

Emiliano Molin, Marco Gabriele, Riccardo Brunetti

FURTHER NEWS ON HARD SUBSTRATE COMMUNITIES
OF THE NORTHERN ADRIATIC SEA WITH DATA ON GROWTH
AND REPRODUCTION IN *POLYCITOR ADRIATICUS* (VON DRASCHE, 1883)

Riassunto. *Ulteriori dati sulle comunità di substrato duro del Nord Adriatico con notizie sull'accrescimento e la riproduzione di Polycitor adriaticus (Von Drasche, 1883).*

La comunità bentonica insediata su di un affioramento roccioso sito a ~ 19 m di profondità e ~ 3 miglia dalla costa Veneziana è stata analizzata ed i risultati confrontati con quelli ottenuti dallo studio di altre comunità della stessa area (Nord Adriatico). Il tasso di sedimentazione sembra essere il parametro ambientale più importante nel controllo della struttura delle comunità, nelle quali il numero di specie appartenenti a Poriferi ed Ascidiacei diminuisce e quello dei carnivori e *scavenger* aumenta all'aumentare del tasso di sedimentazione. Inoltre tra gli Ascidiacei il numero delle forme coloniali diminuisce e la distribuzione di due di esse, *Aplidium conicum* e *Polycitor adriaticus*, sembrano caratterizzare i diversi corpi d'acqua. *P. adriaticus* è la specie di ascidia più importante sia come abbondanza che biomassa. Di questo è stato studiato il ciclo biologico: la riproduzione sessuata ha luogo dall'autunno alla primavera (da Settembre ad Aprile) ed è seguita da un breve periodo (Maggio) durante il quale le colonie sono prive di zooidi filtranti.

Summary. The benthic community living on an outcrop at a depth of ~ 19 m and ~ 3 miles off the Venetian coast was analysed and compared with those previously studied in other areas of the same northern Adriatic Sea. The sedimentation rate seems to be the most important environmental parameter in controlling the structure of the communities in which the Porifera and Ascidiacea diversity decreases and the percentage of carnivorous and scavenger species increases as the sedimentation rate rises. Moreover among Ascidiacea the number of colonial forms drops but the distribution of two of them, *Aplidium conicum* and *Polycitor adriaticus*, seems to characterize different water bodies. *P. adriaticus* is particularly important both in terms of abundance and biomass. The biological cycle of this species was analyzed. The sexual reproduction take place from autumn to spring (from September to April) and is followed by a brief period (May) during which colonies lack filtering zooids.

Key words: northern Adriatic Sea, benthic communities, ascidians, growth, reproduction, image analysis.

INTRODUCTION

On the shallow sedimentary northern Adriatic floor there are a considerable number of outcrops, quite or partially bioconstructed, which are densely colonized by benthic organisms. Recently some of us began the biological study of these formations showing that turbidity is the most important environmental factor controlling abundance and structure of the communities (GABRIELE et al., 1999). Later on the *Istituto di Biologia del Mare (Venezia)* gave the present authors the chance to visit repeatedly another “*tegnua*” (local name of these outcrops), making it possible to better evaluate the influence of turbidity on the biological communities, and to study some aspects of the biology of *Polycitor adriaticus* (VON DRASCHE, 1883), probably the most abundant ascidian species in the area. Some data collected on other formations during the previous study, and not included in the above cited article, are reported too.

MATERIAL AND METHODS

I. Study area

The study was performed on a rocky outcrop located ~ 3 miles off Venetian coast (45° 13' 0" N, 12° 34' 13" E) at a depth of ~ 19 m. The relief, named "*Tegnua D'Ancona*" (in honour of the great Italian zoologist Umberto D'Ancona), is ~ 68 m length and ~ 41 m wide and rises up to 3 m from the surrounding sediment (Fig. 1). A geological study of this formation may be found in BOLDRIN et al. (1980). The granulometry of the surrounding sediment sampled at stations 1s and 2s was also analysed (BUCHANAN, 1984) to indirectly evaluate the sedimentation rate on the basis of arguments proposed by GABRIELE et al. (1999). In this article data on the study area and on the four stations indicated as TSO ("*Tegnua del sorse*": 45° 20' 15" N and 12° 43' 30" E, -23 m), TCH ("*Tegnua Chioggia*": 45° 13' 15" N and 12° 23' 03" E, -21 m), RWR (naval wreck: 45° 21' 52" N and 12° 26' 30" E, -17 m) and BMI (~ 150 m off the coastline of Miramare (Trieste), -15 m) are given too.

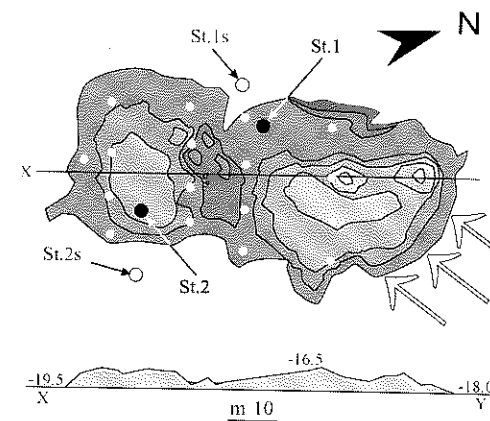


Figure 1. Topography of the *Tegnua D'Ancona* with indications of sampling stations. The arrows indicate the direction of the prevailing stream.

II. The investigated species

Polycitor adriaticus (VON DRASCHE, 1883) is a colonial ascidian belonging to the Polycitoridae family (order Aplousobranchiata). The colony is stalked with a roundish head, up to ~ 15 cm in diameter, where thoraces are accommodated. Generally the colonies present several heads and the stalks are connected by a basal test which penetrates into the cavities of biogenic rock and can come out from its apertures to form other heads (Fig. 2a). A more thorough description of the species is given in BRUNETTI (1994).

III. Data collection

Stations 1 and 2 were periodically visited from May '98 to February '99, other stations (white dots in Fig. 1) only in February '99. In all stations rectangular areas (replicates) of 54 x 34 cm were photographed with a Nikonos IV held at 90 cm from the surface, so every photo furnished a picture of 1500 cm² of substratum. During each dive 10 colonies (or pieces of different colonies) were collected at random to be dissected to study the reproductive cycle.

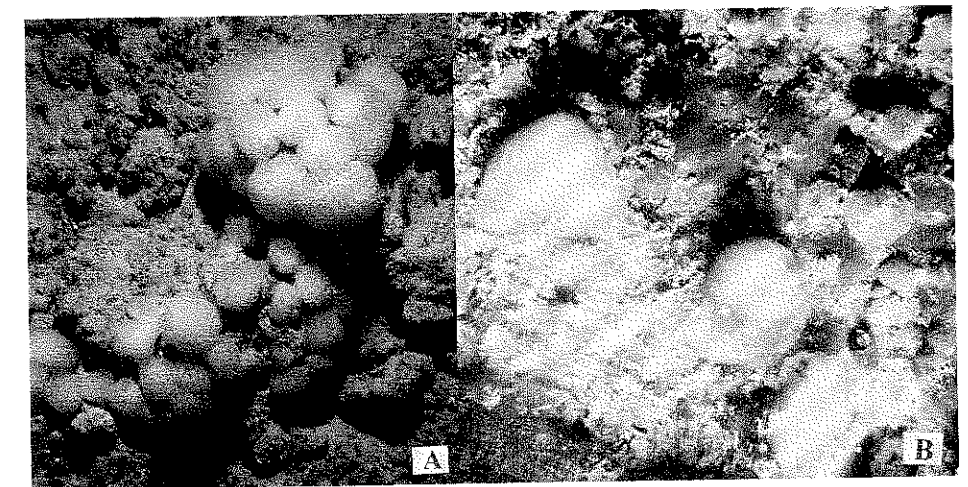


Figure 2. a) Colony of *Polycitor adriaticus* ("head"); b) Not feeding colony.

Moreover the organisms present in different areas randomly chosen on the outcrop (for a total of about 5 m²) were collected to have a qualitative picture of the benthic community.

IV. Data treatment

Photos were digitized and analysed on a Casti imaging Image NT. On the first picture of every series the heads were numbered and their characteristics monitored in time. The parameters recorded were the perimeter and the major and minor axes of the optical section of the heads. Differences in perimeter (dP) were expressed as daily growth rate (r): $r = dP/dt$ where dt is the time in days. About 80 heads were monitored. The same data were utilized to calculate the biomass value of the heads. To do this we first determined the "real" volume of 51 heads as displacement of the water level in a container after sample immersion. Then the volume of the same heads was calculated by means of the ellipsoid formula: $V = 4/3 \pi r_1 r_2 r_3$ where r_1 to r_3 are the semi-axes values. At last the regression line between the two series of data was calculated; $y = 1.1159x - 0.1394$, where y is the log of calculated volume and x the log of "real" one, it resulted highly significant: $R = 0.9884$; $P < 0.01$. The following step was to calculate the regression line between the "real" volume and the surface (A) of the optical section of the heads calculated from the only major and minor axes ($A = \pi r_1 r_2$). Also in this case regression was highly significant ($y = 1.0129x + 0.2388$; $R = 0.9404$; $P < 0.001$). Thus on the basis of the values of major and minor axes obtained from image analysis we can calculate volumes and from these, using the suitable conversion factor (GABRIELE et al., 1997), the biomass value as g/m² of ash-free dry weight (AFDW). Of course we must bear in mind that these biomass values are only a sub-estimate, probably only about 50 %, of the real value (being considered only one part of the colony). Finally using the previous data we calculated the "circularity index" of the heads (area of optical section of the head / area of a circle of equivalent perimeter). This index, suggested by TURON & BECERRO (1992) for encrusting co-

lonial ascidian, ranges from 1 (perfect circularity) to 0. The meaning of the index is the evaluation of the trouble degree, as consequence of predation, space competition or other, to the optimal growth (in fact when grown in optimal environmental conditions the head optical section is perfectly circular). The abundance of the species was expressed as number of heads/m². This was considered the simplest method, since colony morphology (see above) and rock porosity makes it difficult to detect one colony from another.

RESULTS

I Community structure

A total of 65 species were recorded (Table 1), of these only three were autotrophic, a consequence of the high water turbidity. The main taxonomic group was Porifera (20 %) followed by Bivalvia (18.5 %) and Ascidiacea, Annelida and Crustacea (every one of them with 12.3 %). Among the animals, the active suspension feeders make up 54.8 % (Table 2). The majority of ascidian species were solitary (75 %), of the two colonial forms, *Aplidium conicum* and *Polycitor adriaticus*, the latter is dominant, with regard to both abundance and biomass.

II Abundance and biomass of *P. adriaticus*

The abundance and biomass values of *P. adriaticus* are reported in Table 3. The comparison among the samplings in station 1 and 2 did not show a significant difference (Tab. 3A and B). Thus a comparison between the two stations was performed utilizing the data from all samplings (Tab. 3C). The abundance values at station 1 resulted significantly higher ($P < 0.05$) than those at station 2. No significative difference was detected between the biomass values. That would indicate that at station 1 there are more "heads" but of small dimensions. The mean abundance and biomass values on the whole outcrop are reported in Table 3D.

III Growth

No statistical difference was shown in the growth of the colonies living at stations 1 and 2, but the growth rates differ significantly in different seasons ($p < 0.001$ and $p < 0.01$ at st. 1 and 2 respectively) (Fig. 3). During the spring the growth rate has a negative value because there is a reduction in the size of the "heads" due to a colonial regression (see below).

IV The circularity index

This index does not change significantly with time but the values calculated on colonies of st. 1 ($n = 212$; average = 0.731; st. dev. = 0.111) are slightly higher ($p < 0.05$) than those of st. 2 ($n = 152$; average = 0.702; st. dev. = 0.012).

V Reproduction

The results of the analysis of the materials sampled about monthly are shown in Table 5. They would indicate a period of sexual reproduction presumably beginning towards mid-August, when the water temperature is about 20 °C, and continues till the following spring. BRU-

Table 1. List of the species found in the studied outcrop (TD'A). Trophic categories (tc): c/s = carnivorous or scavenger; p = photosynthetic; l = limivorous; as = active suspensionfeeder; ps = passive suspension feeder. In Ascidiacea asterisks indicate the colonial species.

| | | | |
|---------------------------------|-----|----------------------------------|-----|
| RHODOPHITA | | <i>*Aequipecten opercularis</i> | as |
| <i>Pleonosporium borrieri</i> | p | <i>*Crassostrea gigas</i> | as |
| <i>*Peyssonnelia squamaria</i> | p | <i>*Chamelea gallina</i> | as |
| <i>*Pseudolithophyllum</i> sp. | p | <i>Plagiocardium papillosum</i> | as |
| PORIFERA | | SIPUNCULIDA | |
| <i>*Tethya aurantium</i> | as | <i>*Physcosoma granulatatum</i> | ps |
| <i>*Tethya citrina</i> | as | ANNELIDA | |
| <i>*Chondrosia reniformis</i> | as | <i>*Nereis</i> sp. | c/s |
| <i>Geodia cydonium</i> | as | <i>*Eunice</i> sp. | c/s |
| <i>Suberites domuncula</i> | as | <i>*Serpula vermicularis</i> | ps |
| <i>*Dysidea</i> sp. | as | <i>*Pomatoceros lamarekii</i> | ps |
| <i>Aplysina aerophoba</i> | as | <i>*Pomatoceros triqueter</i> | ps |
| <i>*Mycale massa</i> | as | <i>*Hydroides</i> sp. | ps |
| <i>*Mycale tunicata</i> | as | <i>*Spiroboris</i> sp. | ps |
| <i>*Hemimycale columella</i> | as | <i>*Sabella</i> sp. | ps |
| <i>Hymeniacidon sanguinea</i> | as | CRUSTACEA | |
| <i>Cliona nigris</i> | as | <i>Galathea strigosa</i> | c/s |
| <i>Tedania anhelans</i> | as | <i>Homarus gammarus</i> | c/s |
| ANTHOZOA | | <i>Dromia personata</i> | c/s |
| <i>Adamsia palliata</i> | c/s | <i>Maja verrucosa</i> | c/s |
| <i>*Sagartia elegans</i> | c/s | <i>*Maja squinado</i> | c/s |
| <i>Caryophyllia inornata</i> | c/s | <i>Paguristes oculatus</i> | c/s |
| <i>*Cerianthus membranaceus</i> | c/s | <i>Eupagurus prideaux</i> | c/s |
| <i>*Epizoanthus arenaceus</i> | c/s | <i>Chthamalus depressus</i> | as |
| GASTROPODA | | ECHINODERMATA | |
| <i>*Murex trunculus</i> | c/s | <i>Cocumaria planci</i> | l |
| <i>*Diodora</i> sp. | c/s | <i>*Holothuria forskali</i> | l |
| <i>*Calliostoma</i> sp. | c/s | <i>*Sphaerechinus granularis</i> | c/s |
| <i>*Gibbula</i> sp. | c/s | ASCIDIACEA | |
| BIVALVIA | | <i>*Aplidium conicum</i> | as |
| <i>*Arca noae</i> | as | <i>*Polycitor adriaticus</i> | as |
| <i>*Lithophaga lithophaga</i> | as | <i>Phallusia fumigata</i> | as |
| <i>*Pecten jacobaeus</i> | as | <i>Phallusia mammillata</i> | as |
| <i>*Venus verrucosa</i> | as | <i>Styela partita</i> | as |
| <i>*Modiolarca subpicta</i> | as | <i>Microcosmus</i> sp. | as |
| <i>*Hiatella arctica</i> | as | <i>Pyura microcosmus</i> | as |
| <i>*Ostrea edulis</i> | as | <i>Pyura tessellata</i> | as |
| <i>*Chlamys varia</i> | as | Total number of species: 65 | |

NETTI (1994) reported, at TSO, the presence, at the end of April, of ripe colonies with larvae, and, in June, of unripe young and larger colonies. These observations agree with the present deductions. During the winter the zooids have an abdomen full of reserve material. At the end of May the larger colonies do not have filtering zooids and show a glassy surface: zooids show regressed thoraxes and the segmented abdomens regenerate new zooids (Fig. 2b). The new settled colonies probably ripen in the following year and their presence are the cause of the lower values of the percentage of ripe colonies during fall and winter.

Table 2. Distribution of the organisms among the main taxonomic groups and trophic categories (symbols as in Table 1). Data from TD'A (present study) are compared with those from areas previously studied by Gabriele et al., 1999.

| Stations | TSO* | TD'A | TCH* | RWR* | BMI* |
|----------------------------------|------|------|------|------|------|
| Granulometry gradient (sand %) | 94 | 79** | 66 | 28 | 8 |
| Number of animal species (nas) | 37 | 62 | 44 | 47 | 61 |
| Porifera (% on nas) | 27 | 21 | 9 | 9 | 8 |
| Ascidacea (% on nas) | 32 | 13 | 20 | 23 | 25 |
| Ascidacea: % of solitary species | 25 | 75 | 67 | 64 | 60 |
| Bivalvia (% on nas) | 11 | 19 | 16 | 26 | 15 |
| as (% on nas) | 76 | 55 | 55 | 64 | 52 |
| cs (% on nas) | 5 | 31 | 30 | 25 | 30 |
| ps (% on nas) | 14 | 11 | 14 | 11 | 11 |
| <i>P. adriaticus</i> | + | + | + | - | - |
| <i>A. conicum</i> | + | + | - | - | - |

* from Gabriele et al. (1999) and unpublished data of the same authors

** mean value between station 1s (74.1) and station 2s (82.6) (see fig. 1).

+ = present

- = absent

Other symbols as in Tab. 1.

DISCUSSION

In their article, GABRIELE et al. (1999) supposed the structure of the benthic communities of the north Adriatic outcrops were controlled mainly by the sedimentation rate which may be deduced by the granulometry of the surrounding sediment. Our observations on "tegnua D'Ancona", agree with that hypothesis. In Table 2, where stations are reported in decreasing order of sand percentage (indicative of rising turbidity), data concerning the present study and other from the former one are compared. Among the main taxonomic groups the most sensitive to the increasing sedimentation rate is Porifera of which the percentage presence at TCH is more than halved compared to other stations. Also the number of ascidian species decreases along the granulometry gradient, but overall in this case a strong increment in the percentage of the solitary species is present. Also as far as the trophic categories are concerned, the community of the offshore outcrop (TSO) sharply differs from all others owing to the percentage reduction in active suspension feeders and the conspicuous increment in carnivorous-scavengers. These differences in the community structure indicate the passage from the relatively clear offshore waters to the coastal ones characterized by high turbidity and sedimentation rates. In particular some species may be considered as bioindicators of the two situa-

Table 3. Abundance (number of "heads"/m²) and biomass as AFDW (g/m²) of *P. adriaticus*

| | Abundance (n/m ³) | | | Biomass (ASDW, g/m ³) | | |
|---|-------------------------------|---------|---------|-----------------------------------|---------|---------|
| Sampling date | repl. | average | st. dev | average | st. dev | |
| A - Station 1 | | | | | | |
| 15 May 1998 | 4 | 116.7 | 90.8 | 32.67 | 11.8 | |
| 10 July 1998 | 4 | 116.7 | 98.9 | 26.89 | 18.6 | |
| 27 November 1998 | 3 | 113.3 | 76.8 | 30.01 | 19.7 | |
| 19 March 1999 | 4 | 108.3 | 42.6 | 28.35 | 19.0 | |
| Comparison among samplings: not significant | | | | | | |
| B - Station 2 | | | | | | |
| 21 April 1998 | 4 | 55 | 39.4 | 38.04 | 16.27 | |
| 10 July 1998 | 4 | 70 | 46.7 | 21.97 | 5.60 | |
| 27 November 1998 | 4 | 60 | 35.7 | 27.48 | 17.39 | |
| 18 December 1998 | 4 | 60 | 31.7 | 25.65 | 15.22 | |
| 19 March 1999 | 4 | 77 | 43.7 | 33.57 | 24.88 | |
| Comparison among samplings: not significant | | | | | | |
| C - Comparison between station 1 and 2 (pooled data) | | | | | | |
| Station 1 | 15 | 113.8 | 71.5 | 29.44 | 15.54 | |
| Station 2 | 20 | 65.4 * | 38.2 | 29.27 ^{ns} | 16.42 | |
| Comparison: * = significant (p<0.024), ns = not significant | | | | | | |
| D - mean values on the whole outcrop | | | | | | |
| | repl. | average | st. dev | repl. | average | st. dev |
| TSO* | 6 | 41.33 | 20.34 | 3 | 38.17 | 16.91 |
| TD'A** | 55 | 61.24 | 56.43 | 55 | 50.93 | 108.17 |
| TCH* | 21 | 58.67 | 26.66 | 7 | 41.59 | 15.51 |
| * on all samples | | | | | | |
| ** on all samples collected on March 1999 | | | | | | |

tions: the ascidian *Aplidium conicum* and, as already signalled by GABRIELE et al. (1999), the sponge *Chondrosia reniformis* are present only in TSO. The absence of *A. conicum* at stations TCH, RWR and BMI is not due to the high water turbidity (that is to a clogging of the branchial structure) but to a direct effect of the sedimentation rate. In fact *A. conicum* and *P. adriaticus* have similar branchial sac, characterized by high number of rows of stigmata of about the same size (BRUNETTI, 1994) but the structure of the colony is very different. In *A. conicum* the test is firm in all the colony, also round the branchial sac, while in *P. adriaticus* the test of the "heads", comprising the thoraces, is soft. So when zooids contract in *A. conicum* the branchial sac is detached from the test and the colony does not change in size. On the contrary in *P. adriaticus* the soft test follows the contracting thorax and the "heads" reduce considerably in size (compare the figures of sampled colonies reported by BRUNETTI, 1994, quite similar to those of VON DRASCHE, 1883, with the aspect of living colonies of fig. 2a).

That means that by periodically contracting the zooids, *P. adriaticus* is able to free itself

Table 4. Results of dissection of colonies collected in different seasons: 10 colonies per sampling, 18 zooids per colony.

| Sampling date | Water temperature | % colonies with ripe gonads | % zooids with larvae per colony |
|------------------|-------------------|-----------------------------|---------------------------------|
| 21 May 1998 | 14 | 0 | 0 |
| 1 August 1998 | 19 | 0 | 0 |
| 4 September 1998 | 21 | 100 | 100 |
| 22 October 1998 | 19 | 80 | 100 |
| 27 November 1998 | 14 | 0 | 0 |
| 4 February 1999 | 7 | 30 | 11 |
| 26 February 1999 | 7 | 0 | 0 |

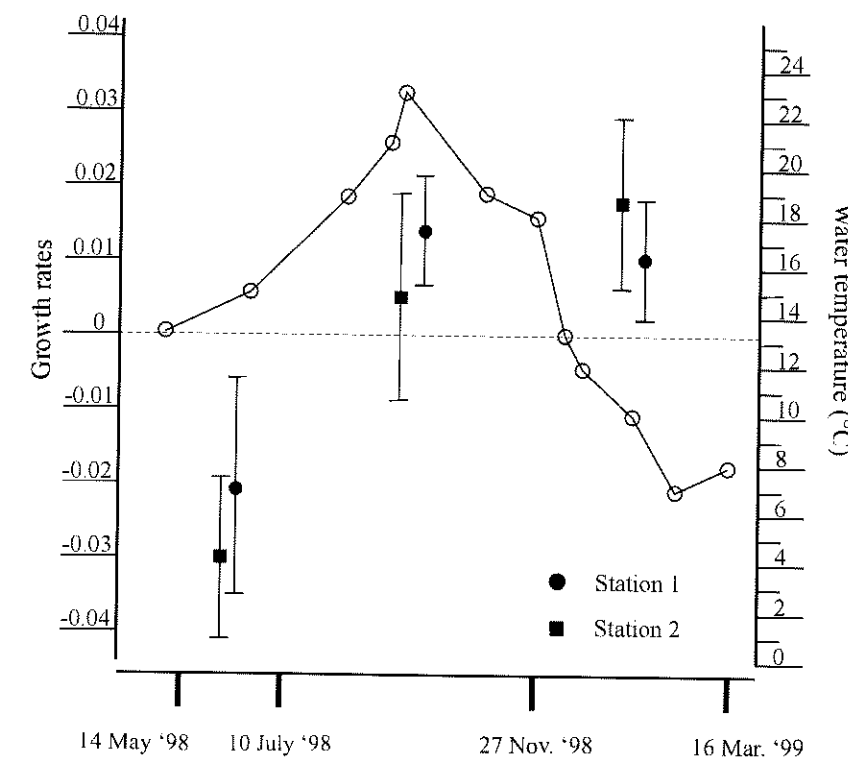


Figure 3. Daily growth rate of *P. adriaticus* at the stations 1 and 2 from May '98 to March '99 (average \pm standard deviation) and water thermal curve.

from a possible covering of silt while in the same conditions *A. conicum* would have the apertures occluded. The observations on TD'A show that while *P. adriaticus* is present whether on vertical or horizontal substrata, *A. conicum* is generally present at the top of prominences

where the effect of the current is stronger and so the sedimentation rate is lower. This capacity to survive in the presence of high sedimentation rates gives *P. adriaticus* a tremendous advantage making it possible for it to exploit to the utmost the trophic potency of waters with strong turbidity. However there is a limit to this adaptability. As we can see from Table 2 this species is absent at RWR and BMI where the sedimentation rate is very high (% of sand in sediment below 30), as generally occurs near the Italian coast. In conclusion the distributions of these two ascidian species *A. conicum* and *P. adriaticus* characterize three water bodies: i) both species present = relatively clear waters (typically of the offshore stations); ii) *P. adriaticus* present and *A. conicum* absent = troubled waters; iii) both species absent = very troubled waters (typically of the most coastal stations).

The difference in "head" size shown at station 1 and 2 can be explained by the characteristic of the substratum. The station 1 is located under the effect of the current therefore the hydrodynamism is less strong and the substratum is very porous being composed by rocky fragments got detached by the higher parts of the formation, on the contrary station 2 is exposed to the current and produces a more compact substratum (Fig. 1). This difference between stations is also shown by the percentage of sand in the surrounding sediment which is lower at the shielded 1s than at station 2s (Table 2). In the first case the basal test of colonies develops inside the rocky cavities and comes out from the several superficial openings giving rise to numerous but not very large heads which are quite separated. In the second one the basal test is adherent to the rock surface in the shape of a compact mass from which rise less numerous but larger "heads". The latter are closer than in the previous case and often meet and join. That explains the little difference between the circularity indexes which are higher at station 1 than at 2. However their mean values (0.731 and 0.702 respectively) indicate the "heads" are quite close to circularity.

This regularity in shape might mean absence of predation by other benthonic or nectonic organisms, perhaps due to a test toxicity as shown in some species (GOODBODY & GIBSON, 1974; DAVIS & WRIGHT, 1990; TEO & RYLAND, 1994). The absence of epibionts agrees with this conjecture. The biological cycle of *P. adriaticus* is characterized by a period of sexual reproduction which extend from summer to the following spring and terminates with a phenomenon of intensive vegetative reproduction during which the colonies lack the filtering zooids: the "heads" present a reduction in size, cause of the negative values in growth rates, and show a glassy surface as described by TURON (1992) in *Polysyncraton lacazei*. However the phenomenon cannot be explained, as in the latter case, as a "rejuvenative" process, nor as a regression and regeneration related to resistance forms, as, for example, takes place in *Clavelina lepadiformis* and *Diazona violacea* (MUKAI, 1977) or in *Botrylloides leachi* (BRUNETTI, 1976; BURIGHEL et al., 1976). In fact in the non feeding colonies of *P. adriaticus*, after the regression of thorax, the zooids undergo a segmentation and the fragments regenerate new zooids, thus it would be a case of NAKAUCHI's *propagative budding* (1982) which follows the winter period of accumulating energetic reserve.

ACKNOWLEDGEMENTS

This research was supported by the facilities of the "Istituto di Biologia del Mare" (Ve-

nice) which placed its ships and assistance at the authors' disposal. In particular we wish to express our sincere thanks to the Director of the Institute, Dr. Sandro Rabitti and to Dr. Tiziano Scovacicchi.

References

- BOLDRI A., RABITTI S., STEFANO A., 1980 - A detailed bio-geological survey of two rocky outcrops in the northern Adriatic Sea. *Sixth International Scientific Symposium of the World Underwater Federation (CMAS)*: 156-166.
- BRUNETTI R., 1976 - Biological cycle of *Botrylloides leachi* (Savigny) (Ascidacea) in the Venetian Lagoon. *Vie et Milieu* 26: 105-122.
- BRUNETTI R., 1994 - Ascidiaceans of the northern Adriatic Sea. Aplousobranchia I. *Boll. Zool.* 61: 89-96.
- BUCHANAN J.B., 1984 - Sediment analysis. In: Holme NA and McIntyre AD (eds), *Methods for the study of marine benthos*. Blackwell, London: 41-65.
- BURIGHEL P., BRUNETTI R., ZANIOLO G., 1976 - Hybernation of the *Botrylloides leachi* (Savigny): histological observations. *Boll. Zool.* 43: 293-301.
- DAVIS A. R., WRIGHT A. E., 1990 - Inhibition of larval settlement by natural products from the ascidian *Eudistoma olivaceum* (Van Name). *J. Chem. Ecol.* 16: 1349-1357.
- DRASCHE R. VON, 1883 - Die Synascidien der Bucht von Rovigno (Istrien). In: Ein Beitrag zur Fauna der Adria. Wien: 41 pp.
- GABRIELE M., PUTRONE V., BRUNETTI R., 1997 - Morphometrics and energetic value of Adriatic ascidians. *Cah. Biol. Mar.* 38: 169-174.
- GABRIELE M., BELLOT A., GALLOTTI D., BRUNETTI R., 1999 - Sublittoral hard substrate communities of the northern Adriatic Sea. *Cah. Biol. Mar.* 40: 65-76.
- GOODBODY I., GIBSON J., 1974 - The biology of *Ascidia nigra* (Savigny). V. Survival in populations settled at different times of the year. *Biol. Bull.* 146: 217-237.
- MUKAI H., 1977 - Histological and histochemical studies of two compound ascidians, *Clavelina lepadiformis* and *Diazona violacea*, with special reference to the trophocytes, ovary and pyloric gland. *Science Report of the Faculty of Education Gunma University*, 26: 37-77.
- NAKAUCHI M., 1982 - Asexual development of ascidians: its biological significance, diversity, and morphogenesis. *Amer. Zool.*, 22: 753-763.
- TEO S. L. M., RYLAND J. S., 1994 - Toxicity and palatability of some British ascidians. *Mar. Biol.*, 120: 297-303.
- TURON X., 1992 - Periods of non-feeding in *Polysyncrator lacazei* (Ascidacea: Didemnidae): a rejuvenative process? *Mar. Biol.*, 112: 647-655.
- TURON X., BECERRO M.A., 1992 - Growth and survival of several ascidian species from the northwestern Mediterranean. *Mar. Ecol. Progr. Ser.*, 82: 235-247.

Authors' address:

E. Molin, Thetis spa, Castello 2737/f, I - 30122 Venezia (Italy)
 M. Gabriele, Askoll Due spa, Via Industria 32-34, I - 36031 Dueville (Vicenza) (Italy)
 R. Brunetti (corresponding author), c/o Municipal Museum of Natural History, S. Croce 1730, I - 30135 Venezia (Italy). E-mail: brunetti@civ.bio.unipd.it