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REPRODUCTIVE BIOLOGY OF THE CRINOID, *COMANTHUS PARVICIRRUS* AND *COMATELLA MACULATA* (ECHINODERMATA: CRINOIDEA)[1]

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Kun-Hsiung Chang, Chang-Po Chen and Jian-Chyi Chen (1990) Reproductive biology of the crinoid, *Comanthus parvicirrus* and *Comatella maculata* (Echinodermata: Crinoidea). *Bull. Inst. Zool., Academia Sinica* **29**(3): 165-171. The gonadal structure of both crinoides is similar. Each gonad consists of three layers, and is the same as other crinoids reported. Nongerminal gonadal cells occur in the body wall and genital lumen of *C. parvicirrus*, but only in the body wall of *C. maculata*. In southern Taiwan, *C. parvicirrus* spawns in October-November and *C. maculata* spawns in September-October. The sex ratio of both crinoids seems to be 1 to 1.

Key words: Reproductive periodicity, Sea lily.

A total of 20 species of crinoids has been recorded from shallow water off Kenting National Park in Taiwan, (Chen *et al.*, 1988). Among them, *Comanthus parvicirrus* and *Comatella maculata* are the most common and abundant ones. They extend and swing their arms from crevices of reefs, making underwater scenes more attractive. For the purpose of conserving these marine lives, the study of their reproductive biology is a major corner stone.

Recently, reproduction of crinoids has been reviewed by Mladenov (1987). Up to date, the reproductive biology of only eight species of tropical crinoids have been studied, two from the Red Sea (Rutman and Fishelson, 1985), five from the Great Barrier Reef (Vail, 1987) and one from the Caribbean sea (Mladenov and Brady, 1987). Some of these tropical crinoids reproduce seasonally.

In the present report, the reproductive cycles of *C. parvicirrus* and *C. maculatus* are described and compared with those of other crinoids.

MATERIALS AND METHODS

In order to avoid destroying the natural population of crinoids, only one or two arms were sampled from each individual. Ten individuals each of *Comanthus parvicirrus* (Muller) and *Comatella maculata* (Carpenter) were examined monthly from August 1987 to July 1988, with the exception of October 1987. The

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sampling sites of Kenting National Park (E 120°45′; N 21°55′), Taiwan, have been described in a previous report (Chen *et al.*, 1988). The arms were fixed in seawater-Bouin's solution for 24 h, and then preserved in 70% alcohol. The total length of each arm was measured. The proximal one third of the arm containing the genital pinnules, was prepared for histological examinations. Paraffin sections were stained with hematoxylin and eosin. The sex of the individuals was then determined. Based on the histological character of reproductive tissues, the development of gonads was categorized into four stages: resting, growing, mature and spent stages. The seasonal changes of gonadal stages were used for analyze the reproductive cycle.

RESULTS

A total of 106 individuals of *Comanthus parvicirrus* was examined. Among them, 38 were females, 12 were males and 56 were unsexable (Table 1). Among 104 individuals of *Comatella maculata* examined, 34 were females, 13 were males and 57 were unsexable (Table 1). In both species, female specimens were distributed in the entire size range of samples (Fig. 1), indicating that most unsexable individuals were at the resting stage of gonadal development.

The gonadal structure is similar in both crinoids. Each gonad consists of three layers: a germinal epithelium enclosing a central lumen, an outer epithelium and an intervening genital haemal sinus (Figs. 2-a, 3-a). However, in *Comanthus parvicirrus*, many accessory cells, containing eosinophilic nutritive granules, occurred in both the body wall and the genital lumen (Figs. 2-b, c), while in *Comatella maculata*, nutritive granules occurred only on the body wall (Figs. 3-a, f).

The character of each gonadal developmental stage is described as following:

The major characteristic of the rest-

Table 1
Monthly changes of gonadal development of *Comanthus parvicirrus* and *Comatella maculata*. Number of individuals belonging to different gonadal stages are given. M, male; F, female

Month	*C. parvicirrus*							*C. maculata*						
	Resting	Growing		Mature		Spent		Resting	Growing		Mature		Spent	
		M	F	M	F	M	F		M	F	M	F	M	F
Aug.	4	1	3	0	1	0	0	0	0	0	3	1	0	0
Sept.	0	1	2	3	3	0	0	4	0	0	3	0	0	5
Nov.	2	0	0	3	0	0	2	5	0	0	2	0	0	3
Dec.	9	0	0	3	0	0	2	9	0	0	0	0	0	0
Jan.	10	0	0	0	0	0	0	9	0	1	0	0	0	0
Feb.	7	0	1	1	0	0	1	9	0	0	0	0	0	0
Mar.	9	0	2	0	0	0	0	6	0	4	0	0	0	0
Apr.	7	0	3	0	0	0	0	6	0	4	0	0	0	0
May	3	0	7	0	0	0	0	5	1	4	0	0	0	0
June	3	0	3	0	0	0	0	2	3	5	0	0	0	0
July	2	0	8	0	0	0	0	2	0	6	1	1	0	0
Total	56	2	29	10	4	0	5	57	4	24	9	2	0	8

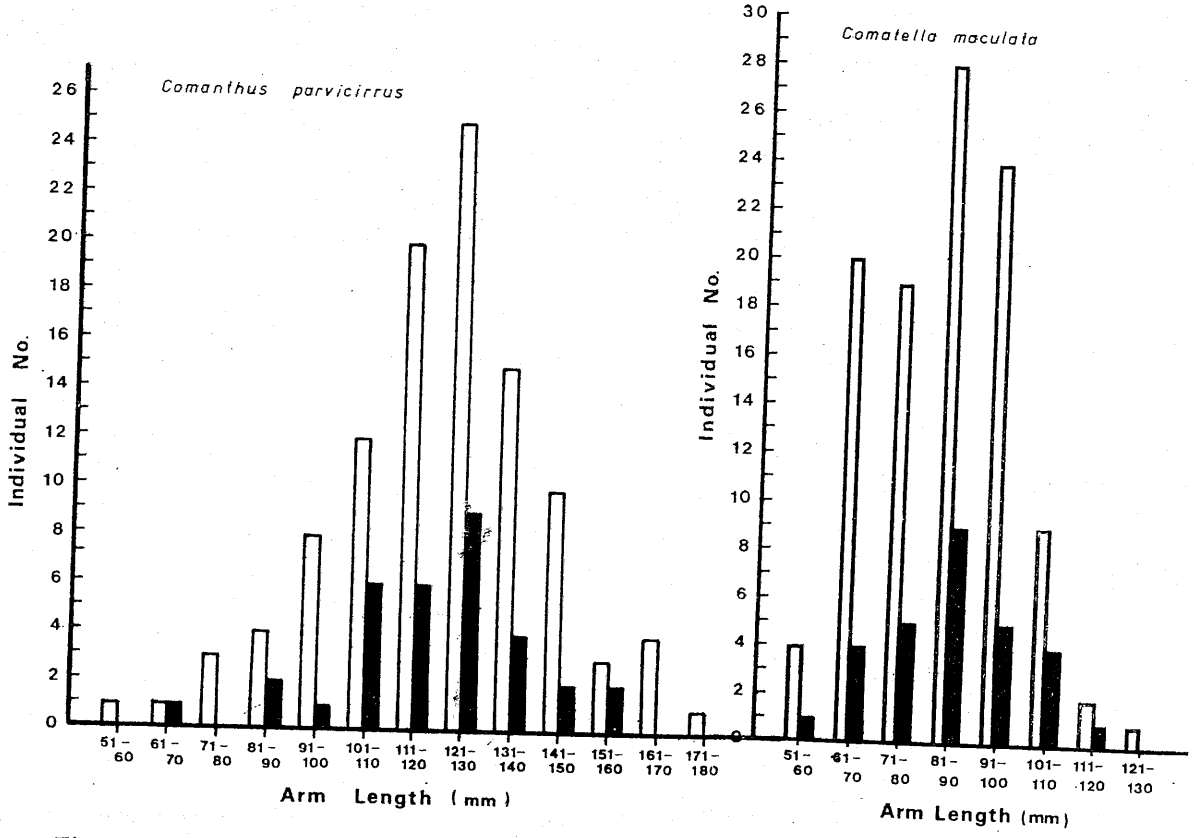

Fig. 1. Size distribution of *Comanthus parvicirrus* and *Comatella maculata*. Black bar, females; White bar, all individuals.

ing stage was the lack of distinguishable sex cells in the genital cords of both crinoids. During this stage, individuals were unsexable.

Characteristic of the growing stage in both crinoids was the appearance of sex cells. Females had small, yolk-less, hematoxylin-philic oocytes distributed along the margin of the germinal epithelial layers of the ovary (Fig. 3-a). Males had spermatogonia and spermatocytes in testes (Fig. 3-e).

In the mature stage, females had many york oocytes (Figs. 3-b, c), and males had a mass of sperm fully filling the genital lumen (Fig. 3-f). After spent, a few dented ova and some remainders of ovulation were left in the ovary (Figs. 2-c, d; 3-d), but no trace was left in the testes.

Gonadal development of both crinoids showed seasonal changes. In *C. parvicirrus*, the resting stage occurred mainly from November to April, growing stage from May to July, mature stage from August to October and spent stage from October to December (Table 1). The reproductive cycle of *C. maculata* was the following: the resting stage occurred from December to February, growing stage from March to June, mature stage from July to September and spent stage from September to November (Table 1).

DISCUSSION

The gonadal structures of *Comatella maculata* and *Comanthus parvicirrus* are

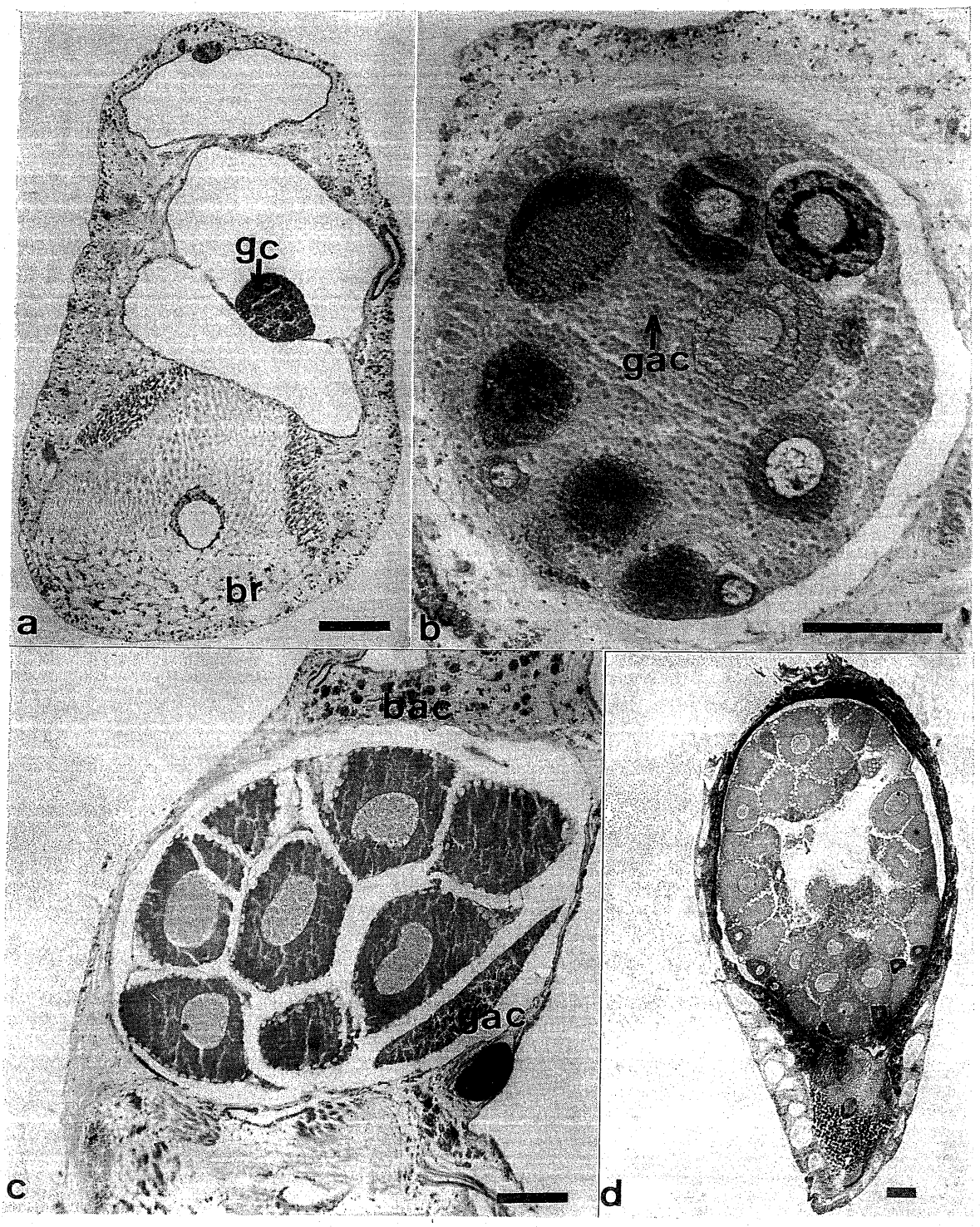

Fig. 2. Histological sections of genital pinnules of *Comanthus parvicirrus*. Black bar indicates 100 μ.
a. resting stage, unsexable (male?), collected in April, 147 mm in arm length; br, branchial; gc, genital cord
b. growing stage, female, July, 68 mm in arm length; gac, gonadal accessory cells
c. mature stage, female, December, 105 mm in arm length; bac, body wall accessory cells
d. spent stage, female, August, 85 mm in arm length

basically similar to those of most crinoids reported. However, the distribution of the nutritive accessory cells was different between these two species. The nutritive accessory cells occur in both the body wall and the genital lumen of *C. parvicirrus*, but only in the body wall of *C. maculata*. The gonadal accessory cells have been reported in *C. parvicirrus* (=*Comanthus parvicirra*), possibly also in *Comatella nigra* (Carpenter 1884, in Holland and Kubota, 1975) and in *Oxycomathus* (=*Comanthus japonica*) (Holland and Kubota, 1975). These accessory cells may play a role in accumulation and transfer nutrients to the germinal cells (Holland and Kubota, 1975).

Morphologically, oogonia are easier to recognize than spermatogonia under light microscope. Due to the difficulty in confirming the presence of spermatogonia, some males may be categorized as unsexable individuals. Thus, at the growing stage, most sexable individuals are identified as females. Because it is also difficult to recognize males at the spent stage, they may be categorized as mature, even though they have already partially released sperm. Therefore, in order to calculate the sex ratio, individuals belonging to both the mature and spent stages should be totalled together. Table 1 lists 10 males and 9 females in the mature and spent stages for *Comanthus parvicirrus*, and 9 males and 10 females for *Comatella maculata*. These data suggest that both crinoids have the sex ratio of 1 to 1.

Although there are two biases in determining gonadal stages as mentioned above, the reproductive cycles of *Comanthus parvicirrus* and *Comatella maculata* revealed in the present study remain valuable. Reproductive cycles of tropical crinoids reported elsewhere are compared below. In southern Taiwan, *C. parvicirrus* spawns in October-November, but *C. maculata* spawns in September-October. In the Red Sea, reproductive activity of *Lamprometra klunzingeri* is continuous, whereas in *Heterometra savignii*, cessation of maturation occurs between April and June (Rutman and Fishelson, 1985). At Lizard Island, Great Barrier Reef, a high level of continuous reproductive activity occurs in *Himerometra bartschi*, *H. robustipinna*, *Conometra bella* and *Colobometra perspinosa* from mid-summer to early/mid-winter, while *Oligometra serripinna* probably has a bimodal reproductive cycle with peaks in February and June (Vail, 1987). In Discovery Bay, Jamaica, *Nemaster rubiginosa* has well-defined and synchronized breeding season from October to March (Mladenov and Brady, 1987). Moreover, temperate crinoid species of Japanese *Oxycomanthus japonicus* spawn in October (Holland *et al.*, 1975), whereas *Florometra serratissima* of Canada spawn year-round (Mladenow, 1986). All these data indicate that the pattern of crinoid reproductive cycles are species specific and unrelated to the location of occurrence.

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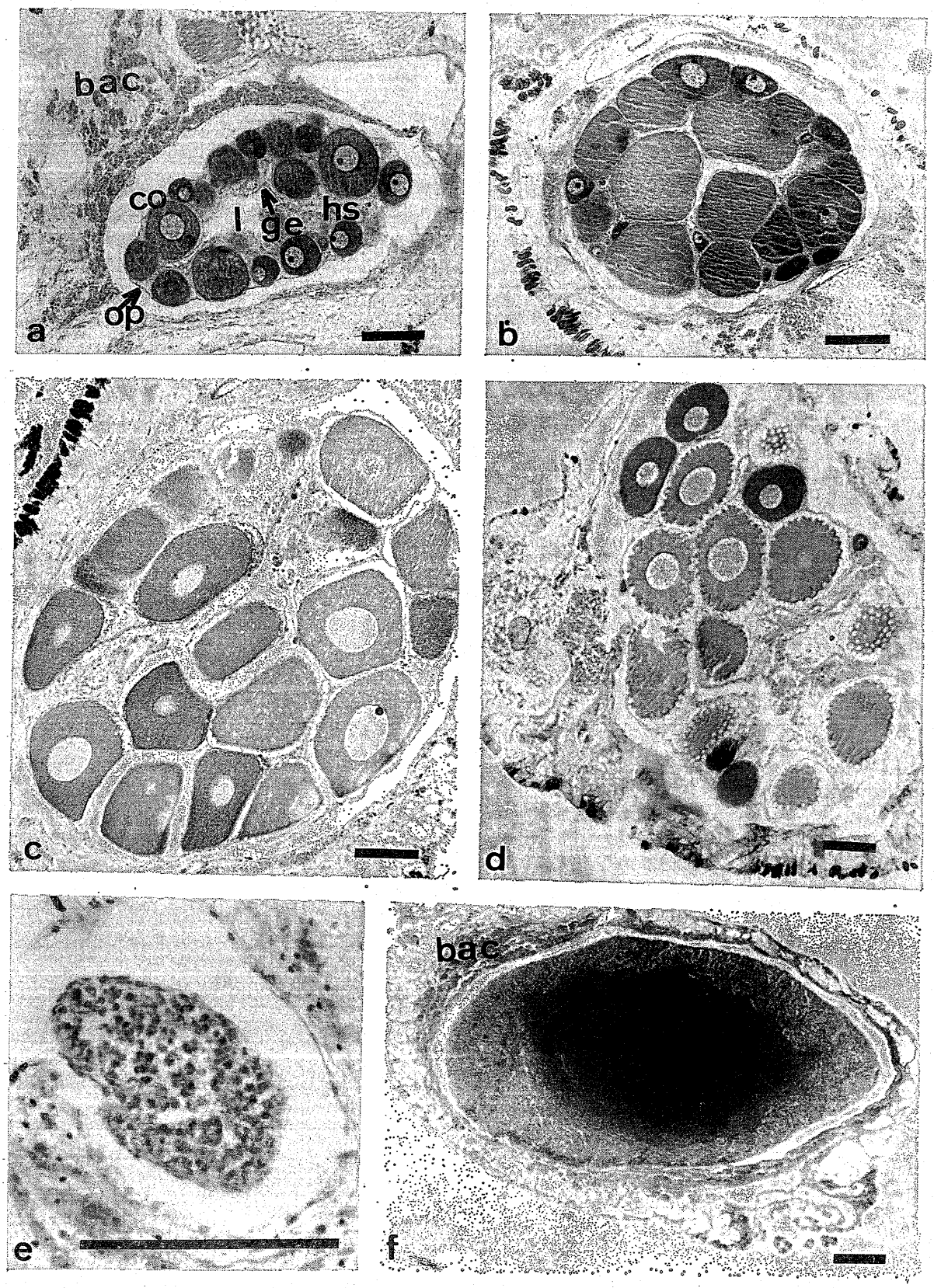
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小卷海齒花 (*Comanthus parvicirrus*) 及斑櫛羽球 (*Comatella maculata*) 之生殖週期

張 崑 雄　陳 章 波　陳 建 祺

這二種海百合的生殖構造相類似，具有三層：圍繞中央腔之生殖上皮、外層上皮及中間的生殖血竇。營養顆粒分布在小卷海齒花的體壁及生殖腔，但只分在在斑櫛羽球的體壁。小卷海齒花在 10～11 月產卵生殖；斑櫛羽球在 9～10 月生殖。

Fig. 3. Histological sections of genital pinnules of *Comatella maculata*. Black bar indicates 100 μ.
a. growing stage, female, June, 82 mm in arm length; bac, body wall accessory cells; co, genital coelom; ge, genital epithelium; hs, genital haemal sinus; l, central lumen; op, outer epithelium
b. mature stage, female, June, 86 mm in arm length
c. mature stage, female, September, 110 mm in arm length
d. spent stage, September, 95 mm in arm length
e. growing stage, male, May, 80 mm in arm length
f. mature stage, male, August, 95 mm in arm length; bac, body wall accessory cells