Sex Chromosomal Polymorphism in the Earwig *Forficula*

S. A. Henderson
Department of Genetics, University of Cambridge, England

Received March 31, 1970 / Accepted April 10, 1970

Abstract. A four-year population sampling programme revealed small annual and marked seasonal variations in the frequency of adult XXY males of the earwig *Forficula auricularia*, where XY and XXY individuals co-exist in the same population as a polymorphism. It is suggested that this may have been due to an effect of the extra X chromosome on development rate. The extra X was also found to reduce autosomal chiasma frequency slightly and to change bodily morphometrics: antenna length was increased and head and abdomen length decreased in a compensating fashion. Chiasma and multivalent frequencies were analysed in 50 spontaneously autotetraploid cells. The range of sex chromosome numbers found in different species, and the variation in *Forficula* due to allosomal polymorphism and non-disjunction, suggests that sex determination in earwigs does not involve a balance mechanism. The role of polyploidy in Dermapteran evolution is supported (Summary see p. 162).

A. Introduction

The common earwig, *Forficula auricularia*, is of particular interest cytologically, because the number of sex chromosomes which may be found in the male is not constant. In so-called 24-chromosome males two sex chromosomes accompany the 11 pairs of autosomes, while in 25-chromosome males three sex chromosomes are present. Furthermore, although sample sizes were variable and often small, the frequency of 24- and 25-chromosome types was not found to be the same in all populations: in Swiss populations Morgan (1928) found the two types to be almost equally frequent, but in samples taken from four different English populations Callan (1941) found the frequency of 25-chromosome males to be quite low, the frequencies ranging from 0—25%.

The normal sex pair are quite noticeably unequal. Callan (1941) was of the opinion that the optional sex chromosome was only slightly larger than the smaller element and as these two smaller chromosomes most commonly appeared to travel together to one pole at anaphase I he considered these to be small X chromosomes, the larger element being a Y. This does not necessarily follow, of course, for it is now known that while a single Y is present in most multiple sex chromosome sys-

* Dedicated to Dr. Sally Hughes-Schrader for her many valuable contributions to the field of cytology.

10 Chromosoma (Berl.) Bd. 31
tems, \(X_Y Y_2\) systems do exist (see Lewis and John, 1963). Callan suggested a phylogenetic scheme linking the sex chromosome systems of several earwig species, in which it was proposed that the Y chromosome was dicentric and that the dispensible \(X_2\) chromosome had one pairing segment in common with one arm of the Y and one pairing segment shared with one of the \(X_1\). In support of the dicentric nature of the Y was the observation that Y univalents were sometimes seen to become attenuated between the two polar groups at telophase. However, it is not uncommon for sex chromosome univalents, with only one centromere, to behave in this way (Bauer, 1931; Wolf, 1941; Henderson and Parsons, 1963). Such attenuation is found when the lagging univalent's centromere becomes functionally double and exhibits amphi
tellic orientation (Bauer, Dietz and Röbbelen, 1961) before complete chromatid separation can take place.

White (1954) has criticised Callan's interpretations. He suggested that the additional \(X_2\) element may be a supernumerary chromosome, either derived from one of the regular sex chromosomes or combining parts of both of them, thereby possessing pairing affinity with both X and Y at meiosis. The dicentric nature of the Y he dismisses as 'no centromeres can be demonstrated by direct visual observation in any of the Dermaptera'. Clearly the situation is far from unambiguous and it seemed desirable to re-investigate the chromosomes of this common insect, using squash preparations rather than sectioned material. In addition, population sampling was repeated over a period of 4 years to determine whether any marked variations occur in the frequency of the two sex chromosome types within one population. In the final year double sampling, at the beginning and end of the season, was carried out to detect any seasonal or local fluctuations in sex chromosome frequency.

**B. Materials and Methods**

The earwigs were collected from the grounds of the Genetics Department in Cambridge. In 1963 only 65 males were taken, but in 1964, 1965 and 1966 each sample was of 100 individuals. Collections in 1963, 1964 and 1965 were made over 1—2 days at unrecorded, but similar, times at the end of August. In 1966, sampling was a little more complex: collections were made at the beginning of the season (early June) and the end of the season (early September) from two localities approximately 100 yards apart on opposite sides of the grounds. The 1963—1965 samples were made to detect annual fluctuations in the frequency of the two chromosome-type males. The 1966 sampling programme was carried out both to detect any differences in the sex chromosome-type frequencies at the beginning and end of the season and also, the within-population duplicates would provide an indication of within-population variability and hence the possible magnitude of the sampling error in the previous annual estimates based on one population sample. There is only one generation per year. In 1967 a further 150 individuals were collected during July for morphometric purposes.