

**Reproductive Season and Some Biological Notes on
a Bivalve-Inhabiting Hydrozoan *Eugymnanthea japonica*
(Thecata-Leptomedusae: Eirenidae) at Shirahama, Tanabe Bay,
Japan, with Comparison of Related Species**

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With Tables 1-3

Abstract At Shirahama, Wakayama Prefecture, Japan *Eugymnanthea japonica* very actively produce medusa buds with mature gonads (in 77-100% of larger hosts examined) from June to November during which water temperature was high (21.3-27.1°C in nearly monthly average). The hydroids were found on every soft body portion of *Mytilus edulis galloprovincialis* attached to rafts, buoys, and ropes within 1 m depth. The association rate of the hydroids of *E. japonica* within larger specimens of this bivalve was very high in every month, maximally 100% (N=78) and 96.7% in yearly average (N=931). The hydroids were simultaneously found in almost all of the hosts harboring a commensal crab *Pinnotheres sinensis* (58 out of 59 ones). Differing from two related species, *Eugymnanthea inquilina* and *Eutima japonica*, the association rate of the present hydroids in smaller specimens of *Mytilus edulis galloprovincialis* was high.

Introduction

Eugymnanthea japonica Kubota, 1979 has a solitary, athecate-like hydroid commensal with bivalves, distributing mainly along the Pacific coasts of central to southern Japan (Kubota, 1987, 1992). In warm and hot seasons the hydroids produce medusa buds in the sea, and it is confirmed that the medusa bud is liberated as a free mature medusa from the hydroid reared at more than 20°C in the laboratory, with the characteristics of an ephemeral medusa such as no tentacles for capturing prey, quick spawning, and short life span, etc. (Kubota, 1979, 1985, 1987, 1991a, b, 1992, 1993a, b). However, no detailed study to clarify the reproductive season of this species has been conducted in a given locality. Therefore the present study was carried out to clarify this subject, using a population from Shirahama, Wakayama Prefecture, Japan. Furthermore, some biological notes such as the attaching site of the hydroids within the host *Mytilus edulis galloprovincialis* Lamarck, 1819 and the simultaneous association with commensal crabs were examined. These results are compared with the available information on two related species, *Eugymnanthea inquilina* Palombi, 1935 (Kubota, 1989; Piraino et al., 1994) and two forms of *Eutima japonica* Uchida, 1925 (Kubota, 1983, 1992), in order to find out any biological differences among them.

Materials and Methods

At Sakata near the Seto Marine Biological Laboratory, Shirahama in Tanabe Bay, Wakayama Prefecture, Japan, in every month between February 1992 and January 1993 75–78 larger specimens of *Mytilus edulis galloprovincialis* which are above 33 mm in anterior-posterior axes and attached to rafts, buoys, and ropes within 1 m depth were dissected within a half day after collection and the rate of association of hydroids, the frequency of the formation of medusa buds (the rate of bivalve specimens harboring hydroids with medusa buds among the hydroid-harboring bivalve specimens), the attaching site of the hydroids within a host, and simultaneous association of commensal crabs with the present hydroids were examined under a binocular microscope. In small specimens of this bivalve of which anterior-posterior axes were below 26 mm the same subjects were examined from November 1992 to February 1993 and from November 1993 to February 1994, also using the same population at Sakata, Shirahama.

Results and Discussion

1. Reproductive season

The hydroids produced medusa buds in most of the months. Very active production of medusa buds (in 76.9–100% of larger hosts examined) was observed from June to November during which the average water temperature for about a month was 21.3–27.1°C (Table 1). Judging from the observations on the laboratory-reared hydroids from the same place (Kubota, 1991a, b, 1992, 1993b, unpubl. data), the medusa buds are liberated as free mature medusae in this period. In contrast, formation of medusa buds was not observed or in very low rate (up to 17.3%) from January to April when the average water temperature was 15.0–17.4°C. In May and December formation of medusa buds took place in about 50% of the hosts, i.e. nearly intermediate frequency between the above periods.

The association rate of the hydroids with larger specimens of *Mytilus edulis galloprovincialis* was very high in every month, showing 88.5–100% (N=75–78) and 96.7% in yearly average (N=931). This is the highest rate so far been recorded in Japan (Kubota, 1992) and also in the world (Kubota, 1983; Kubota & Larson, 1990; Piraino et. al., 1994). The host bivalve grew larger in May to September, but many large specimens died in October and dropped off from the substrata. The association rate of hydroids, however, had not changed along with this change.

In smaller bivalve specimens, of which age may be within a year, the hydroids were also found in high association rate, 88.5% in average (N=192) (Table 1). In these small hosts formation of medusa buds took place in November, while no or low frequency of formation from December to February (Table 1). It is possible that the present hydroids can settle within such a small and young host and become sexually mature within a year.

2. Attaching site of the hydroids within the mantle cavity of *Mytilus edulis galloprovincialis*

Within the larger host the hydroids usually attach to the mantle, the gill, and the visceral mass, while infrequently to the labial palp at any season (Table 2). Such a manner of attachment was noticed in other localities studied at any season (Kubota, 1979, 1985). It was observed that in six out of 177 present larger hosts examined,

Table 1. Occurrence of hydroids and medusa bud formation of *Eugymnanthea japonica* in *Mytilus edulis galloprovincialis* at Shirahama, Tanabe Bay, Japan together with change of surface water temperature.

Date of sampling	Number of bivalves examined	Bivalve size (mm)		Association rate (%)	Rate of medusa bud formation (%)	Water temperature (°C)	
		range	mean \pm SD			sampling day*	average** (period)
Larger bivalves (1992–1993)							
Feb. 3	75	36–60	48 \pm 6	94.7	17.3	13.4	16.6 (Jan. 6–Jan. 31)
Mar. 25	76	41–63	51 \pm 6	92.1	0	16.4	15.0 (Feb. 1–Mar. 25)
Apr. 27	78	46–70	54 \pm 5	94.9	10.3	20.1	17.4 (Mar. 26–Apr. 25)
May 25	78	46–73	60 \pm 6	93.6	55.1	20.8	19.0 (Apr. 26–May 25)
June 30	78	46–78	61 \pm 6	88.5	76.9	21.9	21.3 (May 26–June 30)
July 31	78	38–79	60 \pm 8	100	98.7	30.8	25.9 (July 1–July 31)
Aug. 25	78	40–82	62 \pm 8	98.8	97.4	29.2	27.1 (Aug. 1–Aug. 25)
Sep. 20	78	49–75	63 \pm 6	97.4	93.6	26.0	27.1 (Aug. 26–Sep. 20)
Oct. 21	78	37–75	56 \pm 11	100	100	23.3	24.1 (Sep. 21–Oct. 20)
Nov. 27	78	38–74	59 \pm 10	100	98.7	19.4	21.3 (Oct. 21–Nov. 25)
Dec. 21	78	34–80	50 \pm 13	100	50.0	19.7	19.1 (Nov. 26–Dec. 20)
Jan. 29	78	38–78	57 \pm 1	100	0	17.1	16.7 (Dec. 21–Jan. 25)
Feb. 26	10	59–77	66 \pm 5	100	0	15.1	15.3 (Jan. 26–Feb. 25)
Smaller bivalves (1992–1994)							
Nov. 27	6	14–19	17 \pm 2	100	33.3	See above column	
Dec. 21	11	10–25	16 \pm 4	81.8	44.4		
Jan. 29	10	14–25	20 \pm 4	80.0	0		
Feb. 26	31	13–22	19 \pm 2	87.1	0		
Nov. 25	52	7–25	17 \pm 4	100	92.3		
Dec. 16	28	12–21	16 \pm 3	100	0		
Jan. 28	27	13–20	17 \pm 2	85.2	8.7		
Feb. 22	27	12–24	17 \pm 3	88.9	0		

*: Measured at the collecting site, Sakata.

** : Calculated from measurements taken at a shore north of the Seto Marine Biological Laboratory at 9:00 a.m. nearly every day by the laboratory.

a small number of hydroids were found exclusively on a limited part either on the mantle (N=4) or on the visceral mass (N=2). In other five hosts a small number of hydroids attached to two body portions, namely either on the mantle and the gill (N=3) or on the visceral mass and the gill (N=2). Further, in other five hosts many hydroids attached confined to a part either the mantle (N=2) or the gill (N=3). In the smaller hosts, frequent attachment of many hydroids to the mantle, the gill, and the visceral mass was also observed (Table 2). The hydroids may be able to colonize on any of these soft body portions of this host.

3. Simultaneous association of the hydroids of *Eugymnanthea japonica* and a commensal crab *Pinnotheres sinensis* Shen, 1932 within the mantle cavity of *Mytilus edulis galloprovincialis*

Table 2. Attaching site of the hydroids of *Eugymnanthea japonica*, showing frequencies of bivalve specimens harboring hydroids on four soft body portions of *Mytilus edulis galloprovincialis* at Shirahama, Tanabe Bay, Japan.

Date of sampling	No. of bivalve specimens examined	Frequency (number of bivalves with hydroids) on:			
		Mantle	Gill	Visceral mass*	Labial palp
Larger hosts					
June 30, 1992	69	65	54	58	26
July 31, 1992	52	45	50	42	25
Aug. 25, 1992	34	34	30	25	7
Feb. 26, 1993	10	10	9	9	6
Nov. 25, 1993	12	12	12	12	5
Total (%)	177	166(93.8)	155(87.6)	146(82.4)	69(40.0)
Smaller hosts					
Feb. 26, 1993	27	27	26	27	—
Nov. 25, 1993	52	52	52	52	14
Dec. 16, 1993	28	24	28	27	5
Total (%)	107	103(96.3)	106(99.1)	106(99.1)	19(23.8)

*: Including the base of the foot.

—: Not examined.

In 50 out of 931 larger bivalves examined, *Pinnotheres sinensis* was found in every month except in August, 1992. One to several crab specimens were harbored in one host, and up to seven bivalve specimens were used as hosts in each month. In smaller bivalves only five specimens collected in December in 1993 were used as hosts, and only one small and young crab specimen was found per host, showing very low association rate (2.6%, N=192). In almost all of the hosts harboring this crab, 58 out of 59 ones, many hydroids were simultaneously found. Therefore *Pinnotheres sinensis* and *Eugymnanthea japonica* can live together within the same host.

4. Comparison of the present results with those of related species

At the present collection site only *Eugymnanthea japonica* has been collected as was observed in 1987 and no hydroids of *Eutima japonica* have been recorded here (Kubota, 1991, 1993b, unpubl. data), though a small number of the medusa of the latter species was formerly collected in an inner part of Tanabe Bay by Yamazi (1958).

In contrast to high association rate of the present hydroids in smaller hosts of *Mytilus edulis galloprovincialis* in Japan (61.3% in average, N=610), the association rates of both *Eugymnanthea inquilina* at Taranto, Italy (less than 4.6%, N=219, see Piraino et. al., 1994) and two forms of *Eutima japonica* in Japan (17.8% in average, N=1014) with small host specimens were low (Table 3).

A clear difference was observed between the two *Eugymnanthea* species: the hydroids of *E. japonica* from Japan attach to the gill of *Mytilus edulis galloprovincialis* very

Table 3. Association rate of two hydrozoan species in smaller specimens of *Mytilus edulis galloprovincialis* in Japan (cf. Kubota, 1983, 1992).

Locality (Prefecture)	Host size (range, mm) and sample size	Association rate (%) ¹⁾	Date of sampling
<i>Eugymanthea japonica</i>			
Kushi (Kagoshima)	20-25, 26	11.5	25-VIII-1987
Sukumo (Kochi)	17-25, 59	81.4	5-XI-1987
Saga (Kochi)	18-25, 49	12.2	6-XI-1987
Suzaki (Kochi)	14-25, 41	97.6	6-XI-1987
Shirahama (Wakayama)	23-25, 2	0	23-I-1981
	16-25, 9	0*	25-XII-1987
	7-25, 192	88.5 ²⁾	1992-1994
Nakatsuhamaura (Mie)	21-25, 4	25.0	2-IX-1989
Zagashima Island (Mie)	11-25, 93	100	22-25-XI-1982
	11-24, 69	2.9	13-IX-1984
Shimizu (Shizuoka)	19-25, 17	35.3	2,3-XII-1985
	21-25, 6	0	3-IV-1987
Shimoda (Shizuoka)	14-25, 22	4.5	30-VIII-1983
Ito (Shizuoka)	15-25, 21	19.0	14-X-1983
All combined	7-25, 610	61.3	1981-1994
<i>Eutima japonica</i> (the northern form)			
Atami (Shizuoka)	17-35, 14	7.1	14-X-1983
Enoshima (Kanagawa)	20-25, 4	0	26-III-1980
	14-25, 25	4.0	15-X-1983
	24-35, 18	5.6	8-XI-1987
	26-35, 31	12.9	20-VIII-1990
Matsushima (Miyagi)	22-33, 4	0	4-IV-1986
Kesenuma (Miyagi)	22-35, 153	73.2	2-IV-1990
Kitayamasaki (Iwate)	20-35, 10	17.1*	12-VI-1983
Kabushima (Aomori)	15-35, 12	16.7*	12-VI-1983
Mori (Hokkaido)	24-35, 29	0	1-VIII-1980
Kuroiwa (Hokkaido)	28-35, 38	34.2*	1-VIII-1980
	27-35, 15	0*	14-VI-1987
Utasutsu (Hokkaido)	23-35, 18	88.9*	2-VIII-1980
Oshoro (Hokkaido)	10-24, 148	0.7	1978-1980
	10-24, 238	6.7*	1977-1980
All combined	10-35, 757	23.1	1977-1990
<i>Eutima japonica</i> (the southern form)			
Mukaishima Island (Hiroshima)	20-24, 4	0	9-V-1979
	10-25, 49	4.1	30-III-1980
Mitsuhamma (Ehime)	11-35, 49	0**	11-I-1979
	12-27, 47	0**	18-V-1979
Takahama (Ehime)	8-34, 95	3.2	10-IV-1980
Nuwajima Island (Ehime)	12-24, 13	0	11-I-1979
All combined	8-35, 257	1.9	1979-1980

1) Values include hydroids of which identification is difficult due to absence of well-developed medusa buds. Substrata of hosts were usually rafts, buoys, and ropes within 1 m depth, otherwise intertidal rocks (*) and concrete stairs (**).

2) Present study.

frequently (Table 2) in contrast to the absence or very rare attachment of the hydroids of *E. inquilina* on this part of the same host species in Italy (see Kubota, 1989; Piraino et. al., 1994).

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