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Practical identification of the sand-burrowing mysid, *Archaeomysis vulgaris* (Crustacea: Mysidacea) and its biological characteristics

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Abstract: Practical distinguishing characters between *Archaeomysis vulgaris* and *A. japonica* were described at every developmental stage using specimens collected at sandy beaches in southern Japan. *A. vulgaris* was distinguished from *A. japonica* by (i) subterminal spine length on the lateral margin of the telson, (ii) shape and length of elements at the distomedial corner on the second segment of the antennule, and (iii) presence or absence of a deep posterodorsal slit on the carapace. With *A. vulgaris*, the number of spines on the telson was so variable that it was inappropriate for use as a key trait. The relationship between developmental stage and instar number of these mysids was shown together with the intermolt periods from a laboratory incubation experiment. Secondary sexual characteristics (exopod of the third pleopod in males and marsupial lamellae in females) appeared at instar 3 or 4, and maturity was attained at instar 7 with an intermolt period of approximately 3 to 7 days. Biological characteristics of ecological importance were measured for *A. vulgaris*. The mean standard length of *A. vulgaris* increased from 2.30 to 8.29 mm, and the dry weight changed from 0.014 to 1.68 mg during development. The mean carbon and nitrogen content on a dry weight base ranged from 43.0 to 45.1% and from 10.4 to 12.2%, respectively.

Key words: *Archaeomysis vulgaris, Archaeomysis japonica*, identification, developmental stage, prey

Introduction

In the shallow waters of Japan's sandy coastline, sand-burrowing mysids of the genus *Archaeomysis* were reported to have three intertidal species: *A. vulgaris*, *A. kokuboi*, and *A. articulata*, and two subtidal species: *A. japonica* and *A. ochotensis*, which are morphologically analogous to one another while showing biogeographical variation (Hanamura 1997). It was reported that *A. vulgaris* and *A. kokuboi* inhabit Japan's southern and northern regions, respectively, with a boundary located at 37–38°N. *A. japonica* lives in waters throughout Japan's coastline, while *A. articulata* and *A. ochotensis* are found in Hokkaido (Hanamura 1997). In southern Japan, *A. vulgaris* is one of the most common species and is usually collected together with *A. japonica*. Although biological and ecological studies of *A. kokuboi* (Kaneko & Okata 1995; Takahashi & Kawaguchi 1995, 1997, 1998; Ma et al. 2001; Kaneko & Omori 2003) and *A. articulata* (Hanamura 1999) have recently been made, *A. vulgaris* remains insufficiently studied.

To distinguish among mature *Archaeomysis* species, Hanamura (1997) emphasized differences in posterodorsal slits on the carapace, the number of spines on the telson, and the endopodal joints of the male's third pleopod. To distinguish *A. kokuboi* from *A. japonica* throughout its various developmental stages, Takahashi & Kawaguchi (1996) suggested two practical key characters: the length-ratio of subterminal spines on the telson, and the shape and length of elements on the second segment of the antennule. However, it is still necessary to determine practical keys for distinguishing between *A. vulgaris* and *A. japonica*, particularly in juvenile stages. Once accomplished, it will be possible to efficiently analyze numerous samples in ecological studies of these mysids.

In order to establish basic information on *Archaeomysis*

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vulgaris, this paper documents (1) the relationship between developmental stage and instar for *A. vulgaris* and *A. japonica* by incubation experiments, (2) practical distinguishing characters with special reference to the telson, antennule, and carapace for all developmental stages of *A. vulgaris* and *A. japonica*, and (3) ecologically important biological characteristics (size, weight, and chemical contents) for *A. vulgaris*.

Materials and Methods

Laboratory incubation experiment

The purpose of this experiment was to determine instar numbers and intermolt periods throughout development by incubating newly released *Archaeomysis vulgaris* and *A. japonica* juveniles. Although it has been reported that other mysids have two larval molts during marsupial development (cf. Wortham-Neal & Price 2002), our aim was to count the instar numbers after release from the marsupium, as described by Ma et al. (2001). To obtain juveniles, five mature females carrying stage III larvae (Mauchline 1980) were selected from mysids collected at Doigahama (34°17′N, 130°53′E) on Yamaguchi Prefecture's western coast in February 2004.

Developmental stages were categorized according to the degree of secondary sexual development, as defined by Mauchline (1980). The stout terminal setae found on the exopod of the male's third pleopod and the inner lamellae of the female's marsupium in *Archaeomysis vulgaris* and *A. japonica* were key characteristics in determining maturity; therefore, the mysids observed in this study were classified into the following six categories:

Juveniles I: lacking secondary sexual characteristics, just after release from the marsupium;

Juveniles II: missing sexual characters, and after the 1st or the 2nd molt;

Immature males: the exopod of the third pleopod is in the process of development;

Immature females: the marsupium is in the process of development;

Mature males: the exopod of the third pleopod reaches the fore-part of the sixth abdominal somite; the stout terminal setae on the exopod of the third pleopod are clearly visible;

Mature females: females with embryos or larvae in the marsupium, or, in the absence of embryos and larvae, when the inner and outer marsupium lamellae are approximately equal in size.

Each mature female was incubated at a temperature of 15–18°C in 300 ml of ambient seawater. The mature females of both species were fed a diet of *Artemia* and were transferred into freshly prepared seawater at 3–5 day intervals. Of a hundred newly released juveniles, sixty were reared for approximately two months in 300 ml containers. Some juveniles were fixed in a 10% formalin solution to observe the external morphological differences between *A. vulgaris* and *A. japonica*, and others were frozen to measure biological characteristics.

Sixty juveniles per mysid species (a total of 120 individuals) were observed each morning to determine instar numbers and intermolt periods. If exuvia was present, each individual was observed under a stereo microscope and the number of spines on the lateral margin of the telson was determined (especially in Juveniles I and II) and the secondary sexual characteristics were examined. After examination, the individuals were returned to the container alive.

Observation of morphological differences between *Archaeomysis vulgaris* and *A. japonica*

The purpose of morphological observation was to determine practical distinguishing characters between *Archaeomysis vulgaris* and *A. japonica*. The mysid samples collected at Doigahama in February and July of 2004, and Fukiagehama (31°29′N, 130°19′E) on Kagoshima Prefecture's western coast in May, July, and October of 2002 and March of 2003 were observed under a stereo microscope and sorted into six developmental stages. They were then inspected to determine the number of spines on the lateral margin of the telson, and to look for three distinguishing morphological features: subterminal spines on the lateral margin of the telson, elements on the second segment of the antennule (Fig. 1), and posterodorsal slits on the carapace noted by Takahashi & Kawaguchi (1996) and Hanamura (1997).

Measurement of biological characteristics

Biological characteristics (length, weight, and carbon and nitrogen content) of *Archaeomysis vulgaris* were measured to obtain fundamental information as to its ecological importance as a prey organism. Frozen samples of *A. vulgaris* from the field sampling and from the laboratory incubation experiment (both originally collected at Doigahama in February 2004) were thawed and sorted into six developmental stages. Thus, about 20 individuals (a total of 103 individuals) of *A. vulgaris* in each of the six categories were prepared. The standard length (SL, mm) from the basal part of the eyestalk to the end of the sixth abdominal somite was measured by a digital microscope (KEYENCE, VH-7000). Furthermore, both SL and the total length (TL: length in mm from the apex of the rostrum to the posterior end of the telson) were measured in additional 40 individuals because the TL of mysids eaten by benthic fish is closely related to the fish's mouth size (Hirota et al. 1990). The wet weight (WW, mg) and dry weight (DW, mg) were measured using an electronic balance (PERKIN ELMER, AD-6). Carbon (C) and nitrogen (N) contents were measured using a CHN/S elements auto analyzer (PERKIN ELMER, 2400 II) and stated as % of the DW base.

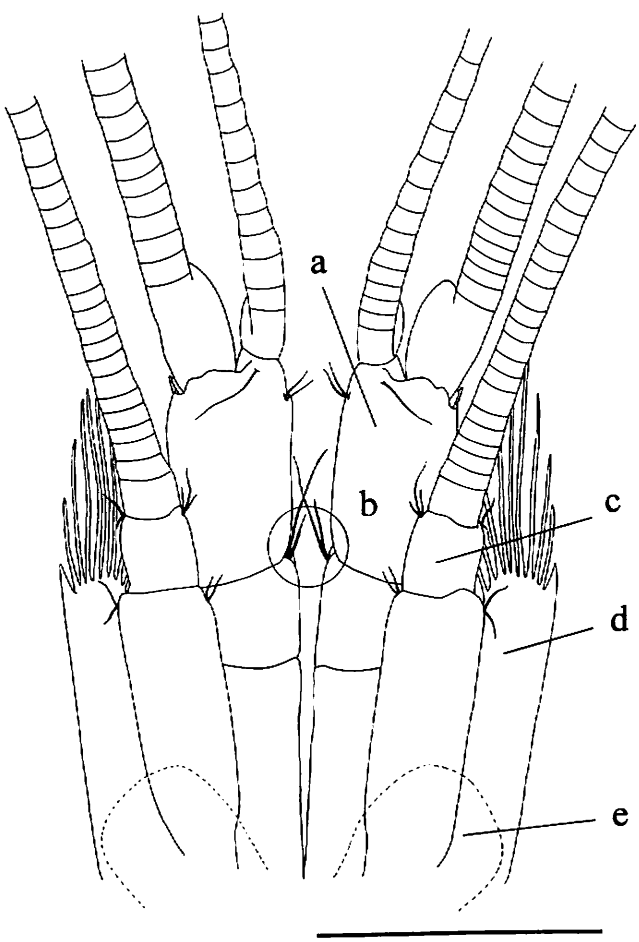

Fig. 1. Ventral view of anterior end of *Archaeomysis vulgaris*. a: third segment of antennule; b: setae at distomedial corner on second segment of antennule; c: second segment of antenna; d: antennal scale; e: eye. Bar indicates 0.5 mm.

Results

Relationship between developmental stage and instar number

The laboratory incubation experiments for *Archaeomysis vulgaris* and *A. japonica* were continued until instar number 11 and 8, respectively. In accordance with secondary sexual characteristic development mentioned previously, the relationship between developmental stage and instar number of both species was established as the following: Juveniles I, as yet unmolted after release, were defined as instar 1; Juveniles II were instars 2 or 3; Immature males were instars 3 or 4 to 6; Immature females were instars 3 to 6; Mature males and females were instars 7 or higher.

Intermolt period

The total cumulative time in days required for each molt is shown in Table 1. The intermolt periods were estimated to be approximately 3 to 7 days. No significant difference (Mann-Whitney's U test, $p>0.05$) in sexual characteristics was noted between *Archaeomysis vulgaris* and *A. japonica* at the second, third (appearance of secondary sexual characteristics), and seventh molt (maturity). However, an interspecific difference was clearly present (Mann-Whitney's U test, $p<0.05$): the mean time for *A. vulgaris* to reach the first molt was 6 days and that for *A. japonica* was 3 days with average incubation temperatures of 17°C and 17.8°C, respectively.

Table 1. Total cumulative time in days of *Archaeomysis vulgaris* ($n=17$) and *A. japonica* ($n=9$) between each molt. Values are means±standard deviations.

Molt	*A. vulgaris*	*A. japonica*
	17.0±1.4°C	17.8±1.6°C
1	5.71±0.85	3.33±0.71
2	10.12±0.99	6.33±0.71
3	13.76±1.30	9.83±0.50
4	19.00±1.77	14.22±0.79
5	23.06±1.68	17.72±0.67
6	27.82±2.00	24.78±1.92
7	33.41±2.65	30.83±1.52

Spines on the telson

Throughout development of *Archaeomysis vulgaris* and *A. japonica*, there was a difference in subterminal spine length on the lateral margin of the telson. In *A. vulgaris*, the subterminal spine was approximately half the length of the distal-most spine (Fig. 2a–f), while both spines were approximately equal length in *A. japonica* (Fig. 2g–l).

Juveniles I of both species lacked one pair of basal spines. The missing basal spines developed after the first molt; thus, Juveniles II had eight spine pairs, a number which remained consistent through the remainder of development (Fig. 2). However, in *Archaeomysis vulgaris* it was observed that non-basal spines were often lacking. Tables 2 and 3 show the relative frequency (%) of the number of spines on the lateral margin of the telson throughout development for *A. vulgaris* and *A. japonica* collected at Doigahama and Fukiagehama, respectively, with the data for Juveniles I and II coming partly from specimens reared in the laboratory. Most individuals of *A. vulgaris* collected from Doigahama in February and from Fukiagehama in March had seven spine pairs during Juveniles I and eight pairs after Juveniles II. However, *A. vulgaris* taken from Doigahama in July and from Fukiagehama in May, July, and October tended to have fewer spines. Therefore, for *A. vulgaris* from these locations, spine number was unsuitable for use as an identifying trait. On the other hand, most individuals of *A. japonica* had seven spine pairs in Juveniles I and eight pairs from Juveniles II through maturity and showed no notable variation.

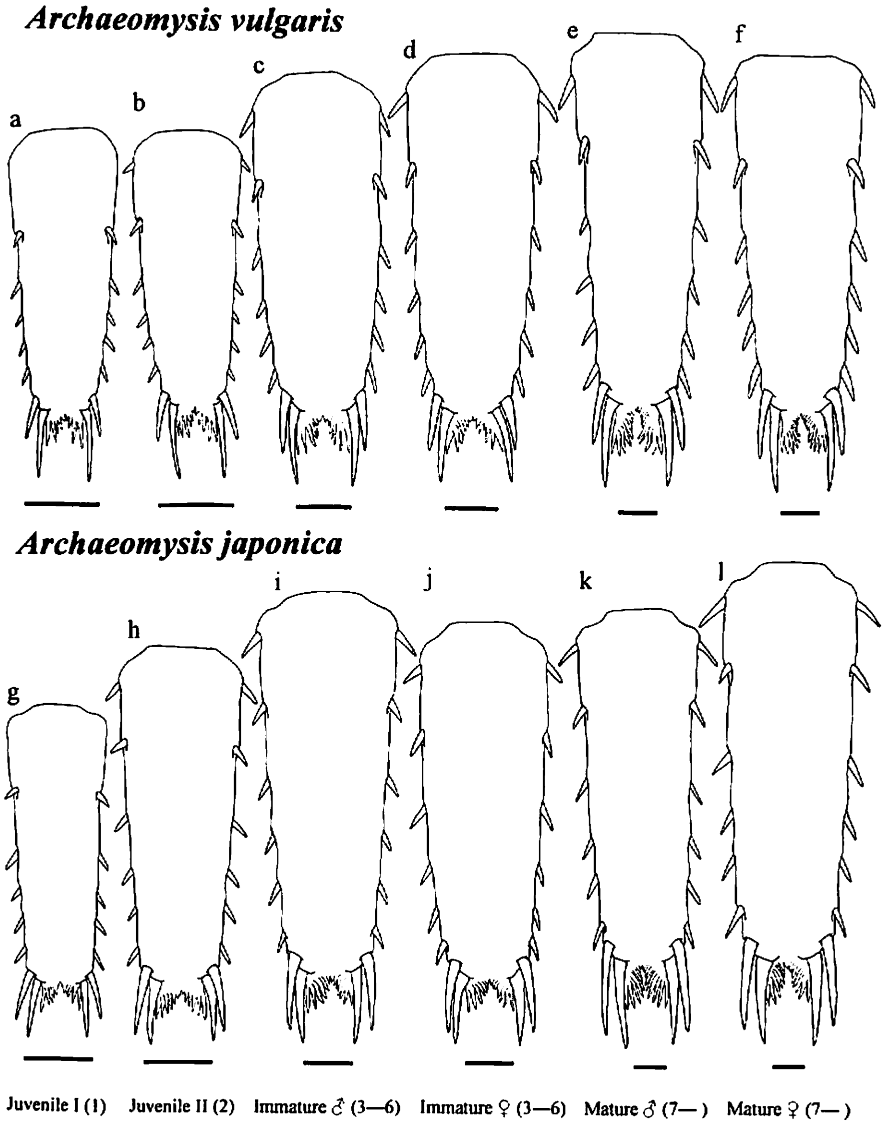

Fig. 2. Dorsal view of telson of *Archaeomysis vulgaris* and *A. japonica*. Bars indicate 0.1 mm. Instars in parentheses are general numbers based on results from laboratory-reared specimens.

Element on the second segment of the antennule

Examination of *Archaeomysis vulgaris* and *A. japonica* revealed differences in the shape and length of elements located at the distomedial corner of the second segment of the antennule. *A. vulgaris* had a long, slender seta in addition to a short seta located at the distomedial corner on the second segment of the antennule, the former extending about halfway along the third segment of the antennule (Fig. 3a–f). In addition to the short seta found in *A. vulgaris*, *A. japonica* also had a short spine which appeared to correspond to the long seta found in *A. vulgaris* (Fig. 3g–l).

Posterodorsal slit on the carapace

There was a difference in the occurrence of a deep posterodorsal slit on the carapace between *Archaeomysis vulgaris* and *A. japonica*. In *A. vulgaris*, the deep slit was absent, and the two lobes of the carapace showed slight posterodorsal overlapping (Fig. 4a–f). In *A. japonica*, the deep slit was present, and the two lobes of the carapace exhibited considerable posterodorsal overlapping (Fig. 4g–l).

Measurement of biological characteristics

Table 4 shows the summary data on SL, WW, DW, ratio of DW to WW (%DW), total C and N content, and C/N molar ratio of *Archaeomysis vulgaris* in each developmental stage. The relationship of DW (mg) and WW (mg) to SL (mm) is shown as the following, where "r" is the correlation coefficient and "n" is the number of data (Fig. 5):

$$DW=0.0008\cdot SL^{3.520} \quad (r^2=0.986, n=103),$$

$$WW=0.0113\cdot SL^{3.224} \quad (r^2=0.985, n=103).$$

The earliest secondary sexual characteristics appeared at

Table 2. Relative frequency (%)* of the number of spines on the lateral margin of the telson throughout development for *Archaeomysis vulgaris* and *A. japonica*. Data of both laboratory-reared and field-collected specimens from Doigahama Beach are shown. Blanks indicate no measurements.

a: *A. vulgaris*

Left-Right No. of spines	Laboratory-reared specimens		Field-collected specimens													
	Juvenile I	Juvenile II	Juvenile I		Juvenile II		Immature ♂		Immature ♀		Mature ♂		Mature ♀	
	Feb.	Feb.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.
6–6	0	0	0	40	0	0	0	0	0	0	0	0	0	0
7–6	0	0	0	5	0	0	0	0	0	0	0	0	0	0
6–7	0	0	0	15	0	0	0	0	0	0	0	0	0	0
7–7	84	0	85	40	0	45	0	60	0	30	0	20	0	7
8–7	10	0	0	0	0	15	0	15	0	20	0	5	0	7
7–8	4	0	10	0	0	20	0	15	0	5	0	10	5	7
8–8	2	84	5	0	85	20	95	10	90	45	80	65	75	79
9–8	0	10	0	0	0	0	5	0	0	0	5	0	0	0
8–9	0	4	0	0	15	0	0	0	10	0	5	0	10	0
9–9	0	2	0	0	0	0	0	0	0	0	10	0	10	0
$n=$	50	50	20	20	20	20	20	20	20	20	20	20	20	14

b: *A. japonica*

Left-Right No. of spines	Laboratory-reared specimens		Field-collected specimens													
	Juvenile I	Juvenile II	Juvenile I		Juvenile II		Immature ♂		Immature ♀		Mature ♂		Mature ♀	
	Feb.	Feb.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.	Feb.	Jul.
7–7	94	0					0		0		0		0	
8–7	2	0					0		0		0		0	
7–8	4	0					0		0		0		0	
8–8	0	94					100		100		100		83	
9–8	0	2					0		0		0		0	
8–9	0	4					0		0		0		0	
9–9	0	0					0		0		0		0	
10–9	0	0					0		0		0		17	
$n=$	50	50	0	0	0	0	6	0	4	0	1	0	6	0

* Shaded values indicate more than 10% values for each month.

instar 3 or 4, which approximately corresponds to 3.34 mm or 3.74 mm in SL, respectively. In addition, the relationship between SL (mm) and TL (mm) is shown by the following:

$$TL = 1.1993 \cdot SL \quad (r^2 = 0.999, n = 40).$$

Juvenile and immature mysids measured less than 5 mm in SL while mature ones were longer than 6 mm in SL, corresponding to 6.0 mm and 7.2 mm in TL, respectively.

The mean of SL for *A. vulgaris* ranged from 2.30 mm in Juveniles I to 8.29 mm in mature stages. The mean of DW ranged from 0.014 mg in Juveniles I to 1.68 mg in mature stages. The mean of the %DW varied in each developmental stage, ranging from 9.3 to 13.8%. The mean of the C and N content also showed a slight variation at each developmental stage, ranging from 43.0 to 45.1%, and 10.4 to 12.2%, respectively. The overall mean values of C and N content were 44.2% and 11.5%, respectively. The mean of the C/N molar ratio ranged from 4.3 to 5.1.

Discussion

The microhabitat and geographical distribution generally differ among *Archaeomysis vulgaris*, *A. kokuboi*, and *A.*

Table 3. Relative frequency (%)* of the number of spines on the lateral margin of the telson throughout development for *Archaeomysis vulgaris* and *A. japonica* collected from Fukiagehama Beach. Blanks indicate no measurements.

a: *A. vulgaris*

Left–Right No. of spines	Field-collected specimens																							
	Juvenile I				Juvenile II				Immature ♂				Immature ♀				Mature ♂				Mature ♀			
	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.
5–6	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6–6	74	85	70	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7–6	8	5	15	10	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6–7	6	5	10	20	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7–7	10	0	5	60	44	70	70	0	38	85	80	5	32	80	60	10	22	55	85	0	32	80	85	10
8–7	0	0	0	0	16	5	20	15	18	10	5	10	20	5	15	5	14	20	10	0	12	5	10	0
7–8	2	0	0	0	20	15	5	10	12	5	10	0	18	5	0	10	16	15	5	5	12	10	5	0
8–8	0	0	0	0	8	5	5	75	32	0	5	80	30	10	25	65	44	10	0	70	42	5	0	65
9–8	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5	0	0	0	0	2	0	0	5
8–9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4	0	0	20	0	0	0	15
9–9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5
n=	50	20	20	20	50	20	20	20	50	20	20	20	50	20	20	20	50	20	20	20	50	20	20	20

b: *A. japonica*

Left–Right No. of spines	Field-collected specimens																							
	Juvenile I				Juvenile II				Immature ♂				Immature ♀				Mature ♂				Mature ♀			
	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.	May	Jul.	Oct.	Mar.
7–6	4	0	0		0	0	0		0	0	0		0	0	0		0	0	0		0	0	0	
6–7	0	10	0		0	0	0		0	0	0		0	0	0		0	0	0		0	0	0	
7–7	96	90	100		0	0	0		0	0	0		0	0	0		0	20	0		0	10	0	
8–7	0	0	0		0	0	0		2	0	0		4	0	0		2	0	0		0	0	0	
7–8	0	0	0		0	0	0		0	10	0		2	0	20		2	0	0		0	0	0	
8–8	0	0	0		96	90	90		98	90	100		90	100	80		82	70	80		88	90	100	
9–8	0	0	0		4	0	10		0	0	0		4	0	0		4	10	10		0	0	0	
8–9	0	0	0		0	10	0		0	0	0		0	0	0		6	0	10		6	0	0	
9–9	0	0	0		0	0	0		0	0	0		0	0	0		4	0	0		4	0	0	
10–9	0	0	0		0	0	0		0	0	0		0	0	0		0	0	0		2	0	0	
n=	50	10	10	0	50	10	10	0	50	10	10	0	50	10	10	0	50	10	10	0	50	10	10	0

* Shaded values indicate more than 10 % values for each month.

japonica; however, these species were occasionally collected together (Jo & Hanamura 1993). Thus, practical keys for distinguishing among these three species are necessary. *A. vulgaris* was distinguished from *A. japonica* throughout development by three practical key characters: (i) subterminal spine length on the lateral margin of the telson, (ii) shape and length of elements at the distomedial corner on the second segment of the antennule, and (iii) presence or absence of a deep posterodorsal slit on the carapace. It was reported that characters (i) and (ii) were very useful in distinguishing between *A. kokuboi* and *A. japonica* even when those specimens were partially damaged or sampled from the stomach contents of fish (Takahashi & Kawaguchi 1996). Our study also showed that character (ii) is especially useful in distinguishing between *A. vulgaris* and *A. japonica* because it can be easily observed using a common microscope.

It was suggested that the number of spines on the telson can be a key character for distinguishing among *Archaeomysis* species despite variation in spine number (Hanamura 1997). Tables 2 and 3 show that during the summer months, *A. vulgaris* with seven spine pairs outnumbered those with eight spine pairs at Doigahama and Fukiagehama. This variation in spine number might be related to differences in

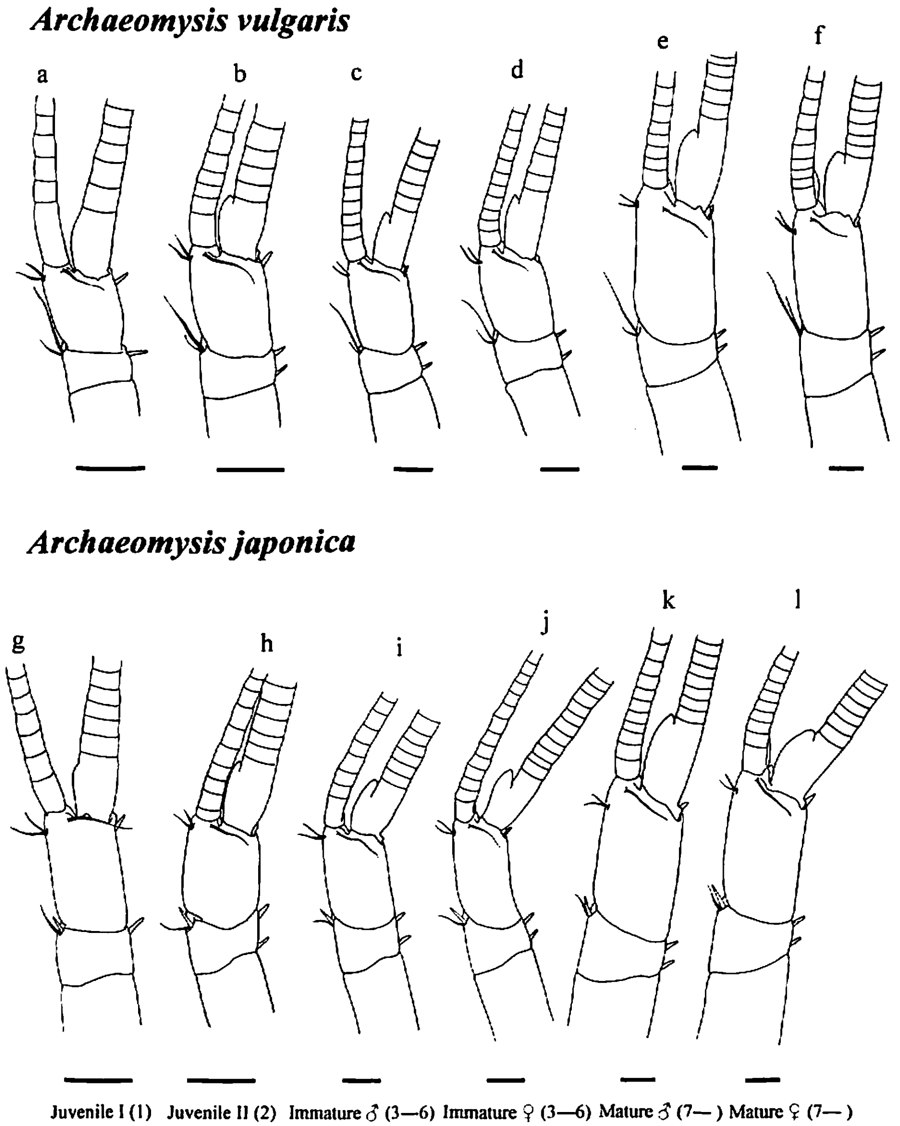

Fig. 3. Ventral view of antennule of *Archaeomysis vulgaris* and *A. japonica*. Bars indicate 0.1 mm. Instars in parentheses are common numbers during incubation experiment.

water temperature or nutritional and genetic conditions, all of which vary with season and geographical location. Hanamura (1997) distinguished between *Archaeomysis* species by variation in the location of a dark patch, a chromatophore, found on the lateral portion of the third abdominal somite. However, in samples of *A. vulgaris*, *A. japonica*, and *A. kokuboi* preserved in formalin, this chromatophore was found inappropriate for use as a key character because it tended to become discolored and invisible (authors' personal observations). In the length-ratio of subterminal spines on the telson and the setal arrangement on the second segment of the antennule, *A. vulgaris* was remarkably similar to *A. kokuboi* (cf. Takahashi & Kawaguchi 1996), but *A. kokuboi* had a deep slit on the carapace (authors' personal observations). Thus, these three species can be identified by a combination of the characters mentioned above: *A. japonica* is distinguished from *A. vulgaris* and *A. kokuboi* by characters (i) and/or (ii), and *A. vulgaris* is distinguished from *A. kokuboi* by character (iii).

In Juveniles I of both *Archaeomysis vulgaris* and *A. japonica*, one pair of basal spines did not develop until after the first molt. This lack of basal spines at Juveniles I was also observed in *A. kokuboi* (Takahashi & Kawaguchi 1996) and can therefore be useful in distinguishing between Juveniles I and later stages.

In *Archaeomysis vulgaris* and *A. japonica*, secondary sexual characteristics appeared at instars 3 or 4, and maturity occurred at instar 7. These instar numbers were similar to those of *A. kokuboi* with external sexual differentiation at instars 4 or 5 and sexual maturity at instar 8 (Ma et al. 2001). It was shown that the mean time for *A. kokuboi* to reach the first molt was 7 days at 15°C, and that water temperature strongly affected growth rate with intermolt periods becoming consistently shorter at higher temperatures

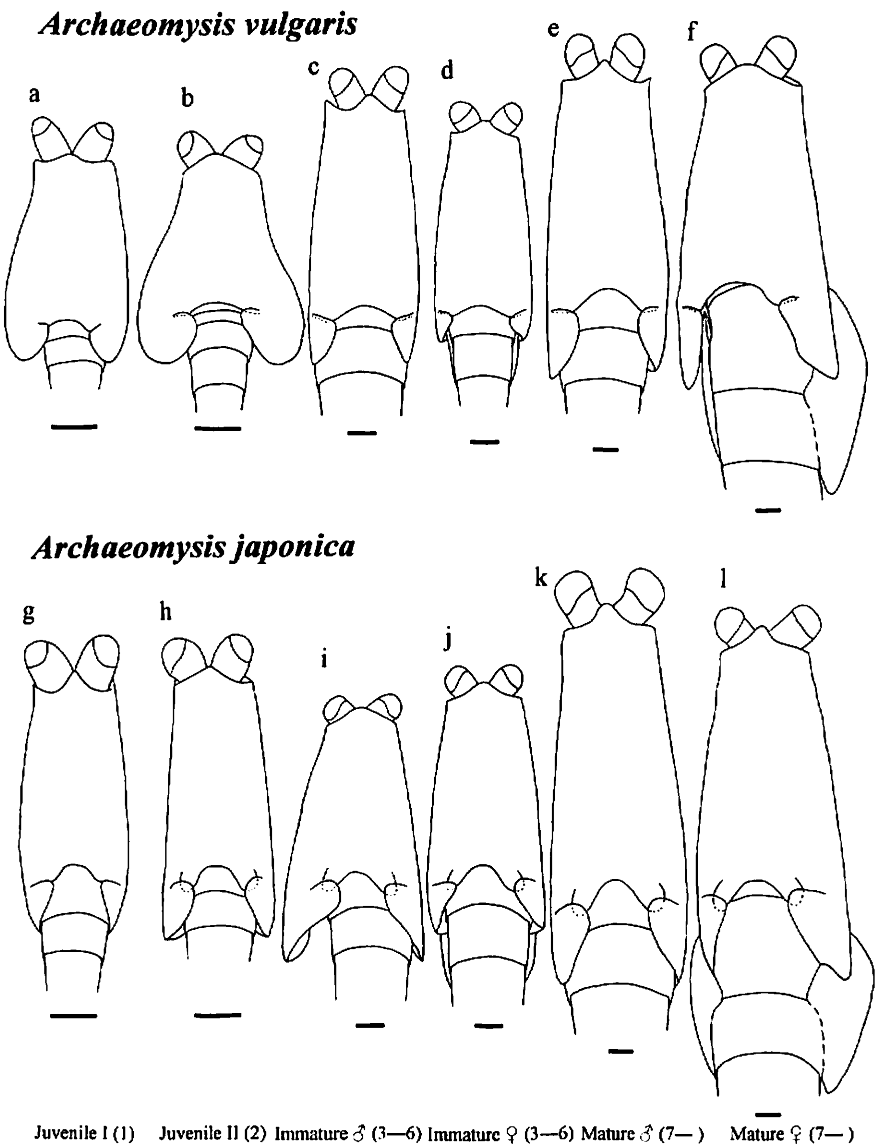

Fig. 4. Dorsal view of carapace of *Archaeomysis vulgaris* and *A. japonica*. Bars indicate 0.2 mm. General instar numbers are in parentheses.

(Ma et al. 2001). Our study showed that it took 6 days at 17°C and 3 days at 17.8°C, respectively, for *A. vulgaris* and *A. japonica* to reach their first molt. Thus, the interspecific differences in total cumulative time might be related to differences in their response to water temperature.

The overall mean values of C of 44.2% and N of 11.5% for *Archaeomysis vulgaris* are similar to those for other mysids. Most species in coastal habitats exhibit values of ca. 40% C and ca. 10% N, e.g. 40.1% and 9.7% for *A. kokuboi* (Takahashi 1996); 34.4% and 8.7% for *A. japonica* (Takahashi 1996); 41.0% and 11.7% for *Neomysis japonica* (Uye 1982); 36.8% and 11.5% for *Metamysidopsis elongata* (Mauchline 1980); 22–35% and 11.4% for *N. integer* (Mauchline 1980).

Taking the chemical content of *Archaeomysis vulgaris* into account, the relationship of C (mg) and N (mg) to SL (mm) is expressed by the following:

$$C=0.0003\cdot SL^{3.53} \quad (r^2=0.987, n=35),$$

$$N=0.0001\cdot SL^{2.87} \quad (r^2=0.988, n=35).$$

A. vulgaris of 2–8 mm in SL was estimated to have about one-third the carbon content of *A. kokuboi* and *A. japonica* (cf. Takahashi & Kawaguchi 1998). Despite similar percentages of C, the relationship between C and SL differed markedly among these species. So this might suggest that the body weight of *A. vulgaris* is less than that of *A. kokuboi* and *A. japonica* of the same length.

Brown & McLachlan (1990) stated that zooplankton inhabiting sandy shores (e.g. mysids and shrimp) clustered in large aggregates, were the primary prey of fish, and formed one center of energy flow in macroscopic food chains. In

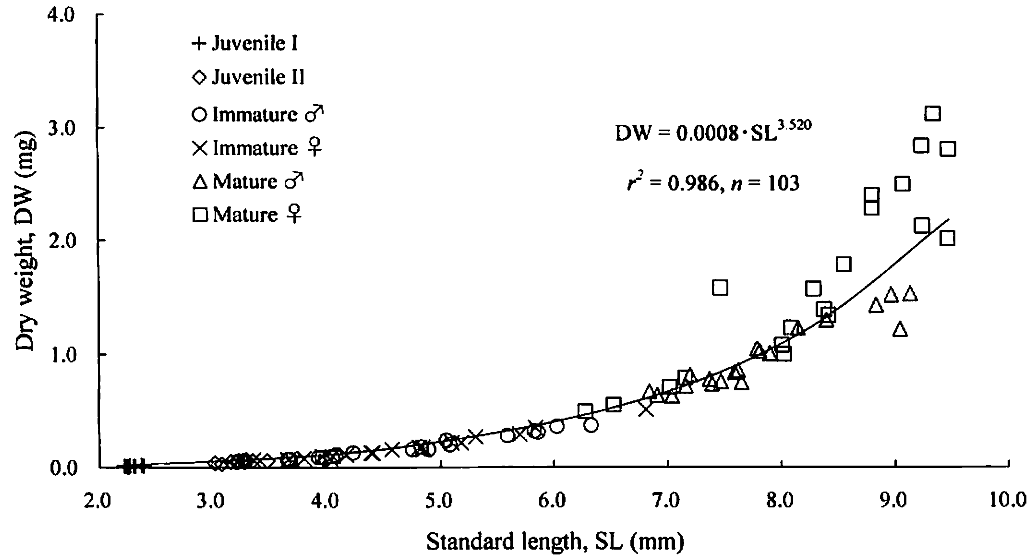

Fig. 5. Relationship between standard length (SL) and dry weight (DW) for *Archaeomysis vulgaris*.

Table 4. Summary data on standard length (SL), wet weight (WW), dry weight (DW), ratio of DW to WW (%DW), carbon as % of the DW base (C), nitrogen as % of the DW base (N), and C/N molar ratio of *Archaeomysis vulgaris*. Values are means ± standard deviations.

Developmental stages	$n1$*	SL (mm)	WW (mg)	DW (mg)	%DW (%)	$n2$**	C (%)	N (%)	C/N molar ratio
Juvenile I	8	2.30±0.06	0.17±0.05	0.014±0.004	9.3±3.0	1	44.2	11.8	4.3
Juvenile II	17	3.24±0.10	0.52±0.11	0.05±0.01	10.6±2.2	5	43.9±1.8	12.0±0.6	4.3±0.3
Immature ♂	19	4.73±0.86	1.73±0.93	0.18±0.10	10.2±1.0	7	44.4±2.3	11.6±1.4	4.5±0.3
Immature ♀	19	4.68±0.85	1.83±1.07	0.18±0.11	9.7±1.3	8	44.3±1.2	12.2±1.5	4.3±0.5
Mature ♂	20	7.81±0.72	8.29±2.27	0.98±0.30	11.7±1.0	8	43.0±0.5	10.9±0.2	4.6±0.1
Mature ♀	20	8.29±0.97	11.83±4.71	1.68±0.80	13.8±1.9	6	45.1±1.3	10.4±0.4	5.1±0.2

* $n1$ indicates the number of individuals in biological mesurements.
** $n2$ indicates the number of C and N measurements.

northeastern Japan, *Archaeomysis kokuboi* is an abundant and important prey organism of fish assemblages (Takahashi et al. 1999). Due to its great abundance (authors' personal observations), *A. vulgaris* might also be a food source for juvenile benthic fish. Therefore, it is important to understand *A. vulgaris*'s role in the ecology of sandy shore ecosystems in southern Japan.

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