

ALTERNATE-2 DISJUNCTION IN THE GERMAN COCKROACH

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ABSTRACT

The evidence in support of two types of alternate disjunction in translocation heterozygotes from the German cockroach, *Blattella germanica* (L.), is reviewed. When unique cytomorphological features occur in the translocation figure, the two types of alternate disjunction are identifiable regardless of the angle of observation. Photographs supporting this contention are presented for alternate-1 and alternate-2 disjunction in $T(7;12)/7;12$. Other evidence in support of the existence of alternate-2 disjunction is also presented.

DOGMAS sometimes become established in fields of science that are difficult to dislodge, in spite of mounting evidence for their incorrectness. This seems to be the case surrounding the existence of two identifiable types of alternate disjunction at metaphase I in reciprocal chromosome translocation heterozygotes. BOUSSY (1982) has rather emphatically stated that alternate-2 disjunction does not exist. He went on to elaborate the traditional view that adjacent-1, adjacent-2 and alternate are the only possible configurations and that, barring any special situations, these three types will appear with equal frequency. It should be noted that he presented no new evidence in support of the traditional view.

The case for the existence of two types of alternate disjunction (alternate-1 and alternate-2) is very strong. Its principal point is that, in order to observe alternate-1 and alternate-2, the translocation figure must have some unique cytomorphological feature. Without it the two types of alternate disjunction will appear to be identical as BOUSSY (1982) stated. In the cotton translocation studied by ENDRIZZI (1974), this feature was chromosomal size differences and a distinctive knob on one of the chromosomes. In the German cockroach translocations with radically different-sized chromosomes provided the necessary recognition (COCHRAN 1976; 1977). The crucial point is that such features can be identified in the ring quadrivalents at metaphase I regardless of how the figure orients on the plate. Figure 1 is a representation of how alternate-1 and alternate-2 differ, with photographs showing the two types of disjunction as they are usually observed, as well as how one of them appears when rotated 90° in the plane of the metaphase plate. Thus, the argument that reported differences in the two alternate disjunction types can be explained away on the basis of how the metaphase I figure happens to get squashed on the slide is

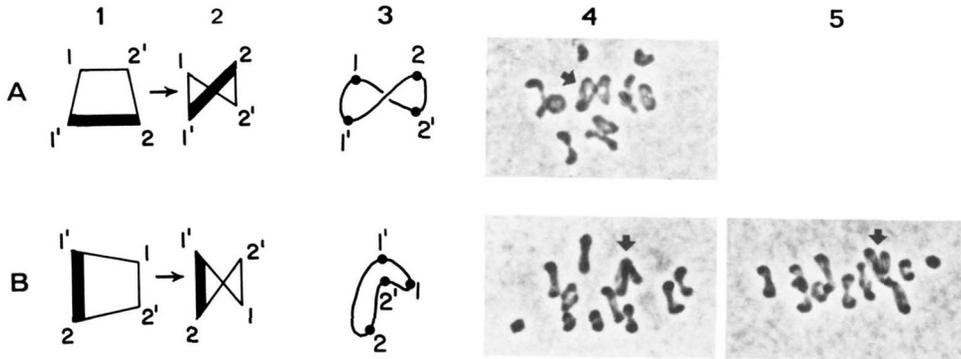


FIGURE 1.—Diagrams and photographs showing alternate-1 (A) and alternate-2 (B) disjunction in the German cockroach. The representations are as follows: (1) adjacent-1 and adjacent-2; (2) alternate-1 and alternate-2 (both schematic); (3) realistic drawings of alternate-1 and alternate-2; (4) photographs showing the normal orientation of alternate-1 and alternate-2 on the metaphase I plate; (5) photograph showing the alternate-2 configuration rotated 90° in the plane of the metaphase I plate. In (4) and (5) the arrows point to the quadrivalent figures.

fallacious. Furthermore, examination of three-dimensional clay or wire models of alternate-1 and alternate-2 disjunction figures, with distinctive cytomorphological features, quickly confirms that they can be identified from any angle. Even when they are somewhat flattened, as in squashing, they are still distinctive.

In addition to the direct cytological evidence, there is other information supporting the two types of alternate disjunction view. In the German cockroach (and in other organisms as well; KODURU 1979) it has been reported that, not only are four disjunction types recognizable, they occur in definite numerical relationships to one another. Thus, with $T(7;12)/7;12$ the ratio is 2:1:1:2 (adjacent-1; alternate-1; adjacent-2; alternate-2), whereas for $T(3;12)/3;12$ the ratio is 2:1:1:4. $T(7;12)/7;12$ shows an overall random disjunction in males, whereas $T(3;12)/3;12$ males have directed disjunction with about 70% of the cells showing alternate disjunction. These values correspond very closely to the observed lethality associated with each stock (49% in $T(7;12)/7;12$ and 30% in $T(3;12)/3;12$) (ROSS and COCHRAN 1975, 1977). Lethality results, of course, from the fact that gametes arising from cells that undergo adjacent disjunction produce inviable zygotes. Furthermore, by genetically manipulating certain of these stocks it is possible to alter both the cytological ratios and the lethality. For example, $T(8;9)/8;9$ males normally exhibit directed disjunction showing about 62% alternate disjunction (COCHRAN 1977). In certain backcross systems $T(8;9)/8;9$ males produce mean lethality of about 38 or 50%. These values correspond closely with observed disjunction types at the cytological level (ROSS and COCHRAN 1977). Also, $T(3;12)/3;12$ males produce about 50% lethality after genetic manipulation and show random disjunction at metaphase I. In the latter instance the change in the disjunction picture was attributable almost entirely to a reduction in the proportion of alternate-2 configurations (COCHRAN 1977). For BOUSSY'S (1982) interpretation to be correct here a preferential squashing bias of major magnitude against the apparent alternate-2 perspective would have to occur.

Furthermore, it would have to produce a precise shift from a 2:1:1:4 to a 2:1:1:2 ratio. The probability of such an exact bias occurring in a series of individual slide preparations is vanishingly small.

It is unfortunate that BOUSSY (1982) has taken such an emphatic position against the occurrence of alternate-2 disjunction at metaphase I. His strongest argument seems to be "the observations of alternate-1 and alternate-2 disjunctions must have involved observing alternate disjunctions from different angles." He has chosen to ignore or minimize the importance of the pertinent observations.

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