INTERTIDAL ABALONES ON THE COAST OF NORTH SULAWESI: A SURVEY OF THE DISTRIBUTION AND ABUNDANCE OF *HALIOTIS VARIA* AND *H. ASININA*

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ABSTRACT

Abalones were studied in intertidal areas on the coast of North Sulawesi. Populations were sampled along transects. Two species amounting to 517 specimens were collected from 6 localities. The most abundant abalone was *Haliotis varia* L., 1758 (n = 497)with a length range from 1.0 to 6.0 cm and widths from 1.5 to 4.5 cm. *H. asinina* L., 1758 (n = 20) had a length range from 2.8 to 6.4cm and widths from 2.0 to 3.7 cm. Abalones were encountered at densities from 1 to 8 ind/m^2.

INTRODUCTION

Molluscs are an important and highly diverse marine resource. According to Dharma (1988), the phylum Mollusca, in terms of species numbers, is the second largest after arthropods. In Indo-Pacific waters, Indonesia is known as a region rich in molluscs species (Soemodihardjo and Kastoro, 1982) but little is known about their distribution and abundance. Among the molluscs, Gastropoda is the richest class in terms of species number and has in Indonesian waters great economical importance. The archaeogastropod *Haliotis* is highly regarded for both meat and shell. According to Dance (1977), at least 21 species of *Haliotis* have been identified including *H.asinina* and *H. varia*. Both species have previously been recorded in North Sulawesi waters where *H. varia* was found to be the most common. The objective of this study was first to make a field investigation of the abundance and distribution of *Haliotis* in general, and second to study the distribution and abundance of the common *H. varia* along the coast of North Sulawesi.

MATERIALS AND METHODS

The animals were sampled by gently removing individuals from the substratum using a thin bladed knife. They were immediately fixed in 10% formalin and later transferred to 70% ethanol for further handling. Length and width were measured with a caliper to the nearest 1.0 mm. Weight was measured to the nearest 0.01 g.

Field Sampling

Transect lines were arbitrarily deployed on intertidal coral reef flats at low tide. The type of substrata were mostly dead coral and rock. All sites had similar substrata except the Malalayang site which was only rock. Animals found along these lines were collected within 1 m on each side (with one exception as shown below). Field sampling occurred at six localities: Likupang (transect 2 m width x 50 m length), Talise (2 m x 100 m), Malalayang (2 m x 25 m), Mokupa (2 m x 50 m), Kapitu (2 m x 50 m), and Teep Bay (4 stations along 2 m x 50 m transects except station 1 that was only 1 m x 10 m, (Fig. 1)). At Mokupa the 3 transects were sampled two times.Statistical analysis was carried out at the 3 sites: Teep, Kapitu, and Mokupa.

Data Analysis

Length - weight relationship were calculated by using the formula log Y = a + b log X, where Y is the dependent variable (weight) and X is the independent variable (shell length).

Size frequency distributions were calculated according to Sudjana (1988). Comparison between locations were done by non-parametric Mann-Whitney test (Elliott, 1977; Praptono, 1986; Fowler & Cohen, 1990; Rice, 1988).

RESULTS AND DISCUSSION

The genus *Haliotis*

From the six localities observed, two species of *Haliotis* were recorded, namely *H. varia* and *H. asinina* identical to the description of the species recorded in Thailand (Nateewathana & Hylleberg, 1986) and in the Philippines (Fuse, 1981) based on the description given by Dance (1977).

The size range of 20 specimens of *Haliotis asinina* was 2.8 - 6.4 cm length and 2.0 - 3.7 cm width. Samples from Talise Island, North Sulawesi.

The size range of 497 specimens of *Haliotis varia* was 1.0-6.0 cm length and 1.5-4.5 cm width. Samples from Likupang, Talise, Malalayang, Mokupa, Kapitu, and Teep Bay.

H. varia was recorded in all the investigated localities while *H. asinina* was only found at Talise Island. The caurse of this limited distribution is not understood and needs further investigation.

Haliotis was generally found in habitats consisting of reef flats with mangroves, but was also found on rocky substrata as in Malalayang. *Haliotis* is a herbivore. Newly metamorphosed *Haliotis* feed on diatom film and other small unicellular algae (Nateewathana & Hylleberg, 1986). The diet will change towards larger algae as the animals grow.

Abundance

A population study was made to determine the abundance of *H. varia* and to make comparisons between sites. The density of *H. varia* varied between 1 and 8 ind./m^2. *H. varia* co-occurred with the gastropod *Turbo* spp. in addition to sea urchins, polychaetes and various fish. According to Bech (1993), juvenile *H. varia* are more susceptable to predators than adults.The observed densities are higher than the ones observed at Phuket Island, Thailand, by Nateewathana & Hylleberg (1986). These authors found only few individuals and considered this to be caused by shell collectors, limited occurrence of algae, competition and predation.

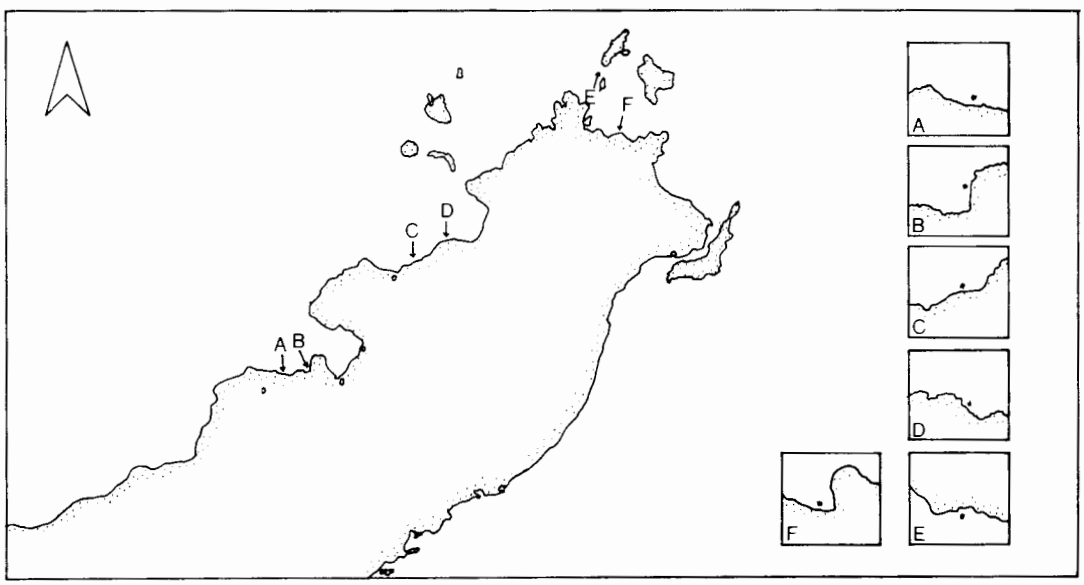

Figure 1. Sampling sites. A. Teep; B. Kapitu; C. Mokupa; D. Malalayang; E. Talise; F. Likupang.

Length-weight relationship

Based on the number of individuals collected, the 3 sites at Teep, Kapitu, and Mokupa, were analyzed in details. The 4 stations at Teep and at Kapitu were pooled. The results of the calculated length (L) and weight (W) relationship was:
Teep: log W = -0.59 + 2.67 log L (r = 0.92);
Kapitu: log W = -0.68 + 2.81 log L (r = 0.90);
Mokupa: log W = -0.75 + 3.01 log L (r = 0.85).
According to Fuze (1981), *H. varia* is fully mature at a shell length at 2.7 cm.

Size Frequency Distributions

The size frequency distribution for each locality is shown in Figs. 2, 3 & 4. These figures show that the size distribution of the population at Mokupa (Fig. 4) was significantly different from the size distribution of the populations at Teep and Kapitu, while the populations at Teep and Kapitu were not significantly different from each other (p = 0.5477, Mann-Whitney Confidence Interval and Test of samples analysis).

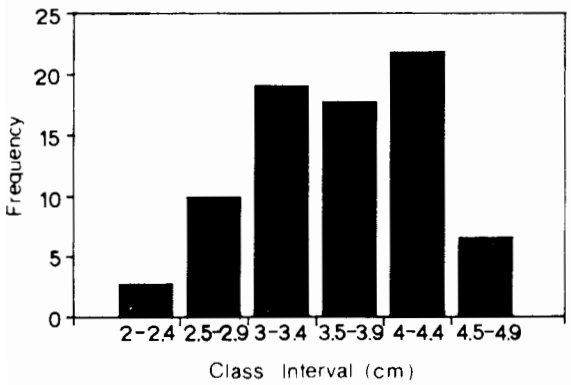

Figure 2. Size frequency distribution of *H. varia* at Teep.

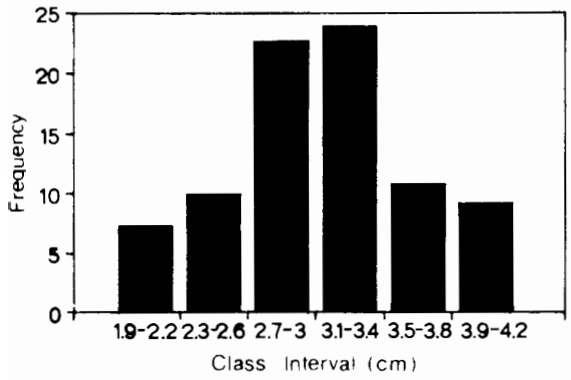

Figure 3. Size frequency distribution of *H. varia* at Kapitu.

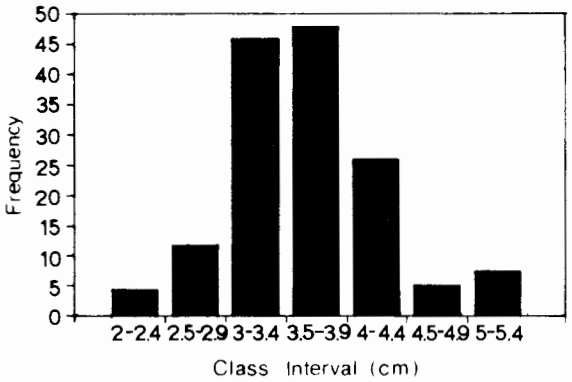

Figure 4. Size frequency distribution of *H. varia* at Mokupa.

Sex Ratios

The sex ratios of the different populations investigated in this study are shown in Fig. 5.The sexes were separated according to Fuse (1981) and Nateewathana & Hylleberg (1986). More males than females were found at all stations (Fig. 5). But it should be noted that that many of the animals were small, and the sex is difficult to determine by visual comparisons of small individuals. Sexually mature abalones can be separate on the horn-shaped gonad, as seen by folding back the mantle margin at the rear of the animal, displaying a beige or white to almost orange colour in the males and different shades of green in the females.

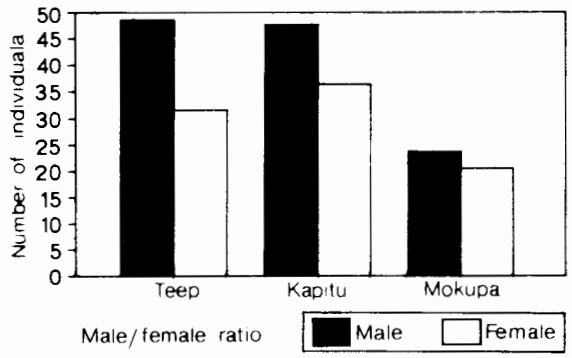

Figure 5. Ratio male/female of *H. varia*. (The sample from Mokupa encompassed only one station).

Substratum Preference

An attempt was made to analyze the relationship between substratum size (dead coral/rock diameter) and length of shell. Data from Mokupa were analyzed from 3 stations each with 3 replicates. A posi-

tive correlation between rock size and shell length was found. However, the lineary fit was low (r = 0.125). A positive correlation may be related to food availability in relation to rock size but also habitat heterogeneity.

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