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Study of the red algae growth *Gracilaria multipartita* (Clemente) Harvey (Rhodophyceae, Gracilariales) of the Moroccan Atlantic coast

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Abstract- The monitoring morphological changes of *G. multipartita* fronds during the study period, shows that the maximum growth was reached in June 2012. This summer form is characterized by large fronds with regular and abundant branches. After growth arrest during the summer, a new growth phase more or less pronounced depending on the year is observed in autumn. Fronds then degenerate to make room for new growth in January on perennial disk. The study indicates that it would be possible to exploit the species in June, before the fronds begin to degenerate.

Index Terms- *Gracilaria multipartita* - Thallus - Growth - Atlantic Coast - Morocco

I. Introduction

In Morocco, seaweed processing is one of the most dynamic of the operating and processing industry sectors seafood products. This industry ensures the strongest marine products and places Morocco in the 3rd place worldwide for the production of agar. This dynamism will result in the marketing of new products, such as "Quick Soluble Agar" or agaroses.

The genus *Gracilaria* represents 60% of the biomass treated in the world. The yield of agar of this kind is very important and can reach up to 40.7% (*G. asiatica*). It lends itself well to aquaculture (Perez, 1997). Aquaculture of *Gracilaria* in Chile has placed this country in the first world rank agar producers (Buschmann et al., 2001). *Gracilaria multipartita* (Clemente) Harvey is widespread in Morocco (Gayral, 1958; El Gourji, 1999; Benhyssoun et al, 2002). It presents a high-quality agar (Givernaud et al. 1999).

The present work focuses on the study of the development cycle of this species to determine good times to harvest in three study stations.

II. Materials and Methods

II.1. Collection stations

The study area is located along the Moroccan Atlantic coast, it is located between the coordinates 33 ° 25 'N and 32 ° 50'S. We selected three stations in this part of research: Lahdida (North of Azemmour), Moulay Abdellah and Sidi Abed (Figure 1).

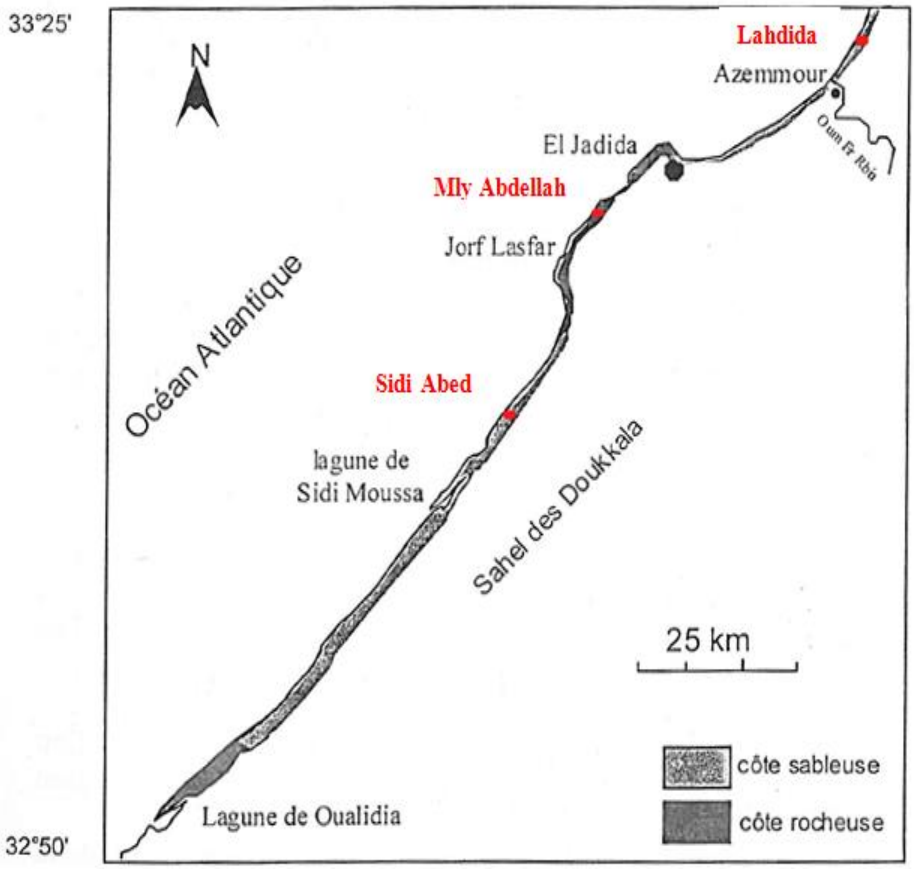


Figure 1: Geographical Aspects of the three study sites.

We chose these three stations among others for the following reasons:

- Stations number was limited to three for difficulties reasons of sampling.
- Stations were too separated to cover the entire coastline Doukkala-Abda.
- Lahdida station was chosen to evaluate the effect of silting caused by the Oued Om Er rbie mouth.
- Mly Abdellah station was chosen to evaluate the pollution effect by discharges of the phosphate complex Jorf Lasfar.
- Sidi Abed station was chosen as reference station by its distance from the pollution and algae raising activities intensively.

II.2. Material used

The red algae species concerned with the biological study is *Gracilaria multipartita*. This agarophyte has a flattened frond branched subdicotomiquement. The identification of *Gracilaria* is very confusing; It was confirmed by molecular analysis using the DNA sequence encoding the rRNA of the small subunit of the ribosome (18SrDNA) and by spacer of rubisco claimed the Coleman and Goff method (Benhissoune S. et al., 2002).

II.3. Methods

The harvest of the red algae species *Gracilaria multipartita* was carried out monthly in three geographically separated stations: Lahdida (North Azemmour), Moulay Abdellah and Sidi Abed. The parameters measurement considered in the biology evolution of the species studied was performed on 100 randomly fronds harvested in natural beds, and are:

- The frond length (cm), it was determined by measuring the frond length;
- The frond mass (g) was determined by weighing each frond using a balance with a precision gram;
- The total number of branches (RT) is counted for each thallus.

III. Results

III.1. Growth analysis of *Gracilaria multipartita*

III.1.1. Qualitative analysis of growth

The monitoring morphological changes fronds of *G. multipartita* during the study period, shows that the maximum growth was reached in June 2012. The monthly variation in growth during an annual cycle is described below:

- **June 2012**, the algae reach its maximum size. This summer form is characterized by large fronds with regular and abundant branches.
- **July 2012**, well developed thalli undergo apical usury which results in a loss of branches.
-**August-September 2012**, the fronds further decrease in size and have a damaged appearance due to the presence of necrosis points at different locations in fronds.

- **October 2012**, there is a growth resumption resulting in an increase in size. But branches number decreases and axes have a hail form.

-**November-December 2012**, thalli undergo partial degradation. First there was a fall ends of the branches that carry the cysts. Axes become weak and brittle due to intercropping necrosis and end by fragmenting under the action of waves. At the end of this period, the fronds are reduced to their fixing disk marking the end of the life cycle of the fronds.

- **January 2013**, the fronds grow from the attachment disk. The size thallus is reduced to less than 2 cm. The principal axes do not wear ramifications of second order and upright base is small and sparsely branched.

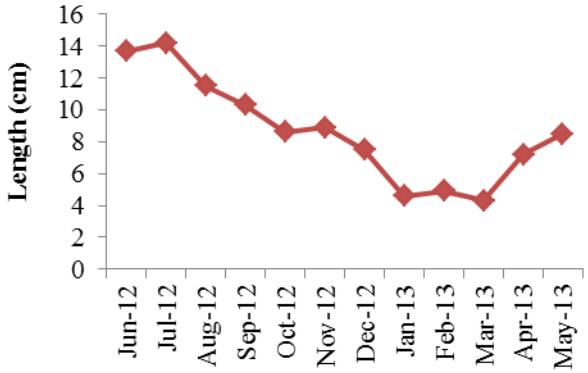
- **February-March 2013**, the algae has the winter characteristics form (reduced size, axes spindly, cylindrical and undeveloped branches).

- **April 2013**, the ramifications are flattening and widening. They become abundant and developed. Their ends are rounded and form acute angles with the main axis.

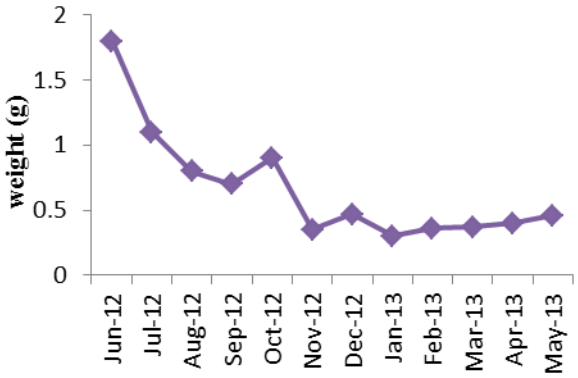
-**May 2013**, the thalli are flattened and the ramifications are abundant and developed. Apical growth is maximum and gives supple and long axes.

III.1.2. Quantitative growth analysis

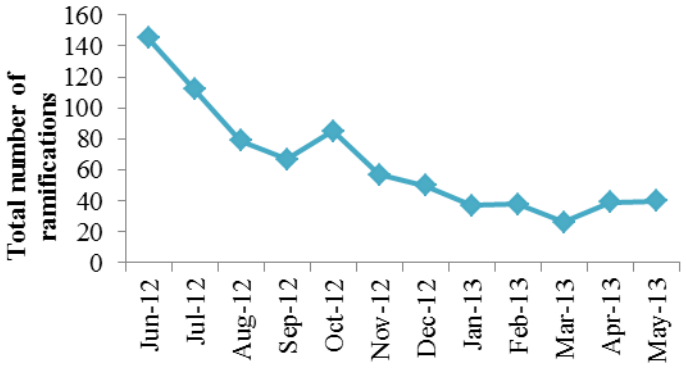
III.1.2.1. in Moulay Abdellah station



a) Average length of fronds



b) Average weight of thalli



c) Average Number of ramifications

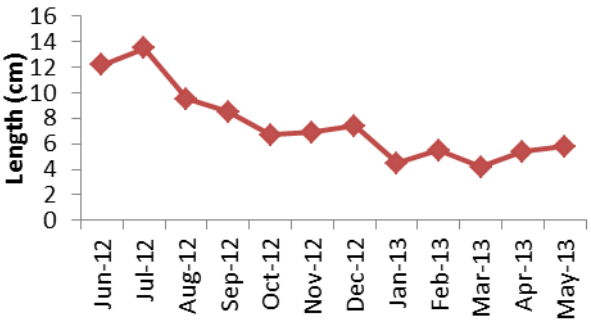
Figure 2: Seasonal variation of the average length, the average weight of thalli, and the average total number of ramifications of *G. multipartita* collected at Moulay Abdellah during an annual cycle.

- **Average length of fronds:** July shows the best thalli length (Figure 2a). Periods of high growth in length are recorded from March to July (with a maximum of 14.2 cm in July) and in September (with a maximum of 10.3 cm). The shorter lengths were recorded in winter, with a minimum of 4.3 cm during the months from January to March.

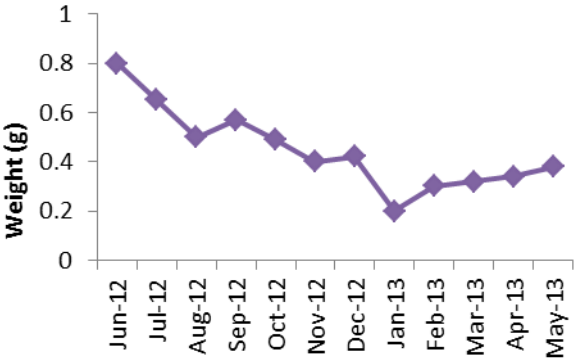
- **Average weight of thalli:** Thalli weight varied from a seasonally (Figure 2b). The low growth in winter, undergoes a slight increase between March and May, and becomes significant from May to a maximum of 1.8 g in June. After a decrease in weight during the summer a second smaller growth peak is recorded in October (0.9 g / individual). Thereafter, the thalli weight decreases to a minimum of 0.3 g / individual in January.

- **Analysis of the average number of ramifications:** The variation curve of the total number of ramifications follows a comparable weight thalli evolution (Figure. 2c). The average number of ramifications is minimal between January and March. It increases slightly between March and May, then becomes more important from May to reach the maximum in June (145 branches per individual), then declines thereafter to reach a minimum of 50 branches per individual in December.

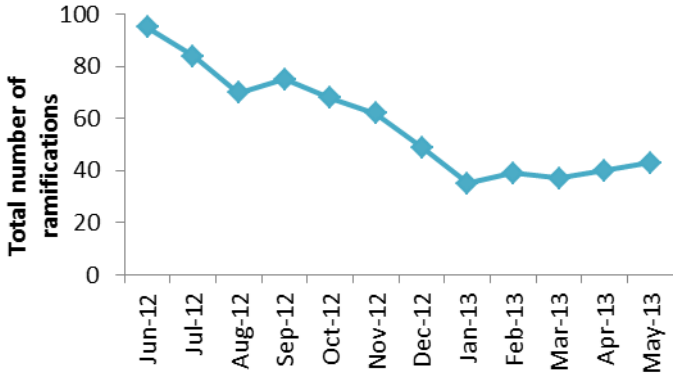
III.1.2.2. in Lahdida station



a) Average length of fronds



b) Average weight of thalli



c) Average Number of ramifications

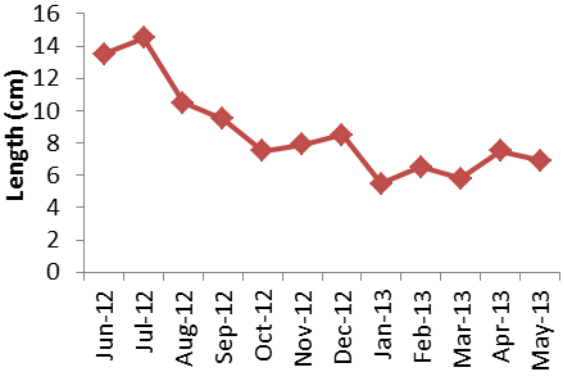
Figure 3: Seasonal variation of the average length, the average weight of thalli, and the average total number of ramifications of *G. multipartita* collected at Lahdida during an annual cycle.

- **Average length of fronds:** We note that July has very good growth in length. Periods of high growth in length (Figure 3a) are recorded from March to July (with a maximum of 14.2 cm in July) and September (with a maximum of 8.5 cm). The shorter lengths were recorded in winter with a minimum of 4.5 cm in the months from January to March.

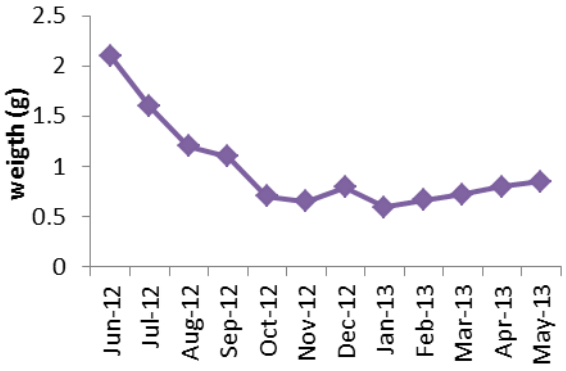
- **Average weight of thalli:** The weight growth undergoes a slight increase between March and May and becomes important from May to a maximum of 0.8 g in June (Figure 3b). After a weight decrease during the summer, a second smaller growth peak is recorded in September (0.57 g / individual). Thereafter, the thalli weight decreases to a minimum of 0.2 g / individual in January.

- **Analysis of the average number of ramifications:** The average number of ramifications is minimal between January and March (Figure 3c). It increases slightly between March and May and becomes more important from May to reach the maximum in June (95 ramifications per individual) and declines thereafter to reach a minimum of 49 ramifications per individual in December.

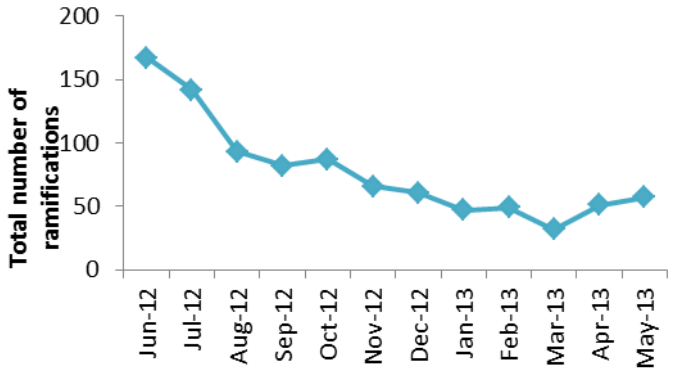
III.1.2.3. in Sidi Abed station



a) Average length of fronds

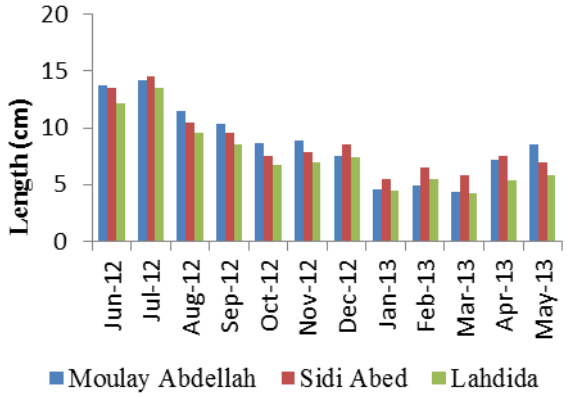


b) Average weight of thalli

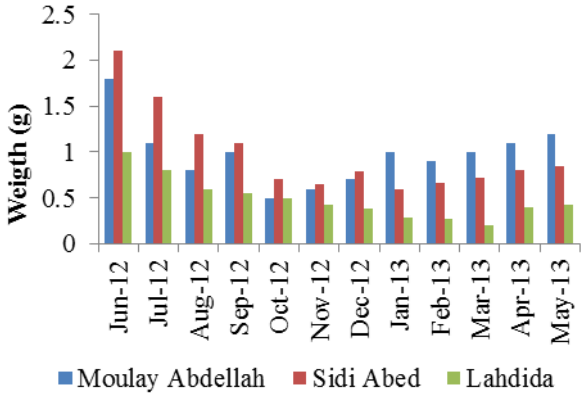


c) Average Number of ramifications

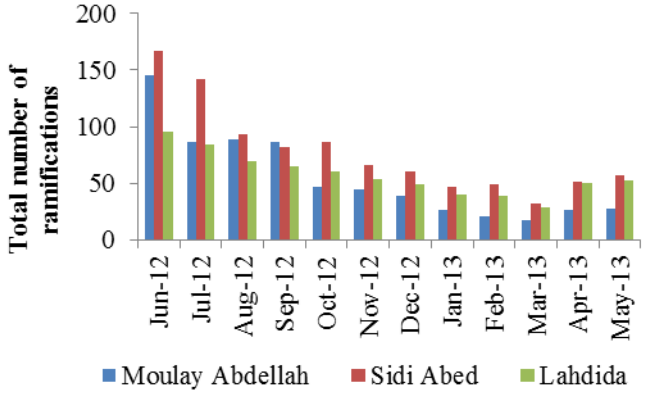
Figure 4: Seasonal variation of the average length, the average weight of thalli, and the average total number of ramifications of *G. multipartita* collected at Sidi Abed during an annual cycle.



a) Average length of fronds



b) Average weight of thalli



c) Average Number of ramifications

Figure 5: Seasonal variation of the average length, the average weight of thalli, and the average total number of ramifications of *G. multipartita* collected at three stations during an annual cycle.

- **Average length of fronds:** The best time for growth in optimum length recognized in the three stations was during June-July 2012 (with a maximum in July) (Figure 5a). During the winter, there was a decrease in average length to reach minimum

- **Average length of fronds:** Seasonal variation in the length of fronds shows that July had the best growth in length (Figure 4a). From March to July, there was a significant increase in length (with a maximum of 13.5 cm in July) and in September (8.5 cm). The winter period is characterized by the lowest lengths (4.5 cm in January).

- **Average weight of thalli:** Seasonal changes in weight of *G.multipartita* thalli shows that weight increases slightly between March and May and reaches its maximum in June (0.8 g). Then, it decreases to a minimum in January (0.2 g), (Figure 9b).

- **Analysis of the average number of ramifications:** The average number of branches is low between January and March (Figure 4c). Then increases slightly to reach its maximum in June (95 ramifications per individual). The winter period is characterized by a decrease in the average total number of ramifications to reach its minimum in January (35 ramifications per individual).

III.1.2.4. Comparisons between three stations

sizes between January and March. From this latter, there is length regeneration in the three study stations.

- **Average weight of thalli:** The evolution curve of the average weight of *G. multipartita* thalli shows a weight increase from March, peaking in June in three stations (Figure 5b). Then, the length parameter decreases during the winter to reach the minimum during the period between January and March.

- **Analysis of the average number of ramifications:** For the evolution of the average total number of ramifications, we note that the richest ramifications period began from April to July (maximum in June), and then decreases to a minimum during the period between January and March. Then, we note a slight increase from March to May (Figure 5c).

IV. Discussion

The species *G. multipartita* has low growth in winter and active growth in spring-summer and lightweight in autumn, similar results concerning growth periods were obtained by (Engel-RC Palmiter, 2000). From September to October fronds become fragmented and disappear and in winter the individuals are in disc form. Pondevida et al. (1996) showed that *G. cervicornis* biomass in Brazil has a maximum growth during the summer and a minimum in winter. The same results were

observed by Luhan MRJ (1996) for *G. heteroclada* and *G. baillinae*. Lee T. M., et al. (1999) distinguished in *G. tenusitipitata* a summer form with developed thalli and a very small in winter. Molloy F. J. and J. Bolton J. (1996) showed that the biomass production of *Gracilaria* species is higher in summer than in winter and attributed this difference to the significant increase in summer light intensity. The growth cycle study of *G. multipartita* shows that it is similar to that of other species also present in the study site; *Gelidium sesquipedale* (Hassani L. M. 2000), *Hypnea musciformis* (Chikhaoui M., 2001) et *Gigartina pistillata* (Amimi A., 2002). Similar results for the species *G. gracilis* growth period in the Cap Gris-Nez (France) region are indicated by (Engel-RC Palmiter, 2000). From September to October, the fronds become fragmented and disappear. Individuals then pass the winter in the disk form. During the year, the available light energy, which is considered the main factor responsible for photosynthesis, is also subject to seasonal variations. During the year, the available light energy, which is considered the main factor responsible for photosynthesis, is also subject to seasonal variations. According Friedlander M., et al. (1987), the growth rate is highly dependent on the temperature for *G. tikvahiae* and after (Lapointe B.E., 1981) according (Lapointe BE, 1981), the *G. multipartita* growth is dependent on light intensity. This light effect was also observed in *G. verrucosa* (Whyte J.N.C. et al., 1981).

V. Conclusion

The *G.multipartita* growth cycle is similar to that of *G. sesquipedale*, Best growth phase *G. multipartita is* recorded at the end of June-July (maximum growth). The exploitation of this species should be carried from this moment with a harvest period reduced at two months maximum to allow the algae grow in autumn. It is important to avoid, for this species, management errors encountered during the operation of *G. sesquipedale*. It must, in particular, respect the disk fixing the species is thalli perennial part ensuring the production of new fronds each year. The exploitation should be accompanied by populations monitoring to evolve the regulations depending on the natural resource response for both red algae (*G.multipartita* and *G.sesquipedale* species).

Thankful

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