BIOVALENTIA : Biological Research Journal **E-ISSN: 2477-1392**
Vol 1, No 1 (2015) : November 2015

Life history of two *Hediste* species (Polychaeta: Nereididae) in an estuary of the Omuta-gawa River, Kyushu, Japan

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Received on 4th October 2015 and Accepted on 30th November 2015

ABSTRAK

Penelitian ini dilakukan di empat stasiun di estuaria sungai Omuta-gawa, Kyushu, Jepang mulai dari bulan Desember 2003 hingga bulan Juli 2005. Secara jelas hasil survei bulanan menunjukkan bahwa *Hediste japonica* memiliki masa hidup adalah satu generasi per tahun. Masa reproduksi spesies ini adalah mulai akhir Desember hingga akhir Februari, masa sejarah hidup ini juga terdapat pada *H. Diaroma* yang juga memiliki masa hidup satu generasi per tahunnya. Masa reproduksi spesies ini di sungai Omuta-gawa berlangsung dari pertengahan bulan Desember hingga akhir bulan April, dimana pada saat tersebut terjadi peristiwa swarming (pelepasan sperma dan ovum secara bersamaan dari individu jantan dan betina dewasa dalam jumlah yang sangat banyak). Masa reproduksi *Hediste diadroma* lebih lama dibanding dengan *H. japonica*. Kedua species ini mengalami peristiwa pemijahan, fertilisasi dan perkembangan awalnya di badan perairan serta mengalami masa kehidupan larva pelagis yang lama.

Kata kunci : Masa hidup, *Hediste japonica*, *H. diadroma*, masa reproduksi, estuaria

ABSTRACT

The research was conducted at four stations in the Omuta-gawa River, Kyushu, Japan from December 2003 to July 2005. The results of the monthly survey clearly indicated that Hediste japonica has one generation per year. The reproductive period of this species is from late December to late February, and also occurred on *H. diaroma*, that it has one generation per year. The reproductive period of this species in the Omuta-gawa River is from middle December to late April, when reproductive swarming of mature adults occurs. This reproductive period is much longer than that of *H. japonica.* Both Hediste species, spawning, fertilization and early development occur in water column with a long pelagic larval life.

Keywords: life history, *Hediste japonica*, *H. diadroma*, reproductive period, estuary

INTRODUCTION

The life history strategy of the species is the main adaptive direction determining success within communities (Sveshnikov, 1985). During its life history the species performs its main functions: self-preservation, reproduction

and dispersal using adapted life forms alternating during the life cycle.

Polychaetes are one of the representative groups in marine benthic communities showing a large variety of feeding types and life strategies. They also are one of the groups with the highest diversity of reproductive traits among marine invertebrates. This is probably due to the relative simplicity of their reproductive system, and to their high plasticity and adaptability to different habitats (Wilson, 1988).

The genus *Hediste* Malmgren, 1867 (Nereididae) is one of the most dominant genera in shallow brackish waters in the North Temperate Zone and consists of five species: *H. diversicolor* distributed in both the European and the North American coasts of the Atlantic (Smith, 1977), *H. limnicola* in the North American Pacific coast (Smith, 1958), and three species in East Asia (Sato and Nakashima, 2003).

Previously, the Asian *Hediste* worms were regarded as belonging to a single species, *H. japonica*. However, the recent studies on the morphology, reproduction, early development and electrophoretic analysis of the allozymes revealed that "*H. japonica*" consists of three distinct species: *H. diadroma* with a small egg size (130-170 µm in diameter) and a long pelagic larval life, *H. atoka* with a large egg size (200-250 µm) and no pelagic larval stage, and *H. japonica sensu stricto* with an intermediate egg size (180-210 µm) and a short pelagic larval life (Sato, 1999; Sato and Masuda, 1997; Sato and Nakashima, 2003; Sato and Tsuchiya, 1987, 1991).

Spawning, fertilization and early development in *H. japonica* and *H. diadroma* occur in water column after reproductive swarming of mature adults (Kagawa, 1955; Sato & Tsuchiya, 1987; Sato, 1999; Hanafiah et al. 2006. On the other hand, in *H. atoka*, spawning, fertilization and early development occur within (or around) a burrow without reproductive swarming (Sato & Tsuchiya, 1987; Sato, 1999). All three species are semelparous: After spawning, the adults died.

The life span of *H. atoka* seemed to usually be about half a year, yielding two generations per year (Kikuchi, 1998), whereas the life span of one year was suggested in *H. diadroma* by a monthly population survey in China (Qiu & Wu,

1993). However, there is no previous study on the life span and any other aspects of the life history of *H. japonica.*

Both *H. japonica* and *H. diadroma* inhabit the intertidal flats in an estuary of the Omuta-gawa River, located at the edge of the geographic range of *H. japonica* in Ariake Sea (Sato and Nakashima 2003; Hanafiah et al. 2006.

MATERIALS AND METHODS

Benthic specimens of *Hediste diadroma* and *H. japonica* were sieved from sediment samples collected intertidally using a core sampler around low tide at four stations (F, P, M, A) (Figure. 1) in the Omuta-gawa River during spring tides from December 2003 to July 2005. The collection sites were selected in an area with relatively high density of *Hediste* species based on preliminary surveys throughout the estuary. One to four sediment samples up to about 20 cm deep were collected using a core sampler with a diameter of 8.3 cm (area: 54.1 cm^2) and sieved with a 1 mm-mesh. Polychaete specimens were fixed in 80% ethanol, and transferred to fresh 80% ethanol for preservation. After taking the sediment samples, the salinity of the interstitial water that drained into the remaining hole was measured with a handheld SCT (salinity, conductivity, and temperature) meter (Model 30, YSI, OH, USA).

To obtain the data on size frequency distribution of body width and monthly changes in body size, I examined a total of 1126 individuals belonging to *H. diadroma* (162 individuals from station M, and 964 individuals from station A), and 134 individuals belonging to *H. japonica* (134 individuals from station M).

For the fixed specimens of two *Hediste* species, anterior maximum body width excluding the parapodia was measured by enlargement (x 10) with a camera lucida on a stereoscopic microscope (Sato and Nakashima, 2003).

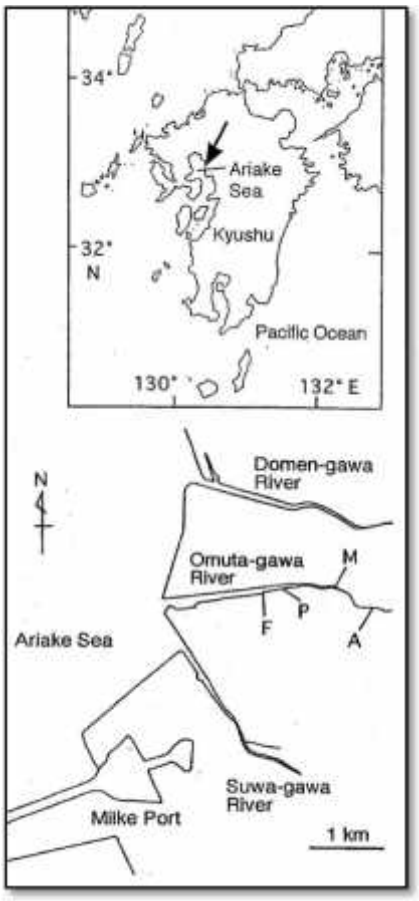

Fig. 1. Map showing collection sites: stations F, P, M, and A in the Omuta-gawa River.

RESULTS AND DISCUSSION

Seasonal changes in the body-size distribution of each species *Hediste japonica*

Size-frequency distributions of *H. japonica* in station M (Fig. 2) were analyzed. In December 2003 and January 2004, only large adults with average body width of 4.0 mm and 3.4 mm respectively were collected. In February and March 2004, no specimen was collected. Newly recruited juveniles with body width less than 1 mm were collected only in April 2004, when the average body width of the population was the lowest (average ± SD: 1.5 ± 0.3 mm). The average body width increased rapidly in June (2.9 ± 0.3 mm), and then gradually in December 2004 (3.9 ± 0.3 mm).

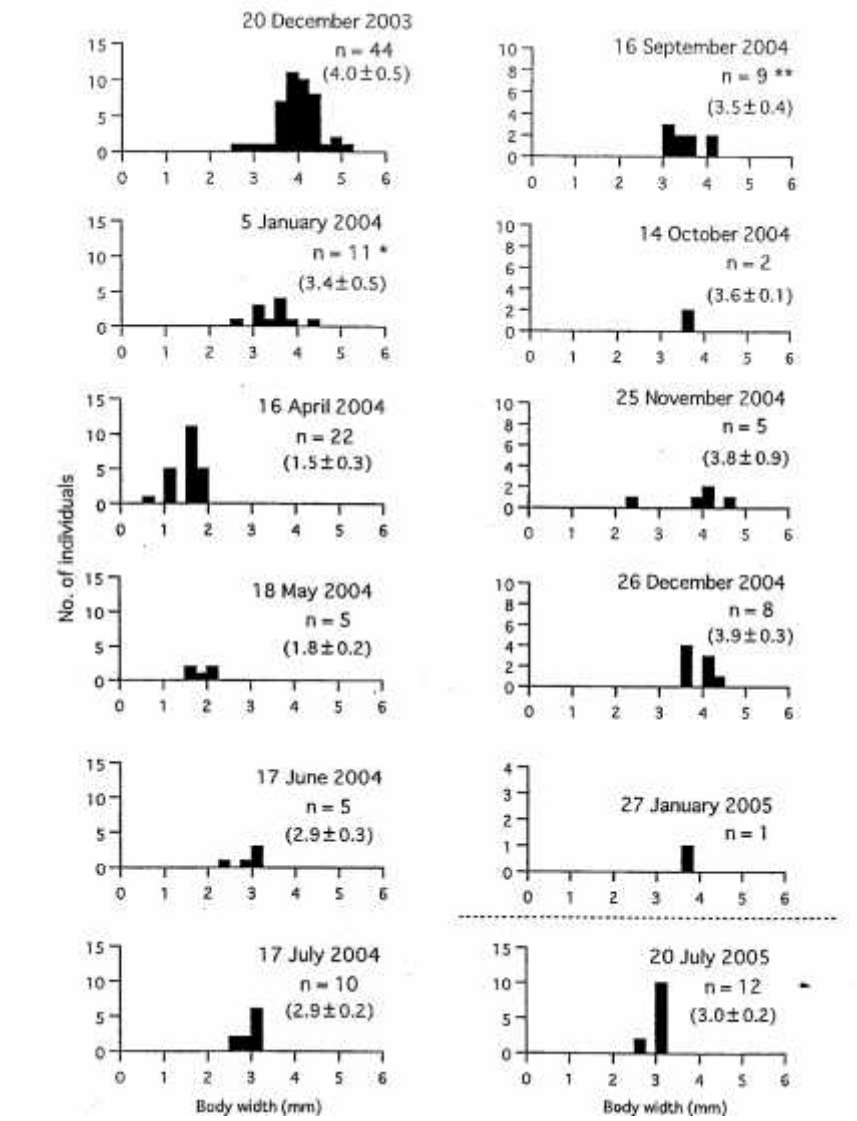

Figure. 2. Size-frequency histogram in *Hediste japonica* collected at station M in an estuary of the Omuta-gawa River during a period from December 2003 to July 2005.
Included one (*) and three (**) specimens collected at Sta. A1.

Hediste diadroma

Size-frequency distributions of *H. diadroma* in stations M and A (Fig. 3) were analyzed. At station M, only a few large adults (average body width ± SD: 3.0 ± 0.8) were collected in December 2003. From January to March 2004, no specimen was collected. Newly recruited juveniles with body width less than 1 mm first appeared in April 2004, and occurred also in May and June 2004. The

average body width increased gradually from April (0.8 ± 0.5 mm) to November 2004 (3.0 ± 0.3 mm)

At station A, large adults were collected in January and February 2004 (2.9 ± 0.7 mm, 2.8 ± 0.8 mm, respectively). Probably newly recruited juveniles with body width less than 1 mm first appeared in April 2004, and occurred also in May, June and July 2004, when relatively large worms with body width more than 3 mm were also coexisted. The average body width decreased gradually from February (2.8 ± 0.8 mm) to May (1.5 ± 0.6 mm), and then gradually increased to December 2004 (3.9 ± 0.5 mm). In most months, the population contained various sized worms represented by large values of SD.

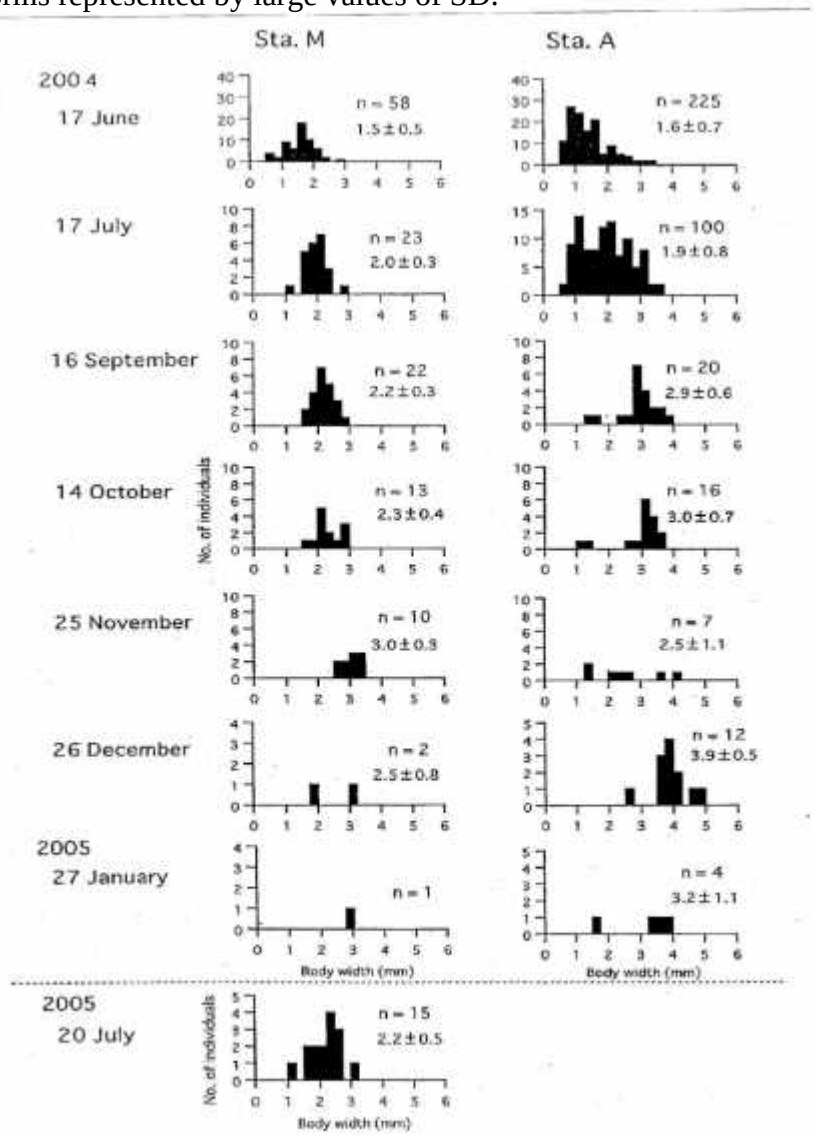

Figure. 3. Size-frequency histogram in *Hediste diadroma* collected at station M and A in an estuary of the Omuta-gawa River during a period from December 2003 to July 2005.

Seasonal changes in the maximum population density of each species

Hediste japonica

The highest population density was recorded in April 2004 (2960 individuals/m^2). Then, the density rapidly decreased to less than 1500 individuals/m^2 from May 2004 to January 2005, with a temporal extreme decrease in October 2004 (185 individuals/m^2).

Hediste diadroma

At station M, the population density increased from April (555 individuals/m^2) to June 2004 (4068 individuals/m^2). After that, the density gradually decreased to November (1479 individuals/m^2) and then rapidly decreased to December (185 individuals/m^2).

At station A, the population density increased gradually from January (417 individuals/m^2) to April 2004 (2589 individuals/m^2), and then rapidly increased in following May (37537 individuals/m^2). After that, the density rapidly decreased to September 2004 (925 individuals/m^2). Thereafter, the density was almost constant until December 2004 (832 individuals/m^2).

Life history of *Hediste japonica*

The results of the present monthly survey clearly indicated that *Hediste japonica* has one generation per year. The reproductive period of this species is from late December to late February, when reproductive swarming of mature adults occurs (Izuka, 1908; Sato and Nakashima, 2003; Hanafiah et al. 2006. Spawning, fertilization and early development occur in water column with a short pelagic larval life around 10 days (Izuka, 1908; Tosuji and Sato, 2006). It is unknown what extent larvae disperse and whether larvae settle directly into the middle reaches of the estuary (station M) or they settle in the lower reaches at first and then juveniles move upwards.

Life history of *Hediste diadroma*

The results show that *Hediste diadroma* also has one generation per year. The reproductive period of this species in the Omuta-gawa River is from middle December to late April, when reproductive swarming of mature adults occurs

(Hanafiah et al. 2006). This reproductive period is much longer than that of *H. japonica*. This seem to result in a long duration (from April to July) of occurrence of newly recruited small juveniles and consequently in monthly population structures with a wide range of body sizes throughout year.

Spawning, fertilization and early development occur in water column with a long pelagic larval life (Tosuji and Sato, 2006). The nectochaeta larvae of the 6-setiger stage, which seemed to gain a tolerance to lower salinity, settled into brackish waters of the adult habitat, moving upstream on rising tides about one month after fertilization (Kagawa, 1955). Thus, the life-cycle is migratory and diadromous, planktonic (embryos and larvae) in a region with higher salinity and benthic (juveniles and adults) in a region with lower salinity (Sato, 1999).

The worms could grow bigger in station A in the upper reaches of the estuary than in station M in the middle reaches, where *H. diadroma* coexisted with *H. japonica*.

ACKNOWLEDGMENTS

I wish to express my heartfelt gratitude and sincere appreciation to Dr. Masanori Sato and Dr. Tosuji Hiroaki for helping me to carry on my field work.

The author also thank Sumiko Sato (Omuta-shi, Fukuoka Prefecture) and Hidetoshi Nakashima (the Omuta Zoo, Omuta-shi, Fukuoka Prefecture) for their kind hospitality during field surveys.

I am indebted to the Ministry of National Education of the Republic of Indonesia and Sriwijaya University, for providing and arranging the fully financial supports through the Technological Professional Skill Development Project (TPSDP)-ADB loan No. 1792 (from February 2003 to October 2006).

Finally, I would like to express my deep gratitude to every one involved in finishing this paper.

REFERENCES

Hanafiah Z, Sato M, Nakashima H, Tosuji H (2006) Reproductive swarming of sympatric nereidid polychaetes in an estuary of the Omuta-gawa River in Kyushu, Japan, with special reference to simultaneous swarming of two *Hediste* species. Zool Sci 23: 205-217

Izuka A (1908) On the breeding habit and development of *Nereis japonica* n. sp. Annot Zool Jap, 6: 295-305

Kagawa Y (1955) Note on the optimum salinities, studied in the adult and larva of the brackish-water polychaete worm, *Nereis japonica*. J Gakugei Coll Tokushima Univ (Nat Sci) 6: 11-16 (in Japanese with English summary)

Kikuchi E (1998) Life history and dispersal pattern of the polychaete worm *Neanthes japonica* (Izuka) in the Nanakita River Estuary, Miyagi Prefecture. The Japanese Journal of Limnology. Vol. 59: No. 2 p. 125-146

Qiu JW, Wu BL (1993) Population dynamics and production of *Neanthes japonica* (Izuka) in a shrimp pond. Chin. J. Oceano. Limno. Vol. 11. No. 4: 360-367

Sato M (1999) Divergence of reproductive and developmental characteristics in *Hediste* (Polychaeta: Nereididae). Hydrobiologia 402: 129-143

Sato M, Nakashima A (2003) A review of Asian *Hediste species* complex (Nereididae, Polychaeta) with descriptions of two new species and a redesdiscription of *Hediste japonica* (Izuka, 1908). Zool J Linn Soc 137: 403-445

Sato M, Tsuchiya M (1987) Reproductive behavior and salinity favorable for early development in two types of the brackish-water polychaete *Neanthes japonica* (Izuka). Benthos Res 31: 29-42

Sato M, Tsuchiya M (1991) Two pattern of early development in nereidid polychaetes keying out to *Neanthes japonica* (Izuka). Ophelia, Suppl. 5: 371-382

Sato M, Y Masuda (1997) Genetic differentiation in two sibling species of the brackish-water polychaete *Hediste japonica* complex (Nereididae). Mar. Biol. 130: 163-170

Smith RI (1958) On reproductive pattern as a specific characteristic among nereid polychaetes. Systematic Zoology, 7: 60-73

Smith RI (1977) Physiological and reproductive adaptation of *Nereis diversicolor* to life in the Baltic Sea and adjacent waters. In Reish, D. J. & K. Fauchald (eds), essays on polychaetous annelids in memory of Dr Olga Hartman. Allan Hancock Foundation, Univ. Southern California, Los Angeles: 373-390

Sveshnikov VA (1985) The life-history of the polychaetes (Polychaeta). Issledovaniya Fauny Morei 34: 112-17.

Tosuji H, Sato M (2006) Salinity favorable for early development and gamete

compatibility in two sympatric estuarine species of the genus *Hediste* (Polychaeta: Nereididae) in the Ariake Sea, Japan. Mar Biol 148: 529-539

Wilson RS (1988) Synonymy of the genus *Nectoneanthes* Imajima, 1972, with *Neanthes* Kinberg, 1866 (Polychaeta: Nereididae). Proc Biol Soc Wash 101: 4-10