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Short Communication

# Characteristics of *Posidonia oceanica* (L.) Delile (Posidoniaceae) seagrass meadows in the Southeast Adriatic Sea of Montenegro

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**Summary.** *Posidonia oceanica* seagrass meadow observations and samplings were conducted by SCUBA diving in the Southeast Adriatic Sea off the coast of Montenegro in November, 2011. Basic phenological parameters were measured for *P. oceanica* meadows from three locations in Montenegro. Although detailed data concerning the state of *P. oceanica* in the Southeast Adriatic is sparse, our data is similar to that available in the literature, and indicates that *Posidonia* meadows in this location are in a good state. Interestingly, in the present study we observed flowering on both orthotropic (vertical) and plagiotropic (horizontal) axes.

**Keywords:** Adriatic Sea, flowering, *Posidonia oceanica,* seagrass.

## Introduction

The seagrass, *Posidonia oceanica* (L.) Del., is a dominant and endemic plant species in the Mediterranean Sea (Pergent et al. 1995; Kirkman 1996), where it plays a very important role as one of the primary producers of organic matter, and serves as a specific habitat for marine wildlife (Pergent and Pergent Martini 1988; Short et al. 1996; Buia et al. 2000; Molenaar et al. 2000). Because of this, *P. oceanica* is listed as a protected species under several international conventions, and is protected by national legislation in Montenegro (Sl. list br 76/06). Furthermore, *Posidonia* meadows are marked as priority habitat in an EU Habitat Directive (Council Directive 92/43/EEC).

In order to be able to apply more adequate protection measures for this endangered seagrass, in the present study we sought to collect basic information concerning the state of *P. oceanica* seagrass meadows off the Montenegrin coast, as part of a larger project monitoring marine biodiversity in Montenegro.

## Materials and methods

The present study was conducted along 100m long transects at 3 locations in Montenegro (South East Adriatic Sea) (Figure 1): Jaz (18° 49' 21.57"E 42° 16' 36.22"N), Cape Platamuni (18° 46' 56.44"E 42° 16' 03.11"N) and Cape Ratac (19° 03' 59.41"E 42° 07' 18.30"N).

*Posidonia oceanica* meadow observations and samplings were conducted by SCUBA diving in November, 2011. Meadow density was recorded *in situ* by counting the number of leaf shoots present inside a square frame (40 x 40 cm, 3 replicate measurements), at a depth of 10 m (Pergent et al. 1995). In order to examine phenological parameters (Pergent and Pergent-Martini 1988), 10 orthotropic (vertical) shoots were collected at a depth of 10 m, and the following parameters were measured: 1) number, length and width of adult, intermediate and juvenile leaves; 2) lengths of leaf sheaths; 2) coefficient "A" (*i.e.*, the percentage of broken leaves); and 3) LAI (Leaf Area Index) per shoot. The following additional parameters were measured for flowering shoots: 1) length of the inflorescence peduncle; 2) number of spikelets; and 3) total length of inflorescence. Interestingly, two rare plagiotropic (horizontal) flowering shoots were also collected.

## Results and Discussion

Although *Posidonia* meadows were found at all three South East Adriatic locations, they were not ob-

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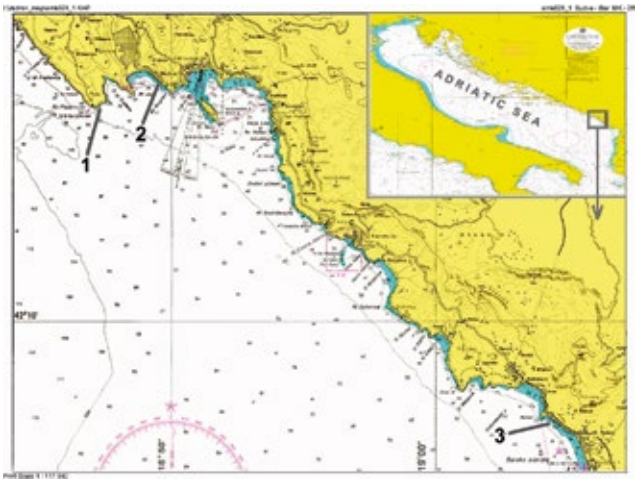


**Figure 1.** Map of the sampling locations (1-3) of seagrass *Posidonia oceanica* in Montenegro.


**Figure 2.** Plagiotropic (horizontally oriented) flowering axes of seagrass *Posidonia oceanica* recorded at Jaz.

served closer to the coastline, and the upper limit of all three meadows was mosaic: at Jaz, *P. oceanica* were found to begin 88 m from the coast at a depth of 10 m; while at cape Platamuni, meadows began 64 m from the coast at a depth of 9 m; and at cape Ratac, meadows began 91 m from the coast at a depth of 8 m. The observed *Posidonia* meadows distribution is probably due to the presence of a sandy bottom and greater wave exposure closer to the coastline. *In situ* observations conducted beyond the 100 m transects designated for monitoring indicate the presence of well-developed *Posidonia* meadows extending deeper and further from the coast. Because of the bottom topology and very gentle slope in this area, it could be presumed that these *Posidonia* meadows are very large. Thus, in future studies, observation of these meadows will be performed at a deeper limit than the present study.

Based on Pergent et al. (1995), the meadow densities measured for all three locations at 10 m depth (Table 1) are indicative of normal meadow density. Mean values for measured phenological parameters are shown in Table 1. For all three locations, measured phenological parameter values were similar, with almost identical LAI values for Jaz and cape Ratac, although LAI values for cape Platamuni were significantly higher. Comparison of these data with previously reported results for the Adriatic and Mediterranean Seas (Pergent and Pergent-Martini 1988; Turk and Vuković 1998; Mačić 2002; Balestri et al. 2005) strongly suggests that these *Posidonia* meadows are in a good state. However, since these data were obtained from only one sampling close to the upper limit of the meadow, additional monitoring is planned for other seasons and at deeper locations, in order to enable better comparisons between the studied locations in Montenegro and other Mediterranean Sea locations.

Interestingly, in the present study *P. oceanica* flowering was recorded at both Jaz and cape Platamuni (Table 1). Although this plant can reproduce both vegetatively and sexually, sexual reproduction has only been reported sporadically, and was believed to contribute little to *P. oceanica* population growth (Pergent and Pergent-Martini 1988; Balestri and Cinelli 2003). However, reports of *P. oceanica* flowering have greatly increased over the past two decades, in parallel with increased observation efforts and reports concerning the importance of sexual reproduction for this seagrass (Mačić 2002; Diaz-Almela et al. 2006).

Because flowering was observed at the beginning, inflorescences were not completely developed and peduncles were only 5.52-9.51 cm long. All measured inflorescences (n = 9) were composed of three spikelets. However, very interestingly, rare flowering was recorded on plagiotropic (horizontally oriented) axes (Figure 2) on two shoots from Jaz. Plagiotropic (horizontally oriented) and orthotropic (vertically oriented) axes are different in morphology and ecology, and, to date, flowering has almost exclusively been reported for

orthotropic axes (Pergent and Pergent-Martini 1988; Balestri et al. 2005). However, in the present study, three spikelets were observed on two sampled inflorescences from plagiotropic axes, as well as on inflorescences from orthotropic axes. Because the collected inflorescences were not completely developed, further research is needed at the same locations to provide information about the number of hermaphroditic and male flowers per inflorescence and possible differences between plagiotropic and orthotropic inflorescences. Also, further studies are necessary in order to evaluate the density of flowering shoots, and to check if there are more horizontally oriented flowering axes, or if the observed shoots are exceptions.

Moreover, since Diaz-Almela et al. (2007) reported that systematic records of flowering could be early indicators of biological change induced by global sea warming in Mediterranean marine ecosystems, results from this study could be used by studies monitoring such changes. Finally, data from the present study should contribute useful information concerning the status of this endangered seagrass, and could be used for further monitoring.

## Acknowledgements

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**Table 1.** Mean values of phenological characteristics recorded for 10 orthotropic shoots of *Posidonia oceanica* for each of 3 surveyed locations in Montenegro.

| | Location | | |
|---|---|---|---|
| Parameter | Jaz | Cape Platamuni | Cape Bar |
| No. adult leaves | 4.38 | 4.30 | 4.13 |
| No. intermediate leaves | 2.00 | 3.50 | 2.63 |
| No. juvenile leaves | 1.63 | 0.80 | 1.38 |
| Length, adult leaves (cm) | 50.12 | 60.48 | 49.54 |
| Length, intermediate leaves (cm) | 13.55 | 18.71 | 20.89 |
| Length, juvenile leaves (cm) | 2.53 | 0.68 | 1.44 |
| Length, sheaths (cm) | 3.49 | 3.88 | 3.87 |
| Coefficient A% (for adult) | 43.25 | 43.80 | 45.38 |
| Width, adult leaves (cm) | 0.94 | 1.00 | 0.89 |
| Width, intermediate leaves (cm) | 0.89 | 0.95 | 0.84 |
| LAI, adult ($cm^2$/shoot) | 203.01 | 261.40 | 182.36 |
| LAI, intermediate ($cm^2$/shoot) | 25.69 | 61.81 | 46.32 |
| LAI, ($cm^2$/shoot) | 228.70 | 323.21 | 228.68 |
| Meadow density (shoots/$m^2$) at 10 m depth | 404.16 | 400 | 387.5 |
| Length, inflorescence peduncle (cm) | $6.86_{(n=5)}$ | $8.60_{(n=4)}$ | / |
| Total length of the inflorescence (cm) | $11.86_{(n=5)}$ | $14.73_{(n=4)}$ | / |
| No. of spikelets | 3 | 3 | / |

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