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Chromosomal analysis of *Chaetarthria seminulum* (HERBST) and six European species of *Laccobius* ERICHSON (Coleoptera: Hydrophilidae)

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Abstract

Karyotypes are presented for *Chaetarthria seminulum* (HERBST), *Laccobius minutus* (L.), *L. biguttatus* GERHARDT, *L. bipunctatus* (FABRICIUS), *L. atratus* (ROTTENBURG), *L. striatulus* (FABRICIUS) and *L. sinuatus* (MOTSCHULSKY). In all cases the diploid number is 16 + Xy (male), XX (female). In the three *Laccobius* ERICHSON species for which preparations of meiosis are available the sex chromosomes show a parachute association in first metaphase (Xyp), and this is considered to be the most likely arrangement in the others. The chromosomes of *C. seminulum* are rather elongate, inviting comparison with *Berosus* LEACH, while those of *Laccobius* are shorter, of a more normal Hydrophilid shape, but are characterised by heavy centromeric C-bands, especially in *L. striatulus* and *L. sinuatus*.

Key words: Coleoptera, Hydrophilidae, *Chaetarthria*, *Laccobius*, chromosomes

Introduction

In Hansen's cladistic analysis of Hydrophiloid phylogeny (HANSEN 1991) the tribes Berosini and Chaetarthriini are placed as closely related sister groups, so a comparison of *Chaetarthria* chromosomes with those of *Berosus* (SHAARAWI & ANGUS 1991a; ANGUS, AOUAD & SHAARAWI 1994) is of interest.

HANSEN (1991) places the genus *Laccobius* in a new tribe, Oocyclini, of which it is the sole European representative. This is reflected by the rather distinctive appearance of *Laccobius* species, which show some slight resemblance to *Berosus*, for example in the swimming ability of the adults and the tendency of the elytra to have punctured striae - though both characters are more developed in *Berosus* than in *Laccobius*. The similarity of the clypeal margins of the larval heads of the two genera is striking (BALFOUR-BROWNE 1958, p. xxxvi) but anatomically incidental as other genera of Berosini have symmetrical head-fronts (HANSEN 1991) and no other oocycline genus is known as a larva. Nevertheless, chromosomal comparison of these two genera is of interest.

Material & Methods

The species studied, their localities of origin, and the tissues used, are given in Table 1. The methods used for preparing chromosomes are given by ANGUS (1982) and SHAARAWI & ANGUS (1991b). For preparations from mid gut and testis, the abdomen of *Chaetarthria* was partly detached in a watch glass of colchicine solution as the beetles were too small to inject. *Laccobius* adults were injected in the normal way, but were left for 15 minutes after colchicine injection, and a further 15 minutes in hypotonic KCl before fixation. These slightly longer times were found necessary for aedequate condensation of the chromosomes. The approximate Relative Chromosome Lengths (RCL) of the largest and smallest autosomes and the X-chromosomes are given. RCL is the length of each chromosome expressed as a percentage of half the total

autosome length (i.e. sex chromosomes not included) in the nucleus. This eliminates differences due to different degrees of condensation of the chromosomes or simply different cell sizes, which can drastically alter absolute chromosome length. This is illustrated by two *Laccobius sinuatus* embryos shown in Figs. 3c, d. Chromosome 1 in Fig. 3c has absolute lengths of about 4 μm, while in Fig. 3d the lengths are about 9 μm. The RCL of the chromosomes in Fig. 3c are 18.6 and 16.9, and in Fig. 3d 15.8 and 17.2. These RCL values illustrate the differences due to individual condensation, and hence the need for statistically significant samples if detailed comparisons are to be made. In the work presented here the samples were too small, and so only approximate values are given. Absolute lengths may be measured from the scales given with the figures.

Species	Locality of origin (All England)	Tissues used
Chaetarthria seminulum	Oxfordshire: Cothill	Mid gut, testis
Laccobius minutus	Berkshire: Wraysbury	Embryo
L. biguttatus	Norfolk: East Walton	Embryo
	Kent: Sheppey	Mid gut, testis
L. bipunctatus	Berkshire: Wraysbury	Embryo
	Oxfordshire: Cothill	Embryo
	Hampshire: New Forest	Mid gut, testis
L. atratus	Hampshire: New Forest	Mid gut, testis
L. striatulus	Berkshire: Wraysbury	Embryo
	Oxfordshire: Radley	Embryo, mid gut, testis
L. sinuatus	Oxfordshire: Radley	Embryo, mid gut, testis

Table 1. Material used for chromosome preparations.

Results

Chaetarthria seminulum

Mitotic chromosomes from a male mid gut are shown in Fig. 1. There are eight pairs of autosomes and sex chromosomes which are a large metacentric X-chromosome (RCL about 11) and a dot-like Y-chromosome, suggesting the usual hydrophilid Xyp arrangement. The longest autosomes have RCL of about 19 and the smallest about 7. Autosomes 1 - 4 are nearly metacentric, though with one pair of arms clearly shorter than the other. Pair 6 has the short arms about half the length of the long ones, while in pair 7 they are shorter still. Pair 8 is acrocentric. The arms of the longer autosomes (pairs 1 - 3) are noticeably long and slender. No C-banding has been attempted, and no preparations of meiosis have been obtained.

Laccobius

Mitotic chromosomes are shown in Fig. 2a - i and Fig. 3a - e. All the species have eight pairs of autosomes whose RCL ranges from about 19 for the longest pair to about 6 for the shortest, with little difference between the species. The sex chromosomes are a small or medium sized metacentric X-chromosome and a dot-like Y. Nearly all the autosomes are metacentric or submetacentric, the exception being *L. biguttatus* (Figs.2c, d) in which autosomes 5 and 8 are subtelocentric.

Fig. 1: *Chaetarthria seminulum*: mitotic chromosomes from male mid gut, Cothill, Oxfordshire. The scale line represents 5 μm.

There is some interspecific variation in the size of the X-chromosome. In *L. minutus* (Figs. 2a, b) it is slightly shorter than autosome 8 (RCL about 9 as against 9.5), while in *L. biguttatus* (Figs. 2c, d), *L. bipunctatus* (Figs. 2e - g), *L. striatulus* (Figs. 3a, b) and *L. sinuatus* (Figs. 3c - e) it is clearly longer than chromosome 8 and appears slightly longer than pair 7, though this is not always clear. The approximate RCL values for chromosomes 7, 8 and X in these species are: *L. biguttatus* - 5, 3.5, 6; *L. bipunctatus* - 8, 6.5, 8.5; *L. striatulus* - 9.5, 7.5, 8.5; *L. sinuatus* - 9.5, 8, 10. The RCL values for these chromosomes in *L. atratus* (Figs. 2h, i) are approximately 9, 5.5 and 7, with the X-chromosome intermediate in length between chromosomes 7 and 8. C-banding has been obtained for all species except *L. biguttatus*. The C-bands are confined to the centromere region, and are conspicuous and large. In *L. atratus* (Fig. 2i) they occupy about a quarter of the length of the chromosomes, in *L. minutus* (Fig. 2b) and *L. bipunctatus* (Fig. 2g) about a third of the length, while they are largest in *L. striatulus* (Fig. 3b) and *L. sinuatus* (Fig. 3e), occupying between rather more than a third and about three quarters of the length of the autosomes. Comparison of Figs. 3b, e suggests that the C-bands of *L. sinuatus* are particularly heavy, with that on pair 7 being the most extreme. However, examination of other preparations from both species reveals irregularities in condensation which affect the apparent sizes of both the chromosomes and the C-bands, so that it is not possible to show a clear distinction between the karyotypes of *L. striatulus* and *sinuatus*.

In general the chromosome arms in unbanded preparations appear rather short and stocky, with the centromeric regions of *L. striatulus* (Fig. 3a) and *L. sinuatus* (Fig. 3d) appearing long, corresponding with the C-bands.

Meiotic metaphases of *L. biguttatus*, *L. bipunctatus* and *L. atratus* are shown in Figs. 3g - i. All show the Xyp configuration, with the small Y-chromosome particularly clear in the *L. atratus* (Fig. 3i), and not visible in the *L. biguttatus* (Fig. 3g), where the sex nucleolus shows as a very clear faintly staining region attached to the X-chromosome.

Fig. 3f shows mitotic chromosomes from a male embryo of *L. sinuatus* with two Y-chromosomes per nucleus. This irregularity is occasionally enountered in hydrophiloid embryos (see the Swedish *Helophorus griseus* HERBST figured by ANGUS (1989). It is not known whether such embryos could survive.

Discussion: The salient feature of the present study is the distinctive nature of the *Laccobius* chromosomes, with their large centromeric C-bands and stocky chromosome arms. No other oocycline genus is known chromosomally, and none of the hydrobiine genera investigated by SHAARAWI (1989) had this type of chromosome. The chromosomal data give no support to any close phylogenetic relationship between *Laccobius* and *Berosus*.

The chromosomes of *Chaetarthria* are not particularly distinctive. Although their rather long slender arms could be considered as resembling those of *Berosus*, their elongation is much less marked than in *Berosus*, and scarcely more pronounced than in hydrobiine genera such as *Anacaena* THOMSON (SHAARAWI & ANGUS 1991a).

Fig. 2, a - i *Laccobius* spp.: mitotic chromosomes. The scale line represents 5 μm. a) *L. minutus*, male embryo, Wraysbury, Berkshire; b) *L. minutus*, female embryo, C-banded, Wraysbury; c) *L. biguttatus*, male mid gut, Sheppey, Kent; d) *L. biguttatus*, female embryo, East Walton, Norfolk; e) *L. bipunctatus*, male mid gut, New Forest, Hampshire; f) *L. bipunctatus*, female embryo, Wraysbury, Berkshire; g) *L. bipunctatus*, female embryo, C-banded, Cothill, Osfordshire; h) *L. atratus*, male mid gut, New Forest, Hampshire; i) *L. atratus*, male mid gut, C-banded, New Forest.

Fig. 3 (opposite page), a - i *Laccobius* chromosomes. The scale line represents 5 μm. a - f: mitotic chromosomes. a) *L. striatulus*, male embryo, Radley, Oxfordshire; b) *L. striatulus*, female embryo, C-banded, Radley; c) *L. sinuatus*, male embryo, Radley; d) *L. sinuatus*, female embryo, Radley; e) *L. sinuatus*, female embryo, C-banded, Radley; f) *L. sinuatus*, male embryo with 2 Y-chromosomes, Radley. g - i: meiotic chromosomes, first metaphase from testis; g) *L. biguttatus*, Sheppey, Kent; h) *L. bipunctatus*, New Forest, Hampshire; i) *L. atratus*, New Forest.

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