

## THE CHROMOSOMES OF AN AUSTRALIAN PASSALID, *AULACOCYCLUS EDENTULUS* MACL. (COLEOPTERA, PASSALIDAE, AULACOCYCLINAE)\*

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### Abstract

The karyotype of *Aulacocyclus edentulus* is  $14^u + XY$ , the majority of the chromosomes being either metacentric or submetacentric. One of the autosome pairs is very large and from the pair 2 to 14 the chromosomes decrease gradually in length. The chromosomes of this species show that the subfamily Aulacocyclusinae follows the same patterns of karyotype evolution as that in the remaining Passalidae-Lucanidae stock.

### Introduction

The family Passalidae has a Gondwana distribution and comprises approximately 500 species, more than half of them being neotropical (Reyes-Castillo 1970). The family is divided into two subfamilies: Passalinae, with a pantropical distribution and Aulacocyclusinae, a small group of genera from the Oriental and Australian regions. The subfamily Passalinae is in its turn divided into two tribes: Passalini and Proculini, the latter with strictly neotropical species.

Three sources of information are available on passalid chromosomes. The first is a paper by Schaffer (1917) in which the karyotype of *Odontotaenius disjunctus* (Illiger) with  $12^u + Xy$  was described. A second paper (Virkki and Reyes-Castillo 1972) deals with the karyotype of 24 species of passalids, 16 of which belong to the tribe Proculini while the remaining 8 are Passalini. In a recent communication (Mesa *et al.* 1977) the chromosomes of three species of Brazilian passalids were described.

Nothing has been so far published on the chromosomes of Aulacocyclusinae species. The present paper deals with the cytology of *Aulacocyclus edentulus* (Macleay), an Australian species that belongs to this subfamily.

### Material and methods

Three male specimens of *A. edentulus* were collected at "Calosoma", N.S.W., 25 km N.E. of Canberra, Australia, on 12.xii.1977, and their testes were fixed in 3:1 methyl alcohol-acetic acid.

In the laboratory, the material was disintegrated in 45% acetic acid and dry flamed. The cells were stained with lactopropionic orcein 1%.

Only one of the specimens showed evidence of meiotic activity.

### Description

The spermatogonial metaphases of *A. edentulus* show 30 chromosomes ( $14^u + XY$ ) (Figs 1 and 2). The longest autosome pair ( $M_1$  in Figs 1 to 5, 9 and 10) is formed by chromosomes whose length is more than twice than that of the next pair in decreasing order of size. In pairs 2 to 14, the chromosomes decrease gradually in length in such a way that the pair 14 is approximately half the size of pair 2. Pairs 1, 12 and 14 are metacentric; pairs 2, 3, 6, 8, 9, 10, 11 and 13 are submetacentric and pairs 4 and 7 subacrocentric. In the specimen studied, pair 5 (Fig. 1) is structurally heterozygous, one member being acrocentric, the other subacrocentric. The X chromosome is metacentric and as long as the second pair. The Y chromosome is the smallest element of the set and is also metacentric (Figs 5, 6, 7 and 10).

During pachytene stage, the X chromosome appears thinner than the autosomal bivalents (Figs 3 and 8) but does not seem to show heteropycnosis. The same happens with the Y chromosome which remains either in contact with the X, as in Fig. 3, or in its proximity, as in Fig. 8, at pachytene.

\* Communicated by E. B. Britton.

† Scholarship holder from "Fundação de Amparo à Pesquisa do Estado de São Paulo (contrato n. 75/112)" and "Conselho Nacional de Desenvolvimento Científico e Tecnológico (contrato n. 1111 2592/76 BL)".

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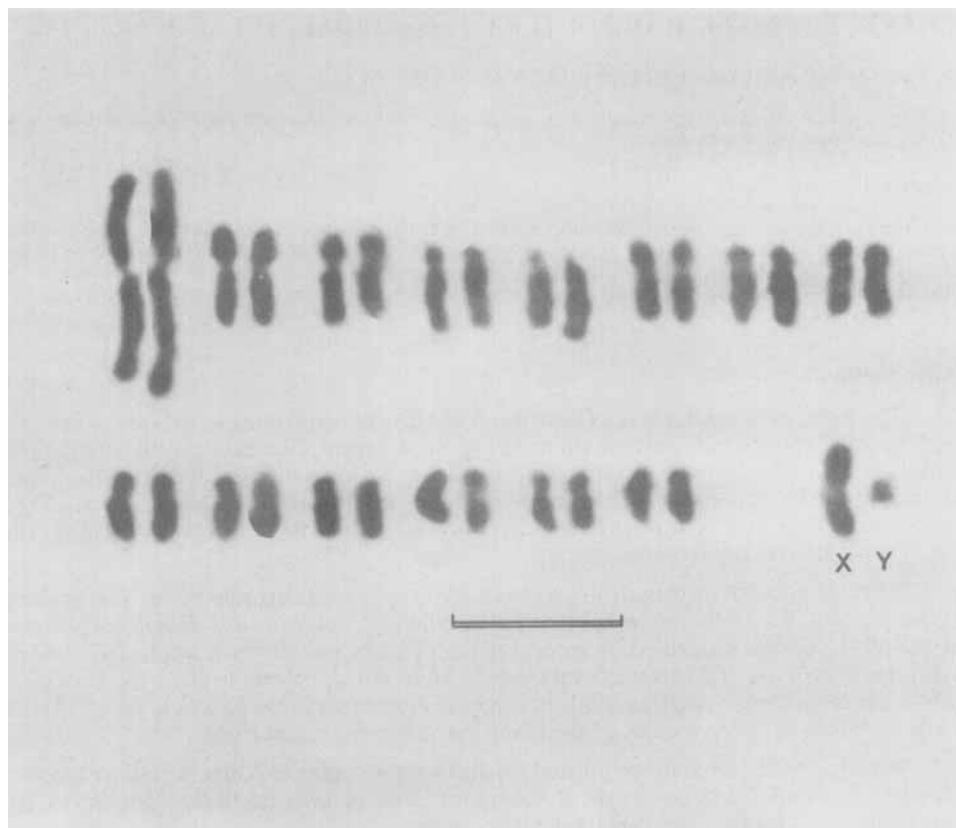


FIG. 1—*Aulacocychus edentulus*, spermatogonial metaphase, chromosome pairs arranged in decreasing order of size with the sex pair at the end (Line beneath corresponds to 5  $\mu$ m).

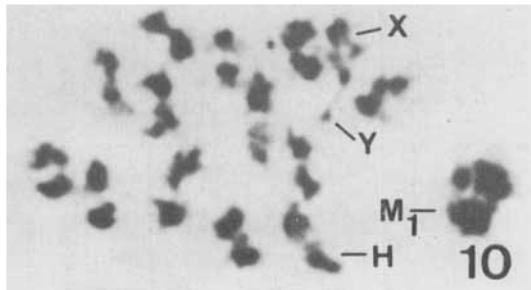
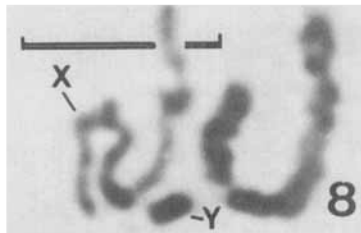
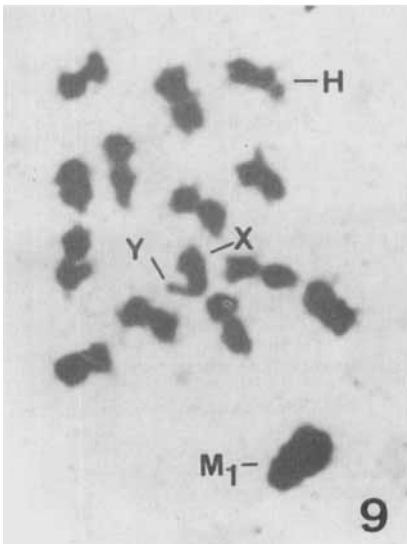
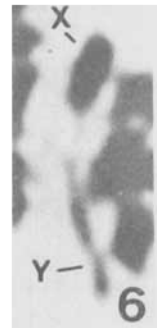
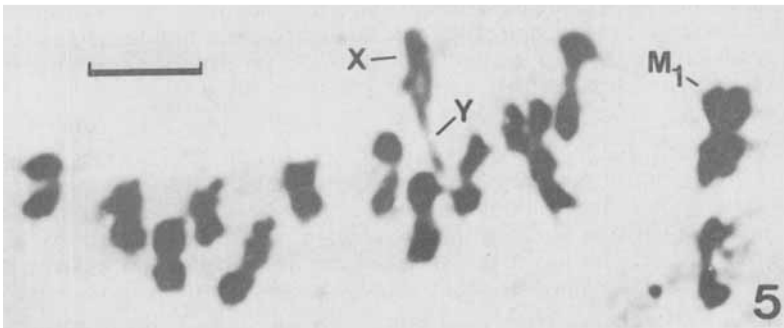
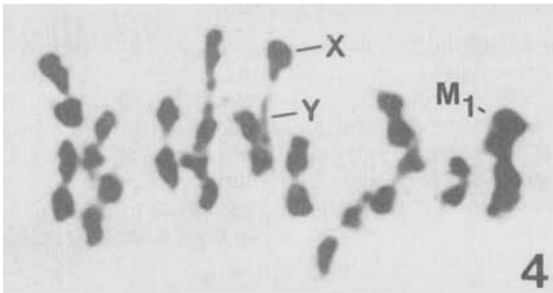
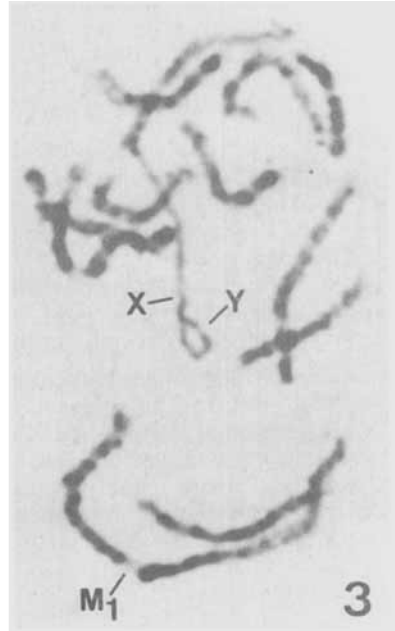
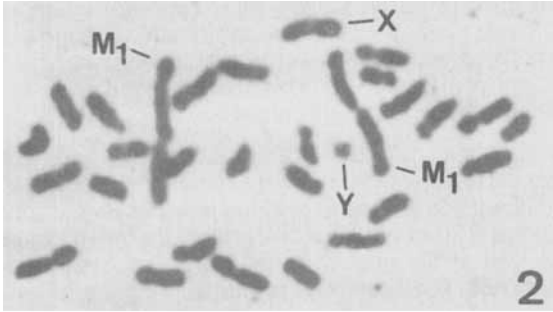
During prometaphase (Figs 9 and 10) and metaphase (Figs 4 and 5) 14 autosomal bivalents and the sex pair are observed. Among the bivalents, the  $M_1$  pair is readily distinguished and with some difficulties, according to the nuclei, the heteromorphic pair 5, is also observed (H). The chiasma localization in the autosomal bivalents seems to be distal, and either one or two chiasmata are formed in each bivalent.

The sex chromosomes appear mostly in contact by a single arm of each chromosome, as observed in Figs 4 and 7. Sometimes both ends of the X make contact with one arm of the Y as seen in Figs 5, 6 and 10. Less frequently, each arm of the X is in contact with a different arm of the Y, as in Fig. 9. In this case, they do not look different from a normal  $Xy_p$  mechanism.

### Discussion

None of the 27 species of passalids hitherto cytologically studied shows the  $9^{II} + Xy_p$  karyotype considered to be primitive in the suborder Polyphaga. According to Virkki and Reyes Castillo (1972), early in the karyotype evolution of the Passalini, the X chromosome entered into a centric fusion with an autosome the original  $y_p$  being lost in the process. Thereafter, followed an increase in chromosome number by means of centric dissociation (or fission) followed by pericentric inversions. So, two species of

Figs 2-10—*Aulacocychus edentulus*: (2) Spermatogonial metaphase; (3) Late pachytene stage; (4) Metaphase I; (5) Metaphase I; (6) Sex chromosomes at metaphase I; (7) Sex chromosomes at metaphase I; (8) Sex chromosomes at late pachytene; (9) Prometaphase stage; (10) Prometaphase stage. (Lines in Figs 5 and 8 indicate 5  $\mu$ m. The latter enlargement corresponds to Figs 6 and 7 and the first one to the remaining figures).



the genus *Oileus* (*O. sargi* and *O. rimator*) studied by Virkki and Reyes-Castillo (1972) show, according to these authors, the most primitive karyotype so far reported within Passalidae, with  $8^{II} + \text{neo XY}$ . A single step, the X-autosome fusion, is necessary according to Virkki, to accomplish this modification. However, it must be kept in mind that a previous transference of the centromere of the normally metacentric X to a subterminal position by means of a pericentric inversion, is needed.

The variation in chromosome numbers within Proculini is remarkable, since in 17 species studied, the following numbers of autosomal pairs were reported: 8, 11, 12, 13, 15, 16, 17 and 18, half of these species being neo XY, and the other half Xy. By contrast, the tribe Passalini shows a good deal of karyotype stability, since among 10 species studied only one has  $15^{II} + X$  (Mesa *et al.* 1977) while the remaining ones have  $12^{II} + X$ . No Y chromosome is known in this tribe. Based on what is known in eight species of lucanids, Virkki and Reyes-Castillo (1972) pointed out that a similar pattern of karyotype evolution occurs in this closely related family of beetles.

If an X-autosome centric fusion did actually take place as suggested by Virkki and Reyes-Castillo, one might be able to observe hints of a compound nature in the present X chromosome, in both neo XY and Xy mechanisms. However, that chromosome appears to be completely homogeneous as the original X should be. Although Virkki and Reyes-Castillo's interpretation of sex chromosome evolution in passalids could be valid, an alternative hypothesis may be formulated. Different sizes in the Y chromosome of the Passalidae can be interpreted as differential accumulation of constitutive heterochromatin in the original  $y_p$ . This trend would have been initiated in the common ancestor stock of the Passalidae and Lucanidae.

To explain the absence of an Y element in Passalini, it is necessary to assume the loss of the male determining function of that chromosome. As the Y chromosome is thought to be the carrier of at least one of the nucleolar organizer regions (John and Lewis 1965) the transference of this zone to other chromosome, either an autosome or the X, should be also expected, rather than a definitive elimination of such an important segment.

Among the 16 species described by Virkki and Reyes-Castillo (1972) in Proculini, 8 are considered by these authors to be of the neo XY type and 8 of the Xy one. The difference between both mechanisms is only in the degree of size of the Y chromosome, and since there is a gradual variation among the species, it is sometimes difficult to decide whether a mechanism belongs to one or another category. For that reason, in the present paper the Y chromosome has been simply designated by a capital letter.

The karyotype of *A. edentulus* shows that this species of the subfamily Aulacocyclinae follows the same pattern of chromosome evolution as that in the remaining species of the Passalidae and Lucanidae stock.

### Acknowledgments

The authors are indebted to Drs E. B. Britton and B. P. Moore, Division of Entomology, CSIRO, for providing the identified specimens as well as the fixed testes of *A. edentulus*.

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[Manuscript received 24 April 1978. Revised 17 August 1978.]