

bordering the anterior paired petals. Their number ranges from 4 to 60 in interambulacra 1 and 4 and 5 to 35 in interambulacra 2 and 3. The surface between and around these enlarged primary tubercles is densely crowded with miliary tubercles. Secondary tubercles with distinct areoles are scattered among them, but are generally rather rare on the apical surface of the test. Only in interambulacrum 5 along the interradiate suture and along the adradial sutures to ambulacrum III in interambulacra 2 and 3 a larger numbers of secondary tubercles is present.

In the interambulacral columns 2b and 3a a conspicuous field of coarse tubercles is developed adjacent to the adradial suture to the adapical part of ambulacrum III (see Pl. 81, Fig. 2b)

On the oral surface interambulacra 1, 2, 3 and 4 are covered densely with camellate primary tubercles arranged in distinct rows. They have deeply sunken, asymmetric areoles and helically spiralled parapets. These tubercles are largest next to the adradial sutures and decrease in size from the centre towards the margin. The plastron is ultramphisternous with a narrow contact between labrum and sternum (Fig. 94). The labrum is triangular and projects slightly into the peristome. Up to two third of the sternal plates are naked, only in the posterior part secondary tubercles are found, which are arranged in a fan-shaped pattern.

Peristome: The peristome is kidney shaped, transversely elongated and lies about 25-28 % TL from the anterior margin. It is moderately large, being about 15 to 16 % TL wide in adult specimens.

Periproct: The periproct lies inframarginally, high on the vertically truncated posterior end of the test. It is oval, transversely elongated and is with approximately 10 % TL distinctly smaller than the peristome. There is a depressed subanal area, which is free of primary and secondary tubercles.

Fascioles: The only fasciole present is a wide bilobed subanal fasciole. The fasciole band is moderately wide and corresponds to the othofasciole type of NÉRAUDEAU et al. (1998b). The existence of an internal fasciole in adult specimens can be excluded. Even in specimens with extremely well preserved aboral tuberculation no traces of fasciole bands were located around the apical disc.

Differential diagnosis:

The closely related *Hemipatagus girundicus* LAMBERT, 1915a from the Burdigalian to Langhian of Bordeaux differs from this species by a broader keel in interambulacrum 5, which is more flattened and more densely tuberculate than in *H. ocellatus* (compare the descriptions in LAMBERT, 1915a: 191; LAMBERT & THIÉRY, 1909-25: 457, pl. 13, fig. 5; LAMBERT, 1927b: 119-121). If this sole feature is enough to keep these species separated is still a matter of debate. CHAVANON (1974: 271-272) and PHILIPPE (1998: 222-223) did not synonymise them, although the latter expressed his doubts and stated that more material is needed to solve this question.

Hemipatagus hoffmanni (GOLDFUSS, 1829) differs by its higher test (test height ranging from 42 to 50 % TL), the bluntly pointed, obliquely truncated posterior end, the laterally flexed anterior petals, the lower number of camellate primary tubercles, which are, moreover, never as large and closely spaced as in *H. ocellatus* [based on the description in GOLDFUSS, 1826-44: 152-153, pl. 47, figs. 3a-c, the type-material in the collection of the Goldfuss Museum (Univ. Bonn) and specimens from the type locality in the collection of the NHMW and the NKM Berlin].

Spatangus ornatus (Cuv.) (as described in GOLDFUSS, 1829: 152; pl. 47, figs. 2a-c), which was the name-inspiring species for SCHAEFFER'S *S. perornata*, is an *Eupatagus*. Its plastron is fully covered with tubercles and a peripetalous fasciole is present according to AGASSIZ & DESOR (1847b: 9). Moreover, albeit generally similar it has no camellate primary tubercles and cannot easily be confused with the species discussed here.

Discussion:

The generic assignment of this species was subject to considerable debate: originally referred to the genus *Spatangus* (e.g. DEFRANCE, 1827; DE LORIO, 1876) it was later placed into the genus *Maretia* (COTTEAU et al., 1891), only to be transferred to the genus *Hemipatagus* by LAMBERT (1909) soon afterwards. During this time the question arose, whether *Maretia* and *Hemipatagus* should be considered synonymous (AGASSIZ, 1872: 568, 1873; COTTEAU, 1885-89: 24; FOURTAU, 1920: 83) or not (e.g. DUNCAN, 1889: 222, 252; LAMBERT, 1909: 107, 1915a: 188, 1927b: 87), or even if *Hemipatagus* is synonymous with *Lovenia* (DUNCAN, 1877: 56). In his "Monograph of the Echinoidea" MORTENSEN (1951: 23-27) lengthily discussed this matter and finally considered *Hemipatagus* DESOR, 1858 a junior synonym of *Maretia* GRAY, 1855. In the "Treatise on Invertebrate Paleontology" FISCHER (1966: U609) adopted MORTENSEN'S view and thus it was soon widely accepted in the scientific community, although some authors (e.g. PHILIPPE, 1998: 222) expressed their doubts.

Based on material of the type-species of the genera in question the present author (KROH, in prep) was able to show that *Hemipatagus* is clearly different from *Maretia* and in fact belongs to the Loveniidae, not the Spatangidae as the latter genus. The features with which the two genera can be separated are outlined above under the remarks to the genus.

The studied specimens clearly belong into the genus *Hemipatagus*, and are conspecific with *H. ocellatus* (DEFRANCE, 1827) recently re-described and illustrated by PHILIPPE (1998: 220-223; pl. 22, figs. 6, 7, 8a-b, 9a-b, 10a-c; under the name *Maretia ocellata*).

Based on the examination of the type material housed at the Krahuletz-Museum (Eggenburg, NÖ, Austria) the species *Spatangus (Maretia) perornatus* SCHAEFFER, 1912a has to be placed into the synonymy of *H. ocellatus*. According to AGASSIZ & DESOR (1847b: 7) and PHILIPPE (1998: 222) *Spatangus nicoleti* AGASSIZ, 1839 is also a junior synonym of *H. ocellatus*. Although, surprisingly similar and originally determined at first as *Spatangus hoffmanni* (WRIGHT, 1855: 176) and later as *S. ocellatus* (WRIGHT, 1864: 487), the Maltese species *Lovenia duncanii* (GREGORY, 1891), is clearly a lovenioid, based on the presence of an internal fasciole as shown by CHALLIS (1980).

The material of VADÁSZ (1914, 1915) attributed to *Hemipatagus ocellatus* is rather poorly preserved. The figured specimen could not be located at the MAFI. The only specimens that are preserved there are three weathered fragments with camellate aboral tubercles (MAFI Ech 237) that are not identifiable at genus level.

Occurrence:

Austria: Early to Late Eggenburgian (Early Burdigalian)

Molasse Zone: Achberg (Scutellensande, Loibersdorf Fm.), near Maria Dreieichen, NÖ (STEININGER, 1971a, b); Eggenburg (Brunnstube), NÖ (STEININGER, 1971a, c); Eggenburg (Kremserberg, Zogelsdorf Fm.), NÖ (SCHAEFFER, 1912a; [KM]); Fels am Wagram (Fels Fm.), NÖ (STEININGER, 1971a); Gösing (Fels Fm.), NÖ ([KM, NHMW]); Grubern (Zogelsdorf Fm.), NÖ (SCHAEFFER, 1912a; [NHMW]); Unternalb (Retz Fm.), NÖ (HARZHAUSER & KROH, 1999; KROH & HARZHAUSER, 1999; LUKENEDER & HARZHAUSER, 2002 [NHMW])

Paratethys (non-Austrian occurrences): Burdigalian, ? Badenian (Langhian-Early Serravallian)

Swiss Molasse: La Chaux-de-Fonds, Jura (AGASSIZ, 1839; DESOR, 1858; MANZONI, 1873; DE LORIO, 1876; LAMBERT, 1915; LAMBERT & JEANNET, 1928); Les Verrières, Neuchâtel (DE LORIO, 1876; LAMBERT, 1915a); Neuchâtel (AGASSIZ & DESOR, 1847b; D'ORBIGNY, 1852; PICTET, 1857)

Great Hungarian Basin (Pannonian Basin): ? Mátra-vevő, Nógrád, Hungary (VADÁSZ, 1914, 1915)

Transylvanian Basin: ? Gârbova de Sus (= Felső-Orbó), Romania (VADÁSZ, 1914, 1915)

Mediterranean: Burdigalian, ? Langhian

Western Mediterranean: Italy, mainland (AGASSIZ, 1840b; PICTET, 1846): ? Monteorsello (MAZZETTI & PANTANELLI, 1883), ? Monte Titano (MANZONI, 1873), ? Rocca S. Maria (MAZZETTI & PANTANELLI, 1883), ? Sasso Bolognese (MANZONI, 1873); Rhône Basin, France (PICTET, 1846, 1857): Beaucaire (PHILIPPE, 1998), Bonnieux (PHILIPPE, 1998), Cap Couronne, near Martigues, Bouches-du-Rhône (NEGRETTE, 1984; PHILIPPE et al., 1990), Carry, Bouches-du-Rhône (GOURRET, 1892; LAMBERT, 1915a), Châteauneuf-Miravail (PHILIPPE, 1998), Clansayes (LAMBERT, 1915a; PHILIPPE, 1998), Couremes, near Vence, Alpes-Maritimes (LAMBERT, 1915a), Crest (PHILIPPE, 1998), Grignan (PHILIPPE, 1998), Istres (PHILIPPE, 1998), Lacoste (PHILIPPE, 1998), Martigues, Bouches-du-Rhône (PHILIPPE, 1998), Ménerbes (PHILIPPE, 1998), Montségur-sur-Lauzon (PHILIPPE, 1998), E of Port des Tamaris, Bouches-du-Rhône (NEGRETTE, 1984), Reillanne, Basse-Alpes (LAMBERT, 1915a; PHILIPPE, 1998), Saint-Mitre-les-Remparts (PHILIPPE, 1998), Saint-Paul-Trois-Châteaux, Drôme (AGASSIZ & DESOR, 1847b; GRAS, 1848; D'ORBIGNY, 1852; DESOR, 1858; MANZONI, 1873; LAMBERT, 1915a; PHILIPPE, 1998), St-Jean-en-Royans, Isere (GRAS, 1848), Taulignan (LAMBERT, 1915a; PHILIPPE, 1998); Sardinia, Italy: Monte de Giave (LAMBERT, 1909)

Atlantic Ocean: ? Middle Miocene

Portuguese Atlantic coast: Foz da Fonte, Portugal (KOTCHETOFF et al., 1975)

Spatangoida indet.

(Pl. 82, Fig. 3)

- 1877 Kleine Spatangiden – FUCHS: 673
1942 Spatangidenstacheln. – WINKLER: 106
1943 Spatangiden – VEIT: 13
1943 Seeigelstacheln – GRILL: pl. 1; pl. 5
1952 Stacheln kleiner Echiniden (Spatangiden?) – PAPP: 17
pp 1952 „Seeigelstachel, Echinidenkiefer, Pedicellarien“ – KÜHN: 124
1953 Spatangidenstachel – GRILL: 87, 88, 97, 98
pp 1955 Echiniden: Platten, Zähne, Kiefertteile, Echiniden-Stachel indet. – TOLLMANN: tab. 1
1955 Spatangidarum gen. et spec. indet. – TOLLMANN: tab. 1
? 1971e *Echinoidea* – STEININGER: 167
1987 fragments of Spatangoida – MAĆZYŃSKA: 147; pl. 5, fig. 2; pl. 6, figs. 1-2; pl. 7, figs. 1, 3-4
pp 1992 Seeigelstachel – SAUER et al.: fig. 85N
pp v 1999 Undetermined echinoid ossicles – KROH & HARZHAUSER: 164; pl. 9, fig. 1-7
v. 2002a Hemiasterina indet. – KROH: 309; fig. 2; pl. 2, figs. 1-8
v. 2002a Spatangoida indet. – KROH: 308-309
v. 2002b Spatangoida indet. – KROH: 12
v. 2003a Spatangoida indet. – KROH: 165; pl. 4, fig. 16
2003b Spatangoida indet. – KROH: 252
v. 2003 spatangoids [...] indeterminable spines and plate fragments – KROH et al.: 92

Material:

Egerian (Chattian-Aquitainian) – Ebelsberg (Ebelsberg Fm.), OÖ, Austria

NHMW: 1 slab with an accumulation of whole spatangoid spines (NHMW 2003z0026/1382)

Egerian (Chattian-Aquitainian) – Pucking (Ebelsberg Fm.), OÖ, Austria

NHMW: 3 slabs with accumulated spatangoid spines (NHMW 2003z0026/0002, 2003z0026/0010, 2003z0026/0328)

Egerian (Chattian-Aquitainian) – Pucking or Ebelsberg or Weikerlsee or Asten (Ebelsberg Fm.), OÖ, Austria

NHMW: 19 spine aggregates (NHMW 2003z0026/1375-1381, 2003z0026/1383-1393)

Egerian (Chattian-Aquitainian) – Weikerlsee (Ebelsberg Fm.), Linz, OÖ, Austria

NHMW: 2 slabs with accumulated spatangoid spines (NHMW 2003z0026/1229-1230)

Late Eggenburgian (Early Burdigalian) – Eggenburg, NÖ, Austria

NHMW: 1 spine fragment (NHMW 2004z0110/0013)

Late Eggenburgian (Early Burdigalian) – Unternalb (Retz Fm.), SE Retz, NÖ, Austria

NHMW: numerous spine fragments (NHMW 1999z0051/0026)

Ottngian (Late Burdigalian) – Höbmansbach, Taufkirchen Bay, ESE Schärding, OÖ, Austria

NHMW: 8 spine fragments (NHMW 1978/1966/12i)

Karpatian (Late Burdigalian) – Teiritzberg, near Stetten, Korneuburg Basin, NÖ, Austria

NHMW: 1 fragmentary specimen and spine fragments (NHMW 1999z0095/0001-2, 1999z0096/0001; 1999z0096/0001a-d)

Karpatian (Late Burdigalian) – Karnabrunn (sample 108/T/B), Korneuburg Basin, NÖ, Austria

NHMW: 12 spine fragments (NHMW 1999z0095/0003)

Early Badenian (Langhian) – Gainfarn, NÖ, Austria

NHMW: 5 test fragments (NHMW 2004z0076/0030, ../0034, ../0040-41, 2004z0154/0003)

Early Badenian (Langhian) – Grund, NÖ, Austria

NHMW: numerous spine fragments (no inv. no.)

Early Badenian (Langhian) – Niederleis, NÖ, Austria

NHMW: 4 test fragments (NHMW 2002z0087/0063-65)

Early Badenian (Langhian) – Bad Vöslau (?), NÖ, Austria

NHMW: 14 spine fragments (NHMW 1997z0178/1329, 1329a-c)

Early Badenian (Langhian) – Stotzing (sandpit Mayer), Bgld, Austria

NHMW: 15 test fragments, 1 spine fragments (NHMW 2004z0050/0010, ../0015)

Badenian (Langhian-Early Serravallian) – Bad Vöslau (brickyard Breyer), NÖ, Austria

NHMW: 35 spines (NHMW 1981/56/4)

Badenian (Langhian-Early Serravallian) – old sandpit between Großhöflein and Kleinhöflein, Bgld, Austria

NHMW: 32 spine fragments (NHMW 2003z0081/0012, ../0029-30), 50 test fragments (NHMW 2003z0081/0011, ../0041)

Badenian (Langhian-Early Serravallian) – Kalksburg, Vienna, Austria

NHMW: numerous fragments (NHMW 1952/14)

Badenian (Langhian-Early Serravallian) – borehole Matzen 325 (1456.5-1464.7 m), NÖ, Austria

NHMW: 1 crushed test (NHMW 2004z0101/0002)

Badenian (Langhian-Early Serravallian) – Perchtoldsdorf (Brunnergasse, highway-ramp), NÖ, Austria

NHMW: 3 test fragments (NHMW 1981/56/9c)

Badenian (Langhian-Early Serravallian) – Steinebrunn (formerly Steinabrunn), NÖ, Austria

NHMW: 5 spine fragments (NHMW 1865.I.612e)

Late Badenian (Early Serravallian) – Winden (Nirgl quarry, N of the village), Bgld, Austria

NHMW: 17 spine fragments (NHMW 1859.L.832a)

Late Badenian (Early Serravallian) – Winden [old quarry, N of the Ludlloch (cave), N of the village], Bgld, Austria

NHMW: 2 ambulacral fragment (NHMW 2003z0082/0033, ../0040), 1 interambulacral fragment (NHMW 2003z0082/0041)

Foreign material for comparison:

Early Badenian (Langhian) – Buituri (= Bujtur), 20 km S of Deva, Romania

NHMW: 23 test fragments and 2 spine fragments (NHMW 1852.II.1603d)

Early Badenian (Langhian) – Lăpuşiu des Sus (= Lapugy), Romania

NHMW: 1 test fragment (NHMW 2004z0001/0027d)

Discussion:

The material discussed under this heading is identifiable to order rank only due to the nature of the studied specimens. The unified discussion under the heading “*Spatangoida* indet.” does not imply that they are conspecific or even congeneric.

Disarticulated and fragmented coronal plates and, even more common, spines of spatangoid echinoids are very abundant in the Austrian Miocene. They occur in bulk samples from the Egerian to the Badenian, and occasionally as reworked material in the polyhaline Sarmatian deposits and have sporadically been mentioned in the geological literature (see above). The highly fragmentary nature of the coronal material and the lack of diagnostic characters in the spines preclude a precise determination.

In the Egerian (Chattian – Aquitanian) Ebelsberg Fm. (area of Linz, OÖ) interesting aggregates of echinoid spine fragments occur (Pl. 82, Fig. 3). These aggregates (NHMW 2003z0026/1375-1381) are dense accumulations of spatangoid spine fragments, fish remains, mollusc debris and larger foraminifers. They are here interpreted as feeding remains (? regurgitated material). Possible producers include asteroids, crustaceans and fishes.

STEININGER (1971e: 167) reports echinoid spines that he tentatively attributed to *Parmulechinus hoebbarthi* (then called *Scutella hoebbarthi*). This species was never found at that locality (nor any clypeasteroids) despite intense sampling. Spatangoid debris is known, however, to occur at that locality and it is much more likely that these spines are spatangoid spines.

Occurrence:

Austria: Egerian (Chattian-Aquitanian) to Late Badenian (Early Serravallian)

Molasse Zone: Ebelsberg Fm., Ebelsberg, OÖ ([NHMW]); Ebelsberg Fm., Pucking, OÖ ([NHMW]); Ebelsberg Fm., Weikersee, Linz, OÖ ([NHMW]); ? Fels am Wagram (Fels Fm.), NÖ (STEININGER, 1971e); Grund, NÖ ([NHMW]); Höbmannsbach, Taufkirchen Bay, ESE Schärding, OÖ ([NHMW]); Unternalb, near Retz, NÖ (KROH & HARZHAUSER, 1999; [NHMW])

Waschberg Zone: Auspitzer Mergel (Boudky Fm., NN2, Eggenburgian according to RÖGL & NAGYMAROSY, 2004), Ernstbrunn, NÖ (GRILL, 1953)

Korneuburg Basin: borehole Korneuburg 1 (GRILL, 1953); Karnabrunn, NÖ ([NHMW]); Teiritzberg, near Stetten, NÖ (GRILL, 1953; KROH, 2002a; [NHMW])

Niederkreuzstetten Bay: Niederkreuzstetten, NÖ (GRILL, 1953)

Vienna Basin: Bad Vöslau (brickyard Breyer), NÖ ([NHMW]); Baden Tegel, NÖ (FUCHS, 1877); Brunn am Steinfeld, NÖ (KÜHN, 1952); Gainfarn, NÖ (KROH, 2002b; [NHMW]); Müllendorf, Bgld (TOLLMANN, 1955); Niederleis, NÖ (KROH, 2003a; [NHMW]); Perchtoldsdorf, NÖ (WINKLER, 1942; [NHMW]); Rauchstallbrunngraben, near Baden, NÖ (KÜHN, 1952); Steinebrunn (formerly Steinabrunn), NÖ ([NHMW]); Winden (Nirgl quarry), Bgld ([NHMW]); Vienna Basin (VEIT, 1943)

Eisenstadt-Sopron Basin: Eisenstadt, Bgld (TOLLMANN, 1955); sandpit between Groß- and Kleinhöflein, near Eisenstadt, Bgld ([NHMW]); Großhöflein, near Eisenstadt, Bgld (TOLLMANN, 1955); Eisenstadt (Hartl Fm., Hartl hill), Bgld (TOLLMANN, 1955; KROH et al., 2003); Kleinhöflein, near

Eisenstadt, Bgld (TOLLMANN, 1955); St. Margarethen (Roman quarry), Bgld (SAUER et al., 1992)

Danube Basin: Winden, Bgld ([NHMW])

Lavant Basin: Ettendorf, Lavanttal, Ktn (PAPP, 1952)

Paratethys (non-Austrian occurrences): Eggenburgian (Early Burdigalian) – Late Badenian (Early Serravallian)

Fore-Carpathian Basin: Korytnica Clays, Korytnica, Poland (MACZYŃSKA, 1987)

Transylvanian Basin: Buituri (= Bujtur), Romania ([NHMW]); Lapugy, Romania ([NHMW])

Additional spatangoid species reported from the Central Paratethys

Schizaster latipetalus VADÁSZ, 1915

v * 1915 *Schizaster latipetalus* n. sp. – VADÁSZ: 222-223; text-fig. 112; pl. 11 (5), fig. 6

Reported occurrence: Ottnangian (Late Burdigalian) of Etes (= Ettes), Nógrád, Hungary (VADÁSZ, 1915).

Remarks: This species is known only from sub-surface material (2 specimens) recovered from a borehole in Etes. The figured specimen of VADÁSZ is preserved at the MAFI (Ech 229) and was re-examined by the author. Although the specimen is a natural internal cast it is very well preserved and is clearly not conspecific with the *Schizaster* species discussed above (contrary to the numerous other *Schizaster* species recorded by VADÁSZ). *S. latipetalus* is characterised by its long and broad petals, which nearly reach the ambitus, and the presence of just two gonopores.

Brissopsis crescenticus WRIGHT, 1855

1915 *Brissopsis crescenticus* WRIGHT. – VADÁSZ: 230; pl. 9 (3), fig. 14; pl. 10 (4), fig. 10

? 1930 *Brissopsis crescenticus* WRHIGT. – VENDL: 50

Reported occurrence: Late Badenian (Early Serravallian) of Gârbova de Sus (= Felső-Orbó), Romania (VADÁSZ, 1915).

Remarks: Unfortunately the two specimens on which VADÁSZ's record is based are not preserved at the MAFI, where there were located according to VADÁSZ (1915). Judging from the illustrations and description provided by VADÁSZ (1915) they fit rather well with material of *B. crescenticus* from the type area Malta. Other records of *B. crescenticus* from the Central Paratethys lack sufficient information to evaluate their correctness.

Plagiobrissus hungaricus VADÁSZ, 1915

* 1915 *Plagiobrissus hungaricus* n. sp. – VADÁSZ: 231-232; pl. 10 (4), figs. 11-13

Reported occurrence: Late Badenian (Early Serravallian) of Gârbova de Sus (= Felső-Orbó), Romania (VADÁSZ, 1915).

Remarks: As stated by PHILIPPE (1998: 201) this species is very similar to *P. imbricatus* (WRIGHT, 1855) from the Burdigalian of the Rhône Basin and the Messinian Upper Coralline Limestone of the Maltese islands. He also summarised the features which might be useful to distinguish the two species, but pointed out that the type-material of *P. hungaricus* needs to be re-examined to judge if the two are synonymous.

Echinocardium deikei DESOR, 1858

* 1858 [*Echinocardium*]
Deikei DESOR nov. sp. – DESOR: 408

- 1875 *Echinocardium Deikei*, Desor. – DE LORIO: 122; pl. 22, figs. 6, 6a-b
 1883 *Echinocardium Deickei*, Des. – GUTZWILLER: 46
 non 1979 *Echinocardium deikei* Desor, 1857 – MAĆZYŃSKA: 33; pl. 9, figs. 2, 4 [= *E. peroni* fide PHILIPPE, 1998]
 non 1979 *Echinocardium deikei* Desor, 1857 – MAĆZYŃSKA: 33; pl. 9, figs. 3 [= deformed schizasterid]
 ? 1984 *Echinocardium cf. deikei* Des. – KÓKAY et al.: 290
 ? 1985 *Echinocardium cf. deikei* Desor, 1858 – MIHÁLY: 245; pl. 5, fig. 6

Reported occurrence: Swiss Molasse: Obere Meeresmolasse (Middle Burdigalian), region of St. Gallen (Desor, 1858; De Lorio, 1875; Gutzwiller, 1883); ? Pannonian Basin: Late Badenian (Early Serravallian), Budapest-Gyakorló, Pest, Hungary (Kókay et al., 1984; Mihály, 1985)

Remarks: *E. deikei* is a poorly known species based on poorly preserved material. Philippe (1998: 229) compared it to *E. depressum* a contemporary species in the Rhône Basin. He also pointed out that the records of *E. deikei* from the Badenian of Poland by Maćzyńska (1979) are misidentified *E. peroni*, respectively deformed schizasterids. According to Radwański & Wysocka (2001: 307) the record of Mihály (1985) is based on material that cannot be identified to species level.

***Echinocardium leopolitanum* Radwański & Wysocka, 2001**

- ? 1953 *Amphidetus* sp. nov. indet. – Szörényi: 40, 92; pl. 2, figs. 8, 8a [fide Radwański & Wysocka (2001: 306-307)]
 * 2001 *Echinocardium leopolitanum* sp. nov. – Radwański & Wysocka: 304-307; pl. 3, figs. 1-4; pl. 4, figs. 1-6; pl. 5, figs. 1-3; pl. 6, figs. 1-3.

Reported occurrence: Early Badenian (Langhian): ? Suchodol (=Suchodol), western Ukraine (Szörényi, 1953); Gleboviti near Bibrka, c. 30 km SE Lwów, western Ukraine (Radwański & Wysocka, 2001)

Remarks: This species has recently been described in detail and the reader is referred to the publication of Radwański & Wysocka (2001).

***Echinocardium peroni* Cotteau, 1877**

- 1906 *Echinocardium* nov. sp. – Vadász: 333
 1915 *Echinocardium* nov. sp. ind. – Vadász: 234; text-fig. 119-120
 pp 1979 *Echinocardium deikei* Desor, 1857 – Maćzyńska: 33; pl. 9, figs. 2, 4 [fide Philippe (1998: 231)]
 non 1979 *Echinocardium deikei* Desor, 1857 – Maćzyńska: 33; pl. 9, figs. 3
 1984 *Echinocardium* n.sp. – Kókay et al.: 290 [later described as *E. biaense* by Mihály (1985)]
 * 1985 *Echinocardium biaense* n. sp. – Mihály: 245-246, 262; pl. 5, figs. 3-5 [fide Radwański & Wysocka (2001: 306-307)]
 1988 *Echinocardium biaense* Mihály, 1985 – Maćzyńska: 62; pl. 5, figs. 1a-e [fide Radwański & Wysocka (2001: 306-307)]
 2004 *Echinocardium peroni* Cotteau, 1877 – Radwański & Wysocka: 385, 386; figs. 4

Reported occurrence: Early Badenian (Langhian): Huta Lubycza and Trzęsiny, Poland (Maćzyńska, 1979); Monastyrz (= Monastyrz), near Rawa Ruska, Ukraine (Maćzyńska, 1979); Świniary, southern Poland (Maćzyńska, 1988; Radwański & Wysocka, 2004); Late Badenian (Early Serravallian): Biatorbágy (= Bia), Pest, Hungary (Vadász, 1906, 1915; Mihály, 1985);

Budapest-Rákos, Pest, Hungary (Vadász, 1915; Kókay et al., 1984; Mihály, 1985)

Remarks: Philippe (1998: 231) and Radwański & Wysocka (2001: 306-307; 2004: 386) referred the specimens illustrated as *E. deikei* by Maćzyńska (1979) to *E. peroni*. One of Maćzyńska's specimens (fig. 3), however, is a deformed schizasterid (compare Radwański & Wysocka, 2001: 307). Radwański & Wysocka (2001: 306-307) placed *E. biaense* Mihály, 1985 in the synonymy of *E. peroni* together with one of the specimens illustrated as *E. nov.* sp. by Vadász (1915).

***Hemipatagus? hungaricus* (Vadász, 1915)**

- * v 1915 *Maretia hungarica* n. sp. – Vadász: 237; pl. 9 (3), figs. 17-18
 ? 1915 *Hemipatagus* nov. sp. – Vadász: 238; pl. 10 (4), fig. 14
 . 1952 *Maretia hungarica* Vadász. – Szörényi: 302, figs. a-b

Type-material:

Holotype: specimen MAFI Ech-225, figured by Vadász [1915: pl. 9 (3), figs. 17-18 (drawing)] and Szörényi [1952: figs. a-b (photograph)]; housed at the Museum of the Hungarian Geological Survey, Budapest

Locus typicus: Mátraverebély, Nógrád, Hungary

Age: Late Badenian (Early Serravallian), Middle Miocene

Remark: specimen damaged since the photograph of Szörényi (1952), petal V now missing

Remarks: Lambert & Thiéry (1924: 458) tentatively referred this species to *Atelospatangus* Koch, 1885 because no anterior poriferous zones of petals II and IV are visible in Vadász's drawing. The correctness of this action was questioned by Mortensen (1951: 79), arguing that the drawing might be incorrect. Mortensen was indeed correct, as shown by Szörényi (1952: 302), only the adapical pores of the anterior poriferous zones of petals II and IV are rudimentary. The holotype (the only specimen known) shows many features characteristic of the genus *Lovenia*. An internal fasciole could, however, not be observed. This species is tentatively referred to the genus *Hemipatagus* on base of general shape, petal structure, distribution of the camellate primary tubercles and the lack of an internal fasciole [see above under *H. ocellatus*, and Kroh (in prep) for the reasons of removing *Hemipatagus* from the synonymy of *Maretia*]. It is possible that the specimen illustrated as *Hemipatagus* nov. sp. from the Late Badenian of Felső-Orbó (Romania) by Vadász (1915: 238, pl. 10, fig. 14) also belongs to this species.

Doubtful records of spatangoid species from Austria and the Central Paratethys

***Schizaster desori* Wright, 1955**

- 1869a *Schiz. Desori* Wright. – Laube: 184
 1871 *Schizaster Desori* Wright. – Laube: 71
 1877 *Schizaster Desori* Wright. – Karrer: 181
 ? 1915 *Schizaster* cfr. *Desori* Wright. – Vadász: 224 [two deformed specimens]

Reported occurrence: Early Badenian (Langhian) Baden Tegel of Baden, NÖ (Laube, 1869a, 1871; Karrer, 1877) and Late Badenian (Early Serravallian) of Gârbova de Sus (= Felső-Orbó), Romania (Vadász, 1915).

Remarks: This species, which occurs in the Lower and Middle *Globigerina* Limestone of Malta (Aquitani to Burdigalian), was reported by Laube (1869a, 1871) and Karrer (1877) from

the Badenian (Langhian-Early Serravallian) of the Vienna Basin. These records are based on a single specimen from the collection "k.k. polytech. Institut" (the Technical University of Vienna today). According to SCHULTZ (NHMW, pers. comm., 06.05.2004) the palaeontological collection was transferred to the GBA (all the palaeozoological part) and the NHMW (palaeobotanic specimens) in the 1950's. LAUBE'S (1871) description is insufficient and not accompanied by an illustration it is currently impossible to evaluate this record. All other *Schizaster* specimens from the Baden Tegel examined during the present study were either too poor to determine specifically or belong to *S. karreri*.

***Schizaster cf. scillae* DES MOULINS, 1837**

1915 *Schizaster* cfr. *Scillae* DESMOUL. sp. – VADÁSZ: 225
[two poorly preserved internal moulds]

Reported occurrence: ? Karpatian (Late Burdigalian) of Zagyvapálfalva (= Pálfalva), Nógrád, Hungary (VADÁSZ, 1915)

Remarks: Specimens not located in the Hungarian collections. VADÁSZ'S statement that the specimens are two poorly preserved internal moulds and the fact that none of the other records of *S. scillae* from the Central Paratethys could be confirmed rises some doubts about the correctness of his identification.

***Schizaster cf. curtus* POMEL, 1887**

v 1915 *Schizaster* cfr. *curtus* POMEL. – VADÁSZ: 224-225
[a single fragment; indeterminate]

Reported occurrence: Late Badenian (Early Serravallian) of Buituri (= Bujtur), Romania (VADÁSZ, 1915)

Remarks: The specimen (MAFI Ech 307) on which this record is strongly fragmented and indeterminate. The record is thus rejected.

***Schizaster cf. parkinsoni* (DEFRANCE)**

1915 *Schizaster* cfr. *Parkinsonii* DEFR. sp. – VADÁSZ: 224
[three poorly preserved internal moulds]

Reported occurrence: Karpatian (Late Burdigalian) of Piliny, Nógrád, Hungary (VADÁSZ, 1915)

Remarks: Like the material of VADÁSZ'S *S. cf. scillae*, the specimens of *S. cf. parkinsoni* mentioned by VADÁSZ could not be located. All other records of this species from the Central Paratethys have turned out to be misidentifications. The Central Paratethyan occurrence of this species thus seems very doubtful

***Hemiaster* sp.**

1882 *Hemiaster* sp. – HILBER: 236
1905 *Hemiaster* sp. – GAÁL: 343, 362

Reported occurrence: Badenian (Langhian-Early Serravallian) Mykolaiv (= Mikołajów), western Ukraine (HILBER, 1882) and Hor. Strháre (= Felső-Esztergály), Slovak Republic (GAÁL, 1905).

Remarks: It is unclear to which of the taxa discussed above these two records belong to. They might refer to misidentified schizasterids (*Schizaster* or *Aliaster*). From the locality Hor. Strháre *Schizaster karreri* was documented, poorly preserved specimens of which might have been misidentified as *Hemiaster*. At the other locality only a species of *Echinocardium*, a

fibulariid and some temnopleurids were recorded by SZÖRÉNYI (1953), who referred to this locality as Mikołajów-Radziejów.

***Pericosmus airaghii* LAMBERT, 1909**

? 1955 *Periscoma airaghii* LAMB. – SENÉŠ: 6
? 1967 *Periscoma airaghii* LAMB. – CÍCHA et al.: 93

Reported occurrence: Karpatian of Hlinné, eastern Slovak Republic

Remarks: Recorded without description or illustration on base of a single specimen (from a locality where all specimens are preserved as deformed internal moulds). Until the specimen is adequately described and/or illustrated the record has to be considered doubtful.

***Macropneustes ? compressus* NEMES, 1888a**

* 1888a *Macropneustes (?) compressus*, nov. sp. – NEMES: 164, 218; pl. 6, fig. 5

Reported occurrence: "Czereczeler Schlier", Tărățel (= Czereczel), western Csetrás Mountains, Hunedoara, Romania

Remarks: *Macropneustes ? compressus*, NEMES, 1888a from the "Schlier" facies of Tărățel, Romania is based on a single, poorly preserved specimen. The figure of NEMES (1888a: pl. 6, fig. 5) reveals that the specimen is not suitable for specific determination and that there are similarities to a deformed *Brisopsis ottnangensis*, a species occurring at that locality too (VADÁSZ, 1915).

***Spatangus cf. corsicus* DESOR in AGASSIZ & DESOR, 1847**

1915 *Prospatangus* cfr. *corsicus* COTT. – VADÁSZ: 236

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

Remarks: Record based on a poorly preserved specimens, identification doubtful. The presence of this species in the Middle Miocene of the Central Paratethys needs to be confirmed. According to PHILIPPE (1998: 204) *S. corsicus* is a junior synonym of *S. delphinus*.

***Spatangus delphinus* DEFRANCE, 1827**

1915 *Prospatangus delphinus* AG. sp. – VADÁSZ: 236;
fig. 122

Reported occurrence: Late Badenian (Langhian-Early Serravallian) of Matraszölös, Nógrád, Hungary (VADÁSZ, 1915)

Remarks: Record based on a single poorly preserved specimen that could not be located in the MAFI collection. Description and illustration do not allow to confidently refer the specimen to any of the species discussed above and the record has to be considered doubtful.

***Spatangus cf. delphinus* DEFRANCE, 1827**

1988 *Spatangus cf. delphinus* DEFRANCE, 1827 – MAČZYŃSKA: 61-62; pl. 5, fig. 3

Reported occurrence: Badenian (Langhian-Early Serravallian) of Rybnica, southern Poland (MAČZYŃSKA, 1988)

Remarks: MAČZYŃSKA (1988) figured only the oral side of her single specimen and the printing quality is too poor to see the plate outlines. Neither the labrum shape nor the number and

arrangement of the aboral primary tubercles are described in the text. It is thus impossible to revise this record without re-examination of the material.

Spatangus desmarestii MÜNSTER in GOLDFUSS, 1829

- ? 1852 *Spatangus Desmarestii* MÜNST. – EICHWALD: pl. 3, figs. 2a-b, 3 a-b
? 1853 *Spatangus Desmarestii* MÜNST. – EICHWALD: 46
? 1968 *Spatangus desmarestii* MÜNST. – STANCU & ANDREESCU: 466, tab.

Reported occurrence: Early Badenian of Zhukov (= Żukowice, = Żukowce), near Wyzgródek, western Ukraine (EICHWALD, 1852, 1853); Badenian (Langhian-Early Serravallian) of Rugi-Delinești, Romania (STANCU & ANDREESCU, 1968)

Remarks: *S. desmarestii* is a species from the Oligocene of Doberg, Northern Germany and it seems likely that the records from the Badenian (Middle Miocene) of Romania and the Ukraine are based on misidentifications.

Spatangus fabianii (LAMBERT, 1924)

- ? 1953 *Prospatangus fabianii* LAMBERT, 1924 – SZÖRÉNYI: 39, 90, pl. 8, figs. 5, 5a
? 1979 *Spatangus fabianii* (LAMBERT, 1924) – MAČZYŃSKA: 32; pl. 8, figs. 1-2; pl. 9, fig. 1
? 1988 *Spatangus fabianii* (LAMBERT, 1924) – MAČZYŃSKA: 62; pl. 5, figs. 2a-e

Reported occurrence: Early Badenian (Langhian) of Potelych (= Potylicz) and Kurzany, western Ukraine (SZÖRÉNYI, 1953), Badenian (Langhian-Early Serravallian) of Świniary, southern Poland (MAČZYŃSKA, 1988) and Huta Lubycka, south-eastern Poland (MAČZYŃSKA, 1979)

Remarks: The specimens figured by SZÖRÉNYI (1953) and MAČZYŃSKA (1979, 1988) have a peculiar profile with the maximum height around the anteriorly displaced apical disc and very low posterior end unlike any of the species discussed above. Partial spine cover, adhering sediment and poor printing quality obliterate nearly all details, including plate boundaries.

Spatangus fothiensis (STRAUSZ, 1926)

- * 1926 *Prospatangus fothiensis* nov. sp. – STRAUZ: 214-215, 368-369; figs. 2a-c
1981 *Prospatangus fothiensis* STRAUZ – HALMAI: 106
2003b *Prospatangus fothiensis* STRAUZ, 1926 – KROH: 252

Reported occurrence: Karpatian (Late Burdigalian) of Somlyó Mt., near Fót, Pest, Hungary (STRAUSZ, 1926; HALMAI, 1981)

Remarks: This is the only record of a species of *Spatangus* from the Karpatian of the Central Paratethys. Unfortunately, the type-material could not be traced in the Hungarian collections (KROH, 2003b). On STRAUZ's illustrations details on plating patterns or tuberculation details cannot be seen, even the shape of the petals is not entirely clear. The general form alone does not allow to differentiate the species from others and must thus be considered as *nomen dubium* until re-described.

Spatangus hungaricus (VADÁSZ, 1915)

- * 1915 *Prospatangus hungaricus* n. sp. – VADÁSZ: 235; text-fig. 121; pl. 11 (5), figs. 1-2
? 1953 *Prospatangus hungaricus* VADÁSZ, 1915. – SZÖRÉNYI: 38-39, 89-90, pl. 8, figs. 4, 4a-b

non 1979 *Spatangus hungaricus* (VADÁSZ, 1915) – MAČZYŃSKA: 32; pl. 6, figs. 1a-e, 2; pl. 7, fig. 1a-f

Reported occurrence: Early Badenian of Pod'yarkov (= Podjarków), near Lwów, western Ukraine (SZÖRÉNYI, 1953), Late Badenian (Early Serravallian) of Gârbova de Sus (= Felső-Orbó), Romania (VADÁSZ, 1915)

Remarks: Unfortunately the type-material of this species could not be examined during the present study. The specimen figured by VADÁSZ (1915: pl. 11, figs. 1-2) has many similarities to *S. austriacus*, including a labrum which extends to the second ambulacral plates. As far as can be seen in VADÁSZ's figure the tubercle arrangement is also similar to *S. austriacus*, while the petals seem to be shorter. The specimens figured by MAČZYŃSKA (1979: 32) under this name do not fit very well with VADÁSZ's description and illustrations and are probable misidentified. One of the figures (MAČZYŃSKA, 1979: pl. 7, fig. 1b) shows a short, broad labrum, which does not extend beyond the first ambulacral plate, very similar to *Spatangus* sp. 2 (see above under that species).

Spatangus hungaricus buekkensis (KUTASSY, 1928)

- * 1928 *Prospatangus hungaricus* VADÁSZ n. var. *buekkensis*. – KUTASSY: 5-6; pl. 1, figs. 1a-b

Reported occurrence: Early Miocene of Királd, Hungary (KUTASSY, 1928)

Remarks: Based on a single specimen in which most of the oral surface is obscured. The test is slightly transversely elongated and the petals are relatively long, extending about three quarters of the corresponding test radius. The specimen does not resemble any of the species of *Spatangus*.

Spatangus peroni COTTEAU in LOCARD, 1877

1915 *Prospatangus peroni* COTT. sp. – VADÁSZ: 235

Reported occurrence: Badenian (Langhian-Early Serravallian) of Tótmarokháza, Nógrád, Hungary (VADÁSZ, 1915)

Remarks: Record based on a single poorly preserved specimen. The specimen could not be located among VADÁSZ's material at the MAFI and the record lacks a sufficient description or illustration. Thus the record is considered doubtful and need to be confirmed.

Spatangus sp. 3

1997 *Spatangus austriacus* LAUBE – MAJČEN et al.: 106; pl. 5, fig. 2

Reported occurrence: provenance unknown

Remarks: The specimen figured by MAJČEN et al. (pl. 5, fig. 2) is very large, has a very deep frontal sinus and much more enlarged primary tubercles than any of the species discussed above. Particularly the en-chevron arrangement of the tubercles in interambulacrum 5 is not observed in the other species (they show thin arrangement only in the paired interambulacra, if developed at all). Additionally, the petalodium is very small. This, however, could also be an effect of allometric growth. Unfortunately the locality and exact stratigraphic provenance of the species are unknown and it is probably not from the Central Paratethys at all.

Echinocardium intermedium LÓCZY, 1877

- * 1877 *Echinocardium intermedium* n. sp. – LÓCZY: 64-67; pl. 5, figs. 1a-f, 2a-h

- 1915 *Echinocardium intermedium* LÓCZY. – VADÁSZ: 233; pl. 3 (9), figs. 20-24
- ? 1953 *Amphidetus intermedus* (LÓCZY), 1877. – SZÖRÉNYI: 40, 91-92; pl. 8, fig. 6
- ? 1969 *Echinocardium intermedium* LÓCZY – MIHÁLY: 257; pl. 2, figs. 4-5
- ? 1984 *Echinocardium intermedium* LÓCZY – KÓKAY et al.: 288
- ? 1985 *Echinocardium intermedium* LÓCZY, 1877 – MIHÁLY: 244-245; pl. 5, figs. 7-8

Reported occurrence: Early Badenian (Langhian): ? Mykolaiv (= Mikołajów) and Radziechów (= Radekhov, = Radziejów), western Ukraine (SZÖRÉNYI, 1953); Late Badenian (Early Serravallian): Biatorbágy (= Bia), Pest, Hungary (LÓCZY, 1877;

VADÁSZ, 1915); ? Budapest-Gyakorló, Pest, Hungary (KÓKAY et al., 1984; MIHÁLY, 1985); ? Budapest-Rákos, Pest, Hungary (MIHÁLY, 1969); Minișu des Sus (= Felménes), Arad, Romania (LÓCZY, 1877; VADÁSZ, 1915)

Remarks: According to RADWAŃSKI & WYSOCKA (2001: 307) the specimen figured by VADÁSZ (1915), which belongs to the syntypes of *E. intermedium* LÓCZY, 1877 does not belong to *Echinocardium* at all based on the apparently closed petals, swollen interambulacral plates and the peculiar outline (but could also be a result of a poor drawing). Unfortunately the specimen could not be located at the MAFI where it was housed according to VADÁSZ (1915). According to RADWAŃSKI & WYSOCKA (2001: 307) the record of MIHÁLY (1985) is based on material that cannot be identified to species level.

