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Abundance of coral-polyp-eating gastropods *Drupella cornus* in Bunaken National Park, Indonesia: indicating anthropogenic impact?

Kelimpahan gastropod pemakan polip karang *Drupella cornus* di Taman Nasional Bunaken, Indonesia: indikasi pengaruh aktifitas manusia?

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Abstract: Corallivorous gastropods, *Drupella cornus* are living in the Indo Pacific coral reefs. To assess the distribution of the snails at Bunaken National Park in Indonesia, a study has been conducted on three zones established in three main islands of the park: core, tourism, and exploitation zones. The zones represent degrees of human interventions in which the least intervention is for core zone, moderate for tourism zone and high for the exploitation zone. The results showed that degrees of human interventions are related to the density of snails where the least human intervention zone (the core zone) had low numbers of snails while the high human intervention (exploitation) zone had high numbers of snails. Three corals in the zones that were preferred by the snails were: *Montipora* spp., *Acropora* spp., and *Porites* spp. The numbers of snails living on the corals followed the percent of coral cover©

Keywords: *Drupella cornus*; corallivorous gastropod; Bunaken National Park; Indonesia.

Abstrak: Gastropod pemakan polip karang, *Drupella cornus* hidup di areal terumbu karang Indo-Pasifik. Untuk mengetahui distribusi dari siput di Taman Nasional Bunaken, sebuah studi telah dilakukan pada tiga zona yang ditetapkan di tiga pulau utama di taman nasional ini: zona inti, zona pariwisata, dan zona pemanfaatan. Hasil penelitian ini menunjukkan bahwa tinggi-rendahnya intervensi manusia berhubungan dengan kepadatan siput di mana zona yang memiliki intervensi terendah (zona inti) memiliki jumlah siput sedikit sementara zona dengan intervensi tertinggi (zone pemanfaatan) memiliki jumlah siput terbanyak. Tiga spesies karang di ketiga zona ini yang disukai oleh siput adalah *Montipora* spp., *Acropora* spp., and *Porites* spp. Jumlah siput yang hidup di karang mengikuti jumlah persen tutupan karang©

Kata-kata kunci: *Drupella cornus*; gastropoda corallivorus; Taman Nasional Bunaken; Indonesia.

INTRODUCTION

The muricid gastropod *Drupella cornus* and the crown-of-thorns starfish, *Acanthaster planci*, have been widely known as predators on coral polyps in the Indo-Pacific region especially in the tropical part of the region (Cumming, 1999; Johnson and Cumming, 1995). Their activities create scars on coral skeletons by removing the soft tissue of the corals or coral polyps with their feeding apparatus (McClanahan, 1994). Since the snails depend on live polyps they are categorised as habitat dependent species (McClanahan, 1994; Kita, *et al.*, 2005).

Although not as massive or destructive as the coral eating starfish, *Acanthaster planci* (Baker, *et al.*, 2008), an outbreak of *Drupella* snails could lead to a great damage on the reef ecosystem. Once present, their population may increase (Black and Johnson, 1994), and their biomass may reach up to 30 percent of the total molluscs in the coral reefs (Sorokin, 1993). They can cause greater than three-quarter decline of coral cover, as occurred in the Ningaloo Reef in Western Australia (Stoddart, 1989). For that reason, the presence of *Drupella* snails may become a threat to corals in other regions including North Sulawesi, Indonesia.

Bunaken National Park (BNP) in North Sulawesi is a protected area in Indonesia in which *Drupella cornus* is found. Previous studies showed several records of *D. cornus* in the Park with a density up to 7 ind.m^{-2} (Boneka *et al.*, 1999; Boneka, 2002; Burghardt *et al.*, 2006). The park has been divided in three major conservation zones: core zone (restricted zone), tourism zone (limited use zone), and exploitation zone (intensive use

zone). The zoning system has existed for more than ten years under a tight control of BNP Authority, and is considered to represent human interference on the reefs or anthropogenic impacts. The core zone is a very restricted zone where human impacts are limited to controlled research. Fish exploitation and other activities beyond research are prohibited in this zone. The tourism zone is merely for tourism and research without any type of exploitation. Open access for fishing is provided in the exploitation zone. The intensity of human impact on the three zones is hypothesised to have influenced the abundance of *D. cornus*, but the extent of the impact is still unknown.

MATERIALS & METHODS

Sampling of *D. cornus* was conducted in Bunaken, Manado Tua and Mantehage Islands (within BNP region) in North Sulawesi, Indonesia. The density of snails was measured in the three zones (core, tourism, and exploitation zones) in the park. The numbers of *D. cornus* and their feeding scars were recorded along 3 x 50 m line transects at 3 to10 m depth. The sampling was conducted one time only and held during the day time. The specimens were collected and measured with the sensitivity 0.05 mm.

Data Analysis

The gastropod densities in different zones were tested by ANOVA, followed by Tukey test using SPSS 14.0. Prior to the analysis, the data were tested for normal distribution. More than 70% of the data are within the range of x ± SD and categorised as normally distributed data.

RESULTS AND DISCUSSION

The density of *D. cornus* in three different zones of three different islands (Bunaken, Manado Tua, and Mantehage) is shown in Figure 1. The density increased following the zoning categories; the lowest density occurred in the core zone while the highest was in the exploitation zone. However, an exception is at the exploitation zone in Mantehage Island where the snail density was low compared to the tourism zone but not to the core zone. The statistical test showed that the density of the snails among the zones of both Bunaken and Manado Tua islands were significant at the level $p<0.001$, while the difference for Mantehage Island was significant at $p<0.02$.

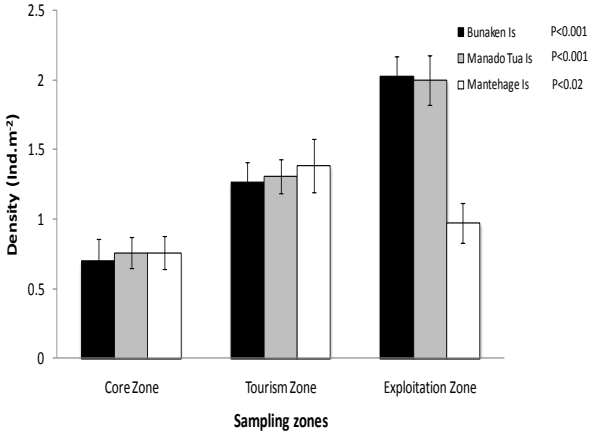

Figure 1. Density of *Drupella cornus* on three islands in Bunaken National Park (BNP), North Sulawesi, Indonesia. The densities in both Bunaken and Manado Tua islands were statistically very significant ($p<001$) [a], while for Mantehage Island was significant for $p<002$ [b].

Figure 2 shows the three main corals in the zones in which snails were found to aggregate: *Montipora* spp., *Acropora* spp., and *Porites* spp. The highest percentage of snails was recorded at the highest coral cover species, *Montipora* spp. while the lowest percentage was recorded at the least coral cover species, *Porites* spp. Furthermore, shell size distribution of the snails was similar among three different zones (Fig. 3). The size of the shells in the core zones in all islands was (x ± SD) 29.3 ± 1.6 mm, 30.2 ± 1.5 mm in the tourism zones of the islands and 29.1 ± 1.6 mm in the exploitation zones, respectively.

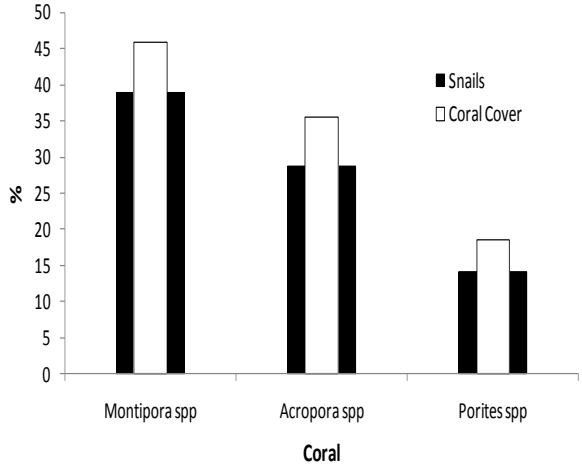

Figure 2. Percent cover of main corals recorded at the study site and the percentage of *Drupella cornus* snails found in the corals.

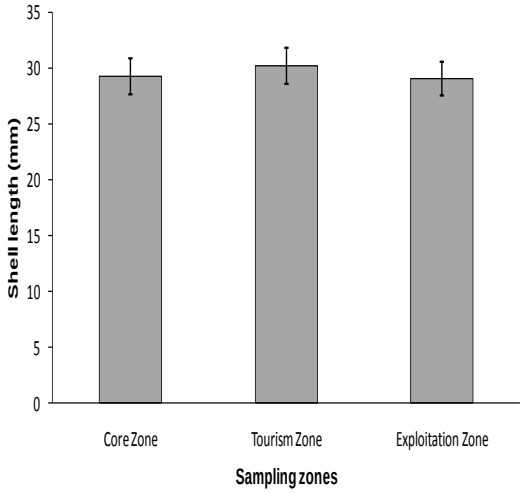

Fig. 3. Shell size distribution (in length) (x ± SD) of *Drupella cornus* collected from three management zones.

The difference in snail density between zones in the sampling sites (islands) may indicate the difference in the intensity of activities of local fishermen or other users at the studied areas. The results of this study agree with the hypothesis that density of *D. cornus* is high in the high pressure exploitation zone and low in the low pressure core zone (McClanahan, 2002). The population growth of *Drupella* can be caused by missing predators due to increasing fishing activities (McClanahan, 1994). In this study, the absence of predatory fishes in the exploitation zone is assumed to be due to intensive fishing activities. This is different from the other zones where some fish were recorded visually. However, as most snails were adults, the particular predators for this life-stage may be rare. To crush the thick shells of adult snails, a predator needs considerable power. Therefore, predation on the snails may mainly occur in their larval or juvenile stages. This study confirms that there is very little indication of predation on the adult stage, based on the data that show similarity of shell sizes of the adults (Fig. 3).

Several previous studies have recorded that the snails prefer to prey mostly on *Acropora, Montipora* and *Porites* (Antonius and Riegl, 1997; Johnson *et al.*, 1993; Boneka *et al.*, 1999; Zuschin *et al.*, 2001; Morton and Blackmore, 2009; Schoepf *et al.*, 2010). This study supports the snail preferences on those coral species (Fig. 2). The polyacetylenic fatty acids in particular corals (such as in *Acropora* spp. and *Montipora* spp.) that are cytotoxic and antibacterial are believed to attract the snails (Kita *et al.*, 2005). Furthermore, the destroyed area is also a good hiding place for corallivorous snails and it becomes a place where the snails eat the polyps nearby (Cumming, 1999; 2002). As the exploitation area is susceptible for coral breaking due to human activities, broken corals might trigger the production of excess coral mucus (Baker *et al.*, 2008) which might attract the predatory snails (Morton *et al.*, 2002).

Intensive human activities in the exploitation zone not only decrease the numbers of fish in the area, but also increase habitat destruction by boat anchoring as well as erratic fishing activities. With increased coral breakage, more snails will aggregate and consume coral polyps, although the snails may finally disappear due to lack of food sources. Therefore, increasing human activities may lead to coral destruction both directly and indirectly.

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