

## Biogeographical considerations of the Adriatic Prosobranchiata

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*Most of the gastropod species, studied from a biogeographical point of view, belong to the Mediterranean province.*

*Side boundaries of the distribution of the Adriatic Prosobranchiata recorded were found to be relatively pronounced. The northern boundary is characterized by Mediterranean-boreal and boreal elements and the southern boundary by Mediterranean-West African elements. Neither the available literature nor my own observations showed any endemic Adriatic species of the Prosobranchiata group.*

*The material on Prosobranchiata group used originates from samplings in the Adriatic and from the available literature.*

### INTRODUCTION

Any biogeographical research of a particular area as a rule begins with zoogeography and phytogeography of individual plant and animal groups. The Adriatic Sea or some of its parts have already been the subject of such studies. Up to 1978 they had been reported in a synthetical paper by GAMULIN-BRIDA and ŠPAN (1978). Their biogeographical analysis was limited to benthic flora and fauna of the Adriatic Sea. For the past ten years a number of papers has been published reporting, among the other topics, the biogeographical distribution of species. These are: GAMULIN-BRIDA and ŠPAN (1980), ŠPAN (1980), ŠPAN and ANTOLIĆ (1983), GAMULIN-BRIDA, JARDAS and ŠPAN (1987), ZAVODNIK (1989).

The material on Prosobranchiata group used originates from samplings in the Adriatic and from the available literature.

### MATERIALS AND METHODS

With respect to the objectives and purpose of this research, my studies included different biotopes of the northern, middle and southern Adriatic and the material of the Fisahery - biology HVAR Expedition. The research was carried out in the coastal shallow and open deeper littoral, that is the supralittoral, mediolittoral, infralittoral and bathyal of hard and mobile substrates.

The study of Prosobranchiata in benthic plant and animal biotopes was carried out by two methods: 1. method of SCUBA diving that is direct observations and sampling; 2. method of indirect sampling by Petersen grab, dredge and trawl.

### RESULTS AND DISCUSSION

GAMULIN-BRIDA and ŠPAN (1978) reported that more than 3/4 of the Adriatic benthic

flora and fauna were common to the Adriatic and the Mediterranean. Of common species the Mediterranean-Atlantic and Mediterranean elements are most numerous. These two authors also stated that peculiar ecological properties of the Adriatic and its relative biogeographical isolation caused ecoevolution through which this sea developed as a separate biogeographical subunit of the Mediterranean Sea. ERCEGOVIĆ (1960) reported that the Mediterranean-Atlantic elements were comprised of the species which originally occurred around Gibraltar wherefrom they spreaded throughout the Mediterranean and to the eastern Atlantic. This author also believed that boreal element was rather frequent in the Adriatic, even considerably more frequent than in the Mediterranean. NORDSIECK (1958) described the distribution of Gastropoda and DANCE (1947) gave the distribution of Mollusca by biogeographical provinces and not by biogeographical regions. DANCE separated Mollusca in 16 biogeographical provinces. Even though a large number of provinces given by NORDSIECK and DANCE coincided geographically and by their names, there are also some differences. So, for instance, the Mediterranean province (after DANCE) NORDSIECK called Lusitanian\*. Another differences between NORDSIECK and DANCE is in their attitudes towards the geographic surface area of the Australian and boreal province. After NORDSIECK (1958) the geographic or horizontal areas of distribution of marine gastropods divided into provinces point to the fact that a defined gastropod species, first of all the so called "leading forms", inhabit only strictly delineated provinces owing to the similar life conditions there.

Using the map of biogeographical provinces after which DANCE (1974) gave the distribution of Mollusca group, the Adriatic gastropods belong to the following biogeographic provinces:

<i>Haliotis tuberculata</i>	West African and Mediterranean
<i>Emarginula huzardi</i>	Mediterranean
<i>Emarginula cancellata</i>	Mediterranean and Caribbean

<i>Emarginula elongata</i>	Mediterranean
<i>Diodora italica</i>	Mediterranean
<i>Diodora graeca</i>	boreal and Mediterranean
<i>Diodora gibberula</i>	Mediterranean, West-African and boreal
<i>Patella caerulea</i>	Mediterranean
<i>Patella aspera</i>	Mediterranean and boreal
<i>Patella rustica</i>	Mediterranean
<i>Calliostoma zizyphinus</i>	boreal and Mediterranean
<i>Calliostoma granulosum</i>	Mediterranean and boreal
<i>Gibbula magus</i>	boreal, Mediterranean and West-African
<i>Gibbula adansonii</i>	Mediterranean
<i>Gibbula divaricata</i>	Mediterranean
<i>Monodonta turbinata</i>	Mediterranean
<i>Monodonta articulata</i>	Mediterranean
<i>Jujubinus striatus</i>	Mediterranean and boreal
<i>Jujubinus exasperatus</i>	Mediterranean and boreal
<i>Clanculus cruciatus</i>	Mediterranean and West-African
<i>Clanculus corallinus</i>	Mediterranean and West-African
<i>Astraea rugosa</i>	Mediterranean
<i>Littorina neritoides</i>	boreal and Mediterranean
<i>Alvania cimex</i>	Mediterranean and boreal
<i>Alvania montagui</i>	Mediterranean
<i>Rissoa variabilis</i>	Mediterranean
<i>Rissoa violacea</i>	boreal and Mediterranean
<i>Rissoa splendida</i>	Mediterranean
<i>Rissoa decorata</i>	Mediterranean and boreal
<i>Rissoa auriscalpium</i>	Mediterranean
<i>Rissoa lineolata</i>	Mediterranean
<i>Archimediella triplicata</i>	Mediterranean
<i>Turritella communis</i>	boreal and Mediterranean
<i>Bivonia triquetra</i>	Mediterranean
<i>Lemintina arenaria</i>	Mediterranean
<i>Bittium reticulatum</i>	boreal and Mediterranean
<i>Gourmya vulgata</i>	boreal, Mediterranean and West-African
<i>Gourmya rupestris</i>	Mediterranean
<i>Triphora perversa</i>	boreal and Mediterranean
<i>Epitonium clathrus</i>	boreal and Mediterranean
<i>Epitonium tenuicostatum</i>	boreal and Mediterranean
<i>Capulus hungaricus</i>	boreal, trans-Atlantic and Mediterranean
<i>Caliptraea chimensis</i>	Mediterranean, West-African and boreal
<i>Crepidula unguiformis</i>	Mediterranean
<i>Aporrhais pespelecani</i>	boreal, Mediterranean and West-African
<i>Erato voluta</i>	boreal and Mediterranean
<i>Trivia europaea</i>	boreal and Mediterranean
<i>Trivia pulex</i>	Mediterranean
<i>Luria lurida</i>	West-African and Mediterranean
<i>Zonaria pyrum</i>	West-African and Mediterranean
<i>Pseudosimnia adriatica</i>	Mediterranean
<i>Simnia spelta</i>	Mediterranean
<i>Lunatia alderi</i>	boreal and Mediterranean

\* It should be pointed out that the term "Lusitania" is an archaic name for Portugal and western parts of Spain (KLAČ, 1962) which NORDSIECK (1958) uses as a basis for giving the name to an entire province.

<i>Lunatia fusca</i>	Mediterranean and boreal
<i>Lunatia guillemini</i>	Mediterranean
<i>Naticarius</i>	
<i>stercusmuscarum</i>	Mediterranean
<i>Naticarius maculatus</i>	Mediterranean
<i>Galeodea echinophora</i>	Mediterranean
<i>Ranella gigantea</i>	Mediterranean
<i>Cymathium corrugatum</i>	West-African and Mediterranean
<i>Charonia tritonis</i>	
<i>seguenza</i>	South and West-African and Mediterranean
<i>Tonna galea</i>	Indo-Pacific, West-African, Mediterranean, trans-Atlantic and Caribbean
<i>Trunculariopsis</i>	
<i>trunculus</i>	Mediterranean and West-African
<i>Murex brandaris</i>	Mediterranean and West-African
<i>Muricopsis cristatus</i>	Mediterranean and West-African
<i>Ocenebrina aciculata</i>	Mediterranean and boreal
<i>Cetarostoma erinaceum</i>	Mediterranean and boreal
<i>Columbella rustica</i>	West-African and Mediterranean
<i>Buccinulum</i>	Mediterranean
<i>Pisania striata</i>	Mediterranean
<i>Sphaeronassa</i>	
<i>mutabilis</i>	West-African and Mediterranean
<i>Cyclope neritea</i>	Mediterranean
<i>Hinia reticulata</i>	boreal and Mediterranean
<i>Hinia incrassata</i>	boreal and Mediterranean
<i>Fasciolaria lignaria</i>	Mediterranean
<i>Fusinus syracusanus</i>	Mediterranean
<i>Fusinus rostratus</i>	Mediterranean
<i>Mitra zonata</i>	Mediterranean and West-African
<i>Raphitoma reticulata</i>	boreal and Mediterranean
<i>Raphitoma bicolor</i>	boreal and Mediterranean
<i>Raphitoma linearis</i>	boreal and Mediterranean
<i>Raphitoma leufroyi</i>	boreal and Mediterranean
<i>Conus ventricosus</i>	Mediterranean and West-African

As shown by the above given data, the largest number of gastropods studied in this paper belong to the Mediterranean province. Mediterranean-Atlantic and Mediterranean elements are best represented in the Mediterranean province as well as in the Mediterranean-Atlantic biogeographical region. Apart from the already stated facts two (here we refer only to the worked out gastropod species) relatively well distinct side gastropod distribution boundaries may be distinguished: northern\* with prevailing Mediterranean-boreal and boreal elements and southern\*\* with prevailing Mediterranean and west-

African element.

The Prosobranchiata group has been rather poorly studied in the Adriatic from the viewpoint of its taxonomy and zoogeography as well as their ecology, physiology etc. Since there has been no revision of all the Adriatic records, it is still not known how many species of Prosobranchiata live in the Adriatic. At the same time the range of variations of their individual morphological characters is not known, either, nor the details of the distribution of all the species. Therefore a revision of all the available data should be done and thereupon the distribution frequency of individual biogeographic elements in the Adriatic malacofauna presented. That is why our biogeographical studies include only the gastropods already worked out. GAMULIN-BRIDA, JADRAS and ŠPAN (1987) only referred to some complex questions of endemism of floral and faunal elements in the sea in general and in the Mediterranean and the Adriatic, as a separate biogeographical Mediterranean province, in particular. It should be pointed out that I found no data on any endemic Adriatic Prosobranchiata species in the available literature. The question of the Adriatic endemic species of other animal groups remains still open, for instance that of the Anthozoa group. Those species have been poorly studied, recorded from too small number of localities in a too small number of individuals to state with certainty that they are endemic in the Adriatic. No conclusion could be drawn, either, based on such poorly studied "endemic species".

As shown by the available literature it is quite obvious that the biogeography of the Mediterranean Sea and consequently of the Adriatic, is still poorly known so that already existing biogeographical distinction (GAMULIN-BRIDA and ŠPAN, 1978; GAMULIN-BRIDA *et al.*, 1987) should be submitted to further examination and checked out. In addition, the total fauna of the Mediterranean and consequently of the Adriatic is still insufficiently known so that actual biogeographic characteristics (GAMULIN-

\* Northern line: stretches up to the Northcape and to the eastern and southern shores of Greenland (author's remark)

\*\*Southern line: stretches along the western African coast (author's remark)

BRIDA and ŠPAN, 1978; GAMULIN-BRIDA *et al.*, 1987; NORDSIECK, 1958; DANCE, 1974) could not yet be defined with certainty.

### REFERENCES

- DANCE, S. P., 1974. The collector's encyclopedia of shells. Mc Graw-Hill Book Company, New York: 288 p.
- ERCEGOVIĆ, A., 1960. Značajne crtice vegetacije alga Jadranskog mora. Acta Bot. Croat., 18-19: 17-36.
- GAMULIN - BRIDA, H. i A. ŠPAN, 1978. Specifičnosti jadranske flore i faune - osnov individualizacije Jadrana kao biogeografske podjedinice Sredozemlja. Biosistematika, 4 (2): 217-225.
- GAMULIN - BRIDA, H. et A. ŠPAN, 1980. Situation biogéographique de la Méditerranée et de l'Adriatique en tant que sous-region distincte. Journ. Étud. Systém. et Biogéogr. Médit.-Cagliari, C. E. S. M.: 73-78.
- GAMULIN-BRIDA, H., JARDAS, I. i A. ŠPAN, 1987. Problemi endema mora s posebnim osvrtom na Jadrano. Akademija nauka i umjetnosti Bosne i Hercegovine, posebna izdanja, knjiga 83. Odjeljenje prirodnih i matematičkih nauka, knjiga 14: 57-73.
- KLAJČ, B., 1962. Rječnik stranih riječi izraza i kratica. Zora, Zagreb: p. 894.
- NORDSIECK, F., 1958. Meeresschnecken. Kosmos, Stuttgart: 63 p.
- ŠPAN, A., 1980. Composition et zonation de la flore et végétation benthique de l'île de Hvar (Adriatique moyenne). Acta Adriat., 21(2): 169-194.
- ŠPAN, A. i B. ANTOLIĆ, 1983. Prilog poznavanju fitobentosa crnogorskog primorja (južni Jadran). Studia Marina, 13/14 (3): 87-110.
- ZAVODNIK, D., 1989. Stanje poznavanja jadranske faune. VII. Echinodermata. 2. kongres biosistematikov Jugoslavije (Gozd Martuljek), izvlečki poročila: p. 78.

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## Biogeografska razmatranja u svezi sa skupinom jadranskih Prosobranchiata

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### KRATKI SADRŽAJ

Najveći broj obrađenih vrsta puževa u biogeografskom smislu pripada mediteranskoj provinciji. Uočene su i razmjerno izražene bočne linije rasprostranjenja jadranskih Prosobranchiata, i to sjeverna, u kojoj su značajni mediteransko-borealni i borealni elementi, te južna linija, u kojoj su značajni mediteransko-zapadno-afrički elementi. Na osnovi literaturnih podataka i vlastitih istraživanja, nije utvrđeno postojanje jadranskih endemskih vrsta puževa iz skupine Prosobranchiata.

Za pisanje ovog rada korišten je materijal skupine Prosobranchiata iz Jadrana i postojeća literatura koja mi je bila na raspolaganju.