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Workshop on invasive *Caulerpa* species
in the Mediterranean

Heraklion, Crete, Greece, 18-20 March 1998

**REPORT OF THE WORKSHOP ON INVASIVE *CAULERPA* SPECIES
IN THE MEDITERRANEAN**

Introduction

1. The Extraordinary Meeting of the Contracting Parties to the Barcelona Convention (Montpellier, July 1996) approved the organization of a Workshop on *Caulerpa* species, which have been expanding in recent years, to which interested Mediterranean scientists would be invited to exchange scientific experience and views on the subject.
2. The Secretariat decided to hold a "Workshop on Invasive *Caulerpa* Species in the Mediterranean" from 18-20 March 1998. The Institute of Marine Biology of Crete agreed to host the Workshop at its premises in Heraklion, Crete. The MAP Focal Points were invited to circulate an information note concerning the Workshop to all interested scientists in their countries and to nominate one scientist to prepare and present a country report covering the situation in the country with regard to the spread or eventual presence of *Caulerpa* species.
3. The Workshop was attended by 53 scientists, while 19 countries namely, Albania, Algeria, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libyan Arab Jamahiriya, Malta, Monaco, Morocco, Slovenia, Spain, Syrian Arab Republic, Tunisia and Turkey nominated representatives. A full list of the participants appears as Annex I to this report.

Opening of the Workshop and organization of work

4. The Workshop was opened by Mr G.P. Gabrielides, Senior Programme Officer of the MAP Coordinating Unit, on behalf of the MAP Coordinator, Mr L. Chabason. Mr Gabrielides provided the participants with a brief overview of the activities of the MAP and of the Barcelona Convention and its related protocols, with particular reference to the recent revision of the Convention and the protocols. In the third phase of MED POL, the emphasis had changed from pollution assessment to pollution control. MAP had been following the situation with regard to *Caulerpa taxifolia* and acknowledged the quality of the work carried out by scientists in the region, particularly within the context of the European Union's DG XI Life Programme. A document on the subject had been prepared and distributed to the Meeting of MAP Focal Points held in 1995. At the 1996 Meeting of the MAP Focal Points, the representative of a country which had been recently affected by *Caulerpa taxifolia* had called upon MAP to take action. The Contracting Parties had decided to hold a Workshop on *Caulerpa* to exchange views and consider whether there was a scientific basis for recommending further action. The present Workshop was the result of that decision and was attended by scientists who were called upon to discuss scientific rather than political issues. The principal purposes of the Workshop were to exchange information and views and prepare conclusions and recommendations, as appropriate. Finally, he gave thanks to the Institute of Marine Biology of Crete for its kind proposal to host the Workshop.
5. Professor A. Eleftheriou (Institute of Marine Biology of Crete) welcomed the participants to Crete. He emphasized that, although Crete was not currently directly affected by the issue of *Caulerpa taxifolia*, it was not a question of if, but of when the waters of the Eastern Mediterranean would be affected. The problem of *Caulerpa taxifolia* was a matter of concern and interest for all ecologists. He informed the participants that the Institute of Marine Biology of Crete had now been in operation for a decade and worked in the fields of the environment and fisheries, as well as aquaculture and genetic questions related to fishing. It operated a research vessel and a fish farm and its multimedia team produced reports, CD-ROMs and videos, as well as a dictionary of the terms used in aquaculture in four languages. He invited the participants to visit the Institute's facilities during the course of the Workshop.

6. Mr M. Barbieri (Regional Activity Centre for Specially Protected Areas) gave a brief overview of the role of the Tunis Centre (SPA/RAC), in particular with regard to the implementation of the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean. Although the Protocol had not yet entered into force, it was hoped that it would do so fairly soon. The Protocol provided a very appropriate legal framework for dealing with the issue of *Caulerpa taxifolia*, particularly in its provisions respecting the introduction of non-indigenous or genetically modified species. Article 13 of the Protocol stated that:

1. *The Parties shall take all appropriate measures to regulate the intentional or accidental introduction of non-indigenous or genetically modified species to the wild and prohibit those that may have harmful impacts on the ecosystems, habitats or species in the area to which this Protocol applies.*

2. *The Parties shall endeavour to implement all possible measures to eradicate species that have already been introduced when, after scientific assessment, it appears that such species cause or are likely to cause damage to ecosystems, habitats or species in the area to which this Protocol applies.*

7. Professor C.-F. Boudouresque (Centre d'Océanologie de Marseille), Coordinator of the projects on *Caulerpa* approved within the framework of the European Union's DG XI Life Programme, gave a brief overview of the two phases of the Programme covering the years 1993-95 and 1996-98 respectively. The second phase of the Programme concerned France, Italy and Spain from the Northern Mediterranean and Algeria, Malta and Tunisia from the Southern Mediterranean, in association with Croatia and Turkey, as well as around 30 laboratories and institutions and a large number of researchers. Its major activities included: monitoring and awareness-raising; the cartographic surveillance of the expansion of *Caulerpa taxifolia*; the development of a control strategy based on the identification of realistic techniques for the eradication of *Caulerpa taxifolia* and the limitation of its extension; and training. As a result of the Programme, *Caulerpa taxifolia*, which was considered to be one of the four major marine invasions at the global level, was now the marine invasive species for which the greatest mass of information was available.

8. The Workshop elected the following officers:

President: Professor A. Eleftheriou, Institute of Marine Biology, Crete
Vice-Presidents: Professor C.-F. Boudouresque, University of Marseille-Luminy
Professor G. Giaccone, University of Catania
Rapporteur: Professor A. Meinesz, University of Nice-Sophia Antipolis

9. The Workshop agreed on a programme of work, which appears as Annex II to this report.

General Presentations

10. In his presentation on introduced species in the Mediterranean, routes, kinetics and consequences, Professor C.-F. Boudouresque defined *introduced species* as "species the expansion of which is linked directly or indirectly to human activity, and which are naturalized, in the sense that they are able to reproduce *in situ* without human assistance". He then described the various routes through which alien species arrived in the Mediterranean, the processes of their distribution and the principal recipient areas. He reviewed the principal phases in the introduction of such species and their possible affects on biodiversity. Although only 1 per cent of arriving species were normally successful in their establishment and

subsequent naturalization in a new environment, some of them could become invasive and displace or replace native species. He emphasized that the Mediterranean had a higher level of introduced species than any other major sea and concluded that the introduction of alien species was an important phenomenon because it was still in the phase of exponential increase, with the number of alien species almost doubling on average every 20 years. Moreover, the ecological consequences of introduced species were often underestimated, while their economic consequences were difficult to anticipate. National legislation was an inadequate instrument in providing protection to autochthonous biodiversity and was often unrealistic and always ineffective. Introduced species were no respecters of national frontiers and international agreements were therefore of vital importance. Finally, the precautionary principle should always be applied in respect of these species.

11. In his presentation on the general situation with regard to the expansion of *Caulerpa taxifolia* in the Mediterranean and the analysis of the biotopes affected, Professor A. Meinesz emphasized that the areas affected by *Caulerpa taxifolia* evolved rapidly from year to year. There were now over 110 *Caulerpa taxifolia* colonies in the Mediterranean overall, some of which had become so large they were impossible for divers to measure accurately. He described the origins and first sightings of *Caulerpa taxifolia*, the campaign of awareness carried out in the early 1990s and the efforts that were made on a continuous basis by a large number of divers to document the spread of *Caulerpa taxifolia* throughout the Mediterranean. There is no evidence that *Caulerpa taxifolia* was spread through sexual activity. On the contrary, each cutting which took root spread through the extension of its stolons rapidly to the surrounding area. Over longer distances, it was most probably spread by the anchors of boats and fishing nets. New sightings of *Caulerpa taxifolia* were almost always in mooring areas for pleasure or fishing vessels. In conclusion, he warned that, since its introduction, *Caulerpa taxifolia* had undergone massive expansion and, in particular, attacked the richest ecosystems of the Mediterranean. Because of its biological characteristics, the whole of the Mediterranean could be affected. *Caulerpa taxifolia* therefore constituted a major threat to the most important ecosystems in the Mediterranean between 0 and 50m in depth.

12. In her intervention on the ecological and possible economic consequences of the spread of *Caulerpa taxifolia* in the Mediterranean, Professor C. Rodríguez-Prieto described the seasonable variations in the density of *Caulerpa taxifolia*, the maximum dimensions of its primary and secondary ramifications and the density of its rhizomes and plant biomass. The latter was considerably lower than that of autochthonous marine flora. She also referred to the broad range of temperatures, depths and substrata on which *Caulerpa taxifolia* could flourish. The main consequences of the proliferation of *Caulerpa taxifolia* consisted of the disappearance of native algae, which affected most animal groups, although molluscs did not appear to suffer much and some types of fish remained unaffected. It also resulted in a loss of species diversity and of biomass, with a resulting reduction in the quantity and quality of marine production. Because the reduced capacity of *Caulerpa taxifolia* to absorb nutrient salts favoured the development of plankton, a further result was a rise in the turbidity of the water column. The continued expansion of *Caulerpa taxifolia* would therefore lead to the development of an increasingly uniform seabed, implying a loss of its attractive value for certain kinds of tourism. The reduction of fish stock could also lead to problems for small-scale fishing activities. In reply to the comment by Professor G. Giaccone that research in Italy had produced very different conclusions with regard to biodiversity, she pointed to the difficulties inherent in comparing different types of research and the need for quantitative as well as qualitative data in measuring real changes in biodiversity. Professor A. Meinesz added that it was generally accepted that invasion by *Caulerpa taxifolia* resulted in a drastic decline in biodiversity in the affected areas.

13. In his intervention on the ecological and toxicological aspects of *Caulerpa taxifolia*, Professor F. Dini highlighted the sharp differences in growth characteristics between the strains of *Caulerpa taxifolia* found in the Mediterranean and those occurring in tropical areas around the world. Indeed, a comparative study of the genome of three *Caulerpa taxifolia* strains from widely differing geographical locations disclosed broad genetic differences. With regard to the toxicity of *Caulerpa taxifolia*, the populations colonizing the Mediterranean were characterized by the production of seven unprecedented terpenoids, as well as the already known terpenoids oxytoxin and the very toxic caulerpenyne. However, research showed that this last terpenoid in solution, on exposure to daylight and in the presence of oxygen and chlorophylls or phaeophytins, rapidly degraded and eventually produced bioinactive products. Research carried out on the Island of Elba over a period of three years showed that, with an increasing colonization of *Caulerpa taxifolia* over the years, the incidence of gram-negative bacteria increased, while that of gram-positive ones declined. Hence, *Caulerpa taxifolia* exercises strong selective pressure on bacterial communities. Although the North-Western Mediterranean Sea is suffering drastic modifications as a result of the aggressive ecological behaviour of *Caulerpa taxifolia*, the behaviour of the bacteria communities suggested ongoing adaptation of the ecosystem to the new situation. A scenario of a balanced settlement of *Caulerpa taxifolia* in the ecosystem of the North-Western Mediterranean Sea could therefore be forecast eventually. In reply to a comment by Professor Meinesz that a large corpus of work on the subject supported the hypothesis that the toxicity of *Caulerpa taxifolia* amplified the ecological problems of its expansion, Professor Dini pointed out that, although there were currently few organisms which fed on *Caulerpa taxifolia*, this would probably change in the future.

14. Addressing the issue of whether the spread of *Caulerpa taxifolia* could be controlled, Mr V. Gravez outlined a number of elements for a strategy for this purpose. He noted in this respect that the Convention on Biodiversity and the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean provided a good legal framework for such a strategy. He added that a great deal of research had been undertaken with substantial monitoring activities. This was very important in order to fulfill the first requirement of a strategy to control the expansion of *Caulerpa taxifolia*, namely the dissemination of information to decision-makers and scientists. A second element of the strategy was the prevention of the contamination of new sites and countries. Although regulations had been adopted for this purpose in France and Spain, they had encountered difficulties of application. Awareness-raising and information programmes were therefore needed for seafarers of all types, including fishermen and yacht owners, as well as for owners of aquaria. About 90 per cent of the present knowledge of the extent of the *Caulerpa taxifolia* invasion was a result of awareness campaigns requesting divers to report new colonies. A third important element of the strategy was the preservation of patrimonial sites, and particularly marine protected areas in the Mediterranean. A special approach was needed for this purpose, including training, awareness-raising activities, the investigation of risk areas, regulations to limit the use of anchors by ships and control operations, particularly with a view to eradicating small new colonies.

15. An important element of a strategy to control *Caulerpa taxifolia* consisted of the control of existing colonies. This included the management of areas which were already strongly colonized through information activities, the regulation and where necessary prohibition of anchoring by ships and of fishing, and the marking of such areas, for example on marine charts and through the use of buoys. Another important consideration was to prevent the propagation of *Caulerpa taxifolia* during harbour dredging operations. Dredging sludges from colonized areas should not be dumped at sea, at least until sufficient time had passed to ensure that the alga no longer survived. Control measures needed to be adopted for small colonies located far from strongly colonized areas. However, current eradication techniques, including the use of

suction pumps, only permitted the treatment of a few square metres of seabed. Even then, *Caulerpa taxifolia* always came back and regular surveys of treated areas were therefore needed. It was only currently possible to slow down the expansion of the alga. However, if nothing was done in the short term, the problem very quickly got out of control. The only solution was therefore to use current techniques while awaiting the development of more efficient methods. The methods that were currently under examination included covering *Caulerpa taxifolia* beds with opaque plastic sheeting to restrict photosynthesis, spreading salt and treatment with copper techniques. The only long-term solution consisted of the development of biological control methods. Two exotic species of sea slug (*ascoglossan*) had been identified and experiments in aquaria showed that they offered possibilities of regulation of the algal population. It is now necessary to proceed with *in situ* experiments under controlled conditions, but any decision concerning the control of the algae should be taken at the international level. In the meantime, it was necessary to adopt a schedule, identify the financial resources and establish priorities. It was also very important to give official recognition to the threat that *Caulerpa taxifolia* constituted for biodiversity and society.

16. After a number of speakers had welcomed Mr Gravez' intervention, Professor Meinesz added that a decision needed to be taken. Either *Caulerpa taxifolia* was a natural phenomenon, which might even be good for the Mediterranean, in which case no action should be taken. Or, as maintained by most of the scientific community, it constituted a major risk for ecosystems, in which case the necessary administrative, legal, information and control measures had to be taken, as emphasized by many scientists since 1991. Professor A. Eleftheriou emphasized the need to involve politicians in the question, as they were the ones who controlled public resources.

Specific presentations

17. Introducing a six-year study of the impact of *Caulerpa taxifolia* on fish populations in Cap Martin (Menton, France), Dr M. Harmelin-Vivien described the results of over 1900 visual censuses on invaded and reference sites, mainly composed of rocky substrata and *Posidonia oceanica* seagrass beds. The study showed a significant decrease in mean species richness, and the average density and biomass of fish in sites colonized by *Caulerpa taxifolia* compared to the reference sites. The reduction in the number of species was of between 20 and 30 per cent, while the decrease in the density was of over 30 per cent and that of biomass over 50 per cent. However, the populations of certain species of fish in areas affected by *Caulerpa taxifolia* remained constant or even increased in some species of the family Labridae, suggesting a complex biological phenomenon. The impact on fish fauna was particularly severe where the original ecosystem had been of a high complexity, offering many different types of shelter and food sources for fish.

18. Presenting the work carried out on the modelling and simulation of the expansion of *Caulerpa taxifolia* in the North-Western Mediterranean, Dr P. Coquillard described the efforts of a team of experts to develop a model which could predict future colonization by *Caulerpa taxifolia*, its spatial distribution and would provide both statistical and cartographical projections. It had been necessary for this purpose to take into account a broad variety of parameters, including the receptivity of various types of seabed, currents, seasonal variations, spatial effects and long distance interactions, as well as several factors which could influence colonization. After providing a description of many of the activities carried out to validate the programme, he expressed the opinion that the model was now partially valid and could be further improved through the integration of more detailed data on currents and on human activities. The model could contribute to a policy of identifying and safeguarding areas which required special protection, as well as projecting the effect of various control measures.

19. Describing experimental investigations into the contrasting effects of *Posidonia oceanica* on *Caulerpa taxifolia*, Dr G. Ceccherelli described a series of experiments carried out at the Island of Elba to investigate the factors in *Posidonia oceanica* meadows which affected the growth of *Caulerpa taxifolia*. The length and the density of the fronds of *Caulerpa taxifolia* were used as a measure of the growth of the alga when located alone, at the edge of *Posidonia* meadows and within *Cymodocea nodosa*. The research found that *Posidonia* had a positive effect on the growth of *Caulerpa taxifolia*, which was probably due to the shelter it provided from hydrodynamic disturbance. The results of the research suggested that dense *Posidonia* meadows were likely to be less vulnerable to invasion by *Caulerpa taxifolia* than sparse ones which, conversely, provided a good compromise between protection and shading for *Caulerpa taxifolia*. The more vigorous growth of *Caulerpa taxifolia* at deeper levels (of over 10m in depth), confirmed that *Posidonia* meadows were in greater danger at lower depths, where *Caulerpa taxifolia* deprived them of the light that they needed.

20. Addressing the Workshop on the presence of *Caulerpa taxifolia* in the Balearic Archipelago, Dr A.N. Grau described the surveillance and preventive measures taken since the first appearance of *Caulerpa taxifolia* on the islands in 1992. Control measures had included eradication by hand and the use of suction pumps, supported by an extensive programme of monitoring the sites on which eradication measures had been taken and other neighbouring sites which were at risk of colonization. Experience showed that the use of suction pumps was at least twice as effective as manual eradication measures. Although he was not optimistic about the future evolution of the situation, he pointed out that *Caulerpa taxifolia* had been present in the Archipelago for nine years and that the measures taken had succeeded in confining its expansion to two areas. These measures therefore made it possible to significantly slow down the expansion of *Caulerpa taxifolia*. In reply to several questions, he noted that the programme of measures taken in the Balearic Archipelago cost in the region of Pts.10 million a year. He also indicated that, although *Caulerpa taxifolia* had probably been transported to one of the affected areas by boat, this was extremely unlikely for the other area, which was protected by a barrier in the summer months. This latter area might have been contaminated by the dumping of the contents of an aquarium.

21. Following a showing of the video film "On the Trail of Caulerpa", Mr T. Belsher described the elements of cartography and changes of *Caulerpa taxifolia* along the Alpes Maritimes and Monaco coasts. He outlined the action taken within the context of the European Union Life II Programme, as well as at the national level, to study the expansion of *Caulerpa taxifolia*. A variety of surveillance methods had been used over the years, including air photography and the use of underwater video supported by a special computer programme. This enabled the operators to quantify the population of *Caulerpa taxifolia* in a given area very rapidly. The technique permitted visualization down to a depth of between 80 and 100m, depending on technical factors and meteorological conditions. In the study zone, it had therefore been possible to follow closely seasonal variations, the expansion of *Caulerpa taxifolia*, and its progression towards deeper waters, as well as the impact of meteorological events. The use of new techniques is envisaged, including that of laser equipment adopted for sea work. This would provide coverage of a much wider area and permit a more precise surveillance of the impact of *Caulerpa taxifolia* on marine ecosystems.

22. Introducing a presentation on the problem of the *Caulerpa* invasion and the initiatives taken by the ENEA Centre of La Spezia, Dr A. Peirano said that the agency was involved in national and international programmes concerning biodiversity, oceanography and climate changes. Of particular interest was the mapping project that it had carried out of the *Posidonia oceanica* and *Cymodocea nodosa* beds in Liguria before they had been affected by *Caulerpa taxifolia*. Referring to the expansion of *Caulerpa taxifolia* in Liguria, he described the threat to

the marine national parks. He presented two mid-term ten-year scenarios concerning the invasion of *Caulerpa taxifolia* in Liguria. Both *Posidonia oceanica* meadows and coralligenous communities were in danger. He emphasized that the proliferation of *Caulerpa* species was of great importance not only for the Ligurian coastal areas, but also for all Italian coasts. He therefore hoped that the Workshop would serve as a stimulus for greater awareness of the problem by the Italian Government so that efforts could be made to develop technical tools, including cartography of the algal status of the coastline.

23. Introducing a presentation on the marine phytobenthos of the Moroccan Atlantic and Mediterranean coasts, and *Caulerpa taxifolia*, Professor L. Najim described the characteristics of the Moroccan coastline, which extended over some 3,500 km, including some 450 km of Mediterranean coast, and displayed a great wealth of algal species. After reviewing the studies that had been carried out of the Atlantic and Mediterranean coastline, he described the conditions under which *Caulerpa prolifera* was present in the lagoon of Nador on the Mediterranean coast. The lagoon in question suffered from a high level of pollution from municipal waste and consisted of a rather enclosed expanse of water. He hoped to create a network for collaboration, develop prevention measures and awareness of the problem of *Caulerpa taxifolia* and join the European Union's Life Programme.

24. Dr A. Djellouli provided information on the situation as regards *Caulerpa racemosa* along the Tunisian coast. The species had first been reported off Sousse in 1926. Until 1995, it had been known to be present only along the coast south of Sousse and in the Gulf of Gabes. In 1996 it has been observed in the Bizerte lagoon in the north of Tunisia, indicating the progression of the species. The species showed great ecological adaptability. It had been observed down to 80-90m and presented morphological differences *in situ* and in aquariums. Further research was needed to investigate the physical and chemical factors which might influence the development of the alga and a comparison should be carried out between the various sites at which it was present. With regard to *Caulerpa taxifolia*, he noted that Tunisia had joined the European Union's Life Programme and that information materials had been translated into Arabic. He invited interested Arab-speaking countries to make use of them. He emphasized the vigilant attitude adopted by his country with regard to any introduction of species.

Presentation of country reports

25. Presenting the country report on Albania, Dr L. Kashta noted that the Albanian coast presented typical Mediterranean characteristics with species from various parts of the Mediterranean. No colonization by *Caulerpa taxifolia* had yet been identified, although it was not possible to be completely certain on this point since no studies had been made on the marine flora in recent years and no monitoring system had been organized for this purpose. The only species from the genus *Caulerpa* found on the Albanian coastline was *Caulerpa prolifera*. He called for the creation of an observation network in collaboration with institutions in other Mediterranean countries.

26. Introducing the country report on Algeria, Dr R. Semroud emphasized that research had confirmed that *Caulerpa taxifolia* constituted a significant risk to biodiversity and ecodiversity in the Mediterranean. Moreover, there were no grounds for envisaging a natural slowdown in its expansion. Although the alga was not present in his country, as a Contracting Party to the Barcelona Convention, Algeria was naturally concerned by this very important ecological threat in the Mediterranean. He cited Article 13 of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean, and emphasized that the development of eradication measures needed to be accompanied by a strategy to slow down the expansion of

Caulerpa taxifolia in the Mediterranean basin. It was particularly important in this connection to apply the precautionary principle established in the Convention on Biological Diversity.

27. Reporting on the situation with regard to *Caulerpa taxifolia* in Croatia, Mr A. Zuljevic said that the alga was present in three areas on the Croatian coast. The first observation had been in 1994. Various methods had been used at each location for the eradication of the alga, including manual extraction, extraction by suction pump and covering the alga with black PVC foil. The *Caulerpa taxifolia* at the site in the Barbat Channel had been fully eradicated, whereas it had only been partially eradicated from the site in Malinska. In the region of Stari Grad Bay, action was being taken to prevent further expansion. These measures were financed by the local government. It had been found that *Caulerpa taxifolia* died under the black PVC foil after a period of three months. Further eradication activities were planned on each of the sites. Other measures taken to prevent the spread of the alga included the prohibition of fishing in affected areas and an information campaign. Monitoring was also carried out, both of treated sites and of areas at risk from colonization, in collaboration with diving clubs. The Croatian experience showed that small areas of *Caulerpa taxifolia* could be eradicated completely, especially from muddy bottoms.

28. Describing the situation in Cyprus, Ms M. Argyrou noted that, although *Caulerpa taxifolia* had not been found in her country, the Red Sea species *Caulerpa racemosa* had been present in the coastal waters of Cyprus since 1991. It was currently proliferating around most of the coast of the Island, with the greatest abundance in the south-eastern region. She added that it formed dense green mats in a wide range of habitats, on sandy as well as muddy bottoms, from shallow waters down to a depth of 60m. The expansion of *Caulerpa racemosa* could be a particular threat to *Posidonia* meadows. A recent study had shown significant changes in the composition and abundance of macrofaunal assemblages, which could be attributed at least in part to the prolific growth of *Caulerpa racemosa*. Moreover, recent work suggested that the recent decline of the population of the fish *Siganus luridus* and *Siganus rivulatus* could be related to their habit of grazing on *Caulerpa racemosa*. However, more data were required to investigate the ecological consequences of the changes produced by the arrival and expansion of *Caulerpa racemosa*, which was still in an evolutionary process.

29. Introducing the country report for Egypt, Dr A.N. Khalil explained that his country had over 1,000km of coastline composed mainly of sandy, muddy and rocky shores. The area around Alexandria was particularly rich in its biodiversity. Although no *Caulerpa taxifolia* had been observed, various forms of *Caulerpa* were present in the area. *Caulerpa prolifera* was very abundant, while *Caulerpa scalpelliformis* was found in two areas off the coast of Alexandria. Over the past few years *Caulerpa racemosa* had also invaded the area and had first been observed near sewage outlets. A new study on the occurrence of the algal association in deeper areas (40 m) along the Alexandria coast show a high cover percentage of *Penicillus* and *Caulerpa* species. In view of the limited available information, further studies are required on the distribution and occurrence of marine algae along the Egyptian Mediterranean coast, where *Caulerpa* species and other algae may occur.

30. Introducing the country report on France, Mr T. Belsher outlined the action taken since the first observation of *Caulerpa taxifolia* in Monaco in 1988 and in Cap Martin, France, in 1990. An awareness campaign had been launched in 1991 and a coordinating and a scientific committee setup in 1992, which had led up to an increase in monitoring, experiments with a number of eradication measures and further action to raise awareness. Action had increased with the launching of the two European Union Life Programmes, while collaboration had developed at the various levels in France from the central government to local authorities. The

significant material resources employed (helicopters, submarine research vessels, etc.) contributed to the collection of a mass of information on the progression and characteristics of *Caulerpa taxifolia*.

Continuing the description of the situation in France, Mr V. Bentata presented the five-year plan of action that was being initiated in France at the initiative of the Ministry of Land Planning and the Environment to predict the development and evaluate the consequences of *Caulerpa taxifolia*, as well as to develop control techniques. The action programme placed emphasis on research, surveillance and the development of techniques for eventual action to prevent the expansion of *Caulerpa taxifolia* and control it in zones of particular patrimonial and economic value. The research would cover the characteristics of the alga, as well as methods of predicting its expansion, the development of knowledge on its effects on biodiversity and its social and economic impact. The development of techniques to control *Caulerpa taxifolia* would emphasize biological measures, through the use of species that were indigenous to the Mediterranean area. In addition to mapping the expansion of *Caulerpa taxifolia*, surveillance measures would focus on the local development of ecosystems in areas colonized by the alga. In the field of preventing and combating the spread of *Caulerpa taxifolia*, emphasis would be placed on the development of a range of tools, with priority being given to sites that needed particular protection. After the completion of the five-year period, progress would be reviewed and the necessity of further action determined.

31. Dr P. Panayotidis, informing the Workshop of the situation in Greece, commented on the country's very long coastline and said that it was not possible to be certain that *Caulerpa taxifolia* did not exist in Greece, even though none had yet been observed. He noted that regular monitoring activities were carried out of the coastal ecology in Greece and the expansion of new species from the Red Sea was followed closely. He described the progression of *Caulerpa racemosa*, which had first been observed in 1993 and had since become the dominant element of vegetation in some sites. It had also been observed in Crete for the first time a few days before the holding of the Workshop. Although insufficient knowledge was yet available on the impact of *Caulerpa racemosa*, he did not believe that it was comparable to that of *Caulerpa taxifolia*, which was very aggressive, especially with regard to *Posidonia* meadows. He said that, in the event of its occurrence, measures would be taken to eliminate *Caulerpa taxifolia* in Greece before it proliferated as it had in several Mediterranean countries.

32. Describing the situation in Israel, Dr R. Einav stated that four species of *Caulerpa* had been observed off the Israeli coastline, but not *Caulerpa taxifolia*. She noted that *Caulerpa mexicana* was quite common on the Israeli coast. She also warned that *Caulerpa taxifolia*, the sub-species that looked like *Caulerpa mexicana*, could easily be concealed in a big stand of *Caulerpa mexicana*. Since the two species were very close, special attention should be paid when monitoring *Caulerpa mexicana* communities. She observed that *Caulerpa scalpelliformis*, although not so common as *Caulerpa mexicana*, was also present on the Israeli coast. Of the two other species, *Caulerpa prolifera* had once been common, but had now disappeared, at least from shallow waters. *Caulerpa racemosa* had not been observed on the Israeli coast for the past 20 years. There had been no monitoring of algal species in deep waters off the Israeli coast for some 20 years and it was therefore impossible to be certain that these species did not exist at greater depths. One explanation for the disappearance of the various *Caulerpa* species off the Israeli coast could be the presence of a lessepsian fish species (*Siganus rivulatus*), which was now becoming common and presented the unusual characteristic of being a pure herbivore.

33. After reviewing the collaboration between various research institutions in his country, Professor G. Giaccone described the situation with regard to the propagation of *Caulerpa* species in Italy and its consequences. After noting that neither *Caulerpa racemosa* nor *Caulerpa taxifolia* had been observed before 1990, he stated that *Caulerpa racemosa* was the most common species in the Ionian Sea, in the Straits of Sicily, the Tyrrhenian Sea and the Gulf of Cagliari, as well as being present in Liguria. There were two populations of *Caulerpa taxifolia*, the first of which was found principally on the coast of Sicily and Calabria and presented *mexicanoid* characteristics. The second, which presented *taxifolioid* aspects, was found mainly on the coast of Tuscany and Liguria. With regard to *Caulerpa racemosa*, there could be no doubt as to its Lessepsian origin. However, the origins of *Caulerpa taxifolia* were less clear and genetic studies would be needed to determine its precise genetic composition and origins. The various research projects carried out in Italy on almost all the issues raised by the international scientific community with regard to the *Caulerpa* species, led to the conclusion that the current invasive expansion of certain species in the Mediterranean was due to several complex causes. These included the excessive deterioration of coastal zones, maritime traffic and fishing activities over areas colonized by *Caulerpa* species, the deepening of the Suez Canal and the closure of the Aswan Dam. Other causes consisted of the multiplication of the number of aquaria and aquaculture sites, the increase in the average temperature of the seawater and the evolutionary phenomena taking place in *Caulerpa* populations in the Mediterranean.

Professor F. Cinelli and Dr G. Ceccherelli emphasized the danger of the expansion of *Caulerpa taxifolia* for biodiversity in the Mediterranean Sea and for *Posidonia* meadows in particular.

34. Presenting the country report for Lebanon, and also describing the situation in the Syrian Arab Republic, Mr G. Bitar regretted the lack of research work on the fauna and flora of the Lebanese coast. Although *Caulerpa taxifolia* did not appear to exist on the Lebanese coast, other species of *Caulerpa* had been observed: *Caulerpa prolifera* and *Caulerpa racemosa*. *Caulerpa mexicana* had been observed in Beirut but had then disappeared. A cause of concern in both Lebanon and the Syrian Arab Republic was the introduction from the Red Sea of the brown alga *Styopodium zonale*, which had invaded much of the coastline and threatened species such as *Stypocaulon scoparium*. Finally he expressed appreciation of the assistance provided by other Contracting Parties which provided documentation on environmental issues and wished that an international collaboration network is created. Mr Ahmad mentioned that the species of *C. prolifera*, *C. racemosa*, *C. scalpelliformis* and *C. mexicana* are found on the Syrian coast and especially in the regions of Tartous and Lattakia, up to 60 m (according to Prof. Mayhoub).

35. Dr A. Elmansori, presenting the country report for the Libyan Arab Jamahiriya, said that studies had shown that the Libyan coastline was the poorest in the Mediterranean in terms of marine flora. Although his country did not appear to have been colonized by *Caulerpa taxifolia*, patches of *Caulerpa prolifera* had been observed and *Caulerpa racemosa* was endemic in one area. The Libyan coastline offered good conditions for the expansion of *Caulerpa* species, due to its shallow water and high water temperatures, and vigilance would be required to prevent the introduction of *Caulerpa taxifolia*.

36. Ms C. Tanti in presenting the report prepared by Mr D. Stevens on the situation as regards the *Caulerpa* species in the Maltese Islands, she explained that, due to its position in the middle of the Mediterranean, the Maltese coastal environment was of an intermediate nature and included species from both the West and the East of the Mediterranean, including such lessepsian species as *Caulerpa racemosa*, which had been observed for the first time in 1997.

Caulerpa prolifera used to form extensive meadows, but was declining in importance, probably due to physical disturbances in its area of distribution. Although *Caulerpa taxifolia* had not yet been observed, Maltese waters were at high risk of colonization due to their proximity to Sicily and the frequent maritime traffic between the two islands. Small-scale fishing activities, which favoured the spread of the species, were also of great importance to the Maltese economy. If Malta were to be colonized by *Caulerpa taxifolia*, it would threaten the Maltese sea grass communities and would have an adverse economic impact on fishing and tourism.

37. Presenting the country report for Monaco, Professor J. Jaubert said that the area that was most strongly colonized by *Caulerpa taxifolia* was situated under the Rocher de Monaco. This population is monitored by the Oceanographic Museum, which carries out tests regular measurements, especially of plant biomass. The measurements have shown that this population seemed to have stabilised for several years; the natural return of *Pinna nobilis*, which had disappeared from the area for several decades was also observed. He added that a significant development of *C. taxifolia* under Loews Drop-Off had been noted in a report by the Association Monégasque pour la Protection de la Nature (AMPN). He then described the cartographic work carried out by the European Oceanological Observatory of the Scientific Centre of Monaco to map marine habitats in shallow waters (between 0 and -15 to 20 m). This work was carried out in the Bay of Menton, which had a topography much better suited to this type of study than the Bay of Monaco. The techniques used included a Compact Airborne Spectrographic Imager (CASI) mounted on a small helicopter. Mr Jaubert stated that the area most heavily colonized by *C. taxifolia* was a zone in front of two storm water drains which evacuated waste from the city of Menton and the surrounding hills. In that area, the *Posidonia* meadow present in the beginning of the century had disappeared several decades ago due to pollution, leaving an almost deserted area of muddy-sandy bottom which had recently been colonized by *Caulerpa taxifolia* and *Cymodocea nodosa*. The situation seemed now to have stabilized. Over the past two years an increase in the number of individuals of the *mexicanoid* type of *Caulerpa* with leaves and much broader pinnules than the one of the *taxifoloid* type was observed. Data obtained through the use of CASI in the Bay of Menton, generally considered one of the most heavily colonized areas of the French Riviera, contrasted sharply with certain claims in the literature concerning the size of surfaces covered by *C. taxifolia* and the alga's capacity to cover beds of *Posidonia oceanica*. In fact, preliminary processing of CASI data indicated: (a) a very low average cover rate (approximately 2.5 %) in the category of accessible depths (0 and 15-18 m) and (b) that the dense populations of *Caulerpa taxifolia* were confined to two distinct localities. Moreover, none of the patches of *Posidonia oceanica*, recorded on coloured photographs taken by the French National Geographic Institute in 1988 had been overgrown by *C. taxifolia*. One of the most interesting aspects of the data was that the mixed communities of *C. taxifolia* and *C. nodosa* were now showing evidence of renewed colonization by *Posidonia oceanica*.

38. In response to the previous speaker, Professor Meinesz and Mr Belsher raised a number of questions about the effectiveness of remote detection in identifying *Posidonia* meadows which were affected by *Caulerpa taxifolia*. They referred to information obtained from underwater videos and photographs which contradicted the information provided by Professor Jaubert and demonstrated that most of the *Posidonia* meadows in the coastal waters of Cap Martin were indeed being invaded by *Caulerpa taxifolia*.

39. Mr M.S. Kahouadji, introducing the country report for Morocco, regretted the lack of studies on biodiversity in Moroccan coastal waters. Although no *Caulerpa taxifolia* had been observed in his country, there were several species considered as invasive. One lagoon on the Mediterranean coast had been invaded by *Caulerpa prolifera*. *Caulerpa racemosa* had also been observed in 1945 in Tangiers, but since then the alga had never been encountered or spotted.

In view of its commitment to the environment and to sustainable development, his country intended to undertake a programme of research on its coastal areas and to develop prevention and awareness raising measures before the occurrence of any major and irreparable invasion by *Caulerpa taxifolia*.

40. Mr R. Turk, presenting the country report for Slovenia, noted that regular and systematic research of the benthic flora had been carried out for over 25 years. There was no evidence of the presence of *Caulerpa taxifolia* or any other species of the genus *Caulerpa* so far in the Slovenian Sea. Although the presence of *Caulerpa prolifera* had been signalled 20 years ago on the western coast of Istria (Croatia), it no longer seemed to be present. He noted that the Slovenian coastal area, which extended for 46km over the southern part of the Gulf of Trieste in the North Adriatic, consisted of a shallow marine ecosystem with freshwater inputs, which therefore experienced considerable temperature and salinity variations. Another important characteristic of the coastline was its intensive urbanization and the consequent serious degradation of the coastal ecosystems.

41. Dr M.A. Ribera, presenting the country report for Spain, described how her country had been active on the issue of *Caulerpa taxifolia* since 1992, even though the alga had not then appeared in the country. Surveillance had been carried out, particularly of the Catalan coast, which was the closest to the known locations of *Caulerpa taxifolia*. A national commission had been established to follow the issue and, in collaboration with the autonomous regions bordering the Mediterranean coast, had played an important role, particularly in encouraging Spain's involvement in the European Union's Life Programme. Research had been carried out on various issues, including the toxicity of *Caulerpa taxifolia*, and monitoring systems had been set up in all the Mediterranean regions, and particularly Catalonia, Valencia and the Balearic Islands. When sites colonized by *Caulerpa taxifolia* had been found in Mallorca, it had been decided to attempt to eradicate the alga. Although a large area was affected, eradication efforts had been successful in slowing the expansion of *Caulerpa taxifolia*. She added that the three autonomous regions had each adopted decrees and the central government had adopted an order prohibiting the extraction of *Caulerpa taxifolia* with a view to preventing its expansion. Finally, she referred to the Workshop held in Barcelona in 1994, at which the Barcelona Appeal had been drafted with a view to alerting national authorities to the emergence of the problem. It called on national authorities to apply the precautionary principle and define a national strategy with regard to *Caulerpa taxifolia*.

42. Introducing the country report for Tunisia, Mr S. Belkhiria reported on the initiatives undertaken in his country to prevent the introduction of *Caulerpa taxifolia* and to control its expansion in case this species appears. In this regard an action plan had been developed by the Ministry of Environment and Land Planning. Under the action plan, a committee had been set up which included the concerned administrations and research institutions. Awareness campaigns had been launched, including the preparation and dissemination of information materials and the organization of an information day in collaboration with SPA/RAC. Specific legislation had been adopted to prevent the introduction of foreign species in Tunisia and a survey of the northern coast had been carried out in August 1997, which had been organized by Greenpeace Tunisia and supported by the Ministry of the Environment and had not found any colonies of *Caulerpa taxifolia*. Fishers and sailors on yachts had been asked whether they had observed *Caulerpa taxifolia*, leading to a few reports of sightings off the shores of Tunisia which had not, however, been substantiated. The spread of *Caulerpa racemosa* along the Tunisian coast was being monitored and he considered that this species deserved more attention from the scientific community and funding agencies.

43. Describing the situation in Turkey, Ms E. Terzioglu reported on the initiatives taken in her country with regard to the *Caulerpa* species. No reports of *Caulerpa taxifolia* had been produced and disseminated to a targeted public. A project will be prepared for monitoring and control activities. She added that *Caulerpa racemosa* was known to be present in the South and South-Western Turkey.

Professor S. Cirik, reporting on the status of the *Caulerpa* genus along the Turkish Mediterranean coast, noted that three species *Caulerpa prolifera*, *Caulerpa olivieri* and *Caulerpa racemosa* had been reported. *Caulerpa racemosa* had to be considered a lessepsian immigrant and according to the first observations displayed invasive behaviour in certain points. It also demonstrated great ecological adaptability and had a significant effect on indigenous communities. He emphasized the importance of public information and awareness-raising campaigns in this respect.

44. At the end of the presentations, Mr G.P. Gabrielides informed the participants that the Secretariat intended to issue a special volume of the MAP Technical Reports Series which would include the full texts of the papers presented. These texts should be submitted to the Secretariat before 30 May 1998. Those participants who had already provided the full texts of their papers could modify them on the basis of the discussions which had taken place during the Workshop. Instructions for the preparation of the full texts of the papers would be sent out to all participants together with the final report of the Workshop.

Conclusions

45. After a discussion the Workshop agreed on the following conclusions:

a) There exist more than 70 species of the genus *Caulerpa* but only a handful of these are present in the Mediterranean sea.

b) *Caulerpa taxifolia* is a tropical species and was observed for the first time in Monaco in 1984. Since then it has expanded covering large areas of the Western Mediterranean and Adriatic coastal region (more than 3000 ha at the end of 1996). At the same time another *Caulerpa* species, *Caulerpa racemosa*, is expanding in many parts of the Mediterranean.

c) *Caulerpa taxifolia* has been studied extensively in the Mediterranean and the following can be concluded based on the results obtained:

- (i) *Caulerpa taxifolia* which colonizes the Mediterranean has some unusual morphological and physiological characteristics with respect to known *Caulerpa taxifolia* inhabiting the tropical seas.
- (ii) *Caulerpa taxifolia* can adapt itself to different light conditions and is found in dense beds down to 50 m depth.
- (iii) The growth curves as a function of water temperature show an adaptation to a large range of temperatures and a resistance to cold winter temperatures (3 months survival at 10°C).
- (iv) There is no connection between the development of *Caulerpa taxifolia* and water quality; it develops equally well in clean and polluted waters.

- (v) *Caulerpa taxifolia* synthesizes 9 toxic substances, including caulerpenyne which is predominant. The percentage of toxins by dry weight in *Caulerpa taxifolia* is usually higher in the Mediterranean than in the tropical seas.
 - (vi) It has been shown that caulerpenyne in solution degrades rapidly in daylight conditions, in the presence of oxygen and chlorophylls or phaeophytins.
 - (vii) No caulerpenyne has been found to accumulate in sea urchins which have consumed *Caulerpa taxifolia*.
 - (viii) No toxicity risk to humans has been observed.
 - (ix) *Caulerpa taxifolia* colonizes all types of sea bottoms, such as, rock, sand, mud and dead *Posidonia* meadows.
 - (x) *Caulerpa taxifolia* invades indigenous biocenoses modifying biodiversity and ecodiversity.
- d) *Caulerpa racemosa* has not been studied intensively, like *Caulerpa taxifolia*. Nevertheless, the following can be concluded based on the available literature on *Caulerpa racemosa* inhabiting the Mediterranean.
- (i) *Caulerpa racemosa*, which is currently colonizing the Mediterranean, may present different morphological characteristics from one region to another and from the specimens described in the same region at the beginning of the 20th century.
 - (ii) *Caulerpa racemosa* colonizes all types of substrate such as rock, sand, mud and dead *Posidonia* meadows down to 60m depth and interferes with marine coastal biocenoses. Also, it develops equally well in both clean and polluted water.
 - (iii) The expansion of *Caulerpa racemosa*, according to preliminary research, may alter marine habitats.

In view of the above, the Workshop agreed that the most serious risk from *Caulerpa taxifolia* and *Caulerpa racemosa* was the upsetting of the ecological balance.

Recommendations

46. In the light of this ecological risk, the Workshop decided to prepare a set of recommendations addressed to the Contracting Parties. For this purpose a working group, consisting of 12 participants, was set up to prepare the first draft. The final recommendations adopted by the Workshop were the following:

- Taking into account the conclusions of this Workshop;
- Taking into account the Convention on Biological Diversity adopted at Rio de Janeiro in 1992, which stipulates that each Party “prevents the introduction of (...) those alien species which threaten ecosystems, habitats or species”;

- Taking into account the 1995 Protocol of the Barcelona Convention concerning Specially Protected Areas and Biological Diversity in the Mediterranean, which states that the Parties shall:

take “all appropriate measures to regulate the intentional or accidental introduction of non-indigenous or genetically modified species ... and prohibit those that may have harmful impacts on the ecosystems or species” and

endeavour “to implement all possible measures to eradicate species that have already been introduced when, after scientific assessment, it appears that such species cause or are likely to cause damage to ecosystems, habitats or species in the area to which this Protocol applies.”

The participants at the Workshop recommend:

A. Recommendations to all Mediterranean countries

- (i) That in each country the necessary measures be adopted for the application of the above Protocol and Convention.
- (ii) To promote national and international coordination and cooperation of all the partners to prevent and slow down the spread of *Caulerpa taxifolia* and *Caulerpa racemosa* in the Mediterranean.
- (iii) To support international programmes for the exchange of information, training and scientific research.
- (iv) To prohibit the sale and use of *Caulerpa taxifolia* and *Caulerpa racemosa*, and to avoid the sale and use of the genus *Caulerpa* for aquaria (with the exception of the Mediterranean species *Caulerpa prolifera*).
- (v) To support the dissemination of information designed to encourage users of the sea to prevent the spread and indicate the presence of *Caulerpa taxifolia* and *Caulerpa racemosa*.
- (vi) That official instructions call upon users of the sea to indicate the presence of *Caulerpa taxifolia* and *Caulerpa racemosa* to the designated bodies.

B. Recommendations to countries in which one or both of the two species are present

- (i) To issue official instructions for all users of the sea to be called upon to avoid practices contributing to the spread of these species, particularly through the cleaning of anchors, fishing and diving equipment on the spot. The release of fragments of these algae at sea must be avoided. Large colonized areas should be indicated in port offices and nautical instructions.
- (ii) To establish inventories and carry out cartographic surveys of colonized areas.
- (iii) To monitor changes in the biocenoses of affected areas.

(iv) To support scientific research into all the aspects relating to these species, the understanding of the phenomenon, the evolution of its consequences and the control of its dynamics.

(v) To control, where possible, the expansion of the two species, particularly through the eradication of small colonies in areas that are highly valued for their natural heritage and regions that are distant from strongly colonized areas.

Closure of the Workshop

47. In his closing remarks, Mr G.P. Gabrielides expressed his satisfaction for the outcome of the Workshop and thanked all the participants for their active participation. Specifically, he mentioned that he was glad that the Workshop was kept to the scientific level and that a compromise was reached which enabled a unanimous decision as regards the conclusions and recommendations. He finally thanked the host institute and all the staff who worked hard to make the Workshop a success.

48. Prof. A. Meinesz, speaking on behalf of the participants described the Workshop as a success and thanked Mr Gabrielides for the outcome which he considered as a great achievement.

ANNEX I

**LIST OF PARTICIPANTS
LISTE DES PARTICIPANTS**

**COUNTRY REPRESENTATIVES
REPRESENTANTS DU PAYS**

**ALBANIA
ALBANIE**

Mr Lefter Kashta

Fakulteti i Shkencave te Natyres
Universiteti "Luigj Gurakuqi"
Shkodra
Albania

Tel: 355-224-3747

Fax: 355-42-65229

E-mail: cep@cep.tirana.al

**ALGERIA
ALGERIE**

M. Rachid Semroud

Institut des Sciences de la mer et de
l'Aménagement du Littoral
Ministère de l'Enseignement Supérieure
et de la Recherche Scientifique
B.P. 54
Sidi Fredj 42321
Alger
Algérie

Tel: 213-2-393538/391976

Fax: 213-2-393538

**CROATIA
CROATIE**

Mr Ante Zuljevic

Institute for Oceanography and Fisheries
Setaliste Ivana Mestrovica 63
HR-21000 Split
Croatia

Tel: 385-21-358688

Fax: 385-21-358650

E-mail: ante.zuljevic@jadran.izor.hr

CYPRUS
CHYPRE

Ms Marina Argyrou
Fisheries Department
Ministry of Agriculture, Natural Resources
and Environment
13 Aeolou Str.
1416 Nicosia
Cyprus

Tel: 357-2-807833
Fax: 357-2-775955

EGYPT
EGYPTE

Mr Abdel Ghani Khalil
Department of Oceanography
Faculty of Science
Alexandria University
Moharrem Bey, 21511
Alexandria
Egypt

Tel: 20-3-4843171/2
Fax: 20-3-4911794
E-mail: pro@dataxprs.com.eg

FRANCE
FRANCE

M. Thomas Belsher
Institut français de recherche pour l'exploitation
de la mer (IFREMER)
Centre de Brest
B.P. 70
29280 Plouzané Cedex
France

Tel: 33-2-98224319
Fax: 33-2-98224348
E-mail: belsher@ifremer.fr

M. Vincent Bentata
Ministère de l'Aménagement du territoire
et de l'Environnement (DNP)
20, Avenue de Ségur
75007 Paris
France

Tel: 33-1-42191866
Fax: 33-1-42191979
E-mail: dnp-sdcffs.bffs.fau@
environnement.gouv.fr

GREECE
GRECE

Mr Panayotis Panayotidis
National Centre for Marine Research
Institute of Oceanography
Aghios Kosmas
166 04 Athens
Greece

Tel: 30-1-9653520/1
Fax: 30-1-9653522
E-mail: ppanag@posidon.ncmr.ariadne-t.gr

ISRAEL
ISRAEL

Ms Rachel Einav
Department of Life Sciences
University of Bar Ilan
Ramat Gan 529000
Israel

Tel: 972-66-390448
Fax: 972-66-392221
E-mail: einavr@maritime.co.il

ITALY
ITALIE

M. Giuseppe Giaccone
Dipartimento di Botanica
Università di Catania
Via A. Longo 19
95125 Catania
Italy

Tel: 39-095-507490
Fax: 39-095-441209
E-mail: giaccone@mbox.dipbot.unict.it

LEBANON
LIBAN

M. Ghazi Bitar
Faculté des Sciences (Section I)
Université Libanaise
Hadeth
Liban

Tel: 961-3-315162
Fax: 961-1-790770
E-mail: Lusc1@CNRS.edu.Lb

LIBYAN ARAB JAMAHIRIYA
JAMAHIRIYA ARABE LIBYENNE

Mr Abdalla Elmansori
Faculty of Science
P.O. Box 13555
Alfateh University
Tripoli
Libya

Tel: 218-21-605438
Fax: 218-21-607000

**MALTA
MALTE**

Ms Christina Tanti
Environment Protection Department
Ministry of Foreign Affairs and the Environment
Floriana
Malta

Tel: 356-230617
Fax: 356-241378

**MONACO
MONACO**

M. Jean Jaubert
Centre Scientifique de Monaco
Observatoire Océanologique Européen
Avenue Saint Martin
MC 98000 Monaco
Principauté de Monaco

Tel: 377-92167983
Fax: 377-92167981
E-mail: jaubert@naxos.unice.fr

**MOROCCO
MAROC**

M. Mohammed Said Kahouadji
Ministère de l'Environnement
Avenue Roosevelt
Ex résidence de l'Ambassade de France
Rabat
Maroc

Tel: 212-7-680744/796908
Fax: 212-7-680746

M. Larbi Najim
Laboratoire de Botanique (Algologie)
Département de Biologie
Faculté des Sciences
Avenue Ibn Batouta
B.P. 1014
Rabat
Maroc

Tel: 212-7-775461
Fax: 212-7-775461
E-mail: najim@fsr.ac.ma

SLOVENIA
SLOVENIE

Mr Robert Turk
Regional Institute for Natural and Cultural
Heritage Protection
Trg Bratstva 1
Piran
Slovenia

Tel: 386-66-75676
Fax: 386-66-73562
E-mail: robert.turk@zvnkdpi.sigov.mail.si

SPAIN
ESPAGNE

Mme María Antonia Ribera
Departamento de Botánica
Facultad de Farmacia
Universidad de Barcelona
c/Juan XIII, s/n
08028 Barcelona
Espagne

Tel: 34-3-4024490
Fax: 34-3-4021887
E-mail: ribera@farmacia.far.ub.es

SYRIAN ARAB REPUBLIC
REPUBLIQUE ARABE DE SYRIE

Mr Kazem Ahmad
Ministry of State for Environmental Affairs
P.O. Box 3773
Tolyani Street
Damascus
Syria

Tel: 963-11-2234309
Fax: 963-11-3335645 or 963-43-321916

TUNISIA
TUNISIE

M. Sami Belkhiria
Agence Nationale de Protection
de l'Environnement (ANPE)
12 Rue du Cameroun
B.P. 52
Belvédère 1002
Tunis
Tunisie

Tel: 216-1-840563
Fax: 216-1-848069

**TURKEY
TURQUIE**

Ms Ergül Terzioglu
Ministry of Environment
Department of Environmental Protection
Eskisehir Yolu, 8 Km
Balgat
Ankara 06530
Turkey

Tel: 90-312-2879963
Fax: 90-312-2862271

M. Sükran Cirik
Institute of Marine Science and Technology
Dokuz Eylül University
1884/8 Sokak No. 10
P.O. Box 478
35260 Izmir
Turkey

Tel: 90-232-2785565
Fax: 90-232-2785082

Mr Oguzhan Ertugrul
Turkish Embassy
8, Vassileos Georgiou Str.
106 74 Athens
Greece

Tel. 30-1-7245915
Fax: 30-1-7229597

OTHER PARTICIPANTS
AUTRES PARTICIPANTS

M. Charles-François Boudouresque
Centre d'Océanologie de Marseille
UMR 6540 CNRS, Campus
Université de Marseille - Luminy
13288 Marseille Cedex 09
France

Tel: 33-4-91829130
Fax: 33-4-91411265
E-mail: boudour@com.univ-mrs.fr

Ms Giulia Ceccherelli
Dipartimento di Scienza dell' Uomo et
dell'Ambiente
Università degli Studi di Pisa
Via A. Volta
56126 Pisa
Italy

Tel: 39-050-500018
Fax: 39-050-49694
E-mail: cecchere@discat.unipi.it

M. Francesco Cinelli

Departimento di Scienza dell'Uomo et
dell'Ambiente
Università degli Studi di Pisa
Via A. Volta
56126 Pisa
Italy

Tel: 39-050-500018/500943
Fax: 39-050-49694
E-mail: cinelli@discat.unipi.it

M. Patrick Coquillard

Laboratoire d'Ecologie végétale
et cellulaire
Université d'Auvergne
P.O. Box 38
63000 Clermont-Ferrand Cedex 1
France

Tel: 33-4-73608074
Fax: 33-4-73277907
E-mail: Coquillard@u-clermont1.fr

Mr Jaume Darder

Fisheries Department
Govern Balear
Conselleria d'Agricultura
Comerç i Industria
C/. Foners, 10
07006 Palma de Mallorca
Spain

Tel: 34-71-176104
Fax: 34-71-176157

M. Christophe Destombe

Laboratoire de génétique et Evolution des
Population végétales
URA CNRS 1185, Bat. SN₂
Université de Lille I
Villeneuve d'Ascq 59655 Cedex
France

Tel: 33-3-20434991
Fax: 33-3-20436979
E-mail: Destombe@univ-Lille1.fr

Mr Aristidis Diapoulis

National Centre for Marine Research
Aghios Kosmas
166 04 Athens
Greece

Tel: 30-1-9829239
Fax: 30-1-9833095

M. Aslam Djellouli

Institut National des Sciences & Technologie
de la mer
28 Rue du 2 Mars 1934
2025 Salammbô
Tunisie

Tel: 216-1-730420
Fax: 216-1-732022

M. Fernando Dini

Università di Pisa
Dipartimento di Etologia, Ecologia ed Evoluzione
Via A. Volta 4
56126 Pisa
Italy

Tel: 39-050-24252
Fax: 39-050-24252
E-mail: f.dini@discat.unipi.it

Mme Zohra El Asmi-Djellouli

Faculté des Sciences de Tunis
Campus Universitaire
Tunis
Tunisie

Tel: 216-1-749971

Mr Anastasios Eleftheriou

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992
Fax: 30-81-241882
E-mail: imbc@imbc.gr

M. Vincent Gravez

GIS Posidonie
Parc Scientifique & Technologique de Luminy
Case 901
13288 Marseille cedex 09
France

Tel: 33-4-91829135
Fax: 33-4-91411265
E-mail: gravez@com1.com.univ-mrs.fr

Mr Antonio M. Grau

Marine Resources Service
Govern Balear
Conselleria d'Agricultura
Comerç i Industria
C/. Foners, 10
07006 Palma de Mallorca
Spain

Tel: 34-71-176104
Fax: 34-71-176157

Mme Mireille Harmelin-Vivien

Centre d'Océanologie de Marseille
CNRS UMR 6540
Station Marine d'Endoume
Rue Batterie des Lions
13007 Marseille
France

Tel: 33-4-91041628
Fax: 33-4-91041635
E-mail: harmelin@com.univ-mrs.fr

Mr Ioannis Karakassis

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992

Fax: 30-81-241882

E-mail: jkarak@imbc.gr

Mr Drosos Koutsoubas

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992

Fax: 30-81-241882

E-mail: drosos@imbc.gr

Ms Thalia Lazaridou

Greek Biotope - Wetland Centre
14th Km Thessaloniki-Mikaniona
570 01 Thessaloniki
Greece

Tel: 30-31-476262

Fax: 30-31-471795

E-mail: thalia@ekbij.the.forthnet.gr

M. Alois Maurizi

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992

Fax: 30-81-241882

E-mail: alois@imbc.gr

E-mail: maurizi@crit.univ-montp2.fr

M. Alexandre Meinesz

Laboratoire Environnement Marin Littoral
Université de Nice Sophia Antipolis
06108 Nice cedex 2
France

Tel: 33-4-92076846

Fax: 33-4-92076849

E-mail: meinesz@unice.fr

Ms Konstantia Papadopoulou-Smith

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992

Fax: 30-81-241882

E-mail: imbc@imbc.gr

Mr Andrea Peirano

Italian Agency for New Technology
Energy and Environment
Environmental Research Center
C.P. 316
19100 La Spezia
Italy

Tel: 39-0187-536296
Fax: 39-0187-536273
E-mail: peirano@estosf.santateresa.enea.it

Ms Vivi Pitta

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992
Fax: 30-81-241882
E-mail: imbc@imbc.gr

Ms Wanda Plaiti

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992
Fax: 30-81-241882
E-mail: imbc@imbc.gr

M. Attilio Rinaldi

Istituto Centrale per la Ricerca Scientifica
e Tecnologica applicata al Mare (ICRAM)
Via di Casalotti 300
00166 Roma
Italy

Tel: 39-6-615701
Fax: 39-6-61550581
E-mail: icramdir@rdn.it

Mme Conxi Rodriguez-Prieto

Universitat de Girona
Campus de Montilivi S/N
17071 Girona
Spain

Tel: 34-972-418157
Fax: 34-972-418150
E-mail: cacrp@fc.udg.es

Ms Ekaterini Siakavara

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992
Fax: 30-81-241882
E-mail: siakava@imbc.gr

Mr Mustafa Tolay

Scubadivers Sport Club Association
Iskele Cikmazi No. 69
Caddebostan
81070 Istanbul
Turkey

Tel: 90-532-2664628

Tel: 90-216-3555628

Fax: 90-216-3605250

Mr Manolis Tsapakis

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992

Fax: 30-81-241882

E-mail: imbc@imbc.gr

M. Leonardo Tunesi

Istituto Centrale per la Ricerca Scientifica
e Tecnologica applicata al Mare (ICRAM)
Via di Casalotti 300
00166 Roma
Italy

Tel: 39-06-8088712/80

Fax: 39-06-61561906

E-mail: snezana@imbc.gr

Ms Snezana Zivanovic

Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992

Fax: 30-81-241882

E-mail: imbc@imbc.gr

**REGIONAL ACTIVITY CENTRE FOR SPECIALLY PROTECTED AREAS (SPA/RAC)
CENTRE D'ACTIVITES REGIONALES POUR LES AIRES SPECIALEMENT
PROTEGEES (CAR/ASP)**

M. Marco Barbieri

Expert-Marine Biologist
Centre des Activités Régionales pour les
Aires Spécialement Protégées (CAR/ASP)
Boulevard de l'environnement
B.P. 337
1080 Tunis Cedex
Tunisie

Tel: 216-1-795760

Fax: 216-1-797349

E-mail: car-asp@rac-spa.org.tu

SECRETARIAT

**UNITED NATIONS ENVIRONMENT PROGRAMME
COORDINATING UNIT FOR THE MEDITERRANEAN ACTION PLAN**

Mr Gabriel P. Gabrielides
Senior Programme Officer
Coordinating Unit for the Mediterranean
Action Plan
P.O. Box 18019
48, Vas. Konstantinou Avenue
116 10 Athens
Greece

Tel: 30-1-7273103
Fax: 30-1-7253196/7
Email: gabriel@unepmap.gr

LOCAL ORGANISERS

**INSTITUTE OF MARINE BIOLOGY OF CRETE
INSTITUT DE BIOLOGIE MARINE EN CRETE**

Mr Anastasios Eleftheriou
Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992
Fax: 30-81-241882
E-mail: imbc@imbc.gr

Ms Eftychia Mironaki
Institute of Marine Biology of Crete
P.O. Box 2214
71003 Heraklion
Crete
Greece

Tel: 30-81-242022/241992
Fax: 30-81-241882
E-mail: imbc@imbc.gr

ANNEX II

PROGRAMME / PROGRAMME

Wednesday 18 March / Mercredi 18 mars

Registration of participants / Inscription des participants

Opening of the workshop and organisation of work / Ouverture de l'atelier et organisation des travaux

General presentations / Présentations générales

Introduced species in the Mediterranean, routes, kinetics and consequences, by **Prof. C.-F. Boudouresque**

Situation générale de l'expansion de *Caulerpa taxifolia* en Méditerranée et analyse des biotopes atteints, par **Prof. A. Meinesz**

Ecological and possible economical consequences of the spread of *Caulerpa taxifolia* in the Mediterranean, by **Prof. C. Rodriguez-Prieto**

Ecotoxicological aspects related to the rapid spreading of populations of the tropical green seaweed, *Caulerpa taxifolia*, along the Mediterranean coasts, by **Prof. F. Dini**

Est-il possible de contrôler l'expansion de *Caulerpa taxifolia* en Méditerranée? Propositions pour une stratégie, par **Mr. V. Gravez**

Specific presentations / Présentations spécifiques

Impact de *Caulerpa taxifolia* sur les populations de poissons: six ans d'étude, par **Dr. M. Harmelin-Vivien**

Modélisation et simulation de l'expansion de *Caulerpa taxifolia* en Méditerranée nord occidentale, par **Dr. P. Coquillard**

Suivi de l'expansion de l'algue verte, *Caulerpa taxifolia*, en Méditerranée nord-orientale: résultats préliminaires d'une étude par imagerie multispectrale aéroportée et photographie aérienne, par **Prof. J. Jaubert**

Contrasting effects of *Posidonia oceanica* on *Caulerpa taxifolia*, by **Dr. G. Ceccherelli & Prof. F. Cinelli**

Presence of *Caulerpa taxifolia* in the Balearic Archipelago, by **Dr. A.M. Grau**

Eléments de la cartographie et les modifications de *Caulerpa taxifolia* le long du littoral des Alpes-Maritimes et de Monaco, par **T. Belsher, J. Dimeet, M. Raillard, E. Emery, M. Boutbien, C. Prudhomme and R. Pucci**, suivi de la présentation d'un video sur les traces de la *Caulerpe*

The problem of *Caulerpa* invasion: The initiatives of the ENEA Center of La Spezia (Italy), by **Dr. A. Peirano**

Le phytobenthos marin marocain de l'Atlantique à la Méditerranée et *Caulerpa taxifolia*, par **Prof. L. Najim**

Thursday 19 March / Jeudi 19 mars

Presentation of country reports / Présentation des rapports par pays

Dr. Lefter Kashta, Albania/Albanie
Dr. Rachid Semroud, Algeria/Algérie
Mr. Ante Zuljevic, Croatia/Croatie
Ms Marina Argyrou, Cyprus/Chypre
Dr. Abdel Ghani Khalil, Egypt/Egypte
Mr. Vincent Bentata/Mr. Thomas Belsher, France
Dr. Panayotis Panayotidis, Greece/Grèce
Dr. Rachel Einav, Israel/Israël
Prof. Giuseppe Giaccone, Italy/Italie
Mr. Ghazi Bitar, Lebanon/Liban, **Mr. Kazem Ahmad**, Syria/Syrie
Dr. Abdalla Elmansori, Libya/Libye
Ms Christina Tanti, Malta/Malte
Prof. Jean Jaubert, Monaco
M. Mohammed Said Kahouadji, Morocco/Maroc
Mr. Robert Turk, Slovenia/Slovénie
Dr. María Antonia Ribera, Spain/Espagne
M. Sami Belkhiria, Tunisia/Tunisie
Ms Ergül Terzioglu/Prof. Sükran Cirik, Turkey/Turquie

Afternoon/Après-midi:

Preparation of conclusions and recommendations / Formulation des conclusions et des recommandations

Friday 20 March / Vendredi 20 mars

Adoption of the report / Adoption du rapport

Closure of the Workshop / Clôture de l'atelier