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On the karyotypes of the British high chromosome number Nabidae (Insecta: Heteroptera)

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Abstract. Chromosome data are given for *Himacerus apterus* (Fabricius, 1798) – 2n= 36+XY, *H. mirmicoides* (O. Costa, 1834) – 2n=32+XY and *Stalia major* (A. Costa, 1841) – 2n= 30+XY. The X chromosome of the two *Himacerus* species is about four times the length of the longest autosomes. In *H. apterus* the Y chromosome is also large, about half the length of the X chromosome, but in *H. mirmicoides* it is small, about a fifth the length of the X chromosome. In *Stalia major* the X chromosome appears similar in length of the largest autosomes, but the Y chromosome is small, as in *H. mirmicoides*. The karyotype of *Stalia boops* (Schiødte, 1870) remains unknown.

Key words: Heteroptera, Nabidae, *Stalia major*, karyotypes.

Introduction

The diploid chromosome numbers found in the family Nabidae, tribe Nabini reviewed by Kuznetsova, Maryańska-Nadachowska (2000) and Kuznetsova et al. (2004), have a sharply bimodal distribution, with one group of genera having approximately 16 pairs of autosomes while others, mainly *Himacerus* Wolff, 1811, have about 32-36 pairs. Following the work of Nokkala et al. (2007) it is now clear that this is a result of reduction of the chromosome number within the family from an initial high number to the lower one, as a result of chromosome fusions. Within the group of species retaining the high chromosome number, *H. apterus* (Fabricius, 1798) has presented peculiar problems. Most authors have recorded it as having 32-38 pairs of autosomes, but two, including Leston (Leston, 1957) in England, recorded only 16 pairs of autosomes. In an attempt to resolve this situation V. G. Kuznetsova suggested to the senior author that he might be able to solve the problem, at least as far as English material was concerned. This led to two student projects, involving first S. McCartney and then L. Thompson, which have done much to clarify matters, and also provided the first data on *Stalia major* (A. Costa, 1841).

Material and methods

The localities from which material giving successful chromosome preparations was obtained are given in Table 1. Nomenclature is after Southwood, Leston (1959), though it should be noted that Kerzhner (1996) places *Stalia major* in *Himacerus*, subgenus *Aptus* Hahn, 1831 (along with *H. mirmicoides* (O. Costa, 1834)) but leaves *S. boops* (Schiødte, 1870) in *Stalia* Reuter, 1872 but as a subgenus of *Himacerus*.

The method of chromosome preparation

Table 1. Material used for chromosome analysis.

Species	Locality
Himacerus apterus	England, Dorset, Studland Heath
	England, Surrey, Bookham Common
H. mirmicoides	England, Berkshire, West Ilsley
	England, Middlesex, Staines Moor
	England, Surrey, Chobham Common
Stalia major	England, Surrey, Bookham Common

is as described by Shaarawi, Angus (1991). All successful preparations were from testis, though ovary and mid gut yielded good results from *Nabis* Latreille, 1802 species, and almost complete oogonial metaphases have been obtained from *H. apterus*.

Results

Himacerus apterus

Clear and consistent results were obtained from only one specimen, a half-grown nymph taken on Studland Heath in July 2007. The testes of this specimen yielded abundant material of both first and second divisions of meiosis, which totally consistent chromosome numbers. The chromosomes are shown in Fig. 1. Meiotic metaphase I (Fig. 1, b, c) shows the chromosome number of 18 pairs of autosomes and the univalent X and Y chromosomes while metaphase II (Fig. 1, c, d) shows 18 autosomes and the distance pairing of X and Y chromosomes. Spermatogonial mitotic metaphase (Fig. 1, f), while not good enough to allow assembly of a karyotype, shows the very large sex chromosomes with their degree of condensation comparable with that of the autosomes – i.e. not more condensed as in meiotic preparations. An incomplete karyotype assembled from an oogonial metaphase from a Bookham common specimen is shown in Fig. 3, a. This shows the relative sizes of the chromosomes very clearly. Fig. 1, a shows condensation stage of first division of meiosis. The small number of condensed elements may perhaps be the source of records for low numbers of chromosomes for this species, especially as clear preparations of meiosis are relatively unusual.

Himacerus mirmicoides

This species has proved far more amenable to investigation that its congener. Fig. 2, a-d shows meiotic chromosomes of a male from West Ilsley. Metaphase I (Fig. 2, a, b) shows the 16 autosomal bivalents and the univalent X and Y chromosomes, with the distinct gap in the X chromosome and the very small Y chromosome. Metaphase II shows the single-stranded X and Y chromosomes contrasting with the double-stranded autosomes. Fig. 3, b shows a karyotype prepared from spermatogonial mitotic metaphase from a male from Staines Moor. This karyotype has one extra, unmatched chromosome, probably a "stray" from a different nucleus. However, it shows the autosomes much smaller than the X chromosome (as in *H. apterus*), and much smaller than might be assumed from the meiotic preparations, where differential condensation obscures the relative sizes. It also shows the very small smallest pair of autosomes (pair 16), unmatched in *H. apterus*.

Stalia major

Although this species was taken and processed on a number of occasions, only one male, from Bookham Common, had actively

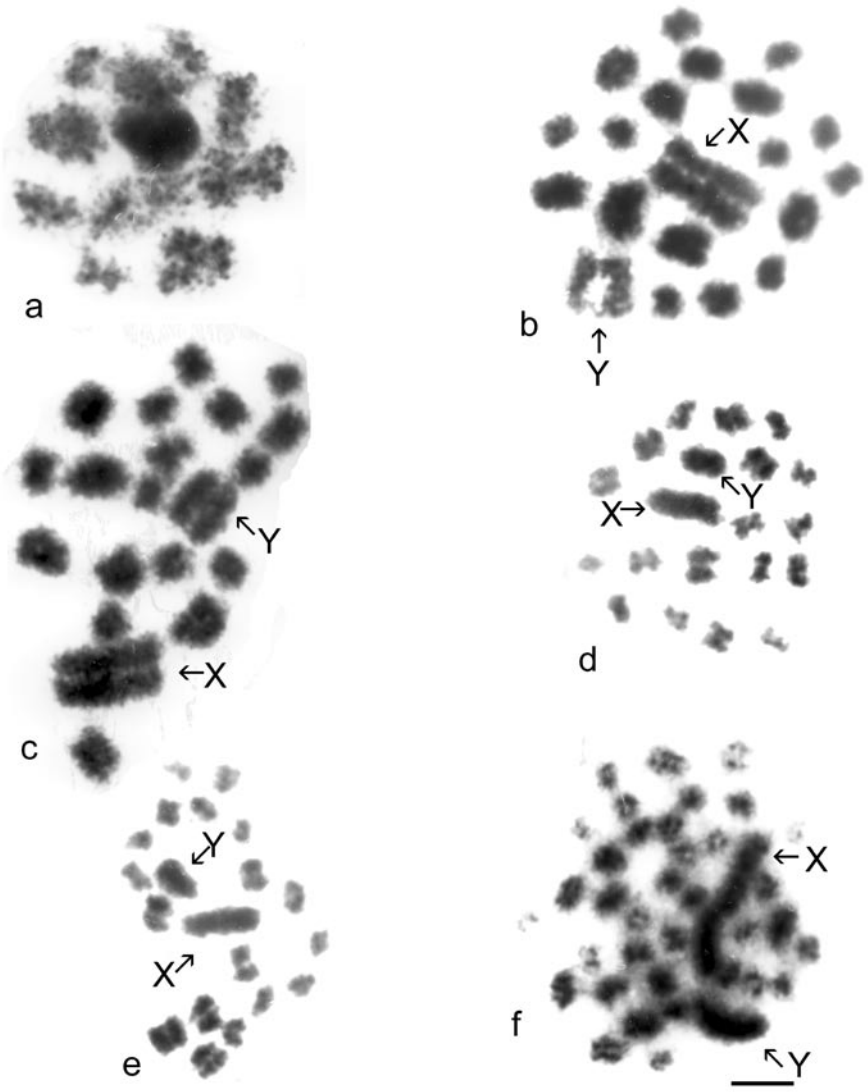

Fig. 1, a-f. Chromosomes of *Himacerus apterus*. **a -** condensation of prophase 1 (Chobham Common, Surrey). **b-e -** meiosis, metaphases I and II (Studland Heath, Dorset); **b, c -** metaphase I. The X and Y chromosomes are clearly double-stranded, and more condensed than the autosomes; **d, e -** metaphase II. The X and Y chromosomes are single-stranded and heavily condensed. Note the wide separation of the X and Y chromosomes (distance pairing). **f -** spermatogonial mitosis. Note the large X and Y chromosomes (Studland Heath, Dorset). Bar = 5 μm.

dividing cells in the testes. Fig. 4, a shows prophase I with the sex chromosomes far more condensed than the autosomes, and demonstrates the long X and short Y chromosomes. Late condensation phase of prophase I (Fig. 4, b) and metaphase I (Fig. 4, c) show the 15 autosomal bivalents and the more condensed X and Y chromosomes contrasting with the autosomes. Metaphase II shows the remote pairing of the single-stranded X and Y chromosomes, contrasting with the double-stranded autosomes. Only a few, not very clear sper-

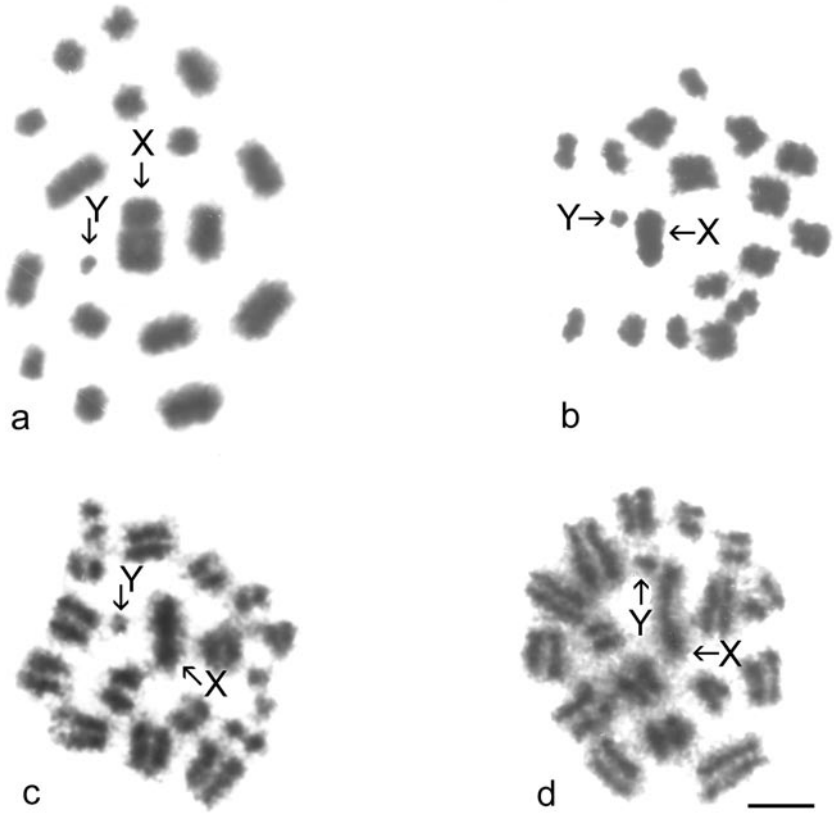

Fig. 2, a-d. Meiotic chromosomes of *Himacerus mirmicoides*. **a-c -** from West Ilsley, Berkshire. **d -** from Chobham Common, Surrey. **a, b -** metaphase I. Note the distinct gap in the X chromosome in a. **c, d -** metaphase II. The heavily condensed single-stranded X and Y chromosomes contrast sharply with the more diffuse double-stranded autosomes. Bar = 5 μm.

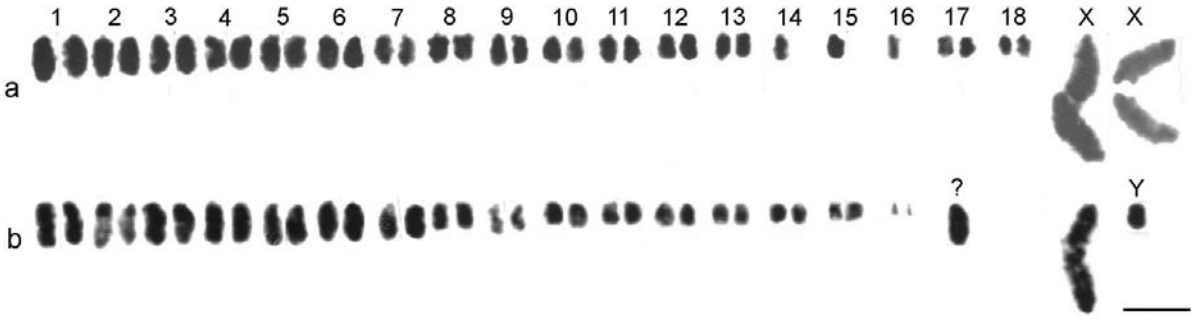

Fig. 3, a, b. Mitotic chromosomes of *Himacerus* spp, arranged as karyotypes. **a -** *H. apterus*, Bookham Common, oogonial metaphase, incomplete. **b -** *H. mirmicoides*, Staines Moor, spermatogonial metaphase, with 1 additional chromosome, perhaps from a different nucleus. Bar = 5 μm.

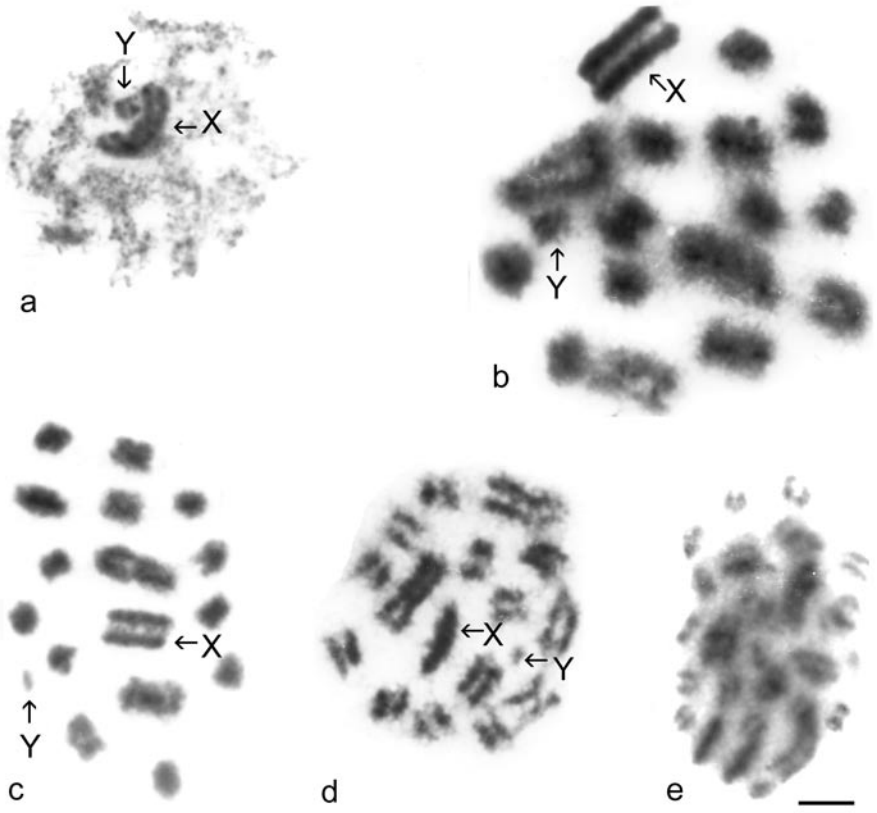

Fig. 4, a - e. Chromosomes of *Stalia major*. **a -** meiosis, early prophase 1 showing the condensed X and Y chromosomes, with the Y very much smaller than the X. **b -** prophase I, late condensation stage. The X and Y chromosomes are double-stranded and more condensed than the autosomes. **c -** metaphase I. The Y chromosome appears small and faint, but the X is still more condensed than the autosomes. **d -** metaphase II, with the X and Y chromosomes clearly single-stranded in contrast to the double-stranded autosomes. Note the wide separation between the X and Y chromosomes (distance pairing). **e -** spermatogonial mitosis, metaphase. A poor preparation, but with no indication that the X chromosome is significantly larger than the larger autosomes. Bar = 5 μm.

matogonial mitoses were obtained. Fig. 4, e shows one of these, and it is sufficient to show that some of the autosomes are as long as the X chromosome.

Discussion

The results presented here show that all three species have different chromosome numbers, 2n = 36+XY for *H. apterus*, 32+XY for *H. mirmicoides* and 30 +XY for *S. major*. Regarding *H. mirmicoides*, the same karyotype has been reported by all authors (Kuznetsova et al., 2004). In contrast, *H. apterus* has a number of different recorded karyotypes, but the number given here (36+XY) is in agreement with the data given by Yoshida (1950) and Kuznetsova et al. (2004). The two *Himacerus* species agree with one another in the long X chromosomes and much shorter autosomes, but they differ in the size of the Y chromosome – long in *H. apterus* and short in *H. mirmicoides*. The karyotype of *Stalia major* agrees with those of the *Himacerus* species in the long X chromosome, and with *H. mirmicoides* in the

short Y chromosome. However, in this species the longest autosomes appear to be about as long as the X chromosome.

These results may be considered in the light of the phylogenetic tree given by Nokkala et al. (2007). This places *S. boops* and *H. apterus* as a pair of sister species, and *S. major* and *H. mirmicoides* as a second such pair. These two pairs are then placed as sister groups to each other. The small Y chromosomes of *S. major* and *H. mirmicoides* support this arrangement, but the arrangement of the autosomes does not. In the two *Himacerus* species all the autosomes are small or very small, but in *S. major* some of the autosomes appear as large as the X chromosome. This leaves it as particularly unfortunate that we were unable to obtain *S. boops*. This species has been fairly widely recorded in the southern half of England and is not listed as requiring any particular protection, but no-one appears to have taken it for the last 20 years or so. It is reputed to be crepuscular, which may be part of the explanation. Clearly, the karyotype of this species would be of great interest.

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