referred to this subgenus: *S.* (*S.*) *compactus* Koehler (Bengal Sea and Western Australia), *S.* (*S.*) *edwardsi* Cotteau (Gulf of New Guinea), *S.* (*S.*) *lacunosus* (Linné) (Indo-malayan region and western Indian Ocean), and *S.* (*S.*) *orbignyanus* Agassiz (Caribbean) (see Mortensen, 1951; McNamara & Philip, 1980b). They are deposit-feeders and capable of burrowing up to c. 25 cm deep into the sediment. Little is known on their biology otherwise.

Schizaster (*S.*) *eurynotus* Sismonda, 1841

(Fig. 63; Pl. 63, Figs. 4-5; Pl. 64, Figs. 1a-c; Pl. 66, Figs. 1a-c)

non	1840b	*Schizaster eurynotus* Ag. – Agassiz: 2, nos. P. 86 and X. 93 (*nomen nudum*)
*	1841	*Schizaster eurynotus* Ag. – Sismonda: 22
pp	1841	*Schizaster canaliferus* Ag.– Sismonda: 20-22 [fossil Maltese material, fide Challis (1980: 223-224)]
?	1843	*Schizaster eurynotus* Ag. – Sismonda: 31-32; pl. 2, figs. 2-3
	1847b	[*Schizaster*] *eurynotus* Agass. – Agassiz & Desor: 21; no. P86
	1855	*Schizaster eurynotus,* Agassiz. – Wright: 262-264
	1857	*Sch.*[*izaster*] *eurynotus*, Ag. – Pictet: 199
pp	1858	[*Schizaster*] *Scillae* Agass. et Desor – Desor: 389-390
pp	1864	*Schizaster Scillæ*, Desmoulins. – Wright: 484 [fide Challis (1980: 220)]
# v.	1869a	*Schizaster leithanus* Laube. – Laube: 183
	1869a	*Schiz. Scillae* Desmoulins. – Laube: 184
v.	1870	*Schizaster leithanus* Lbe. – Laube: 314
v.	1871	*Schizaster Leithanus* Laube. – Laube: 69-70; pl. 18, fig. 7
	1871	*Schizaster Scillae* Desmoulins sp. – Laube: 71
	1874	*Schizaster eurynotus* – Quenstedt: pl. 89, fig. 6
	1875	*Schizaster eurynotus* – Quenstedt: 672
	1877	*Schizaster scillae* Desm. – Karrer: 170
	1883	*Schizaster Scillai*, Ag. – Gutzwiller: 46 [fide Cottreau (1913a: 68)
?	1884	*Schizaster Leithanus* Laub. – Coppi: 191, no. 277
pp	1891	*Schizaster scillae* (Desmoul.), 1837. – Gregory: 617-618.
	1906a	*Schizaster* (*Aplospatangus*) *eurynotus* Agassiz (in Sismonda), 1841. – Lambert: 117-118, fig. 3(4)
	1907a	*Schizaster eurynotus* Agassiz, 1840. – Lambert: 67-69; pl. 5, figs. 6-7
? #	1907a	*Schizaster Capederi* Lambert. – Lambert: 74; pl. 10, figs. 3-4
	1907	*Schizaster Scillae* Desm. – Schaffer: 28
	1908a	*Schizaster eurynotus* Agass. – Stefanini: pl. 17, figs. 13, 13b
.	1913a	*S.* [*chizaster*] *eurynotus* Ag. (in Sismonda) – Cottreau: 68, 114-115; fig. 29; pl. 14, fig.1, 1a, 2-4, 5, 5a, 6
v.	1915	*Schizaster eurynotus* Ag. – Vadász: 220; fig. 107; pl. 11 (5), figs. 3, 7
?	1915	*Schizaster calceolus* Lambert. – Vadász: 220; text-fig. 108.
?	1915	*Schizaster* cfr. *lajtanus* Lbe. – Vadász: 224 (two poorly preserved specimens)
	1920	*Schizaster eurynotus*, Agassiz 1840 – Fourtau: 78-79
	1928	*Schizaster Scillae* Desm. – Bobies: 48
	1928	*Schizaster eurynotus*, Ag. – Jeannet: 44-47; pl. 4, figs, 25-26; pl. 5, figs. 6-8
	1936	*Schizaster eurynotus* Agssiz. – Paucă: 143, 196-197; pl. 1, figs. 5-6

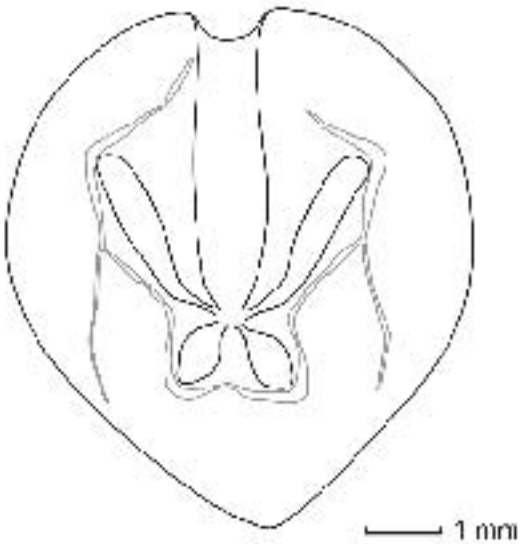

Figure 63: *Schizaster* (*S.*) *eurynotus* Sismonda, 1841: outline of the peripetalous and latero-anal fascioles (grey) (Early Badenian, Stotzing, Bgld, Wanzenböck coll. W31).

	1939	*Schizaster eurynotus* Agassiz – Taviani: 46-47; pl. 3 (5), figs. 8a-b
	1942	*Schizaster Scillae* Desm. – Schaffer: 130
?	1955	*Schizaster eurynotus* Ag. – Seneš: 6
?	1956	*Schizaster eurynotus* Agassiz – Socin: 11
	1963	*Schizaster eurynotus* Agassiz – Comaschi Caria: 30; pl. 3, figs. 8
pp	1964	*Schizaster eurynotus* Agassiz – Wigglesworth: 73-78; pl. 12
?	1967	*Schizaster eurynotus* Ag. – Cicha et al.: 93
	1967	*Schizaster eurynotus* Agassiz – Menesini: 147-149; pl. 46 (1), figs. 1, 1a
	1974a	*Schizaster eurynotus* – Rose: 345; fig. 3
pp	1974b	*Schizaster eurynotus* – Rose: 345; fig. 3
	1975	*Schizaster* (*Ova*) *eurynotus* – Bromley & Asgaard: 279
	1975	*Schizaster eurynotus* Agassiz – Menesini: 96-101; fig. 1b
pp	1975	*Schizaster eurynotus* Agassiz – Rose: 79; tab. 12
v.	1975	*Schizaster leithanus* Laube 1871 – Stojaspal: A193
.	1979	*Schizaster eurynotus* Agassiz 1840 – Challis: 256
	1979a	*Schizaster eurynotus* Agassiz 1840 – Menesini: 61
?	1979a	*Schizaster cavernosus* Pomel 1887 – Menesini: 61 [fide Challis (1980: 221)]
	1979b	*Schizaster eurynotus* Agassiz 1840 – Menesini: 803
?	1979b	*Schizaster cavernosus* Pomel 1887 – Menesini: 803 [fide Challis (1980: 221)]
.	1980	*Schizaster eurynotus* Agassiz – Challis: 220-224; pl. 83, fig. A-C; pl.86, fig. C; pl. 88, fig. A-C; pl. 89, fig. A-C
.	1984	*Schizaster eurynotus* – Boggild & Rose: 61, 64, 65; figs. 2-3
	1994	*Schizaster eurynotus* Agassiz – Ragaini: 288, 289; tab. 1-2
.	1998	*Schizaster eurynotus* L. Agassiz, 1841 – Rose & Watson: 813; fig. 5a-d
?	1998	*Schizaster* (*Shizaster*) *eurynotus* Agassiz, 1840 – Philippe: 172-175; pl. 20, figs. 1-3

Type-material:
Schizaster eurynotus Sismonda, 1841:
Type-material: whereabouts unknown, not indicated in original publication

Locus typicus: Colli Torinesi, Italy
Age: Middle (?) Miocene
Remarks: the specimen figured by Sismonda (1843: pl.2, figs. 2-3) is peculiar, while the outline, profile, and shape of the paired petals fit very well with *S. eurynotus*, the figure shows multiple rows of pores in the poriferous zones of aboral ambulacrum III and a peripetalous fasciole, which is not indented in interambulacra 2 and 3. Sismonda's figure might thus be a composite image based on specimens of *S. eurynotus* and the extant *S. canaliferus*.

Schizaster leithanus Laube, 1869:
Holotype: specimen figured by Laube (1871: pl. 18, fig. 7); Geological Survey of Austria, Type collection, specimen no. 1871/3/2
Locus typicus: Mörbisch (Merwisch) near Rust, Bgld, Austria
Age: Badenian (Langhian-Early Serravallian), Middle Miocene
Remarks: Laube's figure is not very accurate (compare Pl. 66, Fig. 1a-c)

Material:
Early Badenian (Langhian) – Stotzing (sandpit Mayer), Bgld, Austria
NHMW: 12 specimens (NHMW 2004z0093/0006-17)
Wanzenböck coll.: numerous specimens
Badenian (Langhian-Early Serravallian) – Mörbisch (formerly Merwisch) near Rust, Bgld, Austria
GBA: 1 specimen [GBA 1871/3/2 (**holotype** of *Schizaster leithanus* Laube, 1869)]
Late Badenian (Early Serravallian) – Müllendorf (Mühlendorfer Kreide AG quarry), Bgld, Austria
NHMW: 1 specimen (NHMW 2004z0094/0001)

Foreign material for comparison:
Late Badenian (Early Serravallian) – Gârbova de Sus (= Felsö-Orbó), Romania
MAFI: 3 specimens [MAFI Ech 241 (reference material of Vadász, 1915)]

Dimensions (in mm)**:**

Inv. No.	TL	TW	TH
NHMW 2004z0093/0008	~60	56.2	>40
NHMW 2004z0093/0009	72.3	65.6	~46
NHMW 2004z0093/0010	~70	~67	-
NHMW 2004z0093/0013	67.7	61.4	~42

Description:
Size and shape: Test of medium to large size ranging from 60 to 80 mm TL in the studied material. The outline is heart-shaped and elongated antero-posteriorly. The anterior margin is rounded with a distinct frontal sinus. In some specimens a slightly asymmetry is observed. In these specimens one side – usually the right one – projects further anterior than the other. The posterior margin is sharply pointed. The maximum width lies slightly anterior of the centre. In profile the test is strongly wedge-shaped with its maximum height roughly halfway along highly arched keel in interambulacrum 5. A distinct rostrum overhangs the periproct.
Apical disc: The apical disc lies posterior of the centre, about 60 to 65 % of TL from the anterior margin. It is lacking in all examined specimen, but was reported to be ethmolytic with two to four gonopores (the anterior of which are only about 25 % the diameter of the posterior ones) in Mediterranean specimens (Lambert, 1907a; Challis, 1980).
Ambulacra: The ambulacra are all petaloid and rather deeply sunken. Ambulacrum III is deeply sunken with overhanging walls. It closes slightly distally, where the pores become smaller and less closely spaced. The pores are arranged in two straight rows. They are slightly oblique partitioned isopores with an axially positioned neural canal. There may be up to 40 pore pairs in each row. The interporiferous zone is very broad and bears many secondary, but few primary tubercles.

The anterior paired petals are long, relatively narrow and strongly flexed anteriorly. Their tips tend to flex slightly laterally. The posterior paired petals are much shorter, extending about 38 to 45 % of the lengths of the anterior petals. Anterior paired petals form an acute angle of about 60-70° with each other, the posterior ones an angle between 60 to 65°. The posterior paired petals are broadest at their midpoint, whereas the anterior petals are broadest near the distal flexure. The poriferous zones of the paired petals consist of conjugate elongate isopores and tend to close distally. The interporiferous zones are slightly smaller than a single poriferous zone and bear only secondary tubercles.

Outside the peripetalous fasciole, the ambulacral pores are minute, vertically elongated constricted unipores. Adorally the ambulacra form distinct phyllodes consisting of large partitioned anisopores with a large, transversely elongated interporal partition.

On the oral surface ambulacra I and V form long narrow peri-plastronal areas lacking primary tubercles. Each bears four partitioned isopores on each side of the posterior end of the plastron.
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 and within the peripetalous fasciole. On the oral side primary tubercles are larger and more strongly crenulate. They are not so densely packed as on the aboral surface and more secondary tubercles are found between them. The largest tubercles are situated on the anterior half of the oral side, sideways of the peristome. 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 T-shaped.
Peristome: The peristome is situated in 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 is 10.0 mm wide and 3 to 4 mm long in a 61.5 mm test length specimen.
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. The periproct is about as large as the peristome. It is 10.5 x 6.7 mm in a 71 mm specimen.
Fascioles: The peripetalous fasciole is broad, especially at the anterior end of the test. It is widest at the tips of the petals and in ambulacrum III; narrowing in the interambulacra. The peripetalous fasciole is slightly indented in interambulacrum 5, distinctly indented in interambulacra 2 and 3 (Fig. 63). The degree of indentation in interambulacra 1 and 4 varies from deeply to slightly indented. The latero-anal fasciole branches off from the peripetalous fasciole about halfway along petal II and III running laterally towards the periproct and forming a deep, narrow "V" beneath it.

Differential diagnosis:
This species differs from the similar *Schizaster scillae* (des Moulins, 1837) by its antero-posteriorly elongation, its shorter posterior paired petals, its more strongly wedge-shaped profile and its different peripetalous fasciole outline (compare Lambert, 1907a and Challis, 1980).

Schizaster parkinsoni (Defrance) and *Schizaster desori* Wright, 1855, two common Early to mid-Miocene representatives of the genus are rather easily distinguished from *S. eurynotus* by their subequal length and width, shallower fron-

tal ambulacrum III and less strongly wedge shaped profile. Furthermore, the shape of the peripetalous and latero-anal fascioles helps to distinguish these forms (compare Challis, 1980; Rose & Watson, 1998).

Schizaster karreri Laube, 1869 is usually much smaller and can readily distinguished from *S. eurynotus*: *S. karreri* has a less rostrate, near-vertically truncated posterior end, a distinct sub-anal heel, a different peripetalous fasciole outline (not indented at all in interambulacra 2 and 3), longer posterior paired petals and a less posteriorly displaced apical disc.

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

Discussion:

The specimens considered here are clearly conspecific with the Early to mid-Miocene specimens from the Mediterranean area named *Schizaster eurynotus* Agassiz, 1840b by Sismonda (1841) or Rose & Watson (1998). There are, however, some taxonomic problems associated with this name and species:

1) The name *Schizaster eurynotus* Agassiz, 1840b is a *nomen nudum* according to the ICZN rules (ICZN 4th ed., 2000, Article 12.1.).
2) The next author who published a description for this name is Sismonda (1841), which is thus the valid author for *S. eurynotus* (ICZN 4th ed., Articles 11. and 12.).
3) Sismonda (1841: 22) based his description on species from the Early to mid-Miocene of the Colli Torinesi in Italy, which is thus the type area for this species.
4) Agassiz's specimens (which are plaster casts) are not conspecific with the material of the type area.
5) Hence, the name *S. eurynotus* has been used in two different senses: a) in the sense of Agassiz (1840b) [but this is a *nomen nudum*] from the Burdigalian of France (e.g. Philippe, 1998) and b) in the sense of Sismonda (1841) (e.g. Rose & Watson, 1998).

Lambert, obviously being aware that the name *S. eurynotus* Agassiz, 1840b is a *nomen nudum*, often referred to the taxon as "*Schizaster eurynotus* Agassiz (in Sismonda), 1841" (e.g. Lambert, 1906a: 115; Lambert, 1915a: 159).

Philippe (1998) reported *S. eurynotus* from the Burdigalian of the Rhone Basin, but his specimens differ from typical *S. eurynotus* by their oval outline with less pointed posterior end, lack of a pronounced rostrum, lack of the lateral flexure of the tips of the anterior paired petals and its different peripetalous fasciole, which is straight in interambulacra 2 and 3 and only slightly indentation in interambulacra 1 and 4 (Philippe, 1998: pl. 20, figs 2a-b). These specimens in fact resemble large specimens of *S. karreri* to some extent.

Schizaster capederi Lambert, 1907 from Sardinia is closely similar to *S. eurynotus*, as stated also by Lambert (1907a) himself. The species is based on a laterally deformed specimen missing the posterior end. According to Lambert (1907a: 74) it differs from *S. eurynotus* by its "sillon antérieur plus allongé" and the presence of four gonopores. Concerning the latter feature the reader is referred to the introductory remarks under the genus *Schizaster* (see above). The former feature may also result from the lateral compression to which Lambert's specimen was obviously subject and it seems very likely that *S. capederi* and *S. eurynotus* are conspecific.

Laube (1869a) established the species *Schizaster leithanus* for a single specimen from the Badenian (Langhian-Early Serravallian) Leitha Limestone of Mörbisch (formerly Merwisch; near Rust, Bgld, Austria). The type could be located in the type collection of the Geological Survey of Austria (specimen no. 1871/3/2). Laube's (1871) illustration is misleading, as it depicts a nearly circular specimen. This, however, is due to the poor preservation of the specimen, which lacks the posterior end and nearly the complete oral surface. When compared to well preserved specimens of *S. eurynotus* from Stotzing (Bgld, Austria) and the Maltese Islands no features could be found which would allow to separate the two species. Hence, *S. leithanus* is considered as junior synonym of *S. eurynotus* Sismomda, 1841. The characteristic difference to *S. eurynotus* (under the name *S. scillae*, following Desor, 1858) mentioned by Laube (1871: 71) "durch den Mangel eines Fortsatzes nach hinten" (by the lack of a posterior projection) is obviously no original feature but simply due to poor preservation (see Pl. 66, Fig. 1a-c). Whether the two specimens of "*Schizaster* cfr. *lajtanus* Lbe." mentioned by Vadász (1915: 224) really belong to *S. eurynotus* is doubtful. Yet the mention of a strongly eccentric apex fit well with this species.

Laube (1869a, 1871) followed Desor (1858) in placing *S. eurynotus* into the synonymy of *S. scillae*. Although his material of *S. scillae* could not be located his description indicates that he had specimens of *S. eurynotus*. This is also supported by the fact that all known specimens of *Schizaster* (museum material as well as specimens collected by private collectors recently) from the Leitha Limestone exposed in Baden belong to *S. eurynotus*. Additionally Laube's comparison materials [partly preserved at the NHMW] from the Miocene of Malta which are labelled *S. scillae*, are actually misidentified *S. eurynotus*. All other references of *S. scillae* from the Miocene of Austria are just re-iterations of Laube's record and not based on new material. *S. scillae* (des Moulins, 1837), a species based on the figure in Scilla (1670, 1752) was re-described by Lambert (1907a) from the Tortonian of Sardinia and by Challis (1980) from the Messinian of Malta. Both describe a large species which differs from *S. eurynotus* by its longer posterior paired petals.

Schizaster eurynotus has also been reported from the Middle Miocene of Venezuela by Jeannet (1928). Despite the lack of records from other places in the Caribbean and in the area between Venezuela and the Iberian peninsula (the western-most occurrence of this species, apart from Jeannet's record) Jeannet's determination seems to be correct. At least, nothing in his description or illustrations gives reason to doubt it and this could be a fossil example of a transatlantic taxon (for other examples see Poddubiuk & Rose, 1984). Today there are also a number of purportedly transatlantic echinoid taxa [e.g. *Brissus unicolor* (Leske), *Echinometra lucunter* (Lamarck), *Tripneustes ventricosus* (Lamarck), ...] (see e.g. Fell, 1967; Pawson, 1978). In most cases it is unknown if these species maintain gene-flow across the Atlantic and molecular genetics has yet to tackle this question. A notable exception are the recent studies by the working-group around H.A. Lessios: in a study on the East Pacific and Atlantic species of *Echinometra* McCartney et al. (2000) discussed also the amphi-atlantic *E. lucunter*. According to their results gene-flow between the Caribbean stock of *E. lucunter* and the rest of the Atlantic Ocean is restricted, with all investigated specimens from outside the Caribbean sharing a single substitution in COI that distinguished them from the Caribbean individuals. In *Eucidaris tribuloides* (Lamarck), in contrast, very little genetic differentiation between Western and Eastern Atlantic populations could be documented by Lessios et al. (1999). Only the populations on the Central Atlantic islands Ascension and St. Helena (formerly considered either as subspecies of *E. tribuloides* or as separate species) form a resolved subclade within the Atlantic clade. In *Diadema antillarum*, the situation is yet again different. According to the results of Lessios et al. (2001b) the differences in the mitochondrial DNA of the East and West Atlantic lineages is as different as between several other accepted morphospecies and they estimate that the two were separated between 1.02 and 1.86 my ago. The populations from the Central Atlantic islands were found to nest as monophyletic entity within the Western Atlantic lineage of *D. antillarum* and Lessios et al. (2001b) support Pawson's (1978) decision to treat them as subspecies of *D. antillarum*.

Occurrence:

Austria: Early to Late Badenian (Langhian-Early Serravallian)
- Vienna Basin: Baden (Leitha Limestone), NÖ (Laube, 1869a, 1871; Gregory, 1891 (erroneously reported from the Baden Tegel)]; Müllendorf (Mühlendorfer Kreide AG quarry), Bgld ([NHMW]); Rauchstallbrunngraben, near Baden, NÖ (Karrer, 1877; Schaffer, 1907, 1942; Bobies, 1928); Stotzing (sandpit Mayer), Bgld (Kazár, 2002; [NHMW])
- Eisenstadt-Sopron Basin: Mörbisch, Bgld (Laube, 1869a, 1871; Stojaspal, 1975 [GBA])

Paratethys (non-Austrian occurrences): ? Karpatian (Late Burdigalian), Late Badenian (Early Serravallian)
- Swiss Molasse Basin: St. Gallen, Switzerland (Gutzwiller, 1883; Cottreau, 1913a)
- Great Hungarian Basin (Pannonian Basin): ? Hont, Börzsöny, Hungary (Vadász, 1915)
- Transcarpathian Basin: ? Hlinné, eastern Slovakia (Seneš, 1955; Cicha et al., 1967)
- Transylvanian Basin: Gârbova de Sus (= Felsö-Orbó), Romania (Vadász, 1915; [MAFI]); region east of Taşad, Beiuş Basin, Romania (Paucă, 1936)

Mediterranean: Aquitanian to Messinian
- Western Mediterranean: Algeria (Cottreau, 1913a); Corsica, France (Agassiz & Desor, 1847b; Lambert, 1906a): Bonifacio (Gregory, 1891; Cottreau, 1913a), Santa Manza (Wright, 1855; Desor, 1858; Quenstedt, 1874, 1875; Gregory, 1891); France, mainland: Peripignan (Agassiz & Desor, 1847b; Wright, 1855; Desor, 1858; Laube, 1871), Vence, Alpes-Maritimes, (Lambert, 1906a; Cottreau, 1913a); Italy, mainland: ? Monte Pelegrino (Desor, 1858; Laube, 1871), Nice (Pictet, 1857; Lambert, 1906a), Palermo, Sicily (Desor, 1858; Laube, 1871; Gregory, 1891), Piemont (Cottreau, 1913a), Posano, near Volterra, Prov. di Pisa (Menesini, 1967), Reggio Emilia (Cottreau, 1913a), Rosignano, Toscana (Stefanini, 1908a); Salento, Apulia (Ragaini, 1994); Sardinia, Italy (Pictet, 1857; Gregory, 1891; Lambert, 1906a; Cottreau, 1913a): Cagliari (Agassiz & Desor, 1847b; Wright, 1855), Cap Sant'Elia, Coroneddu (near Bosa), Cadréas (Bonorva), ? Fontanaccia, ? Montevecchio, Soddi and Zuri (Lambert, 1907a); Funtanazza (Comaschi Caria, 1963)
- Central Mediterranean: Italy, mainland: ? Asti (Desor, 1858; Laube, 1871; Gregory, 1891); Maltese Islands (Desor, 1858; Laube, 1871; Cottreau, 1913a): *Globigerina* Lst. indifferenciated (Wright, 1855; Menesini, 1975; Boggild & Rose, 1984); Lower *Globigerina* Lst. (Menesini, 1979a, b); Middle *Globigerina* Lst. (Rose, 1974b, 1975; Challis, 1980; Rose & Watson, 1998); Xwieni Conglomerate Bed [basal Upper *Globigerina* Lst. (= C_2 phosphate conglomerate of Pedley et al., 1976) (Challis, 1979, 1980; Rose & Watson, 1998); Upper *Globigerina* Lst. (Rose, 1974b, 1975); Blue Clay (Rose, 1974b, 1975; Challis, 1980); Greensand (Rose, 1974b, 1975; ? Menesini, 1979a, b; Challis, 1980); records from the Upper Coralline Lst. (Rose, 1974b, 1975) are dubious and are probably misidentified *S. scillae*
- Eastern Mediterranean: Armenia (Cottreau, 1913a); Wadi Ramlieh, near Marsa Matrouh, Egypt (Fourtau, 1920); Turkey (Cottreau, 1913a); Greece: Attika (= Attique) (Cottreau, 1913a), Morea (= Morée) (Desor, 1858; Laube, 1871; Gregory, 1891); Libya: Cyrene, Cyrenaica (Rose, 1974a); Umm er Rzem, Cyrenaica (Taviani, 1939)

Atlantic Ocean: Middle Miocene
- Caribbean: Ojo de Agua, Capadare, San José de la Costa and Cerro de Chichiriviche, Venezuela (Jeannet, 1928)

Indian Ocean: ? Early Miocene
- Eastern African coast: ? Ehil, Somalia [Socin, 1956 (specific identification needs to be confirmed)]

Schizaster (*S.*) *karreri* Laube, 1869

(Figs. 64-65; Pl. 65, Figs. 1-7)

	1869a	*Schiz. Parkinsoni* Defr. – Laube: 183
*	1869a	*Schiz. Karreri* Laube. – Laube: 184
	1869	*Schizaster Karreri* Laube sp. ined. – Fuchs: 194
	1869	*Schizaster Parkinsoni* Defr. – Fuchs: 194
	1870	*Schizaster Karreri* Lbe. – Laube: 314
	1870	*Schizaster Parkinsoni* Defr. – Laube: 314
	1871	*Schizaster Parkinsoni* Defrance sp. – Laube: 70
	1871	*Schizaster Karreri* Laube. – Laube: 70-71; pl. 16, fig. 6
	1877	*Schizaster Karreri* Laube – Karrer: 312
	1877	*Schizaster Parkinsoni* Defr. – Karrer: 312
	1877	*Schizaster karreri* Laube. – Lóczy: 63
?	1884	*Schizaster Karreri* ? Laub. – Coppi: 191, no. 279
	1887b	*Schizaster* cfr. *Karreri*, Laube. – Koch: 270
pp	1891	*Schizaster parkinsoni* (Defrance), 1827. – Gregory: 616-617 [Austrian material only]
	1891	*Schizaster Karreri* Laube. – Roth von Telegd: 151
	1894	*Schizaster* cfr. *Karreri*. Laube. – Lörenthey: 61
#	1895	*Schizaster Lovisatoi*, Cotteau, 1895. – Cotteau: 45-46; pl. 5, figs. 9-10
#	1895	*Schizaster sardiniensis*, Cotteau, 1895. – Cotteau: 46-47; pl. 5, figs. 11-12
?	1896	*Schizaster Karreri* Laube. – Botto-Micca. 359
#	1902a	*Schizaster bouziguensis* – de Loriol: 26-28; pl. 4, figs. 1a-c [not seen; fide Philippe (1998)]
	1905	*Schizaster Karreri*, Lbe. – Gaál: 344, 362
? #	1906a	*Schizaster* (*Aplospatangus*) *calceolus* – Lambert: 118
#	1906a	*Schizaster morgadesi* Lambert – Lambert: 119; pl. 8, figs. 3-4
#	1906a	*Schizaster gymnesiæ* Lambert – Lambert: 119-120; pl. 10, figs. 1-2
#	1906b	*Schizaster venetiensis* – Lambert: 45-46; pl 7, figs. 3-5 [reference not seen; fide Philippe (1998)]
v. #	1906	*Schizaster Karreri* Lbe. var. *hungaricus* nov. var. – Vadász: 333-335; pl. 10, figs. 3a-b
v. #	1906	*Schizaster Lovisatoi* Cotteau var. *rákosensis* nov. var. – Vadász: 335-336; pl. 10, figs. 4a-b
	1907a	*Schizaster calceolus* Lambert, 1907. – Lambert: 69-70; pl. 5, fig. 8
	1907a	*Schizaster sardiniensis* Cotteau, 1895. – Lambert: 71-72; pl. 4, figs. 8-10
	1907	*Schizaster Parkinsoni* Defr. – Schaffer: 35
? pp	1909	*Schizaster parkinsoni* Defrance (*Spatangus*), 1827. – Lambert: 66-67 ; pl. 5, figs. 3-4 [fide Lambert, 1909]
#	1909	*Schizaster decipiens* Lambert. – Lambert: 74-75; pl. 6, figs. 6-7
#	1909	*Schizaster Ilottoi* Lambert. – Lambert: 75-76 [new name for the specimens figured as *S. parkinsoni* in 1907; fide Lambert, 1928 & Philippe, 1998]
	1913a	*Schizaster Lovisatoi* Cotteau. – Cottreau: 118-120; pl. 13, figs. 2-7
?	1915	*Schizaster calceolus* Laub. – Májer: 29, 82
v.	1915	*Schizaster rákosensis* Lamb. – Vadász: 218-219; text-figs. 103-105; pl. 10 (4) , fig. 7
v.	1915	*Schizaster hungaricus* Vad. – Vadász: 219; text-fig. 106; pl. 10 (4) , fig. 8
non	1915	*Schizaster calceolus* Lambert. – Vadász: 220; text-fig. 108. [probably a misidentified *S. eurynotus*]
.	1915	*Schizaster Ilottoi* Lambert. – Vadász: 221; text-fig. 109; pl. 10 (4), fig. 6
.	1915	*Schizaster barcinensis* Lamb. var. ? – Vadász: 221-222; text-fig. 110; pl. 11 (5), fig. 4
.	1915	*Schizaster ventiensis* Lamb. – Vadász: 222; text-fig. 111; pl. 9 (3), fig. 19

. 1915 *Schizaster Karreri* Laube. – Vadász: 223; pl. 12 (6), fig. 8
v. 1915 *Schizaster* cfr. *Bellardi* Ag. – Vadász: 224; text-fig. 114
1915a *Schizaster Jacquemeti* Lambert. – Lambert: 163-165; pl. 13, figs. 2-5
1915a *Schizaster ventiensis* Lambert, 1906. – Lambert: 165
? 1919 *Schizaster Lovisatoi* Cott. – Stefanini: 147-148; pl. 14 (8), fig. 5a-b [fide. Philippe (1998: 175)]
1923 *Schizaster Bellardii* Agassiz & Des. 1847 – di Giorgio: 121-122; pl. 2 (1), fig. 2
1923 *Schizaster ventiensis* Lambert 1906 – di Giorgio: 122; pl. 2 (1), fig. 3a-b
1927a *Schizaster Lovisatoi* Cotteau 1895 – Lambert: 29
1931 *Schizaster Karreri* Laube – Janoschek: 84
1936 *Schizaster calceolus* Lambert – Paucă: 143, 195-196; pl. 2, figs. 3-4
? 1939 *Schizaster Lovisatoi* Cotteau – Stchepinsky: 10; pl. 2, fig. 4-6
1939 *Schizaster Lovisatoi* Cotteau – Taviani: 45-46; pl. 3 (5), figs. 6-7
1942 *Schizaster Parkinsoni* Defr. – Schaffer: 94
1953 *Schizaster karreri* Laube, 1871. – Szörényi: 41, 93; pl. 2, fig. 5
1953 *Schizaster sardiniensis* Cotteau, 1895. – Szörényi: 42, 94; pl. 2, figs. 6, 6a
1953 *Schizaster ilottoi* Lambert, 1908. – Szörényi: 42, 94; pl. 2, figs. 7, 7a
1960 *Schizaster ventiensis* Lambert 1906 – Kojumdgieva & Strachimirov: 232; pl. 9, figs. 4a-c
1962 *Schizaster parkinsoni* Defr. – Bachmayer: 378
? 1963 *Schizaster lovisatoi* Cotteau – Comaschi Caria: 29-30; pl. 3, figs. 5-6
? 1966 *Schizaster* cfr. *karreri* Laube – Kókay: 83
? 1967 *Schizaster sardiniensis* Cott. – Cicha et al.: 93
1967 *Schizaster lovisatoi* Cotteau – Menesini: 149-151; pl. 46 (1), figs. 2, 2a, 4, 3a, 4, 4a, 5, 5a, 6, 6a; pl. 47 (2), figs. 1, 1a, 2, 2a, 3. 3a, 4, 4a, 5, 5a
1968 *Schizaster "parkinsoni"* – Küpper: pl. 4, fig. 33
pp 1970 *Schizaster* cf. *karreri* Laube – Bałuk: pl. 1, fig. 8
1970 *Schizaster "parkinsoni"* – Thenius: p. 211; pl. 3, fig. 33
? 1972 *Schizaster lovisatoi* Cotteau, 1895. – Marcopoulou-Diacantoni: 138-140; pl. 15 (1), fig. 3 [fide Philippe (1998: 175)]
? 1972 *Schizaster calceolus* Lambert. – Marcopoulou-Diacantoni: 156 [fide Philippe (1998: 175)]
1974 *Schizaster "parkinsoni"* Defrance – Thenius: 70-71; fig. 13/25
? 1977 *Schizaster ventiensis* Lambert, 1836 – Mączyńska: 197; pl. 8 figs. 1a-g [fide Philippe (1998: 175)]
1979 *Schizaster lovisatoi* Cotteau, 1895 – d'Alessandro et al.: 93; pl. 17, fig. 10
1979 *Schizaster "parkinsoni"* – Thenius: 52; pl. 3, fig. 25
? 1981 *Schizaster scillae* Desor – Mitrović-Petrović: 181; figs. 12a-b
1983 *Schizaster "parkinsoni"* – Thenius: 119; pl. 7, fig. 25
1984 *Schizaster rákosensis* Vadász – Kókay et al.: 290
1984 *Schizaster hungaricus* Vadász – Kókay et al.: 290
1984 *Schizaster lovisatoi* Cotteau, 1895 – Negretti: 115-116, pl. 9, figs. 1-6
1985 *Schizaster rákosiensis* Vadász, 1906– Mihály: 244; pl. 5, figs. 1-2
1985 *Schizaster hungaricus* Vadász, 1906– Mihály: 244
? 1987 *Schizaster ventiensis* Lambert, 1906 – Mączyńska: 149 [fide Philippe (1998: 175)]
1987 *Schizaster karreri* Laube, 1871 – Mączyńska: 149
1989 *Schizaster lovisatoi* Cotteau – Philippe: 31; tab. 4
1990 *Schizaster lovisatoi* Cotteau, 1895 – Philippe et al.: 245
1992 *Schizaster* cf. *lovisatoi* Cotteau – Blondel & Philippe: 438, 441; pl. 2, fig. 4
1998 *Schizaster* (*Schizaster*) *lovisatoi* Cotteau, 1895 – Philippe: 175-178; pl. 20, figs. 4-7
1998 *Schizaster karreri* Laube – Schultz: 120; pl. 54, figs. 2
1999 *Schizaster karreri* – Piller & Harzhauser: 223; fig. 24

Type-material:

Schizaster karreri Laube, 1869:
Holotype: Laube (1871: 69) chose an exceptionally well preserved specimen form "Bid [sic] im Pester Comitat" [= Biatorbágy (formerly Bia), Pest, Hungary] as holotype. That specimen was figured by Vadász [1915: pl. 12 (6), fig. 8], who stated that it was housed in the collection of the "Wiener Hofmuseum" (old name for the NHMW). Unfortunately, the holotype could not be located at the NHMW. The figured specimen of Laube (1871: pl. 16, fig. 6; here Fig. 65.A-C) is a different specimen (NHMW 1865.XXX.73), which is labelled as coming from "Sóskút im Stuhlweissenburger Comitat". The two localities approximately five kilometres apart (despite belonging to different counties in the 19th and early 20th century).
Locus typicus: Biatorbágy (= Bia), Pest, Hungary
Age: Badenian (Langhian-Early Serravallian), Middle Miocene

Schizaster lovisatoi Cotteau, 1895:
Holotype: the specimen figured by Cotteau (1895: pl. 5, figs. 9-10); private collection of Lovisato (not seen, current whereabouts unknown)
Locus typicus: Castelsardo, Sassari, Sardinia, Italy
Stratum typicum: "couches arénacée inférieure aux couches langhiennes à *Vaginella depressa*"
Age: Langhian, Middle Miocene

Schizaster sardiniensis Cotteau, 1895:
Syntypes: private collection of Lovisato (not seen, current whereabouts unknown)
Locus typicus: Cuccuruddu, below Chemerule, Thiesi, Sardinia, Italy
Stratum typicum: "Calcaire argileux"
Age: Middle Miocene

Schizaster bouziguensis de Loriol, 1902:
Holotype: figured by de Loriol (1902a: pl. 4, figs. 1a-c); a cast of the type is housed at the Centre des Sciences de la Terre, Lyon under the number FSL 27 470 (Philippe, 1998: 323)
Locus typicus: Bouzigues, France
Age: Middle Miocene
Remark: Re-examined by Philippe (1998) and placed into the synonymy of *S. lovisatoi* Cotteau, 1895, which in turn is here placed into the synonymy of *S. karreri*.

? *Schizaster calceolus* Lambert, 1906:
Holotype: whereabouts unknown
Locus typicus: ? Bonorva, Sardinia, Italy
Age: "Langhien" of Lambert, Early or Middle Miocene

Schizaster morgadesi Lambert, 1906:
Holotype: specimen figured by Lambert (1906a: pl. 8, figs. 3-4), private collection of J. Almera (not seen)
Locus typicus: Calafell, Province Barcelona, Spain
Age: "Helvétien", Early or Middle Miocene

Schizaster gymnesiae Lambert, 1906:
Holotype: specimen figured by Lambert (1906a: pl. 10, figs. 1-2), private collection of J. Almera (not seen)

Locus typicus: Ciudaadèla, Menorca, Balearic Islands, Spain
Age: "Helvétien", Early or Middle Miocene

Schizaster lovisatoi rakosensis Vadász, 1906:
Holotype: specimen MAFI Ech 127
Locus typicus: Budapest-Rákos, Pest, Hungary
Age: Late Badenian (Early Serravallian), Middle Miocene
Remarks: The holotype falls well within the variation observed in *S. karreri*. No features could be found, which would allow a confident separation of this form.

Schizaster karreri hungaricus Vadász, 1906:
Holotype: specimen MAFI Ech 128
Locus typicus: Budapest-Rákos, Pest, Hungary
Age: Late Badenian (Early Serravallian), Middle Miocene
Remarks: As in the former nominal (sub)species, none of the characters shown by the type allow to distinguish it from *S. karreri*.

Schizaster decipiens Lambert, 1909:
Holotype: the specimen figured by Lambert (1909: pl. 6, figs. 6-7); current whereabouts unknown
Locus typicus: Cuccuruddu, Thiesi, Sardinia, Italy
Stratum typicum: Calcaire marneux
Age: "Helvétien", Early or Middle Miocene

Schizaster ilottoi Lambert, 1909:
Holotype: the specimen figured by Lambert (1907a: pl. 5, figs. 3-4) as *S. parkinsoni*; current whereabouts unknown
Locus typicus: Cadreas, grande tranchée de Bonorva, Sardinia, Italy
Age: "Langhien" of Lambert, Early or Middle Miocene

Schizaster jacquemeti Lambert, 1915:
Syntypes: casts of the two syntypes of this species are housed at the Centre des Sciences de la Terre, Lyon under the number FSL 27 467 and in the collection Lambert (Muséum national, Paris) (Philippe, 1998: 323-324)
Locus typicus: la Couronne, Martigues, France
Age: "Langhien" of Lambert, = Burdigalian, Early Miocene (Philippe, 1998)

Material:
Early Badenian (Langhian) – Baden (Badener Tegel), NÖ, Austria
NHMW: 1 specimen (NHMW 1933.X.108)
Early Badenian (Langhian) – Retznei [Weissenegg Fm., Lafarge (formerly Perlmoser) quarry Rosenberg], Styria, Austria
NHMW: 2 specimens (NHMW 2004z0001/0033-34)
Early Badenian (Langhian) – Wagna (brickyard Wagna), Styria, Austria
NHMW: 5 specimens (NHMW 2004z0001/0035-39)
Badenian (Langhian-Early Serravallian) – Haschendorf, near Neckenmarkt, Bgld, Austria
NHMW: 1 specimen (NHMW 1848.III.62)
Badenian (Langhian-Early Serravallian) – Kalksburg, Vienna, Austria
NHMW: 9 specimens (NHMW 1866.XLVII.37, 1868.VIII.59, 1997z0178/1670, ../1671, 2004z0001/0032a-b, ../0061, ../0064-65)
IPUW: 1 specimen (no inventory no.)

Foreign material for comparison:
Badenian (Langhian-Early Serravallian) – Soskút, Hungary
NHMW: 1 specimen [NHMW 1865.XXX.73 (figured specimen of *Schizaster karreri* in Laube, 1871)]
Remarks: According to Vadász (1915: 105, footnote) there are only strata of Sarmatian age outcropping at Soskút and material from the marine Badenian comes from the nearby Leitha Limestone of Bia.
Badenian (Langhian-Early Serravallian) – Piliny (Köhegy), Hungary
MAFI: 1 specimen [MAFI Ech 153 (figured specimen of *Schizaster* cf. *bellardi* in Vadász, 1915)]
Late Badenian (Early Serravallian) – Budapest-Rákos, Pest, Hungary
MAFI: 2 specimens [MAFI Ech 127 (**holotype** of *Schizaster lovisatoi rákosensis* Vadász, 1906), Ech 128 (**holotype** of *Schizaster karreri hungaricus* Vadász, 1906)]

Dimensions (in mm)**:**

Inv. No.	TL	TW	TH
NHMW 1865.XXX.73	46.1	45.3	26.7
NHMW 1866.XLVII.37	63.9	58.6	37.8
NHMW 1933.X.108a	43.3	39.6	-
NHMW 2004z0001/0032a	50.8	52.4	28.2
NHMW 2004z0001/0032b	41.4	39.8	-
NHMW 2004z0001/0033	50.9	48.7	35.3
NHMW 2004z0001/0034	34.8	35.5	30.9
NHMW 2004z0001/0035	43.3	41.3	>24.0
NHMW 2004z0001/0036	27.2	25.5	19.1
NHMW 2004z0001/0037	30.5	29.9	25.2
NHMW 2004z0001/0038	~21	~20	17.7
NHMW 2004z0001/0039	49.2	46.4	>27.5
NHMW 2004z0001/0061	48.2	44.1	28.4

Description:
Size and shape: Test ranging from *c.* 21 to 63 mm test length in the studied material. Test outline ranges from polygonal-subcircular in smaller to elongated antero-posteriorly in larger specimens. The posterior end may be bluntly pointed, giving the test a cordiform appearance. There is a well-developed, moderately deep frontal notch. In some specimens a slightly left-right asymmetry is observed (primary, not resulting from post-sedimentary compaction). In these specimens one side – usually the right one – projects further anterior than the other. The maximum width lies subcentrally. In profile the test is moderately to strongly wedge-shaped with its maximum height roughly halfway along a highly arched keel in interambulacrum 5. Wedge-shapedness and test height vary considerable, even if post-sedimentary deformation effects are taken into account. In profile the posterior end is vertically truncated with the posterior part of the plastron forming a slightly projecting subanal heel. A small rostrum overhangs the periproct.
Apical disc: The apical disc lies slightly posterior of the centre, its exact position varies between c. 50 to 60 % of TL from the anterior margin. It is ethmolytic with 2 gonopores (Fig. 64.D-E). There are no gonopores in the anterior genital plates.
Ambulacra: The ambulacra are petaloid and rather deeply sunken. Ambulacrum III is very deeply sunken with overhanging walls. It closes slightly distally, where the pores change from partitioned isopores to minute unipores. The pores are arranged in straight single rows in each half ambulacrum. Ambitally ambulacrum III is less deeply sunken forming a moderately deep frontal notch.

The anterior paired petals are long, relatively narrow and strongly flexed anteriorly. In large specimens (TL > 50 mm) the tips may very slightly flex laterally. The posterior paired petals are much shorter, usually extending less than 50 % of the length of the anterior petals. In larger specimens, however, (e.g. NHMW 1866.XLVII.37) they may extend up to 60 % of the anterior petals. Similar allometric growth with an increase of posterior petal length during ontogeny was observed in extant *S.* (*S.*) *compactus* by McNamara (1995).

Anterior paired petals form an acute angle of about 65 to 75°, the posterior ones an angle between 55 to 65°. The posterior paired petals are broadest at their midpoint, whereas the anterior petals are broadest in their distal third. The pores of the paired petals are conjugated elongate isopores. The interporiferous zones are slightly smaller than a single poriferous zone and bear only secondary tubercles.

Outside the peripetalous fasciole, the ambulacral pores are minute (? constricted) unipores. Adorally the ambulacra form