CHROMOSOME STUDIES ON THE DIPTERA II. THE PAIRED ASSOCIATION OF CHROMOSOMES IN THE DIPTERA, AND ITS SIGNIFICANCE

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EIGHT PLATES

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INTRODUCTION

Attention was first called to the pairing of chromosomes in the Diptera by Miss N. M. Stevens during 1907 and 1908 in connection with studies upon the heterochromosomes of insects (Stevens '07, '08). Although primarily concerned with the heterochromosomes and maturation phenomena, Stevens nevertheless found the paired association of chromosomes, in the nine species she studied, so conspicuous as to warrant the statement that, "perhaps the most interesting point in the whole study is the pairing of chromosomes in cells somewhat removed from the sphere of the reduction process. This was found to occur in the ovarian follicle cells, the spermatogonia and some embryonic cells. This is not an occasional phenomenon, but one which belongs to every oogonial and spermatogonial mitosis"

CYCLORRHAPHA

Syrphidae

Eristalis tenax Linne.
Eristalis bastardi Macq.
Eristalis aeneus Fabr.
Eristalis meigeni Wied.
Volucella obesa Fabr.
Mesogramma marginata Say.
Toxmerus annulatus Loew.

Acalypterae

Micropezidae

Calobata lasciva Fabr.
Calobata nebulosa Loew.

Sepsidae

Piophila casei Linne

Ortalidae

Chaetopsis fulvifrons Macq.
Camptoneura picta Fabr.
Euxesta stigmatius Loew.
Euxesta anonae Fabr.

Trypetidae

Euaresta melanogaster Loew.

Sapromyzidae

Physegenua vittata Macq.

Drosophilidae

Drosophila.—27 species, many undescribed, see text.
Cladochaeta nebulosa Coq.
Scaptomyza adusta Loew.
Scaptomyza graminum Fall.

Sciomyzidae

Neuroctena analis Fullen.

Calypterae

Anthomyidae

Homalomya spp.
Fucellia marina Macq.
Ophyra leucostoma Wied.

Muscidae

Calliphora viridescens Desv.
Calliphora erythrocephala Meig.
Musca domestica Linne.
Muscina stabulans Fall.
Phormia regina Meig.
Lucilia sericata Meig.
Pseudopyrelia cornicina Fabr.

Sarcophagidae

Sarcophaga falculata Pand.
Sarcophaga tuberosa serraceniae Riley.
Sarcophaga dalmatina Schin.
Sarcophaga bullata Park.
Ravinia communis Park.
Ravinia peniculata Park.

dae (figs. 4–20) having a similar chromosome group. In Chaetopsis no good figures of early spermatogonial prophases have been secured, owing to the small size of the nuclei, and to difficulties in fixation. Metaphases, however, are distinct (figs. 117–118) and plainly show the paired arrangement of the chromosomes. These, when compared with maturation divisions showing the haploid group (fig. 119, first division) leave no doubt of the relations in this species.

Camptoneura picta (figs. 120, 121). Since C. picta shows pairing relations similar to those in the last named species it attracts attention only because it differs so markedly from Chaetopsis in respect to the number and size relations of its chromosomes. As a matter of fact Chaetopsis excites the greater interest, for Camptoneura has the chromosome group (fig. 120, diploid, and 121, haploid) found in several families (all those above mentioned, as well as the Sapromyzidae, Micropezidae, Sepsidae, Syrphidae, and one species of Bombyliidae), while the group found in Chaetopsis is found in no other species I have studied outside the Drosophilidae.

Sapromyzidae

Physegenua vittata (fig. 122). I have had difficulty in obtaining suitable material from Sapromyzid flies, but as in the case of the Trypetidae enough has been secured to determine the essential point—that the chromosomes are associated in pairs. Figure 122 (spermatogonium) represents one of the few complete polar views found. It is seen somewhat diagonally, with the result that some of the pairs appear to lie beneath the others, but in reality they form an almost flat plate, entirely comparable with those seen in the Muscidae, etc. The two small chromosomes are doubtless the sex-chromosomes (X Y), just as are the small ones in the Muscidae.

Drosophilidae

(See pp. 222–224, "Reality of chromosome pairing." For specific references see explanation of plates; also Metz '14.)

PLATE 1

EXPLANATION OF FIGURES

All figures were drawn with the aid of a camera lucida, using a Zeiss 1.5 mm. apochromatic objective and compensating ocular no. 12, with tube length of 160 mm. The drawings are reproduced natural size. They are taken from sections cut 5 μ thick unless otherwise noted.

1 and 2 Drosophila virilis Sturtevant mss.,[19] diploid metaphase, ovarian cell.

3 D. ramsdeni Stt. mss., diploid metaphase, ovarian cell.

4 Scaptomyza graminum Fall., diploid metaphase, spermatogonium.

5 Same, ovarian cell.

6 Same, haploid, second spermatocyte.

7 Drosophila robusta Stt. mss., diploid, early anaphase, spermatogonium; polar view showing separation of daughter halves of chromosomes.

8 Same, ovarian cell; slightly earlier stage showing division of chromosomes.

9 Same; slightly later stage.

10 D. nebulosa Stt. mss., haploid, second spermatocyte prophase.

11 Same, diploid, ovarian cell.

12 Same, diploid, ovarian cell, two poles of anaphase; lower figures displaced in order to compare the two groups (upper pole at left, lower at right); upper figure a diagram showing the two anaphase groups as they appear in the section. The small, spherical members are not evident.

13 D. amoena Loew, haploid, late metaphase, second spermatocyte.

14 Same, ovarian cell, prophase, diploid group.

15 Same, diploid, metaphase, spermatogonium.

16 Same, diploid, early anaphase, ovarian cell, showing separation of daughter halves of chromosomes.

17 D. busckii Coq., diploid metaphase, ovarian cell.

18 Same, haploid, first spermatocyte.

19 D. ampelophila Loew, diploid metaphase, ovarian cell.

20 D. dimidiata Loew, diploid, metaphase, ovarian cell.

21 D. ornatipennis Will., diploid, ovarian cell, metaphase; this individual apparently possesses three small, spherical chromosomes.[20]

22 Scaptomyza adusta Loew, diploid, metaphase, ovarian cell.

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[19] See footnote 3, page 221.

[20] Apparently this case is comparable with that of the supernumerary 'm-chromosome' described by Wilson ('10) in Metapodius, and results from non-disjunction of the small chromosomes in one of the parents. Unfortunately only two or three good figures were found in my specimen (as is usually the case in flies), and although these show the same features they are too few to be demonstrative. It may be noted that the three chromosomes are associated together in each of the figures.

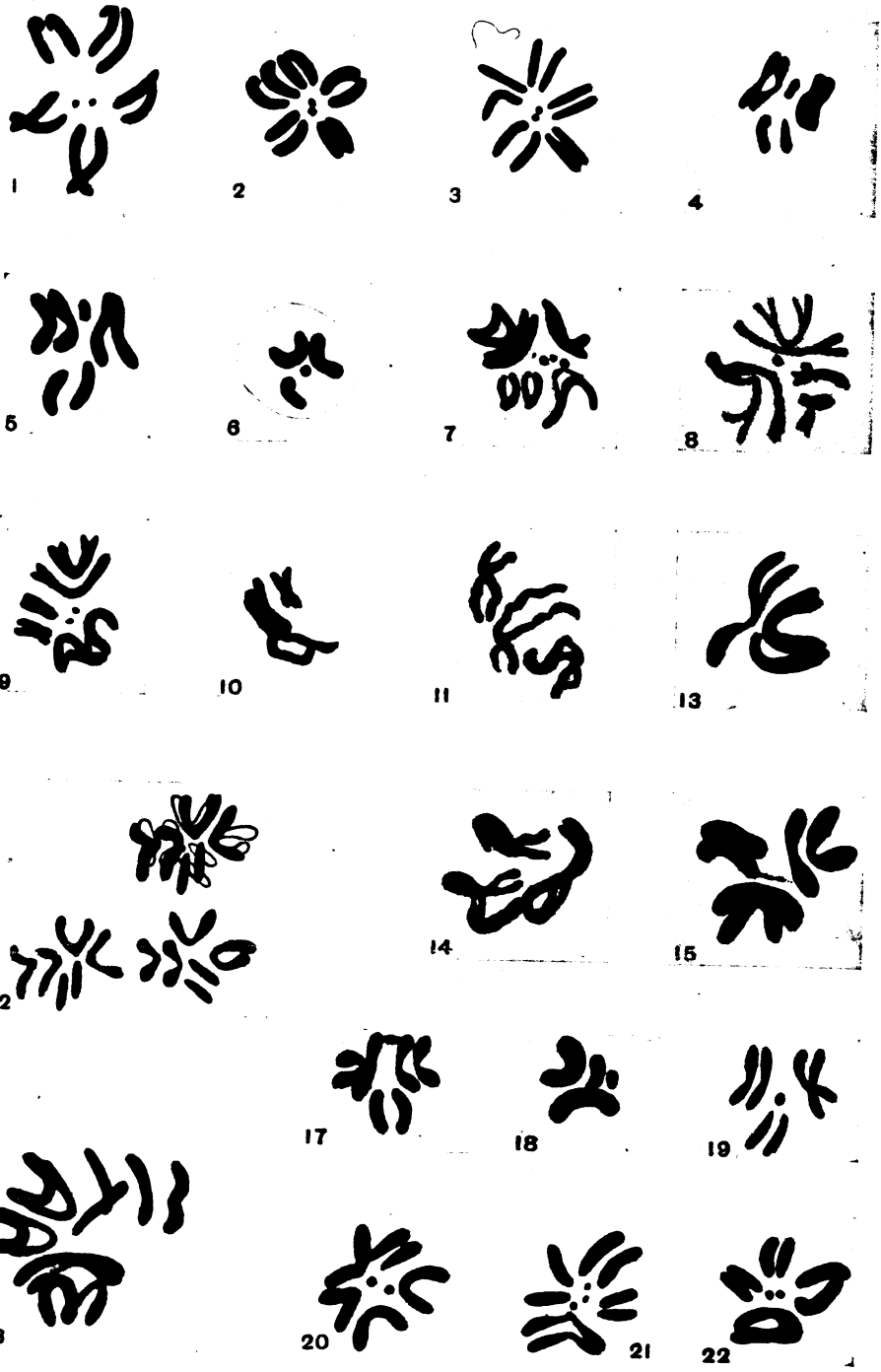
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PLATE 2

EXPLANATION OF FIGURES

23 Drosophila neglecta Stt. mss., diploid, metaphase, spermatogonium; (small chromosomes not evident, unless represented by the small chromatic body in upper part of figure.)

24 Same, all chromosomes present; made from an aceto-carmine smear.

25 and 26 Same, haploid, second spermatocytes; aceto-carmine.

27 D. funebris Fabr., diploid, metaphase, ovarian cell.

28 Same; aceto-carmine smear, slightly later stage showing division.

29 Same diploid, metaphase, spermatogonium; note the separation of the two large chromosomes.

30 Same, diploid, ovarian cell, anaphase in side view; note separation of large chromosomes.

31 Same, with large chromosomes in their normal position.

32 Same, early anaphase, side view, showing division of the chromosomes.

33 Same, haploid, first spermatocyte anaphase in side view for comparison with figure 31.

34 D. procnemis Will., diploid, ovarian cell, prophase.

35 and 36 Same, slightly later stages.

37 D. tripunctata Loew, diploid, metaphase, ovarian cell.

38 Same, diploid, ovarian cell, two poles of anaphase in polar view, displaced for comparison of the two groups.

39 D. repleta Woll., diploid, metaphase, ovarian cell; aceto-carmine smear.

40 Same, late metaphase showing division of chromosomes, from section. The two round bodies at left of figure are chromatic (?) inclusions, not chromosomes.

41 Same, spermatogonium.

42 D. affinis Stt. mss. diploid, metaphase, spermatogonium.

43 Same, late prophase, ovarian cell.

44 and 45 D. obscura Fall. diploid, metaphase, spermatogonia.

46 Same, ovarian cell, (small chromosomes not evident).

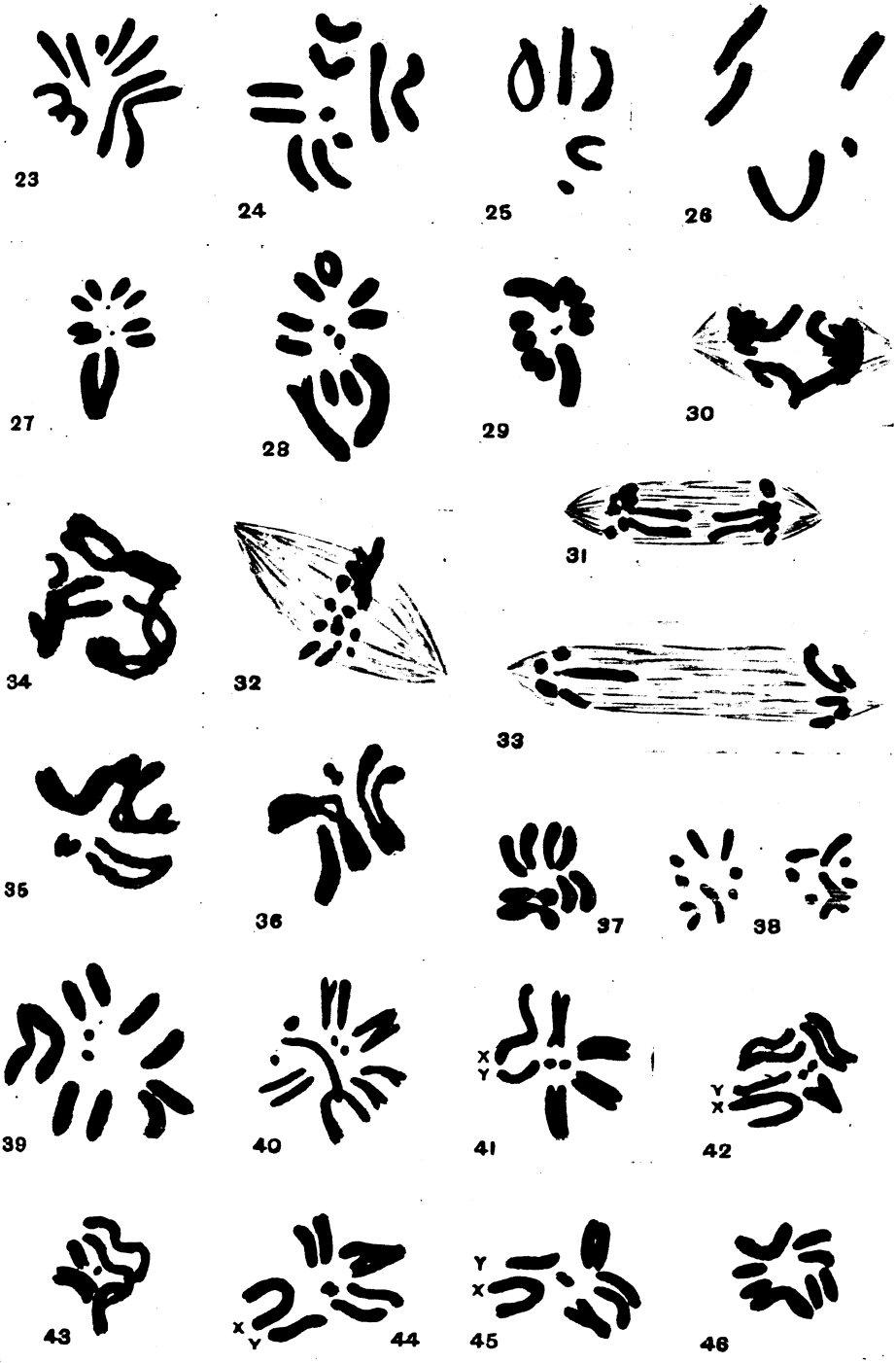
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PLATE 3

EXPLANATION OF FIGURES

47 Drosophila obscura, diploid, late prophase, from an embryonic cell during a late cleavage stage in the egg.

48 Same, haploid, metaphase, first spermatocyte.

49 Same, haploid metaphase, second spermatocyte, X-containing class.

50 Same, haploid metaphase, Y-containing class.

51 and 52 Calliphora erythrocephala, haploid, metaphase, first spermatocytes.

53 to 56 Same, diploid, metaphases, ovarian cells.

57 Same, somatic.

58 Same, diploid, somatic, early prophase, entire, or almost entire nucleus, one pair partly displaced in the figure to show all of the threads.

59 Same, somatic, only part of figure shown.

60 and 61 Same, somatic, two sections of one nucleus.

62 Same, somatic, entire or nearly entire nucleus.

63 Same, ovarian cell, entire nucleus.

64 Same, somatic, only three pairs represented.

65 Same, somatic, entire nucleus.

66 Same, later prophase, ovarian cell, showing separation of the two members of a pair in late prophase.

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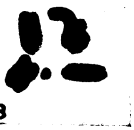
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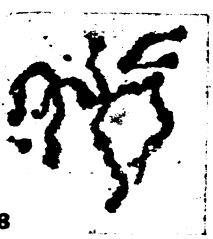
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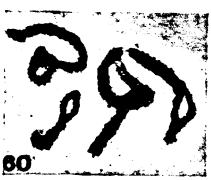
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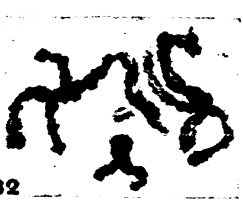
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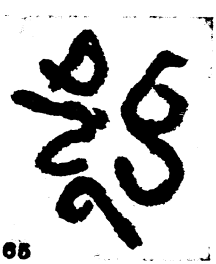
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