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An estimation of the phytoplankton carbon biomass in the Mali Ston and Gruž bays (the southern Adriatic)

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A one year study of the Mali Ston and Gruž bays phytoplankton carbon biomass was performed from July 1984 - June 1985. Nano-, micro- and total phytoplankton carbon biomass were estimated bimonthly from the volume data, at the depth intervals of 1 m. In both bays nano-, micro- and total phytoplankton quantity maxima were recorded in the surface layer during a pronounced summer temperature and salinity vertical gradient. If compared to the literature data for the Mediterranean, maximum microphytoplankton carbon contents (51.7 μg C l^{-1} in the Mali Ston Bay and 316.6 μg C l^{-1} in the Gruž Bay) were relatively low.

INTRODUCTION

The phytoplankton biomass in Mali Ston and Gruž bays (southern Adriatic) has been so far expressed by means of chlorophyll *a* concentration (PUCHER-PETKOVIĆ *et al.*, 1978; MARASOVIĆ and PUCHER-PETKOVIĆ, 1981) and volume (VILIČIĆ, 1985a, 1985b, 1989; JASPRICA, 1989). Phytoplankton biomass can also be expressed in terms of dry weight, ATP, organic nitrogen and carbon contents. Expressing phytoplankton biomass in terms of organic carbon contents is especially suitable when studying the transport of the matter through the ecosystem, the carbon being the commonest unit in biomass estimation of all the links in the ecosystem food web (STEELE and MENZEL, 1962).

Methods used for a direct assessment of the phytoplankton carbon content do not provide reliable data due to difficulties encountered in separating phytoplankton from other particulate matter (GOLDMAN *et al.*, 1979). Measurement of particulate organic carbon in the ocean provide an upper bound to concentration of phytoplankton carbon. Phytoplankton carbon content can be estimated indirectly by using a conversion factor from chlorophyll *a* concentration (EPPLEY *et al.*, 1977; BANSE, 1977; RIEMANN *et al.*, 1989), ATP (HOLM-HANSEN and BOOTH, 1966; HOLM-HANSEN, 1970; HUNTER and LAWS, 1981) and volume (MULLIN *et al.*, 1966; STRATHMANN, 1967).

This paper presents nano-, micro- and total phytoplankton carbon contents distribution from volume estimates in Mali Ston and Gruž bays. Along with the results by ANDREOLI and TOLOMIO (1985, 1988) from the Venice Lagoon, these have been so far the first detailed data on volume-derived phytoplankton carbon contents for the Adriatic.

The Mali Ston Bay is closed between Pelješac peninsula and the mainland. Basic hydrographic and chemical parameters showed markedly strong influence of land runoffs (VUKADIN, 1989). The Bay is scarcely inhabited and is well known as an oyster and mussels farming region. If considering its hydrographic properties and the photosynthetic rate, the Bay may be included into the highest of four productivity zones established for the Adriatic (BULJAN, 1964; PUCHER-PETKOVIĆ and ZORE-ARMANDA, 1973).

The Gruž Bay is a relatively small bay, strongly influenced by the open sea waters on the one hand and sewage waters on the other, and considerably influenced by the fresh waters from Ombla River (ZORE-ARMANDA, 1978). According to the annual phytovolume distribution and the eutrophication level, VILIČIĆ (1989) has included the Gruž and Mali Ston bays into the 3rd category of moderately eutrophicated ecosystems.

MATERIAL AND METHODS

In the Mali Ston Bay phytoplankton samples were collected at station Usko at 12 meters depth and in the Gruž Bay at 17 meters depth (Fig. 1) from July 1984 to June 1985. The phytoplankton samples were taken bimonthly with an 30 l min^{-1} hand pump with 32 mm intake tube diameter, at the depth intervals of 1 meter. A total of 456 samples were collected and analyzed. All samples were preserved with a two percent neutralized formaldehyde solution. Samples of 25 and 50 ml were analyzed by

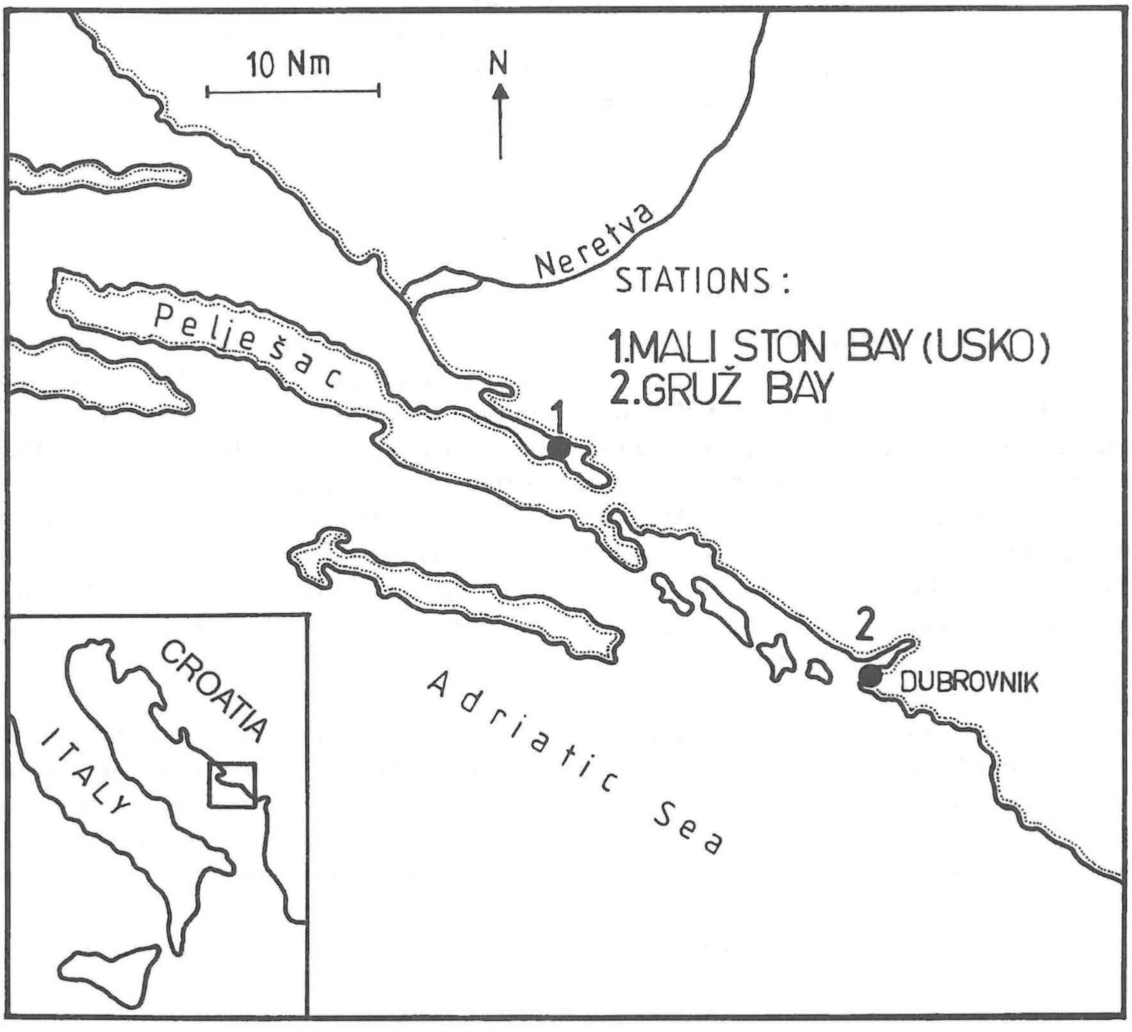

Fig. 1. Location of the stations

inverted microscope method (UTERMÖHL, 1958) after a sedimentation time of 24 or 48 hours. The phytoplankton cells with a maximum length between 2 and 15 μm were designated as nanoplankton, and cells longer than 15 μm as microplankton. The counting of microplankton cells was performed under magnifications of 200 and 80 x. Nanoplankton cells were counted in 20-30 randomly selected fields of vision along the counting chamber base-plate, under the magnification of 320 x. The precision of the counting method was about ± 10 per cent.

Cell density and size were determined simultaneously in each sample. Cell volumes of various species were determined according to cell models (geometrical bodies) constructed by means of light microscopy (or scanning electron microscopy) microphotographs and drawings (VILIČIĆ, 1985b). From cell density and cell volume data of each species, total cell volume was calculated according to SMAYDA (1978). Phytoplankton biomass in terms of carbon content was estimated from the total cell volume according to EPPLEY *et al.* (1970):

$\log_{10}C = 0.76 (\log_{10}V) - 0.352$ (diatoms)
$\log_{10}C = 0.94 (\log_{10}V) - 0.600$ (other taxonomic categories and nanoplankton)

where V is total cell volume ($\mu m^3\ l^{-1}$), and C organic carbon content ($pg\ l^{-1}$).

Microplankton was ranked in three taxonomic categories: *Bacillariophyceae* (BACI), *Dinophyta* (DINO), *Chrysophyceae* and *Prymnesiophyceae* (CHRY).

Temperature and salinity were determined by a HORIBA WATER CHECKER probe, model U-7. The precision of the temperature measurement method was ± 0.5 °C, and for electrolytic conductivity ± 2.5 mS m^{-2}.

RESULTS

Temperature and salinity values in the study areas during the period from July 1984 to June 1985 are presented in Figs. 2 and 3. Temperature in the Mali Ston Bay varied from 7.5 to

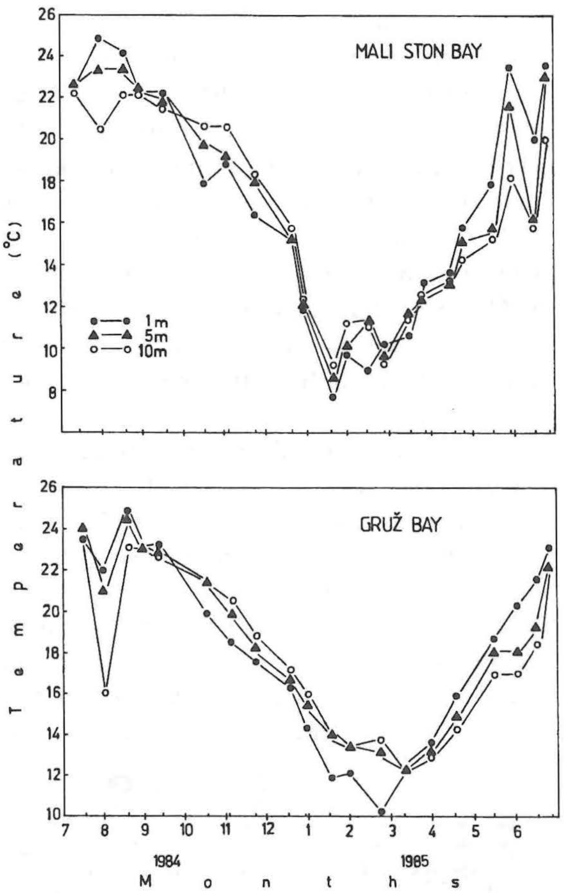

Fig. 2. Temperature variations at 1, 5 and 10 meters depth in the Mali Ston and Gruž bays

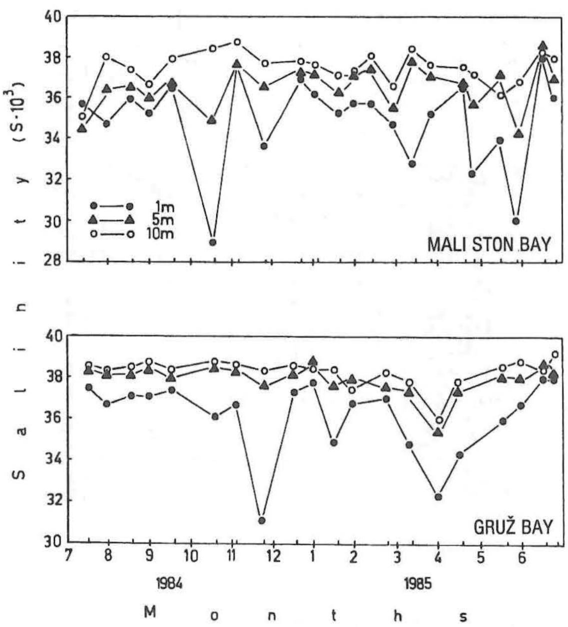

Fig. 3. Salinity variations at 1, 5 and 10 meters depth in the Mali Ston and Gruž bays

25.2 °C and in the Gruž Bay from 9.1 to 25.3 °C. Salinity values in the Mali Ston Bay ranged from 29.10 x 10^{-3} to 38.81 x 10^{-3} and in the Gruž Bay from 21.97 x 10^{-3} to 38.85 x 10^{-3}. The most pronounced vertical temperature and salinity gradients in both bays were noted in late July 1984. A temperature inversion occurred from October to March and was more pronounced in the Mali Ston than the Gruž Bay. Relatively stable salinity values were recorded at greater depths in the Gruž Bay throughout the investigated period.

The seasonal and vertical distribution of total phytoplankton carbon content at the investigated bays is presented in Fig. 4. The total phytoplankton carbon content ranged from 2.8 to 57.5 µg C l^{-1} in the Mali Ston Bay and 1.7 to 332.5 µg C l^{-1} in the Gruž Bay. Maximum total phytoplankton carbon content was noted in August during a pronounced vertical temperature and salinity gradients. Increased values were recorded in late spring in both bays. Mean annual phytoplankton carbon content in Gruž Bay was 1.8 times that of the Mali Ston Bay.

Contrary to Gruž Bay, no marked changes in vertical and seasonal distribution of microphytoplankton carbon contents were observed in Mali Ston Bay (Fig. 5). The microphytoplankton carbon content ranged from 0.258 to 51.7 µg C l^{-1} in the Mali Ston Bay and in Gruž Bay from 0.016 to 316.6 µg C l^{-1}. Microphytoplankton carbon content lower than 1.0 µg C l^{-1} was noted during the winter. Considering microphytoplankton carbon biomass, anual average ratio among diatoms, dinoflagellates and coccolithophorids was 4 : 26 : 1 in Mali Ston Bay and 1 : 60 : 1 in the Gruž Bay. As illustrated in Fig. 6, seasonal distribution of the microphytoplankton carbon content is dependent upon the distribution of *Dinophyta*. The contribution of dinoflagellates to microphytoplankton carbon content in Mali Ston Bay ranged from 47

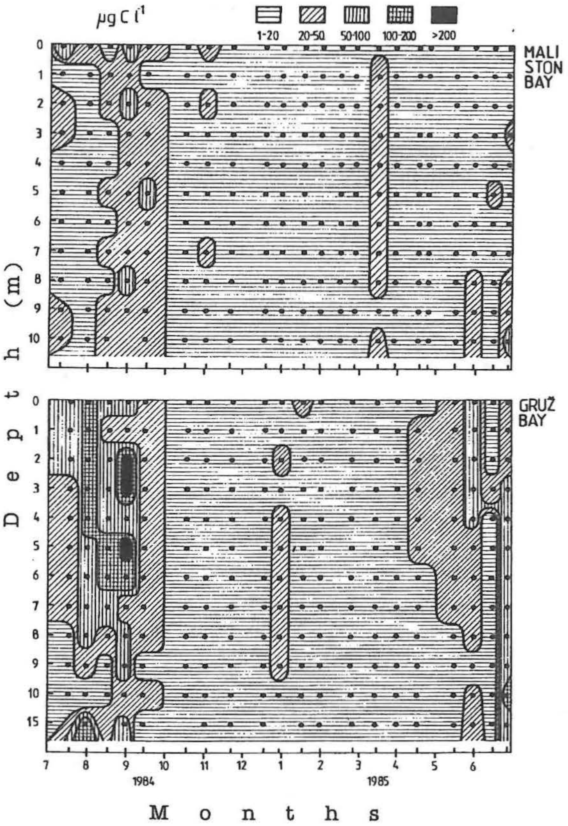

Fig. 4. Seasonal and vertical distribution of TOTAL PHYTOPLANKTON carbon contents in the Mali Ston and Gruž bays.

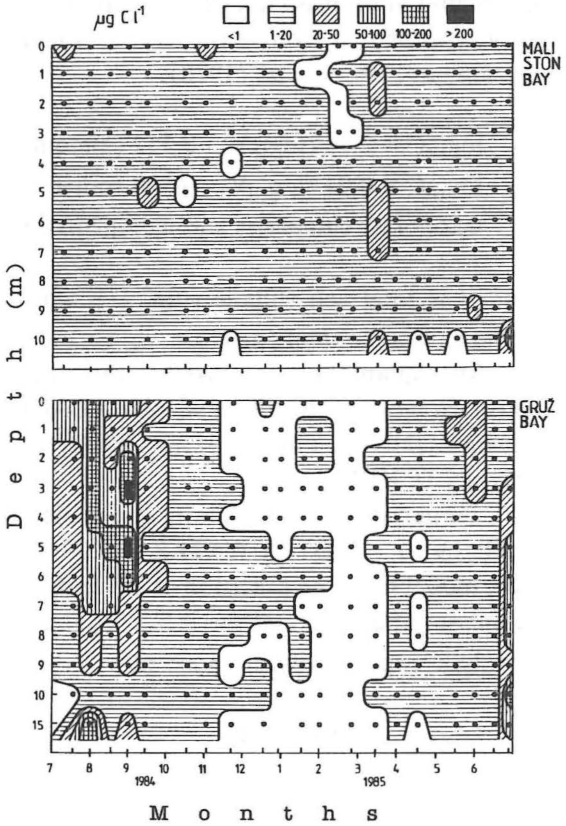

Fig. 5. Seasonal and vertical distribution of MICROPHYTOPLANKTON carbon contents in the Mali Ston and Gruž bays.

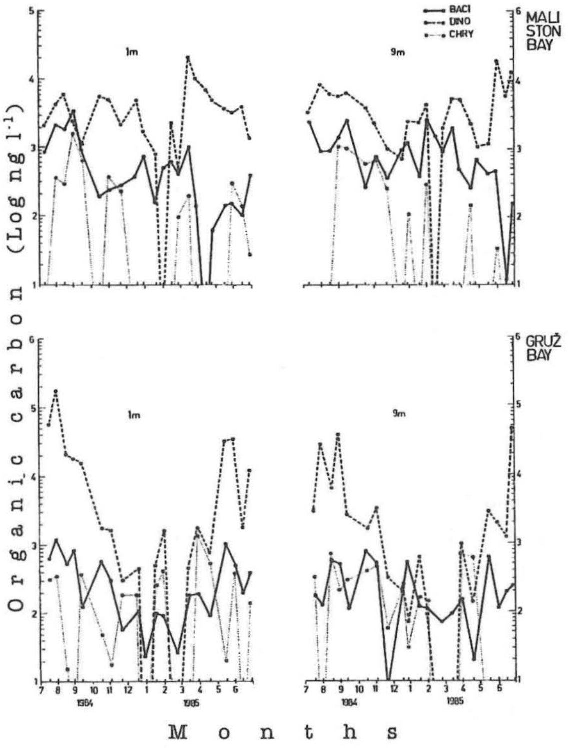

Fig. 6. Seasonal variations in the carbon content of taxonomic categories of microphytoplankton *Bacillariophyceae* (BACI), *Dinophyta* (DINO) and *Chrysophyceae* and *Prymnesiophyceae* (CHRY) at 1 and 9 meters depth in the Mali Ston and Gruž bays.

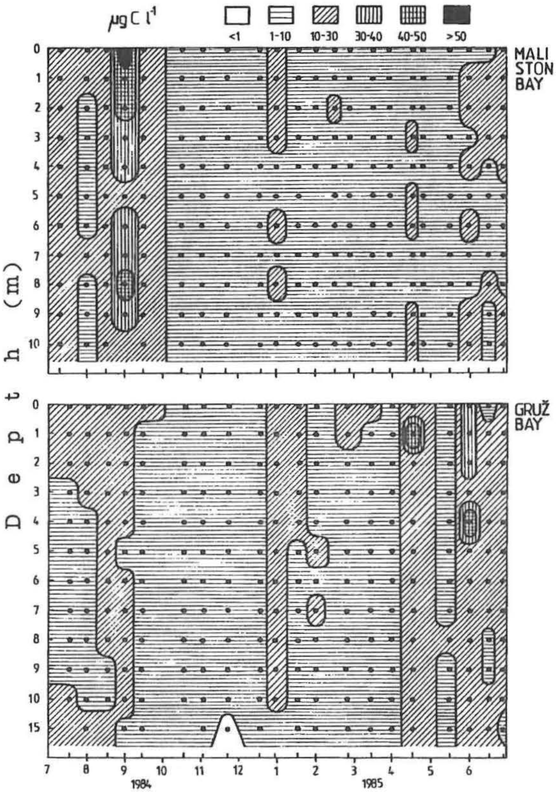

Fig. 7. Seasonal and vertical distribution of NANOPHYTOPLANKTON carbon contents in the Mali Ston and Gruž bays.

to 95% and in the Gruž Bay from 31 to 99%. The highest contribution of *Dinophyta* in both bays was recorded in August, and the lowest in February. In Mali Ston Bay, diatoms contributed 3% (May) to 52% (February) to microphytoplankton carbon contents, whereas in Gruž Bay from 0.5% (July) to 35% (February). A relative contribution of *Chrysophyceae* and *Prymnesiophyceae* to the microphytoplankton carbon content was higher in the Gruž Bay (0-51%) than Mali Ston Bay (0-12%). The presence of silicoflagellates was noted only during winter whereas coccolithophorids were present throughout the year without marked changes in carbon contents.

The average ratio between microphytoplankton and nanophytoplankton carbon contents was 0.69 in Mali Ston Bay and 1.9 in Gruž Bay. Increased nanophytoplankton values were noted in summer 1984 and spring 1985 in both bays (Fig. 7), whereas in Gruž Bay the same was observed in winter as well. Nanophytoplankton carbon content in Mali Ston varied from 1.7 to 50.0 µg C l^{-1}, whereas in Gruž Bay from 1.1 to 41.6 µg C l^{-1}. A relative contribution of nanoplankton to total phytoplankton carbon (Fig. 8) in Mali Ston varied from 22% (March) to 83% (August), while in Gruž Bay from 10% (July) to 97% (February). In general, higher contribution of nanoplankton to the total phytoplankton carbon was noted in winter, whereas lower in spring and summer.

DISCUSSION

Increased nano-, micro- and total phytoplankton carbon content values in Mali Ston and Gruž bays were recorded in surface layers in late spring, whereas the highest values were noted in sumer during a pronounced vertical temperature and salinity gradient. A rather simi-

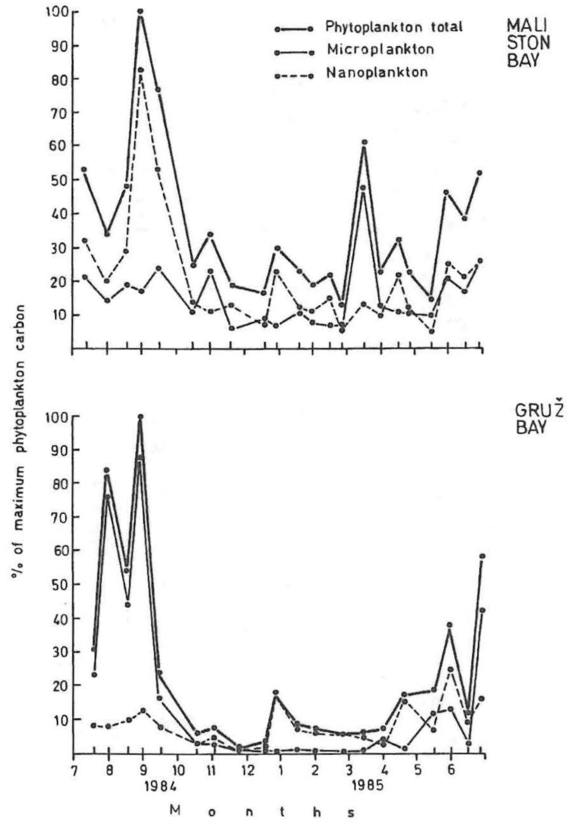

Fig. 8. Relative contribution of microplankton and nanoplankton to phytoplankton carbon contents in the Mali Ston and Gruž bays.

lar distribution pattern was observed in volume-derived biomass estimates (JASPRICA, 1989). The Gruž Bay had higher maximum and mean annual micro- and total phytoplankton carbon contents than Mali Ston Bay. In summer, sufficient nutrient quantities for the development of microphytoplankton population in Gruž Bay were supplied by the sewage waters (VUKADIN and STOJANOSKI, 1978). Due to an inflow of the open sea oligotrophic waters with specific physical-chemical characteristics into the Gruž Bay a lower winter nano-, micro- and total phytoplankton carbon contents and more pronounced seasonal fluctuations were observed in the Gruž Bay than in the Mali Ston Bay. The Mali Ston Bay is more closed than the Gruž Bay and therefore not directly influenced by the open sea waters.

Microphytoplankton carbon contents depend upon the contribution of diatoms to the phytoplankton population. Due to relatively large vacuoles, diatom cells have lower carbon contents per unit volume than same-sized cells of other phytoplankters (STRATHMANN, 1967). Therefore, a higher contribution of diatoms to microphytoplankton volume in Mali Ston than in Gruž Bay (JASPRICA, 1989) has resulted in a low microphytoplankton carbon contents in Mali Ston. HITCHCOCK (1983) found that plasma volume provides a more precise estimate of cell carbon than does the cell volume. Such an estimation must be done on non-preserved samples since the preservation destroys the protoplasma structure. According to WILLIAMS (1964), carbon content was correlated more to cell surface than volume. Studies on the relationship between volume and carbon contents cannot be considered completed and the formulae used are constantly being reworked with regard to the cell shape and taxonomic composition of phytoplankton population (ROTT, 1981; ROCHA and DUNCAN, 1985).

The distribution of nanophytoplankton carbon content is in accordance with the volume distribution (JASPRICA, 1989). However, the percentage of nanoplankton in total phytoplankton biomass is considerably higher if the biomass is expressed by carbon contents rather than volume. It is especially pronounced in Mali Ston Bay where nanoplankton in phytoplankton carbon biomass dominates through most of the year. In Gruž Bay, nanoplankton exceeded microplankton contribution to phytoplankton carbon biomass only during the winter which is in accordance with the data by VILIČIĆ (1985a) for volume-biomass ratio in the same bay. A reduced nanoplankton contribution to phytoplankton carbon contents in spring concurs with the data noted for other bays (DURBIN *et al.*, 1975; SMETACEK, 1981). In literature, there abound data from the different parts of the world on the nanoplankton domination in the phytoplankton population (MALONE, 1980; TAKAHASHI and BIENFANG, 1983; GEIDER, 1988). In the coastal waters of California, 2-12 μm nanophytoplankton size fraction comprises 20-55% of the phytoplankton carbon biomass (REID, 1983), whereas 2-5 μm size fraction in the subarctic Pacific 38% (BOOTH, 1988). In the

Chesapeake Bay during the summer, the contribution of 3-15 μm nanophytoplankton size fraction to phytoplankton carbon content amounted to 81% (RAY *et al.*, 1989). Other data on the nanophytoplankton contribution to phytoplankton carbon contents for the Adriatic are lacking, but the data presented in this paper is comparable to nanophytoplankton contribution to the concentration of chlorophyll *a* (SMODLAKA, 1981; FAGANELI *et al.*, 1989) and primary production (GILMARTIN and REVELANTE, 1980).

Maximum microphytoplankton carbon content in Mali Ston and Gruž bays is relatively low if compared to the literature data for the Mediterranean (ANDREOLI and TOLOMIO, 1985; TRAVERS and KIM, 1985) and the Atlantic ocean (DURBIN *et al.*, 1975; FURNAS, 1983). Summer microphytoplankton carbon contents in the study area are comparable to the most frequent values recorded at the surface in the northern Adriatic in July 1984 (VILIČIĆ and JASPRICA, 1990). Organic microphytoplankton and nanophytoplankton values were 50-100 and 30-50 times lower, respectively, in the open middle and southern Adriatic waters than those registered during the present study. When comparing volume-derived phytoplankton carbon estimates from different areas, phytoplankton population structure should be considered also. A relative contribution of carbon content in taxonomic categories to microphytoplankton carbon contents is dependent upon their respective contribution to the microphytoplankton population density and volume. More precise cytomorphometric investigations by fluorescent microscopy (BOOTH, 1987) will facilitate future research and give a more accurate estimation of the phytoplankton carbon from volume.

REFERENCES

ANDREOLI, C. e C. TOLOMIO. 1985. Indagine preliminare sulla biomassa fitoplanctonica in Val Dogà (Laguna di Venezia). Oebalia, 11: 157-165.

ANDREOLI, C. e C. TOLOMIO. 1988. Ciclo annuale del fitoplancton in una valle da pesca della laguna di Venezia. Archo Oceanogr. Limnol., 21: 95-115.

BANSE, K. 1977. Determining the carbon-to-chlorophyll ratio of natural phytoplankton. Mar. Biol., 41: 199-212.

BOOTH, B. C. 1987. The use of autofluorescence for analyzing oceanic phytoplankton communities. Botanica mar., 30: 101-108.

BOOTH, B. C. 1988. Size classes and major taxonomic groups of phytoplankton at two locations in the subarctic Pacific Ocean in May and August, 1984. Mar. Biol., 97: 275-286.

BULJAN, M. 1964. Ocjena produktivnosti Jadrana dobivena na temelju njegovih hidrografskih svojstava. Acta Adriat., 11(4): 35-45.

DURBIN, E. G., R. W. KRAWIEC and T. J. SMAYDA. 1975. Seasonal studies on the relative importance of different size fractions of phytoplankton in Narragansett Bay (USA). Mar. Biol., 32: 271-287.

EPPLEY, R. W., F. M. H. REID and J. D. H. STRICKLAND. 1970. The ecology of the plankton off La Jolla, California, in the period April through September 1967. III Estimates of phytoplankton crop size, growth rate and primary production. Bull. Scripps Inst. Oceanogr., 17: 33-42.

EPPLEY, R. W., W. G. HARRISON, S. W. CHISHOLM and E. STEWART. 1977. Particulate organic matter in surface waters off Southern California and its relationship to phytoplankton. J. mar. Res., 35: 671-695.

FAGANELI, J., M. GAČIĆ, A. MALEJ and N. SMODLAKA. 1989. Pelagic organic matter in the Adriatic Sea in relation to winter hydrographic conditions. J. Plankton Res., 11: 1129-1141.

FURNAS, M. J. 1983. Community structure, biomass and productivity of size-fractionated summer phytoplankton populations in lower Narragansett Bay, Rhode Island. J. Plankton Res., 637-655.

GEIDER, R. J. 1988. Abundances of autitrophic and heterotrophic nanoplankton and the size distribution of microbial biomass in the southwestern North Sea in October 1986. J. Exp. Mar. Biol. Ecol., 123: 127-145.

GILMARTIN, M. and N. REVELANTE. 1980. Nutrient input and summer nanoplankton bloom in the northern Adriatic Sea. P. S. Z. N. I.: Marine Ecology, 1: 169-180.

GOLDMAN, J. C., J. J. MCCARTHY and D. G. PEAVEY. 1979. Growth rate influence on the chemical composition of phytoplankton in oceanic waters. Nature, 279: 210-215.

HITCHCOCK, G. L. 1983. An examination of diatom area: volume ratios and their influence on estimates of plasma volume. J. Plankton Res., 5: 311-324.

HOLM-HANSEN, O. 1970. ATP levels in algal cell as influenced by environmental conditions. Pl. Cell. Physiol., 11: 689-700.

HOLM-HANSEN, O. and C. R. BOOTH. 1966. The measurement of adenosine triphosphate in the ocean and its ecological significance. Limnol. Oceanogr., 11: 510-519.

HUNTER, B. L. and E. A. LAWS. 1981. ATP and chlorophyll *a* as estimators of phytoplankton carbon biomass. Limnol. Oceanogr., 26: 944-956.

JASPRICA, N. 1989. Distribution of the phytoplankton population density and volume-biomass in the Mali Ston and Gruž bays (the southern Adriatic). Ekologija, 24: 83-96.

MALONE, T. C. 1980. Size-fractioned primary productivity of marine phytoplankton. In: P. Falkowski (ed.), Primary productivity in the Sea. Brookhaven Symposia in Biology, 31: 301-319.

MARASOVIĆ, I. and T. PUCHER-PETKOVIĆ. 1981. Promjene produkcijskih prilika u Malostonskom zaljevu nakon 17-godišnjeg perioda. Zbornik radova Savjetovanja "Malostonski zaljev prirodna podloga i društveno valoriziranje", Dubrovnik, pp. 89-107.

MULLIN, M. M., P. R. SLOAN and R. W. EPPLEY. 1966. Relationship between carbon content, cell volume and area in phytoplankton. Limnol. Oceanogr., 11: 307-311.

PUCHER-PETKOVIĆ, T. et M. ZORE-ARMANDA. 1973. Essai d' évaluation et pronostic da la production des factuers du milieu dans l' Adriatique. Acta Adriat., 15(1): 1-37.

PUCHER-PETKOVIĆ, T., I. MARASOVIĆ and B. HOMEN. 1978. Fitoplankton. In: Ekološka proučavanja šireg područja Dubrovačke Rijeke, 72-81. Studije i elaborati Instituta za oceanografiju i ribarstvo, Split.

RAY, R. T., L. W. HAAS and M. E. SIERACKI. 1989. Autotrophic picoplankton dynamics in a Chesapeake Bay sub-estuary. Mar. Ecol. Prog. Ser., 52: 273-285.

REID, F. M. H. 1983. Biomass estimation of components of the marine nanoplankton and picoplankton by the UTERMÖHL settling technique. J. Plankton Res., 5: 235-252.

RIEMANN, B., P. SIMONSEN and L. STENSGAARD. 1989. The carbon and chlorophyll content of phytoplankton from various nutrient regimes. J. Plankton Res., 11: 1037-1045.

ROCHA, O. and A. DUNCAN. 1985. The relationship between cell carbon and cell volume in freshwater algal species used in zooplanktonic studies. J. Plankton Res., 7: 279-294.

ROTT, E. 1981. Some results from phytoplankton counting calibrations. Schweiz. Z. Hydrol., 43: 34-62.

SMAYDA, T. J. 1978. From phytoplankters to biomass. In. A. Sournia (Ed.), Phytoplankton manual. UNESCO, Paris, pp. 273-279.

SMETACEK, V. 1981. The annual cycle of protozooplankton in the Kiel Bight. Mar. Biol., 63: 1-11.

SMODLAKA, N. 1981. Nanoplankton contribution to the primary production and chlorophyll *a* biomass of the west Istrian coastal waters. Rapp. Comm. int. Mer. Médit., 27(9): 127-130.

STEELE, J. H. and D. W. MENZEL. 1962. Conditions for maximum primary productions in the mixed layer. Deep-Sea Res., 9: 39-49.

STRATHMANN, R. R. 1967. Estimating the organic carbon content of phytoplankton from cell volume or plasma volume. Limnol. Oceanogr., 12: 411-418.

TAKAHASHI, M. and P. K. BIENFANG. 1983. Size structure of phytoplankton biomass and photosynthesis in subtropical Hawaiian waters. Mar. Biol., 76: 203-211.

TRAVERS, M. et K. T. KIM. 1985. Comparasion entre plusieurs estimations de biomasse phytoplanctonique dans deux milieux très differents. Rapp. Comm. int. Mér. Medit., 29(9): 155-157.

UTERMÖHL, H. 1958. Zur Vervollkommung der quantitativen Phytoplankton - Methodik. Mitt, Int. Ver. Theor. Angew. Limnol., 9: 1-38.

VILIČIĆ, D. 1985a. Phytoplankton study of southern Adriatic waters near Dubrovnik for the period from June 1979 to July 1980. CENTRO, 1: 35-56.

VILIČIĆ, D. 1985b. An examination of cell volume in dominant phytoplankton species of the middle and southern Adriatic waters. Int. Rev. Ges. Hydrobiol., 70: 829-843.

VILIČIĆ, D. 1989. Phytoplankton population density and volume as indicators of eutrophication in the eastern part of the Adriatic Sea. Hydrobiologia, 174: 117-132.

VILIČIĆ, D. i N. JASPRICA, 1990. Raspodjela biomase fitoplanktona u Jadranskom moru u srpnju 1984. Pomorski zbornik, 28: 631-641.

VUKADIN, I. 1989. The ecosystem of the Bay of Mali Ston natural and anthropogenic influence. Toxicol. Environ. Chem., 20/21: 209-215.

VUKADIN, I. i L. STOJANOSKI. 1978. Stupanj eutrofizacije. In: Ekološka proučavanja šireg područja Dubrovačke Rijeke. Studije i elaborati Instituta za oceanografiju i ribarstvo, Split.

ZORE-ARMANDA, M. 1978. Dinamika mora. In: Ekološka proučavanja šireg područja Dubrovačke Rijeke. Studije i elaborati Instituta za oceanografiju i ribarstvo, Split.

Williams, R. B. 1964. Division rates of salt marsh diatoms in relation to salinity and cell size. Ecology, 45: 877-880.

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Prosudba količine organskog ugljika fitoplanktona u Malostonskom i Gruškom zaljevu (južni Jadran)

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KRATKI SADRŽAJ

Istraživanje fitoplanktona u Malostonskom i Gruškom zaljevu izvršeno je u periodu od srpnja 1984. do lipnja 1985. godine. Količina organskog ugljika fitoplanktona, prosuđena iz volumena, analizirana je dvaput mjesečno, po dubini u intervalima od jedan metar. Maksimalna količina organskog ugljika nanofitoplanktona, mikrofitoplanktona i ukupnog fitoplanktona u oba zaljeva je zabilježena u površinskom sloju ljeti za vrijeme izraženog vertikalnog gradijenta temperature i saliniteta. Maksimalne vrijednosti mikrofitoplanktona (51.7 $\mu g\ C\ l^{-1}$ u Malostonskom i 316.6 $\mu g\ C\ l^{-1}$ u Gruškom zaljevu) su, u usporedbi s podacima iz literature za Mediteran, bile relativno niske.

Nanoplankton je u količini ugljika fitoplanktona sudjelovao u Malostonskom zaljevu s 22-83%, a u Gruškom s 10-97%. Tijekom većeg dijela godine u mikrofitoplanktonskoj populaciji su dominirali dinoflagelati, a njihov udio u količini mikrofitoplanktonskog ugljika bio je u Malostonskom zaljevu 47-95%, a u Gruškom 31-99%.