

C. folium, the type specimen of which was figured by MICHELIN (1861: pl. 20, figs. 2a-d). Moreover, specimen attributed to *C. scutellatus* (e.g. MICHELIN, 1861: 131-132; pl. 23, figs. 2a-f) are very different from *C. folium*. To the author's knowledge, the holotype of *C. scutellatus* was never figured.

Juvenile and subadult specimens of *C. folium* differ slightly from adult specimens in outline and shape of the oral side. While the marginal indentations are often very distinct and characteristic in adults, they are less well developed in juveniles and subadults of up to approximately 50 mm test length. The same is true for the oral surface, while it is distinctly flattened in adults, it is slightly concave in juveniles and subadults (this is caused by the infundibulum, which needs proportionally more space in smaller specimens than in larger ones). These differences led VADÁSZ (1915) to propose two new species for such subadult specimens: *C. sublaganoides* and *C. n. sp.*

LAMBERT & THIÉRY (1914: 309) stated that *C. subfolium* POMEL, 1887 is a synonym of *C. folium* AGASSIZ in AGASSIZ & DESOR, 1847 and I agree with them. In fact the two species were nearly always reported from the same localities (e.g. COTTEAU et al., 1891; VADÁSZ, 1915;...) and the differential diagnostic features reported can in part be explained by the differences between juvenile/subadult and fully adult specimens.

Clypeaster herepeyi KOCH, 1887 was synonymised with *C. folium* by VADÁSZ (1915: 195) based on a re-examination of the holotype. Although I had no opportunity to examine KOCH's (1887b) type specimen, I fully agree with VADÁSZ based on KOCH's description.

Occurrence:

Austria: Early Badenian (Langhian)

Vienna Basin: Stotzing (sandpit Mayer), Bgld (KAZÁR, 2002; [NHMW])

Paratethys (non-Austrian occurrences): Early to Late Badenian (Langhian-Early Serravallian)

Styrian Basin: Šentilj, Slovenske gorice, NE Slovenia (MIKUŽ & MITROVIĆ-PETROVIĆ, 2001)

Great Hungarian Basin (Pannonian Basin): Hird, Hungary (SOMOS & KÓKAY, 1960); Hor. Strháre (= Felső-Esztergály), Slovak Republic (VADÁSZ, 1915); Márkháza, Nógrád, Hungary (VADÁSZ, 1915); Matraszölös, Nógrád, Hungary (KALABIS, 1937c); Mátraverebély, Nógrád, Hungary (VADÁSZ, 1915; [MAFI]); Sámsonháza near Matraszölös, Nógrád, Hungary (KALABIS, 1937c)

Transylvanian Basin: Gârbova de Sus (= Felső-Orbó), Romania (KOCH, 1887b; VADÁSZ, 1915; KALABIS, 1937c; [MAFI])

Zala, Sáva and Dráva Basins: ? Zaprešić Breg, Croatia (POLJAK, 1938)

Mediterranean: Middle (?) Miocene

Western Mediterranean: Capo Sant'Elia, Sardinia (COTTEAU, 1895); Coroneddu between Tresnuraghes and Bosa, Sardinia (COTTEAU, 1895); Monte Alvu and Canales near Modulo (Planargia), Sardinia (COTTEAU, 1895); ? Oued Sebti, E of Tizi-Ouzou, Kabylie, Algeria (COTTEAU et al., 1891); Palermo, Sicily, Italy (AGASSIZ & DESOR, 1847a; DESOR, 1858; MICHELIN, 1861); south of Piano, Sardinia (COTTEAU, 1895); near Pozzomaggiore, Sardinia (COTTEAU, 1895)

Central Mediterranean: ? Tropea-Brattirò, Calabria (IMBESI SMEDILE, 1958)

Clypeaster intermedius DES MOULINS, 1837

(Pl. 28, Fig. 1-2)

1768 *Scuta angularia* [...] KLEIN – WALCH: 182-183

1768 [*Scuta angularia* KLEIN] – KNORR: pl. E.V., figs. 1-2

* 1837 *C.[lypeaster] intermedius*. Nob. – DES MOULINS: 65-65, no. 15

1840b *Clypeaster crassicosatus* AG. – AGASSIZ: 6, Q.12 [*nomen nudum*] [fide PHILIPPE, 1998: 112]

pp 1847a [*Clypeaster*] *scutellatus* M. de S. – AGASSIZ & DESOR: 131

pp 1858 [*Clypeaster*] *Scillae* – DESOR: 241

? 1858 *Clypeaster grandiflorus* BRONN. – DESOR: pl. 29, figs. 1, 2, 2a, 3, 3a [fide PHILIPPE, 1998: 112]

pp 1861 *Clypeaster intermedius*, DES MOULINS – MICHELIN: 128-129

non 1861 *Clypeaster intermedius*, DES MOULINS – MICHELIN: pl. 31, figs. 1a-g [= *C. scillae*, fide Lambert, 1905: 103]

non 1868 *C. intermedius* – KARRER: 570 (footnote)

non 1869 *Clypeaster intermedius* DUES. – FUCHS: 194

non 1869a *Clyp. intermedius* DESMOULINS. – LAUBE: 183

non 1870 *Clypeaster intermedius* MICH. – LAUBE: 314

non 1871 *Clypeaster intermedius* DESMOULINS. – LAUBE: 64-65

non 1877 *Clypeaster intermedius* DESM. – HILBER: 261, 262

non 1877 *Clypeaster intermedius* DESM. – KARRER: 170, 312

? pp 1877 *Clypeaster intermedius* DESM. – LÓCZY: 3

non 1877 *Clypeaster intermedius* DESM. – LÓCZY: 3

non 1878 *Clypeaster intermedius* DESM. – HILBER: 553, 560, 563, 575

1906a *Clypeaster intermedius* DES MOULINS, 1837 – LAMBERT: 85-88

non 1907 [*Clypeaster*] *intermedius* DESM. – SCHAFFER: 28

non 1907 *Clypeaster intermedius* DESM. – SCHAFFER: 35

1912a *Clypeaster sub-Partschi* SCHFF. – SCHAFFER: 188; text-fig. 1; pl. 60, figs. 3

1913a *Clypeaster intermedius* DESMOULINS, 1837. – LAMBERT: 105-107

1913a *Clypeaster crassicosatus* SISMONDA, 1841 – LAMBERT: 107-108; pl. 8, fig. 4

? # 1913a *Clypeaster Guebhardi* LAMBERT. – LAMBERT: 108-110; pl. 8, figs. 1-3

1913a *Clypeaster coronalis* LAMBERT. – LAMBERT: 120; pl. 10, figs. 4-6

1920 *Clypeaster intermedius*, DESMOULINS, 1837 – FOURTAU: 50

1927a *Clypeaster intermedius* DESMOULINS, 1837 – LAMBERT: 13-14

non 1928 *Clypeaster intermedius* DESM. – BOBIES: 48

? 1937a *Clypeaster* sp. – KALABIS: 44, fig. 1

? 1937b *Clypeaster* – KALABIS: 109, 111

? 1938a *Clypeaster* sp. – KALABIS: 5, 11

1938a *Clypeaster sub-partschi* SCHAFFER – KALABIS: 6, 9, 11

non 1939 *Clypeaster intermedius*. – KAPOUNEK: 72

non 1942 [*Clypeaster*] *intermedius* DESM. – SCHAFFER: 130

non 1942 *Clypeaster intermedius* DESM. – SCHAFFER: 94

pp 1949 *Clypeaster intermedius intermedius* DESMOULINS, 1837. – KALABIS: 38-42, 91-97; pl. 2, figs. 1-3

non 1949 *Clypeaster intermedius* DESMOULINS – SCHOUPPE: 143

non 1968 *Clypeaster intermedius* DESM. – FLÜGEL & HERITSCH: 44; pl. 4, fig. 2

1971a *Clypeaster subpartschi* SCHAFFER, 1912 – STEININGER: 594; pl. 3, fig. 2

1971c *Clypeaster subpartschi* SCHAFFER– STEININGER: 129

pp 1975 *C. subpartschi* SCHAFFER – KALABIS: 315

1984 *Clypeaster intermedius* DESMOULINS, 1837 – NEGRETTI: 99-100; pl. 3, figs. 1-6; pl. 4, figs. 2-3

1998 *Clypeaster intermedius* DESMOULINS, 1837 et ses morphes. – PHILIPPE: 112-119; pl. 11, figs. 4a-c, 5a-b, 6a-b; pl. 12, figs. 1, 2a-c, 3a-c, 4a-c

non 1998 *Clypeaster intermedius* MICH. – SCHULTZ: 116; pl. 52b, figs. 7

Type-material:*Clypeaster intermedius* DES MOULINS, 1837:

Holotype: the specimen figured by PHILIPPE (1998: pl. 11, figs. 4a-b); specimen no. CR 5 837 (new number MR 3 001 901); Muséum Requiën, Avignon, France

Locus typicus: unknown

Age: Burdigalian, Early Miocene

Remarks: More information on the type material, its history and a detailed description of the holotype can be found in PHILIPPE (1998: 112-118).

Clypeaster subpartschi SCHAFFER, 1912:

Holotype (Pl. 28, Fig. 1a-c): specimen figured by SCHAFFER (1912a: 188; text-fig. 1; pl. 60, figs. 3); housed at the Krahuletz-Museum, Eggenburg, NÖ, Austria

Locus typicus: Schloßthal, Roggendorf, NÖ, Austria

Stratum typicum: Zogelsdorf Fm.

Age: Late Eggenburgian (Early Burdigalian), Early Miocene

Material:

Late Eggenburgian (Burdigalian) – Roggendorf (Zogelsdorf Fm., Schloßthal), NÖ, Austria

KM: 1 specimen (holotype; no inventory number)

Late Eggenburgian (Burdigalian) – Grübern (Zogelsdorf Fm.), near Maissau, NÖ, Austria

HM: 1 specimen (HM 644)

Dimensions (in mm):

| | TL | TW | TH |
|---------------|-----|-----|----|
| Holotype (KM) | 135 | 131 | 43 |
| HM 644 | 99 | 92 | 24 |

Description:

Size and shape: The test is of large size, slightly antero-posteriorly elongated, with a pentagonal outline. The margin is rounded and moderately thick. The lateral margins are very slightly indented in interambulacra 1, 4 and 5. The maximum width lies anterior of the apical disc, where ambulacral columns IIa and IIIb reach the ambitus. The profile is low arched, with a slightly elevated petaloid area. The maximum height lies subcentrally around the apical disc. The oral surface is flattened, with a broad but shallow infundibulum.

Apical disc: The apical disc lies subcentrally and is not well preserved in the studied specimen.

Ambulacra: All five ambulacra are petaloid, straight and slightly closing distally. The petals are more or less subequal in length and extend about 70 % of the corresponding test radius. The poriferous zones are slightly depressed and moderately wide. The pore pairs are conjugated anisopores. Adjacent pore pairs are separated by narrow ridges with a single row of up to 9 primary tubercles. The interporiferous zones are moderately inflated, flattened and up to four times as wide as a single poriferous zone at the widest point of the petals. They are crowded with primary tubercles similar to those on the interambulacra. On the oral surface shallow, simple unbranched food grooves are present in the axis of the ambulacra.

Interambulacra: Adapically the interambulacra are slightly depressed between the petals. They are crowded with perforate crenulate primary tubercles in sunken areoles. Between the primary tubercles, dense miliary tuberculation is present. Aboral tuberculation is rather homogenous. On the oral surface tubercles are larger and more closely spaced than on the aboral side.

Peristome: The peristome lies subcentrally on the oral side of the test in a moderately deep depression with gently sloping walls.

Periproct: The periproct is subcircular and lies inframarginally.

Internal support system: unknown

Differential diagnosis:

C. calabrus SEGUENZA, 1880, a Middle Miocene species, differs from *C. intermedius* by its higher test, more strongly raised

petaloid area, deeper, steep-walled infundibulum and stronger marginal indentations.

C. campanulatus (SCHLOTHEIM, 1820) (and its phenotypes), a species occurring in the Badenian (Langhian-Early Serravallian) in the Paratethys, differs by its strongly different profile, larger test height, broader petals, more strongly raised petaloid area and thicker margin.

C. folium AGASSIZ IN AGASSIZ & DESOR, 1847, a species restricted to the Early Badenian (Langhian) in the Paratethys, is distinguished from this species by its lower test height, more elongated outline with much deeper marginal indentations in the interambulacra, smaller and less raised petaloid area, and deeper food grooves.

C. latirostris MICHELIN, 1861, a co-occurring species, is distinguished from this species by its subequal test length and width, lower test height, with less raised petaloid area, thinner margin, more flattened oral surface and broad, very shallow infundibulum.

For the difference to *C. neudorfensis* LAMBERT, 1927 see above under that species.

C. scillae DES MOULINS, 1837, an Early to Middle Miocene species, differs from *C. intermedius* by its higher test, more elongated outline, more strongly raised petaloid area, thicker and more tumid margin, deeper, steep-walled infundibulum and less strong marginal indentations (see also PHILIPPE, 1998).

Discussion:

Clypeaster intermedius DES MOULINS, 1837 is a common and rather well defined species, occurring abundantly in the Aquitanian to Burdigalian (Middle Miocene records need to be confirmed) of the Mediterranean. The type material of this species has recently been re-described and illustrated by PHILIPPE (1998: 112-118). The incorrect range extension to the Late Miocene of the Central Paratethys by PHILIPPE (1998) are based on the erroneous dating of Paratethyan sediments as Tortonian, which are in fact Middle Miocene in age (Langhian-Early Serravallian, the Badenian stage in the Paratethys). Still, as discussed below, even the Middle Miocene occurrence of this species remains to be substantiated. The Middle Miocene occurrence in Eggenburg listed by PHILIPPE (1998: 118) in fact refers to SCHAFFER'S specimens which are Late Eggenburgian (Early Burdigalian) in age.

PHILIPPE (1998) placed a number of other species into the synonymy of *C. intermedius*: *C. crassicosatus* AGASSIZ, 1840; *C. diversicosatus* ABICH, 1857; *C. latirostris ventiensis* LAMBERT, 1906 non TOURNOUER, 1897; *C. pillai* LOVISATO, 1909; *C. lamar-morai* LOVISATO, 1910; *C. subpartschi* SCHAFFER, 1912; and *C. guebhardi* LAMBERT, 1913a.

Clypeaster subpartschi SCHAFFER, 1912 is based on a single specimen from the Eggenburgian (Early Burdigalian) of the Molasse Zone. Although this area and time interval has been in the focus of intense research during the last twenty years only a single additional specimens was recovered (HM collection; Pl. 28, Figs. 2a-c). The holotype of *C. subpartschi* is rather similar to some of the *C. intermedius* specimens from the Rhône Basin (e.g. PHILIPPE, 1998: pl. 12, figs. 2a-c). KALABIS (1949: 95) regarded *C. subpartschi* conspecific with *C. intermedius*, based on the type specimen and additional material from Služín (Czech Republic) (but see below). Later, however, KALABIS (1974: 315) renounced his view and stated that *C. intermedius* is not present in the Paratethys at all. Indeed, all Badenian (Langhian to Early Serravallian, Middle Miocene) records of *C. intermedius* species that could be evaluated in the course of this study turned out to be erroneous [most records refer to specimens which were misidentified and belong to *C. scillae* or *C. calabrus* instead; the reason for the common confusion of *C. intermedius* and *C. scillae* resulted from an error of MICHELIN (1861: pl. 31, fig. 1a-g) who depicted a *C. scillae* specimen as *C. intermedius* (see also LAMBERT, 1913a: 103; and VADÁSZ, 1915: 131); MICHELIN (1861) himself, however, never announced *C. intermedius* from the Paratethys Region, neither

did VADÁSZ (1915); the records of *C. intermedius* by SZÖRÉNYI (1936) (an abnormal 4-rayed specimen probably belonging to *C. calabrus*) and POJAK (1938) are highly questionable and could not be confirmed].

Here *C. subpartschi* is considered as junior synonym of *C. intermedius* following KALABIS (1949) and PHILIPPE (1998) as no features were found which would allow to separate the two confidently.

KALABIS (1949: 38-42, 91-97; pl. 2, figs. 1-3) recorded *C. intermedius intermedius* from the locality Služín in the Czech Republic. Later he referred the same specimens into (KALABIS, 1974: 315) to *C. subpartschi*. Yet, they are not very well preserved show some differences to the specimens of *C. intermedius* from the Rhône Basin (see PHILIPPE, 1998) and the Eggenburgian of Austria. Thus, their attribution to *C. intermedius* can be considered as tentative only.

Unfortunately, the age of the locality Služín is unclear. Although KALABIS (1949: 96) referred it to the "Tortonien" [= Badenian (at that time incorrectly correlated with the Late Miocene Tortonian stage of the Mediterranean)] published faunal lists (KALABIS, 1937b) are inconclusive. No younger paper are available and research by Czech colleague in the in the last decades yielded no additional data (written comm. Kamil ZÁGORŠEK, July, 2003).

Occurrence:

Austria: Late Eggenburgian (Early Burdigalian)

Molasse Zone: ? Eggenburg (Brunnstube), NÖ (STEININGER, 1971a, c; reference material not located); Grubern (Zogelsdorf Fm.), NÖ ([HM]); Roggendorf, NÖ (SCHAFFER, 1912a; KALABIS, 1938a; STEININGER, 1971a)

Paratethys (non-Austrian occurrences): Miocene

Molasse Zone: ? Služín, Czech Republic (KALABIS, 1937a+b, 1938a, 1949, 1975)

Mediterranean: Aquitanian to Burdigalian

Rhône Basin: Aquitanian: Littoral de la Nerthe (Martigues, Sausset-les-Pins), France (PHILIPPE, 1998)

Burdigalian: Littoral de la Nerthe (Lavalduc, Martigues, Sausset-les-Pins), France (LAMBERT, 1913a; PHILIPPE, 1998); France (PHILIPPE, 1998); Basse-Provence (Port-de-Bouc), France (PHILIPPE, 1998); Languedoc [Montpellier (le Boutonner)], France (LAMBERT, 1913a; PHILIPPE, 1998); Bassin de Valréas-Visan (Bollène, Chamaret, Montségur-su-Lauzon, Saint-Paul-Trois-Châteaux, Taulignan), France (LAMBERT, 1913a; PHILIPPE, 1998); Sillon périalpine (Oriol-en-Royans), France (LAMBERT, 1913a; PHILIPPE, 1998)

Western Mediterranean: Alpes-Maritimes (Tourettes-sur-Loup), France (LAMBERT, 1913a); Catalonia (St. Pau d'Ordal, St. Sadurn de Noya, Olérdola, and Viladellós), Spain (LAMBERT, 1927a)

Eastern Mediterranean: Gebel Geneifa, Egypt (FOURTAU, 1920)

Clypeaster latirostris MICHELIN, 1861

(Fig. 29; Pl. 29, Figs. 1-4)

- non 1840b *Clypeaster latirostris* AG. – AGASSIZ: 6 [fide LAMBERT & JEANNET, 1928: 125] [*nomen nudum*]
 non 1847a [*Clypeaster*] *Scillæ* DESML. – AGASSIZ & DESOR: 131 [placed *C. latirostris* AG. into the synonymy of *C. scillæ*]
 non 1858 [*Clypeaster*] *scutellatus* MARCEL DE SERRES – DESOR: 242 [placed *C. latirostris* AG. into the synonymy of *C. scutellatus*]
 * v. 1861 *Clypeaster latirostris*, AGASSIZ – MICHELIN: 137-138; pl. 15, figs. 2a-d; pl. 36, fig. 2

- 1869a *Clyp. latirostris* AG. – LAUBE: 183
 1870 *Clypeaster latirostris* AG. – LAUBE: 314
 1871 *Clypeaster latirostris* AGASSIZ. – LAUBE: 65
 ? 1879 *Clypeaster latirostris*, AGASS. – HERMITE: 253
 # 1912 *Clypeaster ventiençis vindobonensis* – LAMBERT: 97
 ? 1912 *Clypeaster ventiençis* TOURNOUER, 1879. – LAMBERT: 97-100
 1912a *Clypeaster latirostris* AG. – SCHAFFER: 187-188; pl. 60, figs. 1-2
 1913a *Clypeaster latirostris* AG. – SCHAFFER: 56; 157-158; pl. 10, figs. 10
 v non 1915 *Clypeaster latirostris* AG. var. *vindobonensis* LAMB. – VADÁSZ: 186
 non 1928 *Clypeaster latirostris* AGASSIZ – LAMBERT & JEANNET: 125
 1938a *Clypeaster latirostris* AG. – KALABIS: 4, 5, 9, 10
 1943 *Clypeaster latirostris* AG. – SCHAFFER: 521
 ? 1949 *C. ventiençis* sensu latissimo – KALABIS: 113
 1951 *Clypeaster latirostris* AG. – SCHAFFER & GRILL: 709
 ? 1956 *Clypeaster latirostris* AG. var. *laganoides* AGASSIZ – SOCIN: 7
 ? 1958 *Clypeaster latirostris* AGASSIZ – IMBESI SMEDILE: 16-17; pl. 1, figs. 4, 4a-b, 5, 5a
 1962 *Clypeaster latirostris* – PAPP & THENIUS in KÜHN: 118
 ? 1967 *Clypeaster latirostris* AGASSIZ – MENESINI: 149-151; pl. 51 (6), figs. 1, 1a
 non 1970 *Clypeaster latirostris* AGASSIZ, 1840. – MARCOPOULOU-DIACANTONI: 249-250; pl. 22, figs. 3a-b [misidentified "*C. marginatus*" (Maltese form)]
 1971a *Clypeaster latirostris* AGASSIZ, 1840 – STEININGER: 594; pl. 3, fig. 1
 1971c *Clypeaster latirostris* AGASSIZ – STEININGER: 129
 1974 *Clypeaster latirostris* AGASSIZ – THENIUS: 47
 ? 1975 *Clypeaster ventiençis vindobonensis* LAMBERT, 1912. – KALABIS: 175

Type-material:

Lectotype (designated herein; Fig. 29): the specimen figured by MICHELIN (1861: pl. 15, figs. 2a-d); housed at the Naturhistorisches Museum Wien (Geologische Abteilung; inventory number NHMW 1860.XIX.6).

Paralectotypes: According to MICHELIN (1861: 138) his material came from the Naturhistorisches Museum Wien and from his own collection, the latter is housed at the École des Mines, Paris today. None of the specimens from Gauderndorf, Austria is accompanied by a label indicating that they were studied by MICHELIN. Yet at least two of the specimens at hand (namely specimens 1848.III.67 and 1860.L.443) had already been in the collection of the NHMW at the time of MICHELIN's visit and have to be considered as potential type material. The same can be assumed for the two specimens from Santa Manza, Corsica (1857.XV.89 and 1857.XV.90)

Locus typicus: Corsica

Age: ? Burdigalian, Early Miocene

Material:

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

NHMW: 1 specimen (NHMW 1904.VIII.25)

Late Eggenburgian (Early Burdigalian) – Eggenburg area (Zogelsdorf Fm.), NÖ, Austria

NHMW: 1 specimen (NHMW 1848.III.67)

Late Eggenburgian (Early Burdigalian) – Gauderndorf (Himmelreich), NÖ, Austria

NHMW: 4 specimens (NHMW 1860.L.443 (**paralectotype** of *C. latirostris* MICHELIN, 1861), 1866.XX.20

[=1869.III.37], 1869.III.36, 2004z0042/0001-2)

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

NHMW: 2 specimens [NHMW 1848.III.67 (**paralectotype** of *C. latirostris* MICHELIN, 1861), 1850.IX.84, 1997z0178/0510]

GBA: 1 specimen (GBA 2004/1/19)

Late Eggenburgian (Early Burdigalian) – Grübern, near Maissau, NÖ, Austria

NHMW: 1 specimen (NHMW1997z0178/0526)

Late Eggenburgian (Early Burdigalian) – Limberg (Zogelsdorf Fm., Hengl quarry), NÖ, Austria

NHMW: 1 specimen (NHMW 2004z0042/0003)

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

NHMW: 3 specimens (NHMW 2004z0042/0004-5, .../0008)

Late Eggenburgian (Early Burdigalian) – Straning, N of Limberg, NÖ, Austria

IPUW: 2 specimens (no inventory no.)

Foreign material for comparison:

Burdigalian ? – Cannelto, Corsica

NHMW: 1 specimen (NHMW 1976/1843/6)

Burdigalian ? – Corsica

NHMW: 1 specimen [NHMW 1860.XIX.6 (**lectotype** of *C. latirostris* MICHELIN, 1861: pl. 15, figs. 2a-d)]

Burdigalian ? – Santa Manza, Corsica

NHMW: 2 specimens [NHMW 1857.XV.89, 1857.XV.90 (**paralectotypes** of *C. latirostris* MICHELIN, 1861)]

Dimensions (in mm):

| Inv. No. | TL | TW | TH |
|----------------------|-------|-------|------|
| NHMW 1848.III.67 | 137.6 | 130.9 | 34.8 |
| NHMW 1866.xx.20 | 129.8 | 125.3 | 27.2 |
| NHMW 1997z0178/0526 | 111.2 | 111.0 | 23.7 |
| NHMW 2004z0042/00003 | 104.1 | 97.3 | ~ 20 |

Description

Size and shape: The test is of large size, with a pentagonal outline and subequal test length and width. The margin of the test is thin, with a rounded profile anterior and a sharp profile posterior. In aboral view the anterior margin is bluntly pointed and the posterior margin transversely truncated. All interambulacra except interambulacrum 5 show slight marginal indentations. The maximum width lies anterior of the centre, where ambulacral columns IIa and IVb reach the ambitus. In profile, the test is very low with a moderately raised petaloid area. The apex is somewhat flattened and coincides with the apical disc. The oral surface is flattened with a broad, very shallow infundibulum.

Apical disc: The apical disc lies subcentrally and belongs to the monobasal type with a large central, subpentagonal madreporite and 5 circular gonopores.

Ambulacra: All five ambulacra are distinctly petaloid, straight and moderately closing distally. The frontal petal is the longest; the paired petals are subequal in length, the posterior ones being a little bit longer than the anterior ones in some specimens. The length of the petals is about 58 to 64 % of the corresponding test radius. The poriferous zones are slightly depressed and relatively wide and are widest near the distal end of the petals. The pore pairs are conjugated anisopores. Adjacent pore pairs are separated by narrow ridges with a single row of 7 to 12 primary tubercles. The interporiferous zone are strongly inflated and usually 2.1 to 2.7 times as wide as single poriferous zone at the widest point of the petals. They are crowded with primary tubercles similar to those on the interambulacra. Outside the petals only minute micropores are present, which are observable only in exceptionally preserved specimens/fragments. On the oral surface simple unbranched food grooves are present in the axis of the ambulacra.

Interambulacra: The interambulacra are moderately inflated

adapically between the petals. They are crowded with perforate crenulate primary tubercles in sunken areoles. Between the primary tubercles, dense miliary tuberculation is present. Tubercle density and size is rather homogenous on the aboral surface. On the oral surface tubercles are slightly larger and more closely spaced. On the oral surface the interambulacra are slightly flattened, producing an even surface, which is not inclined towards the peristome.

Peristome: The peristome is circular and lies centrally on the oral side of the test in a broad, very shallow infundibulum.

Periproct: The periproct is subcircular to very slightly oval, transversely elongated. It lies inframarginally, about 2.2 to 4 mm away from the posterior margin.

Internal support system: The test of this species is single-walled but reinforced by a dense internal pillar system. The pillars are most abundant close to the margin and along the midlines of ambulacra and interambulacra.

Differential diagnosis:

For the difference to *C. barcinensis* ? LAMBERT, 1906 see above under that species.

For the difference to *C. calabrus* SEGUENZA, 1880 see above under that species.

C. campanulatus (SCHLOTHEIM, 1820) (and its phenotypes), a species occurring in the Badenian (Langhian – Early Serravalian) in the Paratethys, differs by its strongly different profile, larger test height, broader petals, more strongly raised petaloid area and thicker margin.

C. folium AGASSIZ in AGASSIZ & DESOR, 1847, a species restricted to the Early Badenian (Langhian) in the Paratethys, is distinguished from this species by its more elongated outline with deep marginal indentations in the interambulacra, smaller petaloid area, broader infundibulum and deeper food grooves.

For the difference to *C. scillae* DES MOULINS, 1837 see below under that species.

C. intermedius DES MOULINS, 1837, an Early Miocene species of the Rhône Basin, is distinguished from this species by its more elongated outline, higher test, more raised petaloid area, thicker margin, less flattened oral surface and deeper infundibulum.

For the difference to *C. neudorfensis* LAMBERT, 1927 see below under that species.

For the difference to *C. scillae* DES MOULINS, 1837 see below under that species.

Discussion:

Clypeaster latirostris AGASSIZ (1840b, p. 4) is a *nomen nudum* according to the ICZN rules 4th ed., 2000, Article 12.1. since it is neither figured nor described in AGASSIZ (1840b). AGASSIZ & DESOR (1847a: 131) and DESOR (1858: 242) are not available as authors because the name *latirostris* is just listed as junior synonym of *C. scillae* and *C. scutellatus* respectively. The next author who published a valid diagnosis for this name is MICHELIN (1861: 137-138; pl. 15, figs. 2a-d; pl. 34, fig. 2), which is thus the valid author for *C. latirostris* (ICZN 4th ed., Articles 11 and 12). According to LAMBERT & THIÉRY (1928) the material ("mouillage" 59 and 60 of the AGASSIZ collection) listed under that name in AGASSIZ (1840b: 6) does not correspond to the material described and figured by MICHELIN (1861). This, however, is irrelevant in this matter as *C. latirostris* AGASSIZ, 1840 is a *nomen nudum*.

LAMBERT (1912: 97) established the name *Clypeaster ventien-cis* [sic] *vindobonensis* for the Austrian material described by MICHELIN (1861). {*C. latirostris vintiensis* [sic] TOURNOUËR, 1877 is actually a *nomen nudum* as the original reference lacks any description, illustration or other indication (see TOURNOUËR, 1877: 844). LAMBERT (1912: 97) elevated this subspecies to species rank, but misspelled the species name}. Curiously the figure (MICHELIN, 1861: pl. 15, fig. 2) LAMBERT (1912: 97) refers to depicts a specimen (NHMW 1860.XIX.6) coming from Corsica, not from Austria. This specimen is the one selected as lectotype

for *C. latirostris* MICHELIN. Therefore the name *Clypeaster vintiensis vindobonensis* LAMBERT, 1912 is superfluous.

Part of the type material of *C. latirostris* MICHELIN, 1861 is housed at the Naturhistorisches Museum Wien, among them the specimen figured on plate 15, figures 2-d of MICHELIN's monograph. The latter specimen is chosen as lectotype. It is a specimen coming from Corsica, most probably from the Burdigalian part of the succession, although the exact provenience of the specimens is unknown. The Austria specimens are rather similar to that of Corsica, albeit larger. In the lectotype, the petaloid area is slightly more inflated than in the Austrian specimens and the test outline a little bit more elongated. These differences, however, are here considered subordinate and attributed to individual variation.

The specimen referred to *Clypeaster latirostris* AG. var. *vindobonensis* LAMB. in VADÁSZ (1915: 186) is a strongly damaged fragment (housed in the collection of the Hungarian Geological Survey, Budapest as MAFI Ech 279). It is very different from *C. latirostris* and probably related to *C. campanulatus* but better referred to as *Clypeaster* sp. on account of its poor preservation.

Some of the specimens from the Burdigalian of the Rhône Basin attributed to *C. intermedius* by PHILIPPE (1998) may actually belong to *C. latirostris* (e.g. the specimen figured on pl. 12, figs. 2a-c)

Occurrence:

Austria: Late Eggenburgian (Early Burdigalian)

Molasse Zone: Eggenburg, NÖ (SCHAFER, 1912; KALABIS, 1938a; SCHAFER, 1943; SCHAFER & GRILL, 1951); Eggenburg (Brunnstube), NÖ (STEININGER, 1971a, c); Eggenburg (Zogelsdorf Fm), NÖ ([NHMW]); "Eggenburger Schichten" (PAPP & THENIUS in KÜHN, 1962; THENIUS, 1974; ? KALABIS, 1975); Gauderndorf (and Gauderndorf, Himmelreich), NÖ (MICHELIN, 1861; LAUBE, 1869a, 1871; SCHAFER, 1912; KALABIS, 1938a; [NHMW]); Grübern, near Maissau, NÖ ([NHMW]); Klein-Meiseldorf, NÖ (SCHAFER, 1912a, 1913a); Limberg (Zogelsdorf Fm., Hengl quarry), NÖ [NHMW]; Pulkau (Retz Fm.), NÖ ([NHMW]); Straning, NÖ ([IPUW])

Paratethys (non-Austrian occurrences): Eggenburgian (Early Burdigalian)

Molasse Zone: ? Slatinky near Prostějov, Czech Republic (KALABIS, 1949)

Mediterranean: Aquitanian (?) – Burdigalian

Western Mediterranean: Cannelto, Corsica, France [NHMW]; Corsica (MICHELIN, 1861; LAUBE, 1871); Le Palendurier, Alpes-Maritimes, France (LAMBERT, 1912); ? Posano, Volterra, Prov. Pisa, Italy (MENESINI, 1967); Saint-Jannet, Alpes-Maritimes, France (LAMBERT, 1912); ? Santa Cristobal, Menorca, Balears, Spain (HERMITE, 1879); Santa Manza, Corsica [NHMW]; Ste-Colombe, Alpes-Maritimes, France (LAMBERT, 1912); Tourrettes-sur-Loup, Alpes-Maritimes, France (LAMBERT, 1912); Vence, Alpes-Maritimes, France (LAMBERT, 1912)

Central Mediterranean: ? Stilo, Calabria (IMBESI SMEDILE, 1958)

Indian Ocean: ? Miocene

East African coast: ? Uanane and Hafun, Somalia (SOCIN, 1956)

Clypeaster neudorfensis LAMBERT, 1927

(Pl. 30, Figs. a-c)

v pp 1861 *Clypeaster melitensis*, MICHELIN – MICHELIN: 129-130; pl. 32, figs. a-c; pl. 33, figs. a

- non 1861 *Clypeaster melitensis*, MICHELIN – MICHELIN: 129-130; pl. 32, figs. d; pl. 33, figs. b-c
- v. 1870 *Clypeaster Melitensis* MICH. – LAUBE: 314
- v. pp 1871 *Clypeaster Melitensis* MICHELIN. – LAUBE: 65
- 1898 *Clypeaster melitensis* MICHELIN – KORNHUBER: 11
- pp 1913a *Clypeaster Guehardi* LAMBERT. – LAMBERT: 109
- ? 1915 *Clypeaster tenuipetalus* SEGU. – VADÁSZ: 188-189, figs. 78-79
- ? 1917 *Clypeaster Carapezzai* CHECCHIA-RISPOLI. – CHECCHIA-RISPOLI, 1917: 61-62; fig. 3; pl. 8(13), fig. 2; pl. 10(15), fig. 8
- * v. 1927b *C.[lypeaster] neudorfensis* – LAMBERT: 101
- v. pp 1949 *Clypeaster campanulatus carapezzai* CHECCHIA-RISPOLI, 1917 – KALABIS: 52-54, 109-111; pl. 7, fig. 1
- pp 1931 *Clypeaster Guehardi* LAMBERT. – LAMBERT: 49
- 1938a *Clypeaster [partschi var.] neudorfensis* LAMBERT-KALABIS: 6, 12
- 1938b *Clypeaster [campanulatus var.] neudorfensis* LAMB. – KALABIS: 6-7, 9
- ? pp 1949 *Clypeaster campanulatus carapezzi* CHECCHIA-RISPOLI, 1917 – KALABIS: 52-54, 109-111; pl. 6, figs. 1-3

Type Material:

Holotype: specimen figured by MICHELIN (1861: pl. 32, figs. a-c; pl. 33, figs. a); specimen no. 34 of MICHELIN; housed at the Naturhistorisches Museum Wien (Inv. No. NHMW 1851.VI.119)

Locus typicus: Devínska Nová Ves (= Neudorf an der March), Slovak Republic

Age: Late Badenian (Early Serravallian), Middle Miocene

Material:

Late Badenian (Early Serravallian) – Devínska Nová Ves, Slovak Republic

NHMW: 1 specimen [NHMW 1851.VI.119 (**holotype**; specimen no. 34 of MICHELIN)]

? Badenian (Langhian-Early Serravallian) – Rauchstallbrunngraben near Baden, NÖ, Austria

NHMW: 3 specimens [NHMW 1846.37.959, 2003z0055/0003 to 0004 (specimens nos. 20 to 22 of MICHELIN)]

Dimensions (in mm):

| Inv. No. | TL | TW | TH |
|------------------|-------|-------|------|
| NHMW 1851.VI.119 | > 160 | 147.3 | 42.1 |

Description:

Size and shape: The test is of large size, with an antero-posteriorly elongated, subpentagonal outline. Test width is approximately 86 % of TL (assuming a TL of c. 170 mm). The margin of the test is relatively thin and only poorly rounded. No marginal indentations are present. The maximum width lies anterior of the centre, where ambulacral columns IIa and IVb reach the ambitus. In profile test low, wedge shaped with gently sloping anterior and more steeply loping posterior part. The apex lies at the posterior margin of the apical disc. The oral surface is distinctly flattened with a very narrow infundibulum.

Apical disc: The apical disc lies slightly posterior of the centre, approximately 52 % TL (assuming a TL of ~170 mm) away from the anterior margin. It is slightly inclined anteriorly and is poorly preserved, but seems to be monobasal.

Ambulacra: The petals are lanceolate in shape, straight and moderately closed distally (width of the IPZ 4.8 to 7 mm distally). The frontal petal is longest, the posterior petals shortest. The length of the petals is about 70 % of the corresponding test radius. The poriferous zones are depressed and relatively wide. The pores are conjugated anisopores. The interporiferous zones are inflated, medially flattened and range from 1.8 to 2.0 times a single poriferous in width. On the oral surface shallow,

simple, unbranched food grooves are present in the axis of the ambulacra.

Interambulacra: Adapically the interambulacra are slightly inflated between the petals, forming weak keels between them. The surface is poorly preserved, but the tuberculation of the aboral surface seems to have been fairly homogenous. Adorally all surface details except food grooves and peristome are obscured.

Peristome: The peristome lies subcentrally to slightly posterior of the centre on the oral surface. It is covered by sediment in the holotype. The infundibulum is very narrow.

Periproct: not preserved

Internal support system: unknown

Differential diagnosis:

C. altus LESKE, 1778 from the Messinian of Malta differs by its higher test, different profile shape, broader petals, thicker margin and broad infundibulum.

For the difference to *C. barcinensis*? LAMBERT, 1906 see above under that species.

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

For the difference to *C. campanulatus* (SCHLOTHEIM, 1820) see below under "Discussion".

C. folium AGASSIZ in AGASSIZ & DESOR, 1847, a species occurring in the Badenian in the Paratethys, is distinguished from this species by its more flattened test with deep marginal indentations in the interambulacra, smaller petaloid area, broader infundibulum and deeper food grooves.

C. intermedius DES MOULINS, 1837, a species occurring in the Burdigalian of the Rhône Basin and the Paratethys, differs by its narrower and more strongly inflated petals, and different profile.

C. latirostris MICHELIN, 1861, a species occurring in the Eggenburgian (Early Burdigalian) of the Molasse Zone, is distinguished from this species by its subequal test length and width, lower test height, and the broad, very shallow infundibulum.

C. marginatus LESKE, 1778 from the Early Miocene of western France differs by its lower profile, strong marginal indentations, small petaloid area and large dish-like marginal area.

The Late Miocene Maltese species, which has often been confused with *C. marginatus* [compare LAMBERT (1927b: 98-101)] differs by its very different shape with a rather small, strongly raised petaloid area and large dish-like marginal area.

C. scillae DES MOULINS, 1837, a co-occurring species, differs by its strongly different profile, thick margin, concave oral surface with broad infundibulum, narrower petals, much more inflated interporiferous zone.

Discussion:

The type material of *Clypeaster melitensis* MICHELIN, 1861 comprised two specimens: an internal cast from the Late Miocene of Malta and a well preserved specimen from the Middle Miocene of the Vienna Basin. Apparently those two specimens are not conspecific and consequently LAMBERT (1927b: 100-101) proposed the name *C. neudorfensis* for the specimen from the Vienna Basin. According to him *C. melitensis* should be restricted to the Maltese species. He included specimens from the Late Miocene of Malta previously erroneously identified as *C. marginatus*. Although, I agree with LAMBERT that the name *C. marginatus* is used for two different species (an Early Miocene Atlantic taxon and the Late Miocene Maltese one) I do not subscribe to his idea to use *C. melitensis* for the latter. The type of *C. melitensis* is an internal cast and it is impossible to determine it to species level or to securely associate other specimens with this species. I would propose to consider *C.*

melitensis as *nomen dubium* and to establish a new species name for the Maltese species should no other name be available.

Earlier (LAMBERT, 1913a: 109) and also later (LAMBERT, 1931: 49), however, LAMBERT associated the specimen from Neudorf with *C. guebhardi* LAMBERT, 1913. This species is a junior synonym of the Early Miocene *C. intermedius* according to PHILIPPE (1998) and is clearly a different species (compare PHILIPPE, 1998: 112-119; pl. 11, figs. 4a-c, 5a-b, 6a-b; pl. 12, figs. 1, 2a-c, 3a-c, 4a-c).

KALABIS (1949: 52-54, 109-111) agreed with LAMBERT (1927b), but considered *C. neudorfensis* a junior synonym of *C. campanulatus carapezzai* CHECCHIA-RISPOLI, 1917. The type material of *C. carapezzai*, however, is very poorly preserved [see CHECCHIA-RISPOLI, 1917: pl. 8(13), fig. 2; pl. 10(15), fig. 8] and it is nearly impossible to decide whether the material is conspecific with the Vienna Basin material. Therefore the name *C. neudorfensis* is retained and *C. carapezzai* included into the synonymy with a question mark only.

Concerning the question whether *C. neudorfensis* could be a phenotype of *C. campanulatus* (i.e. range within the morphological variability of *C. campanulatus*; see also KALABIS, 1938a, b) or not the following can be stated: Only a single specimen, the holotype, can be attributed to this species without doubt (all the references in the synonymy are based on the holotype). All other specimens which were placed in this species are usually poorly preserved and their determination is unclear. The type specimen of *C. neudorfensis* differs from *C. campanulatus* (including its phenotypes) by its lanceolate, long, more closed and relatively narrow petals, its low test height (<25 % TL; whereas even the lowest *C. campanulatus* forma *partschii* usually have a TH of usually have a TH of >30% TL), slightly thinner margin, more elongated outline and conspicuous profile shape. Yet we know nothing about the variability of these features in *C. neudorfensis* and it is easily possible that the type of *C. neudorfensis* is yet another extreme phenotype of *C. campanulatus*. For the time being, however, *C. neudorfensis* is kept as separate species until more material becomes available to investigate this matter at a broader scale.

Three additional specimens in the collection of the NHMW which were labelled as "*C. tarabellianus*" by MICHELIN initially (later he crossed that species name out on the labels and replaced it with "*altus?* LMK.") and later as "*C. campanulatus* aff. var. *neudorfensis*" by KALABIS are tentatively placed into *C. neudorfensis*. All three come from grey sandstone of Rauchstallbrunngraben near Baden, NÖ (a facies not longer exposed) and share the low test height and thin margin with the *C. neudorfensis* holotype. Their petals, however, are broader and slightly shorter.

Occurrence:

Austria: Badenian (Langhian-Early Serravallian)

Vienna Basin: ? Rauchstallbrunngraben, near Baden, NÖ ([NHMW])

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

Vienna Basin: Devínska Kobyla, near Bratislava, Slovak Republic (KORNHUBER, 1898); Devínska Nová Ves, Slovak Republic (pp MICHELIN, 1861; pp LAUBE, 1871; pp LAMBERT, 1913a; LAMBERT, 1982; pp LAMBERT, 1931; KALABIS, 1938a, b, 1949; [NHMW])

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

Mediterranean: ? Middle Miocene

Central Mediterranean: ? Canicattini, province Siracusa, south-central Sicily, Italy (CHECCHIA-RISPOLI, 1917)