TERMINAL DIFFERENTIATION OF THE ADIPOSE TISSUE
IN RELATION TO VITELLOGENESIS IN THE CRICKET

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ABSTRACT. Changes in fat body cell ultrastructure were followed in the female cricket during the first days of adult life (at the onset of vitellogenesis). Cytological evidence was obtained for the depletion of stored lipids, and correlative accumulation of glycogen, in connection with lipidic vitellogenesis. The production of glycoproteic yolk precursors is achieved by the adipose cells following a process of terminal differentiation which transforms into secretory cells. The whole process occurs within the four first days of adult life.

I. INTRODUCTION

Several authors have reported that the fat body is the center of intermediary metabolism in insects (Cook and Eddington [4]; Walker and Bailey [32]). Furthermore, biochemical studies have shown that at the time of sexual maturity, modifications of both carbohydrate and lipid metabolism occur in the female fat body, which strongly suggest that this tissue may play an important part in the elaboration of the female genital products by furnishing the yolk precursors to be stored in the oocytes (review in Gilbert [11]; Dutkowski and Ziaska [5]). In fact, different works have established that the insect adipose tissue, since it is a storage organ, provides lipidic precursors for vitellogenesis (Chino and Gilbert [3]; Martin [18, 19]; moreover, it produces the so-called vitellogenins or female proteins which are finally stored in the oocytes (Brookes [2]; Pan et al. [22]; Pemrick and Butz [24]; and review in Engelmann [6]).

The evolution of the fat body ultrastructure in adult insects has not been extensively studied. Consequently, little is known about the cytological events leading to the synthesis and secretion of the yolk precursors. In connection with an extensive study of vitellogenesis in the cricket (Favard-Séréno [9, 10]) we have undertaken the electron microscopic study of the periovarian fat body in the same insect, in order to analyse the transformations which take place in this tissue after the imaginal moult which permit it to provide for vitellogenesis requirements.

II. MATERIAL AND METHODS

For this study adult, female crickets (Gryllus bimaculatus, Orthoptera) were used within two hours to six days after emergence.

1. Breeding Conditions

The animals were reared at 30°C in an incubator and fed ad libitum a diet made of dry and wet
foods (ground rat biscuits, wheat flour, carrot, green salad and water). As mating may influence egg maturation during the first pre-oviposition period (Pratt and Davey [25]), the newly moulted adult females were always kept with males. In these conditions the females begin to lay eggs seven to eight days after adult ecdysis.

2. Electron Microscopy

Each female was anesthetized with carbon dioxide and small pieces of its periovarian fat body were carefully dissected and fixed for an hour at room temperature in a 2% solution of osmium tetroxide either in veronal-acetate buffer at pH 7.3 (Palade [21]) or in 0.1 M phosphate buffer at the same pH. All samples after dehydration were embedded in araldite (Glauert and Glauert [13]). Thin sections were obtained using a Porter-Blum ultramicrotome equipped with glass knives and collected on uncoated copper grids.

The structures were stained with lead citrate according to Venable and Coggeshall [31] and finally observed in a Philips EM 300 using a voltage of 80 kV.

3. Electron Microscopical Cytochemistry

The periodic acid-thiocarbohydrazide (TCH)-silver proteinate method for the demonstration of polysaccharidic material perfected by Thiéry [30] was applied to unmounted thin sections. Control preparations were made to check the specificity of the results.

III. RESULTS AND DISCUSSION

The periovaran fat body of the cricket is a rather loose tissue, constituted of many wide and thin lobules with interconnecting strands, which surround the gonads. During the first days following adult ecdysis, this tissue undergoes a series of transformations. At first restricted to the importance and nature of the material stored in the tissue, these modifications subsequently affect the organization and functioning of the fat body cells, and can be considered a process of terminal differentiation comparable to that which has been described by Kafatos [16].

1. Modifications of the Stored Material

Immediately after the imaginal moult, a considerable portion of the fat body cell cytoplasm is devoted to the storage of lipid, and, by two hours after adult ecdysis, the adipose tissue exhibits the characteristic ultrastructural features of a storage tissue. The adipose cells are nearly filled with fat droplets. In spite of the fact that osmic fixation has been used, the cytoplasmic droplets, most probably constituted of lipids, appear as empty areas rather than filled by osmiophilic material. Since osmium tetroxide reacts with the double bonds of unsaturated lipids (Pearse [23]), this observation can be related to the fact that the lipid droplets consist mainly of saturated lipids. However, we cannot rule out that this aspect is the result of an excessive time of fixation of unsaturated lipids: the oxidation being prolonged, the polymeric osmic acid esters of glycol might be damaged, and further washed away. In fact, chromatographic analysis of the total lipids in two insects belonging to the Gryllus genus, showing that they contain mainly unsaturated fatty acids, is consistent with this view (Fast [8]; Hutchins and Martin [15]). Moreover, in our material a well contrasted outline marks the lipidprotein interface which is the limit of each fat droplet, as has been seen in the mammal fat and liver (Napolitano [20]; Stein and Stein [29]).

In between the lipidic inclusions, many mitochondria, cytolysomes and few profiles of rough endoplasmic reticulum (RER) are visible (Fig. 1); Golgi saccules are scarce or difficult to detect. No intercellular junctions seem to be present in this tissue, although the space between the individ-