

# STUDY OF THE STRUCTURE, DISTRIBUTION AND DYNAMICS OF *Codium elisabethae* POPULATIONS IN THE AZOREAN REEF ECOSYSTEM, USE OF SUBMARINE IMAGE ANALYSIS.

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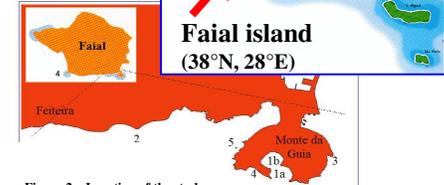
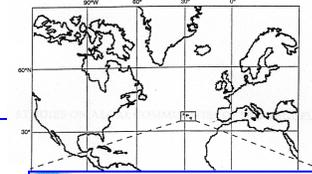


Figure 2 – Location of the study sites



Figure 1 – *Codium elisabethae* O.C. Schmidt

In the context of the Natura 2000 network, 17 Sites of Community Interest (SCI) were established within the Azores archipelago. In the SCI of Monte da Guia (SE coast of Faial island), two study sites were delimited in order to investigate in particular the links between habitat characteristics, population structure, distribution and dynamics of the green alga *Codium elisabethae* (Fig.1), representing the main vegetal biomass on some areas of the reef ecosystem.

The first site is an extensive rocky bottom of an ancient volcano crater (23 m. deep), today half opened to the sea, and classified as a no-go reserve (site of Caldeirinhas, point 1a in Fig.2).

The second site is situated at a similar depth but under more exposed conditions at a distance of about 2km from the first one. Here a more sparse population occupies rocky tables and boulders emerging from shallow sandy deposits (site of Ponta Furada, point 2 in Fig. 2).

## OBJECTIVES AND STUDY SITES

## SUBMARINE VISIBLE IMAGE MOSAICKING AND ANALYSIS

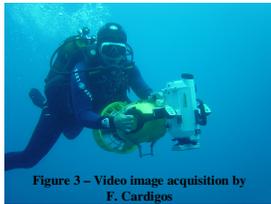


Figure 3 – Video image acquisition by F. Cardigos

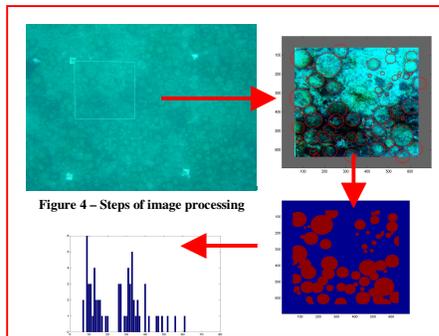


Figure 4 – Steps of image processing

In order to understand the differences in population structure, distribution and dynamics in regard to the characteristics of their habitat, a two-year monthly survey was started in August 2003. These surveys consist in building submarine image mosaics of each site (Salgado et al., 2001) from digital video and still cameras (Fig. 3). Further, a specifically designed Matlab computer-assisted detection program is run on the images in different steps: selection of region of interest and contrast enhancement by equalization of green and blue bands (step 1), automatic or assisted detection of *Codium elisabethae* individuals (step 2), extraction of valuable population statistics information about the *Codium elisabethae* present (step 3; number of individuals per square meter, size histogram of the population, proportion of the rocky substrate occupied by the algae) (Fig. 4). Similar analysis executed in precisely-positioned areas at different periods will yield growth and mortality information as function of size, thanks to individual identification. This technique allows to study a comparatively large zone regarding to the diving time invested.

## POPULATIONS STRUCTURES AND DYNAMICS DEPENDS ON BENTHIC HABITATS



Figure 5 – In-situ counting and measurements for image analysis validation and young recruits density estimation

In August 2003, a density of an order of 110 individuals.m<sup>-2</sup> was measured in situ in the Caldeirinha site (Fig.5), against only 13 individuals.m<sup>-2</sup> in the site of Ponta Furada. Structures of populations were also well distinct, with a more continuous size distribution in Caldeirinhas stands, although large individuals (above 18 cm diameter) are more frequent in Ponta Furada (Fig.6), and reach a maximum diameter higher than in the Caldeirinhas (32 cm against 24 cm).

These values observed in the study sites of Faial are notably larger than the maximum diameter reported by earlier population studies realised in the western Azorean island of São Miguel (Neto, 1997).

Populations were re-evaluated in the exact same quadrats in February 2004, showing important reduction in density in the site of the Caldeirinhas (from 110 to 61 indiv/m<sup>2</sup>; i.e. -44%), and almost steady state in Ponta Furada (13 to 12 indiv/m<sup>2</sup>; i.e. -8%).

Both in situ countings and observation of images indicated an important spatial variability of structures and densities at small spatial scale within each of the sites, both during summer and winter periods. Further efforts involving image analysis and countings will be devoted to statistical quantification of this spatial variability within the marked sites.

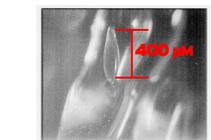
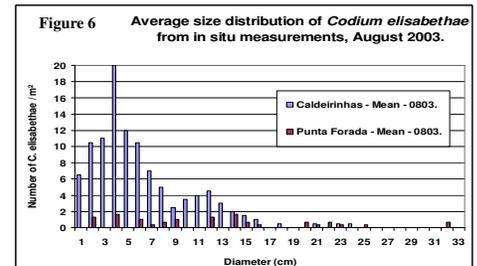


Figure 7 – Gametangia observed in August 2003 (Photo : F. Tempera)

## REPRODUCTIVE STRATEGIES

Both sexual and asexual reproduction strategies were observed for the populations of *Codium elisabethae* encountered around Faial island.

In contrast with the populations studied around the island of Sao-Miguel, where fertiles plants were found from October to February (Neto, 1997), some gametangia were observed on *Codium elisabethae* from Faial both during August 2003 (Fig.7), and February 2004 campaigns. Mean density of young recruits produced by sexual reproduction (diameter < 2 cm) was clearly higher in the site of the Caldeirinhas (order of 20 ind/m<sup>2</sup>) than in Ponta Furada (order of 1/m<sup>2</sup>), for both periods. The low density of recruitment remained almost constant in Ponta Furada, whereas more intense dynamics was observed in Caldeirinhas: while one quadrat showed clear increase of young individual density from summer to winter (9 to 34 ind./m<sup>2</sup>), another one distant of 5 meters showed opposite trend from 25 ind./m<sup>2</sup> in the August to 11 ind./m<sup>2</sup> in February.

Observing individuals from the site of Caldeirinhas, asexual reproduction (Fig.8) was shown to occur on individuals larger than 4 cm in August and on individuals larger than 7 cm in February (Fig.9), and the peak of gem production is reached for individuals of 10 to 13 cm diameter.



Figure 8 – *Codium elisabethae* in gemmation process (diam.= 15 cm)

## CONCLUSION AND PERSPECTIVES

Drastic differences in population structures were observed between the two sites, as possibly expected provided the differences between the selected benthic habitats. These first results confirm also the very patchy nature of population recruitment processes, the possible occurrence of sexual reproduction in the summer, and the intense winter dynamics of smaller class sizes resulting from the combination of winter sexual recruitment and removal effect by intense current and wave actions due to the frequent North Atlantic winter depressions.

Further, they also suggest that sexual recruitment may be strongly influenced by the density and structure of population as seen at a very local scale (couple of meters), in addition to the influence of the seasonal environmental characteristics of their benthic habitat (water temperature, total radiation reaching sea bed, nutrient concentration, advection of gametes and young recruits by currents and removal of individuals due to wave action at bottom), acting most probably at a larger scale. The quantification of these parameters is foreseen in order to explain the differences of population structures and dynamics observed between the confined and protected no-go reserve of Caldeirinhas and the more exposed site of Ponta Furada.

### Acknowledgments

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