

Sea Grapes (*Caulerpa* spp.) (Chlorophyta: Caulerpaceae) from Coron, Northern Palawan, Philippines with Notes on Their Harvest and Production

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ABSTRACT.— *Caulerpa* species, collectively known as “sea grapes”, are widely cultivated and harvested in the Philippines. This study identified *Caulerpa* species from Coron, Northern Palawan based upon their morphology, and described for the first time the current status of *Caulerpa* harvesting in the municipality through a social survey. A total of two species (*Caulerpa lentillifera* and *Caulerpa racemosa*) with two varieties of the latter species (*C. racemosa* var. *turbinata* and *C. racemosa* var. *laetevirens*) were identified and distinguished by their ramuli characteristics. Data from a select group of fisherfolks, market vendors, and buyers showed that wild harvesting of sea grapes has been practiced since the 1990s, signifying that the seaweeds have been regarded as a source of food and income in the last three decades. The dry season (January to April) is perceived as the peak season for sea grape harvesting and their prices have remained constant at PhP 40.00/kg (USD 0.79/kg) over the past four years. The estimated annual income during the peak season is valued at around PhP 48,480.00 (USD 918.53). In Coron, it is suggested that the supply is adequate for their local market demand given the current harvesting methods. The possibilities of phycoculture of sea grapes have also been explored but, at present, with only limited success. This study revealed that *Caulerpa* is still regarded as an economically important crop that provides income and livelihood to the Calamian archipelago and has the potential to be cultivated for sustainable production and use.

KEY WORDS: *lato*, *Caulerpa*, phycoculture, seaweeds, Philippines

INTRODUCTION

Seaweeds are an economically important food crop in the Philippines as they serve as both a food commodity and an income source for coastal communities. Phycoculture, or seaweed farming, in the country has become an established industry for the last three decades, with Region IV (Southern Luzon), particularly Batangas, Quezon, and Palawan, being recognized as the main seaweed farming areas in the Philippines (Mundo et al., 2002; Hurtado, 2013; Trono and Largo, 2019). In 2000, Palawan accounted for the highest production level in

the region at about 138,950 metric tons of farmed seaweeds, which include *Caulerpa* spp., *Euचेuma denticulatum*, and *Kappaphycus alvarezii* (Mundo et al., 2002). Of the seaweed species found in the province, the edible green seaweeds of the genus *Caulerpa*, called “sea grapes”, are one of the most abundant and popular in Northern Palawan, specifically in Coron within the Calamian archipelago (Mundo et al., 2002).

Sea grapes are a select group of edible species of *Caulerpa* that are widely consumed and harvested in the Philippines (Calumpong, 1984; Wagey and Bucol, 2014; Trono and Largo, 2019). They are

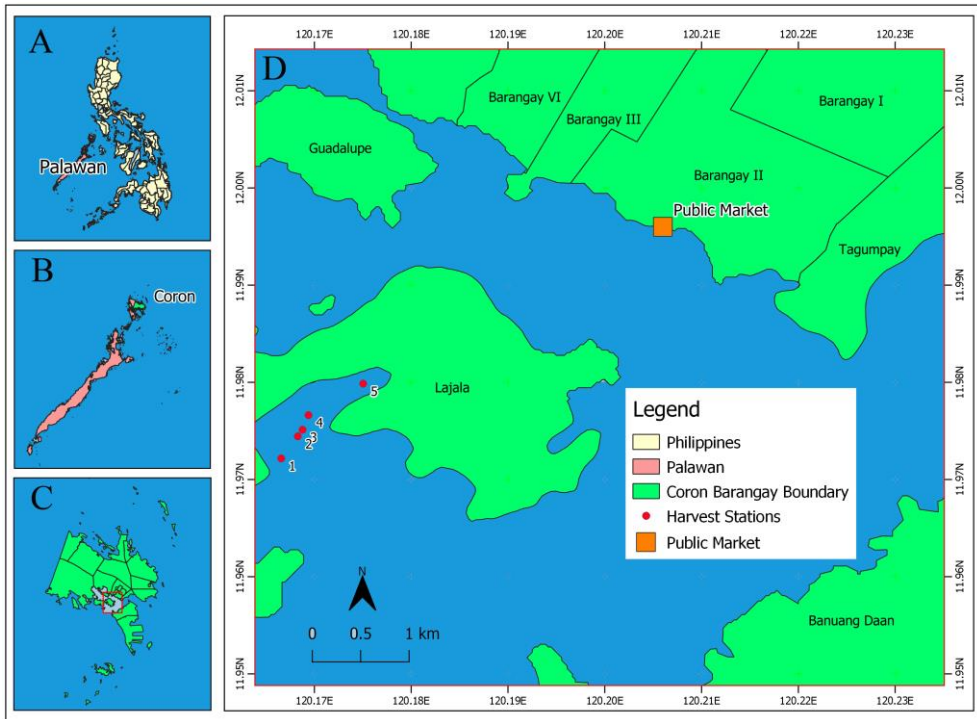


FIGURE 1. Maps showing A. the Philippines with Palawan highlighted, B. Coron in Northern Palawan, C. Coron, and D. location of harvest sites and public market in Coron, Palawan

known for their high content of minerals, protein, and vitamins (Saito et al., 2010; Peña-Rodríguez et al., 2011; Nagappan and Vairappan, 2014) and have long been included in the daily diets and life of the coastal communities in Northern Palawan. One of the original inhabitants of the Calamian archipelago, the indigenous people group *Tagbanuas*, is believed to have the earliest and widest resource use of these seaweeds. In the past three decades, studies regarding the seaweed diversity in the Calamian archipelago of Palawan from wild stocks and even in the local marketplaces remain limited along with studies involving their abundance and harvest. This study, therefore, investigated the *Caulerpa* species of Coron in Northern Palawan, to provide

current data on their harvest, marketing, and production, and the implications for future development and sustainable use.

MATERIAL AND METHODS

Study area

Coron (Fig. 1) is a coastal municipality in the eastern half of Busuanga Island in Northern Palawan, Philippines, and is comprised of fifty minor islets. The municipality belongs to the Calamian archipelago that divides the West Philippine Sea from the Sulu Sea. Coron, which occupies a total land area of 950 km², is geographically located in the northernmost part of the province of Palawan, approximately 367 km away from Manila



FIGURE 2. *Caulerpa* species being sold by vendors in the public wet market of Coron, Palawan

and 363 km away from Puerto Princesa City, the capital of Palawan. The local public wet market in Coron (11°59'43" N, 120°12'19" E) was visited in June 2019 (Fig. 2) as *Caulerpa* was previously described to be abundant during the dry season (Trono and Denila, 1987).

Social survey

Primary data regarding sea grapes were obtained through personal interviews using a pre-tested and semi-structured questionnaire. The questionnaires were translated to the local language (*Cuyonon*) and were performed by enumerators speaking in the local language. Sample size was computed using the standard equations developed by Cochran (1963) and Israel (1992) for the two barangays, Bintuan and Lajala, with the number of fisherfolks and vendors provided by the Municipal Agriculture Office (MAO) of the Local Government Unit (LGU) of Coron. A total of 316 randomly selected

Coron respondents participated in this study. Information regarding their (1) socio-demographical background, (2) perception and awareness of sea grapes, (3) seasonality of sea grapes, and (4) prices and estimated volume (in kg) of harvest per month and per season were collected. The collected data were processed and analyzed using the STATA version 14.1 statistical package. Descriptive and inferential statistics were used in analyzing and characterizing the responses.

Collection and identification of *Caulerpa* species

Specimens were obtained from the intertidal and subtidal parts of the source area at 3-5 m depth below the water surface (Fig. 1D) by snorkeling or wading with a member of the *Tagbanua* tribe and local fisherfolks as guides (Fig. 3). Three replicates were collected for each morphologically distinct species. Species



FIGURE 3. A. *Tagbanuas* harvesting *Caulerpa* and B. cleaning them in wooden boxes with nets before selling it to the public market

examination and identification were performed *in situ* and were primarily based on morphological criteria using Trono (1997, 2004) and Verlaque et al. (2000). Diagnostic characters, particularly the ramuli shape, were noted in delineating the different species. Algaebase, a global species database for seaweed taxonomy, was also used to reference the species names (Guiry and Guiry, 2019). Voucher specimens were prepared and preserved as reported previously (Trono and Ganzon-Fortes, 1988). Underwater photographs of habit specimens were taken using a FUJIFILM FinePix XP120 camera.

RESULTS AND DISCUSSION

Sea grape source area

Sitio Look, Barangay Lajala, Coron, Palawan (11°58'47" N, 120°10'33" E) was found to be the main harvesting area of *Caulerpa* in Coron, Palawan (Fig. 1). The *Tagbanuas*, an indigenous people group residing in stilt houses, are seaweed farmers who gather sea grapes from the source area daily. The harvest sites are characterized as wide seagrass beds in small patches to large

meadows. The substrate of the estimated 75 m² area is primarily sandy and populated by sea grape beds, together with several corals and rocks.

Caulerpa species

A total of two species of *Caulerpa*, with two varieties of one of these species, were found to be offered for sale in the local public market of Coron (Table 1; Figs. 4-7). They were identified from the entire collection as *Caulerpa lentillifera* J. Agardh and *Caulerpa racemosa* (Forsskal) J. Agardh, the latter comprised of the two varieties *turbinata* and *laetevirens* (Verlaque et al., 2000). However, *C. racemosa* var. *turbinata* (J. Agardh) Eubank and *C. racemosa* var. *laetevirens* (Montagne) Weber-van Bosse were regarded as synonyms of *C. chemnitzia* var. *turbinata* (J. Agardh) Eubank and *C. chemnitzia* var. *laetevirens* (Montagne) Weber-van Bosse, respectively, according to Algaebase (Guiry and Guiry, 2019). The respondents attested that all species can be harvested daily all year-round at the source area in Sitio Look, although they noted they were more abundant during the dry season.

The number of edible *Caulerpa* species gathered and sold in Northern Palawan is significantly higher compared to the other

TABLE 1. *Caulerpa* species sold in the local public market in Coron, Northern Palawan, Philippines, including local/vernacular names and morphological descriptions.

| Species | Local/vernacular name | Morphological description | Reference |
|--|--------------------------------|--|----------------|
| 1. <i>Caulerpa lentillifera</i> | <i>lato, bigas-bigasan</i> | Ramuli with globose tips, which are constricted at the base and arranged imbricately in rows of four | Trono, 1997 |
| 2. <i>Caulerpa racemosa</i> | <i>lato, lomo-lomo</i> | Highly variable ramuli, which can be stipitate or substipitate and can be arranged irregularly- distichously, multiseriately, or imbricately | Trono, 1997 |
| 3. <i>Caulerpa racemosa</i> var. <i>turbinata</i> * | <i>lato, tilapon</i> | Having uncrowded ramuli which are clavate with flattened ends | Verlaque, 2000 |
| 4. <i>Caulerpa racemosa</i> var. <i>laetevirens</i> ** | <i>lato, tabangar/tawangal</i> | Have crowded ramuli which are cylindrical to gradually clavate | Verlaque, 2000 |

*Regarded as synonym of *C. chemnitzia* var. *turbinata* according to Algaebase

**Regarded as synonym of *C. chemnitzia* var. *laetevirens* according to Algaebase

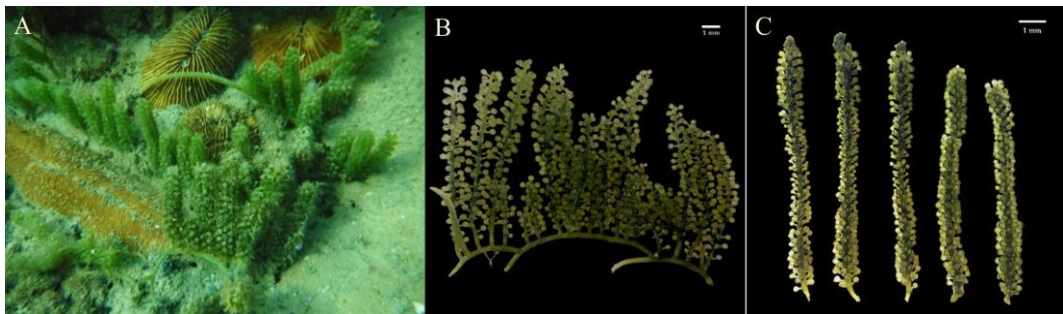


FIGURE 4. *Caulerpa lentillifera* A. *in situ* habit and B., C. photos showing its assimilator having ramuli with globose tips, which are constricted at the base and arranged imbricately in rows of four. Scale bars = 1 mm

regions of the country (Estrada et al., 2020). Except for *C. racemosa* varieties *turbinata* (*lomo-lomo*) and *laetevirens* (*tabangar/tawangal*), all identified species are widely known in other regions in the Philippines as edible species that are traded in public markets (BFAR, 2017; Dumilag, 2019; Trono and Largo, 2019). Thus, these two *C. racemosa* varieties found on sale in the local public market in Coron are newly reported edible species in the genus. It is worth noting, however, that the genus *Caulerpa* exhibits a high degree of morphological plasticity caused by changing environmental

conditions. Species belonging specifically to the *C. racemosa* complex are infamous for taxonomic difficulties and are currently being studied using molecular tools to validate their identification and taxonomic classification (Belton et al., 2014, 2019; Dumilag et al., 2019; Pattarach et al., 2019).

Socio-demographic characteristics of the respondents

Table 2 shows the socio-demographic characteristics of the 316 respondents with the summary and descriptive statistics of the variables taken. The average age of the respondents was 43 years old, with the

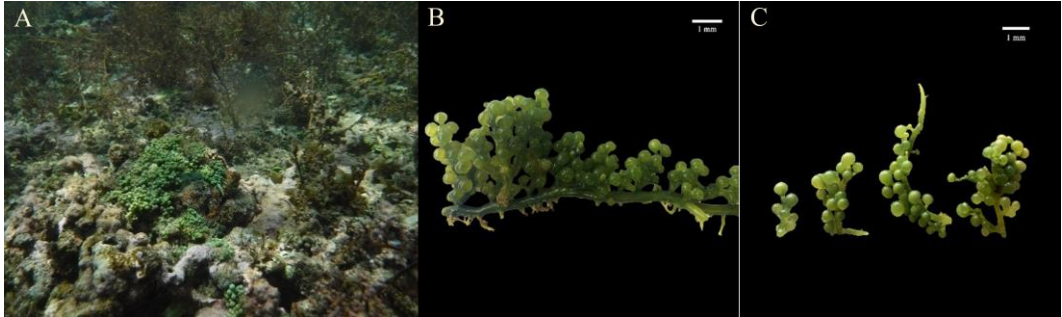


FIGURE 5. *Caulerpa racemosa* A. *in situ* habit and B., C. photos showing its assimiator with highly variable ramuli, which can be stipitate or substipitate and can be arranged irregularly - distichously, multiseriately, or imbricately. Scale bars = 1 mm

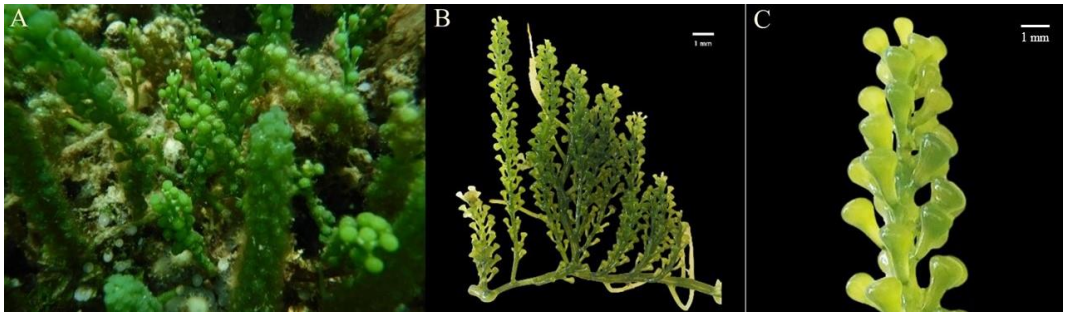


FIGURE 6. *Caulerpa racemosa* var. *turbinata* A. *in situ* habit and B., C. photos showing its assimiator having uncrowded ramuli which are clavate with flattened ends. Scale bars = 1 mm

majority of the fisherfolks being males (80%) and married, while the market vendors were mostly females. The average number of years the respondents attended school (education) was six, which means that majority of the fisherfolks and market vendors reached and/or finished elementary level but did not pursue high school and college-level education. In terms of monthly income, the majority of the respondents (80%) could be grouped as poor with a monthly income below the minimum monthly wage rate of PhP 6,857 (USD 142.85) at the provincial level (DOLE, 2019).

Sea grape harvesting

The majority of the female respondents indicated that their husbands or male members of their family gather the sea grapes from the source area daily. According to them, gathering sea grapes has been a part of their family and the town's culture since the 1990s. The respondents (60%) also indicated that their families have been gathering sea grapes for almost 10 years. This signifies that sea grapes have been regarded as a source of income and livelihood for the past three decades. All of the respondents agreed that the peak season for harvesting sea grapes was during the dry



FIGURE 7. A., B. *Caulerpa racemosa* var. *laetevirens* showing its assimilator having crowded ramuli, which are cylindrical to gradually clavate. Scale bars = 1 mm

season (January to April), while the lean season was during the wet season (May-August). During lean season, harvesters in Coron can only gather an average estimate of 50 kg while during peak season they can harvest up to 101 kg per month. Seasonality of sea grapes is perceived to be affected by the decreasing salinity brought about by rainfall, in accord with previous reports in the Philippines and other *Caulerpa* studies (Trono and Denila, 1987; Chamberlain and Pickering, 1998; Zubia et al., 2020).

Awareness and perceptions of sea grapes

All the respondents were informed by their fellow fishermen about the sea grapes in their areas as early as 1985-1990. Harvesting since then, the majority of the respondents (98%) recognized that sea grapes, regardless of species and varieties, are edible seaweeds that can be a source of income due to their demand, which arises from their reported health and nutritional properties (Saito et al., 2010; Peña-Rodríguez et al., 2011; Nagappan and Vairappan, 2014). The local fisherfolks are able to

differentiate sea grapes from other seaweeds because of their green color and the succulent parts that resemble “grapes”. These local fisherfolks, who are dependent on wild harvesting of natural stocks, are not wary of overharvesting due to their assertion of the abundance of sea grapes in the source area.

Volume of sea grape harvest and prices

During the peak season, the fisherfolks of Coron harvest an estimated total of 101 kg (fresh weight) of sea grapes per month with Barangay Lajala as the main contributor, which is due to its proximity to the source area and access to the public market. From the responses, the source area in Lajala can generate up to approximately four sacks, each weighing 25 kg, of sea grapes monthly during the dry season. In Coron, the bulk of the harvest goes from the fisherfolk to the traders in the local public market and/or directly to seafood restaurants in Coron, and are often exported to Metro Manila and mainland Luzon through exporters/viajeros/processors.

TABLE 2. Summary and descriptive statistics of the respondents in Coron, Palawan

| VARIABLE | OBS | MEAN | STD DEV | MIN | MAX |
|------------------------------|-----|------|---------|------|-------|
| Age (in years) | 316 | 42.5 | 4.5 | 24 | 68 |
| Gender* | 316 | 1 | 0.5 | 1 | 2 |
| Civil status** | 316 | 2 | 0.1 | 1 | 2 |
| Educational attainment*** | 316 | 2 | 0.5 | 1 | 2 |
| Primary income (PhP/month) | 316 | 4429 | 1055 | 2500 | 12000 |
| Secondary income (PhP/month) | 316 | 2428 | 581 | 1250 | 8333 |

*Mean value: 1 – Male; 2 – Female

** Mean value: 1 – Single; 2 – Married; 3 – Separated

***Mean value: 1 – No schooling; 2 – Some elementary; 3 – Elementary graduate; 4 – Some high school; 5 – High school graduate; 6 – Some college; 7 – College graduate; 8 – Some vocational; 9 – Vocational graduate

In terms of the market price, the prices of *Caulerpa* have been stable and are independent of the species and varieties. Vendors from Coron public market offered PhP 20.00 (around USD 0.30–0.40) per heap and PhP 40.00/kg (USD 0.79/kg), and this has remained relatively constant for the last four years (2016–2019). There have been records in the past two decades that prices of fresh *Caulerpa* in Palawan fetched a higher price, ranging from PhP 70.00–80.00 (USD 1.33–1.52) per kg (Mundo et al. 2002). Annually, the fisherfolk of Coron harvest up to 1,212 kg of sea grapes with an estimated annual income of PhP 48,480.00 (USD 918.53) during the dry season. Prices of sea grapes are largely affected largely by people's preference and seaweed resource availability in the various regions. Presently, the main seaweed farming areas are located in Sulu and Tawi-Tawi, Southern Palawan, Zamboanga, Bohol, and Leyte, accounting for more than 80% of the annual production of seaweeds in the country over the last five years (BFAR, 2017; Trono and Largo 2019).

Sea grapes are believed to be important in the diet of the local people of Coron, Northern Palawan. The majority of the respondents regarded sea grapes as their main source of income and livelihood as

well as being a good source of daily food and nutrition. It is noted that the local public market in Coron has a strong seaweed entrepreneurship and fisherfolk-trader-buyer relationship participated by local women and indigenous people. Although the occupations of residents in the municipality mostly involve fishing and tourism-related jobs, the local people of Coron also rely on the wild harvesting of sea grapes as a source of income, although its supply chain, total production level, and other relevant data on the market distribution in Northern Palawan are lacking. Due to the natural abundance of *Caulerpa* species in the area, local fisherfolks have become solely dependent on wild stocks, such that the cultivation of *C. lentillifera* observed in the other main farming regions in the country is yet to be realized in the municipality. In this regard, market knowledge and species catalogs of local seaweeds are vital references for the conservation and protection of marine resources that can be of importance for LGUs, since many seaweed communities in the Philippines have been described as being highly vulnerable to anthropogenic pressures, particularly overharvesting and habitat degradation (Largo, 2002; Harley et al., 2012; Dumilag, 2019).

CONCLUSION

Among the identified species of sea grapes in Coron, Northern Palawan, Philippines, *Caulerpa lentillifera* and *Caulerpa racemosa* were the most common, and are also present in other regions of the country, but the *C. racemosa* varieties *turbinata* and *laetevirens* are only sold and consumed in the area. Thus, these latter two varieties are regarded as newly reported edible and marketable species varieties within the genus.

In this study, we report the updated preliminary data on the estimated total harvest volume during the peak (dry) season, the estimated annual income of harvesters during the dry season, perception of awareness of sea grapes in the area, seasonality, and the prices of sea grapes over the last four years. The present study highlights the importance of sea grapes to coastal communities, like Coron, as valued sources of income and livelihood through wild harvesting and marketing and should be conserved through sustainable harvesting methods.

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