Chromosomes of five species of sea-skater (Gerridae-Heteroptera)

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Abstract

We report here the first chromosome numbers for sea-skaters. Meiotic metaphase figures were obtained from the testes of three littoral species: *Asclepios shiranui, Halobates flaviventris* and *H. robustus* and two pelagic species: *H. germanus* and *H. micans*. In the four species of *Halobates* 2n♂ = 31, the highest chromosome number so far determined for the Gerridae. In a proposed ancestral form, *A. shiranui*, 2n♂ = 23. Males of all five species have an unpaired chromosome, assumed to be the X chromosome of an XO sex chromosome system.

Introduction

Water-skaters or water-striders are often seen on the surface of freshwater ponds and streams. Several genera of this large, predominantly freshwater family of insects contain species (sea-skaters) which live in brackish or marine habitats (Matsuda, 1960). The genus *Asclepios* has four species found in the brackish coastal waters of South India, Singapore, Hong Kong, Korea, Japan and Taiwan (Cheng & Hill, 1982) and *Halobates* has more than 40 described species with a wide, circumtropical distribution (Cheng, 1973; Herring, 1961). The majority of *Halobates* species are coastal and many are endemic to remote islands or island groups. Five species, however, are found in the open ocean, roughly between latitudes 40° N and 40° S. Since it is difficult to study sea-skater species in their natural habitats, much of what we know about them is based on either short-term field studies or analyses of preserved samples collected in the field. We present results of a study on the chromosomes of five sea-skater species: *Asclepios shiranui* Esaki, *Halobates flaviventris* Eschscholtz, *H. robustus* Barber, *H. germanus* White and *H. micans* Eschscholtz.

Material and methods

Collection sites and dates for the five species examined cytologically appear in Table 1. Specimens of the littoral species, *Asclepios shiranui, Halobates flaviventris* and *H. robustus*, were netted out of shallow water in or near mangrove swamps, their natural habitat. The pelagic species *H. germanus* and *H. micans*, were collected from near shore localities after they had been blown ashore by strong winds.

For each collection we first determined that the specimens were in healthy condition. Animals were fixed in three parts absolute ethanol and one part

Table 1. Collection data and chromosome numbers for five species of sea-skaters.

Species	2n(♂)	Collection site and date
Asclepios shiranui	23	Hong Kong, May 1980
Halobates flaviventris	31	Palau, September 1979
H. robustus	31	Galapagos, June 1978
H. germanus	31	Fiji, July 1978
H. micans	31	Grand Cayman, December 1979

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glacial acetic acid; a deep incision was made between the head and thorax to allow rapid penetration of the fixative. Fixed animals were stored at −20 °C until examined. Pieces of testes were stained in lacto-acetic orcein and squashed following the methods described in Newman (1977). Temporary mounts were examined with a Zeiss GFL microscope equipped with fluorite objectives and photomicrographs were taken with Kodak Technical Pan Film 2415. At least three animals were used for each chromosome-number determination. Unfortunately, the complete set of meiotic stages was not found for each species.

Results and discussion

As in other Heteropteran species, the chromosomes of sea-skaters are holocentric with kinetochore activity restricted to the terminal ends of meiotic anaphase chromosomes. The results of our chromosome counts from meiotic metaphase figures are presented in Table 1. *A. shiranui* has 2n(males) = 23 and the four *Halobates* species each have 2n(males) = 31. Photomicrographs of meiotic metaphase figures, all reproduced to the same scale, appear in Figure 1. Metaphase-I and II figures were found in *A. shiranui* (Fig. 1A and B), *H. flaviventris* (Fig. 1C and D), *H. robustus* (only metaphase I illustrated, Fig. 1E) and *H. micans* (Fig. 1G and H). The same number of chromosome elements was found in metaphase-I and II cells; this was 12 for *A. shiranui* and 16 for each of the three *Halobates* species. We found only metaphase-II figures for *H. germanus* (Fig. 1F).

Early meiotic prophase-I cells of the species examined have a single positively heteropycnotic chromocenter. Well spread diplotene figures, found only in *H. flaviventris* and *H. robustus*, have 15 euchromatic bivalents and a dense positively heteropycnotic univalent. One metaphase-I bivalent of *A. shiranui* is clearly negatively heteropycnotic (Fig. 1A) and similar staining was noted among the chromosomes of other species (Fig. 1C and D). A lagging chromosome was found in about half of the telophase-II and spermatid cells of *H. flaviventris* and *H. micans* (Fig. 2).

The XO sex chromosome system is proposed for sea-skaters. This is, however, based entirely on male meiosis; we must have female chromosome numbers to be sure of our conclusion. The X chromosome is assumed to be the single positively heteropycnotic body of prophase I and the lagging chromosome of telophase II. Also in support of the

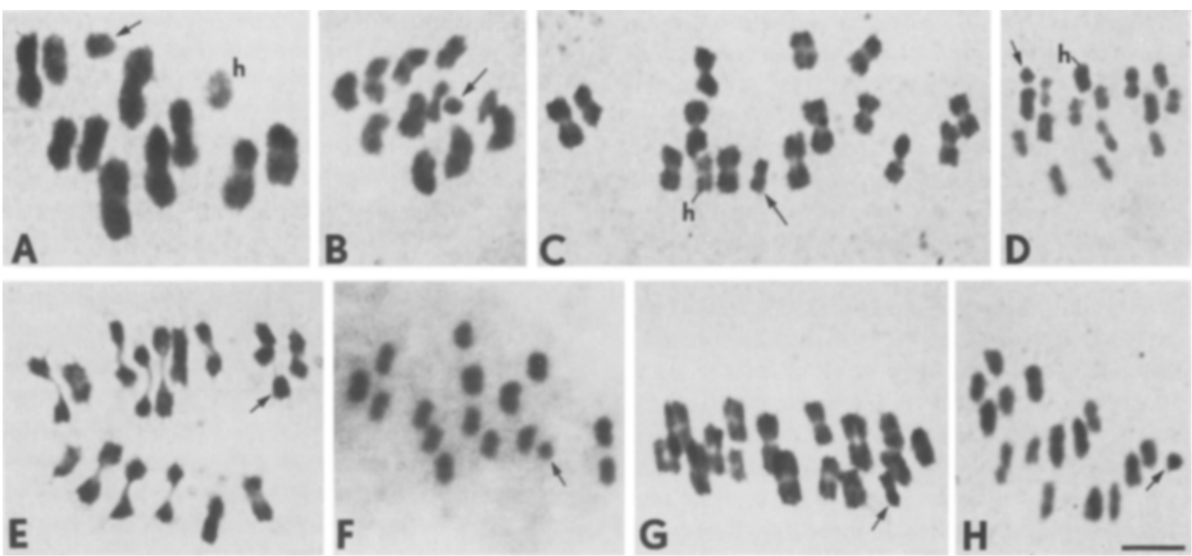

Fig. 1. Male meiotic chromosomes of sea skaters at metaphase I (A, C, E, G) and II (B, D, F, H): (A, B) *Asclepios shiranui*; - (C, D) *Halobates flaviventris*; (E) *H. robustus*; - (F) *H. germanus*; (G, H) *H. micans*. Arrows, X chromosomes; h, heteropycnotic chromosomes. Bar, 5 μm.

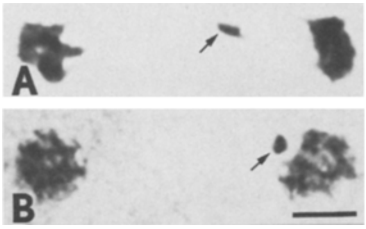

Fig. 2. Telophase-II (A) and spermatid (B) cells from *Halobatis micans*. Note lagging chromosome, presumably the X chromosome, at only one pole (indicated by arrows). Bar = 5μm.

XO system is the determination of the same number of chromosome elements in metaphase I and II.

Male meiosis in these Gerridae is similar to that of most Heteroptera (see Ueshima, 1979). There is no evidence for either supernumerary or m chromosomes in sea skaters.

Anderson (1982) reviewed the literature on chromosome numbers in the Gerridae. The diploid chromosome number in males of 13 freshwater species ranged between 19 and 23, with a modal number of 21. All of these species had an XO sex chromosome system. However, Calabrese and Tallerico (1982), in a report on the chromosomes of an additional seven freshwater species, found an XY system in five and an XO system in the remaining two species.

We report here the first chromosome numbers for sea-skaters. In the four species of *Halobates* 2n(males) = 31, the highest chromosome number so far determined for the Gerridae (Anderson, 1982). The proposed ancestral form, *A. shiranui*, has 2n(males) = 23. Breakage of the holocentric chromosomes may have led to the increased chromosome number in the evolutionarily more advanced *Halobates*.

We may speculate that open-ocean *Halobates* species evolved from populations of inshore or estuarine species washed or blown out to sea. Unable to find suitable 'grounded' substrates on which to lay eggs, they became adapted to oviposit on floating objects, and thereby could complete their life history entirely at sea. In the absence of a fossil record, one has to seek indirect evidence for this by studying presentday species. Coastal *Halobates* species are most numerous in the southeast Asian region, where over half of the known species are found (Cheng, unpublished data). This is not really surprising; Cheng and Fernando (1973) found that in this region the fauna of other Gerridae, too, is much richer than in other parts of the world. *Halobates* may have had a monophyletic origin in southeast Asia, possibly from a brackish water form like *Asclepios*, as proposed by Herring (1961).

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