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The Marine Benthic Algae Diversity of Gabon: Case of the Rocky Foreshore of Cap Estérias

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Abstract

This study has allowed to classify the marine macroalgae from the intertidal zone on the Atlantic side of Cap Estérias (Gabon). This area has a rich biodiversity but very few studies in the knowledge of benthic macroalgae have been done. The first study on the knowledge of the algae of the Gabonese coast was made in February 1974 by John and Lawson. This article has been revised to transcribe books and our study would aim to update the existing collection. The algae census is spread over a year from August 2020 to August 2021 and is the first detailed study carried out over a year, with regard to this part of the Gabonese coast. This study has allowed to know the specific diversity, to determine the structure of the flora and its spread out over time. The results show a significant algal diversity of thirty five (35) identified species. Three classes of macroalgae were determined and the percentage of species in the class (%EC): Floridaophyceae at 50% EC, Phaeophyceae at 30% EC and Ulvophyceae at 20% EC. The red algae are the most common in the area with sixteen (16) species determined against twelve (12) species of brown algae and seven (7) species of green algae. The Phaeophyceae class presents the Dictyotaceae family which is the most diverse with 7 species found. Some species seen appear in the collection of John *et al.*, but others are new species encountered in Gabon such as *Caulerpa sertularioides*, *Bryopsis plumosa* (two Ulvophytes), *Padina arborescens* which is a Pheophyte and *Galaxaura filamentosa*, *Digenea simplex*, *Hildenbrandia rubra*, *Asparagopsis armata and Caulacanthus ustulatus* which are Rhodophytes. Some species are permanently present, they are found in all seasons but with significant abundance from July to September.

Keywords

Marine Algae, Taxa, Atlantic Ocean, Cap Estérias

1. Introduction

Coastal areas are home to great biological diversity. They constitute territories with strong socio-economic and environmental stakes [1]. All marine algae occupy a very important place in the marine world. They represent an important part of the marine flora and are considered to be the first living things to appear hundreds of years ago [2]. These floras are located at different levels of a foreshore: the supra, medio and infralittoral levels [3]. In addition, they are very good bioindicators in that they provide information on the state of the environment in which they operate. These algae help maintain marine balance and clean water [4]. Despite their usefulness, algae face dangers. Climate change affects water quality, leading to eutrophication through increased temperature and reduced flow [5]. This eutrophication can cause algal bloom, in other words, the proliferation of algae or cyanobacteria, which can modify the dominant species of phytoplankton and degrade the organoleptic qualities of the water [6]. Human activity can also weaken marine biodiversity; it can be fishing activities, chemical pollution, which can lead to the appearance of harmful algae or the disappearance of certain species [7].

Gabon, a country in Central Africa, has a seafront stretching over 950 km [8]. The Estuary, the first province of Gabon, is divided into several cities, including Akanda, in which Cap Estérias is located. This county is bordered by the Atlantic Ocean and its beach by a rocky foreshore, a landscape with cliffs [9]. It is part of the bay of Corisco which constitutes an area of great marine biodiversity [10]. Actually, there is an impressive marine flora serving as food for sea turtles [10]. Also, this bay is made up of several remarkable turtle spawning sites: the islands of Corisco and Hoco as well as the Mbanié marine park [10].

Artisanal fishing activities for fish, mollusks and crustaceans and the capture of green turtles are carried out mainly by the local population, an ethnic group of Gabon [10]. In the same way, the presence of marine algae is very important from an ecological point of view because they allow the production of organic matter, the oxygenation of coastal waters and constitute an ideal habitat for marine animals [11]. However, this symbiosis between flora and marine fauna is subject to anthropogenic dangers. Faced with this situation, it is clear that the population is flocking to Akanda commune, because of its rampant urbanization. In the long term, these two factors could have negative consequences on the marine environment [12]. Additionally, this anthropization can be accentuated by climate change, thus leading to the destruction of the marine balance [13], among other things the anarchic proliferation of algae that can alter the quality of the water or the appearance of opportunistic algae. Harmful to fauna,

flora and humans [7]. Above and beyond, very few studies have been done in Gabon [14] [15] compared to other countries on the Atlantic coast [16] [17] [18] [19] [20]. A study on algae in Gabon was carried out in February 1974 [14] from Cap Estérias to Owendo, including Libreville. Therefore, this study intends to contribute to a better knowledge of the taxonomic structure of benthic macroalgae of the rocky coast of Cap Estérias and specifically to 1) identify the macroalgae encountered in order to update the existing collection; 2) determine their annual distribution.

The paper is structured as follows. In the materials and methods section, the presentation of study area, sampling site and method are presented. In the results section, the presentation of data. In the following discussion and conclusion section, the algal diversity is discussed. Finally main findings of this work are given in the summary.

2. Materials and Methods

2.1. Presentation of Study Area

Gabon is located on the west coast of central Africa bordered by the Atlantic Ocean. This tropical rainforest country is crossed by the equator and has a total land-surface area of 267,667 km^2 with a coastline about 955 Km. This country is "housed" in the Gulf of Guinea. The region is influenced by four seasons: two dry seasons (June to August and December to February); and two rainy seasons (from September to December and February to May).

The Atlantic ocean and particularly the Gulf of Guinea area is more studded [21] [22] [23] [24]. Which allowed to better understand the physical functioning of this area. These studies allowed to describe ocean movement in the Gulf of Guinea and currents variability at different time scale [21] [22] [23] [24]. The Gulf is characterized by a seasonal flow of currents and carry warm and cold waters along African coastlines [25].

The Gabonese coastline is influenced by two major currents [26] [27], the Benguela and Cabon-Congo currents:

- The Benguela current flows slowly along Africa coast (from South to West African coastlines) carrying out colder water. The offshore wind blows the surface water away from the coast which are full of nutrient provide a food source for phytoplankton and the kelp floor (called upwelling, it occurs of June to October). Several species such as turtles, whales visit the Gabon coast during these months, where they mate and give birth [27]. Cap Estérias area is also a vital feeding place for marine turtles [28].
- The Gabon-Congo under current carrying warm water and this current carries low concentrations of nutrients with high salinity.

On the intertidal zone off Cap Estérias, the sea level rises and falls twice a day and certain organisms which are underwater like macroalgae are uncovered by changes in tide level.

This zone is characterized by the rocky shores and a great biodiversity of

plants as well as animals live where they can attach to the firm substratum, shelter in nooks and crannies.

Cap Estérias is home to a marine park, M'banié Island, and two aquatic reserves; these protected areas are administered by the National Agency for National Parks (ANPN), which were created in June 2017 according to the Decree No. 00161/PR [29]. The M'banié Island Marine Park is a feeding and nesting area for protected species such as the green turtle and the hawksbill turtle [10].

2.2. Sampling Site and Method

The harvest of these algae was carried out about thirty kilometers from the M'banié marine park, at the level of the rocky foreshore of Cap-Estérias with geographical coordinates N00 37'01.9"; E009 19'17.5" (**Figure 1**). The portion of coast which extends from Cape Santa Clara to Cape Estérias is characterized by a significant contribution of sediments and an intense organic activity, which explains the presence of sedimentary rocks in particular the Senonian limestones alternated with layers of clay and of marne [30]. Besides, this coast is characterized by a cliff notched with several openings and an arrangement in successive plates almost parallel to the coast, slightly inclined downwards, similar to a staircase [30]; these orifices or outlets constitute the mouths of rivers and coastal rivers

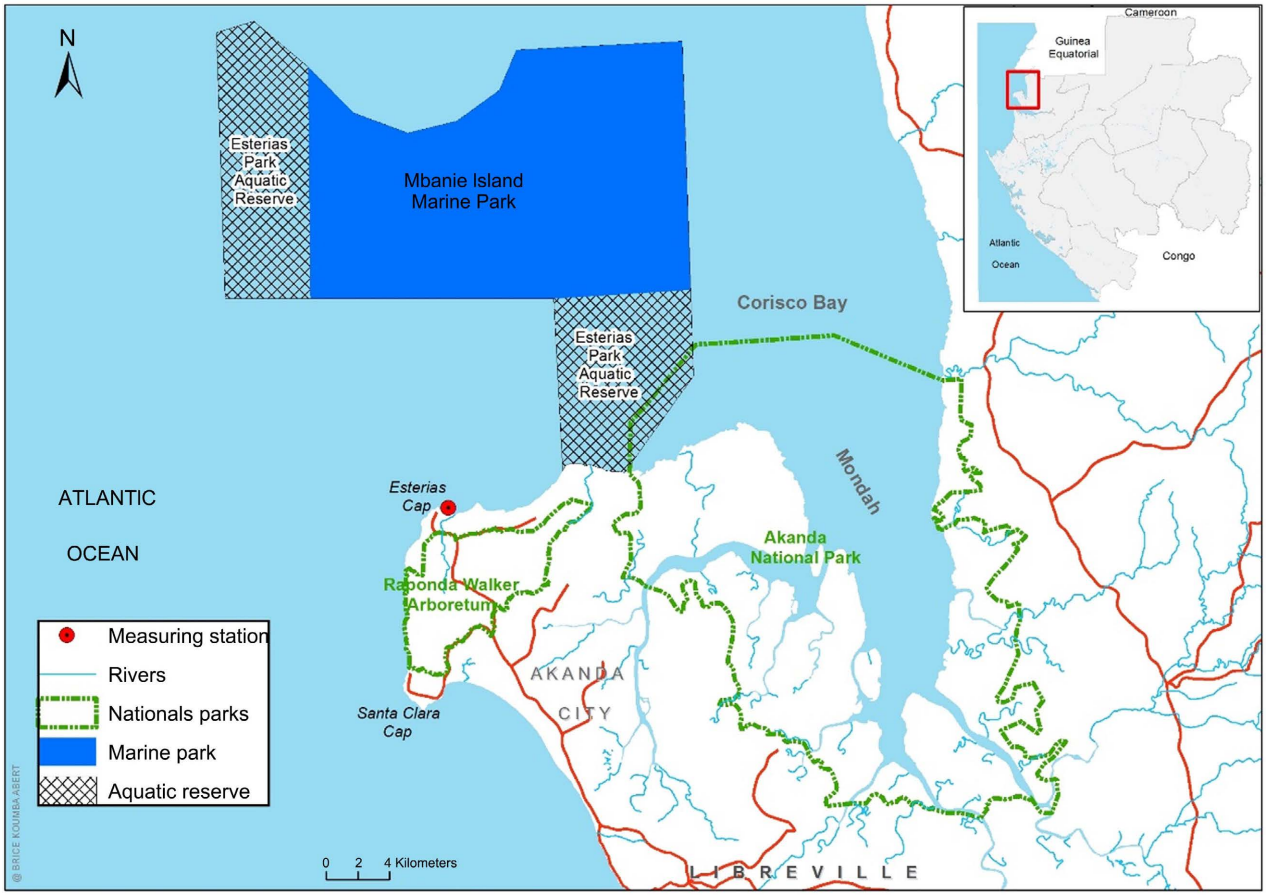

Figure 1. Sampling station around, Akanda National park, Raponda Walker Arboretum, Marine Park and Aquatic Reserve.

[31]. In addition, the erosion of the clay plates creates cavities under the harder limestone plates, which provide habitats for many species of the reef systems, while between the rock bars, sandy surfaces shelter seagrass beds [30].

Moreover, the rocky foreshore of Cap Estérias is not homogeneous. Indeed, the upper supralittoral level is characterized by a land area marked by dwellings with wastewater discharge areas. The mediolittoral level has tanks (or bowls) of variable dimensions which, for some, are teeming with species of algae and for others with marine animals such as sea urchins, mollusks and crustaceans. There are also found tidal channels, calm (sheltered mode) and agitated (beaten mode) areas. Lastly, the infralittoral level is sometimes emerged during the greatest neap tides and is teeming with a good number of algae, especially reds and browns.

2.3. Sampling and Identification of Algae

The algae were harvested during 1 year (2020-2021) every two weeks through the periods of high waves. The collects were carried out vertically from the highest level to the bottom (above towards the infra-littoral) at neap tide, which made it possible to explore the maximum of the coastal surface on foot. The algae trapped in the sea leash and not accessible on foot were also collected.

The collected algae were put in a bag with all information observable in the field, with reference to its ecology and biology (date, time of day of harvest, general description of the habitat, position at the foreshore, degree of exposure to wave action, level of fixation on the rock, associated plants or animals, etc.).

The identification of samples began on the field and continued in the laboratory. It is essentially based on observation with the naked eye, with a magnifying glass or with an electron microscope. The identification was based on the following criteria: color, nature and shape of the thallus, the type of branching, the fixing organs and the level position of the floors.

Our data were compared with some work by John and Lawson [14], John *et al.* [15], Gueye *et al.* [17] [18], Price *et al.* [32]. The Glance of the databases, Algaebase (www.algaebase.org) and World Register Marine Species also made identification easier.

3. Results

3.1. Taxonomic Structure of Benthic Macroalgae Identified in the Cap Estérias Area

This study allowed the identification of three classes namely the Floridaophyceas, Pheophyceae and Ulvophyceae. The taxonomic structure (**Table 1**) shows 35 taxa of macroalgae belonging to 23 genera and 16 families. In terms of number of species, the class of Floridaophyceas is the most represented with 50% of species encountered followed by that of Pheophyceae with 30% of species encountered. The Ulvophyceae class is poorly represented with 20% of species encountered. The Dictyotaceae families are the most represented with 34.29% of

Table 1. Taxonomic structure of macroalgae identified.

Species	Classes		Families	% S.F	N.E.G	N.G.C
	Name	% E.C				
Bryopsisplumosa (Hud.) C. Agardh	ULVOPHYCEAE	20	Bryopsidaceae	5.71	2	5
Bryopsispennata Lamouroux						
Caulerpa sertularioides (S.G. Gmelin) M. Howe			Caulerpaceae	5.71	2	
Caulerpa taxifolia (M. Vahl) C. Agardh						
Chaetomorpha linum (O.F. Müller) Kützing			Cladophoraceae	5.71	1	
Cladophora prolifera (Roth) Kützing					1	
Ulva flexuosa Wulfen			Ulvaceae	2.86	1	
Colpomenia sinuosa (Mertens ex Roth) Derbès & Solier	PHAEOPHYCEAE	30	Scytosiphonaceae	2.86	1	7
Dictyopteris delicatula J.V. Lamouroux			Dictyotaceae	34.29	1	
Dictyota cervicornis Kützing						
Dictyota dichotoma (Hudson) J.V. Lamouroux					3	
Dictyota divaricata (J. Agardh) J. Agardh						
Padina australis Hauck						
Padinagymnospora (Kützing) Sonder					3	
Padinaarboresens Holmes						
Spatoglossum solieri (Chauvin ex Montagne) Kützing					1	
Ralfsia expansa (JL Agardh) J, Agardh			Ralfsiaceae		1	
Sargassum vulgare C. Agardh			Sargassaceae	5.71	2	
Sargassum sp						
Acanthophora muscoïdes (Linnaeus) Bory de Saint-Vincent	FLORIDEOPHYCEAE	50			2	11
Acanthophora spicifera (M. Vahl) Borgesen						
Digenea simplex (Wulfen) C. Agardh			Rhodomelaceae	14.29	1	
Laurencia majuscula (Harvey) A.H.S. Lucas						
Laurencia papillosa (C. Agardh) Greville					2	
Spyridia filamentosa (Wulfen) Harvey			Callithamniaceae	2.86	1	
Galaxaura obtusata (J. Ellis & Solander) J.V. Lamouroux						
Galaxaura marginata (Ellis & Solander) J.V. Lamouroux						
Galaxaura rugosa (J. Ellis & Solander) J.V. Lamouroux			Galaxauraceae	14.29	4	
Galaxaura filamentosa R.C.Y. Chou						
Tricleocarpa fragilis (Linnaeus) Huisman & R.A. Townsend					1	
Hypnea musciformis (Wulen) J.V. Lamouroux			Cystocloniaceae	2.86	1	
Hildenbrandia rubra (Sommerfelt) Meneghini			Hildenbrandiaceae	2.86	1	
Asparagopsis armata Harvey			Bonnemaisoniaceae	2.86	1	
Jania capillacea Harvey			Corallinaceae	2.86	1	
Caulacanthus ustulatus (Mertens ex Turner) Kützing			Caulacanthaceae	2.86	1	

% E.C: Percentage of species by class; % S.F: Percentage of species by Family; N.E.G: Number of species by Genus; N.G.C: Number of Genus by class.

the families followed by those of the Rhodomelaceae and Galaxauraceae with 14.29% each. The Bryopsidaceae, Caulerpaceae, Cladophoraceae and Sargassaceae families represent 5.71% each. Finally, the Ulvaceae, Scytosiphonaceae, Ralfsiaceae, Callithamniaceae, Cystocloniaceae, Hildenbrandiaceae, Bonnemaisoniaceae, Corallinaceae, Caulacanthaceae families are the least represented with each 2.86%.

3.2. Distribution Over One Year of the Algae from Cap Estérias (August 2020 to August 2021)

3.2.1. Ulvophyceae

All the species recorded during 1 year (August 2020 to August 2021) are recorded in Table 2 according to the different months. For the Ulvophyceas class, species such as *Bryopsis pennata*, *Caulerpa taxifolia*, *Chaetomorpha linum and Ulva flexuosa* are permanent but show variable abundance, more important in July to September. We notice that species such as *Bryopsis plumosa*, *Caulerpa sertularioides and Cladophora prolifera* are periodically present, they are found from July to September.

3.2.2. Phaeophyceae

The annual spread out of Phaeophyceae is also detailed in Table 2. The three species of the genus *Dictyota* are permanent all year round (*Dictyota cervicornis*, *Dictyota dichotoma*, *Dictyota divaricata*). For the genus *Padina* species, *Padina gymnospora* is permanent all year round compared to *Padina australis* and *Padina arborescens* which are both present periodically from August to September. The *Padina australis* begins to become scarce from October.

The *Dictyopteris delicatula* species was only found from September to October with a fairly low presence during these two months. The *Ralfsia expansa* species lines the bottom of the *Sargassum* and shows a permanent presence all year round. The *Colpomenia sinuosa*, is found periodically, it was seen in January,

Table 2. Monthly distribution over one year of algae from the rocky foreshore of Cap Estérias.

Classes	Species	August 2020-August 2021												
		J	F	M	A	M	J	J	A	S	O	N	D	
Ulvophyceae	*Bryopsis plumosa* (Hud.) C. Agardh							xx	xxx	xx				Periodic
	Bryopsis pennata Lamouroux	x	x	x	x	x	x	xxx	xxx	xx	x	x	x	Permanent with variable abundance
	Caulerpa sertularioides (S.G. Gmelin) M. Howe							x	x	x				Periodic
	Caulerpa taxifolia (M. Vahl) C. Agardh	x	x	x	x	x	x	xx	xxx	xx	x	x	x	Permanent with variable abundance
	Chaetomorpha linum (O.F. Müller) Kützing	x	x	x	x	x	x	xx	xx	xx	x	x	x	permanent
	Cladophora prolifera (Roth) Kützing							x	x	x				Periodic
	Ulva flexuosa Wulfen	x	x	x	x	x	xx	xxx	xxx	xx	x	x	x	Permanent with variable abundance

Continued

Phaeophyceae	*Colpomenia sinuosa* (*Mertens ex Roth*) *Derbès & Solier*	x	x					x	x					Periodic
	Dictyopteris delicatula J.V. Lamouroux									x	x			Periodic
	Dictyota cervicornis Kützing	x	x	x	x	x	x	x	x	x	x	x	x	Permanent
	Dictyota dichotoma (*Hudson*) *J.V. Lamouroux*	x	x	x	x	x	x	x	xx	xx	x	x	x	Permanent
	Dictyota divaricata (*J. Agardh*) *J. Agardh*	x	x	x	x	x	xx	x	x	x	x	x	x	Permanent
	Padina australis Hauck								x	x				Periodic
	Padina arborescens Holmes								x	x	x	x		Permanent
	Padina gymnospora (*Kützing*) *Sonder*	x	x	x	x	x	x	xx	xx	xxx	xx	x	x	Periodic
	Ralfsia expansa (JL Agardh) J, Agardh	x	x	x	x	x	x	x	xx	x	x	x	x	Permanent
	Sargassum vulgare C. Agardh	x	x	x	x	x	x	xx	xx	xx	x	x	x	Periodic
	Spatoglossum solieri (*Chauvin ex Montagne*) *Kützing*	x	x	x	x	x	x	xx	xx	x	x	x	x	Permanent
Florideophyceae	*Acanthophora muscoïdes* (Linnaeus) Bory de Saint-Vincent								x	x				Periodic
	Acanthophora spicifera (M. Vahl) Borgesen								x	x			x	Periodic
	Asparagopsis armata Harvey						xx		xx	xxx				Periodic
	Caulacanthus ustulatus (Mertens ex Turner) Kützing						xx	xx	xx	xx	x			Periodic
	Digenea simplex (Wulfen) C.Agardh	x	x	x	x	x	x	xx	xx	x	x	x	x	Permanent with variable abundance
	Spyridia filamentosa (Wulfen) Harvey						x	x	x	x				Periodic
	Galaxaura filamentosa R.C.Y.Chou								x	x				Periodic
	Galaxaura marginata (Ellis & Solander) J.V. Lamouroux								x	x				Periodic
	Galaxaura obtusata (J.Ellis & Solander) J.V. Lamouroux								x	xx				Periodic
	Galaxaura rugosa (J.Ellis & Solander) J.V. Lamouroux									xx	x	x		Periodic
	Hildenbrandia rubra (Sommerfelt) Meneghini	x	x	x	x	x	x	xx	xx	xx	x	x	x	Permanent with variable abundance
	Hypnea musciformis (Wulen) J.V. Lamouroux	x	x	x	x	x	xxx	xxx	xxx	xx	xx	xx	x	Permanent
	Jania capillacea Harvey							x	x	x			x	Periodic
	Laurencia majuscula (Harvey) A.H.S. Lucas	x	x	x	x	x	x	x	xx	xxx	x	x	x	Permanent with variable abundance
	Laurencia papillosa (C. Agardh) Greville	x	x	x	x	x	x	xx	xxx	xxx	xxx	xx	x	Permanent
	Tricleocarpa fragilis (Linnaeus) Huisman & R.A. Townsend							x	x	xx	x			Periodic

x: presence; xx: quite representative; xxx: abundante/dominant.

February, August and in October; showing very low abundances during these four months of appearance. The *Spatoglossum solieri* and the *genus Sargassum* (*Sargassum vulgare and Sargassum sp*) species are permanent throughout the year. Furthermore, the Sargassum fields are present all along the foreshore.

3.2.3. Florideophyceae

The annual spread out of Floridaophyceae is detailed in **Table 2** too. On the topic of the Floridaophyceae class, the two species of the genus *Laurencia*, (*Laurencia majuscula* and *Laurencia papillosa*), the species *Digenea simplex*, *Hildenbrandia rubra*, and *Hypnea musciformis* are encountered permanently all year round. The two species of the genus *Acanthophora* documented (*Acanthophora muscoides* and *Acanthophora spicifera*) are seen from August to October, nevertheless *Acanthophora spicifera* was found again in December. The *Asparagopsis armata*, *Caulacanthus ustulatus* and *Spyridia filamentosa* species are found from June to September. The *Asparagopsis armata* species shows significant abundance in August and September, then both decreas in October. The three species of the genus *Galaxaura* (*Galaxaura filamentosa*, *Galaxaura marginata*, *Galaxaura obtusata*) are found periodically from August to September, while the species *Galaxaura rugosa* appears after the three from September until November. The *Janis capillacea and Tricleocarpa fragilis* species are found from July to September. *Janis capillacea* shows a fairly low presence during these months of emergence.

4. Discussion

Based on results here above presented, thirty five (35) taxa were listed with a total of thirty four (34) identified up to the species level, plus an unspecified *Sargassum*. The Rhodophyceae class is more represented with sixteen (16) species distributed in eight (8) families and eleven (11) genera. While the Pheophyceae class appears with twelve (12) species, four (4) families and seven (7) specifics genera. While the Ulvophyceae class is weakly represented with seven (7) species, four (4) families and five (5) genera. These results are in accordance with the works of John and Lawson [14] who counted 96 algae including 57 Rhodophytes, 19 Phaeophytes and 14 Ulvophytes; with a distribution at the level of Cap Esterias of 21 Rhodophytes, 15 Phaeophytes and 4 Ulvophytes, showing the majority presence of red algae on the Gabonese coast.

Our results are also in line with those found by Gervasoni and Ritter [33]; Person [34], who estimate that there is a lower number of Ulvophytes in the world. The green algae *Cladophora laetivirens* which appears in the collection of John and Lawson [14] was not seen during our study. Furthermore, some Ulvophytes such as *Caulerpa sertularioides* and *Bryopsis plumosa* which are listed in our study, do not appear in the collections of John and Lawson [14], Lawson and John [35], John *et al.* [15]. Nevertheless, the *Bryopsis plumosa* is found on the Egyptian [36] and Senegalese [17] coasts. On the other hand, the *Ulva flexuosa and the Chaetomorpha limun* encountered during our study do not appear in

the collection of John and Lawson [14] at the level of Cap Estérias, but was encountered in 1974 in the area of Libreville; it could be that there has been a migration of these species from Libreville to Cap Estérias. These results show that there would have been a dynamic of appearance, disappearance or migration of certain macroalgae on the rocky foreshore of Cap Esterias from 1974 to 2021. This could be attributed to the physico-chemical, ecological conditions and climate change around the rocky foreshore of Cap Esterias, over the past decades marked by the exponential urbanization around the area studied, among others.

We also note that Ulvophytes show a permanent or periodic presence with varying abundances throughout the year. During this present study, we notice that *Caulerpa taxifolia*, *Ulva flexuosa* and *Chaetomorpha limun* are permanent during the year with a more marked abundance in the months of August and September. The *Caulerpa taxifolia* is qualified as an invasive species; it is present on the foreshore of Cap Estérias, both in the basins and in beaten and sheltered mode [37]. In addition, this macroalgae is nicknamed "killer algae" because of the disturbances it could cause on the marine ecosystem and its toxicity [38]. Moreover, the *Chaetomorpha linum* is an integral part of the sea line at the level of the rocky foreshore. This algae is usually entangled on various other algae, wash up on the banks and can proliferate in waters enriched in nitrogen and phosphorus [39]. As for the green algae *Ulva flexuosa*, it showed a significant occurrence from July to September at the end of the present study. This type of species is often present in the lower supralittoral [39] and near domestic water outlets and runoff. In addition, this species which can potentially proliferate in disaster event is also very present in a wide variety of fluid and stagnant waters and prefers alkaline waters and slightly brackish habitats [40].

About the Pheophytes, the three species of the genus *Dictyota* observed during this study (*Dictyota cervicornis*, *Dictyota dichotoma*, *Dictyota divaricata*) are permanent throughout the year and present in the collection of John and *Lawson* [14]. The genus *Dictyota* is also very common on the Brazil coast [41]. The *Colpomenia sinuosa* shows a periodic presence and is also present in the collection of John and Lawson [14]. This brown algae is found in calm mode, is indeed found on calm and well-lit shallow bottoms, tolerates large variations in temperature and of salinity [39] [42].

Regarding the three species of the genus *Padina* encountered during our study, two species (*Padina gymnospora* and *Padina australis*) appear in the collection of John and Lawson [14] the first found in Cap Estérias and the second in Libreville. The *Padina arborescens* is encountered for the first time in Gabon and more precisely in Cap Estérias. It shows a periodic presence from August to September, with a very low abundance.

The species, *Spatoglossum solieri* and *Sargassum vulgare* are encountered for the first time in Cap Estérias during the present study too, but they had been located by John and Lawson [14], John *et al.* [15] in the area of Libreville. They show a permanent stay at the level of the rocky foreshore studied, an important abundance during the dry season and is also found in the sea line during our

study period. We also note the presence of micro-fields of *Sargassum vulgaris* at the foreshore but was already found by Riedel [41] on the Brazil coast.

Concerning the red algae, *Galaxaura filamentosa*, *Digenea simplex*, *Hildenbrandia rubra*, *Asparagopsis armata* and *Caulacanthus ustulatus*, they are not identified in the collection John and Lawson [14], John *et al.* [15] but they have been identified during the present study. *Asparagopsis armata* present from June to September with a great quantity in the months of August to September at the Cap level. This species is known to have been introduced in the northeast Atlantic and in the Mediterranean in the 1920s, probably from Australia [43]. Regarding the *Caulacanthus ustulatus*, this alga was observed in West Africa in the 1980s [35] [44]. Its presence on the Gabonese coast could also be due to the human activity. The species *Hypnea musciformis* appears in the collection of John and Lawson [14] and only found in Libreville. It was seen for the first time in Cap Estérias during our study period. At the level of their annual spread out, *Galaxaura filamentosa*, *Digenea simplex*, and *Hildenbrandia rubra* are seen throughout the year during our study and in great quantity from August to September. The red alga *Spiridia filamentosa* is seen for the first time on the Gabonese coast but was already found by Shabaka [36] on the Egyptian coast.

5. Conclusion

This study has allowed to classify the algal diversity, the taxonomic structure and the spread out of the benthic macroalgae of the rocky foreshore of Cap Estérias. The study area covers the supralittoral, mediolittoral and upper infralittoral, which is the area accessible on foot at a low tide. It reveals a high diversity of marine algae with 35 taxa on the studied area. Certainly, the surveys in deeper habitats (subtidal zone) will further increase the number of sea weed taxa. Done between August 2020 and August 2021, this study remains the first conducted over a period of 1 year and new species were categorized. The aim of this paper is to provide a robust baseline for the monitoring of marine macrophyte along the Atlantic coast of Gabon, especially of Cap Estérias. The overall result of the present study highlights the need to associate and increase physic-chemical parameters research along the Gabon Coastline.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper

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