Karyological Studies of *Sinotaia quadrata* (Benson, 1842) (Gastropoda: Viviparidae) of Korea

Gab Man Park*

Department of Environmental Medical Biology, Catholic Kwandong University College of Medicine, Gangneung 210–701, Korea

Received September 16, 2014; accepted November 5, 2014

**Summary** The karyotypes of *Sinotaia quadrata* using air-drying method collected from Hyogal-ri, Pungyang-myeon, Yecheon-gun, Gyeongbuk, Korea were investigated. The diploid number of chromosomes is 2n=16. The eight chromosome pairs were identified and classified into three groups. The diploid cell has 1 pair of metacentric, 5 pairs of submetacentric and 2 pairs of subtelocentric chromosomes. Observed chromosomes ranged from 3.10 to 4.90 μm and the total length was 34.12 μm. The karyotype of *S. quadrata* is described for the first time.

**Key words** Karyotype, Freshwater snail, Korea, *Sinotaia quadrata*, Viviparidae.

Freshwater snails are the first intermediate host for man and animals of helminthes parasites. *Sinotaia quadrata* has been recorded from eastern China, Taiwan, Japan and Korea (Pace 1973, Lee 2009). *S. quadrata* snail belongs to fresh water snails and has limited distribution in the southern Korean Peninsula. The subfamily Bellamyainae is difficult to taxonomy because of the morphological variety within and between populations. The shell of this species is more solid and narrow than either of the other viviparids, and the embryonic shell is similar to that of *Cipangopaludina chinensis* in shape. To date, only two species of *Cipangopaludina*, *C. chinensis malleata* and *C. japonica*, have been reported in Korea (Kwon et al. 1993). While Kira (1962) listed Korea as within the range of this species, it should be noted that Shiba (1935) said that only *C. chinensis* occurred in Korea. Recently, *Sinotaia quadrata* has been reported as an unrecorded species in Korea (Lee 2009). The adult shell of *S. quadrata* can easily be distinguished from other Korean species by the shell with acute spire and usually with spiral angulations or low carinae on the whorls.

The few species belonging to the Viviparidae have been reported to serve in their native habitat as an intermediate host and a vector to numerous parasites (Pace 1973, Malek and Cheng 1974, Johnson 1992, Chung and Jung 1999, Devkota et al. 2011). While Ito (1964) listed *Cercaria shanghaiensis* and *C. echinolophocauda* from *S. quadrata*, no record was found to indicate that they are important vectors of human parasites.

In recent years, through a considerable number of works, a large amount of information has been accumulated on the chromosomes of the mollusks. Chromosome counts were obtained for 997 molluscan species within 124 terminal taxa and included members of five major extant classes (Polyplacophora, Bivalvia, Cephalopoda, Scaphopoda, and Gastropoda) (Hallinan and Lindberg 2011). Cytogenetic studies of mollusks have been important in aspects of phylogenetics and cytogenetic relationships among the species. Detailed studies of chromosome morphology and population cytology of the Viviparidae are well known (Baršiene et al. 2000, Thiriot-Quiévreux...
The chromosome numbers of nine species in Bellamyinae until now studied by some workers and including the present study were \( n = 8 \), \( n = 9 \) and \( n = 11 \) (Table 1). The aim of this study was to determine the chromosome numbers and to identify the karyotype of *S. quadrata*.

### Materials and methods

The 29 specimens used in this study were collected in Hyogal-bridge, Hyogal-ri, Pungyang-myeon, (128°16’55”E, 36°29’41”N), Yecheon-gun, Gyeongbuk, Korea, May 2014, and examined shortly after collection (Fig. 1). The chromosome preparations were made on gonad of the specimens by the usual air-drying method following the techniques described by Park and Yong (2014). The prepared slides were observed under an Olympus (BX51) microscope. Voucher specimens of the samples studied have been deposited at the Department of Environmental Medical Biology, Catholic Kwandong University College of Medicine, Korea.

### Results

A microphotograph of somatic metaphase chromosomes and the karyogram are shown in Fig. 2, and measurements of the chromosomes in Table 2. The present cytological preparations showed 15 well-spread mitotic cells on a slide. This species showed a diploid chromosome number of \( 2n = 16 \), with 1 metacentric, 5 submetacentric and 2 subtelocentric chromosome pairs. Observed chromosomes ranged from 3.10 to 4.90 \( \mu m \) in length. This species had no inter-specimen variability in chromosome counts. Also, sexual dimorphism of chromosomes was not found in this study.

### Table 1. Chromosome numbers and karyotypes of subfamily Bellamyinae.

<table>
<thead>
<tr>
<th>Species</th>
<th>Diploid no.</th>
<th>Karyotype</th>
<th>Source</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bellamya aeruginosa</em></td>
<td>16</td>
<td>2M+4SM+2ST</td>
<td>China</td>
<td>Zhou et al. 1988</td>
</tr>
<tr>
<td><em>B. angularisa</em></td>
<td>16</td>
<td>2M+4SM+2ST</td>
<td>China</td>
<td>Zhou et al. 1988</td>
</tr>
<tr>
<td><em>B. bengalensis</em></td>
<td>22</td>
<td>7M+4SM</td>
<td>India</td>
<td>Choudhury and Pandit 1997</td>
</tr>
<tr>
<td><em>B. quadrata</em></td>
<td>16</td>
<td>2M+4SM+2ST</td>
<td>China</td>
<td>Zhou et al. 1988</td>
</tr>
<tr>
<td><em>B. unicolor</em></td>
<td>18</td>
<td>5S+2SM+2ST</td>
<td>Egypt</td>
<td>Yaseen et al. 1991</td>
</tr>
<tr>
<td><em>Cipangopaludina cathayensis</em></td>
<td>18</td>
<td>5M+3SM+1ST</td>
<td>China</td>
<td>Zhou et al. 1988</td>
</tr>
<tr>
<td><em>C. chinensis</em></td>
<td>18</td>
<td>5M+3SM+1ST</td>
<td>China</td>
<td>Zhou et al. 1988</td>
</tr>
<tr>
<td><em>C. chinensis malleata</em></td>
<td>18</td>
<td>2M+7SM</td>
<td>Korea</td>
<td>Park et al. 1997</td>
</tr>
<tr>
<td><em>C. japonica</em></td>
<td>18</td>
<td>2M+7SM</td>
<td>Korea</td>
<td>Park et al. 1997</td>
</tr>
<tr>
<td><em>Sinotaia quadrata</em></td>
<td>16</td>
<td>1M+5SM+2ST</td>
<td>Korea</td>
<td>This study</td>
</tr>
</tbody>
</table>

*M, metacentric; SM, submetacentric; ST, subtelocentric chromosomes.*

![Fig. 1. Shell of *Sinotaia quadrata*.](image)
Viviparidae is one of the most cytologically attentive families of Mesogastropoda with three sub-families Bellamyinae, Viviparinae and Lioplacinae (Choudhury and Pandit 1997). *Sinotaia quadrata* of the present study belongs to the subfamily Bellamyinae of Viviparidae. The family Viviparidae is conservative in regard to chromosome numbers in that 34 species range from \( n = 7 \) to \( n = 32 \) (Choudhury and Pandit 1997, Thiriot-Quievréux 2003), but the detailed morphology of chromosomes are available for 16 species only. The published data on chromosome number and metaphase karyotypes for the Bellamyinae, including the new records from this study, are shown in Table 1. The Bellamyinae shows haploid chromosome numbers ranging from 8 to 11. The haploid number of chromosomes in what Inaba (1965) called *Sinotaia histricus* was found to be eight, one less than that reported for *C. chinensis*. In this study, *S. quadrata* has eight chromosome numbers. The highest chromosome number, \( n = 11 \), is reported from *B. bengalensis* within the Bellamyinae (Choudhury and Pandit 1997). Techniques of karyological analysis have greatly improved recently for phylogeny and evolution on gastropods (Thiriot-Quievréux 2003, Pascoe et al. 2004, Hallinan and Lindberg 2011). Many authors reported that low chromosome number is often related to more

### Table 1. Relative lengths and total lengths (μm) of chromosomes of *Sinotaia quadrata*.

<table>
<thead>
<tr>
<th>Chromosome</th>
<th>RL±SE</th>
<th>TL±SE</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.36±0.20</td>
<td>4.90±0.31</td>
<td>M</td>
</tr>
<tr>
<td>2</td>
<td>14.21±0.12</td>
<td>4.85±0.25</td>
<td>SM</td>
</tr>
<tr>
<td>3</td>
<td>14.06±0.24</td>
<td>4.80±0.13</td>
<td>SM</td>
</tr>
<tr>
<td>4</td>
<td>13.92±0.09</td>
<td>4.75±0.16</td>
<td>SM</td>
</tr>
<tr>
<td>5</td>
<td>13.24±0.34</td>
<td>4.52±0.15</td>
<td>SM</td>
</tr>
<tr>
<td>6</td>
<td>10.96±0.17</td>
<td>3.74±0.20</td>
<td>SM</td>
</tr>
<tr>
<td>7</td>
<td>10.14±0.34</td>
<td>3.46±0.32</td>
<td>ST</td>
</tr>
<tr>
<td>8</td>
<td>9.08±0.14</td>
<td>3.10±0.21</td>
<td>ST</td>
</tr>
</tbody>
</table>

* Based on measurements from four sets from *Sinotaia quadrata* of karyotyped cells. M, metacentric; RL, relative length; SE, standard error; SM, submetacentric; ST, subtelocentric; TL, total length.

### Fig. 2. Metaphase chromosomes of *Sinotaia quadrata* (A, B) and karyotype constructed from A (C).

Discussion

Viviparidae is one of the most cytologically attentive families of Mesogastropoda with three sub-families Bellamyinae, Viviparinae and Lioplacinae (Choudhury and Pandit 1997). *Sinotaia quadrata* of the present study belongs to the subfamily Bellamyinae of Viviparidae. The family Viviparidae is conservative in regard to chromosome numbers in that 34 species range from \( n = 7 \) to \( n = 32 \) (Choudhury and Pandit 1997, Thiriot-Quievréux 2003), but the detailed morphology of chromosomes are available for 16 species only. The published data on chromosome number and metaphase karyotypes for the Bellamyinae, including the new records from this study, are shown in Table 1. The Bellamyinae shows haploid chromosome numbers ranging from 8 to 11. The haploid number of chromosomes in what Inaba (1965) called *Sinotaia histricus* was found to be eight, one less than that reported for *C. chinensis*. In this study, *S. quadrata* has eight chromosome numbers. The highest chromosome number, \( n = 11 \), is reported from *B. bengalensis* within the Bellamyinae (Choudhury and Pandit 1997). Techniques of karyological analysis have greatly improved recently for phylogeny and evolution on gastropods (Thiriot-Quievréux 2003, Pascoe et al. 2004, Hallinan and Lindberg 2011). Many authors reported that low chromosome number is often related to more
evolved species in mollusk families (Ahmed 1976, Vitturi et al. 1982). Pascoe et al. (2004) have suggested a general evolutionary trend towards an increase in genome size and a decrease in chromosome number and haploid length within the group. Most of the Viviparidae chromosomes in the karyotype were metacentric or submetacentric. Vitturi and Catalano (1984) have reported that within the mesogastropoda an increase in the amount of chromosomal DNA is not always necessarily accompanied by an increase in the chromosome number. Also, few workers postulated the existence of a chromosomal sex-determining mechanism in Viviparidae and different diploid chromosome numbers in males and females. Patterson (1969) and Stern (1975) have reported XX and XY types in Viviparus purpureus and Tulotoma angulata, respectively. Also, Baršiene et al. (2000) have described a sex-determining mechanism of ZW female/ZZ male from V. ater, V. acerosus and V. mamillatus. In this study, I could not identify the sex chromosome from S. quadrata.

The importance of snails as intermediate and paratenic host for certain species of nematodes, although well recognized, has been overshadowed by the role of snails in the life cycle of medically and economically important trematodes (Chung and Jung 1999, Farahnak et al. 2006). Although some viviparid snails such as Cipangopaludina chinensis malleata act as the second intermediate host of echinostome trematodes in Korea, the parasitological role of S. quadrata has not been reported yet. In this study, I did not find trematode cercarial infection from S. quadrata. Shimazu (1974) described the free (unencysted) brachylaimid metacercaria of Amblosoma suwaense from the viviparid snail Sinotaia quadrata in Japan. More studies will need various analyses for the investigation of the karyo-systematic evolution, and accumulation of karyological information is very much required in the subfamily Bellamyinae.

References


