Chapter 7

A STUDY OF THE LIPASE ACTIVITY IN THE FAT BODY OF POICELOCERA PICTA DURING OOCYTE DEVELOPMENT

The effect of fḁod on facundity has been studied in diverse insects with reference to both larval and imaginal feeding. The food material that go into the formation of eggs may be larval or imaginal depending on the time of maturity of the eggs. The eggs of the bean weevil (Bruchus), for example, are mature on the emergence of the imago and oviposition begins on the first day of life while in the female blow flies (*Lucilia*, *Calliphora*) the eggs do not mature for a week or more after emergence. In the latter case the food reserve is drawn from the fat body (Brues, 1946). The relation between the maturity of the ovaries and the condition of the fat body is well illustrated in some Lepidoptera (Eidman, 1929, 1931). The fat body of the young imago is massive in butterflies and moths with a long imaginal life in which very few fully developed eggs are found at the time of emergence. In most heterocera on the other hand where there is an increase of ripe eggs in the imago, it is small, while in a few Bombycidae Lamantridae etc., where the eggs are fully ripe and no more developed during adult life, it is almost used up. Again in certain blood sucking insects it is known that for the maturity of the eggs, blood meal is essential. But certain autogenous races of mosquitoes are capable of production of viable eggs without the blood meal. Though in such cases it is reported (Kocking, 1954) that histological observations of gravid females revealed autolysis of the flight muscles and the resulting degradation products are incorporated into the egg, it has not been conclusively proved. In the autogenous strain of Culex pipiens however, histchemical evidence has been offered to the effect that the protein accumulated in the fat body is mobilized during ovarian development (Bettini, 1947).

Though in most insects, proteins are essential for egg production, fat also may be of no less importance since fatty yolk forms a major part of the egg. Moreover, it is often seen that the fat body is more developed in females than in males.

The grasshopper, Poicelocera picta is a seasonal insect and lays a large number of eggs in batches. It feeds voraciously on Calotropis leaves even during adult life. The development of the fat body is more in females than in males. Since fatty yolk deposition in the oocyte will require a large scale mobilization of lipid material or its precursor substances and since the fat body is known to play a major role under such conditions it was thought desirable to follow the changes in the general condition and lipase activity of the fat body during ovarian development.

MATERIALS AND METHODS

Adult female Poicelocera picta were used. Lipase activity estimated by the method described earlier, using a 2.5% fat body homogenate. The age of the animals were assessed by their oocyte growth. Poicelocera picta has two panoistic ovaries each consisting of about 95 ovarioles arranged in two rows and opening into the paired oviducts. The terminal oocyte in each ovariole develops more rapidly and the subterminal oocyte develops to full size only after the terminal oocyte had been laid. Ovaries in saline were examined under a binoccular microscope and the length of the terminal oocyte was determined by means of Vernier callippers. Soon after emergence of the adult the terminal oocyte measured about 1.0 mm while its length varied from 7.7 to 9.0 mm in the fully developed ovarioles. The terminal oocytes in any individuals observed developed at the same rate and when their development was complete the subterminal oocytes measured about 1.2 mm.

The fat body of the adult occurs as anastomosing strands of tissue that spreads in the form of thin sheets one or two layers thick. The net like arrangement becomes obscure when it comes to contain large amounts of fat and the fat cells get distended. On the basis of these changes viz., thickness of the strands and distension of the fat cells , the fat body was classified arbitrarily as 1+ (depleted, thin strands with large mesh spaces), 2+ (normal), 3+ (hypertrophied, with thick strands and less of mesh spaces and cells distended) and 4+

(hypertrophied and cells very much distended with a puffy appearance). The fat body in the 4+ condition exerted sufficient pressure to distend the abdomen of the animal.

RESULTS

The relation between the terminal oocyte length condition of the fat body and its lipase activity is shown in Table 1. Soon after adult moult, the fat body was of 1+ type in about 78% of the individuals observed and the rest were of 2+ type. Soon after the laying of the eggs in almost all the individuals observed, the fat body was of 1+ type. In insects with terminal oocyte length from 2.1 to 3.5, the prevalent type of fat body was of 2+ type while in those with the terminal oocyte length from 3.5 to 7.7 it was of the 3+ type. The 4+ type of fat body occured in some whose average terminal oocyte length was 4.9 mm.(fig 1,2&3)

The activity of the fat body lipase showed a great change during ovarian development. It increased three fold when the terminal oocyte length reached about 4.9 mm and was at the minimum when the first series of eggs were laid (fig.4).

DISCUSSION

From the results presented in Table 1, it is clear that soon after the adult moult the fat body was depleted of its reserves and during the course of adult life, the fat body

TABLE 1

No. of days after adult moult	Length of terminal oocyte (mm)	Lipase activity $\mu l/CO_2$/mg.protein/30 minutes.	Condition of the fat body	
			*	% individuals observed
½-1	0.7 ± 0.25	125.5 ± 13.0	1+ 2+	78.0 22.0
4	1.2 ± 0.2	132.5 ± 11.5	1+ 2+	70.0 30.0
8	2.1 ± 0.25	180.0 ± 7.5	1+ 2+	60.0 40.0
15	3.5 ± 0.5	189.0 ± 11.0	2+ 3+	38.0 62.0
22	4.9 ± 0.3	411.0 ± 9.0	3+ 4+	82.0 18.0
29	6.8 ± 0.3	387.0 ± 13.5	3+ 2+	93.0 7.0
36	7.7 ± 0.25	350.0 ± 18.0	3+ 2+	40.0 60.0
35-40 (about to oviposite)	8.5 ± 0.5	291.0 ± 7.0	3+ 2+	6.0 94.0
1 (after eggs laid)	0.9 ± 0.3 (second series)	121.0 ± 18.0	1+	100.0

* 1+ Depleted (fig.1)
2+ Normal (fig.2)
3+ Hypertrophied (fig.3)
4+ Hypertrophied

FIG.1. 100 μ

Photomicrograph showing 1+ type of fat body of Poicelocera picta. Terminal oocyte length = 1,2 mm.

100 μ

FIG. 2

Photomicrograph showing the fat body of 2+ type, in Poicelocera picta. Terminal oocyte length = 3.5 mm.

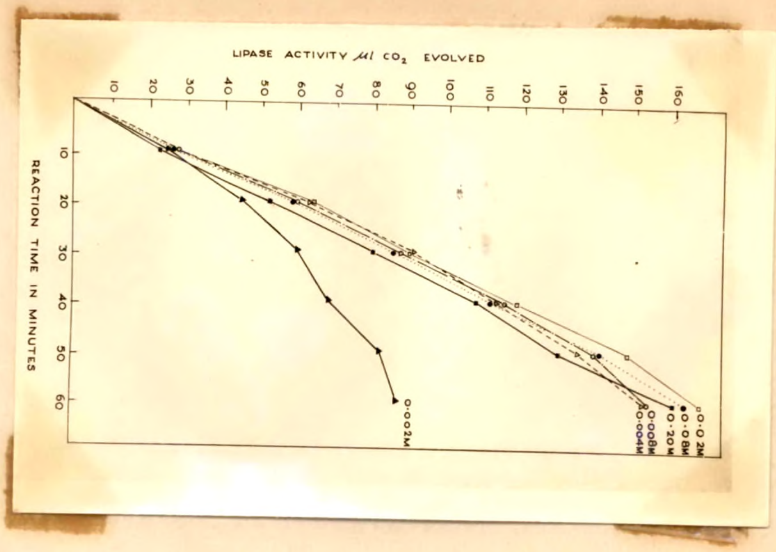

FIG. 3 100μ

Photomicrograph showing 3+ type of fat body of Poicelocera picta. Length of terminal oocyte = 6.2 mm.

FIG. 4

Graph showing lipase activity of the fat body of Poicelocera picta during the period of ovarian development.

built up its food reserve required for various purposes. The metabolic changes taking place in the imaginal fat body in anormal individuals may well be related to the growth of the reproductive system. The depletion of the fat store from the fat body may result mainly due to the yolk deposition in the oocyte, though it may also occur by a process independent of ovarian development. Although yolk deposition may not be the sole cause of reduction of fat store, it may operate to hasten this reduction.

Among the vertebrate animals it is known that oocyte development brings about changes in the composition of the blood and liver (Clavert, 1953). For example total blood proteins rise more than 50% in the fowl and more than double in the pigeon. Lipids and total phosphorus rise about threefold in the fowl blood during the oocyte development. The liver cells in the pigeon exibit a certain degree of hypertrophy and the weight of the liver increases by about 60% at the beginning of the laying period. At the same time an increase in lipid and phospholipid contents is also observed. This is followed by a sudden drop in the contents of the liver at the moment when the rapid growth of the oocyte begins.

Insects eggs are very rich in yolk or deutoplasm, a food reserve with which the developing embryo is equipped at the beginning of its life. It is accumulated in the oocyte during the later phase of oogenesis. The yolk particles are formed in the oocyte from nutrient substances taken up from the surroundings. The growing oocyte is either directly bathed in the fluid in the body cavity or enveloped by follicle or nurse cells which play a part in the transfer of the nutrient substances to the egg cell.

To form the fatty yolk, the reserve substances should come from the fat body. The developing ovariole is known to synthesize lipids in different phases. According to Nath et al (1958) it appears that the fatty yolk granules are originally rich in phospholipids whereas, neutral lipids begin to preponderate at later stages, so that this fatty yolk of full grown oocytes consists nearly or entirely of neutral fats and fatty acids

A possible relation between the condition of the fat body and its lipase activity is obvious. In the earlier part of adult life, metabolic changes occur in the fat body tissue which permit fat to be stored and synthesized considerably more rapidly than stored fat could be utilized. In the later part however, the conditions change so that stored fat for a time is used at rates greatly exceeding the current rate of synthesis.

The fatty yolk deposition starts in the oocyte of Poicelocera picta when it is about medium size (3-4 mm.) and continues till it reaches maturity. Nath et al (1958) have found that in <u>Periplaneta americana</u> the oocyte enters the phase of triglyceride (fatty yolk) synthesis when it is of mediam size. The high activity of lipase observed in the fat body tissue when the oocyte length varied from 3.5 to 7.7 mm, may well be related to the phase of triglyceride synthesis in the oocyte and its fast deposition as fatty yolk.

The high lipase activity and the rapid depletion of metabolites in the fat body observed in the later period of oocyte development (oocyte fully mature or soon after the laying of eggs) may be due to reasons altogether different. From the time of laying eggs till egg laying is complete, for a period of over 24 hours, the animal does not ingest any food material. The abdomen is extended by about 4-6 inches for ovipositing the eggs deep in the soil and the abdominal muscles (intersegmental) are in constant movement. These acts of oviposition may call upon the insects to expend a large amount of energy, which, ofcourse, has to be derived from the reserves in the fat body during this time.

The overall controlling mechanism of oocyte growth is known to be endocrine in nature (Wigglesworth, 1954) and whatever enzymatic changes observed may well be dependent on it. In conclusion it may be said that the growth of the oocyte which is under the endocrine control, brings about changes in the metabolism of the fat body which results in the synthesis of substances that go to form part of the egg yolk. These substances may be carried by the blood to the follicle cells and thence to the oocyte where they are laid down as definitive yolk.