EYE-COLOUR GENES AND TUMOR INCIDENCE*

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Hartung and Hartnett (1951) and Mittler (1952) reported that the incidence of tumor increases when the flies are cultured in the medium to which tryptophane has been added. This fact suggested a thought to the writer that pigment formation which is affected by the tryptophane metabolism may have an intimate relation with the incidence of tumor. The writer made crosses between the *brown tumor* (*bw tu*) strain and the various eye-colour strains of *Drosophila melanogaster* and studied the incidence of the tumor of the strains which were established from these crosses.

Material and method

The *bw tu* strain employed in this experiment has the main tumor gene on the second chromosome and some modifier genes on the same chromosome (Hartung 1950). Eye-colour mutants employed were from the stocks maintained at Kyoto University of Japan. Flies were cultured by *Saccharomyces cerevisiae* in ground wheat and sugar medium $25^{\circ} \pm 1^{\circ}\text{C}$. Throughout the experiments fresh yeast was added from time to time in the culture medium to keep food in good condition. Since tumor flies cannot often be externally distinguished from wild-type flies, all the non-tumor flies were investigated as to whether they contained black specks in the body cavities or not, and the flies which had black specks were classified as tumor individuals.

The *bw tu* flies were out-crossed with the *vestigial* flies and F_1 wild-type flies were inbred. Among F_2 flies, only the tumor flies were selected, and a new *tu* strain was established after six generations. The tumor incidence of this *tu* strain was further investigated during four more generations. Since the incidence of tumor was statistically the same (about 50 percent) in each generation, this tumor strain was symbolized as *tu* (53*d*). The tumor males from the *vermilion* (*v*), *vermilion brown* (*v bw*), *cinnabar brown* (*cn bw*), *scarlet* (*st*), and *brown scarlet* (*bw st*) stocks were mated with the females of *tu* (53*d*). Their F_1 flies were inbred, and the tumor flies were selected in F_2 and in the subsequent generation. After the six generations, *v tu* (53*e^c*), *v tu* (54*e^d*), *cn tu* (53*eⁿ*), *tu* (53*e^a*) *st*, and *tu* (53*e^b*) *st* strains were established. The incidence of tumor among these strains were investigated (Table 1). In the course of these matings, it was often found that the *v bw*, *cn bw*, and *bw st* flies have tumor-like abnormalities which appear as a pale-blue, blackish aggregate or aggregates in

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Table 1

Matings	Strains newly established	Incidence of tumor
<i>bw tu</i> × <i>vg</i>	<i>tu</i> (53 <i>d</i>)	50 (270/538)
<i>tu</i> (53 <i>e</i> ^{<i>A</i>}) × <i>bw</i>	<i>tu</i> (54 <i>f</i> ^{<i>A</i>})	56 (1939/3473)
<i>v tu</i> (53 <i>e</i> ^{<i>O</i>}) × <i>bw</i>	<i>tu</i> (54 <i>f</i> ^{<i>O</i>})	56 (823/1461)
<i>bw tu</i> × <i>bw tu</i>	<i>bw tu</i>	64 (898/1403)
<i>tu</i> (53 <i>e</i> ^{<i>A</i>}) <i>st</i> × <i>bw</i>	<i>bw tu</i> (54 <i>f</i> ^{<i>A</i>})	63 (2011/3214)
<i>v tu</i> (53 <i>e</i> ^{<i>O</i>}) × <i>bw</i>	<i>bw tu</i> (54 <i>f</i> ^{<i>O</i>})	66 (456/691)
<i>tu</i> (53 <i>d</i>) × <i>v</i>	<i>v tu</i> (53 <i>e</i> ^{<i>O</i>})	82 (1066/1299)
<i>tu</i> (53 <i>d</i>) × <i>v bw</i>	<i>v tu</i> (53 <i>e</i> ^{<i>D</i>})	85 (273/321)
<i>v tu</i> (53 <i>e</i> ^{<i>O</i>}) × <i>bw</i>	<i>v tu</i> (54 <i>f</i> ^{<i>O</i>})	76 (233/307)
<i>v tu</i> (53 <i>e</i> ^{<i>O</i>}) × <i>v bw</i>	<i>v tu</i> (54 <i>f</i> ^{<i>D</i>})	83 (256/307)
<i>tu</i> (53 <i>d</i>) × <i>cn bw</i>	<i>cn tu</i> (53 <i>e</i> ^{<i>B</i>})	91 (1007/1111)
<i>v tu</i> (53 <i>e</i> ^{<i>O</i>}) × <i>bw</i>	<i>v bw tu</i> (54 <i>f</i> ^{<i>O</i>})	92 (581/631)
<i>v tu</i> (53 <i>e</i> ^{<i>O</i>}) × <i>v bw</i>	<i>v bw tu</i> (54 <i>f</i> ^{<i>D</i>})	89 (260/291)
<i>tu</i> (53 <i>d</i>) × <i>st</i>	<i>tu</i> (53 <i>e</i> ^{<i>A</i>}) <i>st</i>	98 (7564/7712)
<i>tu</i> (53 <i>d</i>) × <i>bw st</i>	<i>tu</i> (53 <i>e</i> ^{<i>B</i>}) <i>st</i>	98 (537/548)
<i>tu</i> (53 <i>e</i> ^{<i>A</i>}) <i>st</i> × <i>bw</i>	<i>tu</i> (54 <i>f</i> ^{<i>A</i>}) <i>st</i>	97 (3484/3574)
<i>tu</i> (53 <i>e</i> ^{<i>A</i>}) <i>st</i> × <i>bw st</i>	<i>tu</i> (54 <i>f</i> ^{<i>B</i>}) <i>st</i>	96 (5340/5587)
<i>tu</i> (53 <i>e</i> ^{<i>A</i>}) <i>st</i> × <i>bw</i>	<i>bw tu</i> (54 <i>f</i> ^{<i>A</i>}) <i>st</i>	98 (1627/1672)
<i>tu</i> (53 <i>e</i> ^{<i>A</i>}) <i>st</i> × <i>bw st</i>	<i>bw tu</i> (54 <i>f</i> ^{<i>B</i>}) <i>st</i>	98 (1951/1997)

the body cavity. The same abnormalities were also found in the *v bw tu*, *bw tu st* strains. Since these abnormalities were only found in the strains which involve the *bw* and the other eye-colour genes, they were classified as non-tumor group in this experiment. Furthermore the matings of *tu* (53*e*^{*A*}) *st* flies with *bw* and *bw st* flies, and the mating of *v tu* (53*e*^{*O*}) flies with *bw* and *v bw* flies were made. From the offspring of these matings, *tu* (54*f*^{*A*}), *bw tu* (54*f*^{*A*}), *tu* (54*f*^{*A*}) *st*, *tu* (54*f*^{*B*}) *st*, *bw tu*

Fig. 1.

(54*f*^{*A*}) *st*, *bw tu* (54*f*^{*B*}) *st*, *tu* (54*f*^{*O*}), *bw tu* (54*f*^{*O*}), *v tu* (54*f*^{*O*}), *v tu*(54*f*^{*D*}), *v bw tu* (54*f*^{*O*}), and *v bw tu* (54*f*^{*D*}) strains were newly established by the same method mentioned above. The incidence of tumor in each strain was investigated. The results were summarized in Table 1 and graphically shown in Figure 1.

Hartung and Hartnett (1951) reported that the tumor incidence greatly increased on cornmeal agar, and also on the following media:

banana agar, tomato paste, molasses agar, and certain so-called "synthetic media", to which large amounts of tryptophane had been respectively added. From the facts that cornmeal contains much indol-acetic acid or auxin, he suggested that there may be a certain correlation between the stimulative substances which stimulate plant growth and the action of inducing animal tumor. On the other hand, Herskowitz and Burdett (1951) reported that insufficient nutrition during larval development causes a reduction of the incidence of tumor. From the writer's data, it is clear that incidence of tumor increases when the tumor gene is accompanied by the eye-colour gene. An order of the eye-colour genes obtained from Table 1, namely +, *bw*, *v*, *cn*, and *st*, is almost in accord with a distribution of eye-colour mutant which is shown in the schematic representation of the possible interactions in the production of the eye-pigments of *Drosophila* reported by Nolte (1952). From this it is assumed that the incidence of tumor has a certain close connection with the tryptophane metabolic system.

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Summary

1. From the original tumor strain, or *bw tu*, a strain having only the tumor gene, or *tu* (*53d*), was isolated. Various eye-colour strains were mated with *tu* (*53d*). From the offspring of these matings the following tumor strains were newly established: *bw tu*, *v tu*, *cn tu*, *v bw tu*, *tu st*, and *bw tu st*. The incidence of tumor in each strain was studied.

2. The results show that the incidence of tumor increases when the tumor gene is accompanied by the eye-colour gene. According to the rate of increase in the incidence of tumor, newly established strains are arranged in a line as follows: *tu*, *bw tu*, *v tu*, *cn tu*, *v bw tu*, *tu st*, and *bw tu st*.

3. Eye-colours of these eye-colour mutants are considered to be regulated by the tryptophane metabolism in the development of *Drosophila*. It is, therefore, assumed that the incidence of tumor has a certain close connection with the tryptophane metabolic system.

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