Population Biology of *Tripneustes gratilla* (Linnaeus) (Echinodermata) in Seagrass Beds of Southern Guimaras, Philippines

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ABSTRACT

The sea urchin *Tripneustes gratilla* is a major grazer found in seagrass beds of southern Guimaras, Philippines. Monthly length-frequency data from January 2008 to June 2009 were used to estimate the growth, recruitment pattern and mortality rate with the use of FiSAT II. The estimated values for the Von Bertalanffy growth parameters $L\infty$ (asymptotic length) and K (growth coefficient) were 114.2 mm and 1.08 respectively. Monthly densities ranged from 0.06 to 0.58 per m^2 with a mean value of 0.26 per m^2. Monthly biomass ranged from 4.1 to 49.5 grams per m^2 with a mean value of 21.15 grams per m^2. *T. gratilla* density and biomass were observed to be highest during the month of November 2008. The recruitment pattern showed a major broad peak and a minor peak separated by four months. Total mortality (Z) from the length-converted catch curve was computed to be 4.74 per year.

Keywords: sea urchin, growth, mortality, recruitment, *Tripneustes gratilla*, guimaras

INTRODUCTION

Sea urchins are among the major grazers of seagrass coastal habitats. The presence of sea urchins in has been known to influence the community structure of marine plants and algae populations in different habitats. In some areas, overpopulation and overgrazing of sea urchins on macrophyte communities have been a major problem while in others, sea urchin stocks are collapsing due to overexploitation and improper management. Population explosions of sea urchins in some areas have caused rich kelp beds into barren sandy areas creating a significant impact in the ecosystem and species composition of the area. Because of its sedentary and lifestyle and shallow water habitat, sea urchins are vulnerable to overexploitation. Sea urchin roe is considered a delicacy among coastal communities. In the Philippines, *Tripneustes gratilla* is the most targeted because its roe which commands a high price and is preferred over roes of *Diadema setosum* and *Diadema savignyi*. Urchin roe are also used as feed for fattening lobsters. Urchins can be easily harvested by hand picking them. Divers gather urchins in subtidal areas with the use of rakes, spears or dredges. High demand for urchin roe have led to overexploitation in sea urchin stocks and led to under supplied markets (Kessing and Hall 1998 as cited by Kelly 2002). Cage culture of sea urchins and restocking activities the wild have been done in order to help maintain sea urchin stocks.

Tripneustes gratilla is the most abundant sea urchin found in the seagrass beds of southern Guimaras. In the Taklong Island National Marine Reserve and neighboring areas, it occurs together with *Salmacis belli* (Belida et al 2003). This study examined the growth, recruitment, and mortality *T. gratilla* in Southern Guimaras.

MATERIALS AND METHODS

Monthly surveys were conducted from January 2008 to June 2009 in seven stations in southern Guimaras. Three of these sites namely Nabinbinan (N 10.438 E 122.504) , San Roque (N 10.427 E 122.505) , and Kalaparan (N 10.404E 122.507) are located in the Taklong Island National Marine Reserve and the other four stations Santo Nino(N 10.454 E 122.502), Sikangkang Beach (N 10.459 E 122.501), Pulo ni Ramon (N 10.465 E 122.496), Tando (N 10.466 E 122.486) are located north of the reserve (Fig. 1).

In each station, two 50 X 2m belt transects were laid to delimit the area where the necessary data were recorded. The test diameter (from the tip of the interambulacral area to its opposite interambulacral area) of all *Tripneustes gratilla* individuals occurring within the belt transect were measured using plastic vernier calipers. Measurements were rounded off to the nearest mm. After measuring the test diameter, the sea urchins were placed outside the area covered by the transect to avoid being measured twice. Other species of sea urchins, fishes and other invertebrates which were found within the delimited area were also noted. Salinity and temperature were also recorded.

Length-frequency distributions using 5mm size classes were constructed for each month and were used to estimate growth, mortality and recruitment employing the ELEFAN routine in the FiSAT II software (FAO, 2000). Size and weight measurements were conducted periodically to derive a length-weight relationship following the model $W = aL^b$ and provide monthly sea urchin biomass.

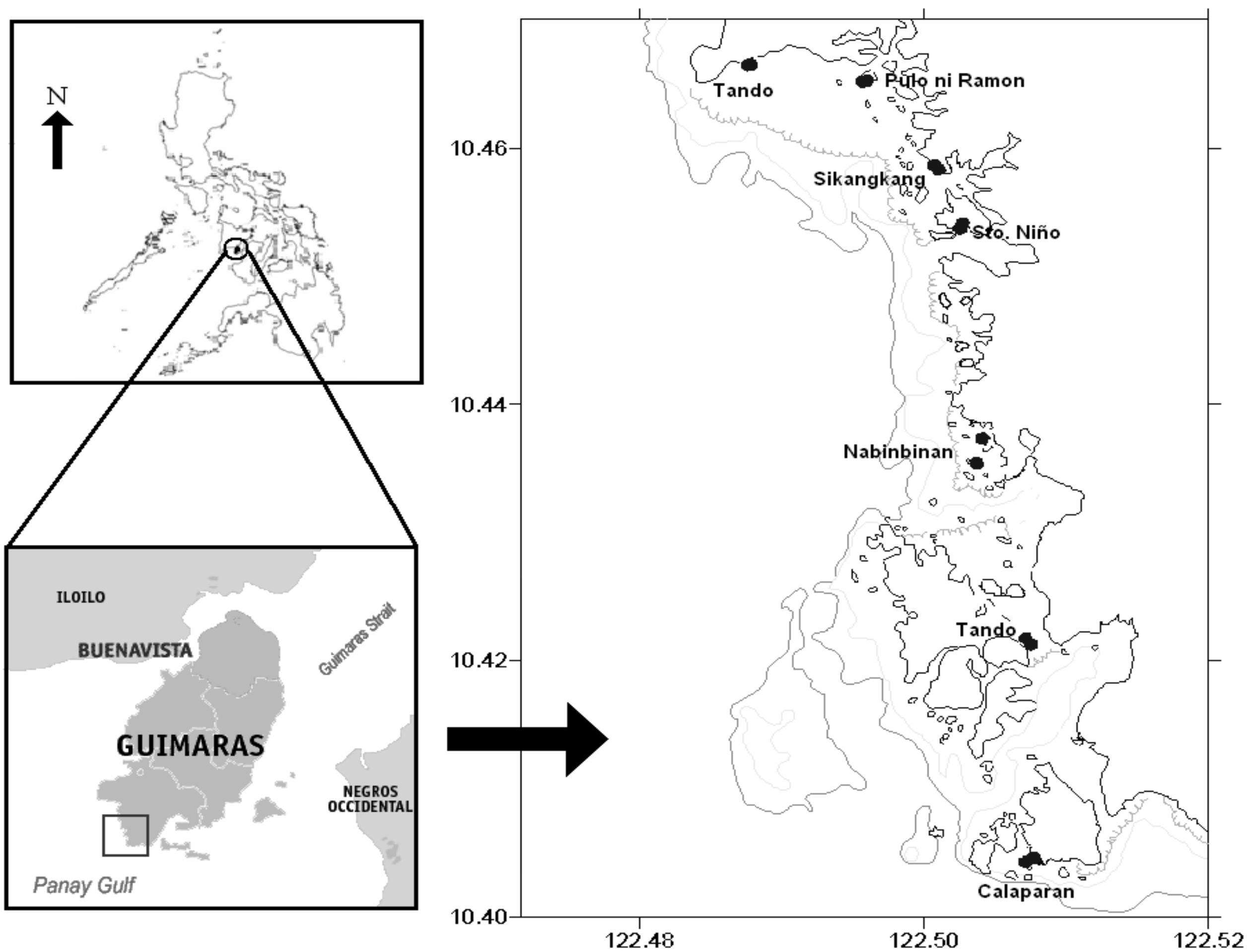

Figure1. Map showing the study area and seven sampling stations in southern Guimaras.

RESULTS

Density

A total of 5631 sea urchin individuals were recorded from January 2008 to June 2009. A peak in, *T. gratlla* density was observed in the month of November 2008 and another peak in late January 2009. Density was observed to be lowest in June 8, 2009. Density ranged form 0.06 -0.58 ind./m^2, with an average density of 0.26 ind./m^2 (Fig. 2).

Biomass

Length and weight of individuals used for the length-weight analysis ranged from 44mm-82mm and 40g-183g respectively. The length-weight relationship is shown in Fig. 3. Data from this model were used to compute biomass estimates for each month. Biomass ranged from 4.8-49.5g / m^2, with an average value of 21.15 g / m^2. Overall mean biomass across all stations was highest in November 2008 and showed a smaller peak in January 2009 (Fig. 2). Seasonal patterns in density and biomass were very similar except for the months of June 2008 and February 2009, where there were relatively large differences in their values.

Growth

The best fitting growth curve showed the values 114.2 mm for L_∞ and 1.08 for the growth constant K. The growth curve superimposed on the monthly length frequency distributions of *T. gratila* is shown in Figure 4. The four (4) curves follow the same growth model but have different starting points, which in this study corresponded to sampling dates where the smallest test diameters were recorded.

Recruitment

Figure 5 shows the estimated recruitment pattern of *T. gratilla* based from the length-frequency data. It can be observed that recruitment occurs almost all throughout the year with a major and minor peak about four months apart.

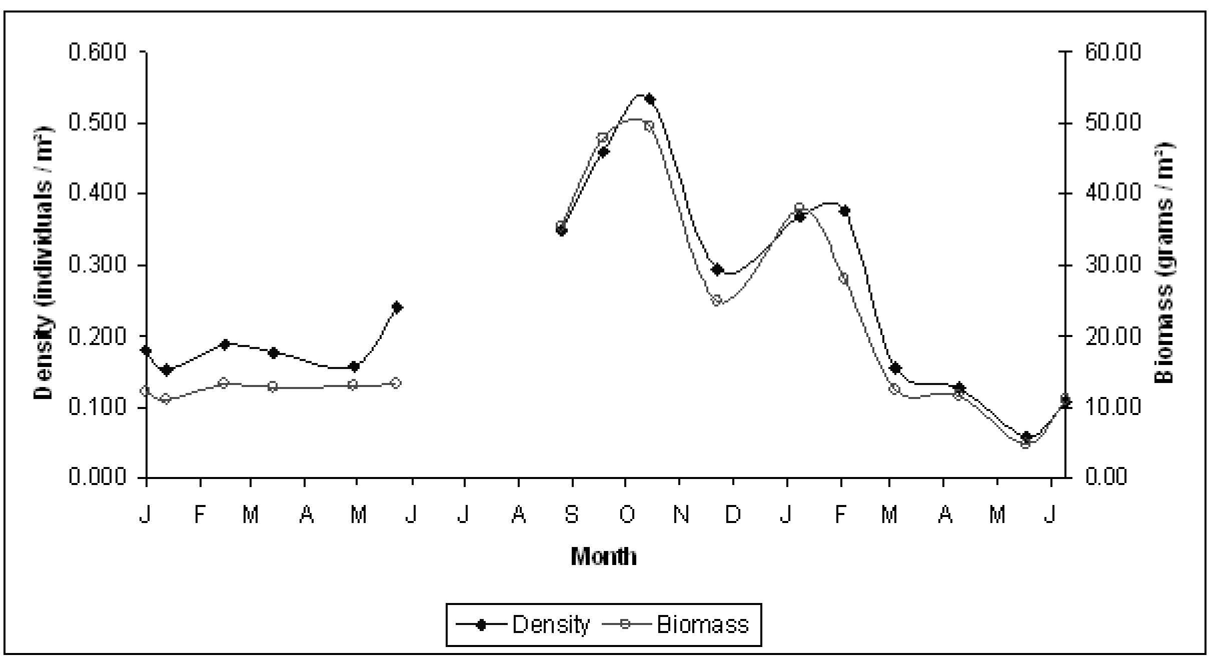

Figure 2. Monthly average density and biomass of *T. gratilla* in southern Guimaras from January 2008 to June 2009.

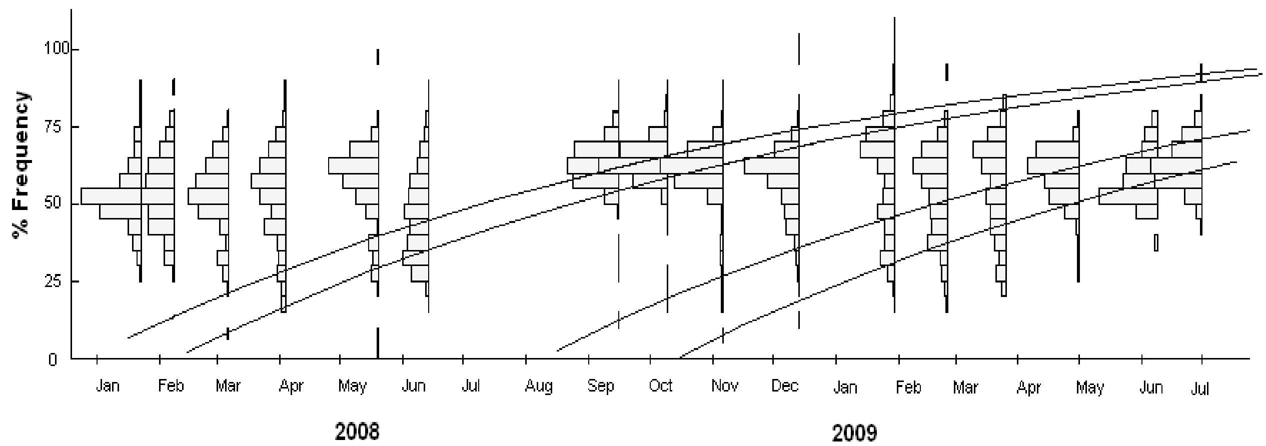

Figure 3. Size-frequency data of *T. gratilla* in southern Guimaras with superimposed Von Bertalanffy growth curve as estimated by FISAT II.

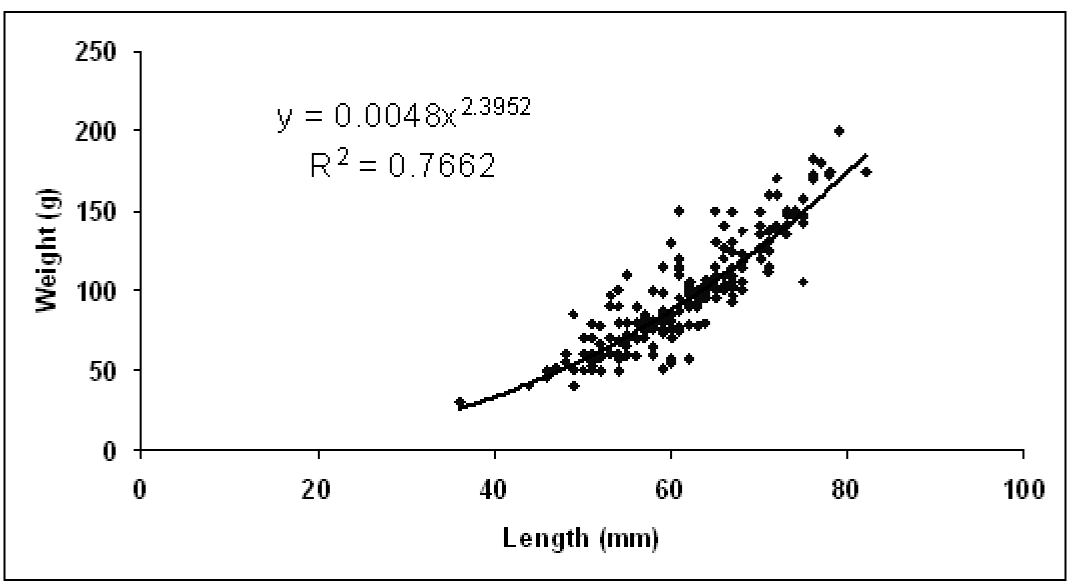

Figure 4. Length-weight relationship data of *T. gratilla* in southern Guimaras.

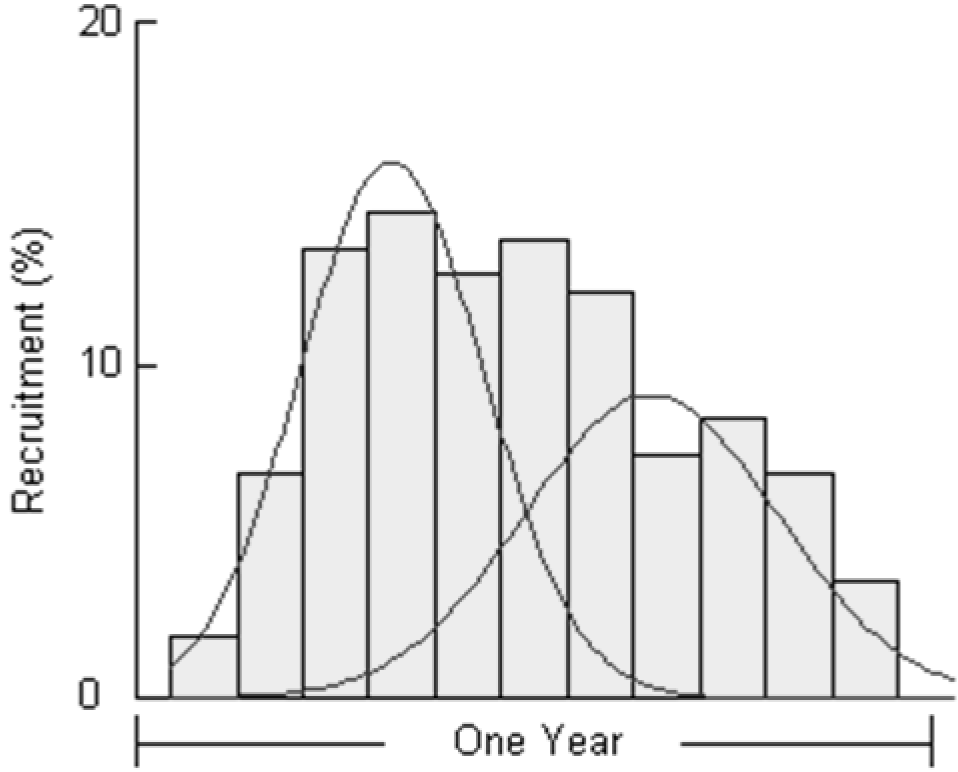

Figure 5. Recruitment pattern of *T. gratilla* in southern Guimaras showing the two recruitment pulses.

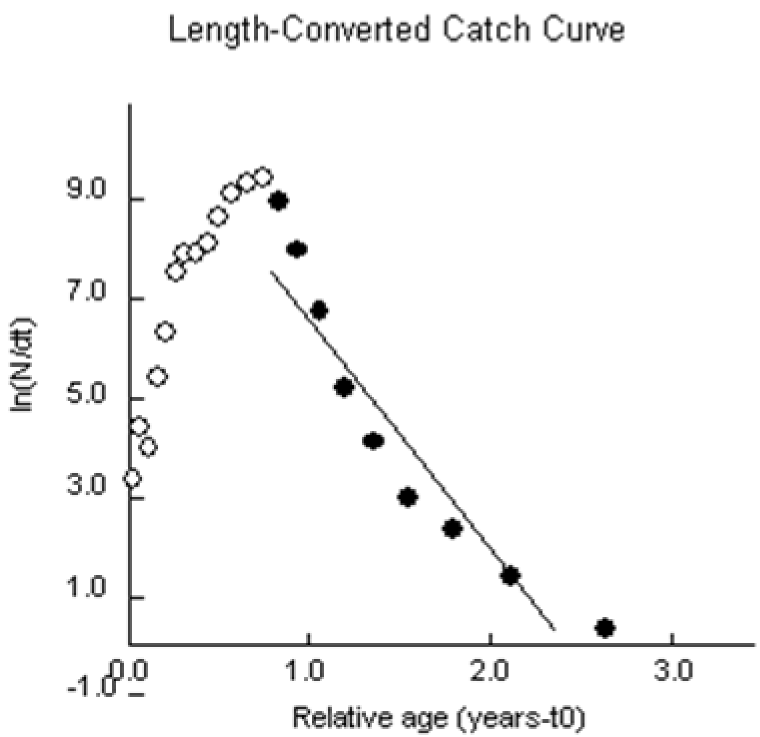

Figure 6. Length converted catch curve for *T. gratilla* in southern Guimaras.

Mortality

Total annual mortality (Z = 4.74) from the length-converted catch curve is shown in Figure 6.

DISCUSSION

The estimated values for the growth constant K and asymptotic length L for *T. gratilla* in southern Guimaras were 1.08 yr^{-1} and 114.2mm respectively. *T. gratilla* in Southern Guimaras can reach a size of 60 mm in about eight months. A study by also conducted in Southern Guimaras Beldia et. al (2001) showed *Tripneustes gratilla* reach sizes of around 40-60mm in 10 months. Southern Guimaras grow as much as 40 mm in the first four months and tapers off as it grows reaching a size of 60mm within ten months. Dafni (1992) estimated a high growth rate for *Tripneustes gratilla elatensis* which grows to 60mm in about three months. Different values for L_∞ and K obtained by Bacolod and Dy (1986) and Juinio-Menez et al. (2008) are shown in Table 1. Differences in estimates of growth parameters show that conditions of a particular site affect the growth of rate and maximum sizes of *Tripneustes gratilla*.

Seasonality and type of available food might be significant factors causing differences in growth rates and maximum size attained by sea urchins. Sea urchins under shortage of food resorb skeletal material and shrink while an abundance of food is maximized by high allocation to gonadal and somatic growth (see note by Andrew 1989). A number of studies have shown that type of food influences the growth rate of different species of sea urchin. Species of *Strongylocentrotus* (Swan 1961), *Psammechinus miliaris* (Kelly 2002), *Tripneustes gratilla* (Juinio-Menez 2008), and *Tripneustes gratilla elatensis* (Dafni 1998) showed variations in growth rate in relation to the type of food they ingest. The seagrass beds in southern Guimaras are mainly dominated by *Thalassia* and *Enhalus sp.*. During the summer months from March to May, other macroalgae species such as *Sargassum sp*. also become abundant. The estimated growth parameters of *Tripneustes gratilla* in southern Guimaras may reflect the seasonality in seagrass and algae in the area.

Tripneustes gratilla abundance was generally high during the Southwest monsoon transitions and decreased towards the summer seasons. Highest recorded densities during the study were recorded in October and November 2008. A gradual decrease followed until May 2009 (Fig. 2).

A combination of different factors such as physical exposure, recruitment variability, substratum type and disease could determine echinoid population abundance (Andrew 1989). Man-made structures like passive fishing gears and human activities like aquaculture and gleaning were also pointed out by Beldia et al. (2003) to affect sea urchin densities. Juvenile migration and movement from one place to another by adults might also affect the number of observable sea urchins in the area.

A high annual mortality rate of 99.3% (Z=4.74) was estimated using the length-converted catch curve. Bacolod and Ty (1986) estimated values of 91%

Table 1. Comparison of estimated growth parameters for *Tripneustes gratilla* from different locations in the Philippines from various studies.

Location	K	L_∞	Reference
Danahon Bank, Bohol	1.8	108	Bocolod and Dy, 1986
Pisalayan, Bolinao	1.7	8.2	Menez et al., 2008
Quezon Island, Bolinao	1.3	113	Menez et al., 2008
Southern Guimaras	1.08	114.2	…

mortality for *T. gratilla* in Danajon Reef, Central Philippines. Juinio-Menez (2008) also report high natural mortality rates of 91-96% from different sites in Northwestern Luzon. Even in the absence of a local fishery for sea urchins, the stock in southern Guimaras still has a high annual mortality rate. This may be attributed to such factors like habitat conditions, predation and disease. Heavy rains and bad weather have been observed to kill sea urchins (Vaitilingon 2005). Different species of starfish, wrass, wolf fish and decapods have been reported to be among predators of sea urchins (Pearse 1987, Bernstein 1981). On rare occasions during field surveys, the starfish *Protoreaster nodosus* was observed to prey on sea urchins. Starfish have also been reported to feed on juvenile sea urchins, which eventually would affect the visible population of the area (Pearse 1987). Further investigations on predator pressure may give more insight on how predation affects changes in sea urchin population.

Sea urchin survivorship in southern Guimaras may be dependent on the changes in its habitat which is in this case the seagrass beds. Storms and heavy waves can destroy or damage the seagrass which are the main diet of sea urchins. Without a thick seagrass cover sea urchins particularly the juveniles may also be more exposed to predators.

Recruitment patterns based on length frequency data show recruitment occurring almost all throughout the year with two peaks separated by four to five months. Beldia (2003) determined two major recruitment pulses in southern Guimaras occur annually: a small peak in June and a major peak in November. The number of recruits in an area greatly depends on the availability of competent larvae in the water column that could settle in the appropriate substratum on the one hand, and the mortality of newly settled juveniles (Cameron and Schroeter 1980, Tegner and Dayton 1977) on the other. Successful larval settlement in an area may also be influenced by biotic factors such as natural chemical settlement cues from different algae (Swanson et al. 2004, Swanson et al. 2006, Williamson 2000) marine biofilms (Naidenko 1996) and presence of conspecific adults (Dworjanyn, and Pirozzi 2007, see also reviews by Pawlik 1992 and Rodriguez 1993).

The reproductive activity of *T. gratilla* has an extended breeding season lasting for several months, a resting period and another period with less intense spawning activity (Formacion 1985 and Tuason 1975). This pattern of spawning behavior agrees well with the derived recruitment pattern, having one major peak and a minor peak occurring about four months later.

Comparison of density and biomass estimates shows younger and lighter individuals to occur in June 2008 and February 2009. This may indicate high number of recruitment for this month (Beldia et. al 2003). The occurrence of spawning activity of *T. gratilla* from March to July and another in December (Formacion 1985) may be used as basis for the high number of recruits.

T. gratilla densities in southern Guimaras right after the MV Solar 1 oilspill were found to be about half of what were previously occurred (Beldia et al., 2003 and Campos & Regalado 2009). Densities obtained by Beldia et. al (2003) from 2000-2002 can be characterized by heavy recruitment, followed by a sharp decrease in population. numbers. Such pattern of rare (once in ten years) episodic increase in urchin populations (*Strongylocentrotus purpuratus)* has been observed by Pearse (1987) in temperate waters. There are no such reports for urchins in the tropics.

Examining other factors such as seasonal changes in habitat and other species that may directly affect sea urchin population must also be conducted. Only by this and by continuously monitoring long term changes in sea urchin population can we characterize the pattern of urchin fluctuations in southern Guimaras. Short term data may not be sufficient to give substantial information to the extent of variability and fluctuation of sea urchin density. Long term monitoring of urchin populations may give a clearer picture on the fluctuations of densities and confirm if indeed the recorded high by Beldia et al. (2003) and the low densities in months after the MV Solar 1 Oilspill is part of the natural fluctuation in urchin densities in southern Guimaras or could be attributed to effects of the oilspill.

In Taklong Island National Marine Reserve, the large difference in densities from the time of Beldia et al 's

(2003) study to the present suggests that growth and mortality would also likely differ. Because of their dominance in seagrass beds in the study area, it is important that variability in population dynamics of *T. gratila* between years and over longer periods are examined to better understand their role in seagrass bed trophodynamics.

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