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Biology

Evaluation of the health status of the *Posidonia oceanica* (Linné, 1813) delile herbarium of a protected area: case of Rachgoun Island (Benisaf, Algeria).

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ABSTRACT The *Posidonia oceanic* seagrass of Rachgoun island located off the coast of Beni Saf, was monitored monthly from october 2015 to october 2016. Sampling of this Magnoliophyte was carried out scuba at a depth of 2 and 3m. Field study was donne, namely density and coverage, with respectively 3 and 10 replicas. Phenology on the leaf biometry, the coefficient "A" the surface area and the leaf index were carried out monthly throughout this work. The study of phenology one of the descriptors that account for the vitality of the herbarium at *Posidonia oceanica* shows a good health state of the latter at the level of the island of Rachgoun.

KEYWORDS : Rachgoun Island, Magnoliophyte, Phenology, *Posidonia oceanica*.

Introduction

Posidonia oceanica is a Mediterranean endemic seagrass species forming lush, extensive meadows between 0 and 45 m depth around the Mediterranean coast. *P.oceanica* meadows provide important services, as they are important carbon sinks [1, 2]. These meadows provide important ecosystem functions, both in terms of production and biodiversity [3].

The Magnoliophyte *Posidonia oceanica* and the seagrass that it constitutes have become, over the last decades, a major protection and management objective of marine environment in the Mediterranean [4, 5, 6]. Indeed, the *Posidonia oceanica* meadows constitute, with the coralligenous, the most important marine Mediterranean ecosystem [7]. For many years, *Posidonia oceanica* has undergone a generalized regression [8, 9,10], which generally results from the joint action of different pressures such as urban and industrial discharges [7], aggressions due to coastal developments [11, 12] and the mechanical action of anchors and trawlers [13].

The protection and conservation of *Posidonia oceanica* meadows are therefore not only justified because of their great heritage value, but also for economic reasons. It constitutes an exemplary illustration of the notion of sustainable development, which came out of the Rio de Janeiro Summit in 1992 [14]. Rachgoun island being classified as protected areas under the Barcelona Convention has led us to undertake a study of the *Posidonia oceanica* seagrass present at this island to assess the state of health thereof and compare it with the meadow present in the algerian coastal fringe on the one hand and with the rest of the Mediterranean seagrass on the other hand. In this work we were interested in the characterization of the seagrass and the phenological study.

Study zone

The island is located about one mile from the west coast of Algeria in front of the mouth of the Tafna (Figure 1). Covering an area of 26 hectares. It is part of the regional geomorphological complex comprising the Habibas islands to the east, distant 30 nautical miles. Due to its small size and lack of water resources, no permanent population lives on the island. This site has been listed since 1990 among the sites of interest in the Mediterranean and is classified as Specially Protected Area under the Barcelona Convention. The archipelago presents an exceptional natural heritage preserved with a high level of endemism, the presence of numerous rare or threatened terrestrial and marine species, the presence of well-preserved ecosystems and vulnerable species on the Mediterranean scale.

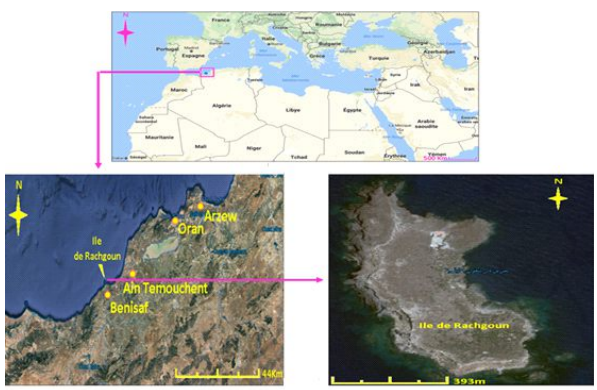

Figure 1: Location of study site (Ile de Rachgoun).

Material and methods

The sampling ranged from october 2015 to october 2016, at the rate of one sample per month. At each sample, 20 beams are taken into account at the upper limit of the *Posidonia oceanica* seagrass and between 2 to 3 meters depth. The harvested rhizomes are immediately preserved in seawater formalin at 10%. Estimating density and recovery has been undertaken in scuba using a quadrate. In laboratory the samples were subject to a phenological study which is a health status descriptor of *Posidonia oceanica* meadows. This study consisted to determinat the leaf biometry, length, width, number, leaf area and leaf area index as well as the coefficient A.

Results and discussions

1. Meadow characteristics

1. 1. Shoots Density

The average density estimated from the 03 counts is 520 ± 32, 71 shoots per m^2, according to [15] the meadow of Rechgoun island is of type II (dense seagrass), on the other hand, according to the latest classification of [16] that takes into account the depth, the seagrass of the studied sites are considered in "good condition", the vitality values of *Posidonia oceanica* in the seagrass of the studied sites are considered satisfactory. For the same depth, this density value is among the lowest values observed in the algerian and Mediterranean basins (Table 1). Indeed, the density factor variability is related to several parameters such as mean turbidity, pollution, hydrodynamism or the substrate nature [17].

Table 1: Average densities of *Posidonia oceanica* meadows found in the literature for different localities and depths.

Locality	Reference	Depth (m)	Density (shoot/m^2)	Type
Rachgoun island (Benisaf, Algeria)	**Present work**	**2-3**	**520**	**II**
Cap Carbon (Arzew, Algeria)	[18]	10	350	III
Ain Franin, (Algeria)			403	II
Cap Blanc, (Algeria)	[19]	5	807	I
Ain Franin (Oran, Algeria)	[20]	1-2	956,64	I
Cap Carbon (Arzew, Algeria)		2-3	827,70	
Sidi Lakhdar (Mostaganem, Algeria)		1-2	1054,83	
Baie de la Palud (Var, France)	[21]	9	349	III
Bagaud interdit (Var, France)			482	II
Bagaud Nord (Var, France)			558	II
Passe de Port Cros (Var, France)			366	III
Baie de Port-Man (Var, France)			551	II
La Marcha, (Algeria) (Algeria)	[22]	2	476	II
Juan-les Pins, (France)	[23]	2 2	1110 Récif-barriére	I
Côte Bleue, (France)	[24]	3	811	I
Port de Galéria, (France)	[23]	2	800	I
Urla-Iskele, (Turkey)	[25]	2	510	I

1.2.Recovery

The average recovery rate calculated from 10 counts is 78.5%.

2. Shoot structure

2.1. *2.1. Leaves number per shoot*

2.1.1. Overall leaves number (adult and intermediate) per shoot

The overall mean number of leaves varies depending on season, corroborating the results of several authors [26, 22, 27 and 18]. This number is maximum at the end of summer and minimum in autumn (Figure 2).

Table 2: Average number of global leaves (adult and intermediate) per *Posidonia oceanica* shoot reported in literature for different localities and depths.

Locality	Reference	Depth (m)	Number of leaves per shoot
Rachgoun island (Benisaf, Algeria)	**Present work**	**2-3**	**2,87 (September) M 1,87 (November) m**
Ain Franin (Oran, Algeria)	[20]	1-2	6,10 (May) **M** 4,75 (August) **m**
Cap Carbon (Arzew, Algeria)			6,10 (February) **M** 5,25 (August) **m**
Sidi Lakhdar (Mostaganem, Algeria)			6,30 (March) **M** 5,40 (August) **m**
Cap blanc (Oran, Algeria)	[19]	5	5,75 (December) **M** 4,35 (February) **m**
Cap Carbon (Arzew, Algeria)	[18]	10	6,37 (December) **M** 5,07 (November) **m**
Ain Franin (Oran, Algeria)			6 ,50 (May) **M** 4,03(September) **m**
Anse de Kouali, (Algeria)	[28]	2	7,20 (December) **M** 5,25 (September) **m**
Tamentfoust, (Algeria)	[22]	2	6,20 (April) **M** 5,20 (October) **m**
Calvi, (Corse,France)	[29]	3	7,10 (January) **M** 5,20 (March) **m**
Tabarca, (spain)	[30]	2-5	6,70 (December-June) **M** 3,40 (August) **m**
Ile de Riou (France)	[27]	10	6,70 (March-May) **M** 4 ,00 (September) **m**
Lacco Ameno (Ishia,Italy)			6,10 (November) **M** 4,40 (June) **m**
Ras Jebel (Tunisia)	[31]	5	5,15 (Winters) **M** 4,17 (Automne) **m**
Baie de La Revellata-Calvi (Corse, France)	[32]	10	9,00 (December) **M** 4,20 (June) **m**

2.1.2. Average number of adult leaves per shoot

The average number of adult leaves per shoot (Figure 2) follows the same seasonal pattern as the mean total leaf number with a maximum in summer (2,92 in august) and a minimum in winter (1,32 in february). This is due to the fact that the older adult leaves persist longer on the axes in summer due to the low water agitation during this season [33, 34 and 18] and undergo a strong hydrodynamism at the beginning of autumn caused by the first storms, which favor the large fall of these leaves.

Table 3: Mean monthly number of *Posidonia oceanica* adult leaves of harvested rhizomes in the studied site. (M: maximum; m: minimum).

Month	Year	Average number
October	2015	2,01
November ember	2015	1,96
December	2015	1,72
January	2016	1,51
February	2016	1,32 m
March	2016	1,45
April	2016	1,65
May	2016	1,81
June	2016	1,93
July	2016	2,31
August	2016	2,92 M
September tember	2016	2,23
October	2016	1,99

2.1.3. Average number of intermediate leaves per shoot

The average number of intermediate leaves remains very low regardless of month of year (Figure 2). This deficiency in intermediate leaves has already been observed in Ischia by [23] and [35]; the first author thinks that it could be a local phenomenon [18]. The number of intermediate leaves (Table 4) has a maximum value of 3,72 in august (summer) and a minimum value of 1,98 in January (winter).

Table 4: Mean monthly number of intermediate leaves of *Posidonia oceanica* harvested rhizomes in the studied site. (M: maximum; m: minimum).

Month	Year	Average number
October	2015	2,34
November	2015	2,15
December	2015	2,17
January	2016	1,98 m
February	2016	2,37
March	2016	2,75

April	2016	2,92
May	2016	3,05
June	2016	3,16
July	2016	3,25
August	2016	3,72 M
September tember	2016	3,51
October	2016	2,95

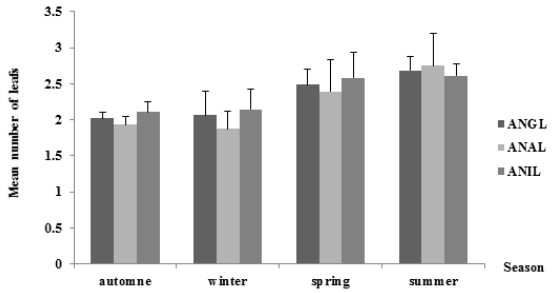

Figure 2: Seasonal evolution of the average number of adult, intermediate and global leaves of *Posidonia oceanica* harvested rhizomes in the studied site.ANGL : Average Number Global Leaves ; ANAL : Average Number of Adult Leaves ; ANIL : Average Number of Intermediate Leaves.

2.2. Leaves length per shoot

2.2.1. Global leaves Length (adult and intermediate) per shoot

According to Figure 3, the average length of the overall leaves varies significantly during the year, these variations depend on the season and the studied station (locality and depth) and on the other hand of the period considered, the maximum length that we mentioned corresponds to spring 369,86 (march), but during the winter the leaves have minimum lengths 193,94 (december). Our values corroborate with the values quoted in the literature (Table 5).

Table 5: Average length of total leaves (adult and intermediate) in mm of *Posidonia oceanica* found in the literature for different localities. Extreme values (maximum: M, minimum: m).

Locality	Reference	Depth (m)	Length of global leaves in (mm)
Rachgoun island (Benisaf, Algeria)	**Present work**	**2-3**	**369,86 (March) M 193,94 (October) m**
Ain Franin (Oran, Algeria)	[20]	1-2	568,25 (May) **M** 285,58 (February) **m**
Cap Carbon (Arzew, Algeria)		2-3	406,40 (May) **M** 178,19 (February) **m**
Sidi Lakhdar (Mostaganem, Algeria)		1-2	608,17 (April) **M** 294,72 (August) **m**
Cap Carbon (Oran, Algeria)	[19]	10	611,63 (July) **M** 426,25 (January) **m**
		5	1334,42 (July) **M** 597,67 (September) **m**
Cap Carbon (Arzew, Algeria)	[18]	10	952,20 (August) **M** 294,30 (November) **m**
Ain Franin (Oran, Algeria)			981,20 (August) **M** 287,90 (January) **m**
Anse de Kouali (Algeria)	[28]	2	675,61 (June) **M** 325,71 (September) **m**
Tamentfoust (Algeria)	[22]	2	302,00 (June) **M** 15,60 (January) **m**
La Marcha (Algeria)	[22]	2	254,40 (July) **M** 12,50 (October) **m**
Port-Cros (France)	[26]	2	476,0 (June) **M** 155,80 (November) **m**
Tabarca (spain)	[30]	2-5	129,00 (August) **M** 66,00 (January) **m**
Baie de La Revellata-Calvi (Corsica, France)	[32]		(Summer) **M** (Winter) **m**
Ile de Riou (France)	[27]	10	604,20 (August) **M** 155,80 (January) **m**
Lacco-Ameno (Ishia,Italy)			652,60 (July) **M** 181,80 (November) **m**

2.2.2. Adult leaves Average length per shoot

Figure 3 shows that the average length of the adult leaves follows the same trend as the mean total leaf length with a maximum of 342,47 mm in spring (april) and a minimum of 154 mm length in winter (january). Many authors in the Mediterranean [36, 25, 28, 32, 37, 18 and 20] mentioned the same evolutionary pattern.

Table 6: Average monthly leaf length of harvested adult rhizomes from *Posidonia oceanica* in the studied site. (M: maximum; m: minimum).

Month	Year	Average length (mm)
October	2015	208,39
November	2015	197,15
December	2015	164,76
January	2016	154 m
February	2016	300
March	2016	324,7 M
April	2016	342,47
May	2016	321,66
June	2016	312,69
July	2016	298,64
August	2016	252,48
September	2016	217,09
October	2016	195,40

2.2.3. Intermediate leaves average length per shoot

The average length of intermediate leaves (Table 7) follows the same seasonal patterns as adult leaves and global leaves with a maximum of 431,19 mm in late spring (may) and a minimum of 179,49 mm in autumn (october). It should be noted that throughout the period of our study the average length of the intermediate leaves was always greater than those of the adult leaves. This disagrees with what has been mentioned in the literature [38, 26, 22, 18, and 20], except in spring where the length of the adult leaves is less than that of the intermediate leaves.

Table 7: Monthly average leaf length of the harvested rhizomes of *Posidonia oceanica* in the studied site. (M: maximum; m: minimum).

Month	Year	Average length (mm)
October	2015	179,49 m
November	2015	248,03
December	2015	224,17
January	2016	252
February	2016	354,12
March	2016	415,01
April	2016	407,70
May	2016	431,19 M
June	2016	414,75
July	2016	358,36
August	2016	382,04
September	2016	349,02
October	2016	289,23

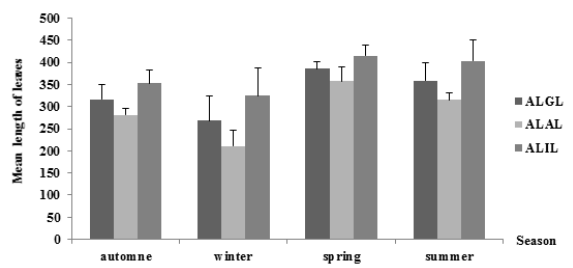

Figure 3: Seasonal evolution of the average length of adult, intermediate and global leaves harvested from *Posidonia oceanica* rhizomes in the studied site. ALGL : Average Length of Global Leaves; ALAL : Average Length Adult Leaves ; ALIL : Average Length Intermediate Leaves.

2.3. Leaves width per shoot

2.3.1. Mean leaf width (adult and intermediate)

The mean width of the global leaves (Figure 4) shows extreme values in spring and late summer. Our results are of the same order of magnitude as those observed in Algeria.

Table 8: Average width of the overall leaves (adult and intermediate) in mm reported in the literature.

Locality	Reference	Depth (m)	Width of global leaves (adult and intermediate) in mm
Rachgoun island (Benisaf, Algeria)	**Present work**	**2-3**	**10,33 (October) M 9,93 (December) m**
Ain Franin (Oran, Algeria)	[20]	1-2	10,08
Cap Carbon (Arzew, Algeria)		2-3	10,10
Sidi Lakhdar (Mostaganem, Algeria)		1-2	10,11
Cap Carbon (Arzew, Algeria)	[19]	10	10,48
		5	10,56
Cap Carbon (Arzew, Algeria)	[18]	10	10,98
Ain Franin (Oran, Algeria)			10,59
Tamentfoust (Algeria)	[39]	2-3	10,26 (April) **M** 9,25 (July) **m**
Anse de Kouali, (Algeria)	[28]	2	10,62 (December) **M** 9,51 (September) **m**
Tamentfoust (Algeria)	[22]	2	10,80 (April) **M** 10,20 (October) **m**
La Marcha (Algeria)	[22]	2	10,80 (April) **M** 10,00 (October) **m**

2. 3.2. Average width of adults leaves

The mean width of the adult leaves also shows seasonal variations, with extreme values in spring and autumn, these results are also shown by [40] (Table 9).

Table 9: Width average of monthly adult leaves of *Posidonia oceanica* of harvested rhizomes in the studied site. (M: maximum; m: minimum).

Month	Year	Average width (mm)
Octoberr	2015	10,63 M
November	2015	10,40
December	2015	10,03
January	2016	10,11
February	2016	10,22
March	2016	10,17
April	2016	10,25
May	2016	10,29
June	2016	10,08
July	2016	10,37
August	2016	10,24
September	2016	10,02 m
October	2016	10,1

2.3.3. Average width of intermediate leaves

The intermediate leaves width (Figure 4) shows no big seasonal variations with a maximum of 10, 45 mm in april (spring) and a minimum of 9, 71 mm in September (autumn).

Table 10: Monthly mean leaves width of harvested rhizomes of *Posidonia oceanica* in the studied site. (M: maximum; m: minimum).

Month	Year	Average width (mm)
October	2015	10,02
November	2015	10,18
December	2015	9,82
January	2016	9,92
February	2016	10,20
March	2016	10,14
April	2016	10,45 M
May	2016	10,33
June	2016	10,17
July	2016	10,28
August	2016	10,05
September	2016	9,71 m
October	2016	9,92

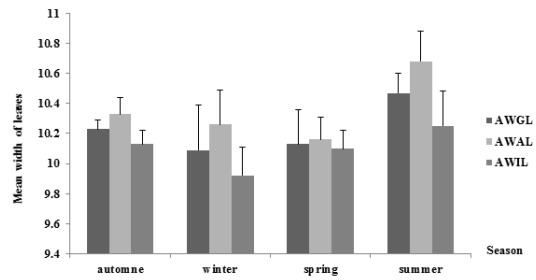

Figure 4: Seasonal variation in mean width of adult, intermediate and global leaves harvested from *Posidonia oceanica* rhizomes in the study site. AWGL : Average Width of Global Leaves ; AWAL : Average Width of Adult Leaves ; AWIL : Average Width of Intermediate Leaves.

3. Surface and leaf index area

The average leaf area and total leaf index vary throughout the year, with a maximum of 3,85 cm² / beam in april, ie 2,01 m² / m² and a minimum of 19,26 cm² / beam in december, ie 1,00 m² / m² (Table 11).

Our foliar index values of global leaves in cm^2 / per beam and m^2 are low compared to literature values found at equivalent depth and periods [25, 28, 41, 37, 18, and 20].

Table 11: Leaf area index Values (L.A.I) per shoot (in cm^2) and per m^2 of *Posidonia oceanica* bed as found in the literature, for different localities and depths.

Locality	Reference	Depth (m)	L.A.I (cm^2/shoot)	L.A.I (m^2. m^{-2})
Rachgoun island (Benisaf, Algeria)	**Present work**	**2-3**	**38,85 (April) M 19,26 (December) m**	**2,01 (April) M 1,00 (December) m**
Ain Franin (Oran, Algeria)	[20]	1-2	56,71 (May) **M** 28,28 (February) **m**	5,42 (May) **M** 2,71 (February) **m**
Cap Carbon (Arzew, Algeria)		2-3	41,44 (May) **M** 17,63 (February) **m**	3,43 (May) **M** 1,46 (February) **m**
Sidi Lakhdar (Mostaganem, Algeria)		1-2	61,71(April) **M** 29,06(August) **m**	6,51(April) **M** 3,07(August) **m**
Cap Carbon (Arzew, Algeria)	[19]	5	61,2(July) **M** 43,4(January) **m**	11,1(July) **M** 4,7(January) **m**
		10	138,1(July) **M** 58,5(September) **m**	3,9(July) **M** 2,8(September) **m**
Cap Carbon (Arzew, Algeria)	[18]	10	99(August) **M** 26,2(October) **m**	3,49 (August) **M** 0,92 (October) **m**

Ain Franin (Oran, Algeria)			90,63(August) **M** 27,13(January) **m**	3,65 (August) **M** 1,09 (January) **m**
Anse de Kouali, (Algeria)	[28]	2	396,00 (June) **M** 164,20 (Septembert) **m**	25,30 (June) **M** 10,50 (September) **m**
Banyuls-sur-Mer (Francce)	[25]	12	251 (July) **M** 72 (December) **m**	13,4 (July) **M** 3,9 (December) **m**
Port Cros (Var, France)		11	297 (July) **M** 133 (January) **m**	9,4 (July) **M** 4,2 (January) **m**
La Marcha (Algeria)	[22]	2	165,00 (July) **M** 69,40 (October) **m**	5,10 (July) **M** 2,90 (January) **m**
Banyuls-sur-Mer, (France)	[26]	2	73,00 (July) **M** 37,00 (December) **m**	8,50 (July) **M** 4,30 (December) **m**
Mondello, (Sicile, Italy)	[42]	2,5	314,58 (June) **M** 84,95 (April) **m**	20,64 (June) **M** 6,73 (August) **m**
Urla- Iskele (Turkey)	[26]	2	262,00 (June) **M** 130,00 (October) **m**	13,40 (June) **M** 6,70 (October) **m**
El Djamila (Algeria)	[41]	8	---------	18,7 **M** 9,5 **m**
Baie de La Revellata-Calvi (Corse, France)	[32]	10	---------	13,6 **M** 3,3 **m**
Ben Ghayadha (Tunisia)	[37]	8	190,0 (Summer)	15,3 (Summer)
Sidi Salem (Tunisia)		10	133,0 (Summer)	6,9 (Summer)
Cap Africa (Tunisia)		10	149,8 (Summer) **M** 114,9 (Winter) **m**	11,3 (Summer) **M** 9,1 (Winter) **m**
Corniche (Tunisia)		12	213,1 (Summer) **M** 98,1 (Winter) **m**	18,8 (Summer) **M** 8,9 (Winter) **m**

3.1. Leaf area of adult and intermediate leaves

The leaf area (cm^2 / rhizome) of the adult leaves and intermediate medium at the study site (Figure 5) follows the same seasonal pattern as those of the global leaves with maximum values observed in spring 38.85 (April) and minimum values recorded in autumn 19,26 (December).

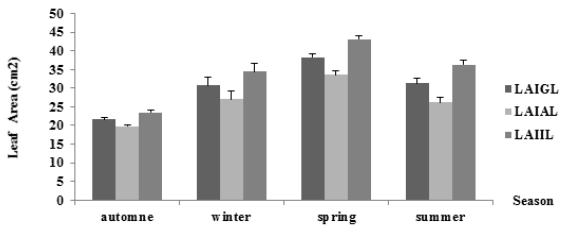

Figure 5: Seasonal evolution of the average surface area of adult, intermediate and global leaves harvested from *Posidonia oceanica* rhizomes in the study site. LAIGL: Leaf Area Inedx of Global Leaves ; LAIAL : Leaf Area Inedx of Adult Leaves ; LAIIL : Leaf Area Inedx of Intermediate Leaves.

3.2. Leaf Index Area (L.A.I)

The total Leaf Index Area expressed in m^2 / m^2 (adult and intermediate leaves) per beam varies significantly during the year in the same way as the leaf area with maximum values in spring 2,01 and values in autumn 1,00 (Figure 6).

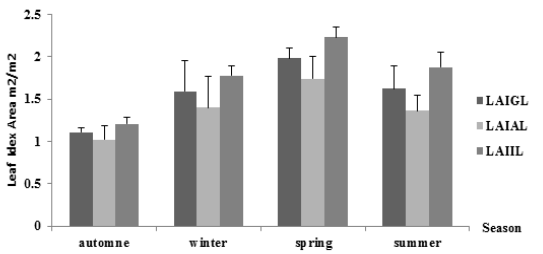

Figure 6: Seasonal trend of the average foliar index of adult, intermediate and global leaves harvested from *Posidonia oceanica* rhizomes in the studied site. LAIGL: Leaf Area Inedx of Global Leaves ; LAIAL : Leaf Area Inedx of Adult Leaves ; LAIIL : Leaf Area Inedx of Intermediate Leaves.

4. Coefficient «A» of the global leaves (Adult and intermediate)

The coefficient «**A**» of the total leaves corresponds to the percentage of intermediate and adult leaves that have lost their apex [43]. On the one hand, they result from the action of hydrodynamism [44, 45 and 46] and on the other hand from grazing by herbivores, in particular the sparid *Sarpa salpa* and the regular sea urchin *Paracentotus lividus* (consumer of epiphytic leaves in *Posidonia oceanica* [26, 47, 48].

The values of the overall coefficient «**A**» in figure 7 show that throughout our study period. The coefficient «**A**» varies with a minimum of 24, 31% in October and a maximum of 100% in January, February and April (Figure 7), this is explained by an epiphytic overlap that is important during this period [49], which leads to increased consumption by herbivores [50, 27, 18].Added to this the action of hydrodynamism [49; 44]. The maximum value of the coefficient « **A** » obtained in our study site is more important compared with the values obtained in the other regions of the Mediterranean basin (Table 12).

Table 12: Extreme values of the mean coefficient A of the global sheets (adult and intermediate) found in the literature (M: maximum, m: minimum).

Locality	Depth (m)	Coefficient «A» (%)	Reference
Rachgoun island (Benisaf, Algeria)	**2-3**	**100 (January, February and April) M 24,31 (October) m**	**Present work**
Ain Franin (Oran, Algeria)	1-2	67,96 (January) **M** 48,36 (May) **m**	[20]
Cap Carbon (Arzew, Algeria)	2-3	58,88 (May) **M** 40,98 (March) **m**	
Sidi Lakhdar (Mostaganem, Algeria)	1-2	53,39 (January) **M** 38,89 (March) **m**	
Cap Blanc (Oran, Algeria)	10	81,82 (July) **M** 40,37 (November) **m**	[19]
	5	72,45 (July) **M** 35,51 (November) **m**	
Cap Carbon (Arzew, Algeria)	10	82,09 (August) **M** 24,77 (February) **m**	[18]
Ain Franin (Oran, Algeria)		80,39 (August) **M** 7,37 (February) **m**	
Anse de Kouali (Algeria)	2	80,42(June) **M** 27,14 (December) **m**	[28]
Ben Ghayadha (Tunisia)	8	51,20 (Summer)	[37]
La Marcha (Algeria)	2	85,70 (July) **M** 60,10 (January) **m**	[22]
Banyuls-sur-Mer, (France)	2	91,5 (May) **M** 62,50 (November) **m**	[26]
Mondello (Sicile, Italy)	2	75,00(April) **M** 31,00 (October) **m**	[43]

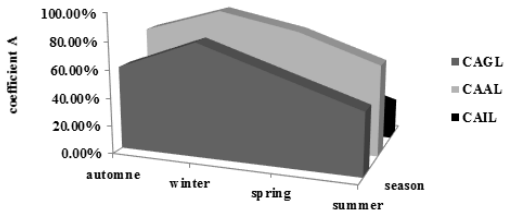

Figure 7: Seasonal evolution of the mean coefficient A of the adult, intermediate and global leaves harvested from *Posidonia oceanica* rice in the studied site. CAGL : Coefficient A of de Globl Leaves ; CAAL : Coefficient A of Adult Leaves ; CAIL : Coefficient A of Intermediate Leaves.

Conclusion

At the end of this work, the conclusions that emerge must be taken with caution given the number of stations studied (one station). The herbarium has an average density of 520 beams / m2 which corresponds to a dense herbarium. The mean values are similar to the values quoted in the literature. Because of its geographical location, the herbarium appears in good condition (protected area) , it will be interesting to follow its evolution and to compare it with a similar study in a site polluted by anthropogenic discharges.

In perspective it would also be interesting to make surveys in this site to ensure the absence or presence of invasive species such as Caulerpa racemosa, which tends to colonize disturbed ecosystems reflecting a reduction of the algal flora (Piazzi and Ceccherelli, 2006 [51] , Klein 2007 [52] , Klein et al., 2008 [53]). Since Caulerpa racemosa is part of invasive species, due to climate change and the adverse effects of pollution, in the Mediterranean basin (Boudouresque et Verlaque, 2002[54]).

It is important to note that the work undertaken at Rachgoun Island is considered preliminary given that no similar work has been undertaken on this site before.

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