MAP OF BENTHIC VEGETATION AND SEA-BOTTOM TYPES IN THE HARBOUR AT BANYULS-SUR-MER (R-O., FRANCE)

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VIE MILIEU, 1991, 41 (2/3) : 165-168

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MAP
BENTHIC VEGETATION
POSIDONIA OCEANICA
POLLUTION

Abstract – A map of benthic vegetation and sea-bottom types in the harbour at Banyuls-sur-Mer shows the presence of a *Posidonia oceanica* (L.) Delile meadows. The area covered by this meadow is important (more than 10 % of the total area of the harbour). The *Posidonia oceanica* meadow presents a high level of vitality in spite of a visible chemical pollution which often appears responsible for the seagrass meadow decline.

CARTOGRAPHIE
VÉGÉTATION BENTHIQUE
POSIDONIA OCEANICA
POLLUTION

RÉSUMÉ – Une carte de la végétation benthique et des types de fond du port de Banyuls-sur-Mer montre la présence d'un herbier à *Posidonia oceanica*. La surface couverte par cet herbier est importante (plus de 10 % de la surface totale du port). L'herbier à *Posidonia oceanica* montre une forte vitalité malgré la présence de pollutions chimiques souvent responsables de la régression des herbiers de phanérogames marines.

PROBLEM

A *Posidonia oceanica* (L.) Delile seagrass meadow is present inside the small harbour at Banyuls-sur-Mer (Pyr.-Or., France), where more than 300 pleasure and fishing boats are berthed. There is an extensive literature devoted to the impact of pollution on *Posidonia oceanica* (Bourcier, 1976; Eugene, 1978; Cristiani, 1979, 1980; Augier *et al.*, 1984a, 1984b, 1987; Libes, 1986) and the resulting dramatic decline of seagrass meadows along the Mediterranean coastline (Augier and Boudouresque, 1970, 1972; Ben Alaya, 1972; Ghirardelli *et al.*, 1974; Giaccone, 1975; Peres and Picard, 1975; Blanc and Jeudy de Grissac, 1978; Giaccone and Calvo, 1980; Meinesz and Laurent, 1980; Boudouresque and Meinesz, 1982; Ardizzone and Pelusi, 1983; Peres, 1984).

The question is, therefore, whether this seagrass meadow is a vestige of a previously-existing meadow in the process of extinction (because of turbidity and/or pollution), or whether it shows signs of expansion. The situation at Banyuls-sur-Mer, which shows an expandive *Posidonia* bed, would tend to contradict the often hasty generalisations that have been made concerning the impact of pollution on *Posidonia oceanica* meadows.

To document the precise existing boundaries of this *Posidonia* meadow, and of other vegetation and types of bottom in the Banyuls-sur-Mer harbour, in order that future developments can be monitored, a map was constructed.

MATERIAL AND METHODS

The turbidity level of the waters at this site precluded the use of aerial photographs which need very clear water to be powerfull. Since the area to be studied was limited (4 to 5 hectares), the transect method was used (Meinesz *et al.*, 1981).

Twenty-four transects were examined by Scuba diving between January and March 1985. The transects were marked out on the bottom with metal measuring tapes stretched between easily-identifiable points on the shore. The composition of the flora and substrates (Meinesz *et al.*, 1983) was recorded metre by metre.

The flora and substrates included in the survey are :

— *Posidonia oceanica* meadow
— Dead *Posidonia oceanica* matte
— Photophilic algal populations on rock
— Mud (< 0.0625 mm *in* Chamley 1986)
— Muddy sand (<0.250 mm *in* Chamley 1986)

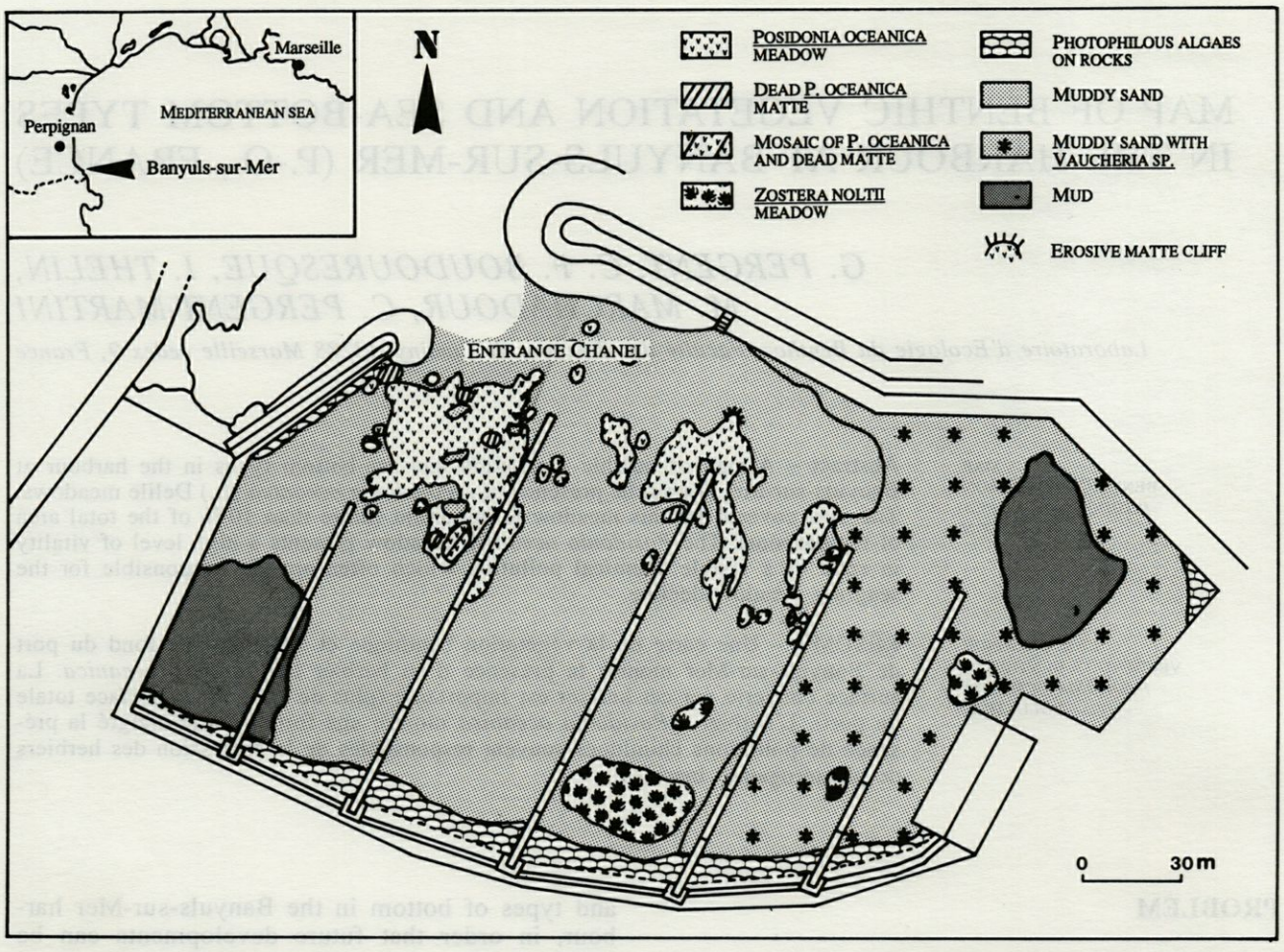

Fig. 1. – Map of benthic vegetation and sea-bottom types in the harbour at Banyuls-sur-Mer (December 1985). Above, on the left corner, localization of Banyuls-sur-Mer harbour.

— Muddy sand with *Vaucheria sp.* (Xanthophyceae)

— Muddy sand with *Zostera noltii* Hornemann (Potamogetonaceae)

RESULTS AND DISCUSSION

The *Posidonia oceanica* meadow covers an area of 3,600 m^2 (between 2 and 5 meters depth), or more than 10 % of the total area of the harbour (Fig. 1).

The meadow shows signs of considerable vitality : (i) a considerable number of creeping plagiotropic rhizomes have colonised the sediment around the perimeter of the meadow; (ii) the dead matte areas are not extensive; (iii) shoot density is relatively high (350 to 500 shoots per m^2); (iv) phenological examination of the leaf shoots shows that the leaves have the highest length (60 cm on average) and leaf index values (between 126 and 292 cm per shoot) recorded in this region (Pergent *et al.*, 1985; Pergent, 1987).

No significant expanse of dead matte was found buried in the sand (digging was carried out to a depth of at least 20 cm), which would seem to suggest that there has been no recent recession of the meadow.

The meadow is probably of ancient origin, since there are cliffs formed of dead matte in the harbour entrance channel, which is regularly dredged. In places, these cliffs reach a height of 1 m. It is known that the vertical growth rate of rhizomes rarely exceeds 5 cm/year (Boudouresque *et al.*, 1984; Boudouresque and Jeudy de Grissac, 1983); over longer periods, an approximate matte thickness growth rate of 1 m per century is generally accepted (Molinier and Picard, 1952). A matte of this thickness therefore indicates that the meadow must have already existed before the construction of the harbour. Pruvot (1894) mentioned a *Posidonia oceanica* meadow in the Banyuls-sur-Mer bay, but on his map all shoreline deposits (gravel beds, sand, seagrass meadows) are grouped together, so that it is impossible to determine the exact position.

On the available evidence, there is nothing to exclude the hypothesis that the surface covered by the meadow has been stable since the construction of the harbour.

Various factors might explain the apparent stability, except in the entrance channel, and high level of vitality of the meadow, which might otherwise seem unlikely in the setting of a harbour : (i) the major causes of the decline of *Posidonia oceanica* in the Pyrénées-Orientales, sedimentary deficiency and vigorous water movements (Molinier and Picard, 1952; Pergent *et al.*, 1985), do not apply within the harbour; (ii) the Banyuls-sur-Mer harbour is relatively small (350 moorings) and the occupancy rate is relatively low outside the tourist season (below 60 %); (iii) no major outlet or watercourse discharges into the harbour, so there is no significant decrease of salinity; (iv) the exposure of the harbour and the hydrological patterns mean that the level of water renewal is high, especially in the vicinity of the entrance channel, where the meadow displays the greatest vitality.

Nonetheless, the level of chemical pollution in the Banyuls-sur-Mer harbour (antifouling paint, detergent, hydrocarbons), particularly during the tourist season, seams at least as high as that recorded at many open sites where seagrass meadow recession has been attributed to pollution : e.g. Port-Cros (Augier and Boudouresque, 1970; Augier *et al.*, 1976; Monnier-Besombes, 1983), Porquerolles (Augier, 1981), Gulf of Marseilles (Peres, 1984). It would appear, then, that the conclusions drawn from data in the literature regarding the extreme vulnerability to pollution of *Posidonia oceanica*, have been hastily drawn. The degree of vulnerability has never been prove experimentally for the content levels actually found in the field (Monnier-Besombes, 1983; Augier *et al.*, 1984b; Libes, 1986, Augier *et al.*, 1987), are perhaps a little hasty. The recession of *Posidonia oceanica* meadows, which has indeed been observed in the vicinity of sources of pollution (Bourcier, 1976; Pergent *et al.*, 1988), might be related to more indirect consequences of pollution or to the effects of synergy between various possible pollution types.

It should nonetheless be pointed out that the Banyuls-sur-Mer harbour constitutes a special case; these remarks should not be taken to apply to harbour environments in general, since they concern an area where the harbour happens to modify certain local conditions which are harmful to the seagrass meadow.

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Reçu le 23 avril 1990; received April 23, 1990
Accepté le 16 Août 1990; accepted August 16, 1990