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SURVEILLANCE PROGRAMME ON THE INTRODUCTION OF *CAULERPA TAXIFOLIA* IN THE CATALAN COAST. YEARS 1992 - 1994

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ABSTRACT

The Junta de Sanejament, attached to the Department of Environment, Generalitat de Catalunya, has established and financed a project of prevention and active search of *Caulerpa taxifolia* along the catalan coast during 1992, 1993 and 1994. The marinas, small-boat harbours, and the coastal areas most frequently visited by recreational boats and closer to the french border were surveyed by SCUBA diving and snorkeling. The number of surveyed stations increased from 67 in 1992, 92 in 1993, and 111 in 1994. Zones with the highest chance of introduction of *Caulerpa taxifolia* were surveyed two or three times in 1992, but increasing the number of stations rather than repeating the visits in the same year was preferred in the 1993 and 1994. No occurrence of *Caulerpa taxifolia* was detected during the surveys. On the other hand, the Generalitat de Catalunya published an order prohibiting the commercialization, distribution and sale of *Caulerpa taxifolia* in order to reduce risks of introduction in the sea.

INTRODUCTION

The tropical green alga *Caulerpa taxifolia* (Vahl) C. Agardh is spreading all over the Western Mediterranean coast after its introduction in Monaco in 1984 (MEINESZ *et al.*, 1993). The area occupied by *Caulerpa taxifolia* is increasing by a factor of six annually and the total covered area amounted up to 1300 ha at the end of 1993 in France (MEINESZ *et al.*, 1994). Since 1989-1990 this species is also present in different sites of the Italian coast (MORUCCI *et al.*, 1994), and in a small cove of the Balearic Islands (Spain) (POU *et al.*, 1993; RIERA *et al.*, 1994). *Caulerpa taxifolia* has a strong invading capacity and outcompetes most of the autochtonous Mediterranean algae and seagrasses (MEINESZ & HESSE, 1991; VILLELE & VERLAQUE, 1994; VERLAQUE & FRITAYRE, 1994). Thus, the highly diverse Mediterranean benthic ecosystems in coastal areas above 30-40 meters depth are being replaced by almost mono-specific meadows of *Caulerpa taxifolia* in invaded areas.

Dispersal mechanisms of *Caulerpa taxifolia* are very effective, both natural ones such as transport of vegetative fragments by currents and waves (perhaps also sexual reproduction), and anthropogenic ones by means of anchors, fishing nets and aquaria (MEINESZ & HESSE, 1991; MEINESZ *et al.*, 1993; SANT *et al.*, 1994). Moreover, *Caulerpa taxifolia* is a highly resilient species. Present eradication techniques are very expensive and deficient (AVON *et al.*, 1994; ESCOUBET & BRUN, 1994; POU *et al.*, 1994) and some attempts to eradicate this species in different places have failed. At most, control of the expansion has succeeded in restricted and well delimited areas (RIERA *et*

al., 1994). Therefore, the underwater survey programme of coastal areas seems to be the most certain and cheapest way in order to detect the first colonization stages and thus avoid or reduce the spreading of *Caulerpa taxifolia* in the Mediterranean.

In this paper we report on the actions taken by the Junta de Sanejament (Department of Environment, Generalitat de Catalunya) between 1992 and 1994 in order to prevent the introduction of *Caulerpa taxifolia* and to detect it as soon as possible in the case of settlement of this species in catalan shores.

MATERIALS AND METHODS

The Generalitat de Catalunya, trying to reduce the chance of introduction of *Caulerpa taxifolia* in the Catalan coast, published an order prohibiting the commercialization, distribution and sale of *Caulerpa taxifolia* within the limits of Catalunya (Order 257/1992, December 2, Diari Oficial de la Generalitat de Catalunya 1677, p. 6932).

The Junta de Sanejament provided funds in 1992, 1993 and 1994 to survey the catalan coast in search for *Caulerpa taxifolia*. The marinas, small-boat harbours, and the coastal areas most frequently visited by recreational boats and closer to the french border were surveyed by SCUBA diving and/or snorkeling. At least two divers carefully surveyed the zones down to 10-25 meters depth, sometimes with the aid of underwater propellers, and annotated the nature of the substratum and other environmental parameters, together with a description of the biotopes by listing the dominant plants and animals. Special care was taken to watch the outer docks of the harbours, the most visited coves and small beaches, and the areas with a high number of offshore moors.

The surveys were carried out from February to December in 1992 to get sure that no extensive colonies of *Caulerpa taxifolia* were already present. Since active growth and expansion of *Caulerpa taxifolia* seem to occur at water temperatures higher than 15°C (MEINESZ *et al.*, 1994; GACIA *et al.*, 1994) and visibility is strongly reduced during winter in Mediterranean coastal areas (BALLESTEROS, 1992), monitoring was only performed from May to December in 1993 and 1994. Zones with the highest chance of introduction of *Caulerpa taxifolia* were surveyed two or three times in 1992, but increasing the number of stations rather than repeating the visits in the same year was preferred in 1993 and 1994.

RESULTS AND DISCUSSION

The number of surveyed stations was 67 in 1992, 92 in 1993 and 111 in 1994. The increase in the number of stations visited each year was done by adding new stations to the list, including all the stations of the former year (with the exception of four stations visited only in 1992, which were not appropiate for *Caulerpa taxifolia*). Geographic situation, name of the stations and years of survey are displayed in Figure 1 and Table I. Figure 2 summarizes the number of marinas and small-boat harbours related to coves and beaches visited in the different years. Detailed maps and the descriptions of each station can be found in BALLESTEROS *et al.* (1992, 1993, 1994).

Caulerpa taxifolia was not detected in any survey. Therefore, we can assert that *Caulerpa taxifolia* was absent or it did not constitute extensive (> 5 m^2) populations in all the visited stations, and thus we assume that *Caulerpa taxifolia* has probably not reached the catalan coast. Nevertheless, the present expansion rates of *Caulerpa taxifolia* all over the Mediterranean (MEINESZ *et al.*, 1993, 1994; MORUCCI *et al.*, 1994), the proximity of some *Caulerpa taxifolia* stations (Saint Cyprien, South-east France; Cala d'Or, Balearic

Islands) (MEINESZ *et al.*, 1993), the boat-related spreading (SANT *et al.*, 1994), and the potentially wide number of habitats where *Caulerpa taxifolia* is able to grow (DELGADO *et al.*, 1994; GACIA *et al.*, 1994), constantly increase the possibility of introduction of this undesirable species in Catalunya. Consequently the Junta de Sanejament will continue to develop its present surveillance programme as part of its environmental protection policy.

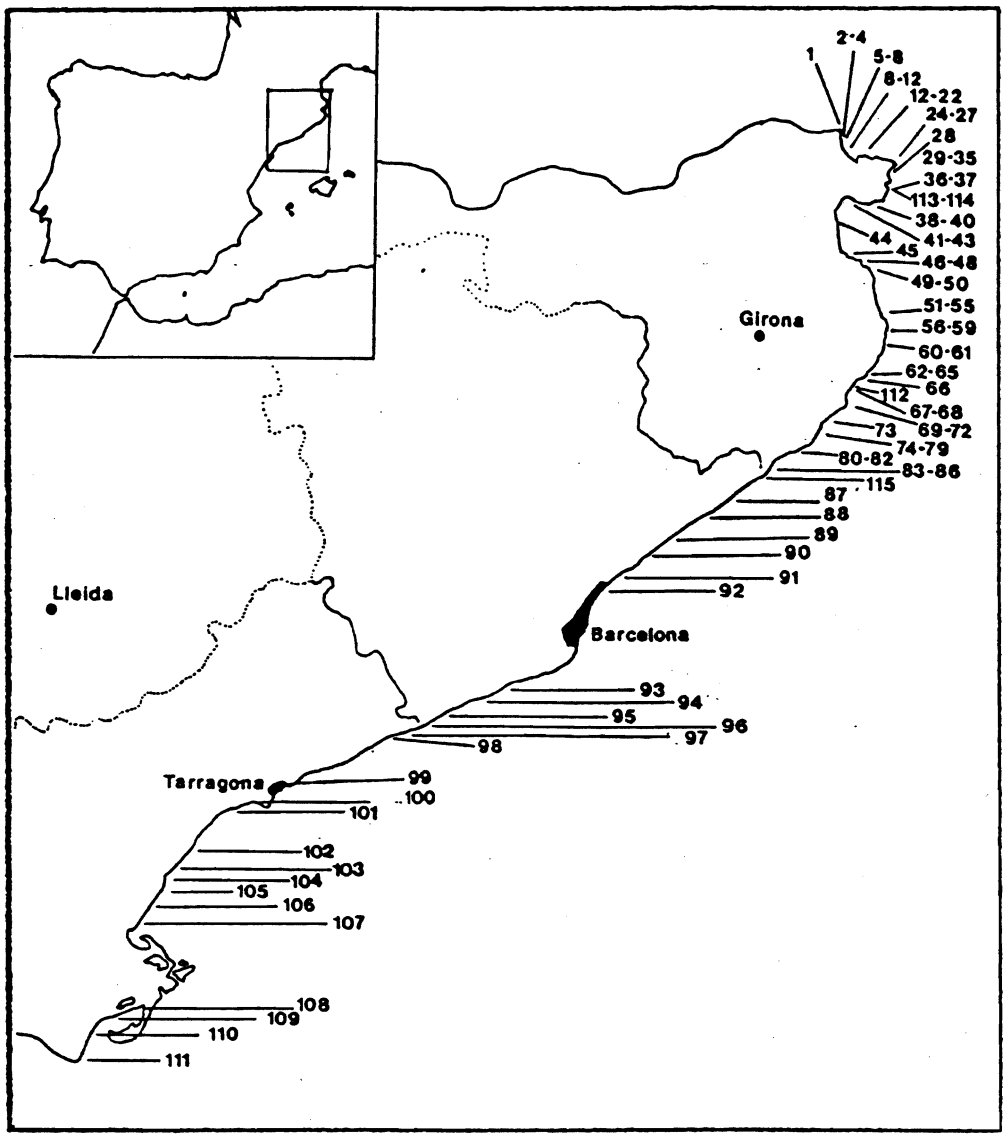

Figure 1: Geographic situation of the stations visited during the Project. Numbers refer to stations listed in Table I.

Table I: Names of the stations and years of survey. The geographic situation of the stations is indicated in Figure 1.

Nº	SITE	LOCALITY	YEAR
1	Port Bou	Port Bou	92, 93, 94
2	Cala Rovellada	Colera	92, 93, 94
3	Colera	Colera	92, 93, 94
4	Platja de Garbet	Colera	92, 93, 94
5	Platges de Bramant/Cros/Grifeu	Llançà	94
6	Llançà	Llançà	92, 93, 94
7	Platges de les Tonyines/Burgat...	Llançà	93, 94
8	Platja de Cau del Llop	Llançà	92, 93, 94
9	Platja de Sota S'Arenella	Port de la Selva	92, 93, 94
10	Platja de la Vall	Port de la Selva	94
11	Les Mores	Port de la Selva	94
12	Port de la Selva	Port de la Selva	92, 93, 94
13	Cala Tamariua	Port de la Selva	93, 94
14	Cala Cativa	Port de la Selva	93, 94
15	Cala Fornells	Port de la Selva	94
16	Cala Galera	Port de la Selva	93, 94
17	Cala Talabre	Port de la Selva	93, 94
18	Cala Tavallera	Port de la Selva	93, 94
19	Cala de Portitxol	Port de la Selva	94
20	Cala Prona	Port de la Selva	94
21	Cala Portaló	Cadaqués	94
22	Cala Culip/Club Méditerranée	Cadaqués	92, 93
23	Cala Fredosa	Cadaqués	94
24	Cala Jugadora	Cadaqués	94
25	Cala Bona	Cadaqués	94
26	Cala Guillola	Cadaqués	94
27	Cala Junquet	Cadaqués	94
28	Port Lligat	Cadaqués	92, 93, 94
29	S'Arenella/Perefet/Confitera	Cadaqués	93, 94
30	Platges d'En Ros/Oliveres/Seca	Cadaqués	93, 94
31	Platges de Pionc i Poal	Cadaqués	93, 94
32	Port Doguer	Cadaqués	92, 93, 94
33	Es Llané	Cadaqués	92, 93, 94
34	Sa Conca	Cadaqués	92, 93, 94
35	Sa Sebolla/Cala Nans	Cadaqués	94
36	Cala Montjoi	Roses	92, 93, 94
37	Cala Rustella	Roses	93, 94
38	Canyelles Grosses/Figuerola	Roses	92, 93, 94
39	Canyelles Grosses/Ullastrell	Roses	92, 93, 94
40	Canyelles petites	Roses	92, 93, 94
41	Roses	Roses	92, 93, 94
42	Sta. Margarida (escullera)	Roses	93, 94
43	Sta. Margarida (varador)	Roses	92, 93, 94
44	Ampuriabrava	Castelló d'Empúries	93, 94
45	L'Escala	L'Escala	92, 93, 94
46	Cala Martina	L'Escala	92, 93, 94
47	Cala Montgó	Torroella de Montgrí	92, 93, 94
48	Cala Pedrosa	Torroella de Montgrí	94
49	Port de L'Estartit	Torroella de Montgrí	92, 93, 94
50	Illes Medes	Torroella de Montgrí	92, 93, 94
51	Sa Riera	Begur	92, 93, 94
52	Aiguafreda	Begur	92, 93, 94
53	Sa Tuna	Begur	92, 93, 94
54	Cala Fornells	Begur	93, 94

Nº	SITE	LOCALITY	YEAR
55	Aiguablava	Begur	94
56	Aiguaxelida	Palafrugell	94
57	Tamariu	Palafrugell	92, 93, 94
58	Platja de Llafranch	Palafrugell	92, 93, 94
59	Calella de Palafrugell	Palafrugell	92, 93, 94
60	Platja Font d'en Rocàs	Palafrugell	93, 94
61	Illes Formigues	Palamós	92, 93, 94
62	S'Alguer i Cala Castell	Palamós	92, 93, 94
63	Cala Fosca	Palamós	92, 93, 94
64	Cala Margarida	Palamós	93, 94
65	Palamós	Palamós	92, 93, 94
66	Torre Valentina	Calonge	92, 93, 94
67	Cala Xaloc	Castell/Platja d'Aro	92, 93, 94
68	Port d'Aro	Castell/Platja d'Aro	93, 94
69	Platja de Sant Pol	Sant Feliu de Guíxols	92, 93, 94
70	Port de Sant Feliu de Guíxols	Sant Feliu de Guíxols	92, 93, 94
71	Platja de Sant Feliu de Guíxols	Sant Feliu de Guíxols	93, 94
72	Cap de Sant Elm	Sant Feliu de Guíxols	92, 93, 94
73	Cala Canyet	Santa Cristina d'Aro	92, 93, 94
74	Cala Salions	Tossa	93, 94
75	Sa Futadera	Tossa	93, 94
76	Cala Giverola	Tossa	92, 93, 94
77	Cala Pola	Tossa	92, 93, 94
78	Cala Bona	Tossa	92, 93, 94
79	Tossa	Tossa	92, 93, 94
80	Cala Canyelles	Lloret de Mar	93, 94
81	Platja de Fenals	Lloret de Mar	92, 93, 94
82	Cala Santa Cristina	Lloret de Mar	92, 93, 94
83	Cala Sant Francesc	Blanes	92, 93, 94
84	Punta de Santa Anna	Blanes	92, 93, 94
85	Port de Blanes	Blanes	92, 93, 94
86	Punta de Sa Palomera	Blanes	92, 93, 94
87	Sant Pol de Mar	Sant Pol de Mar	92, 93, 94
88	Arenys de Mar	Arenys de Mar	92, 93, 94
89	Port d'en Balís	Llavaneres	92, 94
90	Port de Mataró	Mataró	93, 94
91	Port de Premià	Premià de Mar	93, 94
92	Port Olímpic de Barcelona	Barcelona	92, 93, 94
93	Port Ginesta	Sitges	93, 94
94	Port d'Aiguadolç	Sitges	93, 94
95	Port de Vilanova i la Geltrú	Vilanova i la Geltrú	92, 93, 94
96	Desembocadura del riu Foix	Cubelles	92, 93, 94
97	Port de Segur de Calafell	Segur de Calafell	93, 94
98	Coma-Ruga	El Vendrell	93, 94
99	Tarragona	Tarragona	93, 94
100	Salou	Salou	92, 93, 94
101	Cambrils	Cambrils	92, 93, 94
102	Hospitalet de l'Infant	Hospitalet de l'Infant	93, 94
103	Calafat	L'Ametlla de Mar	92, 93, 94
104	Sant Jordi d'Alfama	L'Ametlla de Mar	93, 94
105	L'Ametlla de Mar	L'Ametlla de Mar	93, 94
106	Platja i Cap de l'Àliga	El Perelló	93, 94
107	Port de l'Ampolla	L'Ampolla	93, 94
108	Badia del Fangar	Deltebre	92, 94
109	Port Sant Carles de La Ràpita	Sant Carles de la Ràpita	92, 93, 94
110	Les Cases d'Alcanar	Les Cases d'Alcanar	92, 93, 94
111	Riu Dènia	Les Cases d'Alcanar	94
112	Cap Roig	Palamós	92

Nº	SITE	LOCALITY	YEAR
113	Cala Morisca	Roses	92
114	Cala Jòncols	Roses	92
115	S'Abanell	Blanes	92

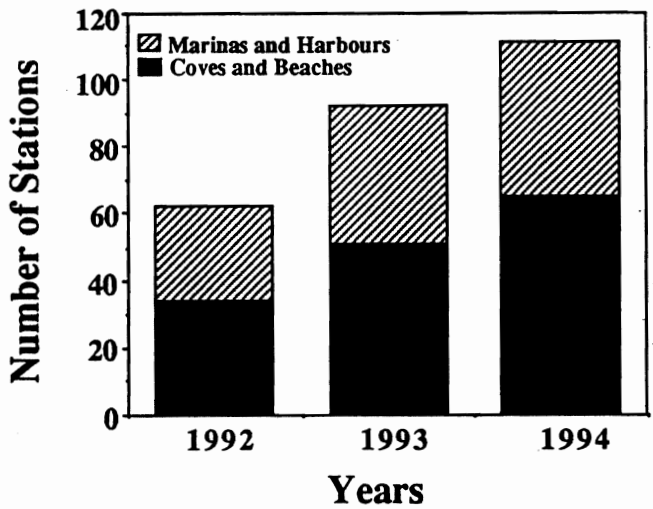

Figure 2: Number of marinas + harbours, and coves + beaches surveyed every year.

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