Abundance, Composition and Distribution of Phytoplankton in Calamianes, Palawan

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ABSTRACT

Phytoplankton in Coron Bay of the Calamianes Islands, Palawan were investigated from 27-29 May 2004. Samples were collected from 33 stations by filtering five 10 L buckets of surface water through a net with a 20mm mesh bag. The phytoplankton consisted of four major groups. Diatoms, showed the highest mean density of 1432.9indivL^{-1}. Silicoflagellates comprised the next most abundant group with a mean density of 132.3 indivL^{-1}. Dinoflagellates followed with a mean density of 94.8 indivL-^{1}, while the cyanobacteria (blue-green algae) had a mean density of 19.4 indivL^{-1}. The top three diatoms were *Chaetoceros, Bacteriastrum* and *Coscinodiscus*. The genus *Peridinium* was the most abundant dinoflagellate, while *Tintinnopsis* dominated the silicoflagellates. Among the cyanophytes, *Trichodesmium* showed the highest density. High phytoplankton concentrations were observed in the vicinity of a pearl farm and in areas adjacent to mangrove forests. Overall abundance and diversity in the study area are higher than in other similarly reef-dominated areas in the country. This may be attributed to factors on both large and local scales.

INTRODUCTION

This study forms part of a larger effort aimed at determining the most suitable sites to set up marine protected areas in various parts of the country (Aliño et al., 2002). One of the emergent aspects in this effort is the productive potential of the site, which is determined by combinations of biological and physico-chemical factors, and manifested by characteristics such as age structure, diversity and abundance of producer and consumer assemblages, nutrient dynamics, water movement and overall habitat structure and complexity. Phytoplankton are among the primary producers in shallow coastal areas and factors that affect them will most likely affect overall productivity of a given site. Hence, characterization of phytoplankton assemblages contributes to the determination of productive potential. This study was conducted to determine the abundance, species composition and distribution of phytoplankton in Coron Bay, Calamianes, Palawan.

METHODOLOGY

A. Study Area and Field Collection

Phytoplankton samples were collected as part of a survey on coral reefs in the vicinity of Coron Bay, Calamianes Group of Islands, Palawan (Fig. 1) from 27-29 May 2004. The study area consists of several islands and islets that effectively separate the inner portion of Coron Bay, where there is little water

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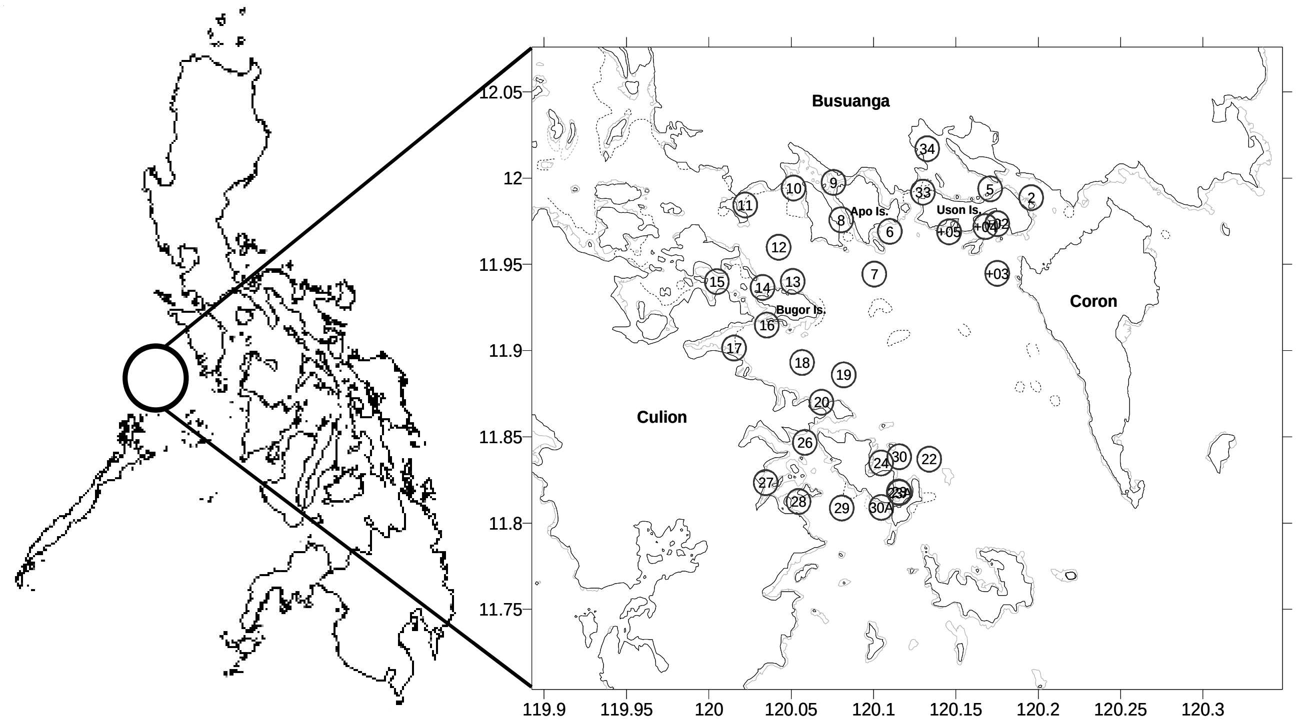

Figure 1. Map of Calamianes Group of Islands, Palawan showing station locations.

movement but with apparently high terrigenous inputs, from the main island of Busuanga. Most stations were located within the semi-enclosed area between the islands and the main island, while other stations were found in more open and exposed waters. A couple of stations were located in the vicinity of pearl farms.

Fifty liters (50L) of surface water phytoplankton were collected in each of the 33 stations using a 10L bucket and were then filtered through a 20µm mesh plankton net. Samples were then placed in properly labeled container bottles and preserved in 10% buffered formaldehyde solution.

B. Laboratory Analysis

The volume of collected samples from each station was standardized to 20ml. For the first few samples, a series of 1ml aliquots were examined with the use of a Sedgwick-Rafter counting cell. The genera cumulative curve constructed from these initial data showed a minimum of five (5) aliquots were needed to adequately represent each sample. The rest of the samples were thus identified using 5 aliquots. Phytoplankton were identified to genera (lowest level possible) and were further grouped into major taxa: blue-green algae, diatoms, dinoflagellates and silicoflagellates. The taxonomic identification was based on references including Gran and Angst (1931), Shirota (1966), Ferguson (1968), Smith (1977) and Yamaji (1962).

RESULTS AND DISCUSSIONS

Density and Composition

One hundred nineteen (119) phytoplankton genera were identified. The top 20 genera (Table 1) are typical tropical phytoplankters (Sverdrup et al., 1942). Mean overall phytoplankton density for the area was 1679.4 indivL^{-1}. The diatoms dominated all samples and showed a mean density of 1432.9 indivL^{-1}, comprising 85.3% of all phytoplankton observed (Table 2). Among them, *Chaetoceros* was the most abundant, with a mean density of 669.8 indivL^{-1}. Diatoms are generally abundant in nutrient-rich nearshore waters (Valiela, 1984) and are considered as the chief component of phytoplankton in the marine environment (Sverdrup et al., 1942).

Table 1
Mean density (indivL^{-1}) and relative density (%) of the top 20 phytoplankton genera (n=119) in Calamianes

Genera	Mean Density	Sd	Relative Density
Chaetoceros	669.84	928.86	45.34
Bacteriastrum	318.11	471.49	21.53
Coscinodiscus	102.44	112.19	6.93
Rhizosolenia	64.94	76.68	4.40
Nitzchia	46.78	68.62	3.17
Peridinium	37.15	41.71	2.51
Tintinnopsis	32.33	61.36	2.19
Fragillaria	26.20	49.79	1.77
Dytilum	25.54	137.38	1.73
Ceratium	21.36	22.78	1.45
Tintinidium	21.30	80.13	1.44
Dactyliosolen	18.79	38.12	1.27
Eutintinnus	16.86	15.72	1.14
Thalassiothrix	16.29	25.38	1.10
Favella	12.42	29.46	0.84
Asterionella	10.81	36.23	0.73
Guinardia	9.59	18.02	0.65
Pyrophacus	9.08	16.80	0.61
Biddulpphia	9.05	10.15	0.61
Navicula	8.46	10.44	0.57

Table 2
Mean density (indivL^{-1}) and percentage composition of major taxa of phytoplankton in Calamianes

Major Taxa	Mean Density	Sd	Percentage Composition
Blue-green algae	19.4	3.2	1.2
Diatoms	1432.9	95.2	85.3
Dinoflagellates	94.8	8.1	5.6
Silicoflagellates	132.3	7.6	7.9
Total	1679.4		

The silicoflagellates were the next dominant in terms of density, comprising about 7.9% of the total phytoplankton density in the area. *Tintinnopsis* was the most abundant silicoflagellate. On the whole, dinoflagellates comprised about 5.6% of the total phytoplankton identified, with *Peridinium* as the most abundant, showing a mean density of 37.2 indivL^{-1}. It is noteworthy that some dinoflagellates and silicoflagellates share similar characteristics. Some genera of the dinoflagellates possess "cyst" stages that may look similar to silicoflagellates when viewed under the microscope (Matsuoka and Fukuyo 2000).

Dinoflagellates were the cause of a harmful algal bloom (HAB) occurrence in 2000 in Malampaya Sound, just south of the Calamianes (Borja et al., 2000). In the present study, some potentially toxic dinoflagellates, like *Ceratium* were observed with a mean density of 21.4 indivL^{-1}. This genus has been reported to cause blooms that result in harmless water discoloration in sheltered bays or enclosed coastal areas. Dense blooms, however, may cause fish and invertebrate kills due to oxygen depletion (Yasumoto et al., 1990). In addition, the same authors note that the genus *Dinophysis* may cause Diarrheic Shellfish Poisoning (DSP), even at concentrations as low as 200 cells•L^{-1}, although they rarely form dense blooms. In the present study, *Dinophysis* showed a mean density of 1.1 indivL^{-1}.

The cyanophytes, or blue-green algae, included only seven genera and showed a mean density of 19.4 indivL^{-1}. Representatives of this group include *Richelia* and *Trichodesmium*, which are known to be nitrogen-fixing organisms in the marine environment. Individuals of *Richelia* were often observed within *Rhizosolenia* or entangled in the setae of *Chaetoceros*. *Trichodesmium* was the most abundant cyanophyte. Blooms of this genus are common in subtropical and tropical waters and are believed to contribute considerably to pelagic nitrogen fixation in the oceans (Carpenter and Capone, 1992). Such blooms are formed under optimum light conditions and good vertical mixing of water layers, when low dissolve inorganic nitrogen concentrations restrict the growth and survival of competing phytoplankton populations. It is not known if such bloom-forming conditions develop in the study area. *Trichodesmium* showed a mean density of 8.2 indivL^{-1}.

Distribution

The percentage composition of phytoplankton is presented in Fig. 2.The highest mean density was recorded in station 15 (Table 3), located in a semi-enclosed bay within the boundaries of a pearl farm. High phytoplankton densities in pearl farms have been reported in Putemun Channel, southern Chile, where algal abundance was positively correlated with the pearl oyster growth (Toro et al., 1999). While the high abundance serves as a significant source of food for the oysters, the accumulation of organic material from oyster fecal material and the accompanying nutrient

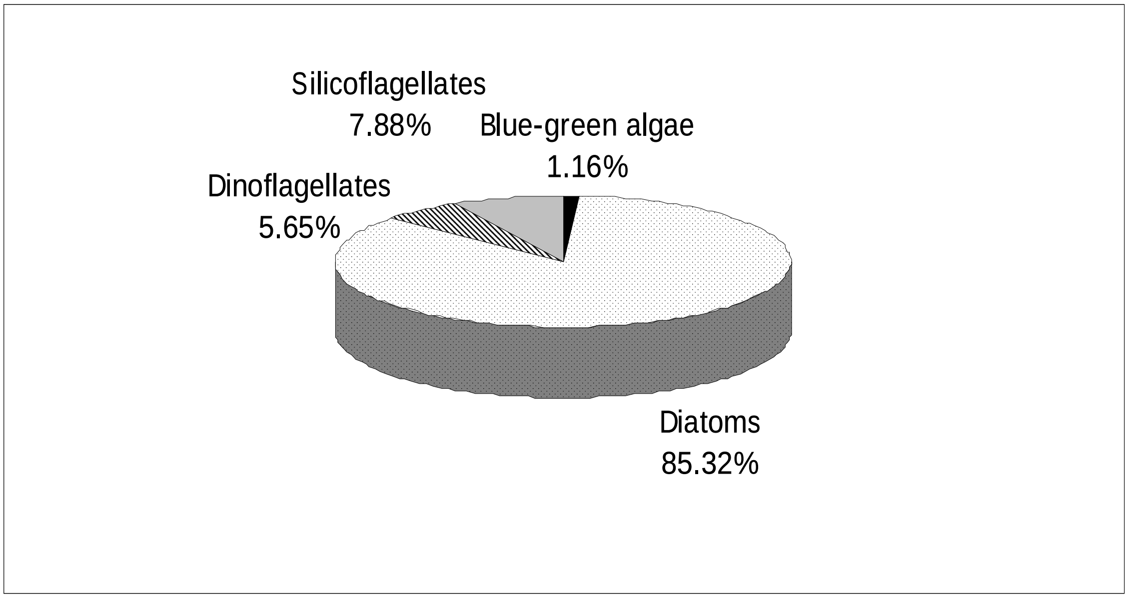

Figure 2. Percentage composition of the major taxa of phytoplankton in Calamianes.

regeneration within the immediate vicinity of the farm would tend to favor high phytoplankton densities in such areas.

In general, overall phytoplankton densities were high in the vicinity of the pearl farm and along the northern portion, but low in the southern portion of the study area (Fig. 3). Diatoms showed a distribution closely corresponding to the overall distribution (Fig. 4), although the dinoflagellates showed highest concentrations along the western portion of the study area (Fig. 5). Similarly, cyanophytes showed lowest densities in the more open stations located in the mid-portion of the study area (Fig. 6). Silicoflagellates showed a patchy distribution with little spatial pattern (Fig. 7).

It is possible that nutrient distributions are responsible for the observed spatial distribution pattern, since diatoms, dinoflagellates and cyanophytes would have different nutrient requirements. There are also other equally important factors in determining distribution, such as water exchange and currents. Overall, there appears to be lower densities along the coast of Culion Island, except in the vicinity of the pearl farm near Bugor Island (Fig. 3). There are other pearl farms along the coast of Busuanga Island, but these are located further east of the surveyed area.

Table 3
Phytoplankton mean density (indivL^{-1}) across stations in Calamianes

Stn No.	Mean Density	Stn No.	Mean Density
1	739.7	23	61.7
2	6242.4	24	833.8
3	1653.8	25	121.7
4	843.7	26	963.0
5	4972.9	27	629.5
6	3379.6	28	1305.0
7	3254.9	29	1048.6
8	1398.4	30	336.8
9	1926.2	31	797.2
10	384.0	32	2534.0
11	1968.7	33	1646.6
12	1319.5		
13	733.8		
14	1922.9	*n*	33
15	6940.4	*mean*	1,679.4
16	197.2	*med*	1,181.8
17	2392.6	*sd*	1,651.2
18	81.3	*min*	61.7
19	1111.8	*max*	6,940.4
20	731.2		
21	1181.8		
22	1765.4		

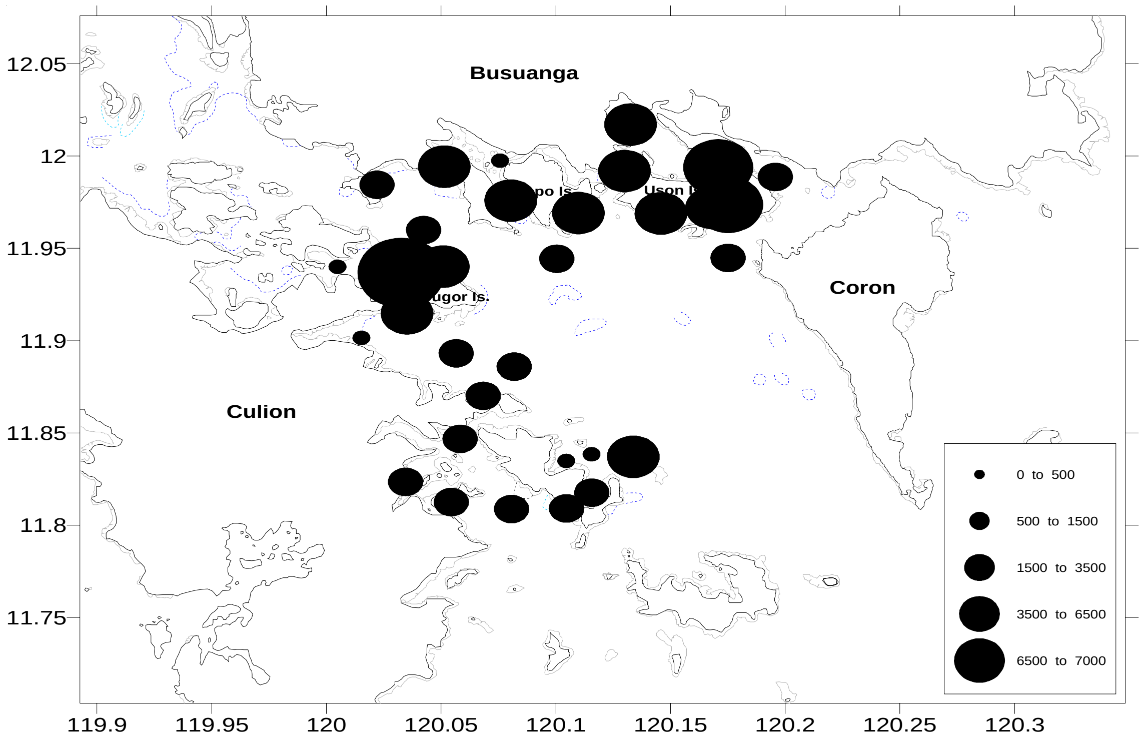

Figure 3. Density distribution (indivL^{-1}) of phytoplankton in Calamianes, Palawan (size classes: <500, 1500, 3500, 6500, 7000)

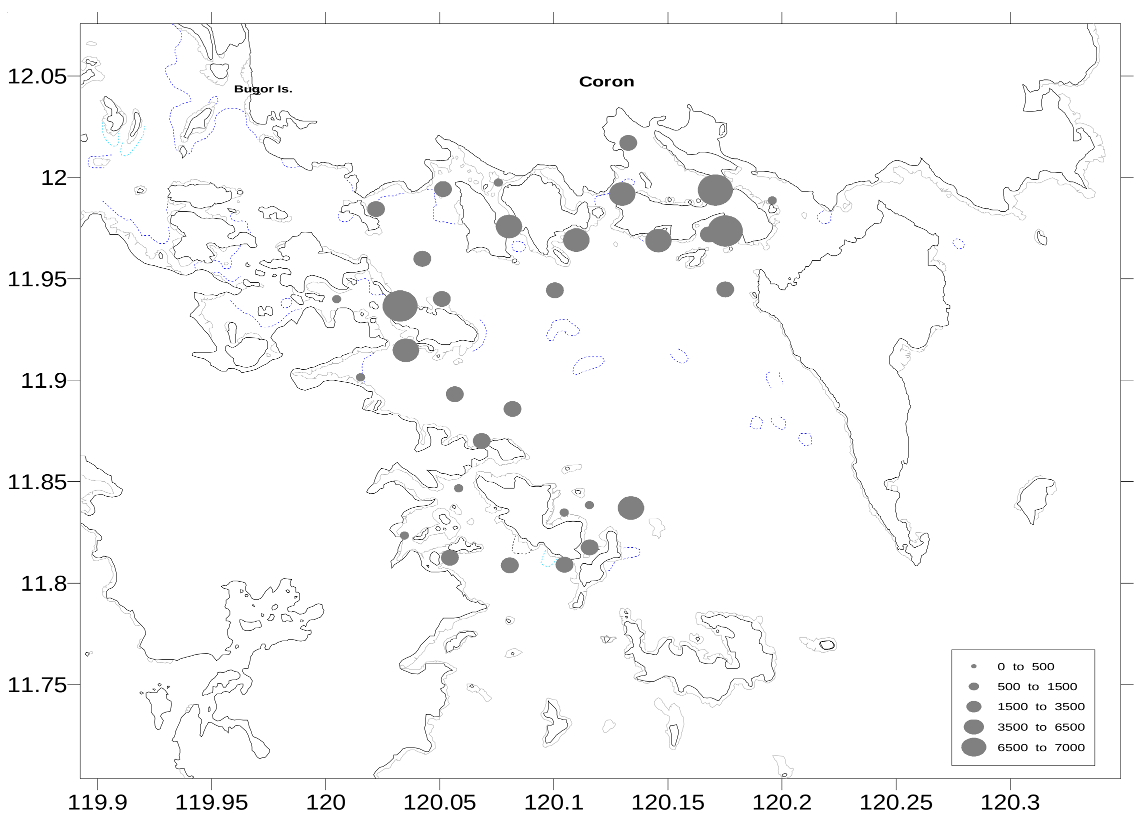

Figure 4. Density distribution (indivL^{-1}) of diatoms in Calamianes, Palawan (size classes: <500, 1500, 3500, 6500, 7000)

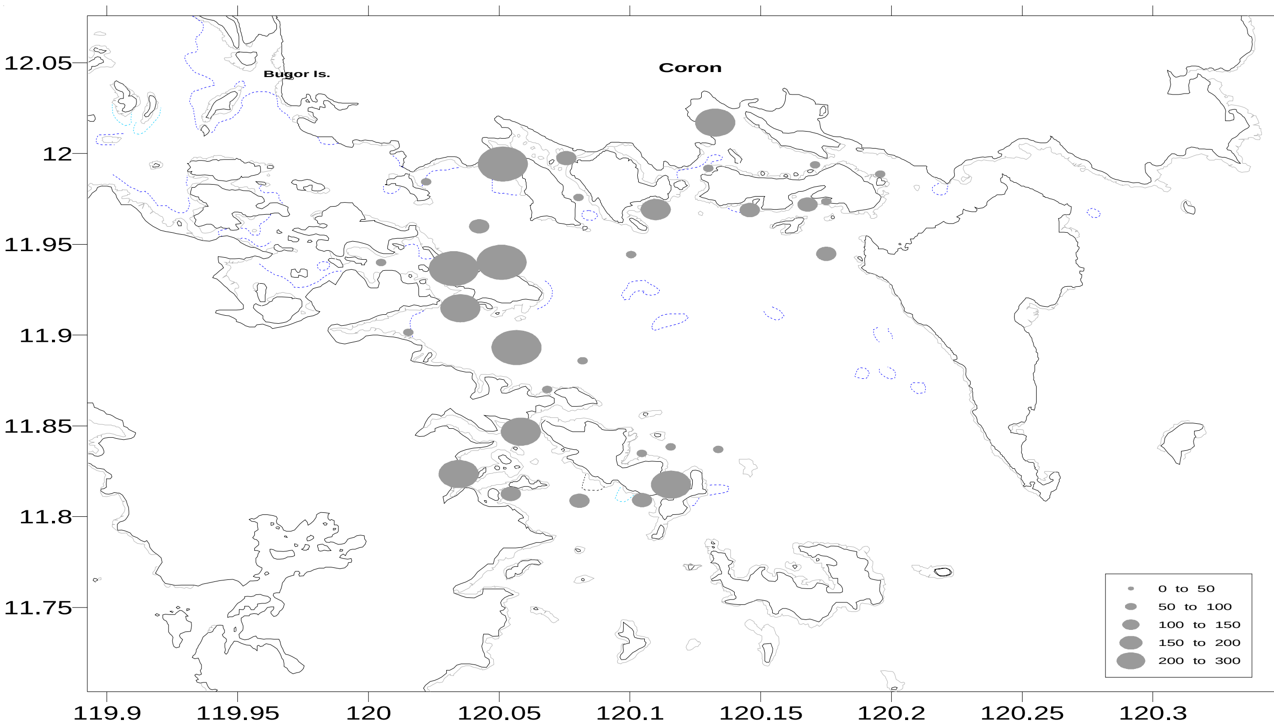

Figure 5. Density distribution (indivL^{-1}) of dinoflagellates in Calamianes, Palawan (size classes: <50, 100, 150, 200, 300)

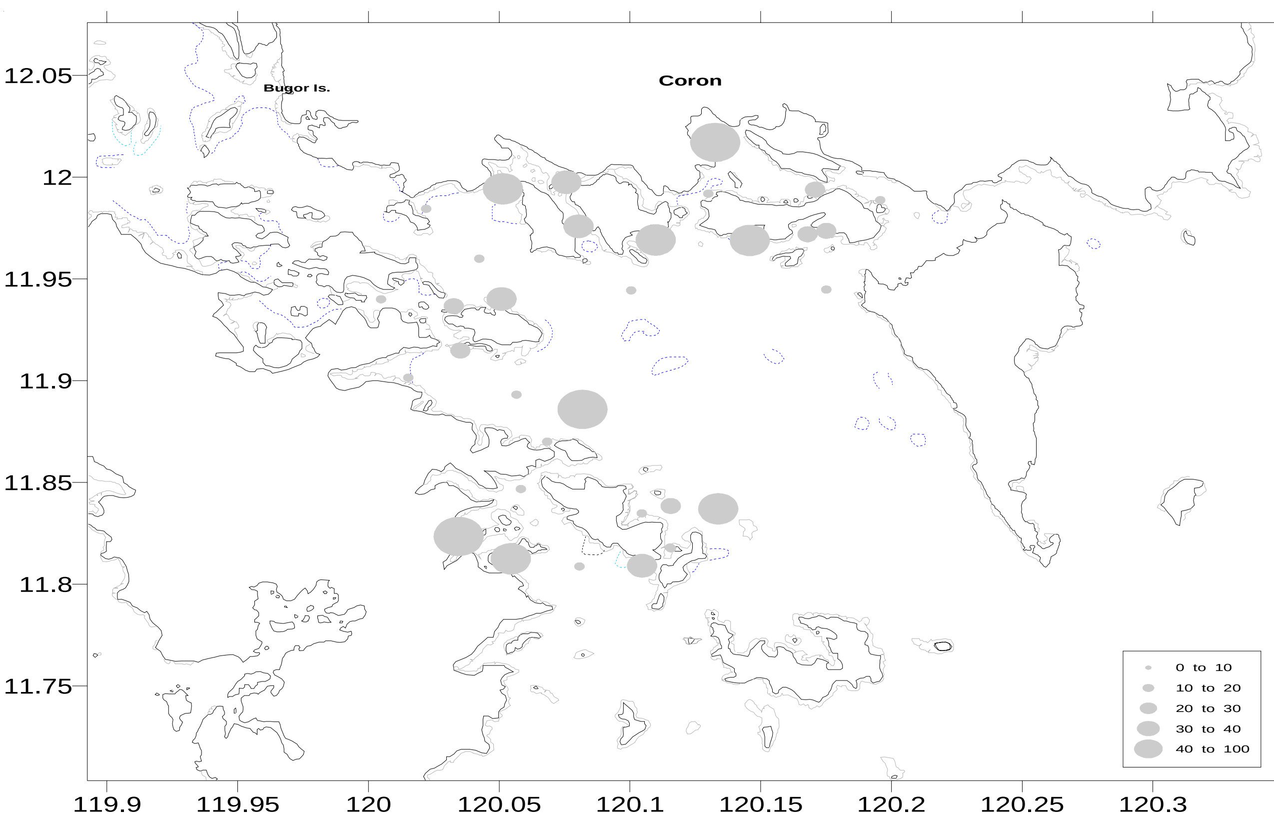

Figure 6. Density distribution (indivL^{-1}) of blue-green algae in Calamianes, Palawan (size classes: <10, 20, 30, 40, 100)

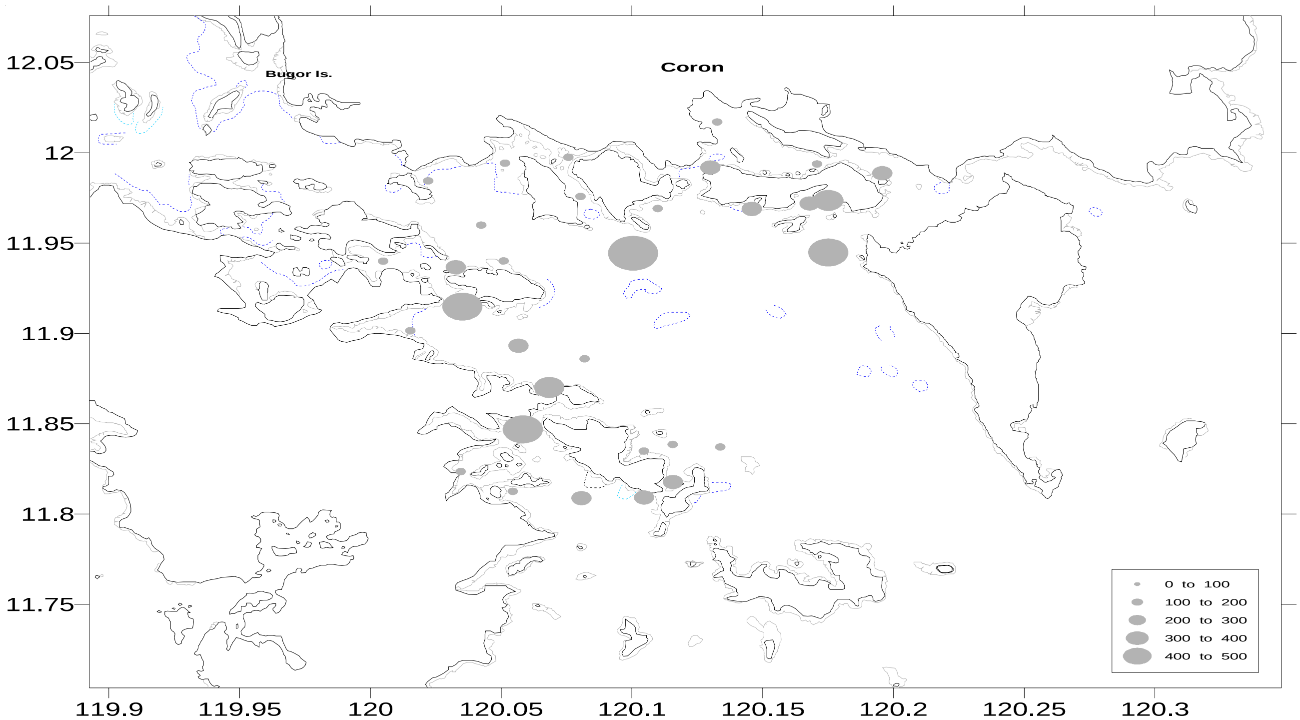

Figure 7. Density distribution (indivL^{-1}) of silicoflagellates in Calamianes, Palawan (size classes: <00, 200, 300, 400, 500)

Mangrove stands and forests line the shores of the islands along the northern portion of the study area, particularly between mainland Busuanga and the major islands of Uson, Apo and others nearby (Fig. 1). Their proliferations in this area is likely a combined result of several factors, including relative protection from rough conditions in more open areas and, as a consequence, slower water exchange and perhaps less water movement. These are typical of mangrove habitats (Lugo and Snedaker, 1974; Mann, 1982). These same conditions, along with enhanced nutrient inputs from the mangroves (Odum and Heald, 1975), may favor higher phytoplankton biomass in this area. Whether such conditions likewise prevail along the northeastern coast of Culion Island is not known, although this area seems to be more exposed and lies along the main channel of water exchange with the northern Sulu Sea where calm conditions with slow flushing are less likely to occur.

Species Richness

The number of species recorded, also termed species richness, is one way of presenting diversity in an assemblage, but its relevance and usefulness is dependent on the extent of the area surveyed or the amount of samples collected. Table 4 shows mean density estimates and number of genera of phytoplankton from four reef areas in the country, surveyed in 2004 and 2005 using the same sampling methods. Density estimates in the Calamianes area are about 33% higher than those reported for reefs in internal water basins (Danajon Bank, Bohol), but are from 2-3 times higher than those recorded in reef areas bordering open waters (Surigao del Sur and Tawi-Tawi). Similarly, the number of genera recorded in the Calamianes is much higher than those recorded in the latter.

Recent investigations in the South China Sea show that the area west of northern Palawan has higher phytoplankton biomass, as indicated by chlorophyll a concentration, than waters further north (Bajarias 2000; Furio and Borja 2000). Relatively high concentrations of chlorophyll a have also been reported for the shelf, shoal, and oceanic areas west of northern Palawan as well as in the Sulu Sea (San Diego-McGlone et al. 1999). Hence the high diversity of phytoplankton

Table 4
Phytoplankton index of richness from different studies

Site	Nearby Basin	Sampling dates	No. of stns sampled	No. genera (S)	Mean density (N)	Richness (S/√N)
Calamianes, Palawan	South China Sea	May, 2004	33	119	1679.4	2.93
Cantilan-Carascal, Surigao del Sur	Pacific Ocean	June, 2004	30	56	453.8	2.63
Tawi-tawi	Sulu/Celebes Sea	August, 2004	19	61	896.1	2.04
Danajon Bank, Bohol	Camotes Sea	December, 2005	28	80	1259.3	2.25

assemblages in the Calamianes may be attributed to the relatively high productivity of waters bordering it, while the relatively high overall concentrations are results of factors such as current and nutrient inputs which act on a more local scale.

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