloculus</th>
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</thead>
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<tr>
<td>38-1</td>
<td>1 (Pl.1, Fig. 4)</td>
<td>0.85</td>
<td>0.45</td>
<td>0.05-0.06</td>
</tr>
<tr>
<td>38-1</td>
<td>2</td>
<td>0.63</td>
<td>0.30</td>
<td>not observed</td>
</tr>
<tr>
<td>38-1</td>
<td>3</td>
<td>0.55</td>
<td>-</td>
<td>0.04</td>
</tr>
<tr>
<td>38-3</td>
<td>4</td>
<td>0.70</td>
<td>-</td>
<td>0.06</td>
</tr>
<tr>
<td>38-3</td>
<td>5</td>
<td>0.65</td>
<td>-</td>
<td>not observed</td>
</tr>
<tr>
<td>38-3</td>
<td>6 (Pl.1, Fig. 10)</td>
<td>0.80</td>
<td>-</td>
<td>not observed</td>
</tr>
<tr>
<td>38-3</td>
<td>7</td>
<td>0.85</td>
<td>-</td>
<td>0.12</td>
</tr>
<tr>
<td>38-4</td>
<td>8</td>
<td>0.72</td>
<td>-</td>
<td>not observed</td>
</tr>
<tr>
<td>38-5</td>
<td>9</td>
<td>0.70</td>
<td>-</td>
<td>0.05</td>
</tr>
<tr>
<td>38-6</td>
<td>10 (Pl.1, Fig. 6)</td>
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<td>0.30</td>
<td>0.06</td>
</tr>
<tr>
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<td>11 (Pl.1, Fig. 11)</td>
<td>0.90</td>
<td>-</td>
<td>not observed</td>
</tr>
<tr>
<td>38-6</td>
<td>12 (Pl.1, Fig. 9)</td>
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<td>-</td>
<td>0.06</td>
</tr>
<tr>
<td>38-6</td>
<td>13</td>
<td>0.66</td>
<td>-</td>
<td>0.11</td>
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<tr>
<td>38-8</td>
<td>14 (Pl.1, Fig.6)</td>
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<td>-</td>
<td>0.10</td>
</tr>
<tr>
<td>38-8</td>
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<td>0.40</td>
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<td>38-10</td>
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<td>-</td>
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<tr>
<td>38-10</td>
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<td>0.70</td>
<td>-</td>
<td>0.13-0.15</td>
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<tr>
<td>38-13</td>
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<tr>
<td>38-14</td>
<td>19</td>
<td>0.50</td>
<td>-</td>
<td>0.07</td>
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</tbody>
</table>

Table 1. Dimensions of Karaisella aff. uzbekistanica (in mm).
over, both genera have a marked rectilinear uniserial stage which is only occasionally developed in our specimens. Karaisella aff. uzbekistanica differs from another Upper Jurassic species, Mesoendothyra iziumiana DAIN, 1958 (with its wall consisting of large pores, DAIN in BYKOVA et al., 1958), by the central position of the aperture, the presence of chomata-like thickenings in the base of the septum and by a lacking of distinct streptospiral coiling.

Karaisella aff. uzbekistanica closely resembles the genus Bosniella GUŠIČ, 1977 by its keriothecal wall structure and growth pattern, but differs from it in the absence of a peneropline stage with cribate aperture and in having only a central aperture. In the latter, the aperture is at first basal, then central and finally cribrate as in “Mesoendothyra” croatica GUŠIČ (GUŠIČ, 1969; FURRER & SEPTFONTAINE, 1977). The genus Bosniella is represented by two species: oenensis from the Lower Jurassic of NW Bosnia (GUŠIČ, 1977) and B. fontainei from the Middle Jurassic of Thailand (BASSOULLET, 1994). It is considered as a junior synonym of Mesoendothyra DAIN (SEPTFONTAINE, 1988). Alternatively, BASSOULLET (1994) removed “Mesoendothyra” croatica GUŠIČ from the genus Mesoendothyra DAIN, because of its keriothecal wall structure, and assigned it to the genus Bosniella GUŠIČ, 1977.

Occurrence: It is abundant in biopeloidal grainstones with oncoids, in association with Nautiloculina circulares and Kurnubia ex. gr. palastiniensis, whereas it is missing or rare in fossiliferous wackestones.

Family Pfenderinidae SMOUT & SUGDEN, 1962
Subfamily Kurnubiinae REDMOND, 1964
Genus Kurnubia HENSON, 1948

Type species: Kurnubia palastiniensis HENSON, 1948

After SMOUT & SUGDEN (1962), who assigned HENSON’s (1948b) species Valvulinella jurassica and V. wellingsi to the genus Kurnubia HENSON and after SARTONI & CRESCENTI (1962), who considered the species K. jurassica synonymous with Kurnubia palastiniensis, REDMOND (1964) described, from isolated specimens only, three new species of Kurnubia: K. variabilis, K. bramkampi and K. morrisi. MAYNC (1965) included all these species in Kurnubia gr. palastiniensis HENSON, except K. morrisi, considering the existence of intermediate forms. GUŠIČ (1969) adopted MAYNC’s (1965) opinion and considered the three infrasubspecific taxa as “forms” jurassica, palastiniensis and wellingsi. HOTTINGER (1967) redescribed K. palastiniensis in detail, including K. jurassica, and retained the three REDMOND’s (1964) species of Kurnubia. Later, this common Late Jurassic genus has been recorded mostly under the name Kurnubia palastiniensis HENSON in many studies (e.g. BASSOULLET & POISSON, 1975; AZÉMA et al., 1977; VELIĆ, 1977; FOURCADE et al., 1985; LUPERTO-SINNI & MASSE, 1994). In general, REDMOND’s (1964) species seem not to be accepted, probably owing to difficulties in comparing with isolated specimens.

The aim of the following descriptions is to contribute more data to the existing knowledge on the subfamily Kurnubiinae, avoiding the creation of new taxa.

Kurnubia ex. gr. palastiniensis HENSON, 1948b
(Pl. II, Figs. 1-7)

Description: See description in HOTTINGER (1967).

Remarks: Our specimens display wide morphologic variations and considerable differences in size. They vary from those smaller in size, only trochospirally, having a weakly developed central column and possessing a hypodermic network (SEPTFONTAINE, 1988) with first order partitions (Pl. II, Figs. 1, 2, 5), to those having a larger test with a marked central column, a more or less developed uniserial stage, and possessing a complete hypodermic network (Pl. II, Figs. 4, 6). The former have a simple, ovoid proloculus, measuring about 0.04 mm (inner diameter) and representing the megalospheric generation. They are included in this group due to the presence of the transitional forms. In the latter forms, the proloculus is not visible. The central column seems to be weakly developed in highly conical specimens (Pl. II, Fig. 6), whereas it is well developed in specimens having a relatively larger basal diameter (Pl. II, Figs. 3, 4).

Kurnubia cf. morrisi REDMOND, 1964
(Pl. II, Figs. 8-12, 14)

?1964 Kurnubia morrisi new species.- REDMOND, p. 253, pl. 1, fig. 4.
1967 Kurnubia cf. morrisi REDMOND.- HOTTINGER, p. 93, pl. 19, figs. 35-37.

Description: Test is fusiform, trochospirally coiled throughout the ontogeny. Early chambers are not visible. Spiral sutures are depressed, at about 30° to the axis of coiling. Septal sutures are obscure. The wall is calcareous, microgranular without agglutinated grains, possessing a complete hypodermic network. The primary aperture is set in the inner margin of the peripheral zone where the septa do not meet the central column (Pl. 2, Fig. 11). It probably represents “intercameral foramina” (SMOUT & SUGDEN, 1962). Prolongations of the adjacent first order vertical partitions projecting inward from the epidermis adjoin to each other and coalesce with the interseptal pillars (Pl. II, Fig. 10). The second order vertical partitions are restricted only to the marginal zone of the chambers. The central zone has a trochoidally laminated appearance (Pl. 2, Fig. 14).
which recalls the apertural plates intergrown with pillars in the Pfenderinidae. The base of the test is strongly convex in the centre and very obliquely set to the axis of coiling.

**Dimensions**: Axial length varies from 2.1-2.5 mm, measured in nearly axial sections. Basal diameter is ≥ 0.8 mm and exceeds up to 1.0 mm. The ratio of length/diameter oscillates around 2.5:1. The width of the peripheral zone surrounding the central zone is nearly constant throughout the adult stage, measuring 0.20-0.22 mm. The central column increases progressively in diameter, up to 0.5 mm.

**Remarks**: K. cf. morrissi has a larger test and central column, and a wider peripheral zone than all other described species of Kurnubia and a complete hypodermic network consisting of two generations of partitions in the adult stage. Furthermore, specimens of Kurnubia ex. gr. palastiniensis do not exceed 0.7 mm in basal diameter. Purely because of the trochospiral coiling, this form is not considered as *K. wellingsi* (HENSON). Six to eight tiers of chamberlets per chamber, mentioned by REDMOND (1964, p. 253), are not accountable in random thin sections.

**Genus Conicokurnubia SEPTFONTAINE, 1988**

**Type species Conicokurnubia orbitoliniformis SEPTFONTAINE, 1988**

*Conicokurnubia orbitoliniformis* SEPTFONTAINE, 1988

(Pl. II, Figs. 13, 15, 16)

**Description**: Test is sharply conical (Pl. II, fig. 13), where chambers do not increase in diameter as added, and broadly conical where chambers increase slowly in diameter. The base is slightly to strongly convex in the centre, with a narrow imperforate rim. The cone side is straight. Proloculus is not visible. The trochospiral arrangement of the early chambers is suggested by traces of the spiral suture. Later and remaining larger portion of the test consists of a co-axial series of ten to seventeen very low chambers which increase slightly in height as added. Septal sutures are distinct and depressed. Each chamber has a peripheral zone with a complete hypodermic network. Each septum is inwardly thickened and then adjoins with the adjacent septum, forming buttress-like interseptal pillars (Pl. II, Fig. 15). The first order vertical partitions form a “reticulate zone” (HENSON, 1948a) in the centre of the test as seen in transverse sections (Pl. II, Fig. 16). Apertural pores are not observable. The primary aperture consists of an opening near the margin of the central zone (Pl. II, Fig. 15).

**Dimensions**: The broadly conical specimens have a basal diameter of 1.25-1.50 mm and a height of 1.75-1.85 mm, measured in nearly axial sections. The sharply conical specimens have a basal diameter of 0.50-0.70 mm and a height of 1.25-2.0 mm, measured in nearly axial sections. The height of the last chamber, for both forms, is ≤ 0.1 mm. The width of the peripheral zone surrounding the central column is 0.10-0.12 mm.

**Remarks**: Specimens of this species from Aydnıcık are closely comparable with SEPTFONTAINE’s (1988) figures (pl. II, figs. 12, 13) from the Oxfordian (?) to Kimmeridian of Western Taurus, Turkey. However, the available axial and transverse sections are insufficient for a complete description of the species.

*Conicokurnubia orbitoliniformis* occurs throughout the Aydnıcık Upper Jurassic section, in association with *Kurnubia ex gr. palastiniensis*. In the random thin-sections, specimens with a marked uniserial stage of the latter might be confused with sharply conical specimens of *C. orbitoliniformis*. The width of the peripheral zone seems to be narrower than in *Kurnubia palastiniensis* and *Kurnubia aff. morrissi*.

## 6. BIOSTRATIGRAPHIC REVIEW AND CONCLUSIONS

The characteristics of the Upper Jurassic limestone section from the Aydnıcık (İçel) area are the presence of *Cladocoropsis*, benthic foraminifera, calcareous algae and the dominance of mudstones which indicate a subtidal, protected lagoon environment.

Stratigraphic distribution of the benthic foraminifera and calcareous algae is shown in a range-chart. Microfossil assemblage corresponds to the *Salpingoporella sellii* subzone of *Kurnubia palastiniensis* cenozoone, established by SARTONI & CRESCENTI (1962).

Ten species of benthic foraminifera are identified and figured. Those of considerable stratigraphic value within the Mesozoic Tethys are described.

## 7. REFERENCES


**PLATE I**

scale bar: 0.2 mm

Fig. 1  *Nautiloculina circularis* (SAID & BARAKAT)
Axial section showing the acute periphery through the ontogeny, sample AY 38-9.

Fig. 2  *Nautiloculina oolithica* MOHLER
Axial section showing the rounded periphery, sample AY 38-9.

Figs. 3-13  *Karaisella* aff. *uzbekistanica* KURBATOV
3: axial section showing streptospiral coiling in the two early whorls, sample AY 38-8; 4: oblique axial section showing spherical proloculus, sample AY 38-1; 5: subaxial section, sample AY 38-4; 6: axial (megalospheric specimen) and oblique subequatorial sections, sample AY38-6; 7: equatorial section of a megalospheric specimen, sample AY 38-13; 8: equatorial section showing the chomata-like thickenings in the base of the septa, as the genus *Charentia* NEUMANN, sample AY 38-8; 9: equatorial section offset by a fracture, showing thinning of the septa towards the apertural area, sample AY 38-6; 10: oblique subequatorial section, sample AY 38-3; 11: oblique equatorial section of a probable microspheric specimen revealing the keriothecal wall structure in the last whorl (arrow), sample AY 38-6; 12: oblique section of a probable microspheric specimen revealing terminally uncoiled chambers, sample AY 38-14; 13: subaxial section, sample AY 38-5.
PLATE II

scale bar: 0.2 mm

Figs. 1-7  *Kurnubia ex. gr. palastiniensis* HENSON
1: axial section of a megalospheric specimen revealing an ovoid proloculus, sample AY 50; 2: axial section showing the first order horizontal partitions only and a weakly developed central column, sample L 4-3; 3: subaxial section, sample AY 38-12; 4: subaxial section, sample AY 50; 5: oblique axial section, sample L 4-1; 6: nearly axial section of a highly conical specimen, sample AY 40; 7: oblique transverse section, sample L 3-2.

Figs. 8-12, 14  *Kurnubia cf. morrisi* REDMOND
8: oblique axial section, sample L 4-2; 9: oblique transverse-tangential section, sample L 1; 10: transverse section showing the first and second order vertical partitions in the peripheral zone, sample L 7; 11: oblique axial section showing the second order partitions which are missing in the deeper part of the peripheral zone. Note that the septa do not meet the central column, leaving an opening near the margin of the central column, sample AY 50; 12: oblique transverse section resembling Fig. 7, included in this species because of its larger diameter, sample AY 49; 14: subaxial section showing curved thin plates in the central column, sample AY 42.

Figs. 13, 15, 16  *Conicokurnubia orbitoliniformis* SEPTFONTAINE
13: subaxial section of a highly conical specimen revealing strongly convex base in the centre, sample AY 45; 15: subaxial section showing labyrinthian appearance of the central zone occupied by interseptal pillars. Note the early portion of the cone recalling trochosiral coiling during the early ontogeny, sample L 3; 16: transverse section passed through the adult stage of a large conical specimen, sample AY 41.
PLATE III
scale bar: 0.2 mm

Fig. 1  *Everticyclammina* sp.
Subaxial section showing a broadly rounded periphery which is not known in the other Jurassic species, *E. virguliana* (KOECHLIN), sample AY 47.

Fig. 2  Indet. Lituolidae
Equatorial-longitudinal section, sample L 4-3.

Fig. 3  *Valvulina lugeoni* SEPTFONTAINE
Subaxial section, sample L 7.

Figs. 4, 5  *Pfenderina* sp.
4: axial section of a broken specimen revealing the keriothecal wall structure, sample L 4-3; 5: transverse section, sample AY 45.

Figs. 6, 7  *Verneuilina* sp.
6: subaxial section, sample AY 38-9; 7: transverse section, sample AY 50.

Fig. 8  *Siphovalvulina* sp.
Axial section showing the spheric proloculus and siphonal canal, sample AY 43.

Fig. 9  *Acolisaccus* sp.
Sample AY 47.

Fig. 10  *Salpingoporella sellii* (CRESCENTI)
Sample L 4-2.

Fig. 11  *Salpingoporella annulata* CAROZZI
Sample AY 38-14.

Fig. 12  *Thaumatoporella parvovesiculifera* (RAINERI)
Sample AY 38-9.