Proceedings of the Fourth International Coral Reef Symposium, Manila, 1981, Vol. 2

LIGHT-DEPENDENT GROWTH FORMS OF *CAULERPA URVILLIANA* MONTAGNE IN THE LAGOON OF THE ATOLL OF TAKAPOTO (FRENCH POLYNESIA)

Jean Jaubert

Université de Nice: UER/ Institut Polytechnique Méditerranéen, Laboratoire de Biologie et d'Ecologie Marines, Parc Valrose, 06034 Nice Cedex (France) and Antenne du Muséum et des Hautes Etudes — Station de Moorea, Polynésie Francaise.

Alexandre Meinesz

Université de Nice: UER/ Institut Polytechnique Méditerranéen, Laboratoire de Biologie et d'Ecologie Marines, Parc Valrose, 06034 Nice Cedex (France).

ABSTRACT

Caulerpa urvilliana is one of the most frequent algae found in the lagoon of Takapoto. This species grows from the surface to a depth of 30 m; it exhibits several different growth forms. In high light intensity habitats, specimens are characterized by a high density of short fronds while those which live in the deep carry long and scattered fronds.

Biometric study and light measurements (quantum flux in the 400-700 nanometers wavelength interval) allowed us to outline the predominant role played by light.

Similar adaptations have been previously described with *C. racemosa* and also with several species of scleractinian corals.

INTRODUCTION

Caulerpa urvilliana Montagne is widely distributed in all tropical and pantropical regions of the Pacific Ocean. It is especially frequent in the lagoons and on the outer slope of the coral reefs of the Marshall archipelago: Taylor (1950), Dawson (1956, 1957); of the Caroline Islands: Trono (1968) and of the Tuamotu archipelago: Weber van Bosse (1910), Denizot (1967), Meinesz, Jaubert and Denizot (1981).

In the atoll of Takapoto (Tuamotu archipelago) the above alga is frequent in the lagoon, from the surface to a depth of 30 m. This wide vertical range of distribution is characterized by the presence of several different growth forms (Figs. 4, 5 and 6). Taylor (1950) noticed the above phenomenon and described 3 aspects of thalli sampled at different depths in the atoll of Bikini.

The atoll of Takapoto is slightly raised and its lagoon is almost closed in. Thus water movements are reduced and the shape variations of *C. urvilliana* seem to depend essentially on the light intensity.

The aim of the present work was to try to point out the predominant role played by the above factor by studying the variations of the biometric characters of the algae according to the variations of irradiance.

METHODS

SAMPLING

Specimens of *Caulerpa urvilliana* were sampled at different depths from the surface to 27 m, along 2 transects located on the slope of 2 coral patches in the center of the lagoon.

CHOICE OF THE BIOMETRIC CHARACTERS

The overhauling of a number of different growth forms led us to choose 2 characters which exhibit the most marked variations: one is the length of fronds and the other is the number of fronds per meter of stolon.

LIGHT MEASUREMENTS

Two series of light measurements were made along the slope of the coral patches from the surface to the maximum depth where the *Caulerpa* was found. The equipment we used was a watertight and self-acting light integrator (designed by Jaubert) equipped with a cosine corrected sensor, producing a photovoltaic current directly proportional to the quantum flux within the 400 to 700 nanometers wavelength interval. Light measurements and sampling were undertaken by SCUBA diving.

RESULTS AND DISCUSSION

LIGHT MEASUREMENTS

Figure 1 shows the irradiance variations according to depth. The average curve is computed from 2 meters of stolon. The data are listed in Table 2. The the data we give are percent of the subsurface irradiance.

BIOMETRIC MEASUREMENTS

For each station the average length of fronds and number of fronds per meter of stolon have been computed from several thalli representing more than 2 m of stolon. The data are listed in Table 2. The length of fronds varies from 30 mm (shallow-water specimens) to 112 mm (deepwater specimens). Since the variation is inversely proportional to the light, we found it more convenient to consider a directly proportional relation between the above factors. Thus, we decided to compute the shortening of the fronds (x %) as following:

$$x = \frac{(L - l)\ 100}{L}$$

where L is the average maximum length of the fronds (112 mm) and l the average length of the fronds of the considered specimen.

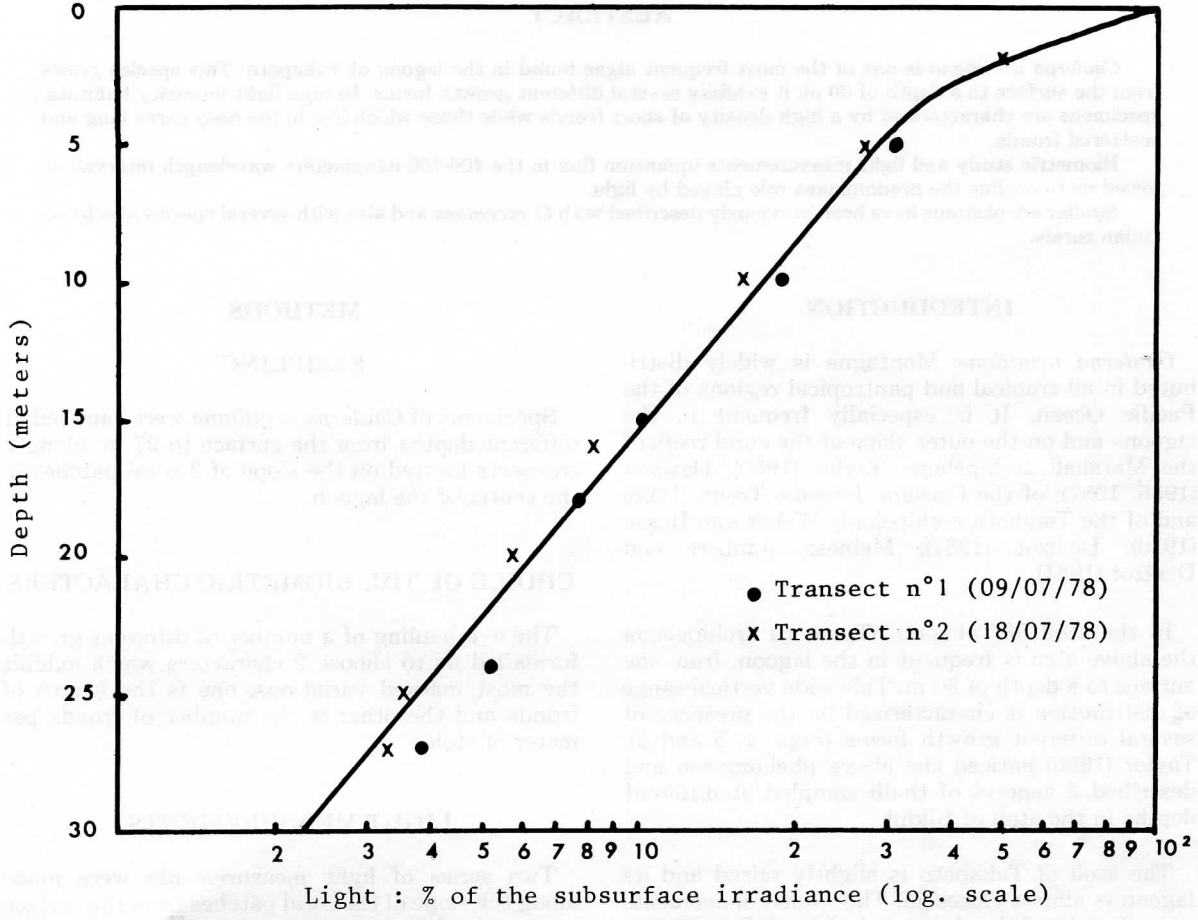


Figure 1. Light variations according to depth.

Table 1. Light measurements along the transects where the different growth forms of *C. urvilliana* were sampled.

Depth (meters):	0	2	5	10	15	16	18	20	24	25	27
Transect 1 (light):	100	—	31.5	19.4	10.3	—	7.8	—	5.4	—	3.6
Transect 2 (light):	100	50.5	27.6	16.2	—	8.3	—	5.8	—	3.6	3.3

Table 2. Table of measured parameters (depth, average length of fronds and number of fronds per meter of stolon) and computed data (light and shortening of the fronds).

	Transect n°1						Transect n°2				
Depth (meters):	1	5	12	19	25	28	5	10	16	20	25
Light (% of sub-surface irradiance):	70	29	14.5	7.4	4	3	20	18	9.8	6.6	4
Average length of fronds (mm):	35	37	38	48	80	75	30	44	51	67	112
Shortening of fronds (% of the 112mm spec.):	69	67	66	57	29	33	73	61	54	40	0
Average number of fronds per meter:	96	74	66	47	27	35	105	71	59	56	35

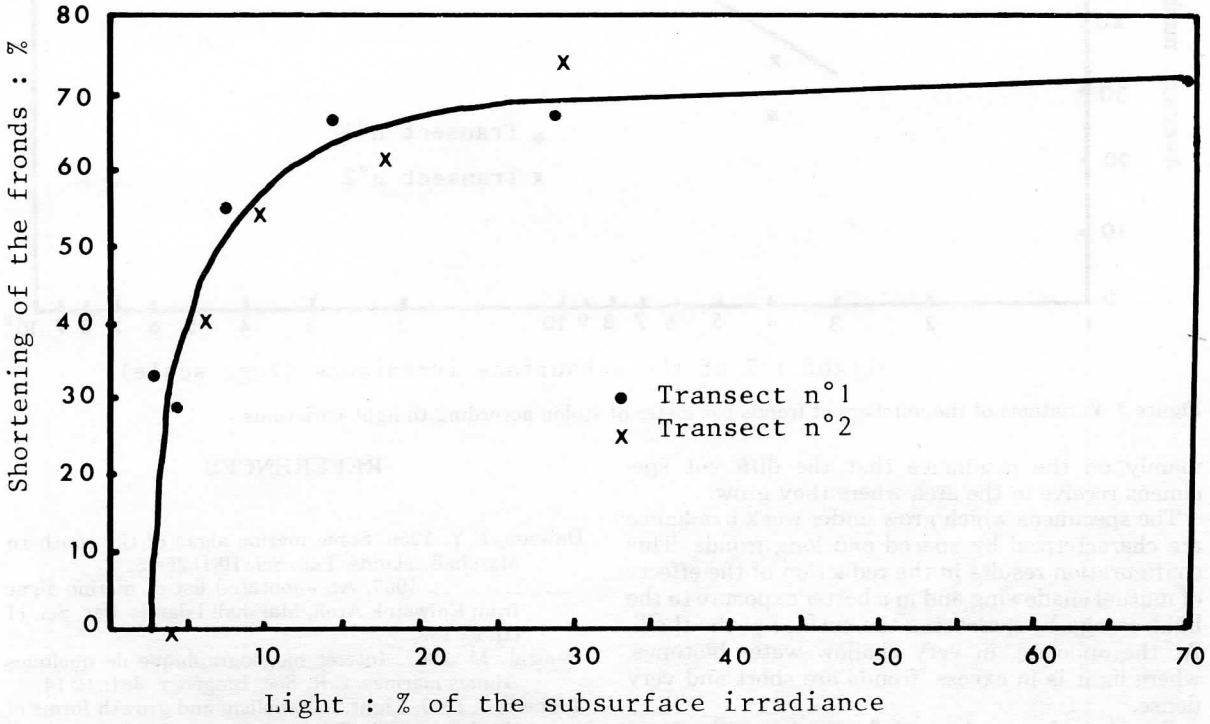


Figure 2. Shortening of the fronds of *C. urvilliana* according to light variations.

Figure 2 shows the variations of the shortening of the fronds. The length of the fronds is maximum at the lower limit of the biotope of the algae. At the beginning, the length of the fronds decreases very fast when irradiance increases; then, from an irradiance of about 12% of the subsurface irradiance, the shortening becomes very slow.

Figure 3 shows the variations of the average number of fronds per meter of stolon. We consider that the upper point is abnormal (105 fronds per meter for an irradiance of only 12%). Thus, if we disregard it, the most probable curve is a straight line. Since the light scale is a log scale, this means that the variation of the number of fronds per meter of stolon is of an exponential type. However, such a simple mathematic relation needs to be confirmed from a more significant number of measurements.

CONCLUSION

In the sheltered waters of the lagoon of Takapoto, the shape variations of *Caulerpa urvilliana* depend

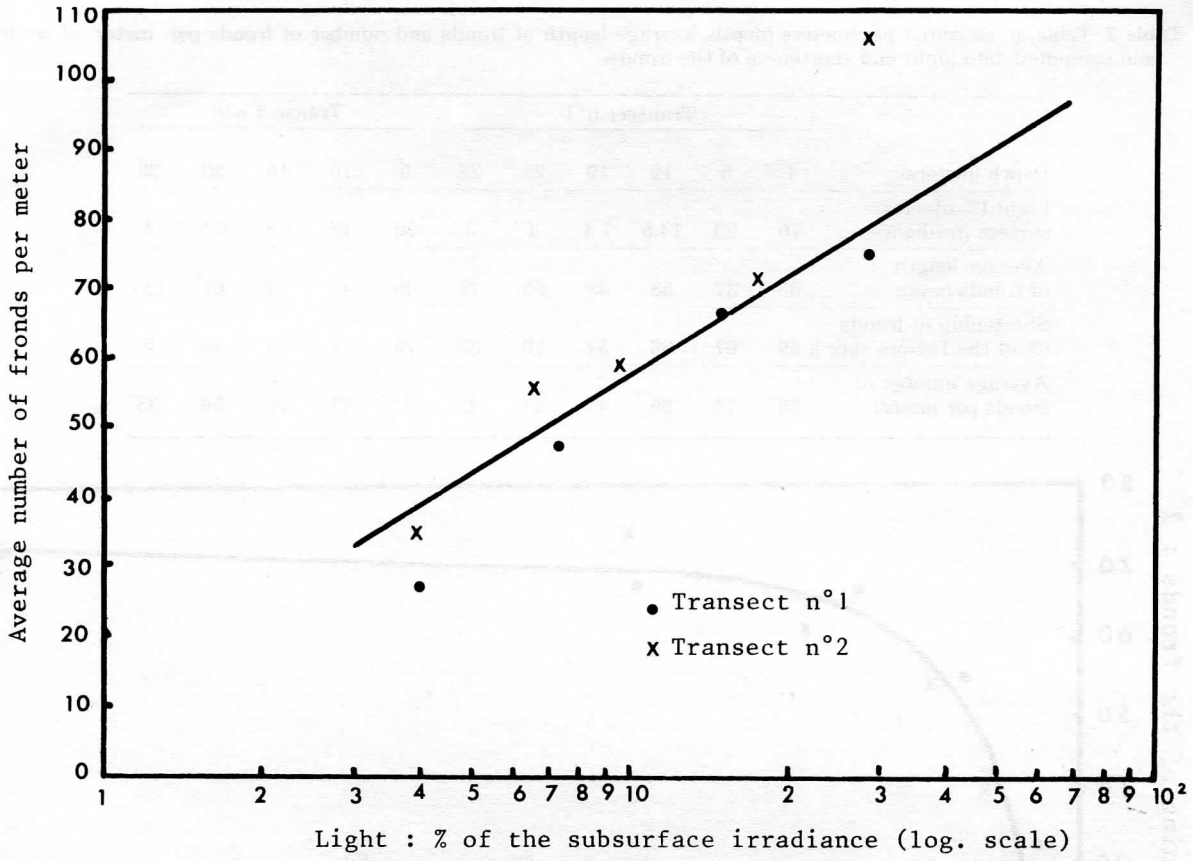


Figure 3. Variations of the numbers of fronds per meter of stolon according to light variations.

mainly on the irradiance that the different specimens receive in the area where they grow.

The specimens which grow under weak irradiance are characterized by spaced and long fronds. This configuration results in the reduction of the effects of mutual shadowing and in a better exposure to the light energy by increasing the surface of the thalli. At the opposite, in very shallow water biotopes, where light is in excess, fronds are short and very dense.

Certain scleractinian corals, such as *Synaraea convexa* Verrill (Jaubert 1977 and 1981) show similar adaptation mechanisms.

ACKNOWLEDGEMENTS

This paper represents a contribution to the programme "Action concertée D.G.R.S.T.: Ecologie et économie des récifs coralliens en Polynésie Française".

Logistic support was supplied by the "Service de la Pêche de Takapoto". Thanks are expressed to M. Abel Hauti for his kind technical assistance.

REFERENCES

Dawson, E.Y. 1956. Some marine algae of the southern Marshall Islands. Pac. Sci. 10(1):25-66.

_____. 1957. An annotated list of marine algae from Eniwetok Atoll, Marshall Islands. Pac. Sci. 11 (1): 92-132.

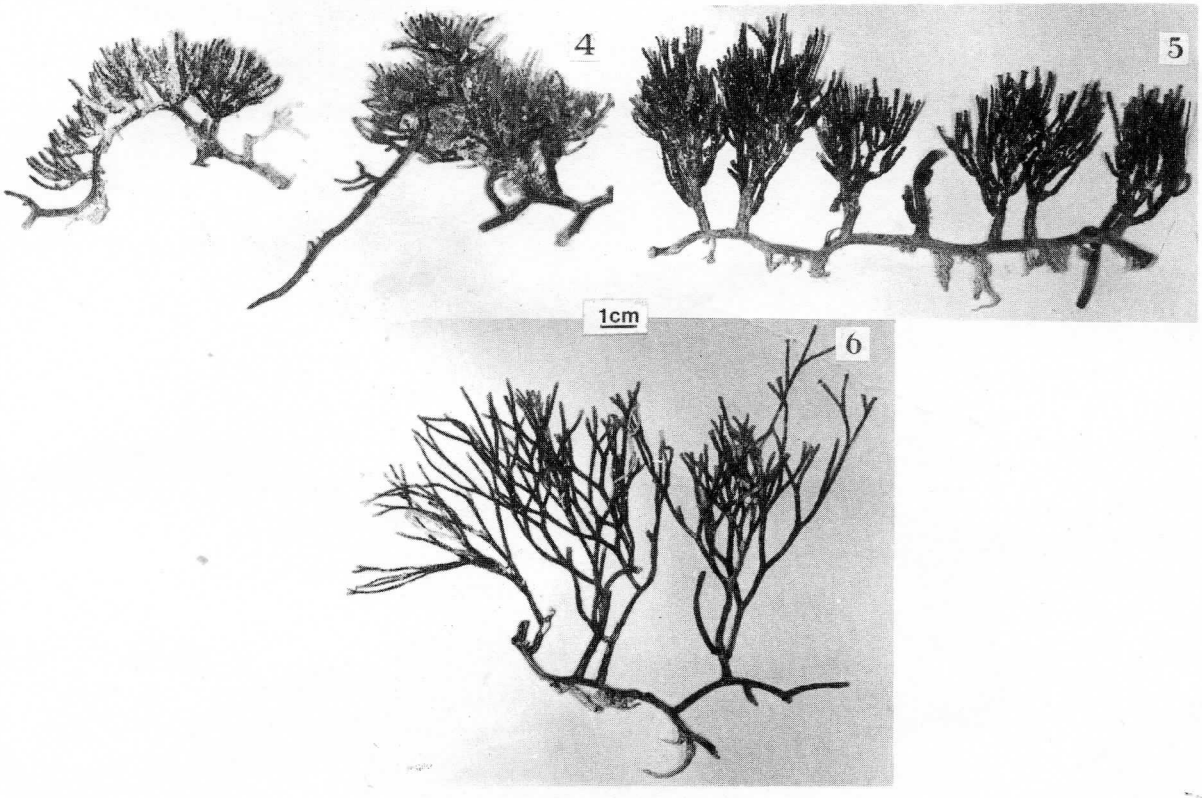
Denizot, M. 1967. Intérêt biogéographique de quelques Algues marines. C.R. Soc. Biogéogr. 381: 10-14.

Jaubert, J. 1977. Light, metabolism and growth forms of the hermatypic Scleractinian coral *Synaraea convexa* Verrill in the lagoon of Morea (French Polynesia). Proc. 3rd Int. Coral Reef Symp. 1: 483-488.

_____. 1981. Variations of the shape and of the chlorophyll concentration of the scleractinian coral *Synaraea convexa* Verril: two complementary processes to adapt to light variations. Proc. 4th Int. Coral Reef Symp. 2:55-58.

Meinesz, A., J. Jaubert and M. Denizot. 1981. Distribution of the algae belonging to the genus *Caulerpa* in the French Polynesia (Atoll of Takapoto and Island of Moorea). Proc. 4th Coral Reef Symp. 2:431-437.

Taylor, W.R. 1950. Plants of Bikini and other Northern Marshall Islands. Univ. Michigan Press, Ann Arbor: 227 p.



Figures 4-6. *Caulerpa urvilliana,* 1 m **(4),** 15 m **(5),** and 25 m **(6).**

Trono, G.C. 1968. The marine benthic algae of the Caroline Islands, I. Introduction, Chlorophyta and Cyanophyta. Micronesica 4(2):137-206.

Weber van Bosse, A. 1910. Note sur les *Caulerpa* de l'île Tahiti et sur un nouveau *Caulerpa* de la Nouvelle-Hollande. Ann. Inst. Océanogr. Monaco 2(1):1-8, pls. 1-2.