

REPRODUCTION OF *HALIOTIS ASININA* LINNAEUS IN NHA TRANG BAY, SOUTH CENTRAL VIETNAM

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ABSTRACT

Two hundred and thirty-five abalone *Haliotis asinina* Linnaeus were collected in Nha Trang Bay, South Central Viet Nam for studies of the gonads and testis. The spawning season extended all the year round in 1997, but peaks were found between January and September. Females attained sexual maturity at 61.1 mm shell length (27.9 mm shell width). Males were sexually mature at 44.7 mm shell length (20.7 mm shell width). The sex ratio was very close to 1:1. The fecundity varied from 740,000 to 2,876,667 eggs per female.

INTRODUCTION

There are three species of abalone in Nha Trang Bay: *Haliotis ovina* Gmelin, *H. asinina* Linnaeus and *H. varia* Linnaeus (Nguyen Van Chung & Le Due Minh, 1996). Among them *H. asinina* is the largest and the commercially most important species. This paper presents surveys of spawning season, size at sexual maturity, sex ratio and fecundity of *H. asinina* (Fig. 1). Knowledge of the reproductive biology of *H. asinina* has become important for management of natural stocks and to the establishment of successful aquaculture.

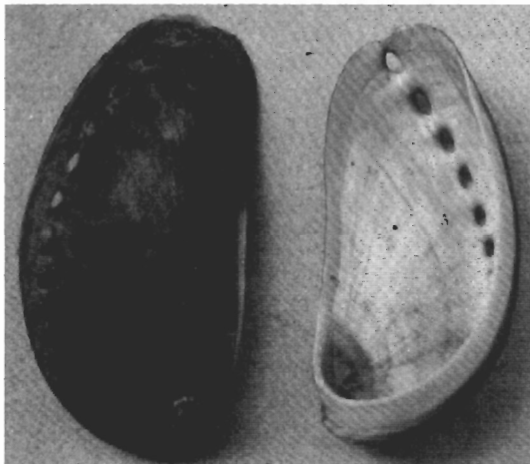


Fig. 1. *Haliotis asinina* in Nha Trang Bay

MATERIALS AND METHODS

The survey was carried out on islands in Nha Trang Bay, South Central Vietnam during 1997 (Fig. 2). The animals were sampled monthly by removing individuals from rocky crevices by using a blunt knife. All individuals were sexed, measured (shell length) weighed (body wet weight) and preserved in 10% buffered formalin for histological study.

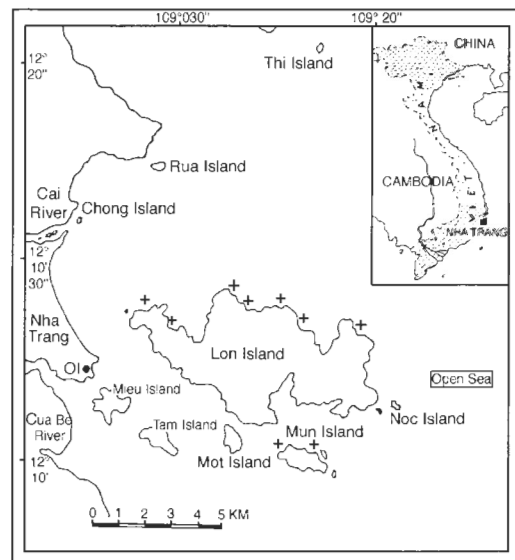


Fig. 2. Nha Trang Bay and surrounding areas. OI shows the Oceanographic Institute of Nha Trang, Vietnam.

The gonads of males and females were sectioned. The sections, 5-7 μm thick, were stained with haematoxylin-eosin and examined under a light microscope. Fecundity was calculated after counting the eggs in a subsample (Bussarawit *et al* 1990). Fecundity was estimated in females from each centimeter size class. All available size classes of *H. asinina* were collected to determine the minimum size at sexual maturity. Sex ratio was calculated for each month and later tested for significance by Chi-Squared goodness-of-fit test (Shepherd, 1974)

RESULTS AND DISCUSSION

Spawning season

H. asinina contained spermatozoa and ripe eggs during all months of the year. However, a period from January to September was characterized by increased gonad activity (Fig. 3) It is suggested that the spawning

possibly begins in spring and continues into the autumn. Nguyen Van Chung & Le Duc Minh (1996) indicated that spawning of the *H. ovina* Gmelin population in Nha Trang Bay was not synchronous, but occurred over a period from April to August. This reproductive variability between species in a relatively small area, might reflect availability of food (Shepherd and Laws, 1974).

Size at sexual maturity

The minimum size of maturity of *H. asinina* was determined by the shell length of the smallest individual containing mature oocytes. In this study males became sexually mature at a shell length of 44.7 mm, while females attained sexual mature at a length of 61.1 mm. The proportion of individuals with recognizable gonads or mature oocytes increased at shell lengths over 60 mm. All males and females over 70 mm were sexually

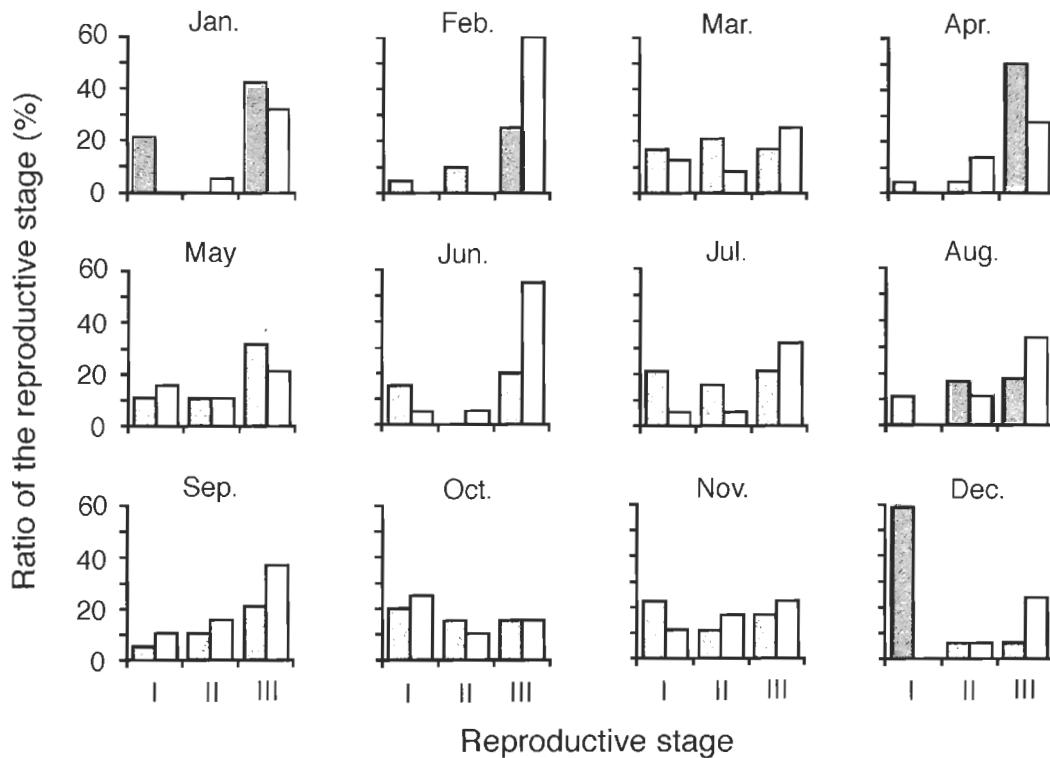


Fig. 3. The percentage composition of the reproductive stages of *Haliotis asinina* in Nha Trang Bay during 1997. Grey bars represent females, white bars show males.

mature. The age at maturity could not be deduced from the minimum size of maturity because of lack of information on the growth rate.

Sex ratio

The mean sex ratio of *H. asinina* was close to 1:1 in Nhatrang Bay as 113 were males and 112 were females (Tab. 1). No significant

Table. 1. Monthly distribution of sexes of *Haliotis asinina* during 1997.

Month	Males	Females	Total	Sex ratio	χ^2
January	7	12	19	0.58	1.32
February	12	8	20	1.50	0.80
March	11	13	24	0.85	0.17
April	9	13	22	0.69	0.73
May	9	10	19	0.90	0.05
June	13	7	20	1.86	1.80
July	8	11	19	0.73	0.47
August	8	10	18	0.80	0.22
September	12	7	19	1.71	0.66
October	10	10	20	1.00	0.00
November	9	9	18	1.00	0.00
December	5	12	17	0.42	2.88
Total	113	122	235	0.93	0.34

difference was found in the proportions of males and females over the year ($p > 0.05$). An equal sex ratio is relatively uncommon for haliotids, although other examples have been documented (Shepherd & Laws, 1974; Nguyen Van Chung, 1996). Sinclair (1963) and Shepherd & Laws (1974) found populations of *Haliotis* species with a predominance of males. Fretter & Graham (1964) found that older populations of dioecious molluscs may have more females and males.

Fecundity

Spawning of *Haliotis* species was not synchronous and gonads were usually partially spawned in specimens from in Nha Trang Bay. The number of mature eggs per female ranged from 740,000 eggs (shell length 71.3 mm) to 2,876,667 eggs (shell length 82.5 mm) (Tab. 2). Fecundity is defined as the total number of mature eggs present in the ovary prior to spawning. *H. asinina* had the highest fecundity of the abalone species inhabiting Nha Trang Bay.

Table 2. The fecundity of *H. asinina* in Nhatrang Bay.

Length (mm)	Width (mm)	Body weight (g)	Fecundity (eggs ind. ⁻¹)
80.3	37.1	78.8	1,270,000
70.9	32.9	38.2	906,000
71.3	32.1	50.5	740,000
91.3	41.1	139	922,000
87.2	39	59.8	926,000
82.5	37.6	113	2,876,667
91.6	40.8	69.8	1,863,333
78.6	39.4	92	1,236,667
72.4	31.7	59.4	773,333

The fecundity of *H. ovina* ranged from 125,300 to 768,400 mature eggs at shell lengths of 42.5 and 82.3 mm respectively. About 31,400 to 345,200 eggs were found in specimens of *H. varia* ranging from 39.4 to 52.6 mm shell length (Le Duc Minh 1997a, b).

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