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The Donacidae of the Bay of Malaga (Spain). Taxonomy

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During a study of the molluscs of the infralittoral zone of the Bay of Málaga (Southern Spain) between 1981 and 1982, all five European species of Donacidae have been found: *Donax* (*Serrula*) *trunculus* L., 1758, *D.* (*Cuneus*) *vittatus* (Da Costa, 1778), *D.* (*C.*) *semistriatus* Poli, 1791, *D.* (*C.*) *venustus* Poli, 1795, and *Capsella variegata* (Gmelin, 1791). Morphological shell description, size, habitat, and geographical distribution are given for each species, with a discussion on the sculpture of the shell as a taxonomic character for some of these species. Details on the shell growth are given for each species. The length and the height of the shell have been the parameters measured. Finally a key to the European species of Donacidae is presented.

Key words: Bivalvia, Donacidae, taxonomy, Spain.

INTRODUCTION

The family Donacidae is represented in the littoral zone of Europe by five species, which are placed in two genera: *Donax* Linné, 1758, and *Capsella* Gray, 1851. These five European species are: *Donax trunculus* L., 1758, *Donax vittatus* (Da Costa, 1778), *Donax semistriatus* Poli, 1791, *Donax venustus* Poli, 1795, and *Capsella variegata* (Gmelin, 1791).

The species are members of the infauna of the intertidal zone and shallow water of sand beaches, where some of them are subject to fisheries.

There exists an extensive literature on the biology and ecology of some species, particularly on *Donax trunculus*: Degiovanni & Mouëza (1972); Mouëza & Frenkiel-Renault (1973); Mouëza & Chessel (1976) on the coast of Algeria; Ansell & Bodoy (1979); Bodoy (1982); Bodoy & Masse (1979) on the coast of the Camargue (France). The biology of *Donax vittatus* has been particularly studied in the Atlantic waters in Scotland (Ansell, 1972) and, in comparison with other species of *Donax*, from the Atlantic littoral zone of France (Ansell & Lagardère, 1980; Guillou & Le Moal, 1980; Guillou, 1982), and from the Mediterranean (Ansell et al., 1980; Ansell & Bodoy, 1979).

The biology of the other European species of *Donax* has been studied very little, especially that of *Donax venustus* and *Capsella variegata*.

However, literature on the taxonomy of this group is scarce, in particular for the European species. Apart from more general treatises on molluscs, there are very few papers (Bertin, 1881; Lucas, 1967; Yaron, 1978).

During research on the molluscs of the infralittoral zone of the Bay of Málaga (S. Spain) between 1981 and 1982, all five European species were found. Intermediate shell morphotypes between some of these species appear to occur in this area, indicating that a taxonomic review of this group of species is necessary. The present work is a study of the shells of the Donacidae collected from the Bay of Málaga.

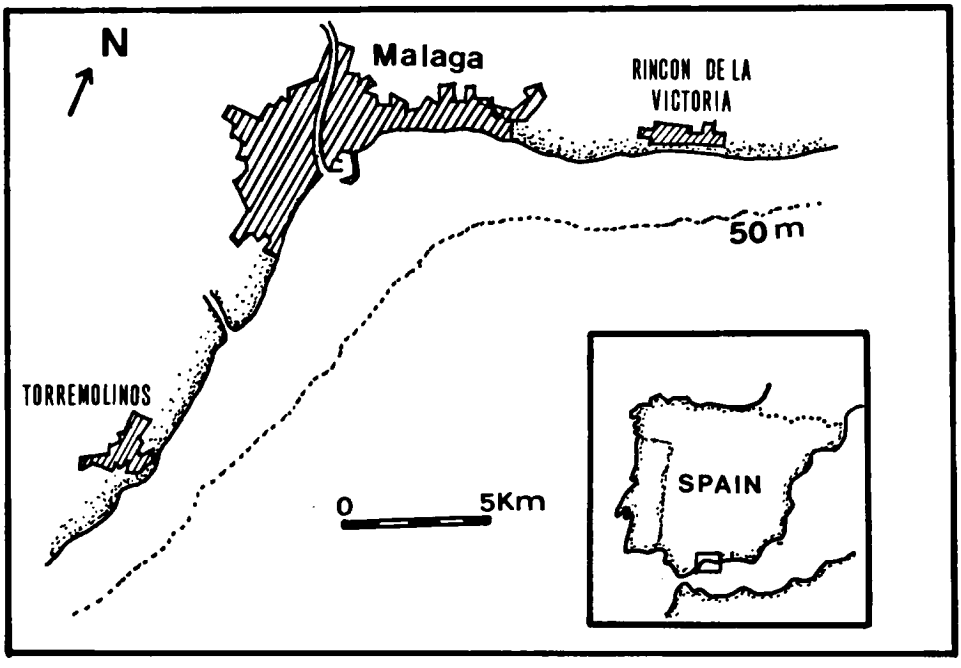

Fig. 1. Geographical situation of the Bay of Málaga, Spain.

MATERIAL AND METHODS

The Bay of Málaga (fig. 1) is on the Mediterrean coast of southern Spain, near to the Straights of Gibraltar. The zone sampled was the infralittoral, depth between 0 and 35 m. Stations were established along 39 transects, perpendicular to the line of coast. At each transect five stations were sampled, at 1, 5, 10, 15 and 20 fathoms respectively. The fauna was sampled using a small dredge; the sediment was taken by a bottom grab.

Linear regressions were fitted to the measurements of the shell length and height for each species and covariance analysis was used to test the significance of the fitted regressions.

THE SHELL

According to Keen (1969), the shell of the Donacidae is trigonal, medium-sized to small, solid, inequilateral, opisthogyrate. The hinge is well-developed, with two cardinal teeth in each valve and lateral teeth, of which the number and disposition is different for the various species. Pallial sinus normally present. The family appears for the first time in the upper Cretaceous.

Genus *Donax* Linné, 1758

Radial sculpture present in most species at least in the form of marginal crenulations; periostracum wanting. Lower Eocene to Recent (Keen, 1969).

Subgenus *Serrula* Mörch, 1853

Elongate, smooth, without posterior carination; posterior margin smooth within. Right valve without lateral teeth (Keen, 1969).

Donax (*Serrula*) *trunculus* Linné, 1758 (figs. 2, 3)

Donax trunculus Linné, 1758; Sowerby, 1866; Römer, 1869; Monterosato, 1875; Bertin, 1881; Dautzenberg, 1913; Hidalgo, 1917; Nobre, 1936; Nicklès, 1953; Pasteur-Humbert, 1962; Parenzan, 1976.
Serrula laevigata Chemnitz, 1782.
Donax rubra Turton, 1822.
Donax brevis Requien, 1848.
Donax atlanticus Hidalgo, 1867.
Donax (*Serrula*) *trunculus* L., 1758; Keen, 1969; Piani, 1980; Yaron, 1978.
Donax (*Serrula*) *trunculus* L., 1767; Nordsieck, 1969; Montero, 1971.

Shell solid, slightly inequivalve, left valve a little more convex and higher in the region of the lunule, than the right. Inequilateral; beak small, opisthogyrate in the posterior half. Lunule long and narrow, in the form of a little depression. Escutcheon posterior and wide, extending over 2/3 of the posterior dorsal margin.

Periostracum thin, green, brown or greenish-brown. Shell colour very variable, cream, light to dark brown or light cream, with bands of colour concentrated about the growth lines, sometimes of purple colour. In most shells there are rays of white radiating from the beak to the ventral margins. The beak zone is always of light colour. Interior of the shell purple with the margins and one posterior ray white.

Ligament external, small and provided with a nymph.

Hinge heterodont: right valve with two cardinal teeth, of which the posterior is bifid and the anterior single; one posterior lateral and one anterior lateral tooth; left valve with two cardinal teeth, of which the anterior is bifid and the posterior single; one weak lateral anterior and one well-developed lateral posterior tooth (fig. 3a-b).

Two muscle scars of similar size and unequal form, with a more elongate anterior scar. Pallial sinus deep and rounded, confluent with the pallial line. Ventral and anterior margins crenulate; posterior margin smooth.

Size. — According to the literature, the greatest length is about 40 mm, which indeed is the length of the greatest specimen from the Bay of Málaga.

Habitat. *D. trunculus* is an intertidal and shallow water species; Nordsieck (1969), however, extends the known depth to 70 m. The species normally lives in sand beaches.

Geographical distribution. *D. trunculus* has been reported from the whole of the Mediterranean and the Black Sea. In the Atlantic Ocean it has been recorded from Senegal (Bertin, 1881; Nicklès, 1953; Pasteur-Humbert, 1962; Lucas, 1967). However, this species has not been reported by Tebble (1966) for the British Isles. It occurs as far north as the French Atlantic coast (Bay of Douarnenez) (Ansell & Lagardère, 1980; Guillou & Le Moal, 1980).

In the Bay of Málaga 247 living and 11 dead specimens, plus 101 valves, have been found during the present research.

Discussion. — According to Keen (1969), the subgenus *Serrula* has no lateral teeth in the right valve; *D.* (*Serrula*) *trunculus* is the type species of the subgenus. However, if one looks at the hinge of the right valve (fig. 3a), it is possible to see one anterior and one posterior lateral tooth, so that the diagnosis of this subgenus must be modified.

Subgenus *Cuneus* Da Costa, 1778

Radiately ribbed, with some oblique striae crossing the central slope; posterior truncation weak. Miocene-Recent (Keen, 1969).

Donax (*Cuneus*) *vittatus* (Da Costa, 1778) (figs. 4-6)

Cuneus vittatus Da Costa, 1778.
Donax anatinus Lamarck, 1818; Reeve, 1854.
Donax vittatus (Da Costa, 1778); Sowerby, 1866; Dautzenberg, 1913; Hidalgo, 1917; Nobre, 1936; Pasteur-Humbert, 1962; Tebble, 1966; Lucas, 1967; Parenzan, 1976.
Donax (*Hecuba*) *vittatus* (Da Costa, 1778); Montero, 1971.
Donax (*Donax*) *vittatus* (Da Costa, 1778); Piani, 1980.
Donax (*Cuneus*) *vittatus* (Da Costa, 1778); Nordsieck, 1969; Keen, 1969; Yaron, 1978.

Shell solid, slightly inequivalve, left valve a little more convex than the right; inequilateral, beak small, opisthogyrate in the posterior half. Lunule anterior, narrow and elongate, extending over nearly all the anterior dorsal margin. Escutcheon small and weak, posterior. Radial ribs present in the posterior 2/3 of the shell, with some oblique striae crossing the central slope. Anterior half of the shell smooth.

Periostracum thin, light green. Shell colour very variable, light to dark green, greenish brown or purple, with three radial white bands on the central slope. Interior of the shell purple, with the margins and one posterior radial band white. Sometimes the interior of the shell can be white with a little posterior purple spot. Ligament external, small and with a nymph, fitting into a posterior depression.

Hinge heterodont: right valve with two cardinal teeth, of which the posterior is bifid and the anterior single; two posterior laterals, but no anterior lateral tooth. Left valve with two cardinal teeth, of which the anterior is bifid and the posterior single; one lateral anterior and one lateral posterior tooth (figs. 6e-f).

Two muscle scars of similar size but unequal in form, with a more elongate anterior scar. Pallial sinus deep, wide and rounded, ventrally confluent with the pallial line. Ventral and posterior margins coarsely crenulate.

Size. — With *D. trunculus*, *D. vittatus* is the largest species of the European Donacidae. According to the literature, the length of the shell can be about 40 mm. The largest specimen from the Bay of Málaga measures 36.5 mm.

Habitat. — This is a shallow water species. It lives in sand beaches, between 0 and 18.3 m depth (Tebble, 1966).

Geographical distribution. — According to Tebble (1966) this species has been reported from the Norwegian Sea and the Baltic, south to the Iberian Peninsula, into the Mediterranean and along the Atlantic coast of Morocco. Pasteur-Humbert (1962) has recorded the species from Senegal. Although *D. vittatus* has been reported from the Mediterranean by Dautzenberg (1913), Pasteur-Humbert (1962), Nordsieck (1969),

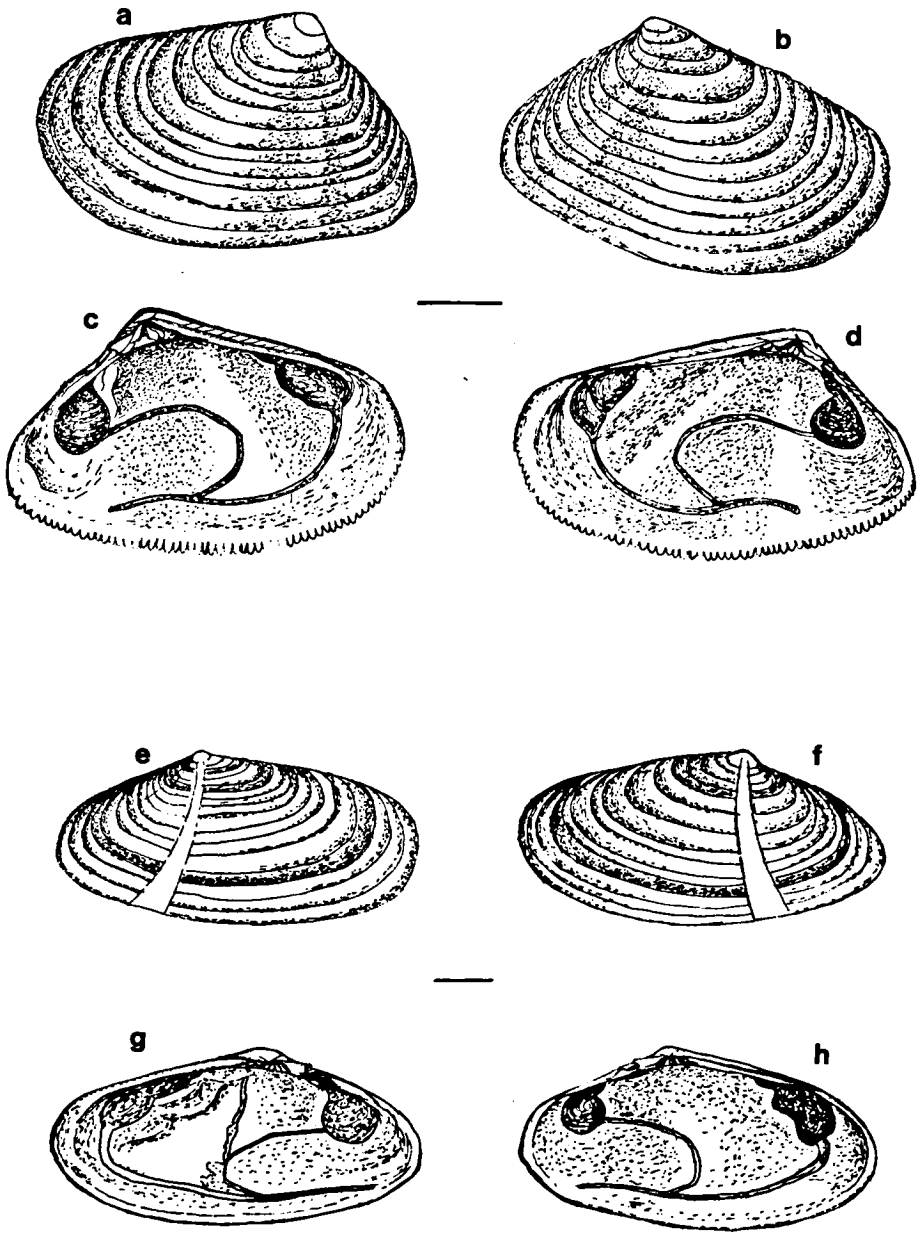

Fig. 2. Shells of Donacidae. a, External sculpture of the left valve of *Donax* (*Serrula*) *trunculus*; b, External sculpture of the right valve of do.; c, Interior of the left valve of do.; d, Interior of the right valve of do.; e, External sculpture of the right valve of *Capsella variegata*; f, External sculpture of the left valve of do.; g, Interior of the right valve of do.; h, Interior of the left valve of do. Scale bars 1 mm.

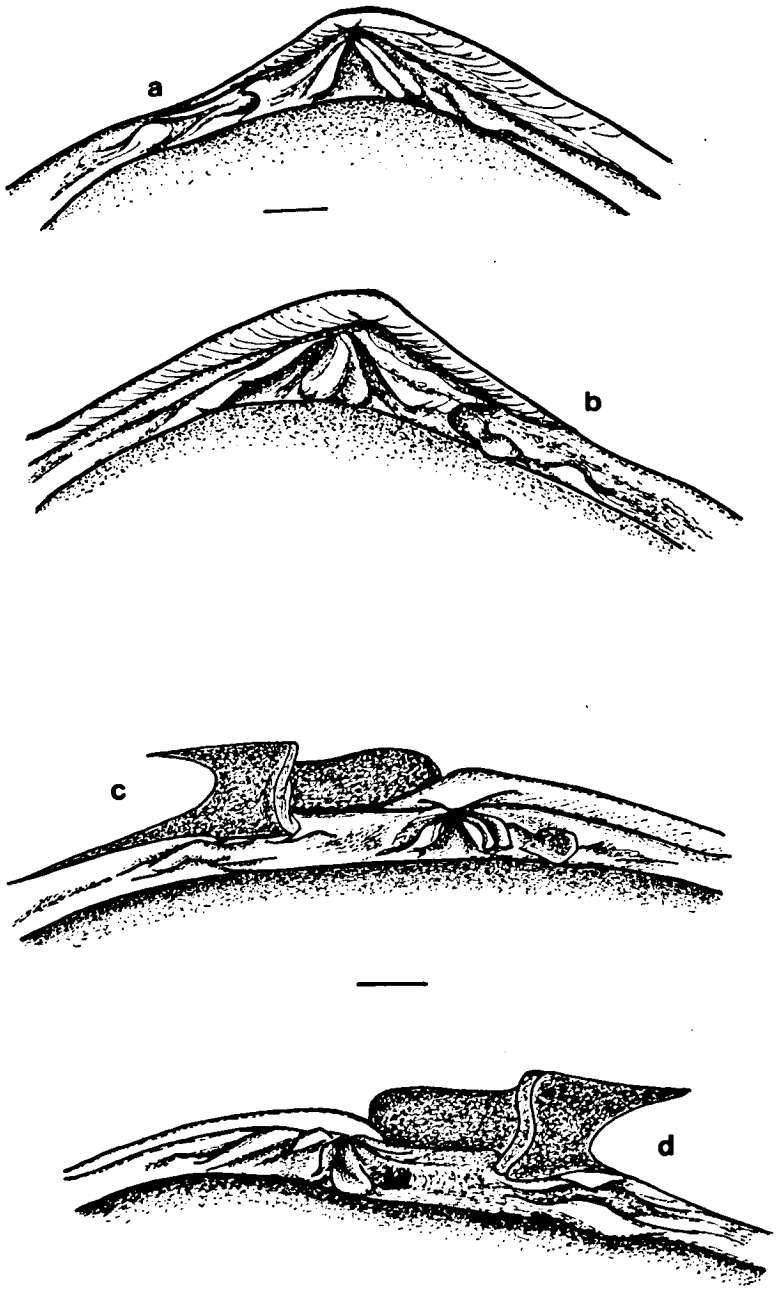

Fig. 3. Hinges of the shells of Donacidae. a, left valve of *Donax* (*Serrula*) *trunculus*; b, Right valve of do.; c, Left valve of *Capsella variegata*; d, Right valve of do. Scale bars 1 mm.

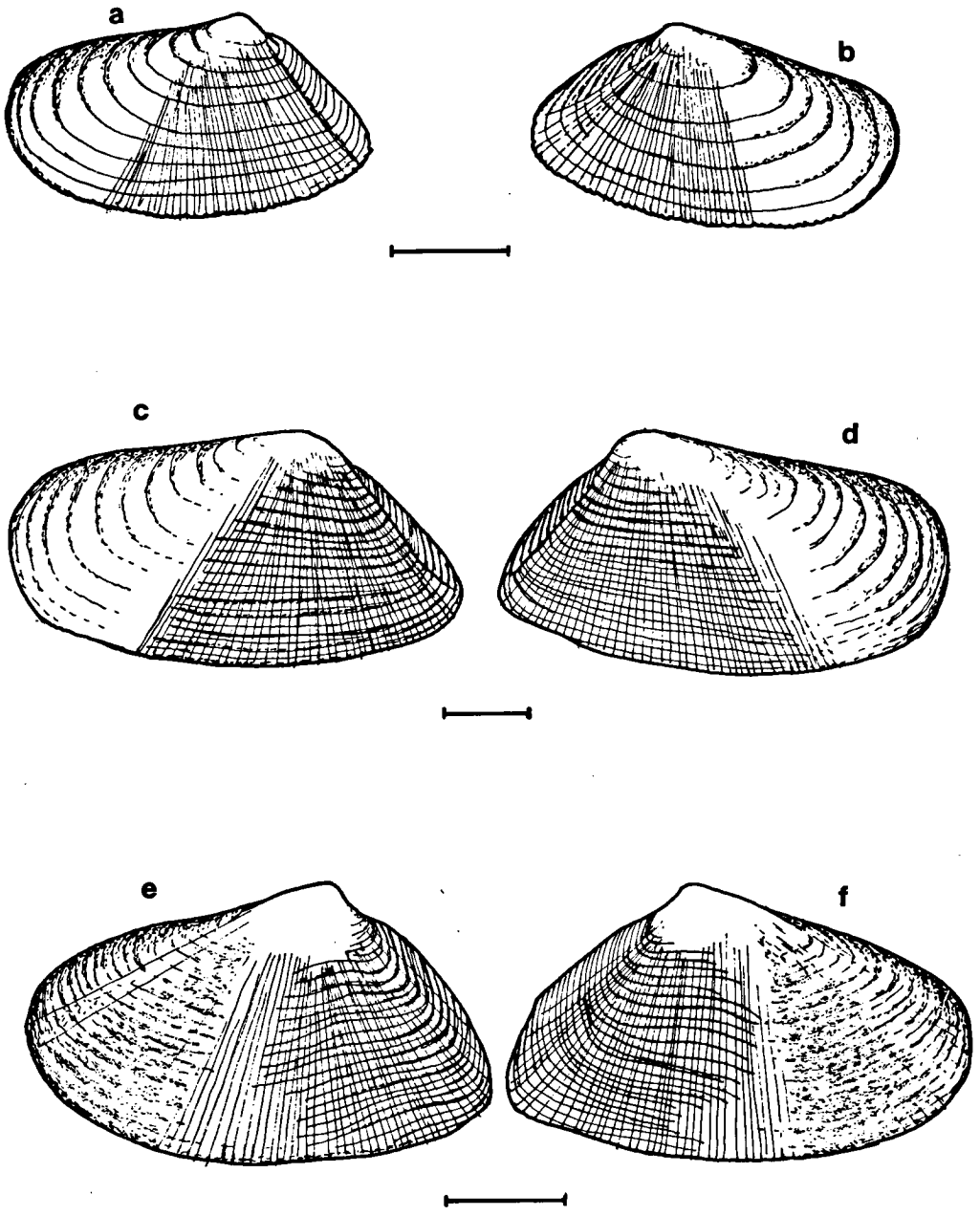

Fig. 4. External sculpture of the shells of Donacidae. a, Left valve of *Donax* (*Cuneus*) *venustus*; b, Right valve of do.; c, Left valve of *D.* (*C.*) *semistriatus*; d, Right valve of do.; e, Left valve of *D.* (*C.*) *vittatus*; f, Right valve of do. Scale bars 5 mm.

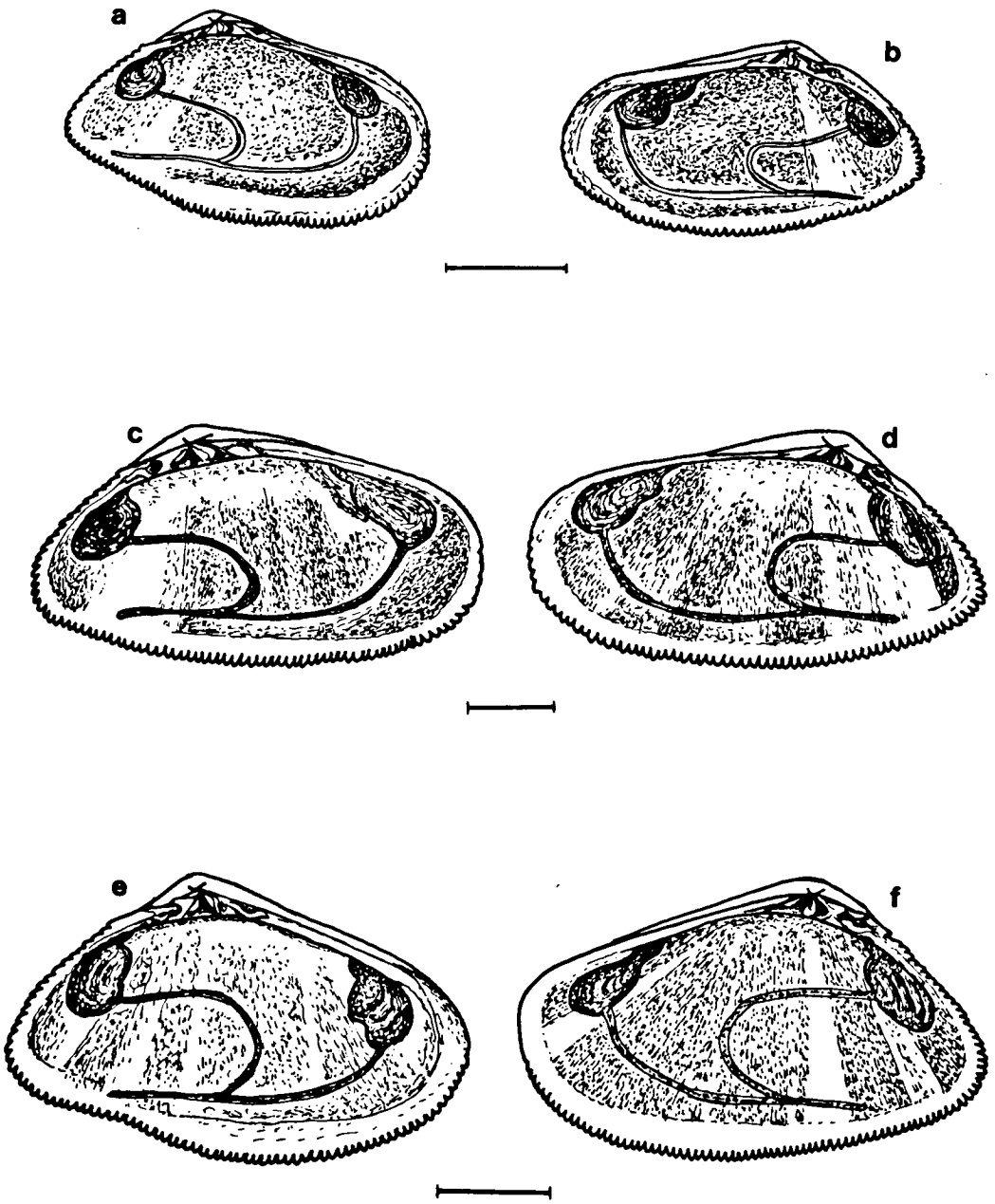

Fig. 5. Interior of the shells of Donacidae. a, Left valve of *Donax* (*Cuneus*) *venustus*; b, Right valve of do.; c, Left valve of *D.* (*C.*) *semistriatus*; d, Right valve of do.; e, Left valve of *D.* (*C.*) *vittatus*; f, Right valve of do. Scale bars 5 mm.

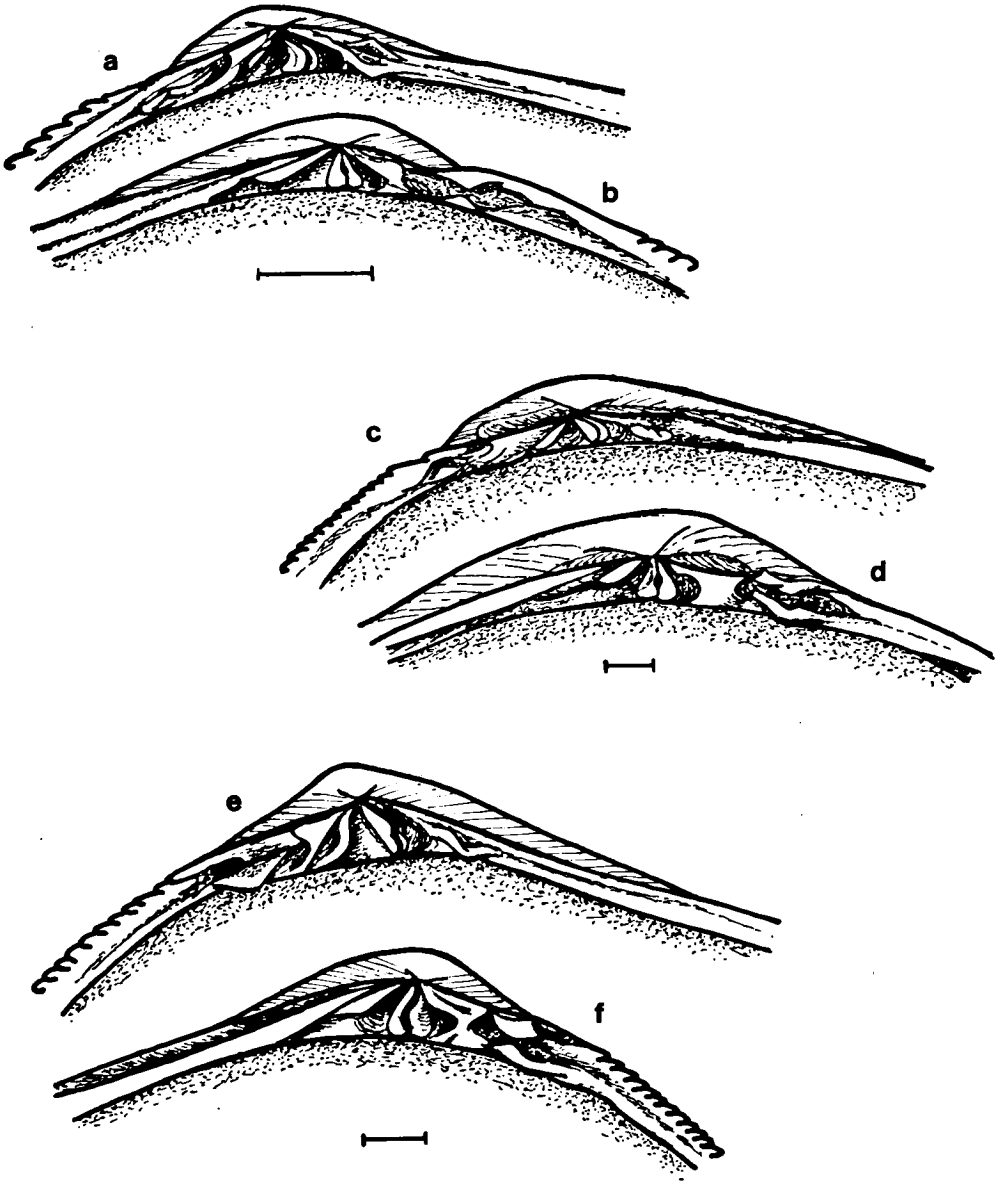

Fig. 6. Hinges of the shells of Donacidae. a, Left valve of *Donax* (*Cuneus*) *venustus*; b, Right valve of do.; c, Left valve of *D.* (*C.*) *semistriatus*; d, Right valve of do.; e, Left valve of *D.* (*C.*) *vittatus*; f, Right valve of do. Scale bars 1 mm.

and Parenzan (1976), it has not been recorded from the Mediterranean littoral of Spain by Hidalgo (1917) and Montero (1971). Neither did Picard (1965) and Amouroux (1974) find it on the French Mediterranean coast, nor Yaron (1978) in the waters of israel.

In the Bay of Málaga 11 living specimens and 3 valves only have been found during the present study. Some of these show sculpture and shell outline intermediate with *Donax semistriatus* Poli, 1791.

Donax (*Cuneus*) *semistriatus* Poli, 1791 (figs. 4-6)

Donax semistriatus Poli, 1791; Reeve, 1854; Römer, 1869; Monterosato, 1875; Bertin, 1881; Hidalgo, 1917; Nobre, 1936; Pasteur-Humbert, 1962; Lucas, 1967; Parenzan, 1976.
Donax denticulatus Montagu, 1803.
Donax anatinus Deshayes, 1833.
Donax (*Cuneus*) *semistriatus* Poli, 1791; Nordsieck, 1969; Yaron, 1978.
Donax (*Hecuba*) *semistriatus* Poli, 1791; Montero, 1971.
Donax (*Donax*) *semistriatus* Poli, 1791; Piani, 1980.

Shell solid, slightly inequivalve, left valve a little more convex than the right; inequilateral, beak small, opisthogyrate in the posterior half. Posterior truncation stronger than in *D. vittatus*; ventral margin convex. Lunule long and narrow, extending over approximately half of the anterior dorsal margin. Escutcheon wide and weak, posterior extending over nearly all the posterior dorsal margin. Strong sculpture present in the posterior 2/3 of the shell, with radial and concentric striae crossing the central slope. The anterior 1/3 of the shell is smooth.

Periostracum thin, greenish-brown or greenish-yellow. Shell normally brown, with two radial whitish-yellow or cream bands in the central zone. Some of the specimens are green. Interior of the shell purple, with the margins and one posterior band white.

Ligament short, with one nymph, fitting into a posterior depression.

Hinge heterodont: right valve with two cardinal teeth, of which the posterior is bifid and the anterior single; two posterior laterals, but no anterior lateral. Left valve with two cardinal teeth, of which the anterior is bifid and the posterior single; one lateral anterior and one lateral posterior tooth (figs. 6c, f).

Two unequal muscle scars, with larger and more elongate anterior scar. Pallial sinus deep and rounded, ventrally confluent with the pallial line. Ventral and posterior margins coarsely crenulate.

Size. — According to the literature, the species can reach a length of 33 mm (Pasteur-Humbert, 1962). Among the specimens from the Bay of Málaga the greatest length was 29.5 mm.

Habitat. — *D. semistriatus* is a shallow water species of sand beaches. Pasteur-Humbert (1962) has reported this species from down to 55 m depth.

Geographical distribution, — *D. semistriatus* is a predominantly Mediterranean species. It has been reported in the whole of the Mediterranean by many authors. Bertin (1881) has recorded its presence in the Atlantic Ocean without giving limits of distribution. The species has been reported from Portugal (Nobre, 1936) and the Atlantic littoral of Morocco (Pasteur-Humbert, 1962).

In the Bay of Malága 24 living and 2 dead specimens, with 104 valves, have been found.

Discussion. — The absence of radial sculpture in the posterior truncation excludes this species from the subgenus *Donax* s.s., and it is included in the subgenus *Cuneus*. There are many specimens in the material from the Bay of Málaga with shell morphotypes intermediate between *D. semistriatus* and *D. venustus* as regards the concentric sculpture and the outline of the shell.

Donax (*Cuneus*) *venustus* Poli, 1795 (figs. 4-6)

Donax venustus Poli, 1795; Reeve, 1854; Monterosato, 1875; Bertin, 1881; Hidalgo, 1917; Pasteur-Humbert, 1962; Lucas, 1967; Parenzan, 1976.
Donax trunculus Dillwyn, 1817.
Donax cattanianus Brusina, 1866.
Donax (*Cuneus*) *venustus* Poli, 1795; Nordsieck, 1969.
Donax (*Platydonax*) *venustus* Poli, 1795; Montero, 1971.
Donax (*Donax*) *venustus* Poli, 1795; Piani, 1980.

Shell solid, slightly inequivalve, left valve a little more convex than the right; inequilateral, beak small, opisthogyrate in the posterior half. Trigonal-elongate in outline, with strong posterior truncation. Ventral margin slightly convex. Lunule long and narrow, extending to 2/3 of the anterior dorsal margin. Escutcheon posterior, weak.

Weak concentric sculpture present on the whole of the shell, stronger in the posterior truncation; weak radial striae present in the posterior 2/3 of the shell.

Periostracum thin, light green or greenish-brown. Shell cream or greenish-yellow, with radial and concentric purple bands, one extending over practically all the anterior half. Interior of the shell purple, with the margins and one posterior radial band white. The interior of the shell in some of the specimens is white with the posterior margin purple and one yellow spot in the central zone, near to the beak.

Ligament external, short and provided with a nymph, placed in a posterior depression.

Hinge heterodont: right valve with two cardinal teeth, of which the posterior is bifid and the anterior single; two posterior laterals, but no anterior lateral. Left valve with two cardinal teeth, of which the anterior is bifid and the posterior single. One lateral anterior and one lateral posterior tooth (figs. 6a-b).

Two muscle scars of similar size and a more elongate anterior scar. Pallial sinus deep and rounded, ventrally confluent with the pallial line. Ventral and posterior margins crenulate.

Size. — *D. venustus* has the smallest shell of the European Donacidae. According to the various authors it can reach 30 mm (Pasteur-Humbert, 1962). Among the specimens of this species from the Bay of Málaga the greatest length was 29 mm.

Habitat. — This is a shallow water species, which lives, normally, in fine sand beaches.

Geographical distribution. — According to some authors, *D. venustus* shows a Mediterranean-Atlantic distribution (Bertin, 1881; Hidalgo, 1917; Lucas, 1967; Montero, 1971; Pasteur-Humbert, 1962); however, the species has not been reported from Portugal (Nobre, 1936), from the West African coast (Nicklès, 1953), nor from Galicia (Cadee, 1968). Shells from Huelva (South Atlantic coast of Spain, near to the Straights of Gibraltar) confirm the presence of this species in Atlantic waters. In the Bay of Málaga, *D. venustus* and *D. trunculus* are the commonest species of Donacidae. A

total of 204 living and 118 dead specimens, with 386 valves of *D. venustus* have been found.

Discussion. — The presence of strong concentric and radial sculpture in the posterior slope of the shell of many specimens has created identification problems, because the hinge, the ligament and the shape of the pallial sinus are very similar in *D. semistriatus* and *D. venustus* (figs. 4-6). This fact has been previously noted by Picard (1965) in the study of the Donacidae of Marseilles (France).

Genus *Capsella* Gray, 1851

According to Keen (1969) *Capsella* is a subgenus of the genus *Donax*, with the following diagnosis: "Elongate-ovate, polished, without radial sculpture, internal margin smooth. Recent". If we look at the diagnosis of the genus *Donax* (Keen, 1969), previously referred to ("Radial sculpture present in most, at least as marginal crenulations, periostracum wanting") and we compare it with the diagnosis of *Capsella*, it is clear that *Capsella* must be excluded from the genus *Donax*. Moreover, the hinge, the ligament and the outline of the shell are very different, so that *Capsella* must be considered as a genus separate from *Donax*; this is in agreement with the opinion of some authors (Nordsieck, 1969; Parenzan, 1976).

Capsella variegata (Gmelin, 1791) (figs. 2-3)

Tellina variegata Gmelin, 1791.
Tellina polita Poli, 1795.
Donax complanata Montagu, 1803.
Donax longus Bronn, 1836.
Donax politus (Poli, 1795); Reeve, 1854; Sowerby, 1866; Hidalgo, 1917.
Donax variegatus (Gmelin, 1791); Deshayes, 1848; Dautzenberg, 1913; Nobre, 1936; Pasteur-Humbert, 1962; Tebble, 1966.
Donax variegatus Lamarck, 1790; Lucas, 1967.
Donax (*Capsella*) *vinaceus* Römer, 1869.
Donax (*Capsella*) *politus* (Poli, 1795); Montero, 1971.
Donax (*Capsella*) *variegatus* (Gmelin, 1791); Keen, 1969; Yaron, 1978; Piani, 1980.
Capsella variegata (Gmelin, 1791); Nordsieck, 1969; Parenzan, 1976.

Shell solid, equivalve, inequilateral, beak small in the posterior half, opisthohyrate. Elongate-ovate in outline, with a small anterior and posterior gape. Lunule narrow and weak anterior, extending to the anterior half dorsal margin. Escutcheon weak, posterior. External surface polished, with a few fine and inconspicuous concentric lines, without radial sculpture.

Periostracum very thin, greenish-yellow. Shell light brown or greenish-brown, with one white radial purple band from the beak to the ventral margin. In some of the shells weak concentric purple bands can appear. Interior of the shell purple, with the margins and one posterior spot white.

Ligament external and small, partly on a nymph and partly, behind this, in a little cavity.

Hinge heterodont: right valve with two cardinal teeth, of which the posterior is bifid and the anterior single; two posterior laterals and one anterior lateral. Left valve with two cardinal teeth, of which the anterior is bifid and the posterior single; one lateral anterior and one lateral posterior tooth (figs. 3c-d).

Two unequal muscle scars, with larger and more elongate anterior scar. Pallial sinus deep, elliptical-rounded in outline, ventrally confluent with the pallial line. Margins of the shell smooth.

Size. — According to the literature, the greatest size of *Capsella variegata* ranges between 30 mm (Yaron, 1978) and 38.1 mm (Tebble, 1966). The only specimen found in the Bay of Málaga during this research is 31 mm long.

Habitat. — *C. variegata* is a shallow water species. It is found from low tide-mark (Tebble, 1966) to 12 m depth (Pasteur-Humbert, 1961). However, in the littoral of Málaga there are many specimens; in the Bay of Málaga one specimen only has been sampled at a depth of 18 m on sand bottom.

Geographical distribution. — This species is distributed in the Mediterranean east to Israel (Yaron, 1978); in the Atlantic, it has been reported from the British Isles (Tebble, 1966) to Tangier (Morocco) (Pasteur-Humbert, 1962).

RELATIVE GROWTH OF THE SHELL

A biometrical study has been carried out with all the shells of Donacidae from the Bay of Málaga. The length and the height of the shell (fig. 7) have been the parameters measured.

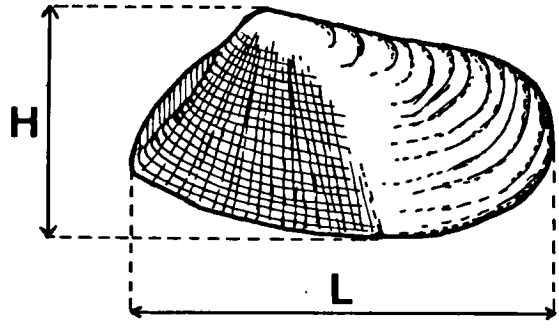

Fig. 7. Shell parameters measured for biometrical studies, L = length, H = height.

Details of the relative shell growth for each species, throughout the time of this research were obtained by fitting linear regressions to measurements of the shell length and height. The growth of the shell for all the species is, in general, nearly isometric for sizes of more than 10 mm length (fig. 8).

To find out whether the linear regressions fitted are significantly different, a regression covariance analysis has been carried out. The values of the F-distribution obtained (table 1) have been compared with the critical values of the F-distribution furnished by table S (Rohlf & Sokal, 1969). Only the linear regression of *Donax trunculus* and *D. vittatus* are not significantly different (table 1).

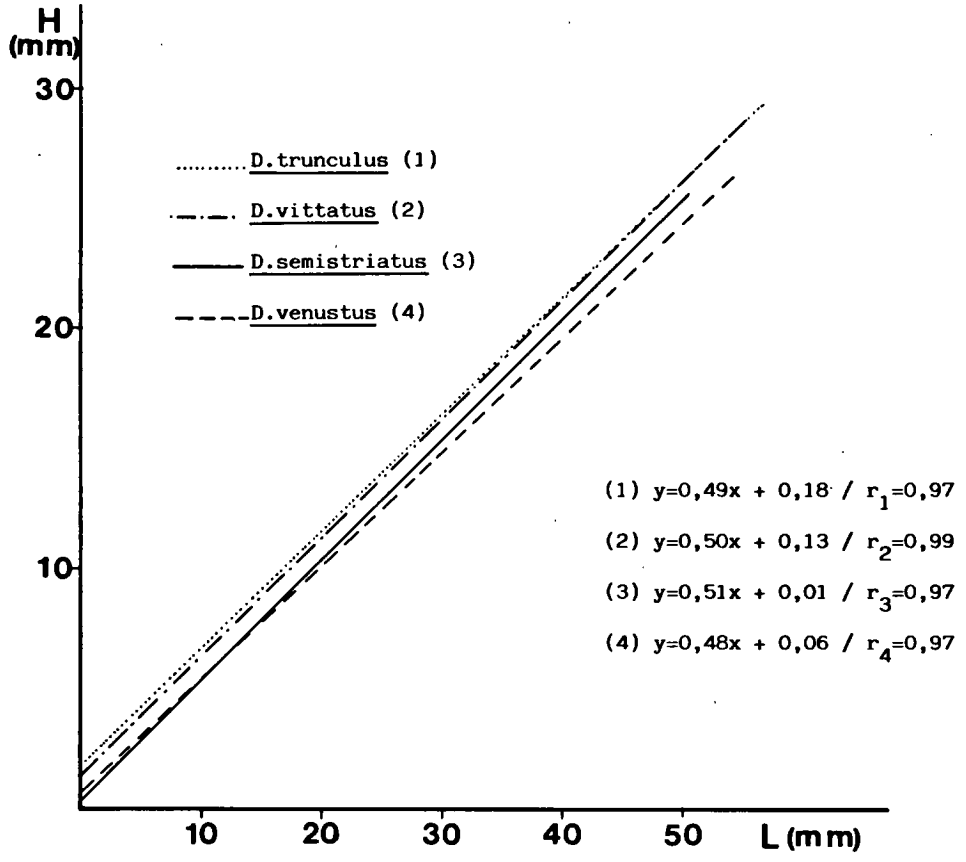

Fig. 8. Regression lines for length (L) and height (H) of the shells of the Donacidae of the Bay of Málaga Spain. *Capsella variegata* has not been included.

DISCUSSION

Within the five European species of Donacidae, *Donax vittatus*, *D. semistriatus* and *D. venustus* are the species with the closest relationship. They have very similar shell morphology, in particular as regards the characters with taxonomical significance, such as hinge, ligament, muscle scars, pallial sinus, etc. In fact, the external sculpture of the shell is the principal feature used for determination, and this varies in different environments. For example, shells of *D. vittatus* from Scotland show very weak sculpture, in contrast with the stronger sculpture of the Mediterranean shells.

This problem of the variability of the sculpture is greater when we look at the shells of *D. venustus* and *D. semistriatus*, because many specimens with intermediate shell sculpture are found in the littoral of Málaga. This occurs more frequently in medium-sized specimens; normally the small shells show the typical sculpture of *D. venustus* and the larger specimens show the typical sculpture of *D. semistriatus*. Between these sizes,

Species		Degree of freedom	SS	MS	F
D. trunculus	v_1	1	2.729	2.729	865.291
D. venustus	v_2	913	2.880	0.003	
D. trunculus	v_1	1	0.396	0.396	83.939
D. semistriatus	v_2	417	1.969	0.005	
D. trunculus	v_1	1	0.003	0.003	0.523
D. vittatus	v_2	376	1.889	0.005	
D. venustus	v_1	1	0.037	0.037	19.853
D. semistriatus	v_2	612	1.127	0.002	
D. venustus	v_1	1	0.217	0.217	118.202
D. vittatus	v_2	571	1.046	0.002	
D. semistriatus	v_1	1	0.091	0.091	50.484
D. vittatus	v_2	75	0.136	0.002	

Table 1. Values of the regression covariance analysis (F-distribution) between the species of Donacidae of the Bay of Málaga.

many shells show a concentric sculpture in the ventral part of the posterior slope (sometimes near the middle of the slope) and the dorsal part of the slope with very weak radial striae like in *D. venustus*.

This fact is not new; both Picard (1965) and Massé (1972), studying the molluscs of the Mediterranean littoral of France, have reported this phenomenon.

The presence of these intermediate shell morphotypes questions the taxonomical "status". The situation of *Cerastoderma edule* (L., 1758) and *C. glaucum* (Poiret, 1789) and between *C. edule* and *C. lamarcki* (Reeve, 1844) is similar. Many studies were necessary (Boyden, 1971; Brock, 1978, 1979, 1980, 1982) to clarify the taxonomical questions and they show that these are really three different species. Similarly, more studies are necessary to clarify the present problem of *D. semistriatus* and *D. venustus*. However, in this case, we draw attention to the fact that both species have very similar ecological requerements (Salas, 1984), and that a study of the alimentary canal in the two species shows a similar disposition and structure (Salas & Hergueta, in press). Also, in both a similar trematode parasite has been found (unpublished data).

The present taxonomical problem has not yet been resolved. More studies in relation with the sexual cycle and biochemistry (by electrophoretical analysis) are necessary to clarify whether *D. semistriatus* and *D. venustus* are two species or two different morphotypes of only one species.

Another interesting fact is the presence of *D. vittatus*, a typically Atlantic species in Mediterranean waters, with a habitat similar to that of *D. semistriatus* and *D. venustus*. Then, perhaps a competition between *D. vittatus* and the other two Mediterranean species has been established, particularly between *D. vittatus* and *D. semistriatus*, both species of similar size and ecological requirements.

According to Ansell et al. (1980), *D. semistriatus* (from the littoral of France) is tolerant of higher temperatures than *D. vittatus* (from Scotland). Considering these facts, it would be interesting to examine the physiological requirements of these species in the Mediterranean littoral of Málaga, where they live together.

KEY TO THE EUROPEAN SPECIES OF DONACIDAE

This key may be used for the typical shell morphotypes only. It has been based on specimens found in the Bay of Málaga.

1a — Internal margins of the shell smooth. Right valve with two posterior lateral teeth and one anterior lateral tooth ..... *Capsella variegata* (Gmelin, 1791)
1b — Internal margins of the shell crenulate 2
2a — Posterior dorsal margin of the shell smooth. Without external sculpture. Right valve with one anterior lateral and one posterior lateral tooth..... ..... *Donax* (*Serrula*) *trunculus* Linné, 1758
2b — Ventral and posterior margins crenulate. With sculpture in the posterior half of the shell. Right valve with two posterior laterals, without anterior lateral..... 3
3a — Strong concentric striae in the posterior truncation. Weak radial sculpture in the posterior half of the shell ..... *Donax* (*Cuneus*) *venustus* Poli, 1795
3b — Concentric and radial sculpture present in the posterior 2/3 of the shell. Strong posterior truncation ..... *Donax* (*Cuneus*) *semistriatus* Poli, 1791
3c — Radial ribs in the posterior half of the shell, with some oblique striae crossing the central slope, that do not reach as far as 2/3 of the shell. Weak posterior truncation ..... *Donax* (*Cuneus*) *vittatus* (Da Costa, 1778)

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REFERENCES

AMOUROUX, J.M., 1974. Étude des peuplements infralittoraux de la côte du Roussillon. II. Faunistique et caractéristiques bionomiques. — Vie Milieu (B) 24: 209-222.

ANSELL, A.D., 1972. Distribution, rate of growth and seasonal biochemical cycle of the bivalve Donax vittatus from Kames Bay, Millport. — J. exp. mar. Biol. Ecol. 10: 137-150.

——, P.R.O. BARNETT, A. BODOY & H. MASSÉ, 1980. Upper temperature tolerances of some European molluscs. 2. Donax vittatus, D. semistriatus and D. trunculus. — Mar. Biol. Berlin 58: 41-46.

——, & A. BODOY, 1979. Comparison of events in the seasonal cycle for Donax vittatus and D. trunculus in European waters. — Europ. mar. Biol. Symp. 13: 191-198.

——, & F. LAGARDÈRE, 1980. Observations on the biology of Donax trunculus and D. vittatus at Ile d'Oléron (French Atlantic coast). — Mar. Biol. Berlin 57: 287-300.

BERTIN, V., 1881. Revision des Donacidées du Muséum d'Histoire Naturelle. — Nouv. Arch. Mus. Natn. Hist. Nat. (2) 4: 57-121.

BODOY, A., 1982. Croissance saisonnière du bivalve Donax trunculus (L.) en Mediterranée nord-occidental (France). — Malacologia 22: 353-358.

——, & H. MASSÉ, 1979. Quelques paramètres permettant de suivre la production organique d'un mollusque bivalve au cours d'un cycle saisonnière. Actes du Colloque du C.N.E.X.O. 7: 753-766.

BOYDEN, C.R., 1971. A comparative study of the reproductive cycles of the cockles Cerastoderma edule and C. glaucum. — J. Mar. Biol. Ass. U.K. 51: 605-622.

BROCK, V., 1978. Morphological and biochemical criteria for the separation of Cardium glaucum (Bruguière) from Cardium edule (L.). — Ophelia 17: 207-214.

——, 1979. Habitat selection of two congeneric bivalves, Cardium edule and C. glaucum in sympatric and allopatric populations. — Mar. Biol. Berlin 54: 149-156.

——, 1980. Evidence for niche differences in sympatric populations of Cerastoderma edule and C. lamarcki. — Marine Ecol. Progr. Ser. 2: 75-80.

——, 1982. Does displacement of spawning time occur in the sibling species Cerastoderma edule and C. lamarcki? — Mar. Biol. Berlin 67: 33-38.

CADEE, G.C., 1968. Molluscan biocoenoses and thanatocoenoses in the Ria de Arosa, Galicia, Spain. — Zool. Verh. Leiden 95: 1-121.

DAUTZENBERG, Ph., 1913. Atlas de poche des coquilles des côtes de France (Manche, océan, Méditerranée) communes, pittoresques ou comestibles (ed. 2). — Bibliothèque de poche du naturaliste 6: i-vii, 1-153. Paris.

DEGIOVANNI, C., & M. MOUËZA, 1972. Contribution à l'étude de la biologie de Donax trunculus (Mollusque, Lamellibranche) dans l'Algérois. Ecologie en Baie Bou-Ismail. — Téthys 4: 729-743.

DESHAYES, G.P., 1845-1848. Exploration scientifique de l'Algérie. Zoologie 1. Histoire naturelle des mollusques: i-xx, 1-609. Paris.

GUILLOU, J., 1982. Variabilité des populations de Donax trunculus et Donax vittatus en Baie de Douarnenez. — Neth. J. Sea. Res. 16: 88-95.

——, & Y. LE MOAL, 1980. Aspects de la dynamique des populations de Donax trunculus et Donax vittatus en Baie de Douarnenez. — Annls Inst. océanogr., Monaco (Nouv. Ser.) 56: 55-64.

HIDALGO, J.M., 1917. Fauna malacológica de España, Portugal y las Baleares. Moluscos testáceos marinos. — Trab. Mus. nac. Cienc. nat. Madr. (Ser. Zool.) 30: 1-752.

KEEN, M., 1969. Family Donacidae Fleming, 1828. In: R.C. MOORE (ed.), Treatise on invertebrate paleontology. Mollusca N 2 (of 3): 628-629. Lawrence, Kansas.

LUCAS, M., 1967. Révision des Donacidae des côtes européennes. — Naturalistes belg. 48: 271-281.

MASSÉ, H., 1972. Contribution à l'étude de la macrofaune des peuplements des sables fins infra-littoraux des côtes de Provence. VI. Données sur la biologie des espèces. — Téthys 4: 63-83.

MONTERO, I., 1971. Moluscos bivalvos españoles. — Anales Univ. Hispalense (Veterinaria) 5: 1-358.

MONTEROSATO, T., 1875. Nuova rivista delle conchiglie Mediterranee (Catalogo delle conchiglie Mediterranee). — Atti Accad. Sci. Lett., Palermo (2a) 5: 1-50.

MOUËZA, M., & E. CHESSEL, 1972. Contribution à l'étude de la biologie de Donax trunculus L. (Mollusque, Lamellibranche) dans l'Algerois: analyse statistique de la dispersion de long d'une plage en Baie de Bou-Ismail. — J. exp. mar. Biol. Ecol. 21: 211-221.

——, & L. FRENKIEL-RENAULT, 1973. Contribution à l'étude de la biologie de Donax trunculus L. (Mollusque, Lamellibranche) dans l'Algerois: la reproduction. — Cah. Biol. mar. 14: 261-283.

NICKLÈS, M., 1953. Scaphopodes et lamellibranches récoltés dans l'Ouest Africain. — Atlantide Rep. 3: 93-230.

NOBRE, A., 1936. Moluscos marinhos de Portugal 2: i-vii, 1-378. Barcelos.

NORDSIECK, F., 1969. Die europäischen Meeresmuscheln (Bivalvia) Vom Eismeer bis Kapverden, Mittelmeer und Schwarzes Meer: 1-256. Stuttgart.

PARENZAN, P., 1976. Carta d'identità delle conchiglie del Mediterraneo. 2. Bivalvi, seconda parte: 283-546. Taranto.

PASTEUR-HUMBERT, Ch., 1962. Les mollusques marins testacés du Maroc II. Les lamellibranches et les scaphopodes. — Trav. Inst. scient. chérif. (Sér. Zool.) 28: 1-188.

PIANI, P., 1980. Catalogo dei molluschi conchiferi viventi nel Mediterraneo. — Boll. malac. 16: 113-224.

PICARD, J., 1965. Recherches qualitatives sur les biocoenoses marines des substrats meubles dragables de la région marseillaise. — Recl Trav. Stn mar. Endoume 52 (36): 1-160.

REEVE, L.A., 1854-1855. Monograph of the genus Donax. — Conchologia Iconica 8: pls. 1-8 [1854], 9 [1855]. London.

ROHLF, F., & R.R. SOKAL, 1969. Statistical tables: 1-253. New York.

RÖMER, E., 1869. Monographie der Molluskengattung Dosinia, Scopoli, (Artemis, Poli). Novitates conchologicae II: Meeres-Conchylien. Suppl. 1: i-vii, 1-87. Cassel.

SALAS, C., 1984. Contribución al conocimiento de los moluscos macrobentónicos infralitorales (en especial Bivalvos) de la Bahía de Málaga. Tesis Doctoral, Universidad de Málaga: 1-541 (unpublished).

——, & E. HERGUETA, in press. The functional morphology of the alimentary canal in Donax venustus Poli and Donax semistriatus Poli, and their taxonomic positions. — Proc. 9th Intern. Malac. Congr., Edinburgh, 1986.

SOWERBY, G.B., 1866. Monograph of the genus Donax, Linnaeus. — Thesaurus conchyliorum 3: 305-317. London.

TEBBLE, N., 1966. British bivalve seashells. A handbook for identification: 1-212. London.

TURTON, W., 1822. Conchylia insularum Britannicarum: i-xlviii, 1-280. Exeter.

YARON, I., 1978. The family Donacidae in the Mediterranean waters of Israel. — Levantina 13: 139-141.