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Population dynamics of *Eudendrium glomeratum* (Cnidaria: Anthomedusae) on the Portofino Promontory (Ligurian Sea)

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Abstract

Eudendrium glomerutum Picard, in the Ligurian Sea, is one of the major components of hard-bottom sessile zoobenthos in the cold season. It settles mainly between 10 and 40m depth, forming a seasonal facies. The presence of *E. glomerutum* has been evaluated by measuring *in situ* the height of the colonies present within a standard surface of 1 m². Observations were carried out every other week for a whole year. The height of the colonies was correlated with their biomass (wet weight) and trophic functionality (number of polyps). The quantitative evaluation of the population shows that the situation is stable, with almost identical values at the extremes of the observed yearly time series. The species is present from October to April–May, and it is absent in the summer. The formation and disappearance of the *E. glornerutum* population are sudden. The colonies are sexually mature from their appearance in October to December–January. Different categories of colonies are recognizable; and are essentially referable to two groups: (1) colonies deriving from regeneration of colonies present in the previous year (45%); (2) colonies deriving from planula settlement (43%). A third group (12%) is of uncertain origin and may belong to either of the abovementioned categories. Mortality is 60% in the first group, and 82% in the second one. By "dead colonies" is meant those which do not reappear after a yearly cycle.

Introduction

Almost all hydroid species, especially in temperate waters, are not present all year round, and the species composition of the hydroid populations changes during the year. Some species can become dominant for longer or shorter periods, forming facies (Boero, 1984).

Hydroids are usually very abundant on hard substrata and constitute one of the major components of hard-bottom zoobenthos. Turpaeva *et al.* (1977), for instance, have shown that a hydroid species is of great importance in the energy balance of coastal waters of the Baltic Sea.

The first step towards the understanding of the role of hydroids in temperate marine ecosystems consists of identification of the quantitatively important species and in the study of the seasonal dynamics of their populations.

The study of the population dynamics of sessile hard-bottom invertebrates has already been carried out *in situ* for some groups, such as madreporarians (Fadlallah, 1983), ascidians (Svane, 1983) and sea anemones (Sebens, in press), but is still in a pioneer stage. Hughes (1977, 1983) and Svoboda (1973) have described, by *in-situ* observations, the life cycles of some hydroid species.

The quantitative importance of *Eudendrium glomeratum* was ascertained with the study of the seasonal and bathymetric distribution of the hydroids of the Portofino Promontory (Boero, 1982). From 1976 onwards, samplings from the surface to 40 m depth have shown that *E. glomeratum* is abundant during the cold season (from October to April–May) and absent during the warm season (Boero and Fresi, in press). The species forms a seasonal winter facies between 10 and 40 m. The distribution, abundance and fertility of *E. glomerutum* were the subjects of this first approach; here we describe its population dynamics.

Characteristics of the studied species

Eudendrium glomerutum (Fig. 1) is one of the bigger Mediterranean hydroids; its colonies reach a height of 20 to 30 cm. It has also been recorded from the Atlantic (Teissier, 1965; Fey, 1969; Boero and Cornelius, in press) and is probably more widespread than generally believed. In fact, in its general appearance it resembles the cosmopolitan species *E. ramosum* L., so that many old records of this last species'could possibly be referring to *E. glomeratum.* The systematics of the genus *Eudendrium* has been reassessed by Picard (1951), who, following the ideas of Motz-Kossowska (1905), stressed the importance of nematocysts for species identification. Many records of *Euden-*

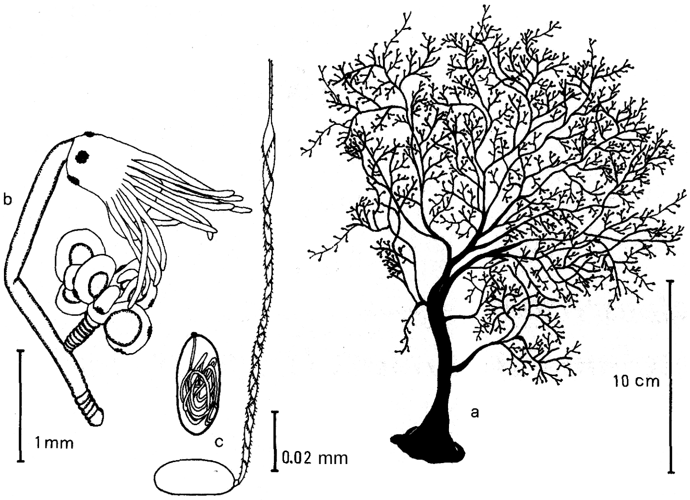

Fig. 1. *Eudendrium glomeratum.* (a) colony; (b) hydranth with female gonophore; (c) undischarged and discharged nematocyst (macrobasic eurytele)

drium species which are not based on the study of nematocysts are thus doubtful.

Eudendrium glomeratum is characterized by the presence of evident protuberances on the hydrant body, constituted by groups of nematocysts (macrobasic euryteles).

Materials and methods

A quadrat delimiting a surface of $1\,m^2$, divided into 16 quadrats of $625\,cm^2$ each, was fastened at the base of a vertical cliff at 20 m depth along the coast of the Portofino Promontory (the locality is named Castello di Paraggi) about 30 km east of Genova. All the colonies of *Eudendrium glomeratum* Picard more than 2-cm-high were identified within the quadrat.

From October 1982 to October 1983 the colonies were measured *in situ* every other week to record their growth. Small fragments of each colony were collected for species identification. Almost all the 68 colonies recorded in the quadrat during the whole time series belonged to *Eudendrium glomeratum.* Only two colonies belonged to different species *(E. ramosum* and *E. racemosum* Gmelin), but they were not considered in the present work.

In February 1982 a stock of individuals was collected outside the quadrat for the evaluation of the number of polyps and the wet weight of colonies of different height. Two mathematical functions relating height to wet weight and number of polyps have been calculated. They are of the type $y = a\,x^b$, where y is the number of polyps or wet weight, and x the height of the colony. The values of the parameters a and b of the curves have been calculated with the search of the regression line by the method of the least squares.

In the case of the relation weight-height (Fig. 2a) the value of b is close to 3 and in the relation between polyp number and height (Fig. 2b) it is close to 2. The functions were used to transform the height of every single colony into weight or number of polyps.

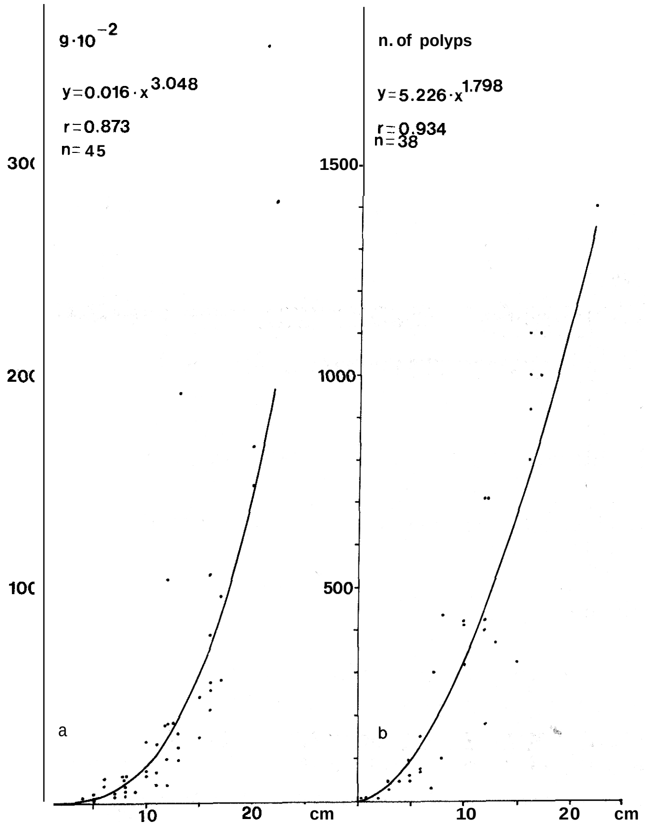

Fig. 2. *Eudendrium glomeratum.* (a) regression curve between height and wet weight; (b) regression curve between height and number of polyps. r: correlation coefficient; n: number of colonies observed

Results

The sum of the heights of the 66 colonies recorded within the quadrat (Fig. 3) underwent a regular yearly cyclic variation, with almost identical values at the extremes of the studied time-series (October 1982–October 1983). Other measures have been taken within the quadrat after October 1983; they are consistent with those of the studied year-cycle.

Eudendrium glomeratum was mainly present from the beginning of fall (October 7th) to the end of spring (May 12th). The growth and degeneration of the colonies were rapid (Fig. 3).

Not all the observed colonies were present at the same time. From a minimum of two (degenerated, i.e. deprived of polyps) colony per m^2 in July–August, the population reached a maximum number of 57 colonies per m^2 in December. The different seasonal trends observed for the studied colonies led to their division into six categories (Fig. 4):

(a) Big colonies disappearing during the warm season and reappearing during the cold season (Fig. 4a). Ten colonies (15%. of the total population) belong to this category. Growth started abruptly at the end of September and continued up to November–December. After a period during which the colonies had almost constant dimensions,

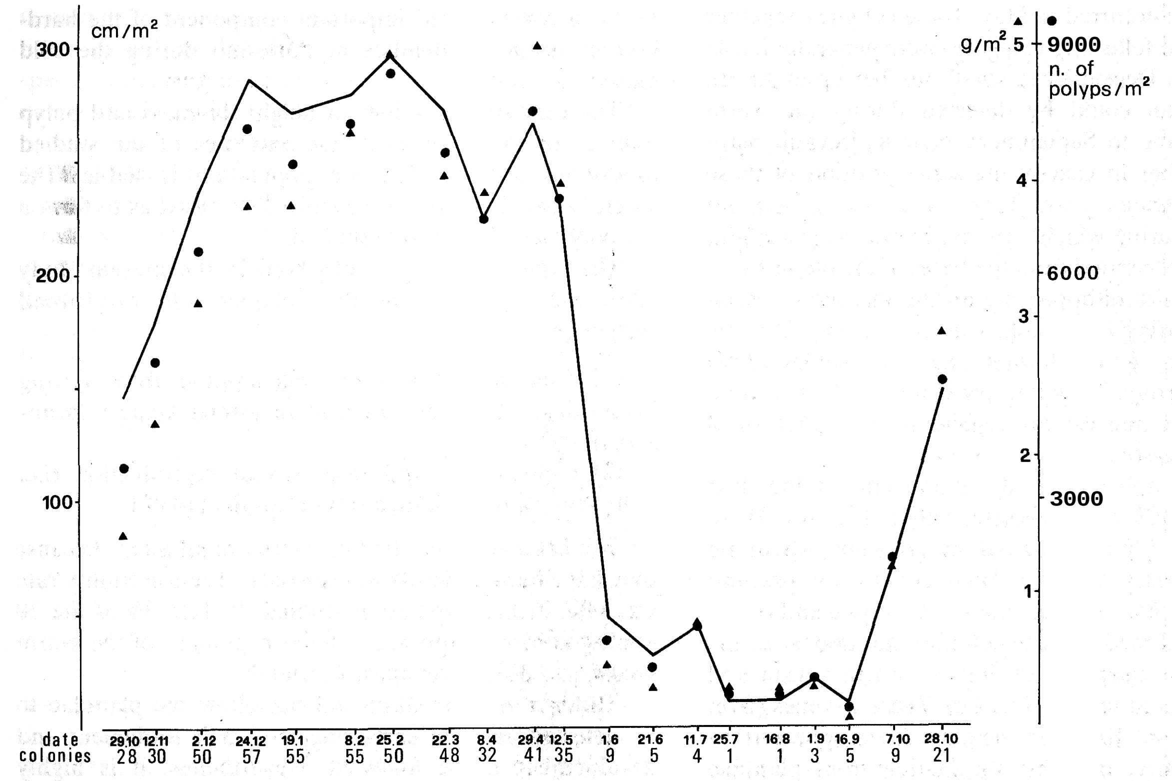

Fig. 3. *Eudendrium glomeratum.* Dynamics of a population within a standard surface of 1 m² from October 1982 to October 1983. Continuous line: sum of colony heights. Triangles: total wet weight in g. Dots: total number of polyps. Wet weight and polyp number have been obtained by the functions represented in Fig. 2. The number of observed colonies is indicated below the date of each sampling

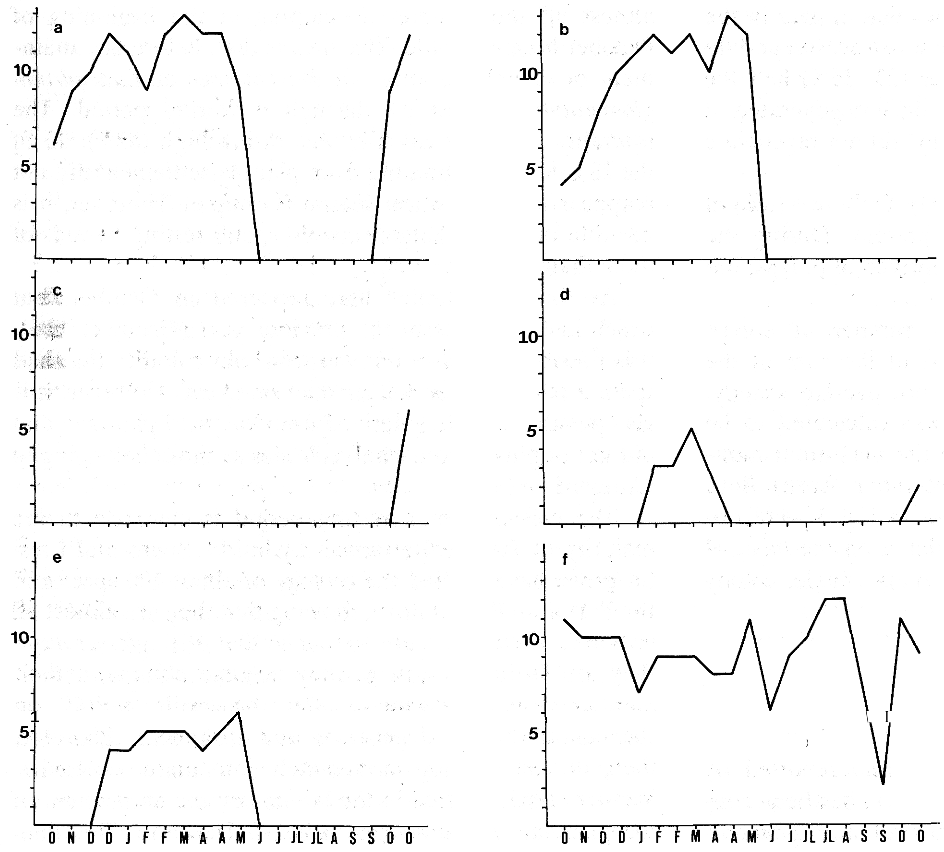

Fig. 4. *Eudendrium glomeratum.* Examples of seasonal dynamics of the six types of colonies observed during a year-cycle (see text for explanation)

a sharp decrease occurred in May. These colonies, together with those of the following category, were generally fertile from October to December (a small number up to April). No sign of them could be detected during the warm season (from June to September). New hydrocauli reappeared in October in exactly the same position of those present the previous year. There was thus a summer resting period during which only the hydrorhizae remain; new colonies regenerated from the bases of the old ones.

(b) Big colonies disappearing during the warm season and not reappearing in the cold season (Fig. 4b). This life cycle was similar to the former one; 18 colonies (27%) belong to this group. They had probably reached the end of their life cycle and did not regenerate at the return of the favourable season.

(c) Colonies appearing only at the end of the time series (October 1983), not present before (Fig. 4c). These colonies (eight: 12%) originated in positions where no colony was formerly detected. Their growth was presumably identical to that of the colonies of Groups a and b.

(d) Small and medium-size colonies that appear in the late cold season, disappear during the warm season and reappear in the cold season (Fig. 4d). These colonies (five: 8%) reached 8 to 10 cm in height. They appeared in December–January, probably originating from planulae released by the colonies of Groups a and b, which were fertile mainly in October–December. In contrast, they did not reach fertility in their first season. Their appearance, like that of the colonies of the c group, was observed at the beginning of October 1983 and their growth was probably identical to that of the a and b groups.

(e) Small and medium-size colonies that appear in the late cold season, disappear during the warm season and do not reappear (Fig. 4e). These colonies (23: 35%) had the same origin of those of Group d but, once degenerated at the beginning of the warm season, they did not regenerate when favourable conditions returned.

(f) Colonies always present (Fig. 4f). Only two (3%) of the observed colonies were always present. During the warm season they were completely deprived of polyps, but their stems did not degenerate.

The evaluation of biomass and number of polyps (Fig. 3) shows a similar trend to that of the sum of the heights, even if the three graphs do not overlap exactly. The maximum wet weight per m² was calculated to be about 5 g (in February–May), while the maximum number of polyps was about 8 000 (in December–April). Both wet weight and polyp number shown in Fig. 3 were obtained by summing the values (calculated on the basis of the regression curves) relative to every single colony recorded in each observation.

Discussion

The seasonality of *Eudendrium glomerutum* reported by Boero (1982) and Boero and Fresi (in press) has been confirmed. Long-term observation has shown that *E. glomeratum* is a constant and important component of the hard-bottom sessile zoobenthos at Portofino during the cold season.

The very similar values of height, biomass and polyp number of the colonies at the extremes of the studied time-series indicate that the population is stable. The species is so abundant and evenly distributed as to form a seasonal facies in the zone studied.

The types of life cycle observed in the present study allow the separation of the colonies into two broad categories:

(1) Colonies derived by regeneration from resting hydrorhizae of colonies present in former years (Groups a, b, f) (45%).

(2) Colonies derived from sexual reproduction (i.e. from newly settled planulae) (Groups d, e) (43%).

The colonies of the first category are all adult, because they have become fertile at least once. Their mortality rate was 60% in the population studied. In fact, 18 of the 30 adult colonies disappeared at the beginning of the warm season and did not reappear (Group b).

The *in-situ* observation did not allow the planulae to be detected and the early stages of their settlement and development to be followed. Nevertheless, it is highly probable that the young colonies, which started their development at the end of the reproductive period, originated from newly settled planulae. These colonies never reached maturity during their first season. Some of them reappeared at the beginning of the following cold season and then had the possibility of becoming fertile: almost all the colonies developing at the beginning of October became fertile. This means that, before the attainment of sexual maturity, all the colonies of *Eudendrium glomerutum* had to go through a resting period. The mortality of young colonies was rather high (82%): 23 of the 28 colonies originating from planula settlement did not reappear after the warm season (Group e). However, it is possible that these colonies could spend resting periods of more than one year.

As for the colonies that appeared in October, but which had been absent the previous year (Group c: 12%), it is possible that they derived from old colonies that had spent a resting phase longer than one year. However, it is also possible that they derived from encysted planulae that did not originate from small colonies as those belonging to Groups d and e.

The existence of a resting period is common to the majority of the Mediterranean hydroids. Boero and Fresi (in press) have studied the ecology of about 100 species of the Portofino Promontory, showing that they are almost all seasonal. Their cycles are similar to that of *E. glomeratum:* they are fertile as soon as they become abundant, their number does not increase after the fertile period; on the contrary, they degenerate and disappear. Planulae, then, do not develop immediately into mature colonies. Werner (1963) studied in the laboratory the encystment of the planulae of *Margelopsis haeckeli* Hartlaub. This phenomenon is probably widespread under natural conditions, especially for the species lacking medusae. The species which produce medusae, in fact, may spend the unfavourable period for the polyp stage as medusa, with no need for a resting stage.

The transformation of measures of height into measures of biomass and number of polyps is probably more satisfactory for the first part of the life cycle of the population (October–March). After the beginning of spring, degeneration and predation by nudibranchs deprive many colonies of their polyps, leaving high "naked" stems. Presumably the decrease in number of polyps and biomass occurs earlier than shown in Fig. **3.**

Despite these limitations, the measure of colony height seems sufficient for a global evaluation of the life cycle of *Eudendrium glomerutum.* The seasonal variation of biomass and polyp number (calculated from the height of every single colony) is not significantly different from the variation of the simple sum of colony heights. This last parameter, furthermore, allows long periods of non-destructive observation on the same group of individuals.

The fact that polyp number varies approximately with the square of colony height (Fig. 2a) is probably related to the observed tendency of the colonies to grow in a single plane (i.e. to become planar). The increase in size of the single parts of the colony, on the other hand, occurs in all directions. For this reason the total weight of the colonies (half of which is due to the perisarc) varies with the cube of the height (Fig. 2b).

Eudendrium glomerutum has probably a high energetical demand between October and December, when growth and gamete production occur. The energy sources utilized by the colonies are still unknown. The examination of thousands of polyps has never revealed the presence of food in their stomachs. However, samplings have always been carried out during the day, and feeding could occur during the night.

Different food sources could contribute to the energy demand of *Eudendrium glomerutum.* Zooplankton is generally considered as a major component of the diet of hydroids. No data are available about the coastal zooplankton in the Ligurian Sea; Della Croce *et al.* (1980) reported a limited and irregular fall peak of off-shore zooplankton, but the appearance of *E. glomerutum* in the fall is regular and probably involves a much larger amount of energy than that provided by this peak. *E. glomerutum* could also feed on vagile organisms, such as amphipods, copepods, annelids etc., which are generally abundant on hard bottoms; or on the larvae of benthic organisms. However, it could also utilize other energy sources, such as dissolved organic matter. Even if no hydroid has yet been reported to utilize DOM as an energy source, Schlichter (1982) demonstrated that this happens in other cnidarians.

After the first period of the cycle, during which growth and sexual reproduction occur, the colonies of *Eudendrium glomerutum* could also survive with no food supply. Crowell (1957) observed hydroids surviving long periods without food.

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