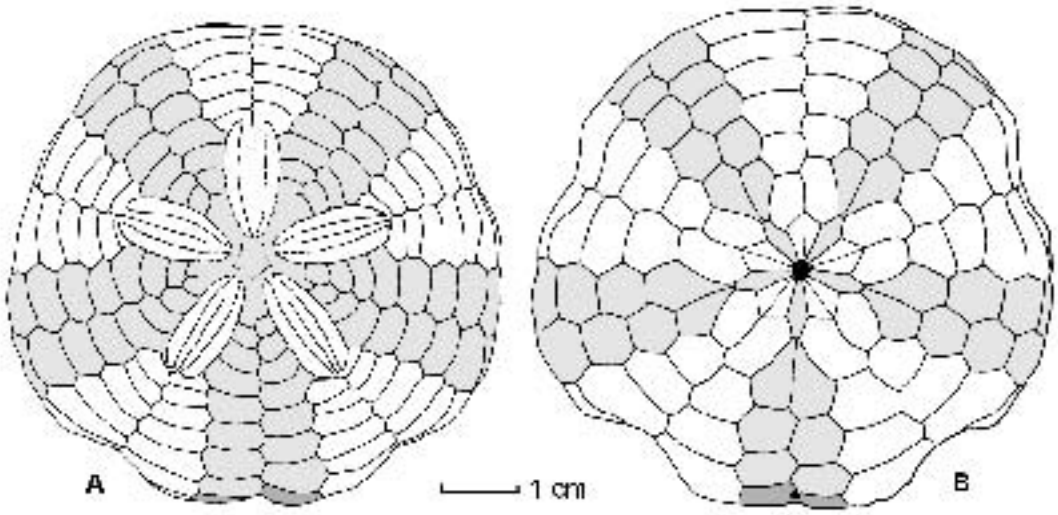

Figure 39: *Parmulechinus hoebarthi* (Kühn, 1936): aboral (A) and oral (B) plating [Loibersdorf Fm., Eichberg, near Maria Dreieichen, NÖ (A: NHMW 1968/781/10, B: NHMW 2002z0118/0025)]. Interambulacra shaded in light grey; postbasicoronal plate pair enclosing the periproct shaded in dark grey.

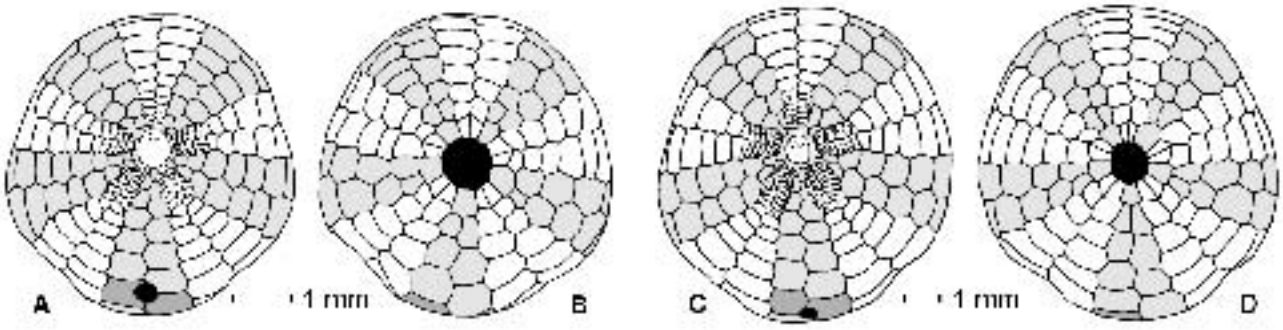

Figure 40: *Parmulechinus hoebarthi* (Kühn, 1936): aboral (A, C) and oral (B, D) plating in juvenile specimens [Loibersdorf Fm., Eichberg, near Maria Dreieichen, NÖ (A, B: IPUW 1992/195b, B: NHMW 1936(No. 69)/1/95)]. Interambulacra shaded in light grey; postbasicoronal plate pair enclosing the periproct shaded in dark grey.

0.7 times as wide as the interporiferous zone. The shape of the basicoronal plates can be seen in Fig. 39.B.

Interambulacra: The interambulacra are about 0.6 to 0.7 times as wide as the ambulacra at the ambitus. They are densely crowded by small perforate crenulate tubercles.

Food grooves: The food grooves are simple, bifurcating at about 22 % of the corresponding test radius from the peristome. From this point on they run along the midline of each ambulacral plate row. Just before they reach the ambitus, they bend in direction of the interambulacra (Fig. 41).

Peristome: The peristome lies centrally on the oral surface. It is rather small, ranging from 1.0 to 3.3 mm in the studied material (corresponds to 1.7 to 5.2 % TL, with a mean of 3.9 %) and has a circular outline.

Periproct: The periproct very small, subcircular and lies marginally, directly at the posterior margin of the oral side. Its posterior margin is depressed and opens into the anal notch. It is 0.65 to 1.62 mm wide (this corresponds to 1.4 to 2.6 % TL, with a mean of 2.0 %). Concerning the plate sutures, the periproct lies between the 4th pair of postbasicoronal plates in interambulacrum 5 (Figs. 39.B, 40.A-C). In a juvenile specimen [NHMW 1935(No.69).I.95] of 8.6 mm TL it lies between the 5th pair (Figs. 40.C-D).

Differential diagnosis:

Parmulechinus agassizi (Oppenheim, 1902) [senior synonym of the type-species *Stenaster labriei* Lambert, 1905 (= *Scutella striatula* Agassiz, 1841a non de Serres, 1829, see Lambert, 1910c: 63) according to Lambert (1915b: 19-29)] differs from *Pm. hoebarthi* by its less strong marginal indentations (especially in ambulacra II, III and IV), by its shorter and more closed petals (around 44 % of the corresponding test radius), and its narrower interporiferous zones [compare illustrations in Agassiz (1841a: pl. 18, figs. 1-5) and Chavanon (1974)]

Parmulechinus lamberti (Airaghi, 1901) from the Oligocene of Italy differs from *Pm. hoebarthi* by its shorter petals (ranging from 43 to 47 % of the corresponding test radius) and its different outline without prominent marginal indentations [based on Airaghi (1901), this species was referred to the genus *Parmulechinus* by Durham (1955:153)].

Parmulechinus paronai (Airaghi, 1901) and *Pm. isseli* (Airaghi, 1901), both from the Oligocene of Italy, are insufficiently known for an adequate comparison with the present species and need to be re-described. While the former has an outline similar to *Pm. hoebarthi*, the latter has a distinctly different, oval, antero-posteriorly elongated outline [both species were referred to the genus *Parmulechinus* by Durham (1955:153)].

Parmulechinus subtetragonus (Grateloup, 1836) from the Oligocene of France differs from *Pm. hoebarthi* by its shorter and lanceolate petals (ranging from 38 to 45 % of the corresponding test radius), its more tetragonal outline with stronger and broader indentations in ambulacra II, III and IV, the different ratio between the ambulacra and interambulacra at the ambitus (*c.* 1:0.5), and differently shaped basicoronal plates

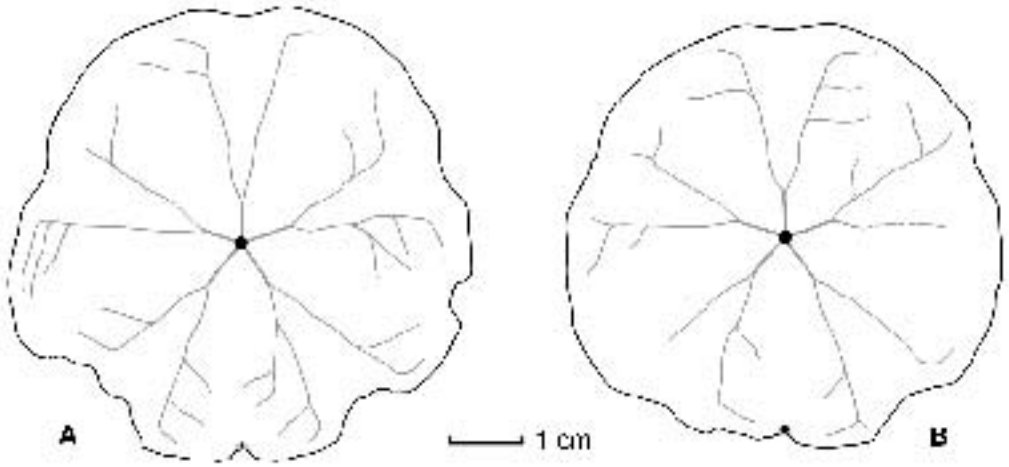

Figure 41: *Parmulechinus hoebarthi* (Kühn, 1936): arrangement of the food grooves [Loibersdorf Fm., Eichberg, near Maria Dreieichen, NÖ (A: NHMW 2002z0118/0008, B: NHMW 2002z0118/0006)].

[compare Grateloup (1836), Cotteau (1889-1894) and the oral plating in Durham (1955: fig. 18e)].

Parmulechinus subtrigonus (Koch, 1887) from the Late Oligocene of Romania differs from *Pm. hoebarthi* by its shorter petals (ranging from 37 to 41 % of the corresponding test radius), its different outline without prominent marginal indentations, the different ratio between the ambulacra and interambulacra at the ambitus (1:0.45), its marginal periproct (in adult specimens), and differently shaped basicoronal plates (interambulacral basicoronal plates about as wide as ambulacral basicoronal plates) [based on Koch (1887a) and material from the type-locality in the collection of the NHMW].

For the differences to the species *Parascutella gibbercula* and *Ps. paulensis* see above under that species.

Discussion:
Based on the infrapetalar position of the periproct between the 4th to 5th pair of postbasicoronal plates, the short petals, the strongly indented ambulacra and the relationship between ambulacra and interambulacra at the ambitus, the species is referred to the genus *Parmulechinus*. The species name was modified from *höbarthi* to *hoebarthi* according to the ICZN rules (Article 32.5.2.1).

Occurrence:

Austria: Early Eggenburgian (Early Burdigalian)
Molasse Zone: Achberg (= Eichberg) near Maria Dreieichen (Loibersdorf Fm.), Horn Basin, NÖ (Kühn, 1936; Schaffer, 1959, 1962; Papp & Thenius in Kühn, 1962; Steininger, 1971a, b; Thenius, 1974; Nebelsick, 1991, 1999; Schultz, 1998; Nebelsick & Kroh, 2002; [NHMW]); Obernholz, NÖ (Steininger, 1971e)

Family Astriclypeidae Stefanini, 1911
Genus *Amphiope* Agassiz, 1840

Type-species: *Scutella bioculata* des Moulins, 1837; by subsequent designation Lambert (1907b: 49).
Diagnosis: Sand-dollar shaped test with two subcircular to transversely elongated (except in Oligocene species) lunules in ambulacra I and V; apical disc slightly eccentric anteriorly; four gonopores; well developed petals of subequal length; posterior ambulacra discontinuous adorally, others variable; interambulacra about as wide as ambulacra at the ambitus; primordial interambulacral plates much larger than primordial ambulacra; periproct on oral side, near the margin; food grooves bifurcating just outside primordial plates (modified from Durham, 1966).
Distribution: Late Oligocene to Late Miocene, ?Early Pliocene – Central and Southern Europe, Northern Africa (probably also in the Middle East, India and Angola)
Remarks: Although Mortensen (1948b: 413) and Comaschi Caria (1972: 42) considered *Amphiope* a subgenus of *Echinodiscus* this view found no acceptance among the echinoderm research community (e.g. Durham, 1955, 1966; Philippe, 1998,…). The genus *Kieria* Míhaly, 1985 (type-species *Kieria semseyana* Míhaly, 1985 from the Badenian of Budapest, Hungary) was established for small astriclypeid specimens with notches instead of lunules in the posterior ambulacra. This, however, is a common phenomenon during the ontogeny of astriclypeids and the type material of *Kieria semseyana* is here interpreted as juvenile *Amphiope* sp. as suggested already by Mooi (1989). Thus *Kieria* has to be considered as junior synonym of *Amphiope*.

Amphiope bioculata (des Moulins, 1837)

(Fig. 42.A-B; Pl. 46, Figs. 5a-b; Pl. 47, Figs. 1a-b; Pl. 48, Figs. 1-3)

* 1837 *S.*[*cutella*] *bioculata.* Nob. – des Moulins: 72
1841a *Amphiope bioculata* Ag. – Agassiz: 73; pl. 11, fig. 1-5
1846 *A.*[*mphiope*] *bioculata* Agass. – Pictet: 155
1847a [*Lobophora* (*Amphiope*)] *bioculata* Agass. – Agassiz & Desor: 136
\# 1847a [*Lobophora* (*Amphiope*)] *elliptica* Desor – Agassiz & Desor: 136
1848 *Amphiope bioculata* (Ag.) – Gras: 40
1858 *Amphiope bioculata* Agass. – Desor: 236
1858 [*Amphiope*] *elliptica* Desor – Desor: 236
v. 1869a *Amphiope perspicillata* Ag. – Laube: 182
v. 1869a *Amphiope elliptica* Desor. – Laube: 182
v. 1870 *Amphiope perspicillata* Ag. – Laube: 314
v. 1870 *Amphiope elliptica* Ag. – Laube: 314
v. 1871 *Amphiope perspicillata* Agassiz. – Laube: 61
v. 1871 *Amphiope elliptica* Desor. – Laube: 61-62; pl. 16, fig. 5
v. 1880 *Amphiope* nov. sp. – Hoernes: 194
\# v. 1883 *Amphiope Styriaca* – Hoernes: 46-50; fig. 1
1892 *Amphiope bioculata*. – Gourret: 130
1892 *Amphiope elliptici*, Desor. – Gourret: 130
\# 1895 *Amphiope Lovisatoi,* Cotteau, 1895. – Cotteau: 16; pl. 3, fig. 15
1907b *Amphiope bioculatas*, Desmoulins (*Scutella*) 1837 – Lambert: 50-53
\# 1907b *Amphiope Lorioli* Lambert – Lambert: 56 (fide Philippe, 1998)

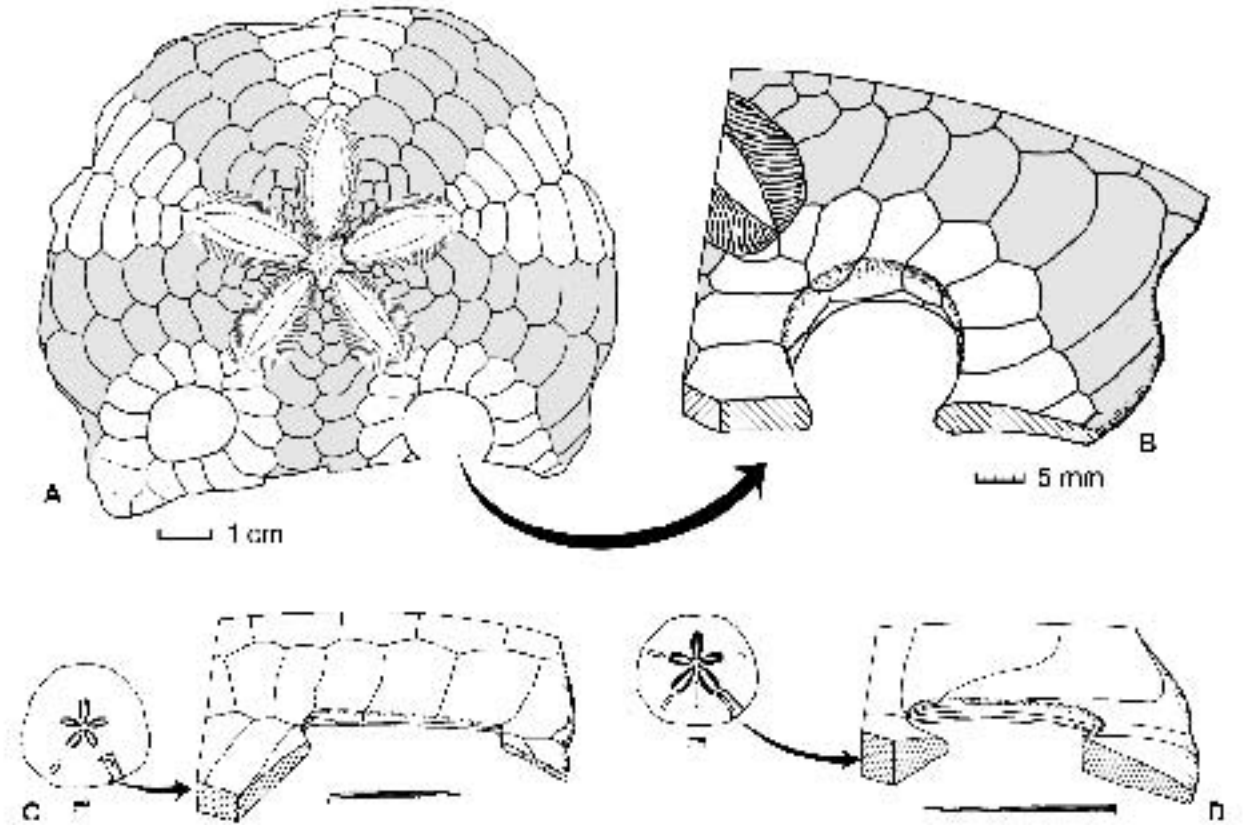

Figure 42: *Amphiope bioculata* (des Moulins, 1837): aboral plating (A) and lunule structure (B; oblique view) [holotype of *A. styriaca* Reuss, 1883 (UGP 1880.XX.5)]; Comparison with the cross-linked lunules of extant astriclypids [C: *Echinodiscus bisperforatus* (Leske), modified from Mooi (1989: fig. 30a); scale bars equal 10 mm] and the festooned lunules of mellitids [D: *Mellita quinquiesperforata* (Leske), modified from Mooi (1989: fig. 30b); scale bars equal 10 mm].

#	1907b	*Amphiope Baquiei* Lambert – Lambert: 56-57; text-fig. (fide Philippe, 1998)
v.	1907b	*Amphiope styriaca* Hoernes, 1883. – Lambert: 57-58
	1910a	*Amphiope elliptica* Desor – Lambert: pl. 3, fig. 24
#	1911a	*Amphiope Montezemoloi* Lov. – Lovisato: 42-47; pl. 6 (3), figs. 1a-b
	1912	*Amphiope bioculata* Desmoulins (*Scutella*), 1837. – Lambert: 75-77
	1912	*Amphiope elliptica* Desor, 1847. – Lambert: 77-79; pl. 6, fig. 1-3
#v.	1912	*Amphiope Laubei* – Lambert: 79 [nom. nov. for *A. elliptica* Laube, 1871 non Desor, 1858]
#	1912	*Amphiope Sarasini* Lambert. – Lambert: 80-82; pl. 3, fig. 24 [under the name *A. elliptica*]; pl. 4, fig. 8-10
	1912	*Amphiope Baquiei* Lambert, 1907. – Lambert: 83-84; pl. 5, fig. 6-8; pl. 6, fig.4
#	1912	*Amphiope transversifora* Lambert. – Lambert: 84-85; pl. 7, fig. 3-5
	1912	*Amphiope Deydieri* Lambert. – Lambert: 85-86; pl. 6, fig. 5-7
	1913a	*Amphiope elliptica* Desor – Cottreau: 94-98; figs. 21-22; pl. 8, fig. 1
v.	1913a	*Amphiope styriaca* Hoern.– Cottreau: 98, 99; fig. 23/3
	1913a	*Amphiope bioculata* Desm. (*Scutella*) – Cottreau: 135-139; pl. 5, fig. 1-8; pl. 6, figs. 1-12
	1915a	*Amphiope elliptica* Desor, 1847. – Lambert: 219-220
#	1915a	*Amphiope transversifora* Lambert. – Lambert: 220
#	1915a	*Amphiope Ludovici* Lambert. – Lambert: 220; pl. 6, figs. 1-3 (under the name *A. elliptica*); pl. 16, figs. 14-15
	1915a	*Amphiope Baquiei* Lambert, 1907. – Lambert: 221
	1915a	*Amphiope Sarasini* Lambert. – Lambert: 221
v.	1915	*Amphiope bioculata* Desmoul. sp. – Vadász: 122-124; fig. 18
	1955	*Amphiope bioculata,* Desm. var. *montezemoloi* Lov. – Comaschi Caria: 184, pl.14-15
	1962	*Amphiope* sp. – Schaffer: 159
v.	1963	*Amphiope elliptica* Desor. – Müller: 522; figs. 685A a-b
v.	1978	*Amphiope elliptica* Desor. – Müller: 569; figs. 697A a-b
	1981	*Amphiope bioculata* Desmoulins – Mitrović-Petrović: 180; figs. 11a-c
	1984	*Amphiope bioculata* Desmar.– Kókay et al.: 288
?	1984	*Amphiope ludovici* Lamb. – Kókay et al.: 288
?	1984	Echinoidea n. gen. és n. sp. – Kókay et al.: 288 [refers to the specimens named *Kieria semseyana* by Mihály (1985)]
	1985	*Amphiope bioculata* (Desmoulins, 1837) – Mihály: 242
?	1985	*Amphiope ludovici* Lambert, 1915 – Mihály: 242-243; pl. 4, figs. 7-8
?	1985	*Kieria semseyana* n. sp. – Mihály: 243, 261; pl. 4, figs. 2-6
	1998	*Amphiope bioculata* des Moulins – Cahuzac & Cluzaud: 426; pl. 2, fig. 3

1998 *Amphiope bioculata* (Desmoulins, 1837) – Philippe: 152-167; pl. 16, figs. 1-8; text-figs. 12-17 [cum syn]
? 2001 *Amphiope gr. bioculata* – Néraudeau et al.: 52; tab. 1
v. 2002a *Amphiope elliptica* Desor, 1847 – Kroh: fig. 1 [reproduced from Laube, 1871]
v. 2002a *Amphiope* sp. – Kroh: 308-309
v. 2003b *Amphiope* sp. – Kroh: 250

Type-material:
Scutella bioculata des Moulins, 1837:
Type-specimens: current whereabouts of the type material unknown.
Type area: "terrain tertiaire, Bordeaux et Sure près Bollène" (des Moulins, 1837: 72-73), the latter locality is Suze-la-Rousse, France according to Philippe (1998:153)

Amphiope styriaca Hoernes, 1883:
Holotype: specimen UGP 1880.XX.5; housed in the collection of the Institute of Geology and Palaeontology, Karl-Franzens-University Graz, Austria
Locus typicus: Seggauberg (formerly Sekkauer Berg), near Leibnitz, Styria, Austria
Age: Early ? Badenian (Langhian), Middle Miocene

Amphiope laubei Lambert, 1912:
Holotype: specimen NHMW 1849.XXIII.39 figured by Laube (1871: pl. 16, fig. 5), preserved in the collection of the Naturhistorisches Museum Wien, Geologische Abteilung
Locus typicus: Niederkreuzstetten, NÖ, Austria
Stratum typicum: Korneuburg Fm.
Age: Karpatian (Late Burdigalian)
Remarks: Laube's figure may be a composite image of specimen NHMW 1849.XXIII.39 and 1849.XXIII.40.

Material:
Karpatian (Late Burdigalian) – Niederkreuzstetten, NÖ
NHMW: 3 specimens [NHMW 1849.XXIII.39 (holotype *A. laubei* Lambert, 1912 and reference specimen of *A. elliptica* of Laube, 1869a, 1870 and 1871), 1849.XXIII.40 (reference specimen to *A. perspicillata* of Laube, 1869a, 1870 and 1871), ? 1861.L.136 (poorly preserved specimen, specific identification uncertain)]
Early ? Badenian (Langhian) – Seggauberg, near Leibnitz, Styria, Austria
LMJ (ex. UGP coll.): 1 specimen [UGP 1880.XX.5 (**holotype** of *Amphiope styriaca* Hoernes, 1883)]

Foreign material for comparison:
Badenian (Langhian-Early Serravallian) – Budafok, Hungary
MAFI: 1 specimen [MAFI Ech-312 (figured specimen of Vadász, 1915)]
Late Burdigalian – Gebel Gharra, near Suez, Egypt
NHMW: 6 specimens (NHMW 2001z0043/0024-27, 57-58) and 10 fragments (NHMW 2001z0043/0059, 102-103)

Dimensions (in mm)**:**

Inv. No.	TL	TW	TH
NHMW 1849.XXIII.39	~55	~57	9.8
NHMW 1849.XXIII.40	70.4	>70	~10
NHMW 1861.L.136	>75	>78.5	13.6
UGP 1880.XX.5	> 100	108.7	11.6

Description:
Size and shape: Medium-sized to large, disc-shaped test with irregular circular outline and subequal length and width. Two large and subcircular to slightly triangular (Badenian material) or small and subcircular to elliptical (Karpatian material), lunules are present in ambulacra I and V. Marginal indentations are well developed in ambulacrum III and interambulacra 1 and 4. Faint indentations present in ambulacra II and IV. Maximum width situated subcentrally, slightly posterior of apical disc. In profile test low with the maximum height anterior of centre in the uppermost part of petal III. Ambitus very thin and sharp; oral surface flattened and slightly concave.
Apical disc: Apical disc approximately centrally or slightly anterior of centre, belonging to the monobasal type with 4 gonopores. Madreporite star-shaped.
Ambulacra: Adapically the ambulacra form well developed petals. These are lanceolate in shape, straight and closed distally. Petals similar in length, frontal one longest, anterior paired petals about 90 % and posterior paired petals about 80 % length of the frontal petal. Frontal petal about 50 % of the corresponding test radius. Anterior and posterior paired petals only 45 respectively 35 % of the corresponding test radius. The pores within the petals are typical, closely spaced conjugated anisopores. Apart from trailing podia (*sensu* Mooi, 1989) only minute microunipores can be found outside the petals. Poriferous zones slightly depressed and interporiferous zones slightly raised. Interporiferous zones as wide as single poriferous zone. Tuberculation on the aboral side, as far as preserved, is homogenous and consists of very small perforate, crenulate tubercles which are densely crowded.

On the oral side the ambulacra are depressed along their central sutures. The typical tubercle differentiation in locomotory and geniculate spine fields (compare Mooi, 1989: fig. 33b) can be observed. Generally tubercles are larger on the oral side than aborally.
Interambulacra: Two faint ridges are developed in each interambulacrum aborally. They run along the midline of each interambulacral column. Otherwise the surface is smooth and densely crowded with small crenulate, perforate tubercles, as on the ambulacra.

On the oral surface the interambulacra are slightly inflated, except adorally, where a radially elongated pit is present along their central suture. As stated above the typical sand-dollar tubercle differentiation can be observed.
Food Grooves: Food grooves well developed but restricted to the oral surface. Primary branching occurs close to the peristome, at the edge of the primordial plates, secondary branching near the margin. No food grooves reach the margin. The posterior pair of the food grooves runs around the lunules.
Lunules: In each one of the posterior ambulacra a subcircular to irregularly triangular (Badenian material) to slightly transversely elongate (Karpatian material) lunule is found. They are situated about halfway between the tip of the posterior paired petals and the margin of the test. Lunule structure corresponds to that of *Echinodiscus* [see Fig. 42.C; from Mooi (1989)] with cross linked lunule wall (Fig. 42.B).
Peristome: The peristome is situated subcentrally to slightly anterior of the centre, just below the apical disc. It is small (3.1 mm in diameter) and subcircular to subpentagonal in outline with food grooves leading into it.
Periproct: The anus is preserved in a single specimen only (NHMW 1849.XXIII.40). There it is small and subcircular, lying near the margin in interambulacrum 5, between the first and second pair of postbasicoronal plates.

Differential diagnosis:
Currently there is only a single other species of *Amphiope* that is described and illustrated in a modern way and thus allows comparison with the species investigated here. Most other nominal species are in serious need of re-examination and revision, a task which is out of the scope of the present contribution.

A. boulei Cottreau, 1913 from the Aquitanian of the Southern Rhône Basin differs from *A. bioculata* by its smaller petalodium (i.e. in *A. bioculata* the tips of the posterior petals nearly reach the lunules, regardless of specimen size, whereas in *A. boulei* there is a large gap between posterior petal tips and margin of the lunules), small and axially elongated lunules

(whereas they are large and subcircular or transversely elongated in most *A. bioculata*) and more distinct anal notch but otherwise less indented margin (compare re-description of *A. boulei* by PHILIPPE, 1998).

Discussion:
With approximately 40 nominal species (see e.g. LAMBERT, 1907b; LOVISATO, 1911a, 1914a; COTTREAU, 1913a; LAMBERT & THIÉRY, 1909-1925; COMASCHI CARIA, 1955; KIER & LAWSON, 1978) *Amphiope* is another Miocene genus with poorly resolved taxonomy. Most of the nominal species are in serious need of revision and many may turn out to be synonymous as indicated by investigations on the forms of the Rhône Basin (PHILIPPE, 1998) where just 2 out of 7 described species proved to be valid.

LAMBERT (1907b: 58) remarked to *A. styriaca* that "*et elle paraît distinguer du* A. bioculata *par ses zones interporifères plus effilées.*" ("... and it appears to be distinguished from *A. bioculata* by its more frayed/elongate/lanceolate interporiferous zones."). It is not quite clear what LAMBERT really meant with "*plus effilées*". The present author cannot see any marked differences between the interporiferous zones in the holotype of *A. styriaca* and those of *A. bioculata* (based on material from the Late Burdigalian of Egypt in the NHMW coll., and on the photographs in PHILIPPE, 1998). The only obvious difference in the holotype is that is that its aboral surface is slightly leached due to diagenetic alteration, resulting in slightly enlarged pores and marked visibility of the sutures. In fact, the type specimen of *Amphiope styriaca* falls well within the variation of "population" D of *Amphiope bioculata* from the Serravallian of Beaume, near Rognes (Bouches-du-Rhône) described and illustrated by PHILIPPE (1998: 161-166, fig. 17, pl. 16, figs. 5, 8a-b). It is especially similar to the large forms of this "population" and to the material from the Middle Miocene of Sardinia described as *Amphiope montezemoloi* by LOVISATO (1911a: 42-47). This species is characterised by its large size, irregularly rounded to slightly elliptical outline, large subtrigonal lunules and transversely truncated posterior margin. It thus differs morphologically from typical *A. bioculata*, which has a more regularly shaped outline (with distinct indentations in ambulacra II, III and IV) and slightly oval, laterally elongated lunule. PHILIPPE (1998: 166), however, based on an analysis of a large number of specimens from 4 different "populations" of different provenience and age found that both outline of the test and shape of the lunules are extremely variable even within a single horizon/outcrop. Similarly, features as the position of the periproct and the eccentricity of the apical disc may vary significantly. This could also be confirmed by an investigation of a number of specimens from the Late Burdigalian of Egypt by KROH (unpublished data). Thus *A. styriaca* is considered a junior synonym of *A. bioculata*.

LAUBE (1871: 61) reported two species of the genus *Amphiope* "aus dem Sande in den Leithakalkschichten von Niederkreuzstetten". SCHAFFER (1962), however, stated that LAUBE's material did not come from sands within the [Badenian (Langhian-Early Serravallian)] Leitha Limestone, but from the "Helvetian" [Karpatian (Late Burdigalian)] sands outcropping in the area around Niederkreuzstetten, NÖ. This seems to be correct, as the preservation of the available specimens is highly similar to that of *Parascutella paulensis* collected from the Karpatian sands of Niederkreuzstetten.

Although initial presumed to be lost (KROH, 2002a) Laube's material could be recovered from the NHMW collection since. The whereabouts of SCHAFFER (1962) material is still unknown. The three specimens of LAUBE are rather similar and differ mainly by there different preservation and shape of the lunules. In the specimen (NHMW 1849.XX.III.39) figured as *A. elliptica* by LAUBE (1871) the lunules are very small and almost circular (contrary to his figure), in the two others the lunules are slightly larger and elliptical. LAUBE's attribution to *A. elliptica* (NHMW 1849.XX.III.39) and *A. perspicillata* (NHMW 1849.XX.III.40) was based on determinations made by Hardouin MICHELIN during his visit in Vienna in 1857 or 1858 (MICHELIN, however, had crossed out *perspicillata* on the label of specimen NHMW 1849.XX.III.40 and attributed this specimen to *A. elliptica* too).

For the specimen figured as *Amphiope elliptica* by LAUBE (1871) LAMBERT (1912: 79) established the name *A. laubei* as he considered it specifically distinct from *A. elliptica*. According to him *A. laubei* differs from *A. elliptica* (a synonym of *A. bioculata* according to PHILIPPE, 1998) by "*à pétales saillants et étroites lunules, plutôt ovales qu'elliptiques, nettement transverses et à bords tuméflés, a sa face supérieure plus tourmentée*" (LAMBERT, 1912: 79). Yet when LAUBE's material is compared with the French specimens described in detail by PHILIPPE (1998) it is evident that it falls well within the variability of the French specimens. In particular the material ascribed to population "B" from the Burdigalian of Saint Christobal (PHILIPPE, 1998: 161, fig. 15, pl. 16, fig. 6) is extremely similar. Contrary to LAMBERT's statement the petals and lunule margin of LAUBE's specimen are much less swollen than the figure [LAUBE, 1871: pl. 16 (1), fig. 5] suggests and aboral surface is very similar to that of French specimens of *A. bioculata*. Consequently *A. laubei* is placed into the synonymy of *A. bioculata*.

As mentioned above, *Kieria semseyana* MÍHALY, 1985 is interpreted as juvenile *Amphiope* sp., it is likely that it represents juveniles of *A. bioculata*, since it is morphological very similar to those (compare with PHILIPPE, 1998: figs. 16a-e) and co-occurs with adult specimens of *A. bioculata*. Similarly the specimen determined as *A. ludovici* from the same locality by MIHÁLY (1985) is most probably also a juvenile specimen of *A. bioculata*.

Although SEILACHER (1979: p. 198 and fig. 8) reports the structure of the lunules in *Amphiope* to correspond to the festooned type (see Fig. 42.D) this is not the case in the present species (see Fig. 42.B). MOOI (1989) considered the lunules of *Amphiope* to be of the cross-linked type, as in *Echinodiscus* (see Fig. 42.C), which is supported by the material studied by the present author.

Occurrence:

Austria: Karpatian (Late Burdigalian), Late Badenian (Early Serravallian)
- Vienna Basin: Niederkreuzstetten, NÖ, Austria (LAUBE, 1869a, 1871; MÜLLER, 1963, 1978; KROH, 2002a, 2003b; [NHMW]); Neubau, near Niederkreuzstetten, NÖ, Austria (SCHAFFER, 1962)
- Styrian Basin: Seggauberg, near Leibnitz, Styria, Austria (HOERNES, 1880, 1883; LAMBERT, 1907b)

Paratethys (non-Austrian occurrences): Late Badenian (Early Serravallian)
- Great Hungarian Basin (Pannonian Basin): Budafok, Hungary (VADÁSZ, 1915); Budapest-Gyakorló, Pest, Hungary (KÓKAY et al., 1984; MIHÁLY, 1985)
- Zala, Sáva and Dráva Basins: unnamed locality in former Yugoslavia (MITROVIĆ-PETROVIĆ, 1981)

Mediterranean: Aquitanian – Serravallian
- Rhône Basin: Aquitanian ("Massalien"): Littoral de la Nerthe (Carry-le-Rouet, Sausset-les-Pins), France (DESOR, 1858; GOURRET, 1892; LAMBERT, 1912; COTTREAU, 1913a; LAMBERT, 1915a; PHILIPPE,1998)
  - Burdigalian: Littoral de la Nerthe (Martigues, Sausset-les-Pins), France (PHILIPPE, 1998); Bassins de Apt-Reillanne-Forcalquier (Céreste, Mane, Reillanne, Villemus), France (PHILIPPE, 1998); Bassin de Vairéas-Visan (Bollène, St Paul-Trois-Châteaux), France (AGASSIZ, 1841a; DESOR, 1858; LAMBERT, 1912, 1915a; PHILIPPE, 1998); Sillon pénalpin/bassin de Crest (Crest), France (PHILIPPE, 1998);
  - Langhian: Bas-Languedoc occidental (Aspiran, Lespignan,

Nissan-lez-Ensérune), France (Philippe, 1998); Vallée du Jabron (Chateauneuf-Miravai), France (Philippe, 1998)

Serravallian: Secteur des étangs (Istres, St Chamas), France (Philippe, 1998); Bassin de Aix (Lambesc, Rognes, Vernègues), France (Philippe, 1998); Bas-Languedoc (Aspiran, Bassan, Boujan, Cruzy, Lapalme, Nissan-lez-Ensérune, Quarante, St Félix de-Lodez), France (Lambert, 1910a; Philippe, 1998); Bordure Sud-Luberon (Ansouis, Cabnères-de Aigues, Cucuron, la Motte-de Algues, Sannes, Vaugines), France (Lambert, 1912; Philippe, 1998); Bassin de Digne (Tanaron), France (Philippe, 1998); Bassin de Faucon-Mollans-Malaucène (Puyméras, St-Romain-en-Viennois), France (Philippe, 1998); Bassin de Vairéas-Visan (St Paul-Trois-Châteaux, Suze la-Rousse), France (Philippe, 1998)

Western Mediterranean: Cruzy, near Nissan, Herault, France (Lambert , 1912; Cottreau, 1913a; Lambert, 1915a); Ploaghe à Chiaramonti, Sardinia (Cotteau, 1895); S. Giorgio, Sardinia (Lovisato, 1911a; Comaschi Caria, 1955)

Eastern Mediterranean: Gebel Gharra, Eastern Desert, Egypt (Kroh, unpublished data)

Atlantic Ocean: Aquitanian to Burdigalian, Serravallian [some authors, e.g. Chavanon (1974), refer the material from this region to other species of *Amphiope* (i.e. *A. ovalifora* des Moulins, 1837, *A. caupianensis* Chavanon, 1974)]

Aquitaine Basin: Bordeaux, France (Agassiz, 1841a); Bougue, Landes, France (Cahuzac & Cluzaud, 1988); Faluns de Touraine, France (Agassiz, 1841a; Agassiz & Desor, 1847a; Desor, 1858); Gornac, Gironde, France (Agassiz & Desor, 1847a); Saint-Maure, Indre-et-Loir, France (Agassiz & Desor, 1847a; Desor, 1858)

Additional clypeasteroid species reported from the Central Paratethys

Clypeaster barcinensis ? Lambert, 1906

(Pl. 32, Fig. 4)

?*	1906a	*Clypeaster barcinensis* – Lambert: 84-85; pl. 6, fig. 7
?	1927a	*Clypeaster barcinesis*, Lambert, 1906 – Lambert: 11-12; pl. 5, figs. 1-2
.	1935	*Stolonoclypus* sp. – Kalabis: 275; figs. 1a-b [x-ray]
.	1938a	*Stolonoclypus* sp. – Kalabis: 4, 10
.	1938b	*Stolonoclypus* sp. – Kalabis: 7, 8, 9-10
.	1949	*Stolonoclypus barcinensis* (J. Lambert, 1906) – Kalabis: 54-56, 111-113; pl. 8, figs. 1-5

Type Material:
Syntypes: specimens figured by Lambert (1906a: pl. 6, fig. 7; 1927a: pl. 5, figs. 1-2); housed at the Museum de Geologia de Barcelona
Locus typicus: Montjuich, Catalonia, Spain
Age: Tortonian, Late Miocene according to Lambert (1927a: 12)

Material:
Late Badenian (Early Serravallian) – Devínska Nová Ves, Slovak Republic
NHMW: 2 fragmentary specimens (NHMW 2003z0048/0001 to 2)

Dimensions (in mm)**:**

Inv. No.	TL	TW	TH
NHMW 2003z0048/0001	> 130	120.4	~ 25
NHMW 2003z0048/0002	> 92	>96	~ 29

Description:
Size and shape: The test is of medium to large size, with an antero-posteriorly elongated sub-pentagonal outline. Test width is approximately 90 % of TL. The margin of the test is thin but rounded and shows shallow but distinct marginal indentations in the interambulacra 1, 4 and 5. The maximum width lies anterior of the centre, where ambulacral columns IIa and IVb reach the ambitus. In profile the test is low with a slightly inflated petaloid area. The apex coincides with the apical disc and lies approximately centrally. The oral surface is distinctly flattened with a shallow and very wide infundibulum.
Apical disc: The apical disc lies subcentrally on the aboral side of the test. It is not preserved in the investigated specimens.
Ambulacra: The petals are ellipsoidal in shape, straight and moderately closed distally (width of the IPZ 4 to 6 mm distally). The anterior paired petals are shortest, the frontal and the posterior ones subequal in length. The length of the petals is about 53 to 58 % of the corresponding test radius. The poriferous zones are depressed and moderately wide. The pore pairs are conjugated anisopores. The interporiferous zones are inflated, medially flattened and range from 2.4 to 2.8 times a single poriferous in width. On the oral surface deep, simple, unbranched food grooves are present in the axes of the ambulacra. The tuberculation of the interporiferous zones is similar to that of the interambulacra, but tubercle density is higher. The tubercles of the interporiferous zones are arranged in series perpendicular to the medial suture of the ambulacra.
Interambulacra: Adapically the interambulacra are slightly inflated between the petals, forming weak keels between them. The tuberculation consists of evenly spaced, small, crenulate, perforate primary tubercles in sunken areoles. Due to the poor preservation of the surface miliary and secondary tubercles are not visible. Likewise no details of the oral tuberculation can be seen on Kalabis' specimens.
Peristome: The peristome lies subcentrally in a shallow but very wide infundibulum. Its shape is not visible in the present specimens.
Periproct: The periproct is poorly preserved in all examined specimens. It is situated inframarginally in interambulacrum 5, about 3 to 4 mm away from the posterior margin.
Internal support system: X-ray images of this species were provided by Kalabis (1935: fig. 1; 1949: pl. 8, fig. 5). These images show an extremely dense pillar and ridge system in the marginal parts of the test, a broad intestine canal and few pillars in the petaloid area.

Differential diagnosis:
C. altus Leske, 1778, from the Messinian of Malta differs by its higher test, different profile shape, broader petals, thicker margin and deeper infundibulum.

C. calabrus Seguenza, 1880, a co-occurring species, differs by its higher profile, thicker margin, concave oral surface with deep infundibulum, narrower petals, more inflated interporiferous zone, and deep marginal indentations.

C. campanulatus (Schlotheim, 1820) (and its phenotypes) differ from this species by its higher profile, longer and broader petals and narrower infundibulum.

C. folium Agassiz in Agassiz & Desor, 1847, a species restricted to the Badenian (Langhian-Early Serravallian) in the Paratethys can, although overally similar to *C. barcinensis* ?, be clearly distinguished from this species. *C. folium* has even shorter petals (44 to 48 % of the corresponding test radius vs. 53 to 58 % in *C. barcinensis* ?), a slightly anteriorly displaced apical disc and petaloid area, and deeper marginal indentations in all interambulacra.

C. intermedius des Moulins, 1837, a species occurring in the Burdigalian of the Rhône Basin and possibly the Paratethys, differs by its narrower and more strongly inflated petals, thicker margin, and higher profile.

C. latirostris Michelin, 1861, a species occurring in the Eggenburgian (Early Burdigalian) of the Molasse Zone, is distin-

guished from this species by its subequal test length and width, longer and less closed petals, and less inflated interporiferous zones.

C. neudorfensis Lambert, 1927, a co-occurring species, differs by its higher profile, lanceolate and longer petals, sharper margin and narrow infundibulum.

C. scillae des Moulins, 1837, a co-occurring species, differs by its higher profile, thicker margin, concave oral surface with deep infundibulum, narrower petals and more inflated interporiferous zone.

Discussion:
The types of *C. barcinensis* Lambert, 1906, are a fragmented specimen showing only the petaloid area and an internal cast, the oral side of which is still embedded in the matrix (presumably preserving the original shell of the oral surface), the aboral surface, however, is nearly completely lost. To the author's knowledge no additional topotypes have been described in the literature. It is thus very difficult to verify Kalabis' (1949) identification of material from the Vienna Basin with this species. The shape of the petals although overall similar, is slightly different in the Vienna Basin specimens, where the petals are shorter and wider. Additionally, the margin seems to be more rounded and slightly thicker in the latter. The conspicuous oblique arrangement of the tubercles in the interporiferous zones of the petals which Lambert (1906a: 84) regarded as characteristic feature of this species is not very evident. Instead an arrangement in series perpendicular to the perradial sutures is more prominent. Currently the identification of the Vienna Basin specimens with the Spanish species cannot be but tentative and has to be critically revised until more and better preserved material of both becomes available.

Occurrence:

Austria: not recorded until now, but occurrence very likely

Paratethys (non-Austrian occurrences): Late Badenian (Early Serravallian)
Vienna Basin: Devínska Nová Ves (= Neudorf an der March), Slovak Republic (Kalabis, 1935, 1938a, b, 1949; [NHMW])

Mediterranean: Tortonian, Late Miocene
Western Mediterranean: Montjuich, Catalonia, Spain (Lambert, 1906a, 1927a)

Clypeaster myriophyma ? Pomel, 1887

? 1885 *Clypeaster myriophyma* – Pomel: pl. B44, figs. 1-6
v 1915 *Clypeaster myriophyma* Pom. – Vadász: 147-149; fig. 40

Material:
Late Badenian (Early Serravallian) – Gârbova de Sus (= Felsö-Orbó), Romania
MAFI: 1 specimens (MAFI Ech 133)

Discussion:
Record based on a single specimen which is similar to members of the *C. campanulatus* group. It differs, however, by its distinctly oval outline and rounded posterior end (as opposed to a transversely truncated one in *C. campanulatus*). Whether or not it is really conspecific with the Algerian type material can not be decided currently.

Occurrence:

Paratethys: Late Badenian (Early Serravallian)
Transylvanian Basin: Gârbova de Sus (= Gîrbova de Sus, = Felsö-Orbó), Romania (Vadász, 1915)

Mediterranean: Early or Middle Miocene
Western Mediterranean: Beni Chougran, Algeria (Pomel, 1885-87)

Unconfirmed records of clypeasteroids from Austria and the Central Paratethys

Additionally to the species described above several other species are mentioned in the geological literature. Because descriptions and illustrations are either insufficient or completely lacking and the material on which the records are based could not be located it is difficult to evaluate them. Most of these records might be misidentifications, although, it cannot be excluded that some might be valid.

Clypeaster airaghii Lambert, 1913

1949 *Clypeaster airaghi* Lambert – Schouppé: 143

Reported occurrence: quarry in Retznei, near Ehrenhausen, Styria (Schouppé, 1949).

Remarks: The name *C. airaghii* was established by Lambert (1913a: 108) for a specimen from the Early Miocene of the Colli Torinesi, Italy figured as *C. crassicostatus* Ag. by Airaghi [1901: pl. 12 (6), figs. 6, 6a]. The specimen figured by Airaghi is extremely similar to *C. scillae* and might well belong to that species. Austrian material referred to *C. airaghii* thus represents most probably *C. scillae*.

Clypeaster angustus Pomel, 1887

1915 *Clypeaster angustus* Pom. var. – Vadász: 180

Reported occurrence: Late Badenian (Early Serravallian) of Gârbova de Sus (= Felsö-Orbó), Romania (Vadász, 1915)

Remarks: As for many others no illustration of this species was published by Vadász. The description is not sufficient to confidently refer the record to any of the species discussed above.

Clypeaster coronalis Lambert, 1913

1915 *Clypeaster coronalis* Lamb. – Vadász: 143; fig. 36
1969 *Clypeaster coronalis* Lambert – Mihály: 256
1984 *Clypeaster coronalis* Lamb. – Kókay et al.: 288

Reported occurrence: Badenian (Langhian-Early Serravallian) of Iablanitja (= Bélajablánc, = Jablanica), Caraş-Severin, Romania (Vadász, 1915); Late Badenian (Early Serravallian) of Budapest, Hungary (Mihály, 1969; Kókay et al., 1984)

Remarks: It is questionable whether any of the specimens from the Badenian of the Central Paratethys referred to this species really belongs to the Early Miocene *C. coronalis* (now considered to be a junior synonym of *C. intermedius* by Philippe, 1998). Unfortunately, none of the specimen could not be located in the MAFI collection and the specific identifications remain doubtful.

Clypeaster gregoryi Lambert, 1913

1949 *Clypeaster gregoryi* Lambert – Schouppé: 143

Reported occurrence: quarry in Retznei, near Ehrenhausen, Styria (Schouppé, 1949).

Remarks: This species was based on a single specimen from the Burdigalian (?) of Tourettes-sur-Loup, Vence, France (Lambert,