Systematic Study on a Bivalve-Inhabiting Hydroid *Eugymnanthea inquilina japonica* Kubota from Central Japan

By

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(With 4 Text-figures and 5 Tables)

The hydroid belonging to the genus *Eugymnanthea* is one of the members of the commensal hydroids associated with bivalves. In Italian waters *Eugymnanthea* was discovered within *Tapes decussatus* (*Venerupis decussata*) and described in detail by Palombi (1935) and afterwards it was redescribed by Cerruti (1941) and Uchida (1964). *Eugymnanthea* is so peculiar in morphology and habitat that it has been treated as an enigmatic hydroid under various families by different authors (see Morri 1981). Hadzi (1963), in his elaborate book, also refered to this hydroid as the most specialized one among thecate hydroids. Based on the comparative studies on the life-histories of the bivalve-inhabiting hydroids, the author concluded that *Eugymnanthea* is one of the members of the Eutimidae and is the most advanced hydroid in this family (Kubota 1983, '84).

As the second occurrence, *Eugymnanthea* was collected from the Pacific coasts of the central Japan (Kubota 1979, '84), far away from the type locality. This Japanese *Eugymnanthea* is distinguishable from the above Italian one in the morphology of the medusa. Based on the morphological difference and the distributional disjunction, these two remote populations were treated as the two different subspecies, namely *E. inquilina inquilina* Palombi, 1935 and *E. i. japonica* Kubota, 1979. However, it is open to question for this taxonomic treatment because there may be two possibilities on the origin of *Eugymnanthea* (Kubota 1983): (1) the European *Eugymnanthea* was introduced to the Orient together with its main host *Mytilus edulis galloprovincialis* which began to settle about half a century ago; (2) *Eugymnanthea* survived in the west and the east corners of the Thetys Sea. The author inclined to think that the former case would happen when the last paper was prepared. If this is proved, the present hydroid is not a subspecies but a mere variety of *Eugym. inquilina*. To the

Jour. Fac. Sci. Hokkaido Univ. Ser. VI, Zool. 24(1), 1985

contrary the latter case is true, the present hydroid should be treated as a distinct species.

To know the natural history of *Eugymnanthea*, particularly to solve the above problem, attempts to reveal 1) the morphological variation range in both the polypoid and medusan generations, 2) the degree of host preference, and 3) the distributional range seem needful. As a step for this study, the above-mentioned three biological aspects on the Japanese *Eugymnanthea* were investigated in the present research together with not only its morphology of gametes, larva, and the nematocyst equipment of the larva but also notes on the life-history; and they were compared with those of the related hydroids such as the Italian *Eugymnanthea*, *Eutima japonica* Uchida, and *Eucheilota intermedia* Kubota.

Materials and Methods

At Zagashima Is. in Ago Bay, Mie Pref., 346 specimens of seven bivalve species were collected during Nov. 22 - 26, 1982, and 485 specimens of 20 bivalve species (including six species of the above ones) were during Sep. 11 - 13, 1984; in Shimoda Harbor, Shizuoka Pref., 639 specimens of 17 bivalve species were during Aug. 30 - Sep. 2, 1983; and on October 14, 1983 in Itô Harbor and Atami Harbor, both near Shimoda, Shizuoka Pref., 93 and 86 specimens of *Mytilus edulis galloprovincialis* were collected, respectively. These bivalves were usually found on rocks or man-made substrata such as rafts, buoys, ropes, and iron chains from the intertidal region, though sometimes from the subtidal region within several meters in depth (collected by skin diving). Many of them were dissected soon after the collection, and the rest, many of which were preserved in formalin solution, were done after carrying back to the laboratory in Sapporo. The specimens of each bivalve species examined were different in number, 1-299, due to the population size.

Through these four occasions of the collection a large number of specimens were obtained and among these the followings were examined in detail: 478 medusan specimens (100 ♀♀ + 145 ♂♂ + 225 sex undetermined ones) liberated from polyps associated with many specimens of two bivalve species (425 ones from *Mytilus edulis galloprovincialis* and 53 from *Crassostrea gigas*) from Shimoda; 138 ones (84 ♀♀ + 12 ♂♂ + 42 sex undetermined) from three bivalve species (102 from *M. e. galloprovincialis*, 30 from *Cr. gigas*, and 6 from *Chlamys farreri*) from Zagashima Is.; and seven sex undetermined ones from *M. e. galloprovincialis* from Itô. Together with 28 medusan specimens previously examined (16 ♀♀ + 12 ♂♂) from Shimoda (Kubota 1979), in all 651 medusan specimens associated with the three bivalve species from the three localities were used to analyze the morphological variation. Some other abnormal specimens from Shimoda mainly concerning their radial canals were excluded from the analysis.

As to the polyp, analysis for the morphological variation and the measurements were not made extensively as the medusa in the present research. Among

a large number of specimens from the above-mentioned four localities, large specimens with medusa-buds from Zagashima Is. were selected and examined in detail. Gametes, larva, and the nematocyst equipment of planula were examined in laboratory in Sapporo. In other many localities than those surveyed before (see Kubota 1983, Fig. 25) the distribution of *Eugymnanthea* was checked, examining various bivalve species, especially *M. e. galloprovincialis*, and of these localities the ones where *Eugymnanthea* was found were treated (Table 1).

The drawings and the measurements in text were made in the living specimens. Figs. 1 and 3 were made with the aid of a drawing apparatus. The measurements are shown in the order: minimum-mean-maximum values, S.D., and the number of specimens examined in parentheses.

Host Preference and Distribution

In Shimoda Harbor including Nabeta Bay *Mytilus edulis galloprovincialis* was most abundant and 299 specimens of different sizes ranged from 14 mm to 100 mm in antero-posterior axis were examined. In this harbor other 16 bivalve species could be collected. Of these, seven species such as *Septifer bilocularis*, *S. virgatus*, *Hormomya mutabilis*, *Barbatia virescens*, *Pinctada fucata martensii*, *Cardita leana*, and *Crassostrea gigas* were examined, 13-99 specimens in respective species, and in each of the other nine ones such as *Mytilus coruscus*, *Trichomya hirsuta*, *Lithophaga curta*, *Barbatia lima*, *Hiatella orientalis*, *Claudiconcha japonica*, *Modiolus auriculatus*, *Crassostrea nipponica*, and *Ostrea circumpicta* only one to five specimens were examined. In these 17 bivalve species, whose mode of life is of attaching type in most of them, only two species, *M. e. galloprovincialis* and *Cr. gigas*, harbored the present hydroid in a relatively high association rate (Table 1). It was observed that in one of the small bays of the harbor, Nabeta Bay, the association of the polyp with *M. e. galloprovincialis* was rare, namely one out of 26 specimens harbored the polyp in the present survey and only three out of 252 ones in the previous survey (Kubota 1979), though the bay adjoins the other. Many specimens of most of these bivalve species except for *M. e. galloprovincialis*, *Cr. gigas*, and *O. circumpicta* were collected in Nabeta Bay, accordingly the host preference of the hydroid for the above two bivalve species should not be overestimated in this place.

Among seven bivalve species associated with the commensal hydroids from Zagashima Is. such as *Mytilus edulis galloprovincialis*, *Crassostrea gigas*, *Chlamys farreri*, *Musculista senhousia*, *Modiolus auriculatus*, *Barbatia virescens*, and *Ruditapes philippinarum*, the former three harbored the present hydroid (Table 1, *E.i.j.*). It is noticeable that most of the specimens of *M. e. galloprovincialis*, even in very tiny ones, harbored the commensal polyp(s). This was ascertained by another examination. Among 69 tiny and youngest specimens of this bivalve (11-24 mm in antero-posterior axis) collected on Sep. 13, '84, which mostly attached to the shells of the pearl oyster, *P. f. martensii*, two ones harbored the

present hydroid (This result was not included in the Table 1). In these two mussels, both 20 mm in size, 19 and 67 polyps of the present hydroid were associated, respectively, and they were found at the anterior portions of the host. Within these bivalve specimens, despite of the small number of polyps per host and the low density, formation of medusa-bud already occurred: 15.8% and 64.2% of the polyps produced the medusa-buds, respectively. This suggests that within *M. e. galloprovincialis* the time from settlement to produce medusa of the present hydroid is shorter than that of *Eutima japonica* (cf. Kubota 1983).

As to the hydroids found within the other four bivalve species, their identification was difficult because the medusa-buds were not fully developed when collected. This can be also said for many specimens of the former three bivalve species harboring polyps with small medusa-buds or those without medusa-buds. Therefore rearing of specimens were carried out as much as possible. It is noteworthy that one of the frequently dwelling places of the commensal polyp(s) for *Ch. farreri* was the foot, and in two specimens of this bivalve the polyp(s) exclusively attached to their feet (81.8% on the foot and 63.6% on the mantle, cf. Table 1). It is also noticeable that in *B. virescens* up to 11 or more patches of polyps were found per host specimen and the tissue of the mantle seemed to be affected by such attachment of the polyps.

In Ago Bay no association of the commensal polyps with other 13 bivalve species were observed. They were the following bivalves and the number of specimens examined are shown in parentheses: *Pinctada fucata martensii* (91); *Chama reflexa* (33); *C. dunkeri* (1); *Pseudochama retroversa* (11); *Cardita leana* (11); *Septifer keenae*(6); *S. virgatus* (1); *S. bilocularis* (1); *Chlamys nobilis* (1); *Kellia porculus* (4); *Irus ishibashianus* (1); *Protothaca jedoensis* (2); *Circe scripta* (4); *Gafrarium divaricatum* (3); among which the latter three are of the burrowing type in the mode of life.

Judging from the above-mentioned survey on the host preference of the Japanese hydroid and that of the Italian one made by Crowell (1957), *Eugymnanthea* may not be a specialist as is the same case in *Eutima japonica*. Although *Eugymnanthea* tends to be a generalist, it may prefer *Mytilus edulis* and oysters like *Crassostrea gigas* to other bivalves. The original host of the present hydroid is unclear, though *Cr. gigas* might be one of the highest possibilities, if the present hydroid is an endemic one.

At Shimoda and its vicinities and Zagashima Is. *Eugymnanthea* may be dominantly distributed, while in other localities *Eutima japonica* is exclusively distributed (Kubota 1983, '84, and unpublished data). This may indicate that in Japanese waters the two species are separated well each other in their utilization of host populations. However, at Atami they could coexist in a single mussel bed attached to a raft (Table 1), though their association rate was low. Moreover, *Eugymnanthea* and *Eucheilota intermedia* lived together within the same host of *M. e. galloprovincialis* at Zagashima Is. (Kubota 1984), though as only one case.

Table 1. Association of *Eugym. i. japonica* and two other commensal frequency of attachment of polyp(s) on various body portions of the

Locality and host bivalve	No. of bivalve specimens		
	examined	associated with polyp(s)	associated with medusa-buds bearing polyp(s)
Zagashima Is.			
Mytilus edulis	241	229	50<
Crassostrea gigas	40	28	21
Chlamys farreri	90	11	7
Musculista senhousia	146	13	1<
Modiolus auriculatus	21	1	0
Barbatia virescens	59	15	0
Ruditapes philippinarum	64	2	0
Shimoda			
Mytilus edulis	299	108	106
Crassostrea gigas	59	24	22
Itô			
Mytilus edulis	93	56	51
Atami			
Mytilus edulis	86	5	5

1) *E.i.j.*: *Eugymnanthea inquilina japonica*; *E.i.*: *Eucheilota inter-*
2) With one specimen *Euch. intermedia* or *Eugym. i. japonica* was
3) m.: mantle; gi.: gill; l.p.: labial palp; v.m.: visceral mass; f.: observed; *: for the other polyps than *Eugymnanthea*.
4) Four out of six bivalve specimens were examined.
5) 105 out of 106 bivalve specimens were examined.

And in this place *E. intermedia* was associated with *Barbatia virescens* and probably with *Ruditapes philippinarum*, but no association was observed between these two bivalve species and the present hydroid (see Table 1). It is unknown to what degree a competitive exclusion principle works for these three hydroids.

Polyp

A total number of 14 solitary polyps with medusa-buds, 10 associated with two specimens of *Crassostrea gigas* and four with one specimen of *Chlamys farreri*, were examined soon after the collection. The polyp is 0.76-2.3-3.5 mm, 0.88 in length and 0.10-0.19-0.27 mm, 0.05 in maximum width when well-extended, with 22-23.3-28, 1.8 (12) tentacles, and with up to five medusa-buds per specimen. The tentacle is 0.94 mm in length in two polyps whose total length is 1.8 mm.

hydroids with seven bivalve species in central Japan, showing host.

No. of bivalve specimens associated with[1]:			Frequency of associated bivalves harboring polyps of *Eugym.* on[3]:					
E.i.j.	*E.i.*	*E.j.*	m.	gi.	l.p.	v.m.	f.	go.
44[2]	4[2]+3?		100	100	+	100	+	
17			100	58.9	47.1			
6			100	33.3	0		83.3	16.7
	1?		100*	100*	+	100*		
			100*	100*		100*		
	6		100[4]*	0*	0*	50.0[4]*	0*	
	1?		0*	0*	100*	100*	0*	
106			90.5[5]	86.7[5]	71.4[5]	83.8[5]	47.6[5]	
22			86.4	54.5	13.6			
51			78.6	100	+	71.4		
2	0	3	100	100	100	100	50.0	

media; *E.j.*: *Eutima japonica*.
simultaneously associated (Kubota 1984).
foot; go.: gonad; +: attachment of polyp on this body portion was

The medusa-bud is produced on the lower part of the hydrocaulus and its position from the pedal disk was 0.23-0.29-0.39, 0.05 (15 medusa-buds) when the polyp was well-extended. In one specimen two stalks were produced at the position of 0.23 and 0.35 from the pedal disk, respectively, and on each of which one or four medusa-buds (the maximum number per stalk) were found. The upper stalk was branched as an exceptional case. The polyp is variable in coloration, showing orange to dark brown. The medusa-bud just before release is 0.67–1.00 mm in diameter.

Compared the above polyp from Zagashima Is. with that from Shimoda described before (Kubota 1979), the former is larger, more than twice as long (wide) as the latter, and the position of the medusa-bud is lower, though with the equal number of tentacles. However, reexamination of the polyp from Shimoda and its vicinities reveals that the polyp there is as large as the polyp from

Zagashima Is. Accordingly the external morphology of the present polyp without well-developed medusa-bud is very similar to that of the Italian *Eugymnanthea* as well as that of *Eutima japonica* and *Eucheilota intermedia*.

Medusa

A total of 138 medusan specimens originated from 15 specimens of three bivalve species such as *Mytilus edulis galloprovincialis* (six specimens), *Crassostrea gigas* (five ones), and *Chlamys farreri* (four ones) from Zagashima Is. were examined: 84 female ones (70 were originated from four specimens of *M. e. galloprovincialis* and 14 were from two specimens of *Cr. gigas*), 12 male ones (two originated from one specimen of *M. e. galloprovincialis*, nine from four ones of *Cr. gigas*, and one from *Ch. farreri*), and 42 sex undetermined ones (30 originated from three specimens of *M. e. galloprovincialis*, seven from five specimens of *Cr. gigas*, and five from three specimens of *Ch. farreri*). The measurements of a small number of medusae obtained in 1982 are shown in Table 2, and the variations in some meristic characters, which examined in many specimens obtained in 1982 and '84, are in Table 3. Besides these specimens, a large number of specimens from Shimoda (the type locality of the present subspecies) were reexamined: 425 ones whose polyps were associated with many specimens of *M. e. galloprovincialis* (102 ♀♀ + 138 ♂♂ + 185 sex undetermined ones) and 53 ones with many specimens of *Cr. gigas* (6 ♀♀ + 7 ♂♂ + 40 sex undetermined). The variation of the number

Table 2. Measurements (min.-mean-max. S.D. (N), in mm) of mature medusa of *Eugym. i. japonica* from Zagashima Is.

	♀	♂	?	Both sexes combined
Umbrellar width	0.86-1.0 -1.2 0.10 (13)	1.0 -1.1 -1.2 0.09 (5)	1.2 -1.3 -1.4 0.07 (5)	0.86-1.1 -1.4 0.14 (23)
Umbrellar height	0.59-0.91-1.1 0.14 (13)	0.73-0.85-0.91 0.09 (5)	0.88-0.90-1.0 0.05 (5)	0.59-0.89-1.1 0.12 (23)
Length of gonad	0.23-0.47-0.68 0.10 (13)	0.32-0.36-0.41 0.05 (5)		0.23-0.44-0.68 0.10 (18)
Breadth of velum	0.18-0.23 (13)	0.14-0.23 (5)	0.19-0.27 (3)	0.14-0.27 (21)
No. of marginal warts	7-7.8-8 0.41 (15)	4-6.6-8 1.6 (10)	6-8.1-9 0.73 (14)	4-7.6-9 1.1 (39)
No. of statocysts	7-7.8-8 0.41 (15)	7-7.8-9 0.63 (10)	8-8.2-9 0.43 (14)	7-7.9-9 0.51 (39)
No. of statoliths	7-7.9-9 0.52 (15)	5-8.0-12 1.9 (10)	8-9.0-14 2.0 (14)	5-8.3-14 1.6 (39)
No. of statoliths per statocyst	0-2 (15)	0-2 (10)	0-3 (14)	0-3 (39)

Table 3. Frequency distribution of the number of marginal warts (Mw), statocysts (St), and of statoliths (Stl) per specimen, and that of the number of statoliths per statocyst (Stl/St) in *Eugym. i. japonica* from Zagashima Is. (host: *Mytilus edulis*, *Crassostrea gigas*, and *Chlamys farreri*).

Sex		No. of Mw, St, and Stl per specimen or no. of Stl per statocyst														No. of individuals examined
		0	1	2	3	4	5	6	7	8	9	···	12	13	14	
♀	Mw						1	3	11	68	1					84
	St							1	4	79						84
	Stl						1		10	63	10					84
	Stl/St	8	647	11												666*
♂	Mw					2	1		3	6						12
	St								3	8	1					12
	Stl						1	1	1	6	2		1			12
	Stl/St	2	87	5												94*
?	Mw							1	6	32	3					42
	St								4	35	3					42
	Stl								1	35	4			1	1	42
	Stl/St	1	325	11	1											338*
All specimens combined	Mw					2	2	4	20	106	4					138
	St							1	11	122	4					138
	Stl						2	1	12	104	16		1	1	1	138
	Stl/St	11	1059	27	1											1098*

* No. of statocysts examined.

Table 4. Frequency distribution of the number of marginal warts (Mw), statocysts (St), and of statoliths (Stl) per specimen, and that of the number of statoliths per statocyst (Stl/St) in *Eugym. i. japonica* from Shimoda (host: *Mytilus edulis* and *Crassostrea gigas*), including the previously examined data (Kubota 1979).

Sex		No. of Mw, St, and Stl per specimen or no. of Stl per statocyst																No. of individuals examined
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	···	17	
♀	Mw					4		1	4	115								124
	St								1	120	3							124
	Stl								1	105	10	4	3	1				124
	Stl/St		967	25	2													994*
♂	Mw					4	4	8	8	126	7							157
	St					1	1	5	7	143								157
	Stl					1	1	5	7	124	7	6	3	1	1		1	157
	Stl/St		1191	36	5													1232*
?	Mw					20	6	5	10	180	4							225
	St						1	3	15	203	3							225
	Stl						1	2	19	183	12	6		2				225
	Stl/St	3	1734	30	1													1768*
All specimens combined	Mw					28	10	14	22	421	11							506
	St					1	2	8	23	466	6							506
	Stl					1	2	7	27	412	29	16	6	4	1		1	506
	Stl/St	3	3892	91	8													3994*

* No. of statocysts examined.

of the marginal warts, statocysts, and statoliths in these specimens is shown in Table 4. Moreover, seven sex undetermined specimens from Itô originated from two specimens of *M. e. galloprovincialis* were examined.

Compared the medusae from Zagashima Is. with those from Shimoda and Itô, they are of nearly similar morphology. And a wide morphological variation, including a still undescribed character state, was observed in the present hydroid: possessing up to nine statocysts, nine marginal warts, and 17 statoliths per specimen, and up to three statoliths per statocyst. A speciman showing such a large variation was illustrated in Fig. 1. It was observed that (1) the medusa is usually wider than high, sometimes with an umbilical canal and a slight depression at its apex; (2) a statocyst containing more than two statoliths had one large statolith and the other small one(s); (3) the umbrellar width of the medusa from Shimoda was 0.56-0.79-1.1 mm, 0.11 (59), which is nearly the same size as that described before (Kubota 1979) and that from Zagashima Is. (Table 2); (4) there was only another male specimen from Shimoda whose manubrium was absent.

According to the combination of the number of the statocysts per specimen (henceforce abbreviated St) and the number of the marginal warts per specimen (Mw) 22 medusan types were discriminated among 36 ones (6×6) expected, together with the types described before (Table 5). A combination always

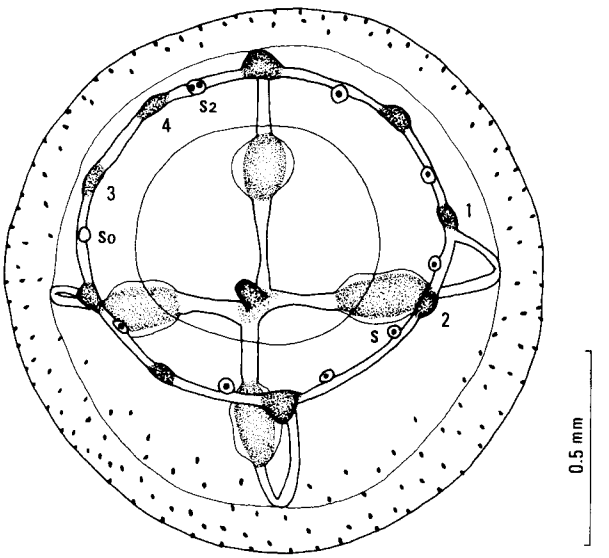

Fig. 1. A spent medusa of *Eugym. i. japonica* from Zagashima Is. originated from *Crassostrea gigas*, oral view. Note irregular disposition of four marginal warts (1-4) among nine ones and that of one statocyst (S) among nine ones, and two statocysts (S_0, S_2) containing zero and two statoliths, respectively (see Fig. 2, 44).

Table 5. Frequency distribution of 22 medusan types of *Eugym. i. japonica* classified by the number of statocysts (St) and that of marginal warts (Mw) per specimen. For each type is given the number of specimens (%), and the number of subtypes (in italics) classified by the position of both the statocysts and the marginal warts on umbrellar margin (see Fig. 2).

No. of St / No. of Mw	4	5	6	7	8	9	Total
4	1(0.2), *1*	2(0.3), *2*	3(0.5), *3*	4(0.6), *3*	21(3.2), *1*		31(4.8), *10*
5		1(0.2), *1*	2(0.3), *1*	3(0.5), *3*	6(0.9), *1*		12(1.8), *6*
6			1(0.2), *1*	4(0.6), *3*	17(2.6), *2*		22(3.4), *6*
7			2(0.3), *2*	13(2.0), *6*	22(3.4), *2*	1(0.2), *1*	38(5.8), *11*
8			1(0.2), *1*	7(1.1), *2*	519(79.7), *1*	6(0.9), *3*	533(81.9), *7*
9					12(1.8), *1*	3(0.5), *3*	15(2.3), *4*
Total	1(0.2), *1*	3(0.5), *3*	9(1.4), *8*	31(4.8), *17*	597(91.7), *8*	10(1.5), *7*	651(100.0), *44*

appears when St≧Mw except for when St=9 (Fig. 2, 38-44). Possession of nine statocysts may be somewhat an abnormal state. When St<Mw a combination rarely occurs. In each type, up to six subtypes were distinguished in terms of their position on the umbrellar margin (Table 5), resulting a total of 44 subtypes (Fig. 2). Among these types the one with eight statocysts and eight marginal warts (Fig. 2, 36) is most abundant in populations (80%), and this is the most regular one in morphology, showing no modification. This type is conceivable as the basic one for the present hydroid. This is deduced from not only the above fact but also the other fact that nearly all the other related bivalve-inhabiting hydroids have eight statocysts and eight marginal warts when they are released from the polyps. Other many types, namely the modified ones, such as the ones with St=8, Mw=7 (Fig. 2, 34-35), one with St=8, Mw=4 (Fig. 2, 30), ones with St=8, Mw=6 (Fig. 2, 32-33), one with St=8, Mw=9 (Fig. 2, 37), and ones with St=Mw=7 (Fig. 2, 22-27) appeared in a low frequency (2-4%), and the other ones were very rare (below 1%). Among 169 male specimens and 208 female ones examined the number of specimens (the percentage) showing the modified types (Fig. 2, 1-35, 37-44) were 38 (22.5%) in male medusa and 28 (13.5%) in female one. This indicates that the male medusa is more variable in morphology, as was already noticed in the original description, though not so distinct as before. Besides the above-described specimens four abnormal specimens were found: one female specimen with three radial canals (Fig. 2, 48), two male ones with a branched radial canal (Fig. 2, 45, 47) in which one had five gonads, and one possibly male specimen whose radial canals were three in number (Fig. 2, 46),

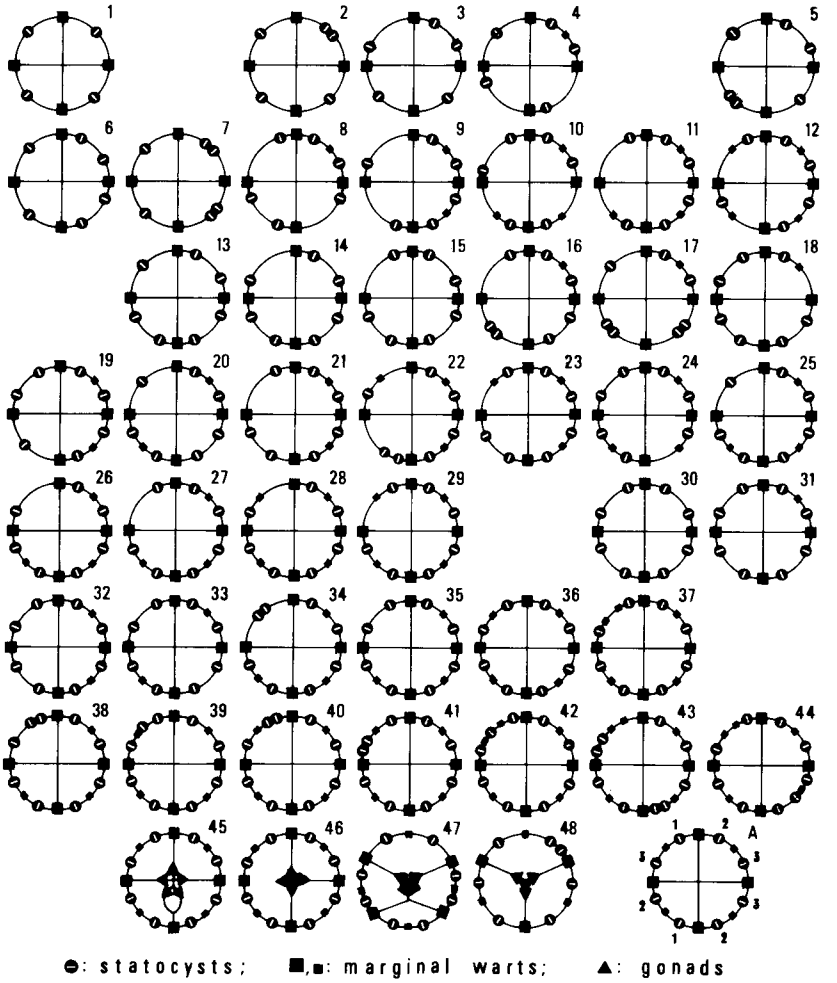

Fig. 2. Schematic illustration of 44 medusan types of *Eugym. i. japonica* (1-44) and four abnormal ones (45-48). 1: number of statocysts (St)=4; 2-4: St=5; 5-12: St=6; 13-29: St=7; 30-37: St=8; 38-44: St=9; A: a male specimen of the type 36 with the maximum number of statoliths (17) per specimen, showing the distribution of the number of statoliths per specimen.

differing the above female one in their angles with the center.

Immediately after liberation or at most within several days after liberation, the medusae became spent ones whose sexes are unable to be determined. On the fourth day, half of the mature medusae reared in laboratory (20 ♀♀ + 10 ♂♂) were completely degenerated at 24-27°C. The life-span was at the longest nine days

(observed in more than 50 specimens). During this short life-span the medusa did not grow further, namely no more formation of gonads was observed after once gametes discharged, no increase of the number of statoliths, and the manubrium slightly reduced, measuring about 0.09 mm in length.

The sex of all the medusae liberated from 17 specimens of *M. e. galloprovincialis* from Shimoda and those from five specimens of *M. e. galloprovincialis*, five specimens of *Cr. gigas*, and one specimen of *Ch. farreri* from Zagashima Is. was checked. In several hosts the medusae were continuously liberated for about a week in laboratory. Although the sex of all of the medusae could not be determined, from any of these hosts the medusae of both sexes did not appear at the same time, e.g. in one specimen 154 medusae were liberated and 113 of them were females; and the female hydroid was more frequently associated than the male one in these hosts (18 : 9). However, from one specimen of *Cr. gigas* from Zagashima Is. the medusae of both sexes were liberated as an exceptional case. It may be safe to say from the present observations that the manner of invasion of the larva of *Eugymnanthea* into the host is the same one as that of *Eutima japonica* (see Kubota 1983).

Compared the present medusa with the Italian one described by Palombi (1935), Cerutti (1941), and Uchida (1964), one of the diagnostic characters of the subspecies (see Kubota 1979), the number of statoliths per statocyst, overlaps with each other. However, in the Japanese medusa a statocyst usually contains one statolith (Tables 3, 4), whereas in the Italian one usually three statoliths, up to four ones. The other diagnostic character, the presence of a manubrium, though its function was lost, appeared as a reliable character because nearly all of the specimens of the Japanese *Eugymnanthea* (with the only two exceptions from Shimoda among 655 or more specimens observed) have this manubrium which was present throughout the life-span of the medusa as described above. Although only one medusan specimen of *Eugym. i. japonica* was found among plankton samples from Zagashima Is. collected on Sep. 11, '84, this medusa had the manubrium. Such a morphological consistency of the Japanese *Eugymnanthea* supports the former taxonomic treatment, namely the separation of *Eugymnanthea* into two subspecies. This might also indicate that the Japanese *Eugymnanthea* is not an introduced hydroid from Europe, differing the case of its host *Mytilus edulis galloprovincialis*. Further biological studies on the European *Eugymnanthea* will be needful to conclude the matter.

Gametes and Larvae

Gametes and larvae of the present hydroid from Shimoda were observed and compared with those of *Eutima japonica* (cf. Kubota 1983). The unfertilized eggs discharged from many medusae are spherical in shape (Fig. 3, A), measuring 32-51-66 μm, 7.8 (49 eggs) in diameter with the exception of an elliptical egg of 64×52 μm. Most of these eggs of the Japanese *Eugymnanthea* examined did not

have a germinal vesicle, and they were slightly smaller than the normal eggs of *E. japonica* (64-82 μm). This can be also said for the discharged eggs from many medusae from Zagashima Is. (24-54-65 μm, 11, in diameter in 33 eggs). The discharged eggs of the Italian *Eugymnanthea* were described as 55-95 μm in diameter (Cerruti 1941), which tends to be larger than the eggs of the Japanese *Eugymnanthea* but nearly the same size as the normal eggs of *E. japonica*.

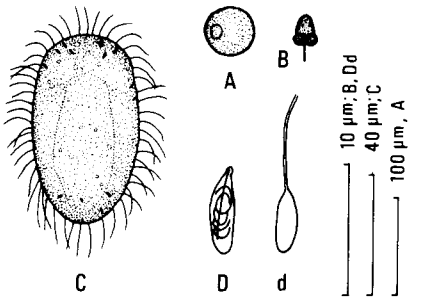

Fig. 3. An unfertilized egg (A), a sperm (B, tail omitted), planula (C), and the nematocysts of planula (Dd) of *Eugym. i. japonica* from Shimoda.

The measurements of the sperm of the present hydroid was as follows: the length of head and middle piece together was 2.4-2.4-2.6 μm, 0.04 (31 sperms); the greatest width of middle piece was 1.8-2.0-2.4 μm, 0.16 (ditto); the length of tail was 48.0-53.9-56.8 μm, 2.7 (10 sperms). Such sperms of the present hydroid are the same as those of *E. japonica* in size and structure on the microscopic level (Fig. 3, B). The morphological comparison of the sperm of these two species on the ultrastructural level, particularly to determine the number of mitochondria per sperm, was made using the specimens of *Eugymnanthea* from Shimoda and the laboratory-reared mature medusa of *E. japonica* from Enoshima Is., Kanagawa Pref. (of which morphology will be

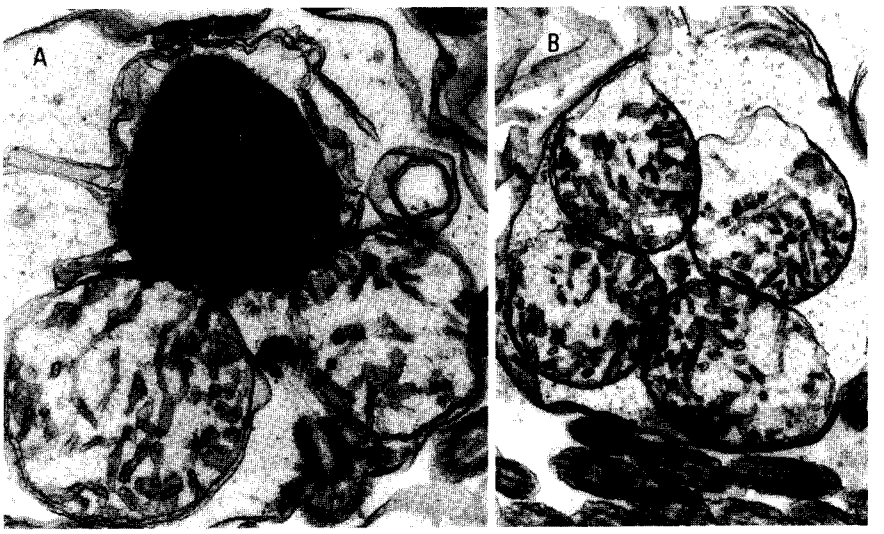

Fig. 4. Longitudinal section (A: ×27,000) and cross section of the middle piece (B: ×18,000) of the sperm of *Eugym. i. japonica* from Shimoda.

reported elsewhere). It was clarified that no distinct difference appeared between them in this level and the number of mitocondria per sperm is four in both the species (Fig. 4, A, B).

The measurements of the present planula 2 or 3 days old were as follows: 48-60-68 μm, 7.4 (11) in length; 34-39-44 μm, 3.2 (11) in maximum width; 16 μm (7) in length of cilia. Such planulae (Fig. 2, C) are smaller than those of *E. japonica*, though the nematocyst equipment (Fig. 2, Dd) is the same as that of *E. japonica*, measuring 4.8-5.9-7.2 μm, 0.88 $\times$ 1.4-1.8-2.2 μm, 0.25 (21 nematocysts from three planulae 2-5 days old) in length $\times$ maximum width of undischarged capsules of atrichous isorhizes.

Summary

Eugymnanthea inquilina japonica Kubota, 1979 may be a generalist in terms of the host preference, associating at least with three bivalve species such as *Mytilus edulis galloprovincialis*, *Crassostrea gigas*, and *Chlamys farreri*. A wide morphological variation of the hydroid revealed by the reexamination of a large number of specimens associated with the above bivalves collected from the central Japan during 1982-'84. A solitary unbranched polyp, attaining to 3.5 mm in length and 0.27 mm in width, with up to 28 tentacles and five medusa-buds on two stalks produced on the position of 0.23-0.48 from the pedal disk; a mature or spent medusa, attaining to 1.4 mm in diameter and 1.1 mm in height, 0.68 mm in length of gonad, and 0.27 mm in width of velum, and with 4-9 marginal warts, 4-9 statocysts, and 17 statoliths per specimen. A statocyst usually contains one statolith, rarely two or three. According to both the number and the position of the marginal warts and the statocysts, 44 medusan types are discriminated, and the male medusa is more variable than the female one in such respects. When a specimen has seven marginal warts and seven statocysts, their position is most variable. In each specimen the number of statocysts is more than that of the marginal warts, and 22 combinations appeared out of 36 ones expected. Among 651 specimens examined, a medusa with eight statocysts and eight marginal warts, a basic type for *Eugymnanthea*, is most abundant (80%). The life-span of medusa was at the longest nine days. The sperm and nematocyst equipment of planula of the present hydroid are the same as those of *Eutima japonica* Uchida, 1925 in size and structure, whereas the unfertilized eggs and the planula tend to be smaller. Two diagnostic characters, the presence of manubrium and the possession of less number of statoliths per statocyst in the medusa, are stable among several local populations in Japan, which confirms the differentiation of *Eugymnanthea* into two subspecies.

Acknowledgments

The author wishes to express his sincere gratitude to Professor Mayumi Yamada, Hokkaido

University, for his kind directions and critical reading of the manuscript. Thanks are also due to Dr. Masakane Yamashita who kindly prepared Fig. 4. The author was so much obliged to Dr. Tadashige Habe for the identification of the bivalves. He is also indebted to the staff of the Shimoda Marine Research Center, the University of Tsukuba and the staff of the Fisheries Research Laboratory, Mie University, particularly to Dr. Seishi Kimura, for the use of facilities and helping him for collecting materials. This study is supported in part by the Grant-in-aid for Scientific Research No. 58740367 from the Ministry of Education, Science and Culture, Japan.

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