variation. Such systems offer substantial advantages for the study of biological processes intervening between a gene substitution and a behavioral difference. The familiar neurological mutants are aberrant in so many ways that it is difficult to establish causal relationships between structure and behavior. Genes such as *asp* may facilitate research on the genetic basis of variation in phenotypes chosen for their intrinsic behavioral significance.

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Mutants at the Bobbed Locus in Drosophila melanogaster: Relation to Ribosomal RNA Synthesis?

Abstract. *An allele of the bobbed locus (bobbed bristle) behaved in crosses with other bobbed alleles as a weak isoallele to which extreme bobbed alleles were dominant. The results are consistent with the hypothesis that the bobbed locus contains multiple cistrons, some threshold number of which are needed to produce ribosomal RNA and the normal phenotype.*

In 1963, I was using a w^{m4} (white-mottled 4) stock of *Drosophila melanogaster* which was homozygous for the X chromosome inversion In(*1*)w^{m4} and was phenotypically wild with respect to the *bb* (bobbed bristle) locus. In crosses between this and another inversion stock, In(*1*)w^{mJ}, which lacks the nucleolus-organizing region (*1*), the resulting F_1 females were bobbed. When w^{m4} females were mated with *car bb* (carnation bobbed, a stock with a typical *bb* allele), with bb^l (deficiency for the *bb* locus, lethal when homozygous) and with $Y^S \cdot XY^L/O$ (attached XY, no free Y) males, the results were: $w^{m4}/$*car bb* females, phenotype wild; w^{m4}/bb^l females, phenotype bobbed; w^{m4}/O males, phenotype bobbed.

These results seem worth considering in terms of the hypothesis of Ritossa *et al.* (*2*). These authors showed that the site of ribosomal DNA (rDNA), which is complementary to ribosomal RNA (rRNA), is in the nucleolus-organizing region and that there is a multiplicity of rDNA cistrons for each of the two rRNA's. A consideration of the properties of the *bb* locus led to the conclusion that it and the rDNA locus are one and the same. According to the hypothesis (i) the array of cistrons present at the *bb* locus in a single X chromosome of a wild-type strain (about 130 cistrons for each of the two rRNA's) is sufficient to produce a normal, wild phenotype; (ii) mutant *bb* "alleles" result from deletion of some of the rDNA cistrons; and (iii) mutant *bb* "alleles" are additive in effect, as pointed out by Stern (although this generalization has been questioned) (*3*).

Let us suppose that x represents the number of cistrons (for each of the rRNA's) required to produce the wild phenotype, and that *any* reduction below x cistrons will result in a fly with a bobbed phenotype. It may be noted in passing that x must be less than 130, but we do not know how much less.

Now an "allele" a with $(x/2)+y$ cistrons (where y may be zero or any positive integer) will produce a wild phenotype when homozygous, because there will be a total of at least x cistrons present. We may therefore consider a a wild-type allele. If another "allele" b has fewer than $(x/2)-y$ cistrons, its homozygote will be bobbed. The heterozygote a/b will also be phenotypically bobbed, because the total number of cistrons will be less than x. Therefore b behaves like a dominant *bb* allele, or, to put it another way, a is an isoallele of bb^+ with weakened dominance.

The results of the w^{m4} crosses can be explained if we assume that the w^{m4} stock had an isoallele at the *bb* locus which had more than half of the cistrons required for a wild phenotype [like allele a, with $(x/2)+y$ cistrons], while the *bb* allele of *car bb* had at least $(x/2)-y$ cistrons. With a total of at least x cistrons, the heterozygote $w^{m4}/$*car bb* would be phenotypically wild. The heterozygotes with w^{mJ} and bb^l [in which very little rDNA is present (*4*)] would be like the a/b heterozygote, in which the extreme *bb* allele has a dominant effect. The bobbed phenotype of the w^{m4}/O males would be expected on the assumption that the w^{m4} allele had fewer than x cistrons.

Ritossa *et al.* say, "One would expect the *bb* phenotype to appear only when the deletion of the rRNA cistrons is greater than one-half of the wild locus." As shown above, however, it is consistent with their hypothesis that (i) a bobbed phenotype can result from a genotype in which one of the "alleles" still has more than half of the cistrons of the wild locus; and (ii) *bb* "alleles" may act as dominants in combination with wild-type "alleles." These points are conceded in a later paper by Ritossa *et al.* in a discussion of a dominant bobbed mutant of *Drosophila funebris* (*4*), which, however, appears to be atypical.

Departures can be expected from the strict quantitative relations suggested above between rDNA and bobbed phenotype, for apparently there is not a simple proportionality between the amounts of rDNA and rRNA present, either in the range above the assumed threshold x (that is, in wild phenotypes) or in the range below, in bobbed phenotypes (*5*).

The w^{m4} stock used in 1963 is no longer extant. Even if it had been maintained, it might well have been impossible to repeat the results obtained previously, owing to the lability of the *bb* locus. Similar stocks should be obtainable, however (if the lability is due to unequal crossing-over in the multicistronic locus) by selection of alleles that show a slight bobbed effect in combination with bb^l and subsequent selection for wild phenotype in combination with *car bb*.

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