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THE GENETIC CONTROL OF DEVELOPMENTAL COMPETENCE AND MORPHOGENETIC TISSUE INTERACTIONS IN GENETIC MOSAICS*

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With 5 figures

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Contents

I. Introduction.
II. Materials and methods.
III. The frequency of the interalar bristle in flies containing Theta and the influence of Minute-\nIV. Genetic mosaics.
  1. Not-Minute Theta tissue.
  2. Not-Minute not-Theta tissue.
  3. The position of the interalar bristle on mosaic thoraxes.
  4. The differentiation of duplicate or supernumerary noninteralar bristles on mosaic thoraxes.
V. Discussion.
  1. The action of Minute Theta in inhibiting the formation of the interalar bristle and the interactions between Minute and not-Minute tissues.
  2. The interactions between Minute Theta and not-Minute not-Theta tissues.
VI. Summary.

References.

I. Introduction

The differentiation of the macrochaetae on the surface of wild type Drosophila melanogaster occurs according to a specific pattern of distribution and individual size. In the early pupa the imaginal hypodermis of the head and thorax consists of numerous small cells of equal appearance. Then, at a few characteristic locations, groups of enlarged cells can be distinguished which differentiate into bristle organs. Combining the results of workers on the origin of the bristle organ in several different

* Dedicated to KARL HENKE on the occasion of his sixtieth birthday.

The basic data were collected a considerable time ago but have only now become intelligible. I wish to acknowledge earlier helpful, critical comments by Dr. A. H. STURTEVANT on an unpublished manuscript dealing with these experiments and of Dr. ALOHA HANNAH-ALAVA on the present report. The analysis was completed during tenure of a John Simon Guggenheim Memorial Fellowship while I enjoyed the hospitality of Professor C. W. WADDINGTON at the Institute of Animal Genetics, Edinburgh, and of Professor A. KÜHN at the Max-Planck-Institut für Biologie, Tübingen.
insects, it appears that such an organ consists of four cells which are derived from a single cell by two mitoses. These four cells form, respectively, the bristle proper, its socket, a sensory nerve cell and its sheath (Lees and Waddington 1942; Schwenk 1947; Henke 1951; Wigglesworth 1953). Obviously, the characteristic locations in which these differentiations are initiated must have properties which distinguish them from their surroundings and from one another. In other words, a "prepattern" must anticipate and condition the appearance of the observed pattern of bristles.

The bristle pattern is subject to genetic control. Some genotypes decrease the number of places in which macrochaetae are formed, others increase them. Moreover, changes in the position of specific bristles may accompany the changes in their total number. There are at least two methods by means of which different genes may determine different bristle patterns. The genes may either affect differently the paths of development prior to the appearance of the prepattern and thus lead to different prepatterns in different genotypes, or the differential effect of different genes may not set in until after the establishment of one and the same prepattern. In the first alternative different bristle patterns would originate in consequence of different prepatterns; in the second, the bristle pattern would depend on the genetically controlled competence of the hypodermal cells to respond or not to respond to the singularities of the constant prepattern.

The results of previous studies involving male vs. female genotypes as expressed in presence or absence of a sex-comb, and normal vs. achaete genotypes as expressed in presence or absence of certain thorax bristles have been interpreted in terms of constant (nonvarying) prepatterns but genetically controlled varying competence of cells (Stern and Hannah 1950; Stern 1954a, b). Other data by Hannah (reported in Stern 1954b) suggest that genes for the formation of extra sex-combs and for the development of legs in place of antennae may act by introducing new prepatterns into the embryonic anlagen of appendages to which tissues with unchanged competence may then respond by differentiations at unusual locations.

The present report continues the analysis of the genetic control of developmental patterns. Specifically it is concerned with the determination of a particular "extra" bristle not found on normal flies of this species. Two different mutant genetic conditions were studied, one which leads to the formation of this bristle, and another which, superimposed on the first, leads to suppression of this specific differentiation. The results show that different genotypes endow the hypodermal cells with different competence. In addition, the data demonstrate morphogenetic interrelations between genetically different tissues in mosaic individuals.