

Chromosomal Analysis of some European species of the genus *Berosus* LEACH (Coleoptera: Hydrophilidae)

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Abstract

Karyotypes of five European *Berosus* species are illustrated. *Berosus (Berosus) affinis* BRULLÉ, *B. (B.) luridus* (L.), *B. (Enoplurus) fulvus* KUWERT and *B. (E.) bispina* REICHE & SAULCY have the diploid number $16 + Xyp$ (δ), $16 + XX$ (φ), while *B. (B.) signaticollis* CHARPENTIER has an additional pair of autosomes, giving a diploid number of $18 + Xyp, XX$. All the species examined have conspicuously long chromosomes when compared with other Hydrophilidae, notably Hydrobiinae, most of which have diploid chromosome numbers of $16 + Xyp, XX$ (SHAARAWI 1989). The karyotypes of all the species are distinctive in details of the relative lengths of various chromosomes.

In the course of a general investigation of the karyotypes of the British Hydrophilidae carried out by the senior author karyotypes of the four British species of *Berosus* were obtained. Subsequently the second author obtained the karyotype of Israeli material of *B. bispina*, and sent material to S. Schödl (Vienna) for identification. This resulted in British "*B. spinosus*" being identified as *B. fulvus*, and gave added interest to the results obtained.

MATERIAL & METHODS: The species studied, their localities of origin, and the tissues used for chromosome preparations, are given in the Table below. The methods used for preparing chromosomes are given by ANGUS (1982), with information specific to the use of mid-gut given by SHAARAWI & ANGUS (1991).

SPECIES	LOCALITY OF ORIGIN	TISSUES USED
<i>B. affinis</i>	England: Somerset, Steart	Embryo
	Greece: Corfu	Embryo
<i>B. luridus</i>	England: Norfolk, East Walton	Embryo
<i>B. signaticollis</i>	England: Hampshire, New Forest	Embryo
	Greece: Corfu	Embryo
	Spain: Provincia de Santander, pools by Embalse de Ebro	Mid-gut, testis
<i>B. fulvus</i>	England: Sussex, Cuckmere Haven	Embryo
<i>B. bispina</i>	Israel: Haifa district, Nesher quarry	Embryo, mid-gut

Table 1. *Berosus* species used for chromosome analysis

***Berosus affinis* BRULLÉ (Figs. 1, 2)**

Chromosome pair 1 is clearly the longest, and all the autosomes except pair 3 are more or less metacentric, as is the X-chromosome. Autosome pair 3 has its short arm little more than half the length of its long one, and the Y-chromosome is dot-like. Pairs 2 and 3 are approximately equal in length, distinctly longer than pair 4. Pairs 4 and 5 are about the same length, slightly longer than pairs 6 and 7, which are also more or less equal in length. Pair 8 is a little shorter. The X-chromosome is about the same length as pair 4 and 5. The sizes and shapes of the chromosomes are the same in both Corfu (Fig. 1) and English (Fig. 2) material.

***Berosus luridus* (L.) (Fig. 3)**

The karyotype is very similar to that of *B. affinis*, but with chromosome pair 3 more obviously shorter than pair 2, and with pair 4 and 5 as long as pair 3. Pair 6 is a little shorter, and pairs 7 and 8 are shorter still, and about equal in length. The X-chromosome is about as long as pair 6, and appears the same as that of *B. affinis*. The Y-chromosome is dot-like.

None of these differences between *B. affinis* and *luridus* is particularly striking, but they contrast with the apparent complete similarity between English and Corfiot *B. affinis*.

***Berosus fulvus* KUWERT (Figs. 4, 5)**

The general arrangement of the chromosomes is clearest in Fig. 5 (female), but Fig. 4 (male) is necessary to identify the X-chromosome. The karyotype is clearly more different from those of *B. affinis* and *luridus* than they are from each other. Chromosome 1 is still clearly the longest, but the difference between its length and that of pair 2 is less than in *B. affinis* and *luridus*. Pair 3 is distinctly shorter than pair 2, with pairs 4, 5 and 6 a little shorter than pair 3, and of about the same length. Pairs 7 and 8 show further progressive reduction, and the X-chromosome is intermediate in length between pairs 7 and 8. The Y-chromosome is dot-like. Pairs 3, 4, 7 and 8, and the X-chromosome, are clearly not metacentric, with one pair of arms distinctly shorter than the other.

***Berosus bispina* REICHE & SAULCY (Fig. 6)**

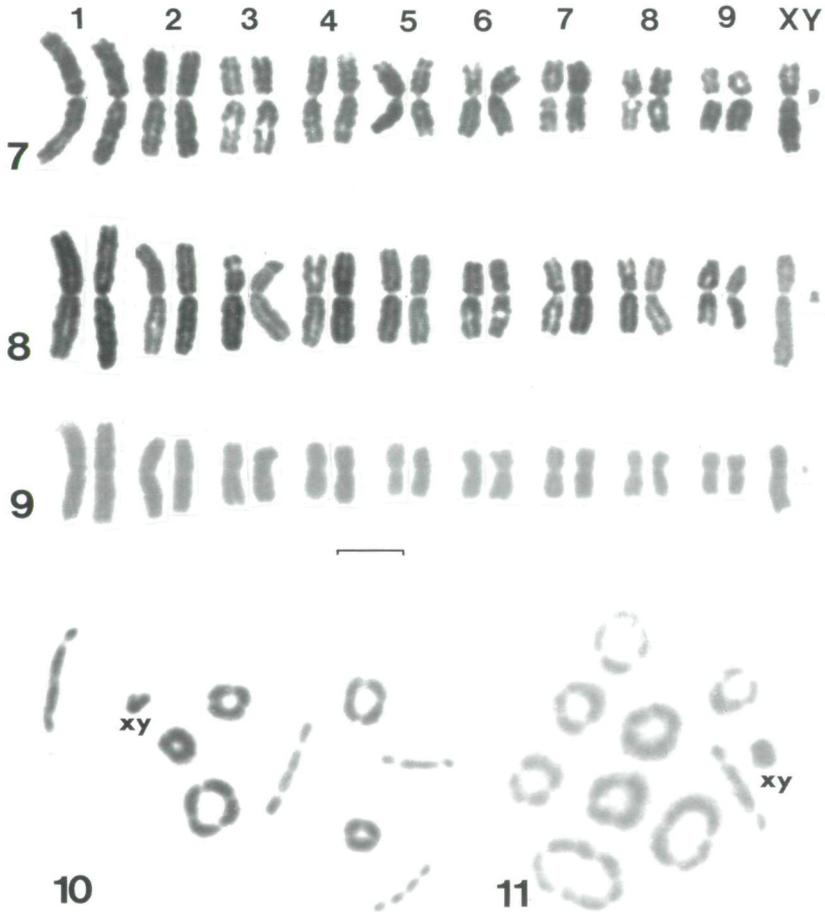
This karyotype is clearly different from that of *B. fulvus*. The length difference between pair 1 and 2 is greater, the X-chromosome is much longer, at least as long as pair 6, and overall the chromosomes are more evenly metacentric. Only pairs 3 and 8 have one pair of arms obviously rather shorter than the other.

***Berosus signaticollis* CHARPENTIER (Figs. 7-9)**

The karyotype of this species is very distinctive, with one more pair of autosomes than the other species studied, and with the X-chromosome much longer, about as long as chromosome pair 2. All the autosomes are more or less metacentric, while the X is submetacentric, with its short arms about half the length of its long ones. The Y-chromosome is dot-like, as in the other species. The fact that all the chromosomes are metacentric or submetacentric means that the additional pair cannot be formed from simple centromeric splitting of one chromosome pair of species with 8 pairs of autosomes (Robertsonian Inversion) - and the lengths of the chromosomes in both *B. signaticollis* and the other species do not suggest that any of the autosomes of these other species is homologous with two autosomes of *B. signaticollis*. Nevertheless, the general appearance of the chromosomes of *B. signaticollis*, with long arms and small centromeric constrictions, is typical *Berosus*. The three karyotypes shown indicate no chromosomal differences between specimens from England, Spain and Greece (Corfu).



Figs. 1-6: Mitotic chromosomes of *Berosus* spp. The scale line represents 5 μ m. 1) *B. affinis*, male, embryo, Corfu, Greece; 2) *B. affinis*, female, embryo, Steart, Somerset, England; 3) *B. luridus*, male, embryo, East Walton, Norfolk, England; 4) *B. fulvus*, male, embryo, Cuckmere Haven, Sussex, England; 5) *B. fulvus*, female, embryo, Cuckmere Haven, Sussex, England; 6) *B. bispina*, male, mid-gut, Neshar Quarry, Haifa, Israel.



Figs. 7-11: Chromosomes of *Berosus signaticollis*. 7-9: mitosis; 10, 11: meiosis, first metaphase. The scale line represents 5 μm . 7) male, embryo, New Forest, Hampshire, England; 8) male, embryo, Corfu, Greece; 9) male, mid-gut, Provincia de Santander, Spain; 10, 11) male, testis, Provincia de Santander, Spain.

Meiosis (Figs. 10, 11)

Meiotic preparations are available only from Spanish *B. signaticollis*. They show that between 4 and 8 of the autosome pairs may form ring bivalents, with the other(s) as rod bivalents. They also show the X- and Y-chromosomes in typical polyphagan "parachute" association (especially clear in Fig. 10) - hence the listing of the sex chromosomes as Xyp. This arrangement is normal in Hydrophilidae (SHAARAWI 1989), and since the Y-chromosome is very similar in all *Berosus* species studied it is assumed that they are all Xyp.

Discussion

The Berosinae are a highly specialised subfamily of Hydrophilidae, with their adaptations to an aquatic existence among the most extreme in the family - the adults are strong swimmers, the

larvae respire by means of tracheal gills, and the egg cocoons are attached to vegetation under water. Nevertheless, the chromosomes retain the general Hydrobiine number of 8 pairs of autosomes plus Xyp sex chromosomes (except for *B. signaticollis*). In addition to the species listed here, the chromosome number of *B. indicus* MOTSCHULSKY is given by AGARWAL (1960) as 8 pairs of autosomes plus Xyp.

The different chromosome number shown by *B. signaticollis* is interesting, and surprising in that it does not reflect any subgeneric classification, and also because differences in chromosome numbers are unusual within Hydrophilid genera. Such differences do occur, however. Thus ANGUS (1989) showed that in *Helophorus* species have either 8 or 10 pairs of autosomes, and that the difference is only partly a reflection of the subgenera, and SHAARAWI & ANGUS (1991) found that in *Anacaena*, while *A. bipustulata* MARSHAM, *A. limbata* THOMSON and *A. lutescens* STEPHENS have 8 pairs of autosomes plus Xyp, *A. globulus* PAYKULL has 7 pairs plus Xyp and *A. rufipes* GUILLEBEAU has 5 pairs of autosomes plus neo-XY sex chromosomes. Thus, on present evidence, changes in chromosome number in many Hydrophilid genera appear to be unusual, and from a taxonomic standpoint, sporadic.

The other feature shown by the karyotypes of the *Berosus* species here studied is that they show interspecific differences - often slight, but apparently always clear. It would be interesting to see the chromosomes of species involved in the taxonomic separation found by S. Schödl (*B. spinosus* Steven for comparison with *B. fulvus*, *B. guttalis* Rey for comparison with *B. bispina*) - the differences between the karyotypes of *B. affinis* and *B. luridus* and between *B. fulvus* and *B. bispina* suggest that these newly separated species might also show differences.

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Zusammenfassung

Die Chromosomen von 5 europäischen *Berosus*-Arten wurden untersucht und sind in der vorliegenden Arbeit abgebildet: *Berosus (Berosus) affinis* BRULLE, *B. (B.) luridus* (L.), *B. (Enoplurus) fulvus* KUWERT und *B. (E.) bispina* REICHE & SAULCY haben die diploide Chromosomenzahl 16 + Xyp (♂), 16 + XX (♀), während *B. (B.) signaticollis* CHARPENTIER ein zusätzliches Autosomenpaar besitzt (18 + Xyp, XX). Alle untersuchten Exemplare haben - im Vergleich zu anderen Hydrophiliden (speziell Hydrobiinae) - außergewöhnlich lange Chromosomen. Die meisten Hydrobiinae besitzen eine Chromosomenzahl von 16 + Xyp, XX (SHAARAWI 1989). Alle untersuchten Arten lassen sich anhand der verschiedenen Länge einzelner Chromosomen unterscheiden.

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