

**TAXONOMY AND DISTRIBUTION OF THE GENUS *HALIMEDA*  
(CHLOROPHYTA, CAULERPALES) IN FRENCH POLYNESIA**

**TAXONOMIE ET REPARTITION DU GENRE *HALIMEDA*  
(CHLOROPHYTES, CAULERPALES) EN POLYNÉSIE FRANÇAISE**

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EPHE en Polynésie française, B.P. 12, MOOREA, POLYNÉSIE FRANÇAISE

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**ABSTRACT**

During several field trips in French Polynesia, ten species of algae belonging to the genus Halimeda (Caulerpales, Udotaceae) were found: Halimeda discoidea, H. gracilis\*, H. incrassata f. incrassata, H. incrassata f. ovata, H. lacunalis\*, H. macroloba, H. micronesica\*, H. minima\*, H. opuntia, H. simulans, H. taenicola. Four of them (\*) were found for the first time in this region of the South Pacific.

The description and distribution of all these taxa is given. The distribution of these Halimeda in French Polynesia shows marked differences in vegetation from one island to another.

**RESUME**

Au cours de plusieurs missions en Polynésie française, dix espèces d'algues appartenant au genre Halimeda (Caulerpales, Udotacées) ont été récoltées: Halimeda discoidea, H. gracilis\*, H. incrassata f. incrassata, H. incrassata f. ovata, H. lacunalis\*, H. macroloba, H. micronesica\*, H. minima\*, H. opuntia, H. simulans, H. taenicola. Parmi ces espèces, quatre (\*) ont été trouvées pour la première fois dans cette région du Pacifique.

La description et la distribution géographique et bathymétrique de ces Halimeda est donnée. Les auteurs ont constaté de grandes différences dans la répartition des Halimeda dans les îles ou atoll explorés.

## INTRODUCTION

The genus Halimeda (Udoteaceae, Caulerpales), includes 31 species, which are widely distributed in all warm seas. This calcareous Chlorophyceae participates in reef building and is known to be one of the major constituents of many tropical atoll deposits. In French Polynesia we have listed from the available bibliographic data (Payri and Meinesz 1985) many references of undetermined Halimeda and of the 8 following species collected by different authors : H. discoidea Decaisne (= H. lessonii Bory ex Chauvin), H. incrassata (Ellis) Lamouroux = H. tridens (Ellis and Solander) Lamouroux, H. incrassata f. ovata J. Agardh, H. macroloba Decaisne, H. opuntia (Linnaeus) Lamouroux, H. simulans Howe, H. stuposa Taylor, H. taenicola Taylor, H. tuna (Ellis and Solander) Lamouroux and H. tuna f. platidisca (= H. platidisca Decaisne). But some of the above determinations seem to us doubtful : H. stuposa, H. tuna listed in Polynesia only once and H. tuna f. platidisca (= H. platidisca) found only by Montagne in 1845.

After many field trips in French Polynesia we have completed the inventory of Halimeda, better defined their biotopes and their local biogeography, and pointed out some morphological and anatomical variation of known characteristics of some taxa.

## METHODS

The species were sampled in different islands or atolls of French Polynesia between 1978 and 1984. Most of our survey was made by scuba diving or snorkeling. The identification of the species was based on the external morphology and on microscopic characters, relating to the taxonomy as in Hillis-Colinvaux's monographs on Halimeda (Hillis, 1959; Hillis-Colinvaux, 1980).

Herbarium and formalin-preserved specimens of the Halimeda listed here are deposited in the "Antenne du museum EPHE" at Moorea (French Polynesia) and in the "Laboratoire de Biologie et d'Ecologie Marines" of the University of Nice (France).

## RESULTS

We found a total of 10 species and one form of Halimeda. For each of these taxa we give its morphological and anatomical description, the characteristics of its biotope and the location of the collected specimens. For each taxa we give also the references of the authors who mentioned it before us in French Polynesia.

### Halimeda discoidea Decaisne

Ref. : Hillis-Colinvaux (1980 p.136-139).

Mentioned from French Polynesia by Setchell (1926a) from Tahiti, Hillis (1959) - rec. Setchell and Seurat in "Society Islands", Moul (1964) from Rarotonga and Payri (1982) from Moorea. Hillis (1959) placed in synonymy with H. discoidea an endemic species, H. lessonii, described from Society islands only by Chauvin (1842).

Description : Fig. 1, 5, 9, 35 and 36.

Specimens examined from : Atoll of Mataiva (Tuamotu): in the lagoon and on the outer slope between 0 and -1 m depth (rec. Payri); Atoll of Takapoto (Tuamotu): on the outer slope between -5 m and -20 m (rec. Meinesz); Island of Makatea (Tuamotu): on the reef between 0 and -1m (rec. Payri); Island of Moorea (Société): outer slope -1m at Tiahura (rec. Meinesz), reef of Temae -1m (rec. Payri) and on sand at Papetoai at -20m (rec. Meinesz); Island of Tahiti (Société): on the NW reef of the island at -3m (rec. Payri); Gambier (rec. Salvat).

This is the most common species of Halimeda in Polynesia. It grows on dead corals either on shallows where the flow is strong (between -1 m and -2 m on reef flats or barrier reefs) or on the outer slope of the reefs between -5 m and -25 m. We have found some specimens growing deep (-25 m) on sand with a small bulbous holdfast (Fig. 35). This species lives mostly in dead coral cavities and is frequently grazed by fishes.

### Halimeda gracilis Harvey ex J. Agardh

Ref. : Hillis-Colinvaux (1980 p.144-147).

Description : Fig. 2, 6, 10 and 37.

First record in French Polynesia. Specimens examined from : Island of Makatea (Tuamotu): outer slope -15 m (rec. Payri).

We have found this species in reproduction in April 1982.

### Halimeda incrassata (Ellis) Lamouroux

Ref. : Hillis-Colinvaux (1980 p.93-96).

Mentioned from French Polynesia by Barton (1901) from Nukuhiva, Rangiroa and Fakarava, by Hillis (1959) rec. Setchell and Parks (as H. simulans) - from Société islands, by Meinesz (1980) from Moorea and by Payri and Naim (1982) from Moorea.

Description : Fig. 3, 7, 11, 41 and 42.

Specimens sampled and examined from : Island of Moorea (Société): reef flat of Tiahura between 0 and -1m (rec. Meinesz. Payri). Pass of Hitia -50 cm (rec. Payri); Island of Tahiti (Société): barrier reef of Maeva -1 m (rec. Payri).

Less common than the form ovata this species grows on sand or on coral debris.

### Halimeda incrassata f. ovata J. Agardh

Ref. : J. Agardh (1886 - 1887). Barton (1901).

Mentioned from French Polynesia by J. Agardh (1887) from Nukuhiva (Marquesas: type locality), by Setchell (1926a) from Tahiti as H. tridens f. ovata (J. Agardh) Howe, and Hillis (1959) rec. Crossland (as H. tridens var. ovata) from Marquesas.

Description : Fig. 4, 8, 12, 38, 39 and 40.

Specimens examined from : Island of Moorea (Société): on the fringing reef of Tiahura between 0 and -1 m (rec. Meinesz. Payri), on the Pass of Papetoai at -20 m (rec. Meinesz) on the channel of Papetoai between -7 m and -15 m (rec. Meinesz); island of Tahiti (Société): fringing reef of Beach Comber -1 m

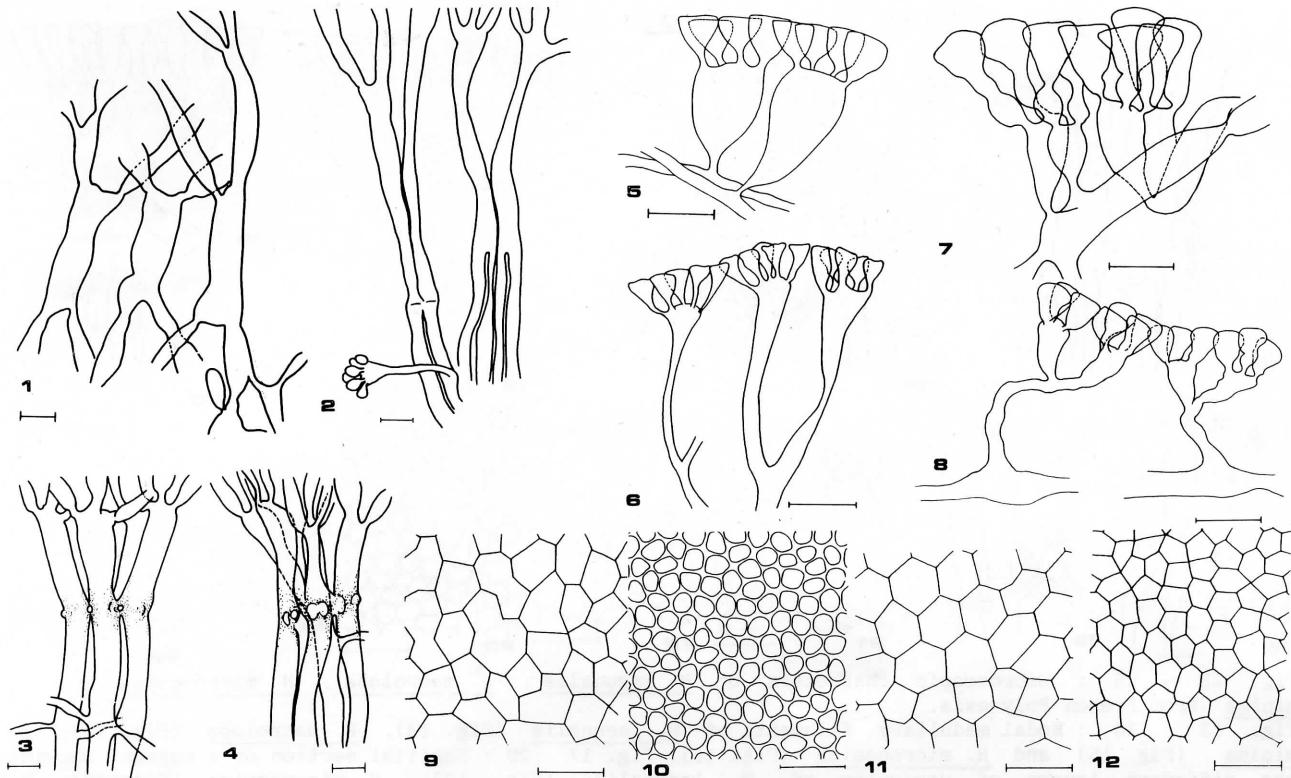


Fig. 1 - 12 : Microscopic characters of H. discoidea, H. gracilis, H. incrassata and H. incrassata f. ovata from French Polynesia.

Fig. 1 - 4 : Nodal medullary filaments of H. discoidea (Fig. 1), H. gracilis (Fig. 2), H. incrassata (Fig. 3) and H. incrassata f. ovata (Fig. 4). Fig. 5 - 8 : Sagittal section of a segment showing the different layers of utricles of H. discoidea (Fig. 5), H. gracilis (Fig. 6), H. incrassata (Fig. 7) and H. incrassata var. ovata (Fig. 8). Fig. 9 - 12: Surface view of the peripheral utricles of H. discoidea (Fig. 9), H. gracilis (Fig. 10), H. incrassata (Fig. 11) and H. incrassata var. ovata (Fig. 12). Scale = 0.1 mm.

(rec. Payri).

This species is very common species at Moorea in shallows of the fringing reef where it can form very dense and wide (between 1 and 3 m<sup>2</sup>) patches on muddy sand. On the deeper sandy bottoms of passes or channels the assimilators are further apart. This form, described for the first time from Polynesia by J. Agardh, is easily distinguishable from the typical one by anatomical characters. The diameter of the first utricles are smaller : 45 µm to 55 µm against 60 µm to 120 µm for the typical form. We have frequently found this species in reproduction : December 1980 and 1981 (rec. Payri) and August 1978 (rec. Meinesz). The anisogamous gametes of these species were described by Meinesz (1980).

#### Halimeda lacunalis Taylor (f. lacunalis Taylor)

Ref. : Taylor (1950). Hillis-Colinvaux (1980 p. 129 132).

Description : 13, 17, 21 and 43.

First record from French Polynesia. Specimens examined from : Island of Makatea (Tuamotu): outer slope -15 m (rec. Payri).

This species grows on corals in shaded overhangs.

#### Halimeda macroloba Decaisne

Ref. : Hillis-Colinvaux (1980 p. 108-110)

Mentioned from French Polynesia by Setchell (1926a) from Tahiti, by Seurat (1934) from Aukena and Mangareva, by Hillis (1959) - rec. Crossland from Société Islands, by Naim (1980a) from Moorea and by Naim and Amoureaux (1982) from Moorea.

Description: Fig. 14, 19, 22, 23, 44 and 45.

Specimens examined from : Island of Tahiti (Société): fringing reef of Beach Comber, Faaa, Taone, and Maeva beach, on sand between 1 m and -3 m (rec. Payri).

This species is frequent at Tahiti on bottoms of muddy sand near fresh water discharges on the reef. We have not found it on similar biotopes at the Island of Moorea (The specimens of H. macroloba listed from Moorea by Naim (1980a) and Naim and Amoureaux (1982) are H. discoidea).

#### Halimeda micronesica Yamada

Ref. : Yamada (1941), Hillis-Colinvaux (1980 p. 149 151)

Description : Fig. 16, 18, 24 and 46.

First record from French Polynesia. Specimens examined from : Island of Makatea (Tuamotu): from the algal ridge to the outer slope between 1 m to 15 m (rec. Payri); Atoll of Mataiva (Tuamotu): algal ridge 1 m (rec. Payri).

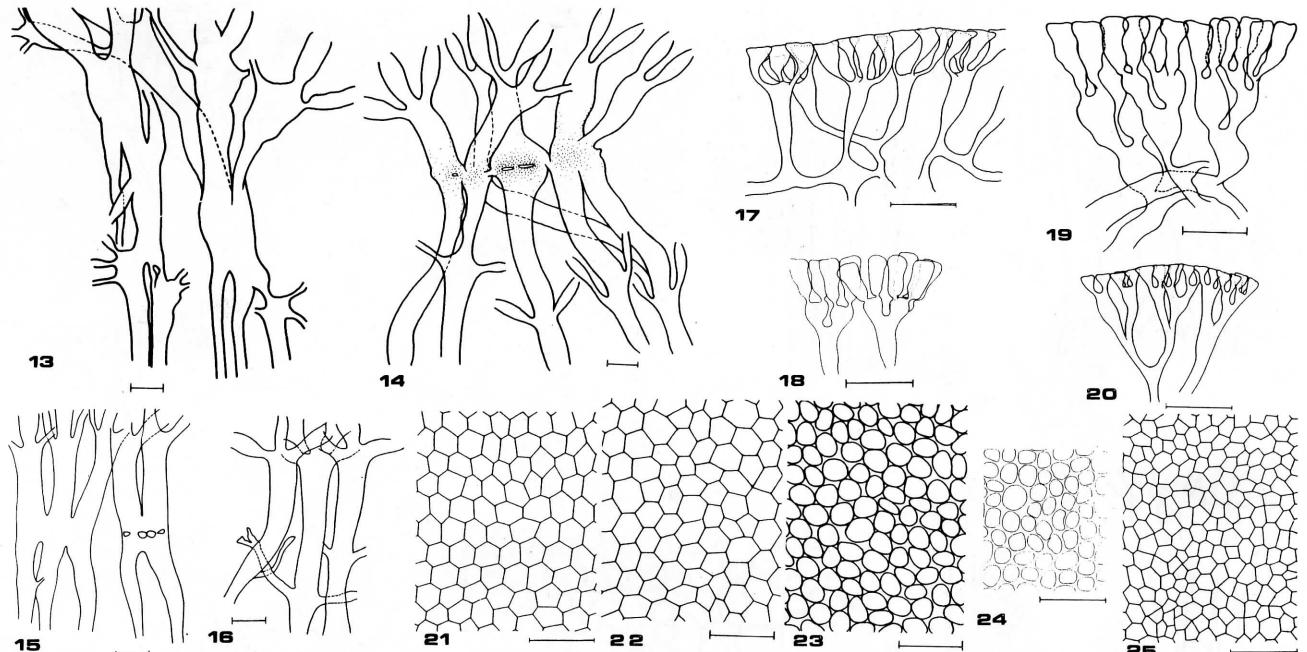


Fig. 13 - 25 : Microscopic characters of H. lacunalis, H. macroloba, H. micronesica and H. minima from French Polynesia.

Fig. 13 - 16 : Nodal medullary filaments of H. lacunalis (Fig. 13), H. macroloba (Fig. 14), H. minima (Fig. 15) and H. micronesica (Fig. 16). Fig. 17 - 20 : Sagittal section of a segment showing the different layers of utricles of H. lacunalis (Fig. 17), H. micronesica (Fig. 18), H. macroloba (Fig. 19) and H. minima (Fig. 20). Fig. 21 - 25 : Surface view of the peripheral utricles of H. lacunalis (Fig. 21), H. macroloba immature segment (Fig. 22) and mature segment (Fig. 23), H. micronesica (Fig. 24) and H. minima (Fig. 25). Scale = 0.1 mm.

It grows on hard coral rocks on exposed sites.

#### Halimeda minima (Taylor) Colinvaux

Ref. : Taylor (1950: as H. opuntia f. minima), Colinvaux (1968) and Hillis-Colinvaux (1980 p.113-115)

Description: Fig. 15, 20, 25 and 47.

First record from French Polynesia. Specimens examined from : Island of Moorea (Société) : outer slope of Tiahura -15 m (rec. Meinesz); Island of Tahiti (Société) -3 m (rec. Payri).

It grows on coral rocks in the shade of cavities.

#### Halimeda opuntia (Linnaeus) Lamouroux

Ref. : Hillis-Colinvaux (1980 p. 110-112)

Mentioned from French Polynesia by Grunow (1867-1868) from Tahiti, by J. Agardh (1886-1887) from Tahiti, by Barton (1901) from Tahiti, by Setchell (1926a, 1926b) from Tahiti, by Seurat (1934) from Aukena, Makaroa, Koaku and Hao, by Hillis (1959) rec. Crocker - from Tubuai and Gambier and - rec. Crossland from Société islands, by Chevalier et al. (1968) from Mururoa, by Denizot (1968), by Denizot (1972) from Hao, by Jaubert et al. (1976) from Moorea, by Naim (1980a, 1980b, 1980c) from Moorea, by Naim and Amoureux (1982) from Moorea, by Payri and Naim (1982) from Moorea and by Payri (1982) from Moorea.

Description : Fig. 26, 29, 32, 48 and 49.

Specimens examined from : Atoll of Takapoto (Tuamotu) : outer slope - 3 m (rec. Meinesz); Island of Moorea (Société) : fringing reef

and algal ridge in front of Tiahura between -0.1 m to -2 m (rec. Meinesz, Payri); Island of Makatea (Tuamotu) (rec. Payri); Island of Tahiti (Société) (rec. Payri). Atoll of Mataiva (Tuamotu) (rec. Payri); Gambier (rec. Salvat).

This species is very common in many islands and atolls. We can distinguish two forms:

One grows either on sheltered sandy sites on the fringing reef, where it forms wide and very dense patches, or between corals in exposed sites such as algal ridges or sites with strong currents (channels). This form presents different shapes of articles and utricles (in general smaller in Tuamotu and at sheltered sites of Société Islands and larger at exposed sites of the Société Islands);

The other form grows hanging in the shadow of coral cavities in algal ridge. The assimilators of this form are more isolated and spread out. The articles and utricles are significantly smaller.

#### Halimeda simulans Howe

Ref. : Hillis-Colinvaux (1980 p. 103-105).

Mentioned from French Polynesia by Setchell (1926a) from Tahiti, by Hillis (1959) - rec. Setchell and Parks from Tahiti and by Payri (1982) from Moorea.

Description : Fig. 27, 30, 33, and 50.

Specimens examined from : Island of Moorea (Société) : on sheltered sandy substratum of the fringing or barrier reef between 0 and 1 m depth at Tiahura or Afareaitu (rec. Meinesz, Payri).

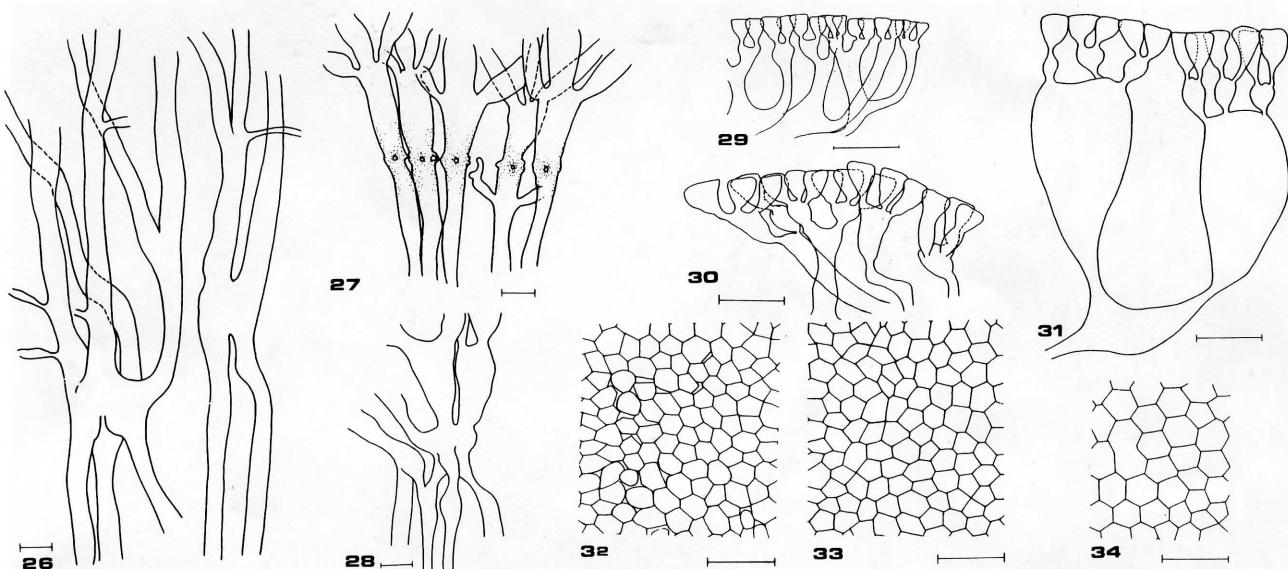


Fig. 26 - 34 : Microscopic characters of H. opuntia, H. simulans and H. taenicola from French Polynesia.

Fig. 26 28 : Nodal medullary filaments of H. opuntia (Fig. 26). H. simulans (Fig. 27). H. taenicola (Fig. 28). Fig. 29 - 31 : Sagittal section of a segment showing the different layers of utricles of H. opuntia (Fig. 29). H. simulans (Fig. 30) and H. taenicola (Fig. 31). Surface view of the peripheral utricles of H. opuntia (Fig. 32). H. simulans (Fig. 33) and H. taenicola (Fig. 34). Scale = 0.1 mm.

#### Halimeda taenicola Taylor

Ref. : Hillis-Colinvaux (1980 p. 139-141).

Mentioned from French Polynesia by Moul (1964) from Raroia, by Guilcher et al. (1966) from Mopelia and by Payri (1982) from Moorea.

Description : Fig. 28, 31, 34 and 51.

Specimens examined from : Island of Makatea (Tuamotu) : outer slope -15 m (rec. Payri); Atoll of Mataiva (Tuamotu) : in the lagoon 1 m and on the outer reef flat -1 m (rec. Payri); Island of Moorea (Société) : on the barrier reef of Tiahura 1 m (rec. Payri).

This species grows in the same biotopes as H. discoidea but is less common.

#### CONCLUSION

Among the 11 species or forms of Halimeda we found in French Polynesia, 4 are new for this region : H. gracilis, H. lacunalis, H. micronesica and H. minima. The distribution of H. lacunalis is extended to the western south Pacific where it was never previously recorded.

For representative species of both Halimeda sections Opuntia and Rhipsalis, we found difficulties in the identification of some specimens. Certain forms such as f. ovata of H. incrassata or very slender forms of H. opuntia result more from genetic variation than from phenotypic plasticity.

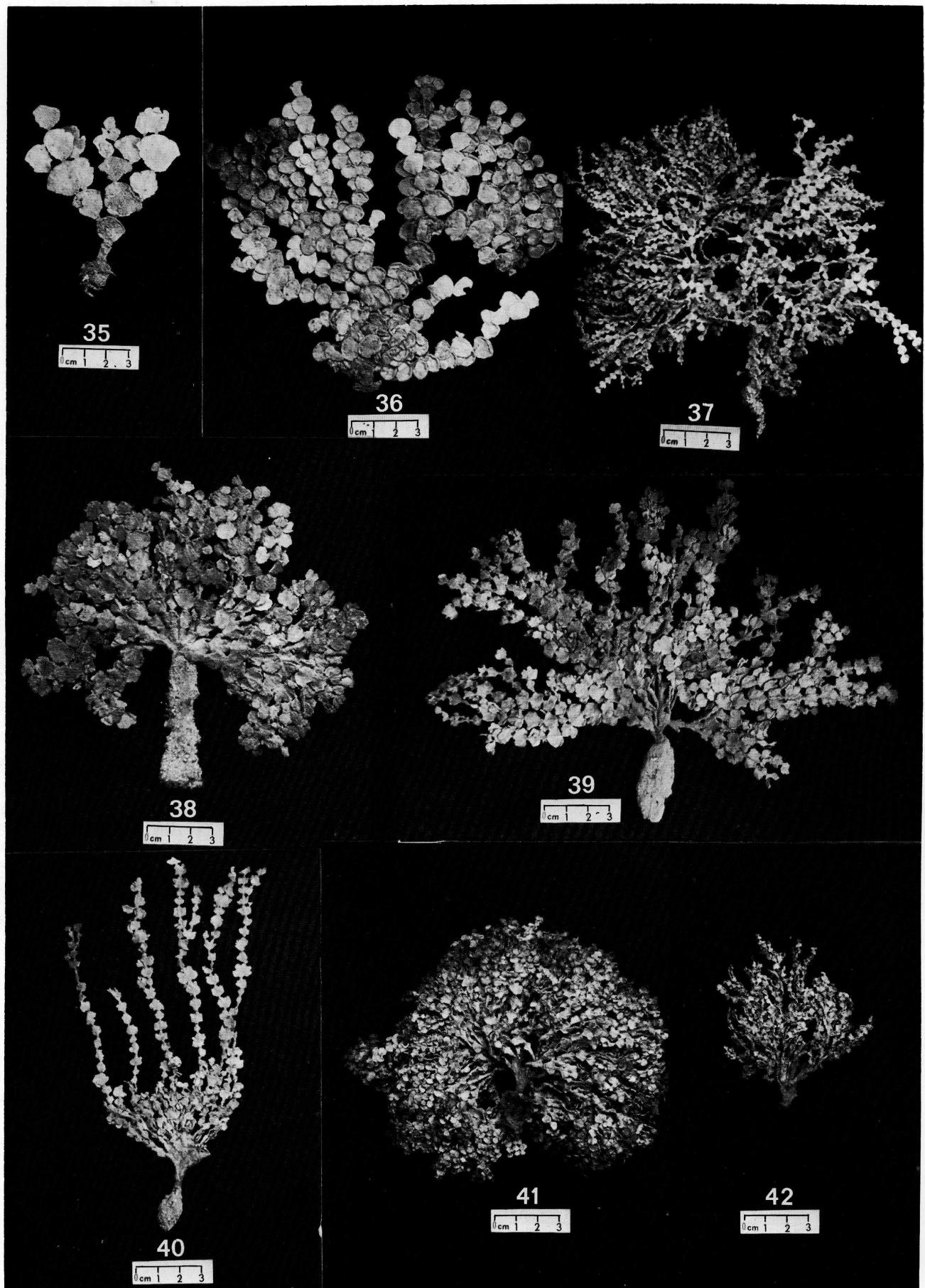
The distribution of the genus Halimeda in this region is very different between each atoll or island. Halimeda discoidea and H. opuntia seem the most frequent. The three species. H. gracilis, H. lacunalis and H. micronesica

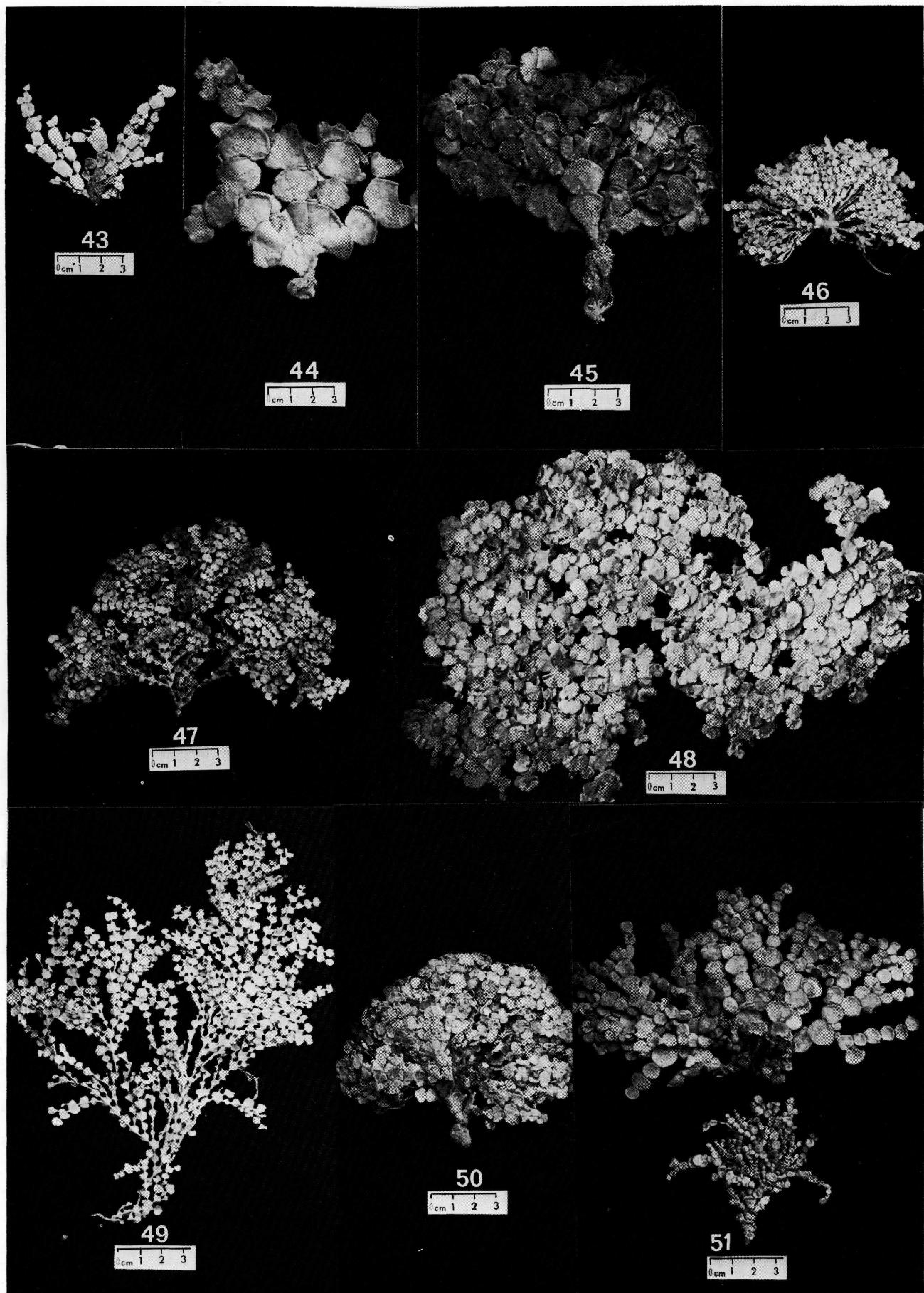
were found only on Tuamotu atolls while H. minima, H. incrassata, H. simulans and H. macroloba were sampled only on the Société islands. H. macroloba is very common and abundant in Tahiti and absent in Moorea.

The number of Halimeda species recorded from Polynesian waters has increased since the publication of the work on Polynesian algae by Setchell (1926a), who listed only 5 species. This genus, however seems less well represented than in other areas of the Western Pacific. Furthermore very common species like H. cylindracea, H. stuposa, H. renschii, H. copiosa, H. cuneata or H. distorta were never found from French Polynesia. Poverty in the number of species is the general rule for many families of seaweeds or seagrasses in French Polynesia: it can be explained by the geographical isolation of Polynesian islands.

#### REFERENCES

- AGARDH J.G.. 1886-1887. Till Algernes Systematik. VIII Siphonae. Acta Lunds Univ. Ars Skrift. 23. Afd. 3(2). 1-174. 3 Pl.
- BARTON E.S.. 1901. The Genus Halimeda. Monographs of the Siboga Expedition. 60. 1-32. 4 Pl.
- CHAUVIN J.F.. 1842. Recherches sur l'organisation, la fructification et la classification de plusieurs genres d'algues, avec la description de quelques espèces inédites ou peu connues. Caen. 132 p.
- CHEVALIER J.P.. DENIZOT M.. MOUGIN J.. PLESSIS Y.. SALVAT B.. 1968. Etude géomorphologique et bionomique de l'atoll de Mururoa (Tuamotu). Cahiers du Pacifique. 12. 1-144. 24 Pl.





- COLINVAUX L., (HILLIS) 1968 . New species of Halimeda : a taxonomic reappraisal. J. Phycol. . 4, 30-35.
- DENIZOT M., 1968. Morphologie terrestre et sous marine. Flore benthique de la Mélanésie et de la Polynésie française. Rap. Lab. Cryptogamie Mus. Natn. Hist. Nat. Paris . 1-41.
- DENIZOT M., 1972. Sur le rôle constructeur des algues en Polynésie française. Proc. 1st. Int. Corals and Coral Reefs Symp., Mar. Biol. Assoc. India, Cochin Ed. . 497-505.
- GRUNOW A., 1867-1868. Reise seiner majestät der Österreichischen Fregatte Novara. Botanischer Theil I. Band: Algen. Wien. 1-104.
- GUILCHER A., DENIZOT M., BERTHOIS L., 1966. Sur la constitution de la crête externe de l'atoll de Mopelia ou Maupihaa (île de la Société) et de quelques autres récifs voisins. Cahiers Océan., Paris . 18 (10), 851-856.
- HILLIS L.. 1959. A revision of the genus Halimeda (order Siphonales). Publications of the Institute of Marine Sciences, University of Texas . 6. 321-403.
- HILLIS COLINVAUX L.. 1980. Ecology and Taxonomy of Halimeda : Primary Producer of Coral Reefs. Adv. Mar. Biol. . 17, 1-327.
- JAUBERT J.. THOMASSIN B.A.. VASSEUR P.. 1976. Morphologie et étude bionomique préliminaire de la pente externe du récif de Tiahura, île de Moorea (Polynésie française). Cahiers du Pacifique . 19, 299-323.
- MEINESZ A.. 1980. Connaissances actuelles et contribution à l'étude de la reproduction et du cycle des Udoteacées (Caulerpales, Chlorophytes). Phycologia . 19 (2). 110-138.
- MOUL E.T.. 1964. New records of Halimeda and Udotea from the Pacific area. Atoll Res. Bull. . 106. 1-10.
- NAIM O.. 1980a. Etude qualitative et quantitative de la petite faune associée aux algues du lagon de Tiahura, île de Moorea. Polynésie française. Thèse de troisième cycle, Université de Paris 6 Ed. . 1 105. 2 annexes.
- NAIM O.. 1980b. Etude de la faune malacologique associée aux algues du lagon de Tiahura. Île de Moorea. Polynésie française. Haliotis . 10 (2). 178.
- NAIM O.. 1980c. Bilan qualitatif et quantitatif de la petite faune associée aux algues du lagon de Tiahura, île de Moorea. Polynésie française. C. R. Acad. Sci. Paris . D. 291. 549-551.
- NAIM O. and AMOUREUX L.. 1982. Le peuplement d'Annelides Polychètes mobiles associé aux algues d'un récif corallien de Polynésie française (île de Moorea. Archipel de la Société). Bul. Ecol. . 13 (1). 25-33.
- PAYRI C.E.. 1982. Les macrophytes du lagon de Tiahura (île de Moorea. Polynésie française). Thèse de troisième cycle, Université des Sciences et des techniques du Languedoc . 1-260.
- PAYRI C.E.. and MEINESZ A.. 1985. Algae: Catalogue and Bibliography of French Polynesian Algae. In: Fauna and Flora: A First Compendium of French Polynesian Seadwellers. Proc. 5 th intern. Coral Reef Symp., Tahiti . 1. 498-520.
- PAYRI C.E.. and NAIM O.. 1982. Variations entre 1971 et 1980 de la biomasse et de la composition des populations de macroalgues sur le récif corallien de Tiahura (Île de Moorea. Polynésie française). Cryptogamie: Algologie . 3 (3). 229-240.
- SETCHELL W.A.. 1926a. Tahitian Algae collected by W.A. Setchell. C.B. Setchell and H.E. Parks. Univ. Calif. Pub. Bot. . 12 (5). 61-142. Pl. 7-22.
- SETCHELL W.A.. 1926b. Phytogeographical notes on Tahiti. II. Marine vegetation. Univ. Calif. Pub. Bot. . 12. 291-324.
- SEURAT L.G.. 1934. La faune et le peuplement de la Polynésie française. Mem. Soc. Biogeogr. Paris . 4. 41-74.
- TAYLOR W.R.. 1950. "Plants of Bikini and other Northern Marshall Islands". University of Michigan Press. Ann Arbor. Michigan. 227 pp.
- YAMADA Y.. 1941. Species of Halimeda in the South Sea. Kagaku Nanya . 4 (2). 108-121.

Fig. 35 42 : Specimens of Halimeda from French Polynesia : photographs of thallus assimilator elements.

H. discoidea from Moorea 25 m on sand (Fig. 35). H. discoidea from Moorea 1 m on corals (Fig. 36). H. gracilis from Makatea 15 m (Fig. 37). H. incrassata f. ovata from Moorea (Papetoai channel) 7 m (Fig. 38). from Moorea (Tiahura fringing reef) 0.5 m (Fig. 39 and 40). H. incrassata from Tahiti (Barrier reef of Maeva) 1.5 m (Fig. 41 and 42). Scale = 0.1mm.

Fig. 43 51 : Specimens of Halimeda from French Polynesia : photographs of thallus assimilator elements.

H. lacunalis from Mataiva outer slope 15 m (Fig. 43). H. macroloba from Tahiti (Beach comber fringing reef) 1 m (Fig. 44 and 45). H. micronesica from Makatea outer slope 15 m (Fig. 46). H. minima from Moorea (outer slope in front of Tiahura) 15 m (Fig. 47). H. opuntia from Moorea (barrier reef of Tiahura) 1 m (Fig. 48) and from Moorea (barrier reef of Tiahura) 1.5 m (Fig. 49). H. simulans from Moorea (fringing reef of Tiahura) 1 m (Fig. 50) and H. taenicola from Makatea 15 m (Fig. 51). CFIG