Korean Journal of Malacology, Vol. 23(1): 59-63, June 30, 2007

# Cytological Study of *Euphaedusa fusaniana* (Stylommataphora: Clausiliidae) of Korea

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## ABSTRACT

The chromosome numbers and karyotype of *Euphaedusa fusaniana,* a kind of Korean land snail are investigated here. From *E. fusaniana,* chromosome numbers of 28 (n) and 56 (2n) were counted. Euphaedusa fusaniana has 15 pairs of metacentric chromosomes and 13 pairs of submetacentric chromosomes. The mean total length of all chromosomes was 128.7 ± 9.93 μm. The maximum length of chromosomes No. 1 was 9.6 ± 0.21 μm.

**Keywords:** *Euphaedusa fusaniana,* Diploid, Land snail, Clausiliidae, Korea.

## INTRODUCTION

Cytology and cytogenetics have had a considerable influence on the development of mollusks taxonomy (Patterson, 1969). Cytotaxonomy covers all aspects of taxonomy at the cellular level, including structural, genetical, physiological and biochemical data. *Euphaedusa fusaniana* is endemic species in Korea. According to Kwon *et al.* (1993), clausiliid snails are five species of three genera in Korea. The chromosome numbers of 30 species belonging to the family Clausiliidae in Europe, Taiwan and Japan had been reported by Inaba (1959), Thaler (1963), Burch (1965), Natarazan (1965), Rainer (1967), and Lo and Chang (1975) (Table 1). The chromosome number of clausiliid species has been reported as 24 to 30 haploid, also based on the meiotic stages. No details on chromosome analysis have been published. As yet, no other species in Clausiliidae of Korea are known cytologically. In this paper, the karyotype analysis of *Euphaedusa fusaniana* based on mitotic metaphase chromosomes is presented.

Received March 15, 2007; Accepted June 8, 2007
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1225-3480/23108


## MATERIALS AND METHODS

The specimens used in this study were collected in

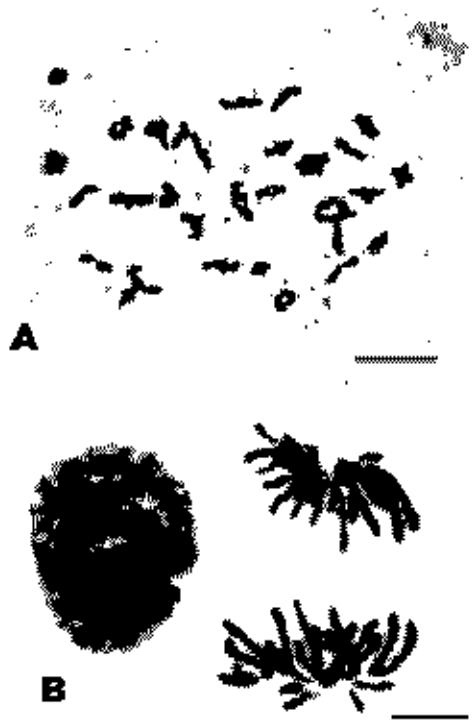


**Fig. 1.** Chromosomes of *Euphaedusa fusaniana*. **A**: diakinesis chromosomes in spermatogenesis; **B**: Spermatogonial anaphase-I. Scale bar indicates 10 μm.

Korea during June 2005 and February 2006, and were examined shortly after the collection. Twenty specimens of *Euphaedusa fusaniana* were collected in the Gungi cave from Jeju-do. Chromosome preparations were made from gonadal tissues by the air-dry method of Park (1994). The prepared slides were observed under an Olympus microscope with a 100 (n.a. 1.25) oil immersion objective and a 10 ocular.

Morphological features of the chromosomes used to compare karyotypes were the total lengths, the arm ratio of the chromosomes, and the positions of their centromeres (primary constrictions). Nomenclature of chromosome morphological types follows Levan *et al.* (1964). Voucher specimens of the species used in this investigation are placed in the Department of Parasitology, Kwandong University College of Medicine, Korea.

## RESULTS

A total of 56 chromosomes was observed in 14 cells. Diakinesis of meiotic chromosomes and anaphase-I in this species were observed (Fig. 1). The daughter chromosomes are nearing the spindle poles. In anaphase-I actual disjunction of synapsed homologs occurs, one longitudinally double chromosome of each pair moving to each pole, thereby completing the process of terminalization. The chromosomes were homologues in each of 28 sets. These chromosomes can be divided into the 15 metacentric chromosomes and 13 submetacentric chromosomes (Fig. 2). The mitotic chromosomes are seen Fig. 2, and the chromosomes have been arranged with their size and centromere position in Fig. 2A. Mean total length of the chromosomes in haploid complements was 128.7 ±

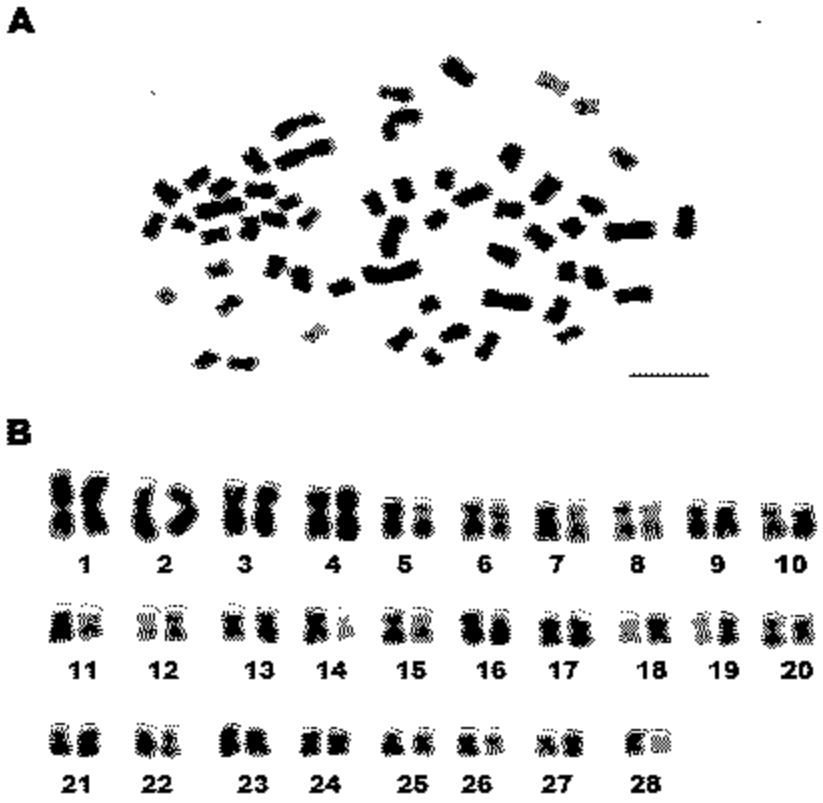


**Fig. 2.** Metaphase chromosome of *Euphaedusa fusaniana* (**A**); Karyotype constructed from A (**B**). Scale bar indicates 10 μm.

**Table 1.** Chromosome numbers of Clausiliidae.

| Species | Chromosome no. | | Source | References |
|---|---|---|---|---|
| | N | 2N | | |
| *Clausilia bidentata* | 24 | | Europe | Natarazan, 1965 |
| *C. parvula* | 24 | | Europe | Thaler, 1963; Rainer, 1967 |
| *C. dubia tettelbachiana* | 24 | | Europe | Thaler, 1963 |
| *C. d. obsoleta* | 24 | | Europe | Thaler, 1963 |
| *C. d. huttneri* | 24 | | Europe | Thaler, 1963 |
| *C. d. vindobonensis* | 24 | | Europe | Thaler, 1963 |
| *Megalophaedusa martensii* | 24 | | Japan | Inaba, 1959 |
| *Phaedusa subaculus* | 24 | | Japan | Inaba, 1959 |
| *Iphigena ventricosa* | 24 | | Europe | Thaler, 1963; Rainer, 1967 |
| *I. plicatula* | 24 | | Europe | Rainer, 1967 |
| *I. p. grossa* | 24 | | Europe | Thaler, 1963 |
| *Cochlodina laminata* | 24 | | Europe | Thaler, 1963; Rainer, 1967 |
| *Herilla bosniensis* | 24 | | Europe | Thaler, 1963 |
| *Laciniaria plicata* | 24 | | Europe | Rainer, 1967 |
| *L. biplicata* | 24 | | Europe | Thaler, 1963; Rainer, 1967 |
| *Graciliaria strobeli* | 24 | | Europe | Rainer, 1967 |
| *Euphaedusa pseudosheridani* | 28 | | Taiwan | Burch, 1965 |
| *E. tau* | 28 | | Japan | Natarajan, 1965 |
| *Hemiphaedusa similaris* | 28 | | Taiwan | Burch, 1965 |
| *H. ooi* | 28 | | Taiwan | Lo and Chang, 1975 |
| *H. sheridani* | 28 | | Taiwan | Lo and Chang, 1975 |
| *H. similaris* | 28 | 56 | Taiwan | Lo and Chang, 1975 |
| *H. odontochila* | 28 | | Taiwan | Lo and Chang, 1975 |
| *H. exilis* | 28 | | Taiwan | Lo and Chang, 1975 |
| *H. swinhoei* | 28 | | Taiwan | Lo and Chang, 1975 |
| *H. formosensis* | 28 | | Taiwan | Lo and Chang, 1975 |
| *H. fusaniana* | 28 | 56 | Korea | Present study |
| *Stereophaedusa japonica* | 30 | | Japan | Natarajan, 1965 |
| *Delima itala* | ca. 30 | | Europe | Rainer, 1967 |
| *Papillifera papillaris* | ca. 30 | | Europe | Rainer, 1967 |
| *Zaptyx crassilamellata* | 28 | 56 | Taiwan | Lo and Chang, 1975 |

9.93 μm. The longest and shortest length of chromosomes No. 1 and No. 28 were 9.6 μm and 2.6 μm respectively. Table 2 shows the mean lengths and arm ratio of each chromosome as examined in two cells.

## DISCUSSION

In recent years, through a considerable number of works, a large amount of information has been accumulated on the chromosomes of the mollusks. With the increasing knowledge on molluscan chromosomes, the general reviews on the karyological attributes of molluscs have been presented mostly by Burch and Patterson (Burch, 1967, 1968; Patterson, 1969, 1971; Patterson and Burch, 1978). Karyotype analyses which involve comparisons of mitotic

metaphase chromosomes between closely related species or populations have proven to be of great value in discerning systematic relationships for many mollusks (Patterson, 1965; Stern, 1975). However, such studies are rare in mollusks, and have been done mostly in a few related species (Ahmed, 1976; Nakamura, 1985, 1986).

Table 1 shows the chromosome numbers of Clausiliidae which have been reported in the literature and by the present study. Patterson (1969) reviewed the chromosome numbers of mollusks and listed 22 species in the family Clausiliidae for which the chromosome numbers are known. Among the 16 European species of clausiliids the haploid numbers are 24 and 30; in four Japanese species the numbers are 24 and 28; and 10 Taiwan species all have 28 (Table 2). In this study, chromosome numbers of *Euphaedusa fusaniana* of Korean species counted 56.

**Table 2.** Total lengths (μm) and arm ratio of chromosomes of *Euphaedusa fusaniana*[*]

| Chromosome pair | Length ($\mu$m) Mean ± SD | Arm ratio Mean ± SD | Type[**] |
|---|---|---|---|
| 1 | 9.6 ± 0.21 | 1.1 ± 0.25 | M |
| 2 | 8.2 ± 0.26 | 2.8 ± 0.13 | SM |
| 3 | 7.4 ± 0.21 | 2.0 ± 0.05 | SM |
| 4 | 7.3 ± 0.37 | 1.3 ± 0.15 | M |
| 5 | 6.0 ± 0.17 | 3.5 ± 0.14 | SM |
| 6 | 5.7 ± 0.26 | 1.1 ± 0.18 | M |
| 7 | 5.5 ± 0.45 | 3.5 ± 0.14 | SM |
| 8 | 5.3 ± 0.36 | 3.7 ± 0.16 | SM |
| 9 | 5.0 ± 0.27 | 4.1 ± 0.12 | SM |
| 10 | 4.8 ± 0.35 | 3.2 ± 0.15 | SM |
| 11 | 4.7 ± 0.22 | 2.8 ± 0.23 | SM |
| 12 | 4.5 ± 0.38 | 1.6 ± 0.21 | M |
| 13 | 4.3 ± 0.18 | 1.2 ± 0.25 | M |
| 14 | 4.2 ± 0.25 | 1.4 ± 0.19 | M |
| 15 | 4.0 ± 0.19 | 1.8 ± 0.11 | M |
| 16 | 3.9 ± 0.25 | 3.2 ± 0.14 | SM |
| 17 | 3.8 ± 0.59 | 1.6 ± 0.16 | M |
| 18 | 3.7 ± 0.39 | 1.8 ± 0.12 | M |
| 19 | 3.6 ± 0.33 | 1.1 ± 0.18 | M |
| 20 | 3.5 ± 0.57 | 1.2 ± 0.11 | M |
| 21 | 3.3 ± 0.17 | 1.0 ± 0.17 | M |
| 22 | 3.2 ± 0.60 | 3.6 ± 0.17 | SM |
| 23 | 3.2 ± 0.58 | 3.8 ± 0.16 | SM |
| 24 | 3.1 ± 0.56 | 1.6 ± 0.20 | M |
| 25 | 2.9 ± 0.48 | 3.7 ± 0.11 | SM |
| 26 | 2.8 ± 0.46 | 1.7 ± 0.22 | M |
| 27 | 2.6 ± 0.42 | 1.2 ± 0.13 | M |
| 28 | 2.6 ± 0.40 | 3.5 ± 0.12 | SM |

[*]Based on measurement of two karyotyped cells.
[**]Abbreviations: M = medianly constricted chromosome; SM = submedianly constricted chromosome.

Conservation of chromosome number has been pointed out for many molluscan groups (Burch, 1965). This constancy of chromosome number has also been assumed within families or superfamilies of the Gastropoda (Nakamura, 1986). In this family, however, considerable variety in chromosome numbers is shown. Three different chromosome numbers are reported in this family, i.e. N = 24, 28 and 30. In some families, it seems that more variety in chromosome numbers as more species are examined (Komatsu and Inaba, 1982). The karyotype has usually a species specific character and hence is potentially useful in species discrimination, especially in taxonomically poorly understood groups. The chromosome of this species are M/SM gradually decreasing in size. Unfortunately we do not have other karyological information on Clausiliidae for cytotaxonomical comparison.

The morphological and behavioral aspects of chromosomes during the mitotic and meiotic cycles are described in detail for the land snail, *Catinella vermeta,* which has only 6 pairs of relatively large chromosomes (Patterson and Burch, 1966). The chromosome cycle in *Catinella* does not differ from that found typically in other animals and especially it resembles of other gastropods observed. Each bivalent in the meiotic plates seemed to be equally stained in this study and there were no special behaviour of chromosomes.

## ACKNOWLEDGMENTS

This work was supported by Kwandong University Research Fund of 2007.

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