Preliminary results of the evolution of the gonad index of *Paracentrotus lividus* (Lamarck) in the Urbinu lagoon in Corsica (France)

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Monitoring of the gonad index of *Paracentrotus lividus* has been carried out at numerous locations : Alger (SEMROUD and KADA, 1987), Marseille (REGIS, 1978), Villefranche Bay (FENAUX, 1968), Corsica (NEDELEC, 1983), Ireland (BYRNE, 1990). The present study was undertaken in the Urbinu lagoon, south of Bastia (Corsica) where there is a large population of *Paracentrotus lividus,* whose density varies according to the biotopes *(Cymodocea nodosa* beds, shingle, sand and muddy bottoms) (FERNANDEZ, 1990; FERNANDEZ and CALTAGIRONE, 1990). This lagoon has been chosen as a site for the echinoculture of *P. lividus.* The initial part of this programme consists of gaining a better understanding of the indigenous populations (population dynamics, stock evaluation, diet, physiological indices) so as to define sites of recruitment, good growth potential, as well as the spawning period. The preliminary results, presented here, concern the definition of the spawning period which is estimated by following the evolution of the gonad index and the percentage of mature females (FENAUX, 1968).

The Urbinu lagoon offers very different trophic conditions according to the biotope. In the *Cymodocea nodosa* algal beds, the trophic factor is not limiting as the urchins readily consume this phanerogame (FERNANDEZ, 1990). It is noted that *C. nodosa* is considered as a preferential food species by *P. lividus* (TRAER, 1980). Individuals living on the shingle bottoms, where often the vegetation resources are quite small, have a very varied diet : either a diet of animal material (crustaceans, gasteropods) and fragments of vegetation or a material obtained from grazing (observation of stomach contents : FERNANDEZ, 1990).

Samples for gonad analysis of urchins living in the beds of *Cymodocea nodosa* were taken monthly from April to August 1990 and from April 1991 to January 1992. Urchins living on the shingle bottoms were sampled from April to August 1990 and quarterly from May to November 1991. Ten individuals were sampled at each sampling session; their test diameter (not including the spines) varied from 35 to 50 mm. Gonads were removed and oven dried for 48 hours at 70°C before being weighted (± 0.1 mg). The gonad index (GI) utilized is that of SEMROUD and KADA (1987) derived from the index of repletion proposed by NEDELEC (1983). It is the ratio between the gonadal dry weight and the cube of the horizontal teste diameter, expressed in mg cm^3.

This index permits the detection of the spawning period and the establishment of a relationship between the development of the gonads and the different biotopes.

The results obtained (Table 1) show that the urchins living in the algal beds have a gonad index which is always elevated in comparison to data in the literature (KADA, 1987; SADOUD, 1988). The curve of evolution of this index shows some statistically significant oscillations, particularly between May and June (Kruskall and Wallis Test and Mann Witney Test) during the two years studied. Moreover, the data concerning the percentage of mature females present during 1991 also shows a sharp decrease during the same period (Table 1). The urchins living on the shingle bottoms, have a lower overall average gonad index but equally show a decrease between May and June 1990.

These data show that spawning of the urchins takes place during May/June at both stations in the lagoon and this is in agreement with other reported spawning times from the Mediterranean (FENAUX, 1968; REGIS, 1978). The gonad indices of individuals living in the beds of C. *nodosa* (whatever the month) are always significantly higher than those of individuals living in the shingle bottoms. This suggests that the urchins living in the *C. nodosa* beds are in a favourable environment perrnitting high gonad production. In constrast, the trophic resources of the shingle biotope constitute a limiting factor. It has been shown that a diet based on the consumption of a preferred vegetable species such asC. *nodosa* promotes high gonad production (FERNANDEZ, 1990). This is comfirmed by the fact that gonad indices in this biotope are generallly higher than those reported in the literature. This is important when considering the dietary regime to be used in urchin rearing. *Cymodocea nodosa* appears to be a choice food which facilitates high gonad growth during the entire year.

Table 1: Average gonad index (GI) of *P. lividus* in the Urbinu lagoon in mg/cm^3, and the percentage of mature females (% mature) in the beds of *C. nodosa.*

	AVR.	MAY	JUNE	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.
GI. *C. nodosa* (1990)	9.76	12.21	9.88	10.64	7.35					
GI Shingle (1990)	3.62	5.70	1.94	0.97	1.62					
GI *C. nodosa* (1991)	8.37	10.06	5.63	7.63	9.33	7.60	5.98	9.05	8.45	9.30
% Mature females (1991)		100	40	25	25	67	50	100	80	75
GI Shingle (1991)		2.01			2.23			5.47		

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Lophogorgia ceratophyta (L.) (Gorgoniidae) in the Bay of Marseilles

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Lophogorgia ceratophyta (Linnaeus, 1768) (Holaxonia, Gorgoniidae) is a large size species (up to 1 m high) (CARPINE, 1963; WEINBERG, 1976) specifically distributed along the French Mediterranean coast. It is found in abundance in the regions of Monaco and Perpignan (WEINBERG, 1976). In between these sites, it is only rarely seen and even appears to be completely absent from Corsican waters (WEINBERG, 1980; F. FINELLI and N. VERNEAU, although it appears on Carpine's recapitulative map of Corsica, at Bastia (1963, p. 53). In one of his earlier works, CARPINE (1963) considers that *L. ceratophyta is* absent from the region of Marseilles. Later on, several colonies are observed near the port of Marseilles by H. Zibrowius and J.G. HARMELIN *(in* CARPINE and GRASSHOFF, 1975; *in* WEINBERG, 1980) or near the port of Madrague (East Marseilles) by J. LABOREL (pers. comm.).

Until 1990, only a few observations of *L. ceratophyta* were made in the Bay of Marseilles and under 10 colonies were found between 25 and 50 meters in depth (pers. obs.; J.G. HARMELIN pers. comm.). Over the past two years, almost 70 colonies have been counted in the Bay of Marseilles, as well as a few others found at La Ciotat or in the Var (Port-Cros and Levant Islands, and Saint-Aygulf). Small size colonies (less than 20 cm high) are the most often observed (61%) and are only found in the North-West part of the Bay of Marseilles, while large size colonies (over 50 cm high) represent 18% of total observations. In this latter case, the colonies had been observed before. Some colonies, remarkable by their localisation, size and depth, have been under observation for several years : over 7 years at Méjean (West Marseilles); over 6 years at Port-Cros (Var); perhaps almost 10 years in Marseilles (Maïre Island). The average size of these colonies was considerable when first observed (over 40 cm high) which tends to prove that they had already been present for several years. *L. ceratophyta* can be observed between 15 and 55 m deep. Small size colonies can be found essentially at over 30 m in 95% of the cases, whereas large colonies are found between 15 and 45 m (91%) of these cases. Most authors (CARPINE, 1963; CARPINE and GRASSHOFF, 1975; WEINBERG, 1976, 1979b) have observed that these colonies are present at the foot of coralligenous falls, on sub-horizontal beds (far from all falls) or near port zones. According to these authors, the waters are very cloudy, and the colonies are usually rooted in sandy and muddy sediments. Most of these colonies are isolated, but, af Méjean, records show a density of approximately 5 colonies/m^2 of *L. ceratophyta* (under 20 cm in height). These figures remain low when compared with observations made by WEINBERG (1976, 1979a) at Banyuls-sur-mer : 12 to 17 colonies/m^2.

According to CARPINE and GRASSHOFF (1975), the epibionts observed for this species only involve *Pteria hirundo.* WEINBERG (1979a) mentioned *Alcyonium coralloïdes.* In 30% of the colonies over 20 cm high, we have observed on the lower thirds of the colony, an Amphiperatidae Gasteropod, *Simnia spelta,* which closely mimics the appearance of the gorgonian. Most often, this species is also found on the *Eunicella singularis* (LAUBIER, 1966; THEODOR, 1967; CARPINE and GRASSHOFF, 1975; SANTANGELO and NAVARRA, 1984) and on *E. cavolinii* (ROSSI, 1965; SANTANGELO and NAVARRA, 1984). Only SANTANGELO and NAVARRA (1984) and WEINBERG (1992) have observed *S. selpta* on *Lophogorgia.* On one *L. ceratophyta* colony under observation since 1986 at Port-Cros (Var), we have noted marked seasonal variations in the quantities of *S. spelta:* gasteropods are present between May and September (up to 6 per colony) and absent, or rarer, during the rest of the year. Reproduction has been observed in May and June. These variations in number correspond to those revealed by SANTANGELO and NAVARRA (1984) on *E. singularis,* in the straits of Messina. The *L. ceratophyta* and *S. spelta* association is therefore frequent and may correspond to that observed by GERHART *et al.,* (1988) between two similar species, *Leptogorgia virgulata* and *Neosimnia uniplicata.* This gorgonian synthesizes secondary anti-fouling metabolites, which limit the number of epibiont species. In spite of these defenses, it is consumed by the symbiotic, trophically specialized gasteropod. Only a few other epibiont species have been observed : a nudibranch *(Flabellina affinis),* laying its eggs on a medium size colony; seaweed is also rarely seen (in 2% of the cases).

CARPINE and GRASSHOFF (1975) insist upon the difficulty of defining its natural habitat. At Banyuls-sur-mer, it shares the habitat of *Eunicella singularis* (WEINBERG, 1979a). The adult colonies prefer turbid waters or strong currents and *L. ceratophyta* could be a turbidity indicator (CARPINE and GRASSHOFF, 1975). For WEINBERG (1979b), the degree of resistance in adult colonies tends to influence natural distribution more than any other factor. The sudden appearance of small size colonies of *L. ceratophyta* in the Bay of Marseilles seems to demonstrate this assumption and could therefore correspond to the changes in environmental conditions, more favorable now to the development of such colonies than before. It is not at present easy to identify the factors involved. The mean degree of water turbidity has greatly increased in the Bay of Marseilles after industrial or touristic developments (GRAVEZ *et al.,* 1990), but at present, this trend seems to be regressing. The lower mortality rate observed in young colonies could be an indirect result of the increase in average water temperature. We must observe the simultaneous and progressive appearance of *Alicia mirabilis* (Actinaria) which had only previously been seen in the bay of Naples (SCHMIDT, 1972) : Italy, Liguria (Spotorno); France, Alpes-maritimes (Nice), Var (Port-Cros, Les Embiez, Saint-Cyr), Bouches-du-Rhône (La Ciotat, Marseille, Carry-le-Rouet, Sausset-les-Pins). The low reproduction rate of these species and the change in environmental conditions (temperature ?) could explain this progressive appearance from the East *(L. ceratophyta* and *A. mirabilis)* and from the South *(L. ceratophyta).* An increase in mean turbidity levels over the past years has perhaps caused the development of an important *L. ceratophyta* population. Future evolution of this population must be monitored, if the degree of turbidity continues to decrease, as is the case today.

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