

Figure 64: *Schizaster (S.) karreri* LAUBE, 1869: outline of the peripetalous and latero-anal fascioles (A: Wagna, Styria, NHMW 2004z0001/0037), oral plating (B: Kalksburg, Vienna, NHMW 2004z0001/0032a), labrum shape and phyllodes (C: Wagna, Styria, NHMW 2004z0001/0035), apical disc (D: Kalksburg, Vienna, NHMW 1866.XLVII.37; E: Sóskut, Pest, Hungary, NHMW 1865.XXX.73). Interambulacra shaded; poorly visible sutures stippled.

distinct phyllodes consisting of large unipores with extended periporal partition.

On the oral surface ambulacra I and V form long narrow peri-plastral areas lacking primary tubercles. Each bears four partitioned isopores on each side of the posterior end of the plastron.

Interambulacra: The interambulacra are highly inflated apically, forming high keels between the sunken petals. The aboral tuberculation is fairly homogenous, consisting of small perforate crenulate primary tubercles with distinct elevated bosses and inclined areoles. On the oral side primary tubercles are larger, more strongly crenulate and less densely arranged. The largest tubercles are situated in the antero-lateral areas of the oral surface. The plastron is large, mesamphisternous and nearly half as wide as the test (~45 % of TW). It shows a confluent fan-shaped tuberculation radiating from the posterior margin. The primary tubercles increase in size from the posterior end of the plastron towards the anterior end. The labrum is moderately wide and roughly T-shaped with a triangular posterior part. The contact between labrum and sternal plates is broad.

Peristome: The peristome lies in the anterior half of the oral side, about 15 to 20 % of TL from the anterior margin. It is kidney-shaped with a protuberant rounded labrum bearing a distinct rim. It measures 8.2 vs. 3.7 mm in a 51 mm TL specimen.

Periproct: The periproct is situated marginally, high on the near-vertical posterior face of the test. It is overhung by a slight rostrum. Its outline varies from horizontally elongated in specimens with low test height to vertically elongated shape in tall specimens. Below the peristome there is a distinct subanal depression, followed by a distinct subanal heel. The periproct is slightly smaller than the peristome. Its largest diameter is c. 4

mm in a 41 mm TL specimen and c. 6 mm in a 51 mm TL specimen.

Fascioles: A peripetalous and a latero-anal fasciole are developed. The peripetalous fasciole is moderately broad and fairly well visible. The latero-anal fasciole is very narrow and often indistinct. It branches off the peripetalous fasciole behind the anterior paired petals, about two third their length from the apical disc. The peripetalous fasciole is not indented in interambulacrum 5, slightly indented in interambulacra 1 and 4, and only faintly indented to nearly straight (Fig. 64.A). Both fascioles belong to the orthofasciole *sensu* NÉRAUDEAU et al (1998b).

Differential diagnosis:

This species can be easily distinguished from *S. eurynotus* SIMONDA, 1841 by its less cordiform outline, subcentral maximum width, longer posterior paired petals, less posteriorly displaced apical disc, presence of a distinct subanal heel, lack of a prominent, hood-like rostrum and weak indentation of its peripetalous fasciole in interambulacra 1 and 4.

Schizaster parkinsoni (DEFRANCE) from the Early to Mid-Miocene of the Maltese Islands and other Mediterranean regions differs by the presence of 4 genital pores (the anterior pore have a diameter of up to 50 % of the posterior ones), more strongly diverging anterior paired petals, longer posterior paired petals and a peripetalous fasciole, which is strongly indented in interambulacra 1 and 4 (compare CHALLIS, 1980 and ROSE & WATSON, 1998).

Schizaster desori WRIGHT, 1855 another species from the Early to Mid-Miocene of the Maltese islands has a shallower frontal notch, a narrower frontal ambulacrum and an overhanging, obliquely truncated posterior end with well developed rostrum. Additionally the peripetalous fasciole is deeply

embayed in interambulacra 1 and 4, the divergence of the anterior paired petals is stronger and the anterior ambitus is less tumid in side view (compare WRIGHT, 1855 and CHALLIS, 1980).

Schizaster scillae (DES MOULINS, 1837) differs by its much longer posterior paired petals and very different overall appearance (compare LAMBERT, 1907a and CHALLIS, 1980).

For the difference to *Schizaster laubei* HOERNES, 1875a see below under that species.

Discussion:

The material discussed here clearly belongs to *Schizaster karreri* LAUBE, 1869. Although the holotype could not be located in the collection of the NHMW, a photograph of that specimen is published in VADÁSZ (1915) and abundant material from the locality Kalksburg and the Styrian Basin was available.

In the Mediterranean area this species is known under the name *Schizaster lovisatoi* COTTEAU, 1895. Indeed, none of the differential diagnostic characters which distinguish the two species according to COTTEAU (1895: 46; more elongated, hexagonal outline, higher test, more strongly wedge-shaped profile, ...) allow a confident separation of the two forms, especially if the intraspecific variation is taken into account. Especially a larger (TL = 63.9 mm), elongated specimen (NHMW 1866.XLVII.37) is extremely similar to the figured specimen of COTTEAU (1895) (see Pl. 65, Figs. 7a-c). Many of the features COTTEAU (1895) used to distinguish *S. lovisatoi* from *S. karreri* are related to ontogenetic changes [similar to those documented by McNAMARA (1995) for *S. (S.) compactus*] and the comparison of specimens of different size. Allometric growth also accounts for the differences between *S. lovisatoi* and *S. sardiniensis* COTTEAU, 1895, which is virtually identical with smaller specimens (TL between 25 and 35 mm) of *S. karreri*.

Likewise, VADÁSZ (1915) under-estimated the intraspecific variation in *Schizaster karreri*. Based on a re-examination of his specimens (at least those, which are still available at the MAFI) seven out of the sixteen *Schizaster* species recognised by him are placed in the synonymy of *S. karreri*. Four others are based on very poorly preserved material, and are very difficult to determine at species level, if possible at all. Three are referred to *S. eurynotus*, one is tentatively referred to *Ditremaster scillae* and the remaining one (*S. latipetalus*) is probably a separate species (this is the only one of VADÁSZ's *Schizaster* species that does not come from Badenian strata).

In 1927 LAMBERT (1927a: 28-29) placed several species (*S. morgadesi*, *S. gymnesiae*, *S. ventiensis*, *S. decipiens* and *S. ilottoi*) he had established earlier into the synonymy of *S. lovisatoi*. PHILIPPE (1998), in a revision of the Miocene echinoids of

the Rhône Basin, shared this opinion and, furthermore added *S. calceolus* and *S. jacquemeti* as junior synonyms. Among the Austrian material attributed to *S. karreri* here there are several specimens which come very close to the morphotype described as *S. ilottoi* by LAMBERT. Apart from the outer shape, which is more elongated in these specimens and a slightly deeper frontal notch, there are few differences to typical *S. lovisatoi*. These differences are attributed to allometric growth as outlined above. Such elongated specimens (among them NHMW 1866.XLVII.37) were misidentified as *S. parkinsoni* by LAUBE (1869a 1871), which clearly is a different species (for the diagnostic characters distinguishing these two forms see above under "Differential diagnosis"). Later records of *S. parkinsoni* from Austria are based on LAUBE's paper and not on new material.

The material reported under the name *Schizaster ventiensis* LAMBERT, 1906 from the uppermost part of the Korytnica Clays by MAČZYŃSKA (1977, 1987) might possibly belong to this species (see also PHILIPPE, 1998: 175), but is too poorly preserved to decide.

Occurrence:

Austria: Early to Late Badenian (Langhian-Early Serravallian)

Vienna Basin: Baden Tegel, Baden, NÖ (PILLER & HARTZHAUSER, 1999; [NHMW]); Hagenbrunn (Veitsberg), NÖ (BACHMAYER, 1962); Kalksburg, Wien (FUCHS, 1869; LAUBE, 1869a 1871; KARRER, 1877; SCHAFFER, 1907, 1942; THENIUS, 1970, 1974, 1979, 1983; SCHULTZ, 1998; [NHMW]); Vienna Basin (LÓCZY, 1877; KÜPPER, 1968)

Oberpullendorf Bay: Haschendorf (= Hasfalva), Bgld (LAUBE, 1869a 1871); Neckenmarkt (Schanzgraben and Schneckenberg), Bgld (JANOSCHEK, 1931)

Styrian Basin: Retznei (Weissenegg Fm., Lafarge quarry Rosenberg), Styria ([NHMW]); Wagna (brickyard Wagna), Styria ([NHMW])

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

Great Hungarian Basin (Pannonian Basin): Biatorbágy (= Bia, = Bid), Pest, Hungary (LAUBE, 1869a 1871; LÓCZY, 1877; VADÁSZ, 1915); Budapest, Pest, Hungary (KÓKAY et al., 1984); Budapest-Rákos, Pest, Hungary (VADÁSZ, 1906, 1915; MIHÁLY, 1985; [MAFI]); ? Herend-Márkó, Veszprém, Hungary (KÓKAY, 1966); Hont, Börzsöny, Hungary (? MÁJER, 1915; VADÁSZ, 1915); Hor. Strháre (= Felső-Esztergály), Slovak Republic (ROTH VON TELEGD, 1891; GAÁL, 1905); Píliny, Nógrád, Hungary (VADÁSZ, 1915; [MAFI]); Sóskut, Pest, Hungary (LAUBE, 1869a 1871; LÓCZY, 1877; [NHMW]); Budapest-Budatétény (= Tétény), Hungary (LÓCZY, 1877)

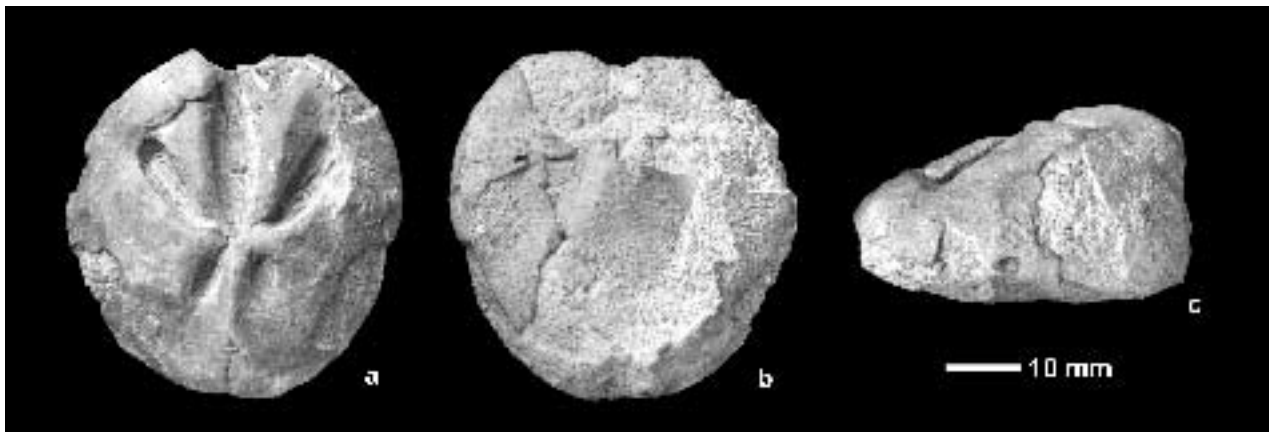


Figure 65: *Schizaster (S.) karreri* LAUBE, 1869: figured specimen of LAUBE (1871: pl. 16, fig. 6) from Sóskut, Pest, Hungary (NHMW 1865.XXX.73).

Fore-Carpathian Basin: Korytnica, Poland (MACZYŃSKA, 1977, 1987); Krzywczycze Górne (= Krzywczycze), western Ukraine (SZÖRÉNYI, 1953); Lwów, western Ukraine (SZÖRÉNYI, 1953); Pod'yarkov (= Podjarków), near Lwów, western Ukraine (SZÖRÉNYI, 1953)

Nowy Sącz Basin: Niskowa, western slopes of the Nowy Sącz depression, Poland (BAŁUK, 1970)

Transcarpathian Basin: ? Hlinné, eastern Slovakia (CICHA et al., 1967)

Transylvanian Basin: Buituri (= Bujtur), Romania (KOCH, 1887b; VADÁSZ, 1915); Gârbova de Sus (= Felső-Orbó), Romania (KOCH, 1887b; LÖRENTHEY, 1894; GAÁL, 1905; VADÁSZ, 1915; [MAFI]); Minișu des Sus (= Felménes), Arad, Romania (LÓCZY, 1877; VADÁSZ, 1915); region east of Tașad, Beiș Basin, Romania (PAUCĂ, 1936)

Zala, Sáva and Dráva Basins: unnamed locality in former Yugoslavia (MITROVIĆ-PETROVIĆ, 1981)

Lom Basin: Opansko bardo, Northern Bulgaria (KOJUMDIEVA & STRACHIMIROV, 1960)

Mediterranean: Burdigalian to Tortonian

Western Mediterranean: Balearic Islands, Spain: Ciudaadela, Menorca (LAMBERT, 1906a); Corsica, France: Bonifacio (COTTREAU, 1913a); France, mainland: Ste-Colombe, near Vence, Alpes-Maritimes (LAMBERT, 1915a); Italy, mainland: ? Carcare, Piemonte (BOTTO-MICCA, 1896), ? Cornino, Veneto (STEFANINI, 1919), Lauro, near Monte Gargano (D'ALESSANDRO et al., 1979), ? Montagnana, Modena (COPPI, 1884), ? Meduno, Veneto (STEFANINI, 1919), Posano, near Volterra, Prov. Pisa (MENESINI, 1967), ? Sottomonte, Veneto (STEFANINI, 1919), ? Vito d'Asio, Veneto (STEFANINI, 1919); Sardinia, Italy (LAMBERT, 1906a; COTTREAU, 1913a): Bonorva, Sassari (LAMBERT, 1907a, 1909), Biugia Targesi, Fangario (LAMBERT, 1907a), Cadreas, Sassari (LAMBERT, 1909), ? Cala Campu Sali (COMASCHI CARIA, 1963), Cap Sant'Elia (LAMBERT, 1907a), Castelsardo, Sassari (COTTEAU, 1895), Cuccuruddu, below Chemerule, Thiesi (COTTEAU, 1895; LAMBERT, 1909), Monte Alvu (LAMBERT, 1907a), Portotorres (DI GIORGIO, 1923); Spain, mainland: Calafell, Prov. Barcelona (LAMBERT, 1906a, 1927a), Monjos, Prov. Barcelona (COTTREAU, 1913a; LAMBERT, 1927a), Panadas, Prov. Barcelona (COTTREAU, 1913a)

Central Mediterranean: Jebel Korbous, Tunisia (BLONDEL & PHILIPPE, 1992)

Eastern Mediterranean: Cyrenaica, Libya: Bardia (TAVIANI, 1939), Bir Acroma (TAVIANI, 1939), Uadi el Hanau (TAVIANI, 1939), Umm er Rzem (TAVIANI, 1939); ? Island of Crete, Greece: Pitsidhia, Iráklion and Achladhia, Sitia (MARCOPOULOU-DIACANTONI, 1972); Turkey: ? Koza aç, E of Celállı, near Sivas (STCHEPINSKY, 1939)

Rhône Basin: Burdigalian: Littoral de Nerthe (Cap Couronne, Carro near Carry, Martigues) (COTTREAU, 1913a; LAMBERT, 1915a; NEGRETTI, 1984; PHILIPPE et al., 1990; PHILIPPE, 1998), Secteur es étangs (Fos-sur-Mer, Istres) (PHILIPPE, 1998), Bas-Languedoc (Béziers, Bouzigues) (PHILIPPE, 1998), Bassin d'Apt-Reillanne-Forcalquier (Pierriere, Saint-Michael-l'Observatoire, Villemus, Reillanne) (LAMBERT, 1915a; PHILIPPE, 1998), Bassin de Valréas-Visan (Bollène, Lacoste, St.-Paul-Trois-Châteaux, St-Restitut) (LAMBERT, 1915a; PHILIPPE, 1998), Burdigalian or Langhian: Secteur es étangs (Fos-sur-Mer, Istres) (PHILIPPE, 1998), Bas-Languedoc occidental (Bouzigues, Loupian, Sète) (PHILIPPE, 1998), Bassin de Mus-Sommières (Aigues-Vives) (PHILIPPE, 1998), Vallée du Jabron (Châteauneuf-Miravail) (PHILIPPE, 1998), Serravallian: Bas-Languedoc occidental (Bouzigues) (PHILIPPE, 1998), Bassin de Faucon-Mollans-Malauccène (Mérindol-les-Oliviers) (PHILIPPE, 1998), Tortonian: Bordure Sud-Luberon (Cucuron) (PHILIPPE, 1998), Bassin de Valréas-Visan (Cairanne) (PHILIPPE, 1998)

***Schizaster (S.) laubei* HOERNES, 1875**

(Figs. 66-68; Pl. 66, Figs. 2a-b; Pl. 67, Figs. 1-2)

- v. 1869a *Schiz.* spec. – LAUBE: 184
v. 1871 *Schizaster* spec. – LAUBE: 71
* v. 1875a *Schizaster laubei* nov. sp. – HOERNES: 385, 387-389; pl. 12, fig. 3; pl. 15, fig. 1a-d
v. 1875b *Schizaster laubei* nov. sp. – HOERNES: 211
v. 1877 *Schizaster laubei* HOERN. jun. – FUCHS: 663
non 1882 *Schizaster laubei* nov. spec. – BITTNER: 96; pl. 11, fig. 1, 1a-b [= *S. postalensis*, see BITTNER (1891: 140)]
non 1883 *Schizaster laubei*, BITTNER – MAZZETTI & PANTANELLI: 80 [= *S. desori*, see STEFANINI (1909: 22-24)]
? 1884 *Schizaster* sp. (*Sch. laubei* R. HOERN.?) – BITTNER: 457
? 1884 *Schizaster* sp. – BITTNER: 487
? 1896 *Schizaster laubei* HÖRNES. – BOTTO-MICCA. 356-357
1913 *Schizaster* cf. *laubei* HÖRN. – DREGER: 70
1913 *Schizaster laubei* R. HOERN. – HILBER: 231
1925 *Schizaster laubei* – SCHWINNER: 197
1927 *Schizaster laubei* HÖRN. R. – HORUSITZKY: 25, 165
1930 *Schizaster laubei* R. HOERN. – VENDL: 50
1936 *Schizaster laubei* R. HÖRN. – MEZNERICS: 119
1943 *Schizaster laubei* R. HÖRN. – VEIT: 6
1951 *Schizaster laubei* R. HOERN. – SCHAFFER & GRILL: 707
1953a *Schizaster laubei* HÖ.R. – SIEBER: 207
? 1955 *Schizaster laubei* R.HÖRN. – SENEŠ: 6
? 1955 *Schizaster ventiensis* LAMB. – SENEŠ: 6, 26
? 1955 *Schizaster sardiniensis* COTT. – SENEŠ: 6
1956 *Schizaster laubei* R. HÖRN. – SIEBER: 317
1960 *Schizaster latipetalus* VAD. – GRIVULESCU & DUȘA: 936-937; figs. 4, 6 [misidentification; the legends of fig. 3 and 6 were confused]
v. 1962 *Schizaster laubei* – PAPP & THENIUS in KÜHN: 330
? 1967 *Schizaster laubei* R. HOERN. – CICHA et al.: 93
? 1970 *Schizaster* cf. *laubei* HOERN. – BAGASARYAN: 17, 23, 128; pl. 7, figs. 3-4
? 1971 *Schizaster* cf. *laubei* R. HÖRNES – SENEŠ: 201
? 1974 *Schizaster* cf. *laubei* R. HOERNES – KALABIS: 314
v. 1975 *Schizaster laubei* R. HOERNES 1875 – STOJASPAL: A193
1978 *Schizaster laubei* HOERN. – CICHA: 170
? 1980 *Schizaster* aff. *laubei* HÖRNES? – WANK & STOJASPAL: 448
? 1981 *Schizaster* cf. *laubei* R. HÖRNES – WANK: 382; pl. 3, fig. 5
1991 *Schizaster laubei* HOERNES – RUPP et al.: 40
v. 1998 *Schizaster laubei* HOERNES – SCHULTZ: 120; pl. 54, fig. 1
2003 *Schizaster laubei* – WEIDLINGER: 199, unnumbered fig.
non 2003 *Schizaster laubei* – WEIDLINGER: 199, unnumbered fig. [misidentified *Brissopsis ottngensis*]
2003b *Schizaster laubei* HOERNES, 1875 – KROH: 251

Type-material:

Schizaster laubei HOERNES 1875:

Syntypes: 1 specimen figured by HOERNES (1875a: pl. 12, fig. 3; pl. 13, figs. 1a-d) in the collection of the Naturhistorisches Museum Wien (Geologische Abteilung; NHMW 1854.II.149), and 3 specimens in the collection of the Geological Survey of Austria (GBA 1875/01/76a-c)

Lectotype (Figs. 66.A, 67; Pl. 67, Figs. 1a-c, 2a-b): the best-preserved specimen (NHMW 1854.II.149a-c) figured by HOERNES is proposed as lectotype

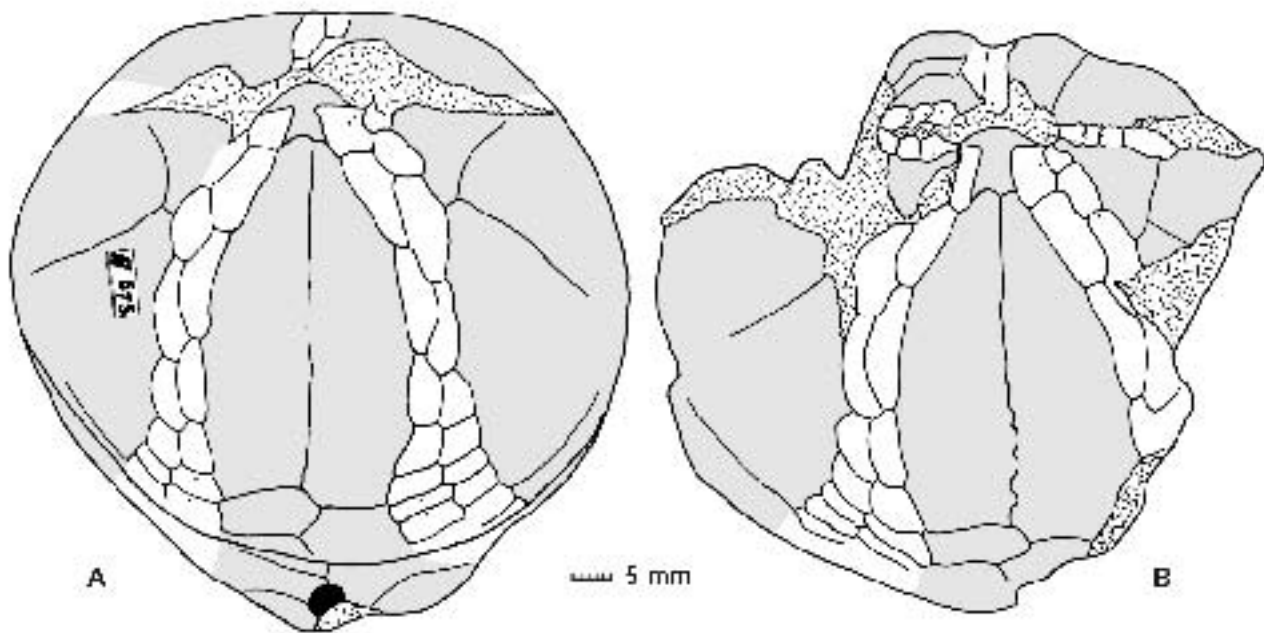


Figure 66: *Schizaster (S.) laubei* HOERNES, 1875a: oral plating (A: lectotype, Otttnang, OÖ, NHMW 1854.II.149b; B: Wetzelsdorf in der Weststeiermark, Stmk, NHMW 2004z0096/0002). Interambulacra shaded; poorly visible sutures stippled; damaged areas hatched.

Locus typicus: Otttnang, OÖ, Austria
 Stratum typicum: Otttnang Schlier
 Age: Otttnangian (Late Burdigalian), Early Miocene

Material:

Otttnangian (Late Burdigalian) – Otttnang, OÖ, Austria
 NHMW: 2 specimens [NHMW 1854.II.149a-c (**holotype**; 1 mould of the aboral side, 1 partial mould of the oral side and 1 internal cast, all of a single specimen), NHMW A677]

GBA: 3 specimens [GBA 1875/01/76a (mould and internal cast), 1875/01/76 (internal cast), 1875/01/76c (mould and internal cast)]

Early ? Badenian (Langhian) – Bad Vöslau, NÖ, Austria
 NHMW: 2 internal casts (NHMW 2004z0103/0004)

Early Badenian (Langhian) – Gainfarn, NÖ, Austria
 NHMW: 1 specimen (NHMW 2004z0154/0001)

Early Badenian (Langhian) – Weitendorf, Styria, Austria
 NHMW: 2 specimens (NHMW 2004z0097/0003-4)

Early Badenian (Langhian) – Wetzelsdorf in der Weststeiermark, Styria, Austria
 NHMW: 3 specimens (NHMW 2004z0096/0001-3)

? Badenian (Langhian-Early Serravallian) – borehole Matzen 325 (1909-1917 m), Austria
 NHMW: 1 specimen (NHMW 2004z0101/0001)

Foreign material for comparison:

Badenian (Langhian-Early Serravallian) – Mogyoród, Hungary
 NHMW: 3 specimens (NHMW 1997z0178/2091)

Dimensions (in mm):

Inv. no.	TL	TW	TH
NHMW 1854.II.149b	77.4	77.9	>>26

All other specimens are crushed and reliable dimensions can only be given for the lectotype.

Description:

Size and shape: Test of large size ranging from 50 to 90 mm test length in the studied material. The outline is broadly heart shaped to slightly antero-posteriorly elongated. The anterior margin is rounded with moderately deep frontal sinus. The posterior margin is bluntly pointed. The maximum width lies

anterior of the centre, about at the level of the end of the anterior paired petals. In profile the test is strongly wedge-shaped with its maximum height along the keel in interambulacrum 5. A distinct rostrum overhangs the periproct.

Apical disc: The apical disc is preserved only in the type specimen. It is ethmolytic with 4 gonopores. The anterior gonopores are slightly smaller than the posterior ones. The madreporite extends well beyond the posterior ocular plates. The apical disc lies posterior of the centre, about 60 to 65 % of TL from the anterior margin.

Ambulacra: The ambulacra are all petaloid and deeply sunken. Ambulacrum III has overhanging walls and closes slightly distally. The pores are numerous and arranged in two straight rows, with up to 35 pore pairs in the largest specimens. The anterior paired petals are moderately long, relatively broad and strongly flexed anteriorly. Contrary to *S. eurynotus* their tips are not flexed laterally. The posterior paired petals are shorter and extend about 60 % of the length of the anterior petals. The anterior paired petals form an acute angle of about 70-80° with each other, the posterior ones an angle between 50-60°. Both anterior and posterior paired petals are broadest at about two third their length from the apical disc. The poriferous zones of the paired petals consist of conjugate elongate isopores. The interporiferous zones are slightly smaller than a single poriferous zone and bear only secondary tubercles. On the oral surface ambulacra I and V form long narrow peri-plastral areas lacking primary tubercles.

Interambulacra: The interambulacra are strongly inflated adapically, forming high keels along the sunken petals. The aboral tuberculation is fairly homogenous, consisting of small perforate crenulate primary tubercles with distinct elevated bosses and inclined areoles. The tubercles become larger towards the ambitus. On the oral side primary tubercles are larger. The plastron is large and belongs to the mesamphisternous type. It is about 40 % of TW wide and shows a confluent fan shaped tuberculation radiating from the posterior margin. The labrum is moderately wide and rather short, with a triangular proximal part (see Figs. 66.A-B).

Peristome: The peristome is situated in the anterior half of the oral side close to the anterior margin of the test. It is kidney-shaped with a protuberant rounded labrum bearing a distinct rim and faces anteriorly.

Periproct: The periproct is situated marginally, high on the vertical posterior face of the test. It is overhung by a distinct rostrum and has an oval, vertically elongated shape. Below the peristome there is a shallow subanal depression.

Fascioles: The peripetalous fasciole is very broad, especially in the anterior part of the test. It is widest at the tips of the petals (up to 3.5 mm) and is narrower in the interambulacra. The peripetalous fasciole forms a slight outwards angle in interambulacrum 5, is deeply indented in interambulacra 2 and 3 and forms a more or less straight line in interambulacra 1 and 4 (Figs. 66.A-B). The latero-anal fasciole branches off from the peripetalous fasciole at about the first third along petal II and III running laterally towards the periproct and forming a deep, narrow V beneath it. It is much narrower than the peripetalous fasciole.

Differential diagnosis:

This species differs from *Schizaster scillae* (DES MOULINS, 1837) from the Messinian of Malta by its longer and differently shaped posterior petals, the presence of relatively large anterior gonopores (those of *S. scillae* are minute according to CHALLIS, 1980) and a more deeply embayed (in interambulacra 1 and 4) peripetalous fasciole. Otherwise, the two species are, however, rather similar and might be closely related. Unfortunately few good descriptions and illustrations of *S. scillae* are published, hampering comparison (compare LAMBERT, 1907a and CHALLIS, 1980).

Schizaster parkinsoni (DEFRANCE) a common Early to mid Miocene species in the Mediterranean region differs by its more strongly diverging anterior petals, which nearly form a right angle and its less wedge-shaped profile (compare CHALLIS, 1980; ROSE & WATSON, 1998).

Schizaster desori WRIGHT, 1855, another common Early to mid Miocene species, differs by its laterally flexed anterior paired petals (respectively their tips), minute anterior gonopores, shorter posterior paired petals, more elongated outline and shallower frontal sinus (compare CHALLIS, 1980).

Schizaster eurynotus SISMONDA, 1841 differs by its less diverging anterior petals with laterally flexed tips, deeper frontal sinus, more elongated outline, shorter posterior petals, indentation of the peripetalous fasciole in interambulacra 2 and 3, and the minute anterior gonopores (if present at all).

Schizaster karreri LAUBE, 1869 differs by the presence of a distinct subanal heel, lack of anterior gonopores, less rostrate posterior end, its more tumid anterior margin (in lateral view), shorter posterior paired petals, subcentral maximum width, slightly more central apical disc, and the broader aboral ambulacrum III.

Discussion:

This species is common in the "Schlier"-facies of the Lower to Middle Miocene in the Central Paratethys. Although the outline of the peripetalous fasciole and the shape of the anterior paired petals is very similar to *Schizaster karreri* LAUBE, 1869 it is unlikely that the two are conspecific, even if changes due to allometric growth (see above under *S. karreri*) are taken into account. The features outlined above (under "Differential diagnosis") and in particular the presence of large anterior gonopores (and the complete lack of anterior gonopores in *S. karreri*) differentiate the two species. Although, anterior gonopores may be developed in species which usually lack them (e.g. *S. eurynotus* or *S. compactus*), they are minute when present.

Schizaster latipetalus VADÁSZ, 1915 from the Lower Miocene "Schlier"-facies of Northern Hungary might seem related at the first sight. Re-examination of the holotype (which is an internal cast), however, showed that the two are not conspecific. *S. latipetalus* has much longer and broader petals, nearly reaching the ambitus, only two gonopores, and a very different overall shape (the specimen is only slightly distorted).

From the Mediterranean no similar *Schizaster* species has been reported until now, although many species are very



Figure 67: *Schizaster (S.) laubei* HOERNES, 1875a: adoral tuberculation (lectotype, Otttang, OÖ, NHMW 1854.II.149a).

poorly illustrated and comparison is difficult [e.g. the *Schizaster* and *Hemiasster* species figured in MAZZETTI & PANTANELLI (1883), ...]. There is only a single record of *S. laubei* from the Miocene of the Colli Torinesi by BOTTO-MICCA (1896). This record, however, lacks sufficient information to evaluate its correctness. For the differences to *S. scillae* see above.

Occurrence:

Austria: ? Eggenburgian (Early Burdigalian), Otttangian (Late Burdigalian), Early Badenian (Langhian)

Molasse Zone: borehole Eisenhub 2, OÖ (SCHAFER & GRILL, 1951); Ort, near Bad Füssing, OÖ (WEIDLINGER, 2003); Otttang, OÖ (LAUBE, 1869a, 1871; HOERNES, 1875a, b; FUCHS, 1877; VEIT, 1843; SIEBER, 1956; PAPP & THENIUS in KÜHN, 1962; STOJASPAL, 1975; RUPP et al., 1991; SCHULTZ, 1998)

Vienna Basin: Gainfarn, NÖ ([NHMW]); Steinberggebiet, Zistersdorf, NÖ (SIEBER, 1953a)

Lavant Basin: ? Mühldorf, Lavanttal, Ktn (WANK & STOJASPAL, 1980; WANK, 1981)

Styrian Basin: Jahring, probably Slovenia (MEZNERICS, 1936); Kollitschberg, near Weißenegg, Styria (HILBER, 1943); Perbersdorf, Styria (SCHWINNER, 1925); Repnik, probably Slovenia (MEZNERICS, 1936); region Wildon-Leibnitz, Styria (DREGER, 1913)

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

Molasse Zone: ? borehole ČČ-3, Vel'ká Čausa, near Prievidza, western Slovak Republic (SENEŠ, 1971); Židlochovice, Moravia, Czech Republic (CICHA, 1978)

Great Hungarian Basin (Pannonian Basin): Győr, Győr-Monson-Sopron, Hungary (VENDL, 1930); Mogyoród, near Fót, Pest, Hungary (HORUSITZKY, 1927; KROH, 2003b)

Transcarpathian Basin: ? Hlinné, eastern Slovakia (SENEŠ, 1955; CICHA et al., 1967; KROH, 2003b)

Transylvanian Basin: Coștei (= Kostěj), Timiș, Romania (GIVULESCU & DUȘA, 1960)

Zala, Sáva and Dráva Basins: ? Trbovlje (formerly Trifail), Slovenia (BITTNER, 1884); ? La'sko (formerly Tüffer; "Schlier" facies), Slovenia (BITTNER, 1884)

Eastern Paratethys: ? , , Western Georgia (BAGASARYAN, 1970)

Mediterranean: Middle Miocene

Western Mediterranean: ? Colli Torinesi, Italy (BOTTO-MICCA, 1896)

Schizaster sp.

1855 *Schizaster* – ROLLE: 354

1871 *Schizaster* – STUR: 562, 563

1877 *Schizaster* sp. – HILBER: 259, 260, 262

1877 *Schizaster* sp. – KARRER: 305

- 1881 *Schizaster* – FRANZENAU: 32, 84
 1897 *Schizaster* spec. ind. – SCHAFFER: 535, 547
 1905 *Schizaster* sp. – GAÁL: 343, 344, 362
 1906 *Schizaster* sp. – SCHAFFER: 63
 1908 *Schizaster* – SCHAFFER: 30
 1915 *Schizaster* spec. – TOULA: 672
 1927 *Schizaster* sp. – HORUSITZKY: 25, 165
 1931 *Schizaster* spec. indet. – JANOSCHEK: 83
 1939 *Schizaster* sp. – KALABIS: 90; fig. 2.
 1940 *Schizaster* sp. – JASKÓ: tab. 11
 1943 *Schizaster* sp. – VEIT: 10
 1965 *Schizaster* – KOLLMANN: 516
 1967 *Schizaster* sp. – CICHA et al.: 87, 88
 1969 *Schizaster* sp. – MIHÁLY: 257
 1970 *Schizaster* – THENIUS: p. 215
 1977 *Schizaster* – THENIUS: 130; fig. 51
 1979 *Schizaster* – THENIUS: 109; fig. 57
 2001 *Schizaster* – GONCHAROVA et al.: 518
 2002 *Schizaster* – GONCHAROVA et al.: 197, 200
 2002 *Schizaster* sp. – KAZÁR: 153; fig. 1
 v 2002b *Schizaster* sp. – KROH: 11
 2004 *Schizaster* – BOJAR et al.: 98
 2004 *Schizaster* – RADWAŃSKI & WYSOCKA: 384

Material:

- Early Badenian (Langhian) – Aflenz, Styria, Austria
 NHMW: 8 specimens (NHMW 1978/2023/1-8)
 Early Badenian (Langhian) – Bad Vöslau, NÖ, Austria
 NHMW: 2 internal casts (NHMW 1933.X.108)
 Badenian (Langhian-Early Serravallian) – Haschendorf, near
 Neckenmarkt, Bgld, Austria
 NHMW: 1 specimen (NHMW 1848.III.63)

Discussion:

The genus *Schizaster* occurs abundantly in pelitic siliciclastics and carbonate mud throughout the Neogene of Austria. Many records are based on poorly preserved and/or fragmented material that does not allow specific determination. In most cases, these remains will probably belong to one of the three *Schizaster* species discussed above.

Occurrence:

- Austria: Ottnangian (Late Burdigalian), Badenian (Langhian-Early Serravallian)
 Vienna Basin: borehole Lichtenwarth 1, NÖ (VEIT, 1943);
 Gainfarn, NÖ (KROH, 2002b); Ottakring, Vienna (SCHAFFER,

1906); Perchtoldsdorf (formerly Berchtoldsdorf), NÖ (KARRER, 1877); Rauchstallbrunngraben, near Baden, NÖ (KALABIS, 1939); Stotzing (sandpit Mayer), Bgld (KAZÁR, 2002); Vienna (THENIUS, 1970); Vienna Basin (THENIUS, 1977, 1979)

Oberpullendorf Bay: Neckenmarkt, Bgld (JANOSCHEK, 1931)

Styrian Basin: Grubthal (Weinleiten), near Gamlitz, Styria (HILBER, 1877); Retznei (Weissenegg Fm., Lafarge quarry), Styria (BOJAR et al., 2004); Spielfeld, Styria (ROLLE, 1855; STUR, 1871); Wagna (brickyard), Styria (KOLLMANN, 1965)

Central Paratethys (non-Austrian occurrences): Oligocene, Ottnangian (Late Burdigalian) to Late Badenian (Early Serravallian)

Vienna Basin: Devínska Nová Ves, Slovak Republic (SCHAFFER, 1897, 1908; TOULA, 1915); Dubovce, c. 7 km ESE Holíč, Slovak Republic (CICHA et al., 1967); Radošovce, c. 9 km ESE Holíč, Slovak Republic (CICHA et al., 1967)

Great Hungarian Basin (Pannonian Basin): Budapest-Rákos, Pest, Hungary (FRANZENAU, 1881; MIHÁLY, 1969); Hor. Strháre (= Felső-Esztergály), Slovak Republic (GAÁL, 1905); Mogyoród, near Fót, Pest, Hungary (HORUSITZKY, 1927); Sajóvárkony, near Ózd, Borsod-Abaúj-Zemplén, Hungary (JASKÓ, 1940)

Fore-Carpathian Basin: Świniary, Poland (RADWAŃSKI & WYSOCKA, 2004)

Zala, Sáva and Dráva Basins: Dráva valley, near Melting, E of Maribor (Marburg), Slovenia (STUR, 1871)

Eastern Paratethys: Mid-Tarkhanian (Late Burdigalian) to Chokrakian (Langhian)

Mid-Tarkhanian: Dzirul massif (Gorisa and Khorshi areas); western and eastern Ciscaucasia; Krasnovodsk plateau, Fore-Kopetdag depression (GONCHAROVA et al., 2001)

Chokrakian: Georgia and Transcaspian region (GONCHAROVA et al., 2002)

Genus *Aliaster* VALDINUCCI, 1974

Type-species: *Opissaster lovisatoi* COTTEAU, 1895; by original designation; regarded as junior synonym of *Hemiasster cotteauii* WRIGHT, 1855 in the present paper.

Emended diagnosis: Test subglobular with subcircular outline; high cushion- to wedge-shaped profile, obliquely or vertically truncated posterior end, ethmolytic apical disc with (2 or) 4 genital pores (see remarks below), deeply sunken frontal am-

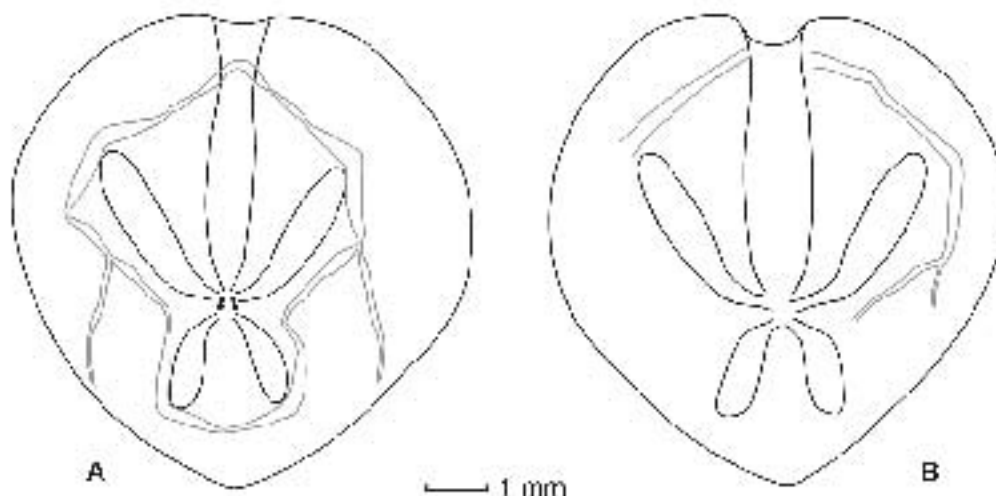


Figure 68: *Schizaster* (*S.*) *laubei* HOERNES, 1875a: fasciole outline (A: lectotype, Ottnang, OÖ, NHMW 1854.II.149a; B: Ottnang, OÖ, GBA 1875/1/76).

bulacrum, very shallow frontal sinus; sunken paired petals, the posterior ones of which are distinctly shorter than the anterior ones; a peripetalous fasciole only, which is deeply indented in interambulacra 1 and 4 and forms a right angle in interambulacra 2 and 3 (modified from VALDINUCCI, 1974a).

Distribution: Early Miocene to Pliocene – Mediterranean region (VALDINUCCI, 1974a)

Remarks: The number of genital pores is not known for many of the species included in this genus by VALDINUCCI (1974a). Some reports state there “seem to be not more than two” (e.g. COTTEAU et al., 1891) despite noting the poor preservation of the apical disc. In fact, in those species where the apical disc is known [*A. cotteauii* (WRIGHT, 1855), *A. lovisatoi* (COTTEAU, 1895), *A. aichnoi* (CHECCHIA-RISPOLI, 1927)] it is ethmolytic with 4 gonopores. Whether or not there are species with 2 gonopores in this genus remains to be shown.

The genus *Trachyaster* POMEL, 1869 (type-species: *Trachyaster globosus* POMEL, 1869, p. 14, by monotypy) differs from *Aliaster* by its more “hemiasteriform” shape with vertically truncated posterior end, more diverging paired petals and its peripetalous fasciole which is hardly indented in the interambulacra. The genus *Opissaster* POMEL, 1869 (type-species: *Opissaster polygonalis* POMEL, 1883, p. 37, by original designation) differs by its more elongated, oval outline, its petaloid area which is displaced anteriorly, an apical disc with 2 gonopores, at least in the type species, occasional presence of a latero-anal fasciole, and its peripetalous fasciole, which is only very slightly indented between the frontal and the anterior paired petals.

Traditionally both *Trachyaster* and *Opissaster* were referred to the family Hemiasteridae. *Aliaster* was likewise placed into this family by VALDINUCCI (1974a). SMITH & JEFFERY (2000), however, transferred the genus *Trachyaster* from the Hemiasteridae to the family Schizasteridae. Here the genus *Aliaster* is referred to the Schizasteridae too, on base of the ethmolytic apical disc and overall “schizasteriform” test shape (it can indeed be difficult to distinguish *A. cotteauii* from e.g. *Schizaster eurynotus*, when deformed or otherwise not optimally preserved).

***Aliaster cotteauii* (WRIGHT, 1855)**

(Fig. 69; Pl. 64, Figs. 2-3)

- * 1855 *Hemiaster Cotteauii*, WRIGHT. – WRIGHT: 190-191; pl. 7, figs. 2a-d
- 1858 [*Hemiaster*] *Cotteauii*, WRIGHT – DESOR: 375
- . 1864 *Hemiaster Cotteau*, WRIGHT. – WRIGHT: 483
- ? # 1869a *Pericosmus affinis* LAUBE. – LAUBE: 183
- ? 1870 *Pericosmus affinis* LBE. – LAUBE: 314
- ? 1871 *Pericosmus affinis* LAUBE. – LAUBE: 68; pl. 17, fig. 2.
- ? 1882a *Hemiaster Cotteau*, WRIGHT. – MAZZETTI: 117
- 1883 [*Opissaster*] *Cotteau* – POMEL: 38
- non 1883 *P.[ericosmus] affinis*, LAUB. – MAZZETTI & PANTANELLI: 67 [= *Trachyaster airaghii* according to STEFANINI (1909: 75)]
- 1891 *Hemiaster cotteau*, WRIGHT, 1855. – GREGORY: 610-611
- . # 1895 *Opissaster Lovisatoi*. COTTEAU, 1895. – COTTEAU: 48; pl. 5, figs. 6-8
- ? # 1895 *Opissaster Mariæ*. LOVISATO, 1895 – COTTEAU: 49; pl. 5, figs. 4-5
- . pp 1906a *Opissaster almerai* LAMBERT, 1906. – LAMBERT: 100; pl. 9, figs. 4-6 (specimens from the Miocene of Sardinia)
- non 1906a *Opissaster almerai* LAMBERT, 1906. – LAMBERT: 100; pl. 7, fig. 5 (specimens from the Miocene of Spain)
- 1909 *Opissaster Lovisatoi* COTTEAU, 1895. – LAMBERT: 77-78
- 1909 *Opissaster Almerai* LAMBERT, 1906. – LAMBERT: 78-80

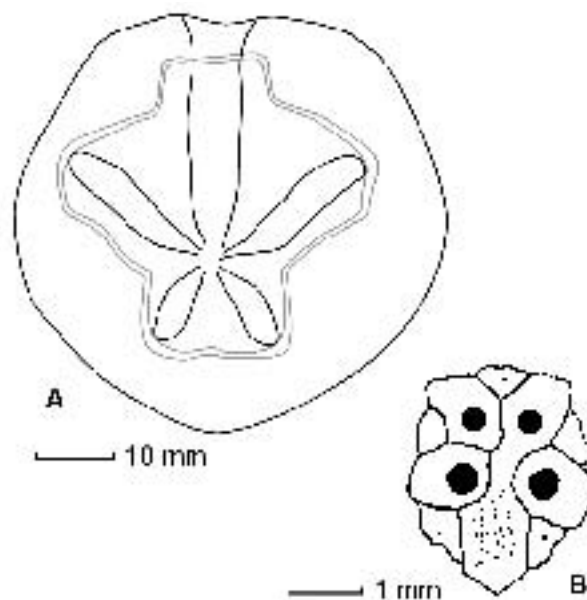


Figure 69: *Aliaster cotteauii* (WRIGHT, 1855): A: outline of the peripetalous fasciole (grey); B: apical disc (Early Badenian, Stotzing, Bgld, WANZENBÖCK coll. W20)

- 1909 *Opissaster Cotteau* WRIGHT (*Hemiaster*), 1855. – LAMBERT: 80
- . 1909 *Trachyaster Lovisatoi* (COTT.) – STEFANINI: 73-74; pl. 2 (4), figs. 9a-b
- 1913a *T. [rachyaster] Lovisatoi* COTT. (*Opissaster*). – COTTEAU: 67
- 1913a *O. [pissaster] Cotteau* WRIGHT (*Hemiaster*). – COTTEAU: 70
- ? 1913a *Pericosmus affinis* LAUBE – COTTEAU: 70
- 1915a *Trachyaster Lovisatoi* COTTEAU (*Opissaster*), 1895. – LAMBERT: 157-158
- 1915 *Trachyaster Lovisatoi* COTT. sp. – VADÁSZ: 225; fig. 115
- v. 1915 *Trachyaster Cotteau* WRIGHT sp. – VADÁSZ: 226; fig. 116
- 1924 *O.[pissaster] Cotteau* WRIGHT (*Hemiaster*) – LAMBERT & THIÉRY: 510
- 1924 *T.[rachyaster] Lovisatoi* COTTEAU (*Opissaster*) – LAMBERT & THIÉRY: 510
- . 1927a *Trachyaster Lovisatoi* COTT. – CHECCHIA-RISPOLI: figs. 3, 3a-c
- ? 1955 *Trachyaster cotteau* WRIGHT. ex. aff. – SENEŠ: 6, 26
- ? 1955 *Trachyaster (Schizaster)?* sp. – SENEŠ: 6
- ? 1967 *Trachyaster cotteau* WRIGHT. ex. aff. – CICHA et al.: 93
- . 1974a *Aliaster (Trachyaster) lovisatoi* COTTEAU – VALDINUCCI: 463-468; pl. 1, figs. 1a-c, 2a-c, 3a-c
- . 1974a *Aliaster (Opissaster) cotteau* WRIGHT 1855 – VALDINUCCI: 468-471
- 1974b *Hemiaster cotteau* – ROSE: 353, fig. 3
- 1975 *Hemiaster cotteau* WRIGHT – ROSE: 79; tab. 12
- pp 1980 *Hemiaster (Trachyaster) cotteau* (WRIGHT) – CHALLIS: 190-194; pl. 71, fig. c; pl. 73, figs. a-c; pl. 74, fig. A
- 1984 *Hemiaster cotteau* – BOGGILD & ROSE: 61, 64; figs. 2, 3
- 1994 *Opissaster cotteau* – NÉRAUDEAU: 329; tab. 4
- 1994 *H. (Trachyaster) lovisatoi* – NÉRAUDEAU: 329; tab. 4
- v. 2002 *Hemiaster* sp. – KAZÁR: 153; fig. 1
- v. 2003 *Trachyaster ? cotteau* (WRIGHT, 1855) – KROH & NEBELSICK: 166-167; fig 5c