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# A REVIEW OF BIVALVE SPECIES IN THE EASTERN ADRIATIC SEA 1.PROTOBRANCHIA (SOLEMYIDAE, NUCULIDAE, NUCULANIDAE)

## PREGLED VRSTA ŠKOLJKAŠA U ISTOČNOM JADRANU I. PROTOBRANCHIA (SOLEMYIDAE, NUCULIDAE, NUCULANIDAE)

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The present knowledge of eight species of Protobranchia (Solemyidae, Nuculidae and Nuculanidae) are reviewed with regard to their synonyms, shell sizes, habitat characters, collection depths, abundances and additional interesting data. Literature quotations, bivalve collections and recently collected specimens were used in this study.

## INTRODUCTION

The considerable synonyms in scientific names of most bivalve species inhabiting the Adriatic Sea, cited in numerous old and recent papers, makes it difficult to answer an often posed question: how many bivalve species have been noted in the Adriatic Sea? In order to answer this question it is necessary to re-examine all existing data in literature and collections. A complete revision of bivalve taxa is an enormous work. As the first step we have chosen to make a revised check-list of the eastern Adriatic primitive bivalve species in the subclass Protobranchia recorded in the literature, bivalve collections and from our collected material. The basis for a classification and nomenclature are the works of Nordsieck (1969) and Allen & Hannah (1986).In the Adriatic Sea, the subclass Protobranchia includes three families (Solemyidae, Nuculidae and Nuculanidae) with eight species.

In the present paper for each species a valid name, synonyms used in the Adriatic sources, shell sizes, habitat characters, collection depth, eastern Adriatic Sea distribution, abundance, and additional interesting data concerning the morphology, biology, ecology and the other records of the species treated are given. The synonyms, as well as the authors using them, are listed chronologically.

## MATERIAL AND METHODS

The material used for this study were old and recent publications with the quotations of the presence of bivalve species along the eastern Adriatic Sea; several bivalve collections such as S. Brusina in Zagreb, don B. Cvitanović in Zadar and collections in Rijeka and Rovinj; and bottom materials collected by skin and scuba divers, "mušular" dredge, bottom trawl net, Van Veen and Petersen grabs.

## RESULTS AND DISCUSSION

subclass: P R O T O B R A N C H I A Pelseneer, 1889

order: S o l e m y o i d a Dall 1889
family: S o l e m y i d a e Gray 1840
genus: *S o l e m y a* Lamarck 1818

*Solemya togata* (Poli, 1795) (Fig. 1)

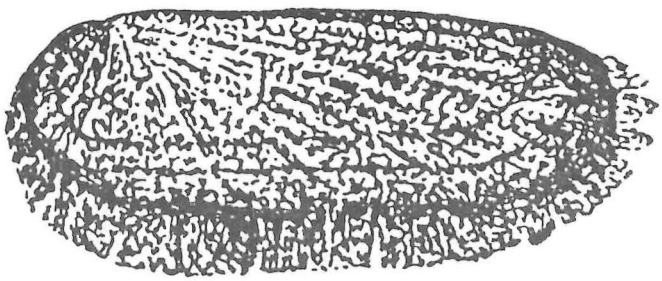

Fig. 1. *Solemya togata* (Poli)

Quotations for the area:

*Solenomya mediterranea*: Heller 1864.

*Solemya mediterranea*: Brusina 1866, Stossich A. 1865, 1866, Stossich M. 1880

*Solenomya togata*: Weinkauff 1867, Carus 1889-1893, Brusina 1907, Vatova 1935, 1943, 1949, Ilijanić and Stošić 1972.

*Solemya togata*: Legac, 1974, 1987, Legac and Hrs-Brenko 1982.

Sizes: 40.6/11.7/- mm.

Habitat: a shallow water species living in depressions in sandy and muddy bottoms filled with decaying sea-weeds, in cracks between rocks covered by algae, and in *Posidonia* beds.

Collection depth: 1-40 m (V a t o v a 1949: 10-50 m).

Distribution: offshore in the northern Adriatic, Rovinj, Unije, Zeča, Cres, Rijeka, Rab (Lopar), Privlaka, Zadar, Šibenik, Vis, Viški kanal (Pakleni otoci), Pakleni kanal, Hvar, Lastovo (Fig. 2).

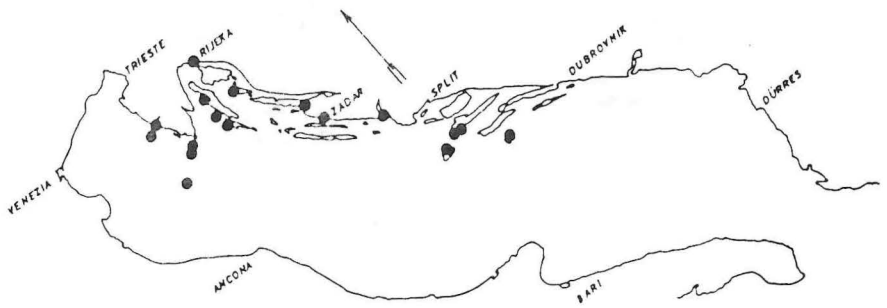


Fig. 2. Distribution of *Solemya togata* in the eastern Adriatic Sea

Abundance: a rare species in the Adriatic Sea.

Morphology: elongated, cylindrical, and fragile shells covered by characteristic periostracum which is thin, strong, and greatly overlaps the shell margin forming the fringes. The shells are smooth, shiny dark brown, with lighter rays.

Ecology: the animal lives in an elongated "Y" shaped burrow near the bottom surface. After strong summer thunderstorms, several specimens laying on the surface of sandy bottom in the shallow water of Lopar Bay (Rab Island) were observed (L e g a c , 1987).

Notice: L u c a s (1981) noted that some authors use the name *Solenomya* which is more correct, since it is derived from the Greek words "solen" (pipe) and "mya" (muscle), but the name *Solemya* is usual. The species name *togata* is probably deriving

from the appearance of the periostracum as a toga.

order: N u c u l o i d a Dall, 1889
family: N u c u l i d a e Gray, 1824
genus: *N u c u l o m a* Cossman, 1907

*Nuculoma aegeensis* (Forbes 1843) (Fig. 3a)

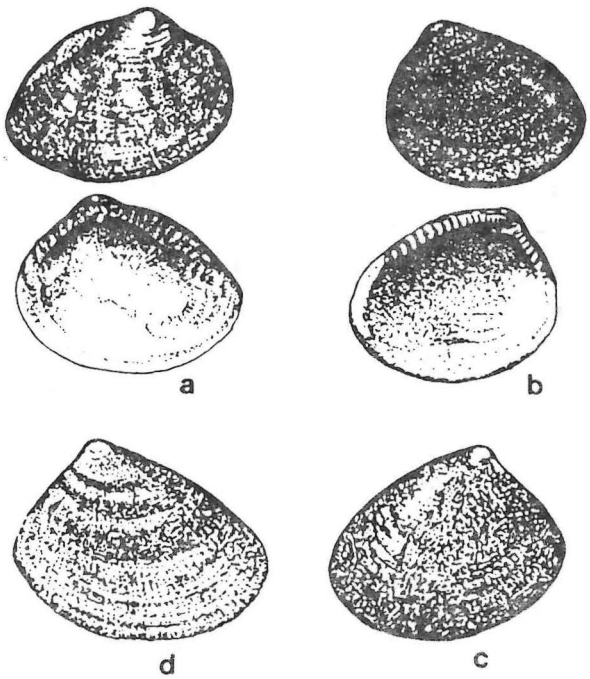


Fig. 3. a) *Nuculoma aegeensis* (Forbes) - internal and external view of the shells; b) *Nucula nucleus* (Linnaeaus) - internal and external view of the shells; c) *Nucula nitida* Bronn; d) *Nucula nitida* Sowerby

Quotation for the area:

*Nucula aegeensis*: Carus 1889-1893.

Sizes: 6.4/3.8/-mm.

Habitat: clay-silty and sandy bottoms with organic detritus.

Collection depth: 76-190 m.

Distribution: Velebitski kanal, Kvarnerić (C a r o z z a , unpublished), and Jabuka Pit.

Abundance: only few single shells.

Morphology: *Nuculoma* has triangular shells with a ventral margin without crenulation distinguishing it from other *Nucula* species.

Notice: concerning its distribution, C a r u s (1889-1893) cited at page 94: "Adria (J e f f r e y s , sed ex opin. Brusinae in Adriatico adhuc non reperta species)". According to C o e n (1933, 1937) M o n t e r o s a t o (1878) had noted this species for the Adriatic Sea, but Coen did not find the specimens in reviewed Adriatic bivalve collections: Coen, Danilo - Sandri, Chiamenti, and in the Museum of Venice (I.V., Stalio, Spinelli, A.P. Ninni), Zadar and Trieste. Distribution localities noted above are indicated by our findings.

genus: *N u c u l a* Lamarck, 1799

*Nucula nucleus* (Linnaeus 1767) (Fig. 3b)

Quotatioins for the area:

*Nucula margaritacea*: Lorenz 1863, Stossich A. 1865, 1866, Faber 1883.

*Nucula nucleus*: Brusina 1866, Stossich, M. 1880, Carus 1889-1893, Odhner 1914, Vatova 1928, 1931, 1934, 1935, 1942, 1943, 1949, Coen 1933, 1937, Gamulin-Brida 1962, Stjepčević 1967, Gamulin-Brida *et al.*, 1968, Šimunović 1969, Radić 1970, 1982, Zavodnik 1971, Ilijanić and Stošić, 1972, Marcuzzi 1972, Legac 1974, 1987, Crvenka 1980, Zavodnik *et al.*, 1981, 1985, Legac and Hrs-Brenko 1982, Stjepčević *et al.*, 1982, Zavodnik and Zavodnik 1986, Zavodnik and Vidaković 1987, Legac and Legac, 1989, Hrs-Brenko and Legac (1990), Legac (1990).

Sizes: 11.7/9.3/5.6 mm.

Habitat: various kinds of sediments such as sandy, muddy, detritic, muddy gravel and coarse detritus sometimes inhabited by phanerogams.

Collection depth: 5-90 m (V a t o v a , 1949: 0-280 m).

Distribution: offshore in the northern and middle Adriatic Sea, Piran, Vrsar, Limski kanal, Rovinj, Pula, Zaljev Raša, Kvarner, Riječki zaljev, Unije, Unijski kanal, Lošinj (Mali Lošinj), Lošinjski kanal, Cres, Tihi kanal, Krk (Soline, Omišalj, west coast), Velebitski kanal, Kvarnerić, Rab (Velo kolo), Pohlibski kanal, Virsko more, Privlaka,

Zadar, Zadarski, Pašmanski, Srednji and Iški kanal, Dugi otok (Veli rat), Murtersko more, Pirovački zaljev, Primošten, Jabučka kotlina, Vis, Viški kanal (Pakleni otoci), Šolta (Maslinica), Splitski (Stomorska) and Brački kanal (Vrulja), Makarska, Brač, Hvarski kanal (Kabal, Sumartin), Hvar, Korčulanski kanal (Šćedro),Korčula, Lastovo, Neretvanski kanal (Lovište), Neretva (Ploče), Malo more, Dubrovnik, Bokokotorski zaliv (Fig. 4a).


Fig. 4a. Distribution of *Nuculana nucleus* (Linnaeaus) in the eastern Adriatic Sea

Abundance: a common offshore species in the eastern Adriatic Sea, island zones and closed bays.

Morphology: a species with triangular shells crenulated along the ventral margin.

Biology: the development is lecitotrophic; the eggs are about 0.1 mm in diameter; larval life is short (W e e b 1987). In the northern Adriatic, the spawning season lasts from March to May (O d h n e r 1914, V a t o v a 1928). Our specimens less than 3 mm in length were found in July and August.

Ecology: nut shells are obligate deposit feeders. The animal penetrates into very shallow soft substrata and only a thin layer of sediment covers the anterior part of the animal where the current enters into the mantle cavity. The gills are used for respiration and elongated palps for groping, collecting and transporting the edible particles from the bottom surface to the mouth (Y o n g e and T h o m p s o n, 1976). Live specimens were found in amphoras filled by mud at Rab island (Velo Kolo) (L e g a c and L e g a c 1989). Findings of nut shells in the gastral cavity of small *Astropecten* sp. (B o g i *et al.* 1982a) indicate their importance in food chains of bottom communities.

*Nucula sulcata* Bronn, 1831 (Fig. 3c)

Quotation for area:

*Nucula sulcata*: Lorenz 1863, Grube 1864, Heller 1864, Brusina 1866, 1872, Weinkauff 1867, Stossich M. 1880, Wimmer 1883, Carus 1889-1893, Vatova 1932, 1935, 1940, 1942, 1942, 1949, Coen 1933, 1937, Coen & Vatova 1932-1934, Gamulin-Brida 1964, 1965, 1967, Gamulin-Brida *et al.* 1968, Šimunović 1969, Ilijanić and Stošić 1972, Marcuzzi 1972, Legac 1974, 1987, Zavodnik 1979, Legac and Hrs-Brenko 1982, Stjepčević *et al.* 1982, Zavodnik *et al.* 1985, Zavodnik and Zavodnik, 1986, Legac and Legac 1989.

Sizes: 19.9/16.9/10.4 mm.

Habitat: lives exclusively in clayey and silty sediments (mud, muddy sand) in deeper zones of the Adriatic Sea.

Collection depth: 25-100 m (V a t o v a , 1949: 40-280 m).

Distribution: offshore in the northern Adriatic Sea, Limski kanal, Rovinj, Pula, Kvarner, Zaljev Raša, Rabac, Riječki zaljev, Opatija, Unijski kanal, Lošinj, Cres, Vinodolski (Novi Vinodolski) and Velebitski kanal (Jablanac, Lukovo Šugarje), Kvarnerić, Rab (Velo kolo), Virsko more, Privlaka, Zadar, Zadarski and Srednji kanal, Dugi otok (Sali), Murtersko more, Pirovački zaljev, Jabučka kotlina, Vis, Splitski (Stomorska) and Brački kanal (Omiš, Vrulja), Brač, Hvarski kanal (Sumartin), Hvar, Korčula, Lastovo, Neretva (Ploče), Malo more, Dubrovnik, Bokokotorski zaliv (Fig. 4b).


Fig. 4b. Distribution of: *Nucula sulcata* Bronn in the eastern Adriatic Sea

Abundance: more frequent on the eastern than on the western Adriatic coast, especially in the northern and middle deep insular zones and also common in Boka

Kotorska Bay.

Morphology: the largest species among nut shells. Only in this species the lunula has transverse corrugations on the triangular matt shells.

Ecology: the specimens were found in amphoras (L e g a c and L e g a c, 1989) and in the gastral cavity of *Astropecten aurantiacus* (B o g i *et al.*, 1982a).

Notice: due to findings more than 0.5 specimens per square metre this species is considered a characteristic one in the zoocoenosis *Nucula profunda* (V a t o v a 1940, 1949). Later investigations (G a m u l i n - B r i d a 1964, 1965, 1967; Z a v o d n i k 1979) proved that this species is also characteristic in the biocoenoses of *Nephrops norvegicus - Thenea muricata (Nucula profunda)"* in muddy bottoms offshore and in the insular zones of the northern and central Adriatic Sea.

*Nucula nitida* Sowerby 1833 (Fig. 3d)

Quotations for the area:

*Nucula nitida*: Weinkauff 1867, Wimmer1833, Vatova 1932, Coen and Vatova 1932-1934, Gamulin-Brida *et al.* 1968, Zavodnik 1971, Zavodnik *et al.* 1978.

*Nucula turgida nitidosa*: Zavodnik *et al.* 1981, 1985, Legac and Hrs-Brenko 1982, Zavodnik and Zavodnik, 1982, 1986, Zavodnik and Vidaković 1987, Hrs-Brenko and Legac 1990).

Sizes: 11.2/9.0/-, and 9.9/7.5/4.8 mm.

Habitat: inhabits mud, very fine sand mixed with silt and clay, and terrigeneous mud with relatively high organic content.

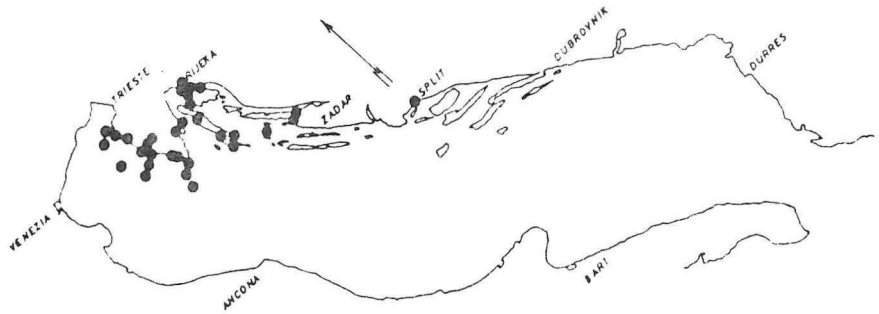


Fig. 4c. Distribution of: *Nucula nitida* Sowerby in the eastern Adriatic Sea

Distribution: offshore in the northern Adriatic, Savudrija, Umag, Zaljev rijeke Mirne, Limski kanal, Rovinj (Valdibora), Zaljev pulske luke, Zaljev Raša, Rabac, Riječki and Bakarski zaljev, Lošinj, Cres (Osor), Krk (Omišalj, Soline), Kvarnerić, Olib (Punta ploč), Zečevo, Ljubački zaljev, Privlaka, Kaštelanski zaljev (Fig. 4c).

Abundance: a common species in coastal zones and in closed bays.

Morphology: the periostracum of triangular shells is shiny light brown sometimes with darker transversal rays.

Biology: this species of a lecitotrophic larval development has relatively large eggs (0.09-0.15 mm in diameter) rich in lipids. The larval planktonic life is short and the metamorphosis occurs when the larvae are 0.17-0.18 mm in length (W e e b 1987). The spawning season of the nut shell, in the northern Adriatic Sea, takes probably place in warm period since specimens less than 3 mm in length were found in October and December.

Ecology: as other *Nucula* species it is an obligate deposit feeder and used as food for other benthic carnivorous animals.

Notice: P é r è s and P i c a r d (1264) and Z a v o d n i k (1971) indicated that this species has a wide ecological distribution, but it is also supposed to be an indicator of environmental instability.

family: N u c u l a n i d a e Adams and Adams, 1858

genus: *N u c u l a n a* Link 1807

*Nuculana fragilis* (Chemnitz 1784) (Fig. 5a)

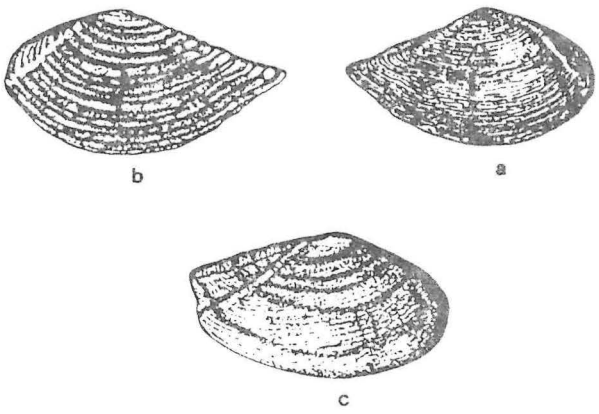


Fig. 5. a) *Nuculana fragilis* (Chemnitz); b) *Nuculana illirica* Carozza; c) *Nuculana pella* (Linnaeaus)

Quotations for the area:

*Leda minuta*: Brusina 1866,

*Leda commutata*: Weinkauff 1867, Stossich M. 1880, Wimmer 1883, Carus 1889-1893, Odhner 1914, Vatova 1928, 1931, 1934, 1935, 1943, 1949, Coen and Vatova 1932-1934.

*Leda fragilis*: Vatova 1932, Coen 1933, 1937, Gamulin-Brida 1962, Gamulin-Brida *et al.* 1968, Radić 1970, Zavodnik 1971, Ilijanić and Stošić 1972, Stjepčević 1967, Stjepčević *et al.* 1982.

*Nuculana fragilis*: Marcuzzi 1972, Legac 1974, 1987, Crvenka 1980, Zavodnik *et al.* 1981, 1985, Legac and Hrs-Brenko 1982, Radić 1982, Zavodnik and Vidaković 1987, Legac and Legac 1989.

Sizes: 13.6/7.8/- and 12.8/7.1/5.5 mm.

Habitat: occurs on various kinds of bottoms (muddy, sandy, detritic, coarse sand and muddy detritic).

Collection depth: 7-65 m (V a t o v a 1949: 20-50 m).

Distribution: offshore in the northern Adriatic, Koper, Limski kanal, Rovinj, Kvarner, Riječki zaljev, Rijeka, Unijski and Lošinjski kanal, Cres, Krk (Omišalj), Sv.Marko, Tihi and Velebitski kanal, Kvarnerić, Rab (Velo kolo), Paški and Pohlibski kanal, Virsko more, Zadar, Zadarski, Pašmanski, Srednji and Iški kanal, Murtersko more, Viški kanal (Pakleni otoci), Šolta (Maslinica), Splitski (Stomorska) and Bračkí kanal (Vrulja), Makarska, Hvarski (Kabal, Sumartin) and Korčulanski (Šćedro) and Neretvanski kanal (Lovišće), Neretva (Ploče), Malo more, Bokokotorski zaliv (Fig. 6a).


Fig. 6a. Distribution of *Nuculana fragilis* (Chemnitz)

Abundance: a common species in insular zones of the northern and middle Adriatic Sea, and Boka Kotorska Bay. In the offshore northern Adriatic Sea live specimens are

rare, but numerous single shells and both shells connected together and filled by mud were often found.

Morphology: elongated shells, fine concentrically sculptured with a posterior rostrum and pallial sinus.

Several specimens were found in amphoras filled by mud (L e g a c and L e g a c 1989) and in gastral cavities of sea stars (B o g i *et al.*, 1982b).

*Nuculana illirica* Carozza 1987 (Fig. 5b)

Sizes: 10.7/5.5/4.4 mm (C a r r o z z a 1987: 14/7/6/ mm).

Habitat: clay-silty and sandy bottoms

Collection depth: 50-100 m.

Distribution: offshore in the northern Adriatic, Kvarner, Riječki zaljev, Velebitski kanal (Karlobag), Plavnik, Rab, Pag (Novalja), Virsko more.

Abundance: it is not known. A revision of al*Nuculana fragilis* specimens existing in the eastern Adriatic collections is necessary.

Morphology: a species similar to *Nuculana fragilis*, but the shells are more flat, clearly rostrate and have widely spaced concentric furrows.

Notice: C a r r o z z a (1987) noted that a holotype of this species is deposited at the Museo Civico di Storia Naturale, Milano, Italy, and that paratypes are deposited in the following Museums: Milano (Italy), Millport (Scotland), Paris (France), Leiden (The Netherlands) and Rovinj (Croatia).

*Nuculana pella* (Linnaeus 1758) (Fig. 5c)

Quotations for the area:

*Nucula emarginata*: Heller 1864.

*Leda emarginata*: Brusina 1866, Stossich A. 1865, 1866.

*Leda pella*: Weinkauff 1867, Brusina 1870, 1896, Stossich M. 1880, Wimmer 1883, Carus 1889-1893, Vatova 1928, 1932, 1934, 1935, 1943, 1949, Gamulin-Brida 1962, Stjepčević 1967, Gamulin-Brida *et al.* 1968, Radić 1970, Zavodnik 1971, Ilijanić and Stošić 1972, Stjepčević *et al.* 1982.

*Leda (Lembulus) pella*: Coen 1933, 1937.

*Nuculana (Lembulus) pella*: Marcuzzi 1972.

*Nuculana pella*: Matjaš *et al.* 1975, Crvenka 1980, Legac and Hrs-Brenko 1982, Radić 1982.

Sizes: 9.3/5.6/4.6 mm.

Habitat: inhabits various kinds of bottoms (muddy, muddy detritic, sandy mud, detritic and gravel covered by algae and phanerogams).

Collection depth: 26-72 m (V a t o v a 1949: 10-150 m).

Distribution: offshore in the middle and southern Adriatic, Koper, Piranski zaljev, Vrsar, Limski kanal, Rovinj, Zaljev pulske luke, Kvarner, Unijski kanal, Lošinj (Mali Lošinj), Cres, Krk, Vinodolski and Velebitski kanal, Kvarnerić, Zadar, Zadarski and Pašmanski kanal, Prokljansko jezero, Vis, Viški kanal (Pakleni otoci), Šolta (Maslinica), Splitski kanal (Stomorska), Makarska, Hvarski kanal (Kabal), Hvar, Korčulanski kanal (Šćedro), Korčula, Makarska, Neretvanski kanal (Lovište), Malo more, Bokokotorski zaliv (Fig. 6b).

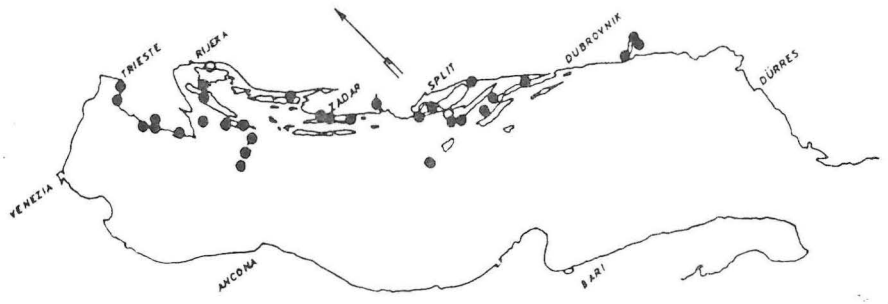


Fig. 6b. Distribution of *Nuculana pella* (Linnaeus) in the eastern Adriatic

Abundance: less common than *Nuculana fragilis* in the Adriatic Sea.

Morphology: the white coloured shell is less rostrate than in *Nuculana fragilis*. The shell sculpture resembles a series of irregular oblique striations.

Notice: P é r è s and P i c a r d (1964) and Z a v o d n i k (1971) characterized this species as an indicator of unstable conditions. The species is found in gastral contents of some echinoderms (B o g i *et al.*, 1982b).

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# PREGLED VRSTA ŠKOLJKAŠA U ISTOČNOM JADRANU. I. PROTOBRANCHIATA (SOLEMYIDAE, NUCULIDAE, NUCULANIDAE)

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## KRATKI SADRŽAJ

Preglednim radom obradjena je primitivna grupa školjkaša Protobranchia koja uključuje tri porodice Solemyidae (*Solemya togata*), Nuculidae (*Nuculoma aegeensis, Nucula nucleus, N. sulcata, N. nitida*) and Nuculanidae (*Nuculana fragilis, N. illirica, N. pella*). Za pojedinu vrstu navedeni su sinonimi iz radova koji se odnose na istočni Jadran; dimenzije ljušturica; karakteristike staništa; dubine uzorkovanja; nalazi u istočnom dijelu Jadrana; obilnost vrste i neki interesantni podaci iz morfologije, biologije, ekologije i druge zabilješke o obradjivanim vrstama.