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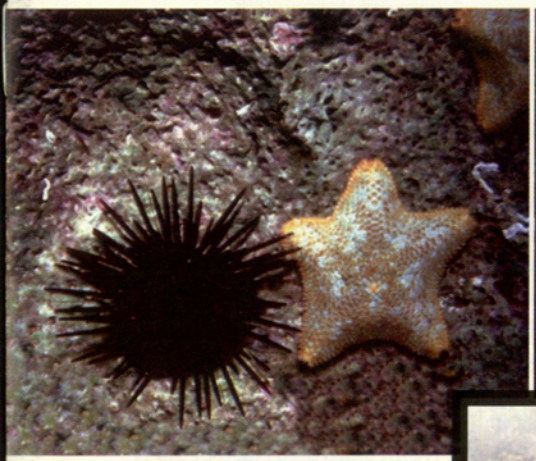

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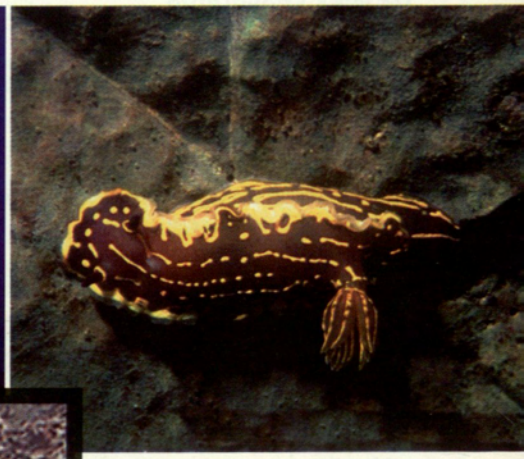

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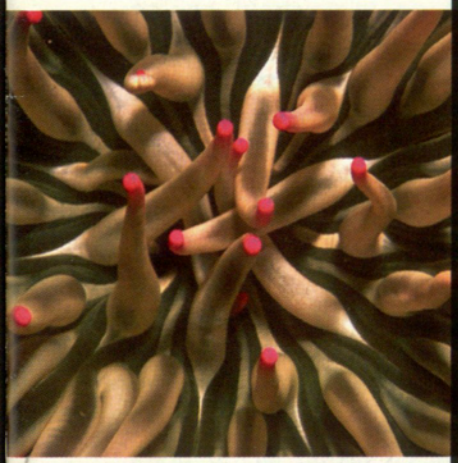

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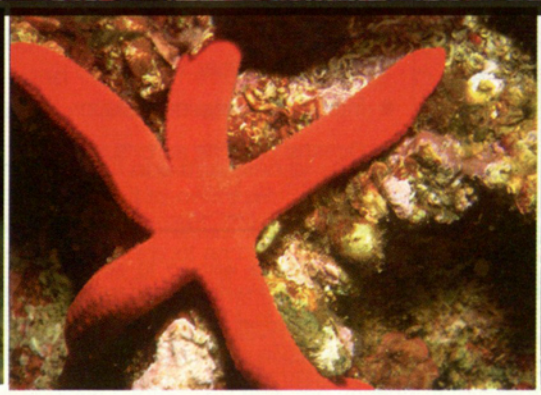

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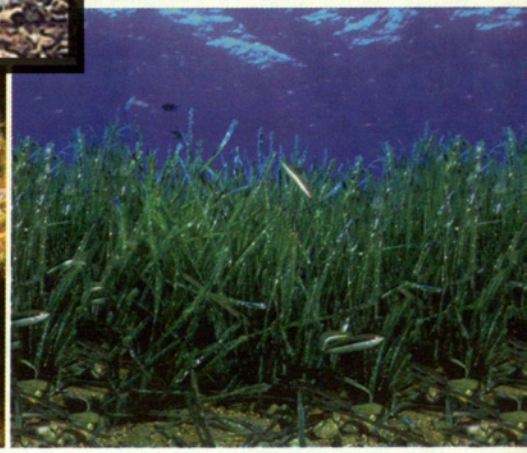

Posidonia oceanica

Special Edition Ocean 98

SUMMARY

WHAT IS MAP ?

The Mediterranean Action Plan (MAP) strives to protect the environment and to foster development of the Mediterranean Basin. It was adopted in Barcelona (Spain) in 1975 by Mediterranean states and the EC, under the auspices of the United Nations Environment Programme (UNEP). Its legal framework is made up of the Barcelona Convention (1976, revised in 1995) and six Protocols covering certain specific aspects of environmental protection. The Action Plan is built up around an Athens-based Coordinating Unit, six Regional Activity Centres scattered around the whole of the Mediterranean, and a MED POL Programme on pollution monitoring and control. The Mediterranean states and the EU meet every two years to decide on MAP's budget and programme.

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To consult the MAP Homepage:
Http://www.unep.org/unep/regoffs/medu/home.htm

Cover page (8), Yannis Troianos, Greece and (1) Photo GREENPEACE

PRINTING RECYCLED PAPER

THE MAP CALENDAR

National Training Course (REMPEC)	14-17 September 1998 Libya
Workshop on sustainable development (MCSD)	17-19 September 1998 Turkey
Workshop on environmental performance indicators (BP-METAP)	24-26 September 1998 Morocco
Fourth Meeting of the Mediterranean Commission on Sustainable Development	20-22 October 1998 Monaco
Meeting to evaluate the action plans on marine turtles, the monk seal and cetaceans	27-31 October 1998 Arta, Greece
Meeting of the Bureau of Contracting Parties	29-30 October 1998 Tripoli, Libya

OCEAN 98

At the decision of the United Nations' General Assembly, 1998 has been proclaimed "International Year of the Ocean", with the theme of "Oceans for Life on Earth: Save the Seas". **OCEAN 98** has been jointly set up as an organisation responsible for support and global coordination by UNESCO's IOC (Intergovernmental Oceanographic Commission), UNEP's Water Branch, UICN, WWF, the World Bank, and other institutions. It aims at awakening public opinion - young people in particular- to the importance of the oceans to the survival of our planet through information and training activities and by providing teaching material (publications, data sheets, Internet, television and radio programmes, CD-ROM, electronic Atlas of the Oceans, etc). Various events are planned within the framework of **Ocean 98**, the most prestigious being the Barcelona universal exhibition in Portugal, which has taken the ocean as its theme, and which boasts amongst other things the imposing United Nations Pavilion and an aquarium, the world's second largest. UNEP's Regional Seas Programme (of which the Mediterranean Action Plan is an integral part) is also actively involved in the overall programme.

Scientists from all disciplines related to oceanography are taking part in numerous meetings, colloquia and workshops, organised around the globe. The first major conferences were held in May in Halifax, Canada (Ocean circulation and climate), June in Hawaii (Third Annual Conference on Clean Oceans), and July in Vienna, Austria (Ninth International Symposium on Acoustic Remote Sensing and Associated Techniques for the Oceans and the Atmosphere). Forthcoming major events are:

- International conference on the climate and water, Espoo, (Finland), 17-20 August 1998
- Integrated coastal management, Victoria (Canada), 30 August-3 September 1998
- World Ports Festival, Rotterdam (Netherlands), 4-6 September 1998
- Forum on Ocean Drilling, Edinburgh (United Kingdom), 16-17 September 1998
- International Marine Pollution Symposium, Monaco, 5-9 October 1998
- Oceans 98 - The art of sustainable use of the oceans, Nice (France), 28 October 1998

Anyone wishing to acquire information about **Oceans 98** should consult Internet homepage HYPERLINK http://www.ocean98.org. Ideas, projects and work may be sent by electronic mail to HYPERLINK: ocean98@unesco.org or to Ocean 98, Koopmanstraat 1, P.O. Box 5807, 2280 HV Risjwijk, Netherlands.

Ocean 98 and the Mediterranean

The United Nations have declared 1998 the **"International Year of the Ocean",** which is why this edition is dedicated to the Mediterranean. Odd, you may think: what has Medwaves been taking up so much column space for over the past thirteen years if not the Mediterranean, its problems and the corrective action being taken? Well, there you have it- the Mediterranean has never been covered for what it basically and essentially is: a very aptly named body of saltwater, since it really is "between the lands" of three continents, tiny in global terms (accounting for a mere 2.5million of the world's total 360million km2 of ocean), assessed physico-chemically, biologically and dynamically by scientists who study its role and its behaviour, whilst trying to predict its evolution and to probe its depths. So we asked four scientists from different parts of the region who have devoted their lives to the study of the marine environment to talk about the **Mediterranean's physical presence.** Lucien Laubier, in an interview, opens the dossier in order to put the problems in perspective. Alex Lascaratos briefly describes the complex physics of the Mediterranean. Emin Ozsoy deals with the eastern basin's sensitivity to global change. And finally, Zitouni Boutiba tells us about marine biodiversity on the southern rim. Physical presence equals **object in law:** the Mediterranean is governed by a set of international rules which aim at ensuring its workings and its protection, and Tullio Scovazzi traces developments on this front, particularly following the recent revision of the Barcelona legal system. Lastly, and only very briefly, pages 19 & 20 of this special **Ocean 98** edition cover MAP's activities and publications since the Xth Ordinary Meeting in Tunis.

The physical presence of the Mediterranean, to say nothing of its geological history which dates back more than 200 million years to the birth of the Tethys ocean, has since time immemorial been seen by the people living on its banks as an obstacle, a threat, and a challenge, even though, starting in the second half of the third millennium, they very gradually began to tame the sea thanks to the techniques of ship-building and navigation, making it both a fantastic vehicle for trade and civilisation, and an object of conquest and war (the Crusades, rivalry between Genova and Venice, the route to India). The history of this vision or "Mediterranean fiction" is important to the understanding of today's Mediterranean and its problems, and we owe it to several authors for having so meticulously explored it (*).

Up until the middle of the XIXth century, the Mediterranean was seen as a capricious vastness, becoming fearsome with the onset of winter, with an unhealthy (malaria) and inhospitable coast (often cut off and hard to cultivate), with unplumbed depths which have closed over countless dramas. In the tales of travellers who, from the XVth century to the "Grand Tour" of the romantics, came in ever-increasing numbers to discover the cradle of several civilisations and the three major monotheistic religions, storms, shipwrecks and other shipping hazards loom large. A mere two centuries ago, depending on the season and the prevailing weather conditions, it still took between one and two months to travel from Gibraltar to Istanbul. That just shows how, with the dawning of the steam age and the propeller as of 1850, and air transport in the 1960s, the Mediterranean literally shrank: the months of yore are now counted in terms of hours to reach and traverse it. At the same time, the trend for sea-bathing, which came in at the turn of the century, have made it a prime location. As the world's leading tourist destination, the Mediterranean nowadays attracts on average 250million visitors (100million of whom are nationals) concentrated in the summer period and around the coasts, with all that that entails. Hence, in the late 70s, a further radical change in our perception: the Mediterranean has long since ceased to be a threat. The tables have been turned and it is now she who is threatened, a fragile environment, prey to our waste and disturbance. Her live resources are becoming scarce, her ecosystems are deteriorating, her seabed is piling up with waste. The scientists who express their views in this edition, like those who do likewise in the countless fora and seminars which regularly deal with the Mediterranean, are generally sceptical about our ability to radically invert the trend. But they are constantly sounding the alarm, and it is to be hoped that the phenomenal development of communication and information technologies will provide them with the echo chamber which they so need. Which they need in order to open the public's eyes so that they in turn may lobby the decision-takers to ensure that- in the Mediterranean as elsewhere- decisions are shaped by long-term considerations. Such is the wish expressed in the preamble by Lucien Laubier, and such is the spirit of this special **Ocean 98** edition.

Medwaves

* The Mediterranean bibliography is made up of one thousand or so titles for the 20th century alone, not to mention publications of a purely scientific nature. Suffice it to quote two authors who are absolute "musts" today: Pedrag Matvejevitch, whose *"Mediterranean Breviary"* ("Mediteranski Brevijar", Zagreb, Graficki Hrvasskem) is an inspired wander blending imagination, poetry, encyclopedic knowledge, study of archives, personal memories, philology and scientific insight on the major Mediterranean issues, and Fernand Braudel, whose *"The Mediterranean and the Mediterranean World in the Age of Philip II"* which has been translated the world over, goes far beyond its title to analyse the whole problem of Mediterranean time and space. And then- but need we remind you- there is the main Blue Plan report, *"Futures of the Mediterranean Basin"* (Economica, Paris, 1988) whose first two chapters "Specific Characteristics and Permanent Features" and "Time-Scales and Geographical Delimitations" cover our specific subject. An updated version of this report is being worked upon at present, and will be available in two years time.

TERMINOLOGICAL GUIDE

Here are some terms which may be of use to the reader, along with explanations provided by the authors of the articles, and the observation instruments defined alongside under the "Observation and Prediction" heading:

Anoxia: absence of dissolved oxygen (anoxic waters)

Bathymetry: measurement of ocean depth, by extension, structure of the seabed; bathymetric: related to depth

Endemic: describes a species with a limited natural geographical spread (species endemic to the Mediterranean: only to be found in the Mediterranean)

Thermohaline circulation: circulation of the oceans due to variations in density stemming in turn from variations in temperature and salinity (thermohaline= relative to temperature and salinity)

Convection: exchange between surface and deeper waters due to the instability of the layers of water

Anticyclonic: clockwise horizontal movement of a current in the Northern Hemisphere (cyclonic moving in the opposite direction)

Eutrophic (waters): rich in nutrients

Eutrophication: process involving the gradual accumulation of organic matter in the water, accelerated by excessive nutrient input (fertiliser residues, etc.), causing proliferation of aquatic plants and oxygen depletion of the deep water;

Forcing: current enhancing factor (such as winds, variations in density, etc.);

Gyre: a large circular current (from Greek, "gyros", circle);

Mesocosm: representative fragment of a real environment restricted for study purposes;

Oligotrophic (waters): poor in nutrients;

Plankton: total suspended organisms in seawater (passively transported by the currents); plant plankton = phytoplankton, chlorophyllian, composed of unicellular algae; animal plankton= zooplankton, non-chlorophyllian, composed of small marine animals (crustaceans (krill), annelids, jellyfish, etc.).

OBSERVATION AND PREDICTION:
in situ instruments, the satellite and numerical modelling in oceanography

Measuring the necessary parameters (temperature, salinity, pollutants, tracers, etc.) has never been an easy job in oceanography. The oceanographic ship has to make many "halts" (stopping at specific points in the sea) which last several hours in order to take its samples, before then carrying out its measurements and analyses (either on board or in a laboratory). Until the early 70s, this was done using Nansen bottles and thermometers sent down by cable. Then in situ sensors known as CTDs (conductivity, temperature, density) came onto the scene. They are attached to a conductor cable by which measurements are sent on board, thus reducing the length and frequency of these halts and making for more accurate measurements. For other parameters, sampling bottles still have to be used. The two methods are based on "rosettes", i.e. bottles attached in a circle around a CTD sensor, which are automatically closed once they reach the required depth. The ship can also take measurements whilst on the move, using thermosalinographs. These "moving" methods have been extended to other parameters (nitrates, planktonic chlorophyll, etc.) and can be installed on ships of the merchant marine, thereby multiplying the number of observations made throughout the world at lesser cost. Finally, apart from ships, fixed apparatus known as moorings mean that ballasted or floating measuring equipment may be installed at sea at different depths and later recovered. This can be used for current meters, particle traps, or inverse echo sounders which are placed on the seabed and measure the distance to the surface, allowing the dynamic surface topography resulting from horizontal pressure variations in the ocean to be assessed.

In the early 80s advanced technologies were developed, such as acoustic tomography, which involves exploring the ocean using sound waves whose speed depends on water temperature and pressure. But it was obviously satellite measurement techniques which really began to revolutionise oceanography in the 70s. With these techniques several characteristics of the global environment can be observed and monitored in a synoptic, repetitive and up-dated manner throughout the life span of each satellite (3 to 5 years): water temperature, wind speed and direction, sea level, wave height and direction, chlorophyll, etc. The dynamic surface topography may be assessed using satellite altimetry.

Finally, satellite remote sensing techniques can be usefully integrated in model construction, in other words the simplified representation of a physical system- like the ocean- which can be put into equation form. If these models are computerised they are called numerical. They can be applied to sediment transfer, pollution, primary production, currents, etc. For example, for the assessment of dispersal of pollutants from land-based sources in marine coastal zones, numerical models- along with temperature charts for the surface of the sea obtained by satellite- are tremendously useful to show marine coastal circulation and to assess the mechanisms of pollutant dispersal. Models also serve as forecasting tools, which will gradually allow us to draw up "states of the ocean" for different points in time. It is easy to imagine their practical significance *(cf. for example, The State of the Marine and Coastal Environment of the Mediterranean region, no.101 of the MAP series of technical reports, p.88, Athens 1996 and Medwaves no.23 on remote sensing).*

...

"STEPS TAKEN HAVE NOT BEEN WIDELY ENOUGH BROADCAST AMONGST THE GENERAL PUBLIC..."

An Interview with LUCIEN LAUBIER*
Director of the Marseille Oceanology Centre

The Mediterranean accounts for a mere fraction of the world ocean, with which it has only limited exchange. Without going into its physical peculiarities- which are dealt with in a later article- what is the oceanologist struck by when he examines this body of water?

It was probably in the Mediterranean with the work of the Count of Marsili that the first observations were made on a remarkable characteristic of this sea, i.e. the vertical homogeneity of water temperature in the winter between the surface and a few hundred metres down (his Physical History of the Sea, published in 1725, is well worth consulting). Since those distant times the Mediterranean, a basin with intense evaporation and such a delicate equilibrium, has been providing oceanographers with a wonderfully accessible model for the discovery and analysis of certain mechanisms such as the formation of deep waters by the cooling down and increased density of surface water exposed to the cold and violent north winds in winter.

Has its small size earned it renewed interest amongst scientists?

Yes, and some oceanologists believe that certain undeniable signs of the increased content of greenhouse gases in the atmosphere are already visible in the Mediterranean, something which has so far not been observed in other regions of the world ocean. So the Mediterranean could well serve as a remarkable indicator of climate change. According to other scientists, the Mediterranean's main annex, the Black Sea, is of recent origin: they believe it was formed around 7500 years ago from a freshwater lake into which the waters of the Mediterranean suddenly burst during a general rise in the sea level caused by ice melting during the interglacial period. Amongst other things, the fact that the shells of the first Black Sea molluscs in both the coastal and deep waters have an average age of 7550 is of particular significance: indeed, had the Mediterranean saltwater moved in progressively, the marine molluscs would have appeared in the deep waters long before they colonised the coast. It is easy to imagine the effect which this rather dramatic incident would have had on the people living around this vast freshwater lake: it has been calculated that the water level rose by 15 centimetres a day!

You are describing a sort of mythical sister to the Mediterranean being struck down by a curse...

From this point of view, the big sister has no cause for envy. Over the same period the eastern Mediterranean basin witnessed a succession of catastrophic events, recorded in the archives made up by the different layers of particular deposits of marine sediment. What lay behind these events was apparently a major reduction in the vertical mixing of waters which caused an abrupt decrease in dissolved oxygen, thus mass mortality. Then, taking a giant stride up to the present day, the eastern Mediterranean has been the site of a major natural experiment: the change in inputs of freshwater, sandy sediment and fertilisers caused by the Aswan Dam. We are now assessing the diverse effects of this development, in particular renewed coastal erosion and the shift of populations of small pelagic fish towards deeper waters.

Mission in Mediterranean March 1998: Launching the sampling rosette (Photo: N. Bensoussan Marseille Oceanology Centre)

Historians and geographers would tend to concur on the idea of permanence in the Mediterranean which, through the ages, has been based on major natural equilibria (physico-chemical, climatic, flora and fauna related, etc.). On the eve of the third millennium are these balances changing, are they being turned upside down?

It is all a question of time-scale. Six

* Lucien Laubier is also a professor at the Mediterranean University (Marseille). From 1992 to 1996 he acted as advisor on science and technology to the French Permanent Representation to the European Union. Several of his works are for the general public ("Vingt mille vies sous la mer"- Twenty thousand lives under the sea- Editions Odiles Jacob, 1992, Paris).

million years ago the Mediterranean virtually dried up completely. On the human scale, however, or talking in terms of centuries, that was not the case, and we could talk of permanence. But today, even on our scale, this permanence is on the line: the population boom in many countries around the Mediterranean, coupled with urban and industrial development both on the banks of the Mediterranean itself and along her major tributaries, are all doing their bit in altering the Mediterranean coastal waters. Increased maritime transport is also causing changes to the fauna and flora which could have major consequences: such is the case with the accidental introduction into the Black Sea of a Ctenoid, *Mnemiopsis leydii;* populations of this species which eats the eggs and larvae of pelagic fish have literally exploded, with the result that catches of these fish have collapsed. In the north-western Mediterranean, the spread of another introduced species, the alga *Caulerpa taxifolia,* would seem to be threatening in places the permanence of the Posidonia meadows.

You have mentioned scientists' concerns about "Mare Nostrum". The people we call the "decision takers" don't seem to be unduly worried...

More serious still because it is more insidious is the deterioration of the coastline as a result of urban tourist development, which affects the marine environment in many ways (deposits of fine mineral particles, dumping of rubble, etc.). How, in the long term, can we cope with this worrying increase in tourism on the Mediterranean coasts? Are the ecosystems we can see today still in a state of equilibrium, or are they actually in a stage of slow dynamic evolution, which is nevertheless perceptible for someone who makes the effort to observe them over a human lifespan? This fourth dimension is very difficult to assess.

Mediterranean co-operation- such as exists under MAP with the Blue Plan and the Split Centre- has been studying the effects of coastal urbanisation on the adjoining marine environment for some years now. However, very little is said about the deeper waters, the sea depths. How do they stand, particularly in terms of their resources?

There are no exploitable live resources lurking in the depths of the Mediterranean; the deepest fisheries, those of the giant Penaeid shrimps, do not go beyond 4-600 metres. However, in terms of pollution of the deep water, we have learned that certain surface water pollutants originating from the land or the air are rapidly transferred to the deepest parts of the Mediterranean. Inversely, a drop in pollutant input causes a virtually simultaneous fall in their levels in the water: this was seen for lead in petrol- when it was substituted by aromatic hydrocar-

CNRS researcher at work. Port Cros.
(Photo: J.G. Harmelin, Marseille Oceanolgy Centre)

A beached fin-back whale measuring 19m near Mostaganen (February 1998) (Photo: Oran ISN, Algeria).

bons the waters of the Mediterranean very quickly showed a drop in lead content. But let me come back to the first part of your question: the effects of coastal urbanisation on the adjoining environment. I am struck by how hard it is to get the very interesting results of this work and the Blue Plan's major demographic simulations across to the public at large. I am one of those people who believe that in our modern democracies respect for the environment and its preservation for future generations are to a great degree the job of the general public. Conversely, the public could maybe exert additional pressure in order to convince political leaders of how important the long term is in environmental management.

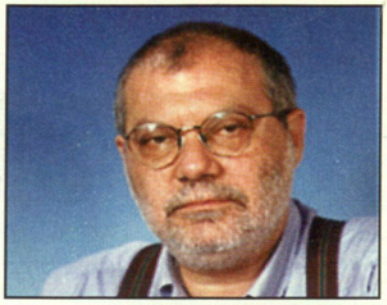
The general public is vaguely aware- largely thanks to television- of what oceanography does towards understanding and protecting the environment. Is the Mediterranean well equipped from that point of view? What infrastructures are available? Is Community policy opening up new possibilities in the age of Euro-Mediterranean partnership?

More than twenty years after the adoption of the Barcelona Convention, even the most superficial of assessments shows that, without in any way prejudging the importance of the results achieved, whatever steps have been taken have not been widely enough broadcast amongst the general public: the vast majority of people are still unaware of them. Probably the most glaring omission is the lack of any real policy to protect the Mediterranean, which is what all countries are calling for, from grassroots level up to the political leaders and regional groups of countries. Media relays for the marine environment are also sadly lacking in the Mediterranean region as a whole. I had high hopes when, in 1994-95, the European Union proposed a policy of renewed dialogue to its Mediterranean partners, along with a substantial increase in the funding which it grants them. Today, the MEDA programme is largely shaped by the national priorities of these partner countries in terms of economic development, and still leaves little or no room for training and research matters. Maybe one day things will change: but in order for that to happen the Mediterranean regional dimension and multilateral cooperation between riparian countries would need to be seriously boosted. Maybe we can do it?

Basically, like the vast majority of scientists, your forecast is pretty grim?

By way of conclusion, and in order to dissipate that impression somewhat, I would like to mention a passage from Colin Moorcraft's book, "Must the seas die?", written in 1972. He stated back then: "It is forecast that in less than three years the once so beautiful Mediterranean coast will be completely bordered by a biological desert 5 kilometres wide. It is hard to see what could prevent this dreadful prediction coming true". As you can see, we are happily a long way off such a situation. These prophecies, however, should not be underestimated: the time-scale may well be wrong, but the general trend is still there. ■

THE MEDITERRANEAN SEA: A FASCINATING SMALL-SCALE OCEAN



*by Alex Lascaratos**

A new Vision

The first efforts to understand the Mediterranean (or parts of it) can be found in antiquity with the works of Aristote and Pytheas. But it was not until the advent of modern times and the development of techniques (Nansen bottles, inverse thermometers, Ekman current meters, etc.) for measuring properties of the sea such as temperature, salinity, currents etc., that the understanding of the Mediterranean really began. The first major oceanographic cruise in the area took place in 1912 with the Danish Expedition (Nielsen). In the next decades and up to the late 70's, a number of basin-scale or more localised cruises contributed to substantially increasing our understanding of the Mediterranean. But the real breakthrough came in the 80s and 90s. There are many reasons for that development: A number of international projects such as PRIMO in the Western Mediterranean and POEM (Physical Oceanography of Eastern Mediterranean) in the Eastern, were launched. Next came the EU/DGXII Marine Science and Technology Programme (MAST) in the late 80s which financed an important number of projects in the area together with two very large Mediterranean Targeted Projects (MTP-I and MTP-II). A second important effect, itself linked with the projects mentioned above, was the appearance of a critical mass of highly qualified marine scientists in Europe and in Mediterranean countries. Finally, one should not forget to mention the development and use of new techniques and tools for the study of the ocean, such as high resolution CTDs, remote sensing and numerical models. Through all these factors, a new and fascinating picture of the Mediterranean Sea has emerged. A detailed presentation of this new picture is beyond the scope of this short contribution. We will limit ourselves to a brief outline of the basic functioning and of the general circulation of the Mediterranean Sea.

The basic functioning

The Mediterranean Sea is an elongated and relatively narrow basin, bounded by the European and the north-African coasts. It is a semi-enclosed basin which communicates with the rest of the world ocean through the narrow (~ 15 km) and shallow (sill depth ~ 250 m) Straits of Gibraltar. The straits of Sicily (sill depth ~ 1000 m) divide the basin into two major sub-basins, the Western and the Eastern Mediterranean respectively. In each of these, a number of smaller basins or seas can further be found such as the Balearic and Tyrrhenean Seas in the west and the Adriatic, Ionian, Aegean and Levantine in the east.

In the Mediterranean, evaporation exceeds precipitation and river runoff. It is what is termed a 'concentration' basin. Because of the communication with the Atlantic Ocean through the straits of Gibraltar, a dynamic equilibrium is established through a two-layer flow in the straits. Lower salinity Atlantic waters enter the Mediterrnean at surface, where they are transformed, through evaporation, into saltier (and denser) Mediterranean waters, sink to an intermediate depth and move back to Gibraltar where they are exported into the Atlantic. An equilibrium is therefore reached, by which the salinity of the basin remains constant. This type of circulation with waters entering the basin at surface and exiting at depth is called a 'lagoonal' circulation. In basins, such as the Black Sea, where precipitation and river runoff exceed evaporation ('dilution' basins) an opposite type of circulation is usually established with fresher waters exiting the basin at surface and a smaller amount of saltier waters entering the basin at depth ('estuarine' circulation). These two circulation types by which a semi-enclosed basin maintains its salinity, whether it is a concentration or a dilution basin, have far-reaching and important consequences. In the first case the deeper layers of the basin are naturally oxygenated through the sinking of surface waters which are in contact with the atmosphere and are saturated in oxygen. This explains the high oxygen content of the Mediterranean throughout the water column. On the contrary, in the second case the deeper layers of the basin are isolated from the atmosphere and have very low or even zero oxygen content. This is for example the case of the Black Sea, where anoxic conditions are found just below the surface fresh water layer. These anoxic conditions are 'natural' and are not in any way pollution-related.

We can, therefore, think of the Mediterranean as a box or a 'themal engine', a term frequently used in physics, which through interaction with the atmosphere (evaporation) transforms fresher (salinity 36.5 psu) Atlantic surface

* *Professor of physical oceanography at Athens University, and the greek representative to MAP.*

waters into saltier Mediterranean waters which are then sent back to the Atlantic at depth. This is the simplest way (or the simplest model) to look at the functioning of the Mediterranean. Of course the Mediterranean is much more complicated than that.

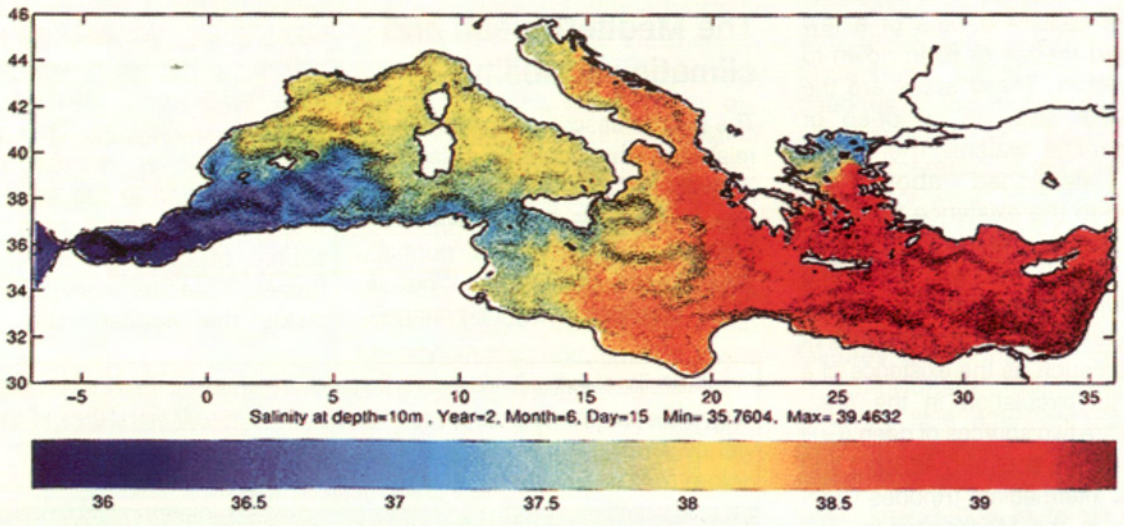
A web of currents

The general circulation of the Mediterranean is made up from a complicated series of currents, jets and meanders as well as gyres or eddies (closed or almost closed circular currents) of different dimensions. Some of these features are permanent or semi-permanent, others undergo important seasonal variability while others are transients.

As we have already mentioned, Atlantic waters enter at surface through the Straits of Gibraltar into the Mediterranean. The amount of this flow is estimated at approximately 1 Sv (1 Sverdrup = 1 million cubic meters per second). These waters enter the Alboran Sea where a strong anticyclonic gyre (a circular clockwise circulation) is formed. They then move along the African coast where they form the so-called Algerian current. This current is often unstable and meanders. Under some conditions when the meandering is strong, anticyclones are formed which then detach themselves from the main current and travel as individual bodies towards the north in the interior of the western basin. In the north of the Western Mediterranean we have a very characteristic current moving west along the south coasts of Italy, France and Spain. It is the Liguro-Provencal current. In figure below, the distribution of surface salinity and currents can be seen. Note the very large difference in mean salinity between the Western and the Eastern Mediterranean. Note also the influence of the low salinity Black Sea waters into the Aegean.

Having passed the straits of Sicily the Atlantic waters enter the Ionian Sea in the Eastern Mediterranean. They are by then called Modified Atlantic Waters (MAW) as they have started modifying their characteristics through the influence of evaporation. The MAW follow a complicated path in the Ionian with a strong movement to the north along the eastern coasts of Sicily followed by a movement to the south and east. They then enter the Levantine Basin. A branch moves eastward along the coasts of Egypt and then towards the coasts of Israel where it moves north. Another branch forms a strong meandering current called the Mid Mediterranean Jet (MMJ) which travels to the east at mid distance between the African coast and Crete. When the MMJ reaches Cyprus it is split into two branches, one bifurcating west of Cyprus and one travelling east and north and turning west in the area between Cyprus and the Turkish coast. These two branches form the so-called Asia Minor Current (AMC). By now, the MAW have completely lost their characteristics and the AMC is a warm and very salty vein of water. The return flow goes south of Crete, and back to the Ionian where it moves north, towards the Adriatic. To conclude this brief description of the currents, we can say that the general circulation of the Mediterranean is indeed quite complicated and made up of both large and smaller (often called 'mesoscale' i.e. about 100km) features. One such famous feature is the often- observed anticyclonic gyre Southeast of Crete, called the Ierapetra Gyre which has its strongest signal in winter. Others are the Mersa-Matruh, the Shikmona and the Pelops anticyclonic gyres. An almost permanent feature of the Levantine Basin is the Rhodes Gyre, a sub-basin scale

Summertime distribution of surface currents and salinity in the Mediterranean.
(numerical model by Athens University's Oceanographic Laboratory).



cyclonic gyre located south of Rhodes and east of Crete. It is bounded in the north by the AMC. The RG plays a very important role in the functioning of the whole Mediterranean as it is the site where the so-called Levantine Intermediate Waters (LIW) are formed in winter.

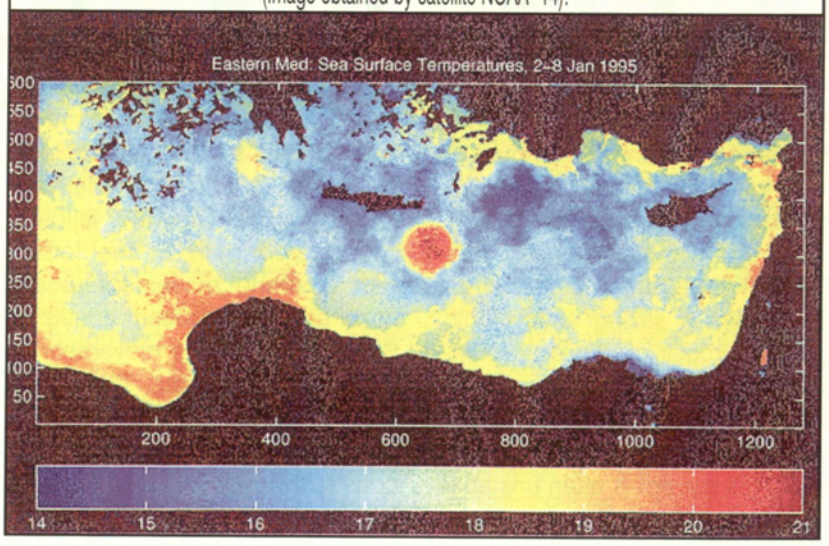
Deep and Intermediate Waters

In winter, over the whole basin, surface cooling increases the density of the surface waters, which become unstable and sink. This sinking homogenises the surface layers and produces what is called the 'winter mixed layer'. The thickness of the winter mixed layer is of the order of 50 to 100 metres. In some very well defined locations and because of specific conditions that prevail in these areas, winter cooling is very violent and the vertical mixing called 'convection' can penetrate to intermediate depths of a few hundred metres or even down to the bottom. These areas are the so-called 'sources' of deep or intermediate waters. The conditions mentioned above are related to the existence of strong cold and dry winds of the northern sector, as well as some favourable conditions regarding the hydrological characteristics of the sea such as the existence of a cyclonic circulation in the area. There are two sources of deep (Gulf of Lions and southern Adriatic) and one of intermediate (Rhodes Gyre) waters in the Mediterranean. The deep waters of the Western and Eastern Mediterranean are confined in the deepest parts of the respective basins because of the sills at Gibraltar and Sicily. In contrast, the LIW sink to a depth of only 200-300 m. They then start a long journey to the west, enter the Ionian, then the Western Mediterranean through the straits of Sicily, and finally exit to the Atlantic through Gibraltar. They are the main contributor(more than 80%) to the outflow into the Atlantic where they can be traced as far as Greenland. The main characteristic of the LIW waters is their high salinity since they originate from an area, the Levantine, where strong evaporation occurs. Their salinity is 39.00-39.05 psu at the formation site. It decreases through mixing along their journey and by the time they reach Gibraltar it is 38.4 psu. On a mean annual basis 0.3 Sv of deep waters are formed at each of the two sites while the production rate for the intermediate waters is estimated to be 1 Sv. A fraction of only 4% of the total LIW present in the Mediterranean is produced annually. In other words, a water particle of LIW formed this year will need approximately 25 years before it will reach Gibraltar and exit the Mediterranean. For the deep waters, this time scale is of the order of 80 to 100 years. The circulation of the deep and intermediate waters inside the basin, the so-called 'thermohaline circulation', is much slower than at surface.

The Mediterranean and climatic variability

The picture described up to now is related to what might be called the 'climatology' of the Mediterranean Sea and reflects the behaviour of that sea under 'mean' or 'normal' atmospheric conditions. What if these conditions vary or change? Recent evidence has shown that the Mediterranean responds very energetically to interannual (year to year) or multiannual variability of atmospheric conditions. These changes are best reflected in the deeper layers of the sea, which are in some way the 'climatic' memory of the ocean. (Indeed, the deep waters bear the memory of the actual atmospheric conditions that prevailed during their formation and keep them 'locked' for many years). There are many indications that show that these variations occur on time scales ranging from a few years or decades to thousands of years. We will only mention two of the most recent such 'changes'. The first is the significant warming (by more than a degree Celsius) of the Western Mediterranean deep waters which has been observed during the last three to four decades. A number of scientists attribute this phenomenon to Global Warming and the 'Greenhouse Effect'. Whatever the explanation, this change is expected to have significant, although still unknown, implications. The second example is a very dramatic event, which occurred in the early 90's, with the appearance of a 'new' source of deep waters for the Eastern Mediterranean located inside the Aegean Sea. What

Distribution of surface temperatures in the eastern Mediterranean. The red spot of a hot anticyclone (Ierapetra Gyre) can be clearly distinguished to the south-east of Crete, as can the blue spot of a cold cyclone (Rhodes Gyre) south-east of Rhodes.
(Image obtained by satellite NOAA -14).



caused this climatic 'jump'? Is this 'new state' going to last or is it just a transient and will the system flip back to normal soon? What are the implications of the redistribution of water masses within the Eastern Mediterranean to its biology? The answers to those questions are still not definite. Actually, this is one of the main themes of the MAST/MTP-II project mentioned above.

The coupling of biology and physics

Our knowledge of the physics of the Mediterranean Sea has greatly increased in the last few decades. We now understand to a great extent its complex general circulation, as well as its seasonal and interannual variability. Of course, as everywhere in science, the more we understand and explain, the more is left to be understood!!!

A major tool that has been developed in recent years are the numerical models which are used, at present, to simulate and further understand the physics of the Mediterranean sea. As our knowledge continues to increase, numerical models will hopefully allow us, in the future, not only to accurately simulate the ocean but also to 'predict' its behaviour and changes. This is what is called 'operational oceanography' and it is a mixture of modelling efforts coupled with new, advanced, measuring techniques.

Parallel to our increased understanding of its physics, a great step forward has also been achieved in understanding the biology of our common sea. The 'coupling' of biology and physics, especially with the use of numerical models, will be one of the major tasks of marine science in the future. A day will come when we will be able to predict not only the currents and water masses but also the distribution of biological parameters, such as phytoplankton, zooplankton and (why not?) fish stocks. Such an evolution will obviously be a precious tool for the protection and the sustainable use of our common heritage, the fascinating Mediterranean Sea. ■

SENSITIVITY TO GLOBAL CHANGE IN THE EASTERN MEDITERRANEAN BASIN AND CONNECTIONS WITH THE ADJOINING REGIONS

by professor Emin Özsoy*

Historically, the region of the Middle East was known as "the land of the five seas". The semi-enclosed and enclosed basins of the Black Sea, the eastern Mediterranean basin and the Caspian Sea form climatically related remote waters of the world ocean, which become more isolated as one proceeds eastwards. If there is any one property which is common to all these areas, it is their sensitivity to change, be it of anthropogenic or of natural origin, resulting from their isolation from the world ocean, and their enclosure by land. Similarly, adverse changes in the ecosystem as a result of man's activities are first identified in these waters. The transitions between marine and continental climates, and the high levels of ocean-atmosphere- land interactions, resulting in high spatial gradients and variabilities on a variety of time scales, make the region prone to extremes. Because of such great variability in interactions with the atmosphere, and in serving as a source of ocean water masses, feedback from the region to the global system could be of a magnitude disproportionate to its size.

The Mediterranean Sea region is one of the main areas of the world where ocean-atmosphere-land interactions on inter-annual and long-term climatic time scales are predominant. Atmospheric circulation is significantly affected by the various marine enclosures, immense flatlands, mountain chains and deserts encircling the region. Teleconnections with global atmospheric systems occur via coupling with adjacent areas, namely the Indian Monsoon system, ENSO (El Nino-Southern Oscillation) and North Atlantic Oscillation (NAO) patterns.

The ocean and land ecosystems are undergoing rapid change, threatening biodiversity, whilst changes in the hydrological cycle as a result of basic ocean-atmosphere interactions are behind a scarcity of water in densely populated coastal regions bordered by deserts. The "old world" is also a region of sharp contrasts in terms of cultural and socio-economic features, and population growth. It is unfortunate that until now relatively little attention has been paid to integrated global change research in the region, despite its great importance in terms of the health and well-being of the people and economies of the region.

Global warming, industrialisation and increased anthropogenic inputs of nutrients via rivers and the atmosphere threaten marine resources in the Mediterranean Sea and the neighbouring bodies which share similar characteristics. In the Black Sea, eutrophication has resulted in considerable destruction of habitats, and reduction in biomass and diversity of species. Similar consequences can be expected in specific areas of the Mediterranean, if the present

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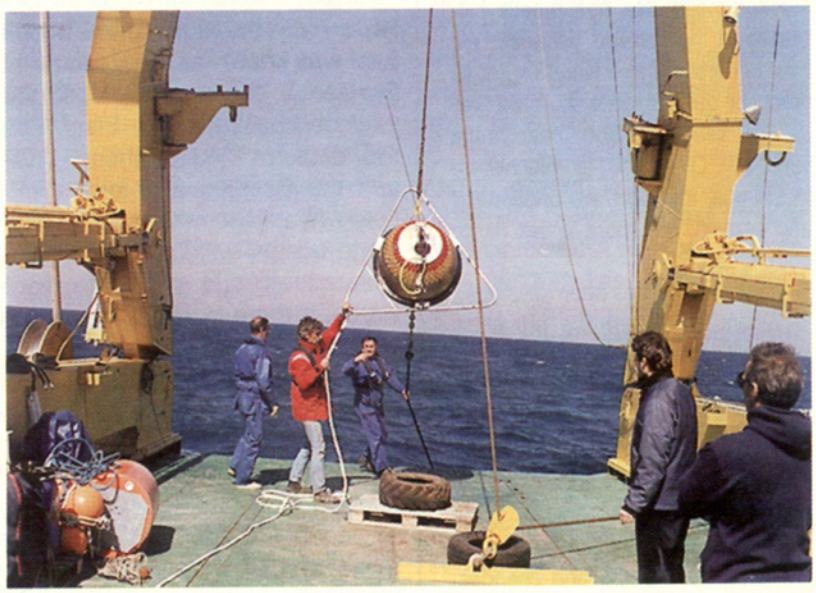
increase in deep water nutrients continues at the same rate, with a probable return to conditions akin to episodic stagnations in the not-so-distant climatic past. On the other hand, a climatically induced switch in the main thermohaline circulation of the eastern Mediterranean deep waters, as has recently been shown, appears to have modified these trends. Migration of alien marine species into the eastern Mediterranean, linked with the Suez Canal, is the prime example of long-term anthropogenic change.

Recent changes.

In the case of the better ventilated Mediterranean Sea, thermohaline circulation and convection events determine the intermediate and deep water properties, recently subject to significant changes, and a build-up of nutrients. In the deep waters of the western Mediterranean, there is evidence of a trend towards increasing temperature and nutrients, linked with the annual events of deep convection modifying the deep water properties. In the eastern Mediterranean, the Levantine Intermediate Water (LIW) is formed and advected westwards from the Levantine Basin. Its cascading outflow from the Straits of Gibraltar determines North Atlantic water mass properties, preconditioning the climatically important North Atlantic Deep Water (NADW). There has been some speculation as to its possible role in triggering the interglacial periods. Thermohaline circulations and convection events determine the intermediate and deep water properties of the eastern Mediterranean, and in very recent times the whole scheme has had to be revised based on observations. It is now clear that the eastern Mediterranean circulation was subject to significant change as of about 1987. It has been discovered that the entire deep water volume of the eastern Mediterranean has been replaced and modified by dense (salty, warm) outflow from the Aegean Sea, in contrast to the classical scheme of deep water renewal by the Adriatic outflow. Radical changes in eastern Mediterranean deep water are appearing for the first time since the beginning of oceanographic observations.



Mission in the Mediterranean, March '98. Raising a drifting buoy. (Photo N. Bensoussan, Marseille Oceanology Centre).

Consequent to these events, major changes have been reported in the deep zooplankton populations, nutrient distribution, and in the geothermal heat flow in brine lakes located at the bottom of the eastern Mediterranean.

Although no exact date for the Aegean outflow (1991-1993) can be established from the available observations, it appears to be linked to convection over a series of cold winters. It is remarkable that the cold anomaly in the winters of 1992 and 1993 covered an area extending from the African continent to the Black Sea and the Caspian Sea, resulting in a great degree of synchronism between these areas and leading to simultaneous convective water mass formation in the eastern Mediterranean and the Black Sea, and possibly in the Caspian Sea.

Marine ecosystems

Marine ecosystems are especially vulnerable, as significant changes in nutrient supplies and habitats are taking place. New, extraneous species are being introduced into the marine environment where they opportunistically fill niches in the changing ecosystem. These changes are most readily felt in coastal areas and in terms of utilisation of food resources. Most remarkably, the natural variability in the system is often of the same order of magnitude as the anthropogenic effects, which makes diagnosis difficult. Signs of ecosystem degradation have already been observed in the Black Sea. Not enough is known about the basic ingredients of Mediterranean marine ecosystems, including the structure and succession of primary production,

the biochemical cycling of materials in relationship to physical processes, their seasonal and long-term changes. Lessepsian migration, after Ferdinand Lesseps, who built the Suez Canal, has been continuously introducing Red Sea and Indian Ocean species of plankton, fish, and other marine organisms into the eastern Mediterranean and causing continuous temporal changes in the ecosystem.

Because the elements constituting the marine ecosystem (coastal water influenced by shelf and riverine water, sub-basin and meso-scale eddies, jets, and fronts) of the eastern Mediterranean are in the form of mesocosms, which are vastly different from the deep ocean oligotrophic areas, the trophic regime of the system may be undergoing long-term transient change that could pass unnoticed. Further anthropogenic changes can be introduced by the nutrient supply to the eastern Mediterranean from the Black Sea and the Aegean Sea, from river sources such as the Nile and the Turkish rivers, and by atmospheric deposition. In the Black Sea, the multiple increase in riverine sources of nutrients is mainly responsible for encouraging eutrophication.

Changes in the hydrometeorological regimes

Not enough is known about the effects of the ocean-atmosphere interactions on the hydrological cycle, with immediate effects on water availability. However, since these interactions determine the precipitation and evaporation regimes, it is crucial to establish a basic understanding of local balances. Anthropogenic effects of land use and changes in land cover such as deforestation/desertification are also important, and have important local impacts on the hydrological cycles.

Changes in the hydrometeorological regime have a major impact on the region. It is most likely that even small alterations to water availability could have critical consequences at all natural and human levels in the Mediterranean region, where much of the population lives in coastal, low-lying areas subject to sea level rise. The Mediterranean shores are vital as tourism resources, and similar development may be expected on the shores of the Black and Caspian Seas in the future. Furthermore, the land ecosystems are amongst the most sensitive in the world for the predicted changes in atmospheric composition and ensuing interactions with water availability. Recent and ongoing changes in land use have contributed to part of the dramatic alterations in ecosystem functioning, leading to serious loss of soil and susceptibility to forest fires.

Dust transport

The aeolian transport of desert dust and other atmospheric aerosols plays an important role in the climate system, by modifying tropospheric as well as marine physics (radiative heat budgets, precipitation) and biogeochemistry (heterogenous reactions, greenhouse gases, nutrient supply, marine fertilisation). Similarities exist between the interannual dust transport from the Great Sahara to the Mediterranean Sea and the Tropical Atlantic Ocean. It is now becoming better established that the Saharan dust transport into the Atlantic often coincides with patterns of large scale atmospheric motion, such that the conditions of the North Atlantic impart their effects on transport, and alternatively, drought conditions in the Sahara influence the Atlantic as well as the Mediterranean.

The transport of aerosols, and more specifically of eroded dust from the Sahara and Arabian deserts has an impact on air sea fluxes, and has been linked to short-term phytoplankton blooms in the eastern Mediterranean. It is also suggested to be the main source for "red soils" of the eastern Mediterranean lands including those in Greece, the Cukurova Plain of Turkey, the Levant coasts and the "Fertile Crescent" of Mesopotamia, where early civilisations thrived.

Nature's warning

This brief review of the state of affairs from an oceanographer's point of view indicates important Global Change processes at work in the region under consideration. It seems that the temperate inland seas of the Euro-Asian continent (or more properly the Euro-Afro-Asian continent) could be one of the foremost areas of the world where one can investigate sensitivity to Global Change.Yet the behaviour of the various individual basins is not sufficiently well understood; or the common mechanisms or patterns of change amongst a series of semi-enclosed and closed basins have not been comparatively studied in their full detail.

The human response to environmental changes in poorly understood systems is often somewhat delayed until they are recognised as threats. However, serious concern seems to be emerging as various severe cases, such as some large lakes (Aral) and shallow (Baltic Sea) or deep (Black Sea and Caspian Sea) landlocked seas in climatically variable regions are emitting emergency signals. Such areas are indeed of global interest, because the changes observed could be nature's warning to other regions of the world. Knowledge gleaned from these seas could therefore benefit the other regions of the world ocean. ■

MARINE BIODIVERSITY
IN THE SOUTH-WESTERN MEDITERRANEAN

by Zitouni Boutiba*

The southern rim of the western Mediterranean basin has a coastline measuring some 3000km. Hydrological conditions in this area are influenced by a strong ocean current, and by "upwelling" (the deep water rising to the surface) along the coast, providing an input of mineral salts which allows the development of phytoplankton and zooplankton, food for the marine fauna which is particularly rich in fish.

This area is located between Europe and Africa, and close to the Straits of Gibraltar (the only channel for the seasonal migration of certain Atlantic species to the Mediterranean, and vice versa), which makes it a real "pool of marine diversity".

Pelagia noctulica
(Photo: Yannis Troianos, Greece)

The ecological interest of the Southern rim

Compared with the rest of the western Mediterranean basin, the southern rim enjoys favourable circulation: the incoming ocean waters with their specific temperature and salinity supply the upper layers of water with a planktonic flora and fauna unlike that which is usually found elsewhere in the Mediterranean; this flora and fauna retains its characteristics by following the surface currents out at sea. This distribution of the "primary bio-mass", in other words the mass of live organic material which represents the first link in the chain, conditions the fauna which feeds on phytoplankton- sardines, anchovies- which will therefore go with the flow of the Atlantic waters. Thus, the path of mackerel and tuna tracks the currents of the surface waters originating from the ocean. Fishing activities are therefore determined by the forced passage of these species along the north-African coasts.

The nature of the coasts and the communities living there

The majority of the southern bank of the Mediterranean (70%) is composed of sheer cliffs interspersed with rocky promontories with jagged contours. The remaining 30% is made up of sandy beaches, some of which are bordered by lines of dunes and enclosed by outcrops of volcanic rock. The continental shelf is one of the narrowest in the Mediterranean, sometimes amounting to nothing more than an underwater cornice less than a kilometre wide. Due to the tortured morphology of the coast, the natural communities of living beings (or biocenoses) are many and scattered, with coralline organisms predominating. There is an abundant and highly varied benthic fauna on the seabed (spongiae, cnidaria, bryozoa, crustaceans, molluscs, echinoderms, etc.).

The Posidonia meadows, which are endemic to the Mediterranean, populate the seabed in the southern Mediterranean basin: their state of health varies from one region to another. They provide spawning grounds and nurseries for several species of fish, crustaceans and molluscs, thus playing an important role in the Mediterranean ecosystem. But, over recent years, they have shrunk back noticeably with the increase of different types of pollution and coastal installations.

The diversity of fauna

Thirteen species of marine mammals frequent or once frequented the waters of the Maghreb. Since 1977 the monk seal has completely disappeared from the Tunisian coast; two erratic individuals were sighted in 1997 on Ragoun island off the western coast of Algeria: ten or so still survive on the Mediterranean coast of Morocco. On the Libyan coast- the Cyrenaic coast to be more specific- several pairs have been spotted, but the survival of these rare individuals would seem to hang in the balance. Apart from mammals, the area boasts a rich and varied fauna, which bears witness to the exceptional quality of its waters. Many of these species are threatened at Mediterranean or world level, whilst others have completely disappeared or have become very rare on the north-western coast of the Mediterranean:

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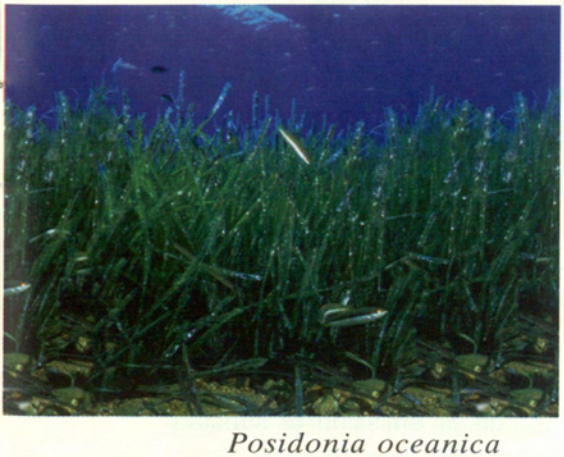
There are quite a large number of molluscs, which make up a large share of the food intake of the many teuthophagous odontoceti. Fishing statistics for the ports on the southern coast show that eight species of cephalopods (squid, cuttlefish, etc.) are regularly caught by trawlers. Crustaceans, such as the large locust lobster (*Scyllarides latus*) which in this region can grow to the impressive size of more than 40cm, or the spinous spider crab (*Maja squindo*), both of which used to be common, even plentiful, have become very scarce, as has the edible sea urchin (*Paracentrus lividus*).

The sea bed would seem to be well supplied with fish (more than 300 species have been recorded). Grouper can still find waters and biotopes conducive to their growth and breeding. However, this species is becoming scarce in the region following an increase in subaqua fishing catches.

As far as reptiles are concerned, two species of marine turtle frequent the area: the loggerhead turtle *Caretta caretta* and the leatherback *Dermochelys coriacea.* The Gulf of Gabes is used as a wintering ground by *Caretta caretta,* which is a common



Posidonia oceanica
(Photo: Yannis Troianos, Greece)

species in Tunisia. Some 10,000 individuals are annually caught by different fishing gear.

Finally, the wetlands and islands provide nesting and wintering grounds for many species of seabird (Audoin's gulls, herring gulls, lesser kestrels, little terns, cormorants, etc.). For the time being, the bird population does not seem to be at risk.

The impact of human activity

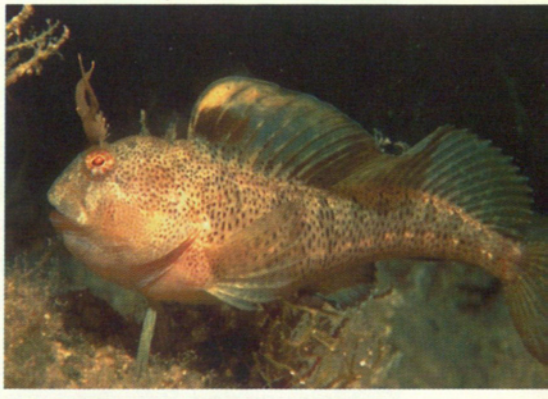
All this marine fauna is threatened with extinction in its own natural habitat, and the causes of mortality can be blamed on human activity, both accidental and intentional.

Although their meat is not eaten in the Maghreb countries, dolphins, sperm whale, whales and seals are intentionally killed by fishermen with harpoons, firearms or explosives, with the excuse that these marine mammals damage their nets. Turning to accidental causes, fishing practices invoving long-lines, drift nets and trawl nets are a virtually constant threat. Several cases of collisions between car ferries and large cetaceans have also been reported, although it was not possible to ascertain the circumstances surrounding these events.

Generally speaking, marine pollution and cases of poisoning are becoming more widespread. Cetaceans, seals and reptiles, like all other marine organisms, are affected by pollutants such as heavy metals, pesticides and hydrocarbons. The monk seal, which is an officially protected species in the riparian states, and which was formerly to be found along the whole length of the Maghreb coast, saw its rate of disappearance pick up during the seventies, once again as a result of marine pollution, intensive coastal development which disturbs the resting and breeding sites, and also because of intentional killings. As far as marine turtles are concerned, large numbers of them are washed ashore each year. More than 20% of them are contaminated by plastic waste and hydrocarbons. They are often attracted by floating plastics, which they mistake for jellyfish and swallow, causing a fatal obstruction of the intestines.

What can be done?

It is not feasible to oppose all development projects, the increase in tourism, nor to eliminate pollution in all its forms. There is, however, one solution which would avoid the massacre of our heritage of marine fauna- the setting up of nature reserves, where the species would be



Parablennius gattorugine
(Photo: Yannis Troianos, Greece)

protected, and where their status, their biology and the areas where they would be likely to persist could be delimited.

Moreover, if these vertebrae are to survive, it would seem essential to strengthen measures for their protection, and to make sure that they are strictly enforced. It is also important to awaken the general public to the problem of extinction of these creatures, starting with the people who live on the coasts and certain groups who are more directly involved, such as fishermen and those using pleasure craft. It must be stressed and stressed again that these creatures are essential links in the chain of the marine environment, and that if they disappear it will cause a disastrous ecological imbalance. It is up to each and every one of us to protect them. Like all living beings they have the right to exist in their free state, in peaceful coexistence with man, within the framework of respect and upkeep of biodiversity in its entirety- this, the irreplaceable natural capital of our planet. ■

IDEAS BEHIND THE NEW OR UPDATED MEDITERRANEAN LEGAL INSTRUMENTS

*by Professor Tullio Scovazzi**

Developments in the Barcelona system

Over the last few years the Barcelona system, consisting of the 1976 Convention on the Protection of the Mediterranean Sea against Pollution and its relevant protocols has undergone important changes in several of its components (**). The Convention and most existing protocols have been amended. New protocols have been adopted. Each of the texts of the updated Barcelona system contains important improvements. Some of the protocols even show a certain degree of legal imagination in envisaging new solutions.

The framework Convention, as amended in Barcelona in 1995, changes its name to **Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean.** It reflects and applies on a regional scale the main ideas arising from the United Nations Conference on Environment and Development (Rio de Janeiro, 1992): the precautionary principle; the integrated management of coastal zones; the resort to best available techniques and best environmental practices and the promotion of environmentally sound technology, including clean production technologies. For the purpose of implementing the objectives of sustainable development, the parties shall take fully into account the recommendations of the Mediterranean Commission on Sustainable Development, a new body which is established within the framework of the Mediterranean Action Plan, Phase II. A new article provides for the right of the public to have access to information on the state of the environment and to participate in the decision-making processes relevant to the field of application of the convention and the protocols.

The Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea (as amended in Barcelona in 1995) presents two major changes with respect to the previous text. It also applies to incineration at sea, which is prohibited. It is based on the idea that the dumping of waste or other matter is in principle prohibited, with the exception of five specifically listed categories of matter. The logic of the previous text is reversed. It assumed that dumping was in principle permitted, unless a different regime was specifically provided for (ban on dumping for matter mentioned on the so-called black list, or special permits required for matter mentioned in the "grey list").

The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based sources and Activities, as amended in Siracusa in 1996, extends its area of application to the hydrological basin, which is defined as the entire watershed area within the territories of the Parties, draining into the Mediterranean. In order to achieve the objective of protecting marine waters, action must in most cases be taken where the polluting sources are located, that is, on the land territory of the Parties. Priority is given to the phasing out of inputs of substances that are toxic, persistent and liable to bioaccumulate. The amended Protocol was the object of extensive negotiations- not only amongst the Parties, but also between the environmentalist non-governmental organisations and those representing the chemical industry- as regards how to implement the obligation to prevent, abate, combat and eliminate pollution to the fullest possible extent. Finally, a satisfactory solution was found. For their part, the environmentalists accepted that an absolute ban by the year 2005 on any kind of discharge or emission of substances which are toxic, persistent or liable to bioaccumulate (as they initially requested) would

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**For the texts see UNEP, Mediterranean Action Plan and Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols, Informal Document (Revised), Athens, 1997.

have been impossible to achieve because of its serious economic and social repercussions. The chemical industry, for its part, agreed to be bound by measures and timetables of a legally mandatory nature, provided that they related to specific groups of substances and were adapted to the specific requirements of the different instances.

Very different from the previous instrument, and formally distinct from it, is the **Protocol concening Specially Protected Areas and Biological Diversity in the Mediterranean,** opened to signature in Barcelona in 1995. The new protocol is applicable to all the marine waters of the Mediterranean, irrespective of their legal condition, as well as to the seabed, its subsoil and to the terrestrial coastal areas designated by each party, including wetlands. The extension to the high seas of the geographical coverage of the protocol was necessary in order to also protect those highly migratory marine species (such as marine mammals) which, by definition, do not respect the artificial boundaries drawn by man on the sea. The new protocol provides for the establishment of a list of specially protected areas of Mediterranean interest (SPAMI list), which may include sites which are of importance for conserving the components of biological diversity in the Mediterranean, contain ecosystems specific to the Mediterranean area or the habitats of endangered species, or are of special interest at the scientific, aesthetic, cultural or educational levels. The decision to include an area in the SPAMI list is taken by consensus by the Contracting Parties during their periodic meetings. Once an area is included in the SPAMI list, all the parties agree to comply with the applicable measures and not to authorise nor undertake any activities which might be contrary to the objectives for which the SPAMI was established.

The Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal, opened to signature in Izmir in 1996, includes some provisions which are more protective than the general regime established by the 1989 Basel Convention. Besides other hazardous waste, the protocol also applies to radioactive waste and to hazardous substances that have been banned in the country of manufacture or export for human health or environmental reasons. Moreover, the protocol introduces an innovative "notification without authorisation" approach as regards the passage of ships carrying hazardous waste

through the territorial sea of a foreign state. This approach tries to strike a fair balance between the interests of maritime traffic and those of the protection of the coastal environment. On the one hand, ships carrying hazardous waste have the right to pass, as their passage is not made conditional on prior authorisation by the coastal State. On the other hand, the coastal State has the right to be notified, in order to know what is happening in its territorial seas and to be prepared to intervene in case of casualties or accidents during passage, which could endanger its environment.

The Barcelona system is completed by the 1976 **Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency,** to which no amendments were proposed, and by **the Protocol concerning Pollution resulting from Exploration and Exploitation of the Continental Shelf, the Seabed and its Subsoil,** which is already in line with recent environmental trends, having been adopted in Madrid in 1994.

New legal instruments within the Barcelona system may follow in the near future. A meeting of government-designated experts on the preparation of appropriate rules and procedures for the determination of liability and compensation for damage resulting from pollution of the marine environment in the Mediterranean Sea area was held in Brijuni in 1997. Lawyers are well aware that this topic presents major obstacles to be overcome, due to the different domestic principles on tort law and environmental damage, as well as all the legal complications, technicalities and subtleties involved therein. The economic consequences arising from the matter as a whole do not facilitate the task. Nevertheless, this kind of obstacle is not peculiar to the Mediterranean, and relates to every field of international environmental law where liability instruments are today being discussed. Any attempt to find reasonable and generally acceptable solutions deserves to be fully explored.

Developments outside the Barcelona system

Whilst mainly taken up by the Barcelona system, the new legal picture of the Mediterranean is not limited to it alone. An Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (so-called ACCOBAMS) was opened to signature in Monaco in 1996 within the framework of the 1979 Bonn Convention on the Conservation of Migratory Species of Wild Animals. It prohibits any deliberate "taking" of cetaceans, with the exception of non-lethal "taking" for the purpose of in-situ research. This goes far beyond the protection granted to marine animals by the 1946 Convention for the Regulation of Whaling.

The amendments adopted in 1997 to the agreement establishing the General Fisheries Council (now Commission) for the Mediterranean could lead to new prospects towards the achievement of a comprehensive regime for the sound exploitation of Mediterranean live resources. This has always been a crucial matter, due to cases of illegal or non-selective fishing practices, instances of difficult delimitation of maritime boundaries, the on-going absence of exclusive economic zones (but some Mediterranean countries have established fishing zones), and other problems.

Another field of future cooperation among the Mediterranean countries could be the preservation of underwater archaeological and cultural heritage.

Prime responsibility

None of the new or updated instruments mentioned above has entered into force yet. This seems, however, to be due more to the time-consuming domestic procedures to implement treaties than to any lack of political will.

It seems more important to remark that the Mediterranean instruments in question go beyond a wishful recollection of principles and a statement of good intentions. Perhaps an underlying idea may be found in all of the innovations envisaged. The Mediterranean could be considered a primary heritage and concern for the riparian States (and for the European Community, which is also a Mediterranean entity), which are better placed than the others to assess its relevant peculiarities. For geographical reasons, this regional and semi-enclosed sea would be entirely covered by exclusive economic zones, if such coastal zones were to be established by the riparian States. Without unduly encroaching on the rights of Third Countries, the regime governing this kind of seas could be particularly oriented towards the protection of the marine environment and the sound management of live resources.

Could the idea of the "special responsibility" (or "prime responsibility") of certain States, which is quite common in spaces very different from the Mediterranean (as Antarctica), present some purpose elsewhere too? ■

Meetings

On 22 and 23 January 1998 a meeting of MAP/GEF national coordinators of all the Mediterranean countries was held in Athens in order to approve the project document laying the foundations for implementation of the Strategic Actions Programme (SAP). Aiming at combating pollution stemming from land-based activities, it involves a GEF financial contribution of some 6.29million dollars, country participation to a tune of 3.04million dollars, and a MAP envelope consisting of 1.12million dollars. The project document was approved by the GEF Board meeting in New Delhi on 1-3 April 1998. The Athens meeting also proposed that a separate SAP should be drawn up on biodiversity.

A technical advisory meeting was held in Athens on 5 February to coordinate the activities of the six working groups of the Mediterranean Commission for Sustainable Development. It brought together representatives of the Coordinating Unit, the directors of the RACs, and the task managers of all six thematic working groups. The meeting agreed on a timetable of meetings for all the groups, with an eye to the fourth meeting of the MCSD in Monaco in October 1998.

The spread of Caulerpa (see Medwaves no.33) was the subject of a meeting hosted by the Institute for Marine Biology in Heraklion, Crete, from 18-20 March, 1998. This was an important meeting in many respects. It brought together 35 experts- the most highly qualified and best renowned on the subject- from 13 riparian states. Country reports and presentations were made and, for the first time since the presence of these non-indigenous algae started creating waves in the scientific community, unanimity was reached on the idea expressed in the conclusions of the report adopted that the most serious risk from *C.taxifolia* and *C.racemosa* was the upsetting of the ecological balance. Indeed, although *Caulerpa taxifolia* dominated the discussions, participants also stressed the threat represented by another caulerpa - *Caulerpa racemosa* - which has not been só extensively studied, and they recommended that all Mediterranean countries should adopt the measures required for the implementation of the provisions of the Protocol on Specially Protected Areas in the Mediterranean Sea (Barcelona Convention), which deals with the intentional or accidental introduction of non-indigenous species and their eradication when they cause or are likely to cause damage to ecosystems, habitats or species.

The Bureau of Contracting Parties to the Barcelona Convention met in Tunis on 28 March 1998, under the chairmanship of Mr.M.Mehdi Mlika, the Tunisian Minister of the Environment. Mr. Lucien Chabason, MAP Coordinator, made a progress report on activities since the X th Ordinary meeting in Tunis in December 1997. As only Monaco and Tunisia have so far ratified MAP's new legal instruments, the Bureau authorised its President to urge the Contracting Parties not having already done so to speed up the process of ratification. Finally, the Bureau chose the remaining members of the MCSD.

The XVIth meeting of the MED Unit and RAC directors was held in Cairo on 1 June 1998, alongside a MAP/METAP workshop. The meeting carried out a careful examination of the Coastal Areas Management Programme (CAMP) and agreed on a clearly defined strategy for the drawing up and implementation of future CAMP

The rosrum at the caulerpa meeting: From Lft, to rt., Mr. Gabrielides (MAP), Mr. Eleftheriou (Institute for Marine Biology, Heraklion, Crete), Mr. Barbieri (SPA/RAC), Mr. Boudouresque (Mediterranean University, Marseille).

projects, including the drafting of a CAMP handbook.

On 2 and 3 June 1998, MAP (PAP/RAC) and METAP jointly ran a workshop in Cairo to go through a study carried out by the two organisations on the "Assessment of Initiatives for Integrated Management of Mediterranean Coastal Zones: experience obtained by METAP and MAP (1988-1996)". Participants exchanged views on their national experiences with the implementation of projects concerning the coasts, particularly CAMP projects. The European Union (DGXII) representative gave information about MEDA/SMAP, the EU's financial mechanism, and about what procedures should be followed to request financing under this mechanism. At the end of the meeting, a body of recommendations was drawn up on future activities and tasks, including the active involvement of partners in the implementation of the Integrated Management of coastal zones in the Mediterranean region.

Comings and goings within MAP

In the Sophia Antipolis BP/RAC, as was announced in our last edition, Mr.Guillaume Benoit has replaced Mr.Bernard Glass at the head of the Blue Plan, and Mrs.Aline Corneau has been appointed scientific director. Both took up their posts in January 1998.

In the Split PAP/RAC, Mr.Ivica Trumbic, who was acting director, has officially become director of the Priority Actions Programme, following a decision taken by the PAP/RAC administrative Board in Zaghreb at the end of November 1997.

In REMPEC, Malta, Mr.Jean-Claude Sainlos stepped down as director of the Centre on 1 June 1998, having been appointed deputy director of IMO's Environment division in London.

In the Athens Coordinating Unit, Mr.Arab Hoballah, formerly deputy director of the Blue Plan, has been appointed deputy Coordinator of MAP, responsible for questions of sustainable development and information. Mr.Francesco Civili, formerly programme administrator/ marine science expert in the Unit, has been appointed MED POL coordinator.

Publications

Series of MAP technical reports: the two new reports in the series which have been published since our last issue are official documents, adopted by the Contracting Parties, which govern MAP activity in the field of pollution control in the Mediterranean, and which we have already dealt with at length: **Strategic Action Programme to address Pollution from land-based Activities** *(no.119, Athens 1998, English and French versions together, 166 pages; see Medwaves nos.34 and 35-36);* **MED POL Phase III, Programme for the assessment and control of pollution in the Mediterranean region (1996-2005),** with the appended programmes of compliance monitoring and site-specific temporal trend monitoring *(no.120 and no.121, Athens 1998, for the English version (130 pages) and the French version (133 pages) respectively; see Medwaves no.33 and 34, Montpellier and Delphi meetings).*

Studies on the implementation of the Barcelona Convention: the development of an international trust regime, *by Evangelos Raftopoulos.* The author, assistant professor in law at Athens University, is also MAP's legal adviser, and as such has become very familiar with the problems related to the implementation of the Barcelona legal system. The first study deals with the legislative implementation of the Barcelona Convention in Greece, Egypt and Israel, the second with beneficiary rights stemming from the Barcelona Convention, and the third with aspects of a liability regime in the Mediterranean. The latter study is of particular relevance, since it is directly related to on-going considerations within MAP which began at the September 1997 Brijuni meeting, on article 14 of the 1976 Convention which is still in force, and article 16 of the Convention revised in 1995, which provide for the drawing up and adoption of appropriate rules and procedures on the determination of liability and reparation for damage resulting from pollution of the Mediterranean marine environment *(Sakkoulas Publishers, Athens 1997, 162 pages)*