less exposed to intraspecific competition for holes, also choose holes with an entrance diameter twice as big as their head diameter. *P. zvonimiri* also occupies holes much longer than its body, while the majority of smaller endolithic species dwell in holes that are approximately as long as their body. Species living in shallow waters prefer sunny hole positions, while *P. rouxi* and *P. zvonimiri* were mostly found in the shade of boulders and rocks. *A. sphynx*, which lives in the mediolittoral belt, avoids competition with other species by choosing vertical holes, while other species mostly occupy horizontal holes.

Six males of *P. zvonimiri* and 6 males of *P. incognitus* were used in laboratory experiments. During 6 series of experiments we found a positive correlation between the rank (the dominance) of males and the access to the hole. Our findings confirm the thesis of "wide territoriality", in which a male defends a net of holes and not just one hole in his territory. *P. zvonimiri* predominates over *P. incognitus*. In the natural environment *P. zvonimiri* dwells in a smaller number of microhabitats then *P. incognitus*. For this reason, it has to defend more successfully its own territory and nests than *P. incognitus*, which is a widely distributed species and could find nesting holes in very different microhabitats.

The results of single-species experiments confirm our field observations, in which *P. zvonimiri* and *P. incognitus* males choose the widest available holes. Both species dwell in holes that are longer than their bodies. In two-species experiments, males of *P. incognitus* were forced to occupy the shortest holes, which confirms the dominance of *P. zvonimiri*. During the series of experiments with differently inclined holes in the aquarium, the two dominant males mostly occupied horizontal holes and holes with 135ş of inclination.

The dissertation gives new knowledge on the ecology of blennies and also useful information about the ecological conditions of hard bottom microhabitats in the marine coastal area. These kinds of habitats are very important not only for blennies, but also for the whole fish assemblage and benthic flora and fauna.

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THE ECOLOGICAL CHARACTERISTICS OF PLANKTONIC DINOFLAGELLATES (Dinophyceae) IN THE GULF OF TRIESTE WITH AN EMPHASIS ON TOXIC SPECIES

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Dinoflagellates are important members of the phytoplankton community in the coastal sea. In temperate regions, dinoflagellates achieve maximal abundance in the late spring and summer period. They are generally well adapted to environments with low turbulence and low nutrient concentrations. Their directional swimming ability is one of adaptation strategies to overcome scarce nutrient availability. Diel vertical migrations through the water column allow dinoflagellates an adequate nutrient uptake, as well as to avoid grazing and high light intensities. The ability to actively choose their depth is an important contributing factor to dinoflagellate bloom formation, but differs among different species and under different environmental conditions. Dinoflagellates blooms may sometimes have harmful consequences on marine ecosystem and humans. Among various types of intoxication, two are of major importance in the Gulf of Trieste, as their causative organisms are commonly found in the northern Adriatic. First is diarrhetic shellfish poisoning (DSP), which is caused mainly by various species of the genus *Dinophysis*. Second, and more dangerous, is paralytic shellfish poisoning (PSP) caused by some species of the genus *Alexandrium*. At shellfish farms on the Slovenian coast, DSP occurs almost every year, and results in the ban on shellfish sale. PSP, however, has not been observed in this area thus far, despite the persistent occurrence of *Alexandrium* in water samples. Recently, there has been a growing interest in new toxin types, such as the yessotoxins. They are produced by *Lingulodinium polyedrum* and *Protoceratium reticulatum* regularly found in the phytoplankton community of the Gulf of Trieste.

The aim of the study was to advance the knowledge of dinoflagellate ecology in two ways. In the first place, long-term data were analyzed in order to uncover seasonal occurrence patterns of toxic dinoflagellates and to determine the predictability of succession of most recurrent *Dinophysis* species. Sea water was sampled from 1995 to 2003 and examined with the use of an inverted microscope. Data from different depths at two sampling sites in the vicinity of shellfish farms were compared. Correlations between some environmental parameters and the abundance of toxic species for the year 1997 were investigated as well. The occurrence pattern of most frequent and abundant *Dinophysis* species was analyzed using the STATIS multivariate analysis. Secondly, to asses the ability of the dinoflagellate species to perform active vertical movements, two 24-hour samplings of the water column were carried out. In order to include the entire set of environmental stresses that dictate the organisms' response, sampling in the natural water environment was chosen. Samples were taken at 4-hour intervals at different depths. The first 24-hour sampling was performed in November during a period of a mixed water column, while the second was performed under stratified water column conditions in June. Combining the findings from the two parts of this study, improvements were suggested

for more effective management and mitigation of harmful dinoflagellate blooms.

During the nine year investigation period, 20 species of toxic and potentially toxic dinoflagellates from the Gulf of Trieste were discovered. 16 *Dinophysis* species were present in the water column, predominantly in the second half of the year. They displayed two yearly abundance maxima in the surface layer: the first in late-spring and the second in autumn. In the middle layer, there was no spring peak, and cell abundance increased gradually from June until the autumn peak. Only four *Dinophysis* species were predominant in water samples and showed a clear succession through time: *D. sacculus* is a typical late-spring species that peaks in June. Simultaneously with *D. sacculus*, *D. caudata* appears in water samples, but reaches its maximum in September. *D. rotundata*, which is present in samples throughout the second half of the year, peaks twice, once in June and again in October. Finally, the presence of *D. fortii* is limited to the autumn period. The lowest abundances were observed (<25 cells l^{-1}) for *D. rotundata*, whereas the other three species occasionally attained cell numbers high enough to cause DSP events (from 100 to several 1000 cells l^{-1}).

Generally, the *Alexandrium* species were present in water samples through the whole year. They were most abundant during the spring and early summer period, while their lowest abundance was recorded between August and December. Small species were predominant in the *Alexandrium* genus, except in June, when *A. pseudogonyaulax* prevailed. The seasonal dynamics of *Alexandrium* was similar in the surface and middle water layers, though abundances were slightly lower in the latter. During peaks, the *Alexandrium* species reached abundances as high as several 100 to several 1000 cells l^{-1}. Two other potentially harmful species, *L. polyedrum* and *P. reticulatum*, whose appearance was limited to the late-spring and summer months, reached their maximum abundance in June.

Some statistically significant correlations were found between species abundance and environmental parameters in the surface layer at station 0024 in 1997. Salinity seemed to be the most important environmental factor, as a number of correlations were found between this factor and species abundance. Correlations between salinity and *Dinophysis* were species specific, while for the *Alexandrium* genus correlation was strictly negative in concordance with literature data. As regards cell numbers during peaks, all species of interest showed considerable inter-annual variability, although they had stable seasonal occurrence patterns. This possibly implies the involvement of stochastic processes, such as wind and current driven cell accumulation and specific environmental variations. Harmful outbursts of such organisms are thus not easily predictable in spite of our knowledge of seasonal dynamics.

The 24-hour samplings both under mixed water column conditions in November and stratified water column conditions in June showed the susceptibility of the shallow coastal sea to short-term alterations. Vertical profiles of temperature, salinity, and density in November confirmed the mixed conditions, since the parameters were uniform along the water column. They changed temporarily only within the first two meters due to the passage of a freshwater front. Despite uniform vertical conditions, migration of the dinoflagellate community through the water column was observed. Autotrophic dinoflagellates (the *Alexandrium* and the *Heterocapsa* species) displayed distinctive day-night dynamics: during daylight, cells accumulated in the surface layer, but gathered mostly near the bottom during the night. Species from the mainly heterotrophic genera *Protoperidinium* and *Diplopsalis* altered their vertical position as well, yet these movements did not coincide with the day-night cycle.

Water column conditions were even more variable during the June 24-hour sampling, when water column stratification was repeatedly disturbed and re-established. Vertical movement under such conditions differed substantially between species. Diel vertical migrations were observed for most of the predominating autotrophic dinoflagellates: *Heterocapsa* spp., *Prorocentrum micans*, *P. triestinum*, *Scrippsiella* spp., *Ceratium furca* and *D. sacculus*. By contrast, diel vertical migrations were not observed for the mostly heterotrophic naked dinoflagellates, for the *Protoperidinium* species and phagotrophic *D. rotundata*.

The expected difference between the vertical migrations of dinoflagellates under stratified and mixed water column conditions was therefore not confirmed. In a constantly changing shallow water column environment, dinoflagellates may preserve their movement pattern as a possible advantage in the exploitation of their environment as well as to avoid grazing. Diel vertical migrations are thus more likely an expression of internal rhythms than a response to environmental conditions. The great dissimilarity in the timing and degree of vertical movements among different species and the possible accumulation of cells in thin layers dictate careful planning of a monitoring programme for toxic species. Thus, sampling should be carried out within as many layers as possible. Integrated water samples from layers of the entire water column should be examined for easier, more accurate and more rapid evaluation.