

# Reproductive cycle and biometric relations in a population of *Actinopyga echinites* (Echinodermata: Holothuroidea) from the lagoon of New Caledonia, western tropical Pacific

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## 1 INTRODUCTION

Despite their importance in the benthic fauna, there is little information on tropical holothurians and their biology and ecology remain little known (Bakus, 1973). The reproductive cycles of three large species of holothurians, *Holothuria* (*Microthele*) *nobilis*, *H. (M.) fuscogilva* and *Thelenota ananas* found in New Caledonia, have been studied (Conand, 1981).

*Actinopyga echinites* (Jaeger, 1833), belonging to the family *Holothuriidae*, is common in New Caledonia (Intes and Menou, 1977) and widely distributed in the Indo-West Pacific (Clark and Rowe, 1971). This paper reports the reproductive cycle of *A. echinites*, and individual and population characteristics.

## 2 MATERIAL AND METHODS

Samples were collected from November 1978 to May 1980 in lagoon sites near Noumea (Fig. 1). Collections were made at monthly intervals by skin diving generally on the reef slope of Maitre Islet, except in November 1978 at Anse Vata site, February 1979 on Ricaudy Reef flat and for collection of a few individuals in May 1980 on Croissant Reef flat.

The abundance was estimated at first indirectly, by assessing the catch per unit effort (CPUE) or number of specimens counted per diver per hour. Density was later measured on transects where the observer, swimming with a board equipped with a flow meter and a compass, counted all individuals within a width of 2 meters, a method used to survey populations of *Acanthaster planci* (Kenchington and Morton, 1976).

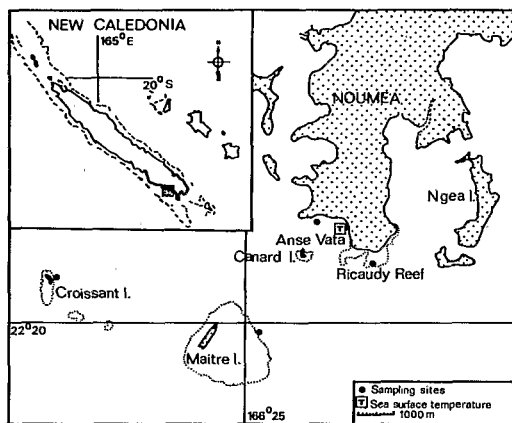


Fig. 1. Sampling sites.

During each sampling, approximately twenty *A. echinites* were collected. Total length (TL), total weight (TW), drained weight (DW) and gutted weight (GW) of individuals relaxed with magnesium chloride, were measured (Conand, 1981).

Direct microscopic observation of formalin-preserved gonads was used to examine the gonads. Sex was determined, diameter and length of the gonadal tubules recorded and oocyte size distribution established. Gonad index (GI) was expressed as a ratio of gonad weight to drained weight. The monthly mean of the gonad index and confidence limits at a probability level of 0.90 were calculated.

Mean sea water temperatures were calculated from daily measurements at the Noumea-Anse Vata coastal station (Fig. 1).

The size at first sexual maturity was obtained by plotting the percentage of individuals with developed or developing gonads against classes of drained weight.

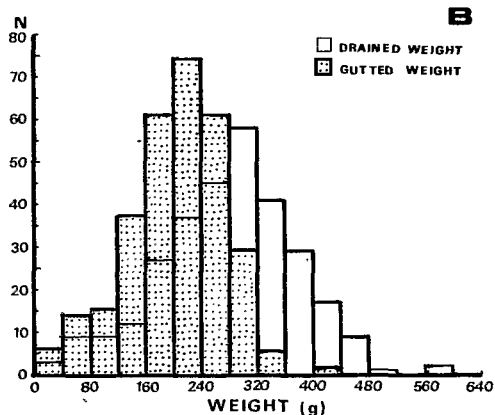
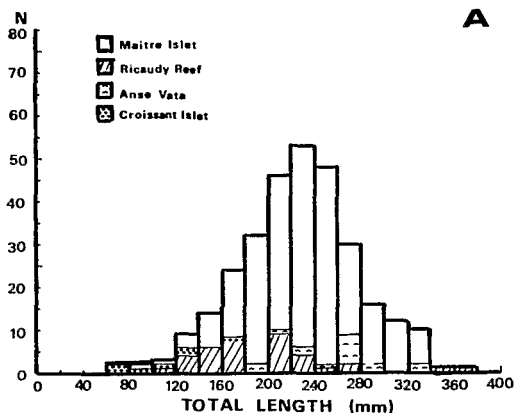


Fig. 2. Frequency distribution of *Actinopyga echinites* of (A) total lengths and (B) weights.

The data for the months in which the gonads were in the resting phase were excluded. The size classes at which 0% and 100% of the individuals were mature determined the interval of first maturity; the size at which 50% were mature ( $DW_{50}$ ) was chosen as an index of first maturity.

### 3 RESULTS AND DISCUSSION

#### 3.1 Distribution and abundance

At Maitre Islet site, *A. echinites* was abundant on the windward reef flat and on the detritic reef slope. The catch per unit effort was assessed during five minute surveys. The mean CPUE remained 200 throughout the period of study. The mean

Table 1. Biometric study: (n : sample size; R : range of the values;  $\bar{m}$  : mean; d.f. : degree of freedom; r : correlation coefficient).

Character	n	R	$\bar{m}$
TL (mm)	303	65 - 365	222
TW (g)	301	16 - 1380	435
DW (g)	299	11 - 580	274
GW (g)	303	9 - 405	200

Relation	d.f.	r
TW = 4.38 TL - 537.72	296	0.84
DW = 1.91 TL - 149.38	297	0.79
DW = 0.49 TW + 64.14	289	0.78
GW = 0.70 DW + 7.80	295	0.96

density, calculated from 8 transects of 400 length, was 8 individuals per 100 square m. This density is less than that reported for the same species from a reef flat in Guam where its density exceeded 1 per square meter (Rowe and Doty, 1977).

#### 3.2 Biometry

Frequency distributions of the total length, drained weight and gutted weight, established for the entire sample were unimodal (Fig. 2A and B). Young individuals were rare. The biometric relations established between pairs of characters are presented in Table 1. Drained weight and gutted weight are the least variable characters (Fig. 3B). Drained weight was used to calculate gonad-index.

#### 3.3 Sexual stages and reproductive cycle

The sexes are separate in *A. echinites*. No hermaphrodite individuals nor individual undergoing fission were observed. One specimen had two posterior ends with two anus, only one of which was connected with the intestine. This abnormality was probably simply regeneration following a wound.

The ovaries and the testes each consist of a single tuft of tubules. A maturity scale of five stages was defined. The macroscopic and microscopic gonadal features of *Holothuria (M.) nobilis* are like those *A. echinites* (Conand, 1981). The

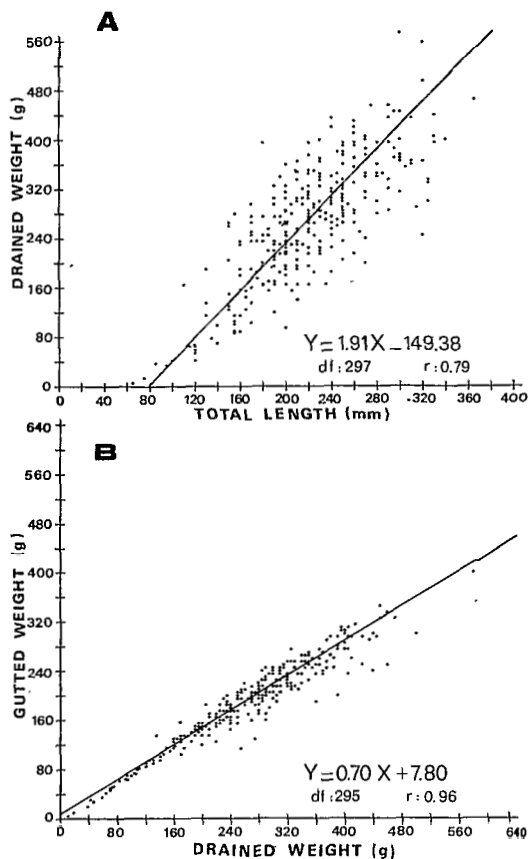


Fig. 3. The relation between (A) length and drained weight and (B) drained weight and gutted weight of *Actinopyga echinites*.

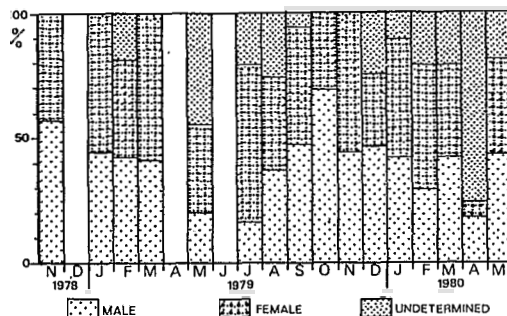


Fig. 4. Monthly percentages of males, females and undetermined *Actinopyga echinites*.

characteristics of the maturity stages of *A. echinites* are given in Table 2. Stages I and II respectively correspond to immature and resting individuals. During these stages sex can not be determined microscopically. It is impossible or very difficult to distinguish resting gonads from immature gonads.

There is a slight sexual dimorphism: testicular tubules are slightly longer and narrower than ovarian ones and the mature ovaries are pink and heavier than the whitish testes.

At stage IV, the gonad index values were 6.1 for the males and 7.8 for the females. The ripe oocytes measured approximately 175  $\mu\text{m}$ . The coefficient of fecundity, estimated by dividing the mean weight of ovaries in stage IV by the cube of the diameter, equals 4700. *A. echinites* is characterized by the relatively large size of oocytes and a low fecundity.

Table 2. Maturity stages ( $\bar{m}$ : mean; n: number of specimens; SD: standard deviation; L: length of tubules;  $\phi$ : diameter).

Maturity stage	Undetermined				Males				Females				
		Gonad tubules L(mm)	Gonad tubules $\phi$ (mm. $10^{-1}$ )	Gonad weight (g. $10^{-1}$ )	GI	Gonad tubules L(mm)	Gonad tubules $\phi$ (mm. $10^{-1}$ )	Gonad weight (g. $10^{-1}$ )	GI	Gonad tubules L(mm)	Gonad tubules $\phi$ (mm. $10^{-1}$ )	Gonad weight (g. $10^{-1}$ )	GI
Stage I													
Immature	$\bar{m}$	10.0	2.3	1.7	0.12								
Stage II	n	49	37	54	54								
Resting	SD	9.7	1.4	1.3	0.14								
Stage III													
Growing	$\bar{m}$	65.5	5.0	28.4	1.08	47.9	6.7	30.2	0.99				
	n	22	22	22	22	30	30	30	29				
	SD	27.7	2.0	26.9	0.88	26.2	2.7	40.9	1.30				
Stage IV													
Mature	$\bar{m}$	114.6	8.0	196.1	6.07	106.8	11.1	251.1	7.84				
	n	42	42	44	42	38	38	39	39				
	SD	29.0	3.1	136.7	3.19	25.8	3.9	189.3	5.29				
Stage V													
Post spawning	$\bar{m}$	52.1	4.4	23.1	0.77	44.1	5.3	28.7	0.94				
	n	53	41	53	53	52	38	53	52				
	SD	30.9	1.6	25.3	0.72	27.1	3.9	44.9	1.40				

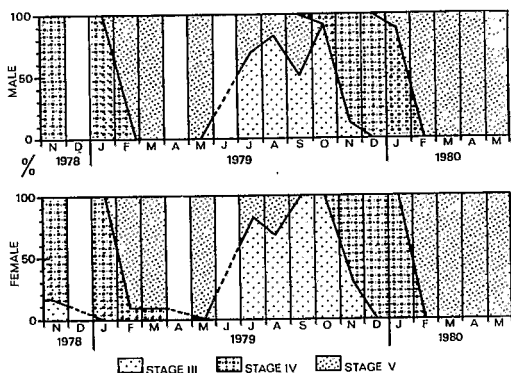


Fig. 5. Monthly percentages of maturity stages of *Actinopyga echinites*.

At stage V of post-spawning, spicules were apparent in the gonadal wall.

Monthly percentages were calculated for males, females and individuals of undetermined sex (Fig. 4). The overall sex ratio

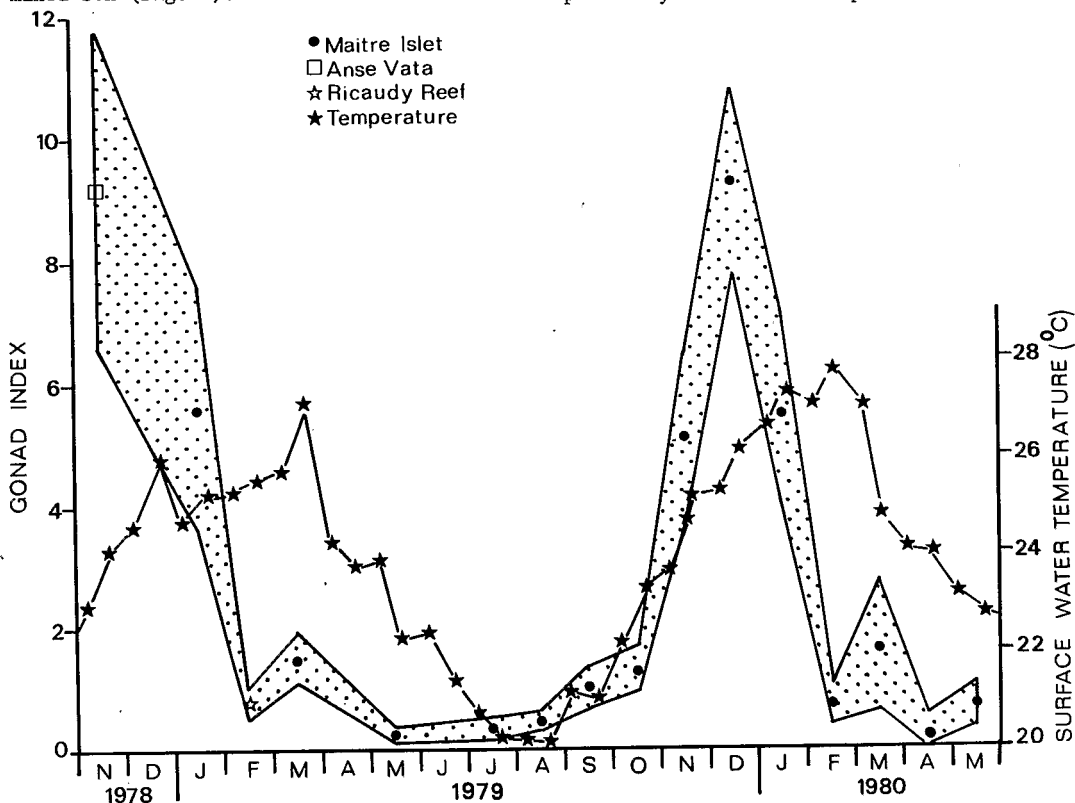


Fig. 6. Monthly changes of gonad index of *Actinopyga echinites* and surface water temperature. The dotted area represents the confidence interval (0.90 probability level) of the mean gonad index.

was 1.0:1.0. Undetermined individuals represented 19% of the total. The percentage of these individuals was low from September to January and higher from April to August. This variation was related to the reproductive cycle.

Monthly percentages of maturity stages (Fig. 5) were similar in both males and females. Stage III was preponderant from July to October, stage IV from November to January. The post-spawning stage V lasted from February to July.

The gonad index cycle (Fig. 6) showed a growing phase from September to November-December, where the values were at their maximum. A rapid decline occurred in January and February in 1979 and in 1980, followed by a phase of low values. The high percentage of undetermined individuals from April to August corresponds to resting individuals.

By considering the gonad index cycle, the variations of maturity stages and the percentages of undetermined individuals all together, it was possible to define more precisely the different phases of the re-

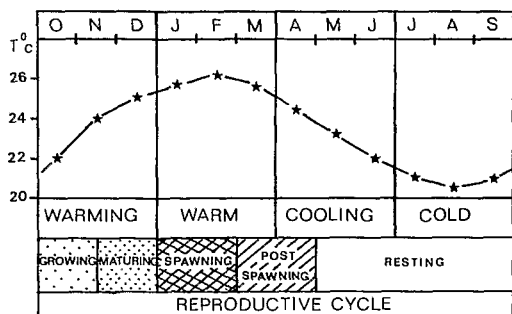


Fig. 7. Phases of the reproductive cycle of *Actinopyga echinites* in relation to sea water seasons.

productive cycle as described by Boolootian (1966). A close relationship existed between these phases and the surface sea water temperature (Fig. 7). The period of increasing temperatures corresponded to activation followed by the growing and maturation phases. Spawning occurred during the warm period in January-February. Postspawning or recession took place during the decreasing temperature period and was followed by the resting phase during the cold season.

This cycle, characterized by a warm season spawning is comparable to the cycle in other tropical holothuroids of New Caledonia; *T. ananas* and *M. fuscogilva* (Conand, 1981), of the Great Barrier Reef in Australia, *H. impatiens* (Harriot, 1980) and *H. leucospilota* (Franklin, 1980) and of Florida, *H. mexicana* and *H. floridana* (Engstrom, 1980). Other species have different modalities varying from an annual reproductive cycle with a different seasonality as in *H. nobilis* (Conand, 1981), to bi-annual reproduction as in *H. scabra* (Krishnawany and Krishnan, 1967), *H. atra* (Harriot, 1980) and *Stichopus chloronotus* (Franklin, 1980), or continuous reproduction as in *H. edulis* (Harriot, 1980). These two latter patterns seem more frequent in species for which asexual reproduction by fission is important.

### 3.4 Size at first sexual maturity

Few data are available on aspidochirote holothurian size at first sexual maturity. Some authors give the size of the smallest mature specimen (Choe, 1963; Engstrom, 1980); others give the size over which individuals are generally mature (Harriot, 1980; Franklin, 1980). The method used

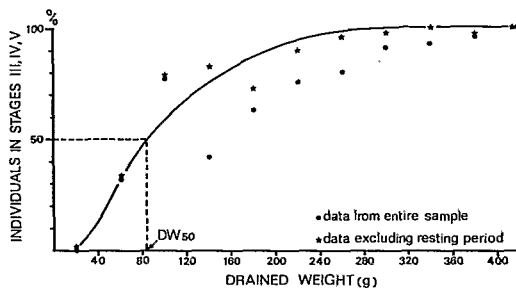


Fig. 8. Weight of *Actinopyga echinites* at first sexual maturity.

here gives a more precise estimate of this parameter and facilitates interspecies comparisons.

There is an increasing percentage of mature individuals between 20 g and 340 g (Fig. 8).  $DW_{50}$ , the weight at first maturity is 85 g. The total length and the gutted weight at first maturity were calculated using the relations of the Table 1:  $TL_{50}$  is 120 mm,  $GW_{50}$  is 67 g.

The ratio between the weight at first maturity and the overall mean weight of the population ( $DW_{50}/DW$ ) is 0.31. This value is lower than the observed values for other species. *A. echinites* is a medium-sized holothuroid whose first sexual maturity occurs at a small size.

### 4 ACKNOWLEDGEMENT

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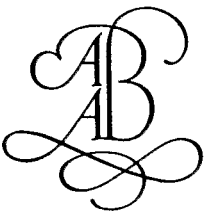
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