Biodiversity of the Western Black Sea

By Dragos Micu and Valentina Todorova

During the summer of 2007 a Bulgarian-Romanian diving team of marine biologists carried out a series of expeditions along the Western Black Sea coast with the main goal of identifying sites suitable for designation as Marine Protected Areas. We found more than we expected, including discoveries that went far beyond the initial scope of our project and which we feel deserve a broader audience.

A newly-discovered unique habitat

We were diving along the rocky shores of the Southern Bulgarian coast, searching for live oysters to verify their occurrence. To our surprise, we came across *Ostrea edulis* biogenic reefs, a new type of habitat and unique to European seas – and probably the world.

(a). Flat oyster (*Ostrea edulis*) biogenic reef.

"Ostrak" is what these reefs are called by local fishermen. They think the name comes from the Bulgarian word "ostar," meaning sharp, and associate it with the edges of oyster shells sticking out from the reef, sharp enough to cut the hands or the neoprene suit of a careless diver. However, in the authors' opinion the name originates from "Ostrakon," meaning oyster shell, and was probably given to the oyster reefs by the ancient Greeks who first witnessed their existence thousands of years ago.

Unlike other European biogenic reefs, dominated by tube-building polychaetes such as *Sabellaria* (Porras *et al.,* 1996; Gruet, 1985; Moore, 1996), *Serpula vermicularis* (Earll, 1992; Bosence, 1973), *Ficopomatus enigmaticus* (Micu & Micu, 2004) or mussels like *Mytilus* (Gosling, 1992) and *Modiolus* (Magorrian *et al.,* 1995), the ostrak is built almost exclusively by the flat oyster, *Ostrea edulis*. Small serpulid polychaetes do occur on the ostrak also, but, if we imagine ostrak as a fortress wall, then the oysters are the stones and the polychaetes are the cement – a very thin one, that is.

Unlike the oyster beds commonly known from the intertidal of Western Europe and North America – 7m in height, 30-50m in length and 10m in width for each mound – Black Sea ostrak are massive, towering biogenic structures, dwarfing the human observer.

Unlike the small, estuarine oyster reefs built by *Crassostrea virginica* on the south-eastern US coast (Posey et *al.,* 2003; Grizzle *et al.,* 2002), ostrak reefs occur in clear marine waters with no freshwater input, forming a belt between 7 and 23m in depth, parallel to rocky coasts. Smaller ostrak formations may also occur on rocky offshore reefs or as a sponge-like structure adhering to rocky vertical drop-off faces.

Local people have pointed out many locations where ostrak is present but, due to the limited time and resources, we were only able to dive briefly at three sites. These reefs were overgrown by sponges, mussels *(Mytilus galloprovincialis)* and algae *(Delesseria ruscifolia* and *Zanardinia prototypus)* and harboured a very diverse marine life. While fresh oyster shells were visible on the reefs, no live oysters were recorded at these sites (see photo b).

Only a few years ago, local people collected live oysters from these very reefs and there are many more sites at which we could not dive, so we are hopeful that other oyster reefs in the

(b). *Ostrea edulis* reef with no live oysters.

area may still be alive.

Our discoveries have raised some questions:

1. Do live reefs still exist? We are currently trying to find funding to carry out more extensive field research which will allow us to map all the sites where ostrak habitat occurs. During this search, we hope to discover some live oyster reefs.

2. Why did the oysters perish at the sites investigated by us? The oysters were never commercially fished, and recreational harvest was very limited, so overfishing can be ruled out as a cause of extinction. Were oysters killed by eutrophication and diseases brought with cultured *Crassostrea gigas* in the Russian part of the Black Sea? Were they decimated by the alien predatory whelk *Rapana venosa*? More research is needed to find out.

3. Is oyster reef restoration possible? The idea of restoring the amazing Ostrak reef ecosystem came to us as soon as we discovered the reefs, but it is very clear that any attempt at reintroduction is futile while we don't understand the reasons/causes behind the oyster reefs die-out in the first place.

Rare species

We encountered a number of rare species during our dives – among them, the Ponto-Caspian relicts *Neogobius kessleri* and

Syngnathus abaster, both found in the Veleka River estuary. This is a new distribution record for *Neogobius kessleri,* previously known only from the Danube, Danube Delta, Dniester and adjacent lakes (Banarescu, 1964; Jivkov & Karapetkova, 2007).

Other Mediterranean fishes, rare in the Black Sea, were *Chromis chromis, Diplodus annularis, Gobius bucchichi, Gobius paganellus, Zosterisessor ophiocephalus, Arnoglossus kessleri, Uranoscopus scaber, Gobius cobitis, Salaria pavo, Blennius ocellatus, Coryphoblennius galerita, Aphia minuta* and *Nerophis ophidion.*

We found several bivalve molluscs which are rare for the Black Sea (Dumont, 1999; Micu, 2004): *Loripes lacteus* in fine sands, *Petricola lithophaga* in sandstone, *Teredo navalis* in wooden debris and *Pholas dactylus* in marl, the latter species listed in the Bern and Barcelona Conventions (Micu, 2007; SoHelME, 2005).

Rare crustaceans (Dumont, 1999; Micu & Micu, 2006) which we found included the barnacle *Chthamalus stellatus,* the endemic mysids *Hemimysis* sp, the thalassinid *Pestarella candida,* the crab *Polybius navigator* and the hermit crab *Clibanarius erythropus.*

Phyllophora nervosa, Delesseria ruscifolia, Laurencia sp and *Zanardinia prototypus* should be pointed out as rare algae (Dumont, 1999; Dimitrova-Konaklieva S, 2000) that we found along the Bulgarian coast.

Climate change-induced phenomena in the Western Black Sea

The Black Sea has, by and large, two climate types: submediterranean on the eastern and southern coasts, and Crimean and temperate on the western and northern coasts. The temperate climate on the western coasts has provided, until now, suboptimal conditions for the development of the alien predatory gastropod *Rapana venosa,* which originates from the warmer Asian seas (Sea of Japan to Hong Kong). Although a common and well adapted species, *Rapana* has never caused local extinction or generalised stock depletion of its bivalve prey species on the western coast. We could say that its invasiveness has proven to be only mild to medium here, and with the onset of commercial fisheries for it in the 1980s, *Rapana* became more a resource than a threat.

We have heard through personal communications, as well as reading in Russian scientific papers, about the occurrence of massive settlements of the alien predatory

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(c). *Rapana* settlement.

gastropod *Rapana venosa* in the Eastern Black Sea (Chikina & Kucheruk, 2005). These cyclic events lead to high densities of young *Rapana,* which wipe out all prey items available in the area before dying off of starvation, which in turn leads to the onset of impoverished and dysfunctional ecosystems. For us who, for decades, lived “peacefully” on the western coast, with *Rapana* well-integrated in our marine ecosystems and a major cash crop for our commercial fisheries, these accounts, even when properly illustrated, were hard to believe. Well, not anymore!

In 2006 and 2007, massive settlement of *Rapana* juveniles occurred at many sites along the Bulgarian coast. Shallow rocky shores and offshore reefs seem to be the preferred sites for such events. We have witnessed and documented incredible densities, with the substrate completely covered with a compact blanket of *Rapana* juveniles of the 0+ to 1+ year-classes. The bivalve populations of the area are completely obliterated, even the smallest species, such as *Mytilaster lineatus.* The whelks then resort to scavenging, consuming all corpses available in the area: fishes, crabs and even seabirds (see photo c). As a last resort, we have observed for the first time cannibalism among *Rapa* whelks, with large, older whelks attacking one of the many juveniles around them, but also with several juveniles attacking together a larger whelk, weakened by starvation.

This *Rapana* superinvasion changes the reef ecosystem drastically and is bound to interfere with the lives of other species inhabiting the reef. The onset of starvation affects not only *Rapanas* but all of the other species of invertebrates and demersal fishes which depend on mussels as their staple food. Those which are mobile enough, like the fishes, will leave the reef for better pastures, while those which are less mobile, like crabs, will starve and eventually die, only to be consumed by the whelks. This leads to a massive loss of biodiversity and impaired reef ecosystem functioning.

Few species can cope with the new conditions, but some do. Until now, there have been very few natural enemies of *Rapana* known from the areas it has invaded around the globe. In the Chesapeakes, blue crabs *Callinectes sapidus* consumed *Rapana* in laboratory experiments, but it is not known if they do so in nature (Harding, 2003). Seastars eat *Rapana* in and around the Bosphorus (Zaitsev & Ozturk, 2001), but they do not live in the Black Sea proper.

On the Bulgarian coast, we have documented for the first time the consumption of *Rapana* by a native species in the wild. The robust crab *Eriphia verrucosa* is strong enough to crush the shells of juvenile *Rapana* and eat them. This is probably why densities of the crab seem unchanged on the reefs affected by the *Rapana* superinvasion (see photo d).

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(d). Robust crab (*Eriphia verrucosa*).

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(e). Red mullet (*Mullus surmuletus*).

Eriphia verrucosa is not a dedicated predator of *Rapana*, normally preferring easier prey such as mussels and smaller crabs. In the event of a superinvasion, however, it is able to switch to a diet of young *Rapanas* and survive. But this is all we can expect from this crab; it is very unlikely that *Eriphia verrucosa* will ever be able to control *Rapana venosa* effectively in the wild.

For the first time, we documented the occurrence of *Mullus surmuletus* all over the Bulgarian coast and at southern Romanian sites. Its only available record from the Black Sea until now refers to the Bosphorus Strait inside Istanbul city (Hureau, 1991). The red mullet's spread to the north is another clear indication of the Black Sea's accelerated mediterranisation, associated with global climate change (see photo e).

Further evidence was provided by the supralittoral association of the barnacle *Chthamalus stellatus* and the snail *Melaraphe neritoides*, whose northern limit used to be at cape Kaliakra but which has extended around 30km northwards to Tyulenovo village.

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Dragos Micu
National Institute of Marine Research and Development, "Grigore Antipa,"
Email: ddrraaggoossmm@yahoo.com

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The Mediterranean & Black Seas

SESAME:

Southern European Seas: Assessing and Modelling Ecosystem Changes

Participants on the first training course in Plankton Production, held at the Hellenic Centre for Marine Research, Greece, in July 2007.

The Integrated Project SESAME IP, launched in November 2006, is a four-year project funded by the EC's 6th Framework Programme. It is designed to study the past, present and future environmental changes in the Mediterranean and Black Sea ecosystems, and how these affect their abilities to provide goods and services with fundamental societal importance, such as tourism, fisheries, mitigation of climate through carbon sequestration, and ecosystem stability through conservation of biodiversity.

SESAME unites scientists from more than 20 countries to investigate the current status of the Mediterranean and the Black Seas. With the help of historical data, in combination with newly collected data, SESAME aims to identify the environmental changes these regions have experienced over the last 50 years. For the first time, the two seas will be approached as a coupled climatic/ecosystem entity. The goal is, based on past and current status, to predict possible changes within the next 50 years. The project will thus provide the basis for developing and implementing sustainable development policies and strategies within these regions, by involving and assisting the relevant stakeholders, especially in a time of strong climate change debates. SESAME's multidisciplinary approach will bring together natural scientists and socio-economists.

Exploring the Mediterranean and the Black Sea

Although regional data are already available, they were, until now, hardly accessible to the international scientific community due to language barriers. During the first year of the project, previously collected historical and current multidisciplinary datasets of physicochemical and biological parameters will be analysed for signals of environmental changes and trends. During the second year, two multidisciplinary and multiship seasonal research cruises will cover the entire Mediterranean and Black Sea basins (see coloured map lines for transects, Fig. 1) in order to collect new information about the actual status of the two ecosystems.

Ten oceanographic research vessels will simultaneously conduct these cruises, which are planned for March-April 2008 and for August-September 2008. The collected high-quality *in situ* data from all the cruises will be used to tune and validate the basin-scale and sub-regional models, and feed the SESAME databases.

Data collection for model validation began at the beginning of SESAME in the seven sub-regional areas, shown as shaded rectangles on the map.

Ten 3D coupled biogeochemical-hydro-dynamical models, three at basin scale (Mediterranean, Black sea and the whole SES area) and seven at regional scale (five sub-basins and the straits – TSS and Gibraltar), as well as a 1D model referring to carbon export, have already been described in terms of their structure, the basic hypotheses on which they rely (e.g. functional/sized classes organisation of the ecosystem) and their resolution. These models will be used for the assessment of the ecosystem functioning modifications that have taken place in the last 50 years. The same models will be used for the prediction of future changes in the ecosystems. Particular focus has been placed on identifying the limitations of the models and the extension/improvement needed to be able to address SESAME's objectives.

The semi-quantitative fields of economics and social sciences will be fully addressed over five study areas (see map). Study of these areas will explore the possibility of transferring and/or adapting state-of-the-art analytical

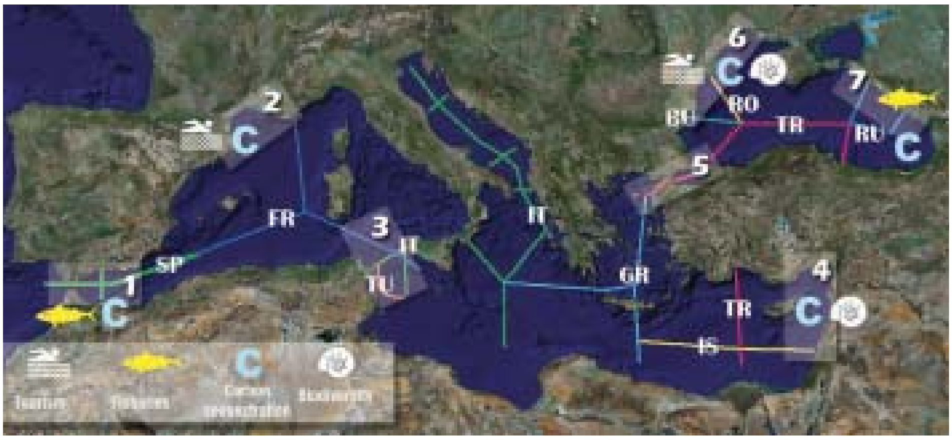

Figure 1. Study area for the SESAME project.