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MORPHO-CHRONOLOGICAL OBSERVATIONS ON JUVENILE SHOOTS OF THE SEAGRASS *POSIDONIA OCEANICA*

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Summary

The phenological and lepidochronological characteristics of *Posidonia oceanica* (L.) Delile juvenile shoots (derived from seeds) from the Island of Ustica and the Gulf of Olbia (Italy) are here described. The higher number of sheaths and leaves born after germination, and the detection of a second lepidochronological cycle of the sheath thickness in juvenile shoots from Olbia suggest that they were about one-year older than those collected at Ustica. In both sets of samples, the trends of sheath thickness (whose values were comparable to those of adult shoots), reconstructed by lepidochronology, did not display any distinct pattern during the first period after germination (first 7 - 8 sheaths). Then, the occurrence of an increase followed by a decrease has been suspected as the appearance and setting of the typical annual cycle. These results improve the available information about morphology and leaf dynamics of *P. oceanica* juvenile shoots. On the other hand, they provide suggestive evidence of the occurrence of the annual cyclic trend in sheath thickness in juvenile shoots, and allow evaluation of their age, and the success of reproduction and survival.

Riassunto

In questo contributo vengono riportati i risultati relativi alla fenologia e lepidocronologia di fasci giovanili di *Posidonia oceanica* (L.) Delile (derivati da semi) prelevati presso l'isola di Ustica ed il Golfo di Olbia (Italia). Il più elevato numero di basi fogliari (scaglie), di foglie nate dopo la germinazione e l'individuazione di un secondo ciclo lepidocronologico nei germogli di Olbia suggeriscono che questi ultimi potrebbero essere circa un

anno più vecchi rispetto a quelli raccolti ad Ustica. In entrambi i campioni, gli andamenti dello spessore delle scaglie (i cui valori sono risultati comparabili a quelli dei ciuffi adulti) ricostruiti tramite la lepidocronologia non hanno mostrato nessun 'trend' particolare nei primi periodi seguenti la germinazione (le prime 7 - 8 scaglie). L'incremento ed il successivo decremento dello spessore delle scaglie più recenti, invece, ha indotto a pensare all'instaurarsi del ciclo lepidocronologico tipico dei ciuffi adulti. I risultati presentati in questo lavoro arricchiscono le informazioni disponibili sulla morfologia e la dinamica fogliare di ciuffi giovanili di *P. oceanica*. Essi forniscono, inoltre, indicazioni sull'instaurarsi dei cicli lepidocronologici annuali dello spessore delle scaglie nei giovani ciuffi di questa fanerogama. Ciò consente di valutare l'età del giovane ciuffo, di datare il suo insediamento ed avere indicazioni sul successo di un evento di riproduzione sessuata.

Introduction

The seagrass *Posidonia oceanica* (L.) Delile forms large and widespread seabeds which constitute one of the most productive Mediterranean ecosystems (OTT, 1980). It reproduces both by vegetative growth and sexually. Flowering is followed by fertilisation, fruiting and dispersal of fruits with seeds, which need suitable sites for settlement, germination and growth. Some authors reported data on the phenology of *P. oceanica* seedlings germinated 'in situ' (GAMBI and GUIDETTI, 1998 and reference herein). However, most of the available information come from laboratory studies (CAYE and MEINESZ, 1989; BALESTRI *et al.,* 1998). Very few data (see BUIA *et al.,* 2001), instead, are so far available on the sheath thickness of juvenile shoots in order to assess if the cyclic trend typical of adult shoots already occurs during the first phases of the ontogenetic development of the plant. This paper, therefore, is aimed (1) at providing additional data on the morphology and leaf dynamics, and (2) at reporting observations on sheath thickness variations of *Posidonia oceanica* juvenile shoots.

Materials and methods

Twenty juvenile shoots of *Posidonia oceanica* were collected in June and August 1998 at Ustica (Sicily, Italy; 38°44'N, 13°11'E) and the Gulf of Olbia (NE Sardinia, Italy; 40°55'N, 09°34'E), respectively, in shallow (0 - 1.5 m) and comparatively sheltered rocky areas.

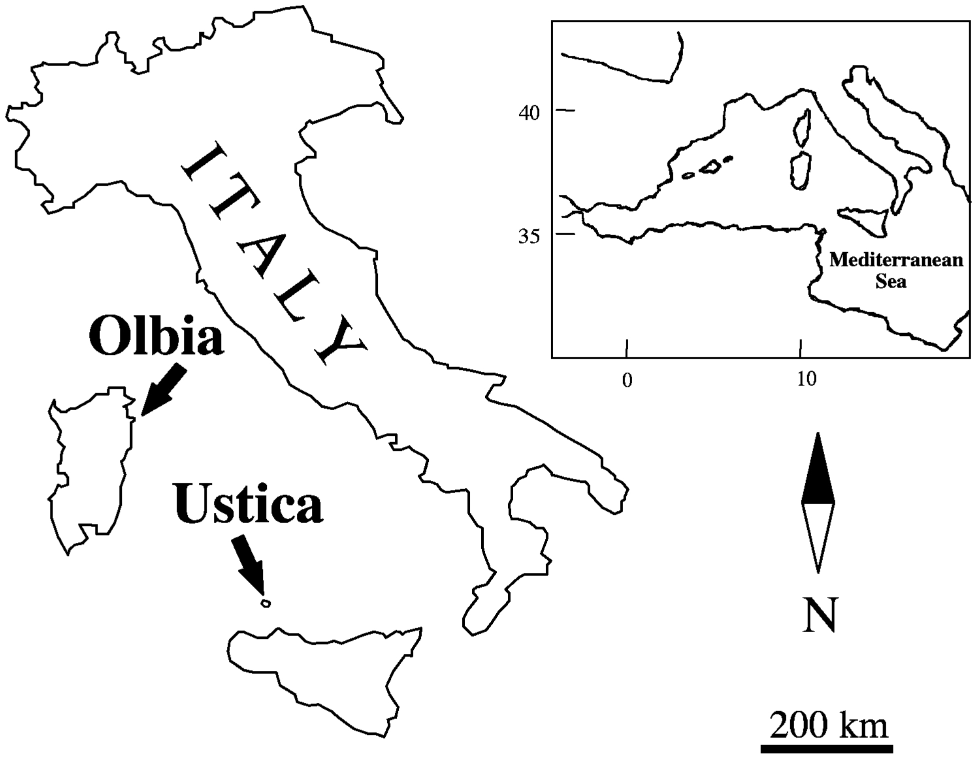

Fig. 1 – Location of sampling areas.

Seedlings from Ustica were 1 year old, since their seeds were tagged at the time of settlement occurred in June 1997 (personal observations).
The phenological analysis of shoots was carried out according to GIRAUD (1979). The number of standing leaves, sheaths (leaf bases persisting along the rhizomes after the leaf fall) and scars (traces of the sloughed sheaths occurring toward the base of rhizomes) was also noted to account for the total number of leaves produced after germination. The lepidochronological analysis was conducted according to standardised procedures (PERGENT, 1990) to detect changes in sheath thickness along rhizomes.
Morphological differences of juvenile shoots from the two sites were tested by t-test or U-Mann-Whitney test basing on the assessment of the normal distribution of data.

Results and discussion

Phenological data of juvenile shoots from each of the two sites studied are reported in Table 1. Only the number of sheaths and the total number of leaves born after germination significantly differed between sites, while similar proportions of adult, intermediate and young leaves, as well as of broken apices were observed (Table 1).

Parameter	Olbia	Ustica	Difference
leaf lenght (cm)	10.0 ± 6.1	10.5 ± 8.4	n.s.
lenght of longest leaf (cm)	16.7 ± 3.2	19.0 ± 5.4	n.s.
leaf width (cm)	0.67 ± 0.08	0.61 ± 0.12	n.s.
number of standing leaves	5.5 ± 1.7	6.3 ± 1.9	n.s.
adult leaves (%)	49.8	46.3	-
intermediate leaves (%)	22.0	21.1	-
young leaves (%)	28.2	32.6	-
leaves with broken apex (%)	30.4	34.7	-
sheats number per shoots	15.7 ± 4.9	9.1 ± 2.4	***
range sheats thickness (mm)	0.20 - 0.98	0.25 - 0.85	-
scar number per shoot	5.5 ± 1.6	5.5 ± 2.5	n.s.
number of leaves produced per shoot after germination	26.7 ± 6.1	22.0 ± 7.0	*
secondary root number	5.8 ± 1.9	5.9 ± 2.4	n.s.

Table 1. Mean values (± SD) of morpho-chronological variables of *Posidonia oceanica* juvenile shoots from the two studies sites (n = 20). Differences evaluated by t test or U Mann - Whitney test (n.s.: non significant; *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$).

Sheath thickness ranged from 0.20 to 0.98 mm in juvenile shoots from Olbia and from 0.25 to 0.85 mm in those from Ustica. At both sites, this parameter did not display any distinct pattern during the first period, while, after the 8th-10th sheath rank, it showed an increase (more evident in juvenile shoots from Ustica) followed by a decrease (Fig. 2).

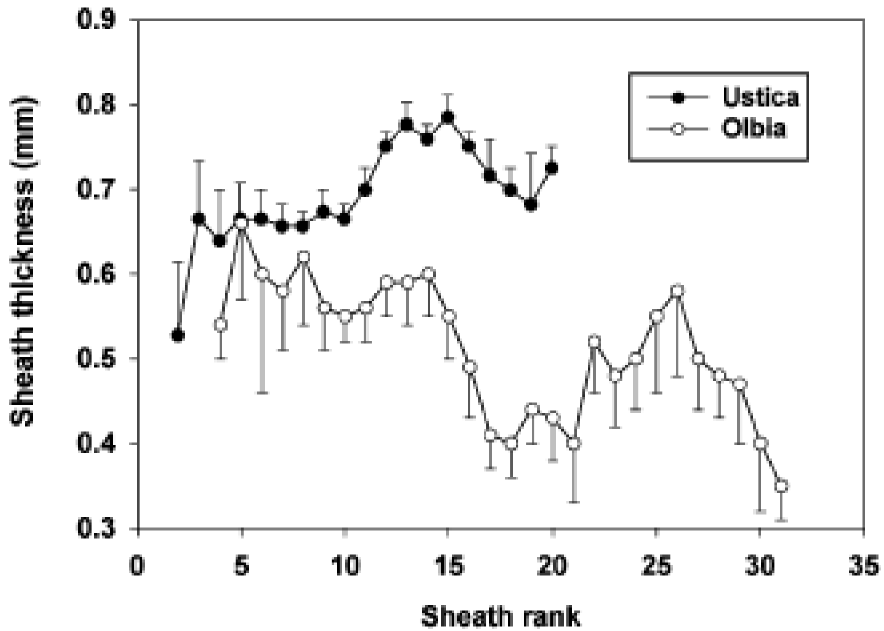

Fig. 2 - Trends of the mean thickness along rhizomes of juvenile shoots from the two sites studied

Such a pattern could be interpreted as the establishment of the cycle typical of adult shoots (PERGENT, 1990). Juvenile shoots from Olbia, furthermore, displayed a second annual cycle.

The above results suggest that the two sets of juvenile shoots are likely to derive from two subsequent reproductive cycles. Young shoots from Olbia were about 2 years old, while (as already known by tagging) those from Ustica were 1 year old. It is thus possible to estimate that the annual rate of leaf production by juvenile shoots is two- three-fold higher than that of adult shoots (WITTMANN, 1984; BUSSOTTI and GUIDETTI, 1996). The number of standing leaves remains constant, the values reported here being around those of adult shoots of *Posidonia oceanica* (WITTMANN, 1984; MARBÀ et al., 1996).

The values of sheath thickness measured in juvenile shoots from Olbia and Ustica fall approximately within the range of those recorded for adult plants (PERGENT, 1990). The variation of this parameter is usually attributed to both environmental (i.e., depth, water movements; PERGENT, 1990) and internal factors (i.e., the distance from the plagiotropic rhizome; PERGENT-

MARTINI and PERGENT, 1994). However, sheath thickness of seedlings and juvenile shoots is potentially affected by further factors, such as the continuous energy supply by seeds during the first phases of life, which could maintain growth dynamics (and sheath thickness) independent of seasonality. This could explain the trend observed in the sheath thickness of seedlings starting from their germination.
The results presented here support what reported by CAYE (1989), who noticed a certain degree of variability in the morphology of *P. oceanica* seedlings reared under different laboratory conditions. Such an intrinsic variability could involve a high plasticity of *P. oceanica* seedlings as a probable response to environmental forcing they experience during development (CAYE, 1989). On the other hand, these data provide suggestive evidence that the cyclic variation of the sheath thickness does not start during the earliest phases of the life history of *P. oceanica*, but after a given time after germination, when seed resources are likely to be completely exploited.

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BIBLIOGRAFIA

BALESTRI E., PIAZZI L., CINELLI F., 1998 - *In vitro germination and seedling development of* Posidonia oceanica *(L.) Delile.* Aquat. Bot. 60, pp. 83 - 93.
BUIA M.C., GAMBI M.C., BADALAMENTI F., 2001 - *Morpho-chronological observations on seedlings and juvenile shoots of* Posidonia oceanica *(L.) Delile collected 'in situ' in various coastal areas.* 32° Congresso della Società Italiana di Biologia Marina, Abstract vol., pp. 104.
BUSSOTTI S., GUIDETTI P., 1996 - *Studio lepidocronologico delle fioriture della prateria di* Posidonia oceanica *(L.) Delile di Noli (Baia di Spotorno, Mar Ligure).* In: A. Virzo de Santo, A. Alfani, G.C. Carrada and F.A. Rutigliano, Eds. S.It.E. Atti 17, pp. 305 - 308.
CAYE G., 1989 - *Mise en evidence d'un polymorphisme sur des jeunes plants de* Posidonia oceanica. In: C.F. Boudouresque, A. Meinesz, E. Fresi and V. Gravez, Eds, International Workshop on Posidonia oceanica Beds. GIS

Posidonie Publ., pp. 77 - 84.
CAYE G., MEINESZ A., 1989 - *Cultures en milieu artificiel de* Posidonia oceanica *a partir de graines.* In: C.F. Boudouresque, A. Meinesz, E. Fresi and V. Gravez, Eds, International Workshop on Posidonia oceanica Beds. GIS Posidonie Publ., pp. 293 - 299.
GAMBI M.C., GUIDETTI P., 1998 - *Morphological observations on seedlings of* Posidonia oceanica *(L.) Delile germinated "in situ".* Biol. Mar. Medit. 5 (1), pp. 549 - 552.
GIRAUD G., 1979 - *Sur une méthode de mesure et de comptage des structures foliaires* Posidonia oceanica *(L.) Delile.* Bull. Mus. Hist. Nat. 39, pp. 33 - 39.
MARBA N., DUARTE C.M., CEBRIAN J., GALLEGOS M.E., OLESEN B., SAND - JENSEN K., 1996 - *Growth and population dynamics of* Posidonia oceanica *on the Spanish Mediterranean coast: elucidating seagrass decline.* Mar. Ecol. Prog. Ser. 137, pp. 203 - 213.
OTT J., 1980 - *Growth and production in* Posidonia oceanica *(L.) Delile.* P.S.Z.N. I: Mar. Ecol. 1, pp. 47 - 64.
PERGENT G., 1990 - *Lepidochronological analysis in the seagrass* Posidonia oceanica*: a standardized approach.* Aquat. Bot. 37, pp. 39 - 54.
PERGENT - MARTINI C., PERGENT G., 1994 - *Lepidochronological analysis in the Mediterranean seagrass* Posidonia oceanica*: state of the art and future developments.* Oceanol. Acta 17 (6), pp. 673 - 681.
WITTMAN K.J., 1984 - *Temporal and morphological variations of growth in a natural stand of* Posidonia oceanica *(L.) Delile.* P.S.Z.N. I: Mar. Ecol. 5 (4), pp. 301 - 316.