EXPERIMENTAL DATA AND OBSERVATIONS
A. GENERAL OBSERVATIONS ON THE ADIPOSE TISSUE OF P. PICTUS

When the insect is dissected, the adipose tissue or the fat body is seen as one of the most conspicuous organs in the body, particularly in the nymphs. It extends throughout the abdominal and thoracic cavities. In the nymphs of all stages and adults (both female and male) of about 15 days, the fat body is deep yellow in colour. This colour disappears as the insect grows in age. During laying it is still light yellow in colour but in laid females and very old males the colour is almost white.

The adipose tissue can be divided into a peripheral part and a central part. The former is attached to the overlying epidermis while the latter exists as a loose mesh-work of anastomosing sheets surrounding the alimentary canal and gonads. These two portions of the adipose tissue are continuous at many points and are intertwined with genital and Malpighian tubules as also observed by Coupland (1957) in S. gregaria. The lobulated sheets of the adipose tissue are flattened so as to expose a maximum area to the blood which is in contact everywhere with the fat body. Thus the organ is well suited for the rapid exchange of metabolites.
with the blood, while oxidative processes could be facilitated by the finely branched tracheoles which penetrate to all parts of the tissue (Munson in Roeder, 1953).

Seen under the light microscope or the phase contrast, the adipose tissue of *P. pictus* shows numerous configurations of fatty globules, each consisting of a big globule in the centre and many smaller globules around it. This type of configuration has also been described by Nair and George (1964) in the larval fat body of *Anthrenus vorax* and recently by Odhiambo (1967) in the fat body of *Schistocerca*. According to Nair and George, these configurations behave as units during the dissociation of the fat body in the prepupal stage; furthermore, while central globules stain for neutral fats, the peripheral globules stain for acidic lipids.
B. CYTOLOGICAL OBSERVATIONS ON THE ADIPOSE TISSUE OF

P. PICTUS

The adipose cells or the trophocytes are almost rectangular in shape arranged in a linear fashion and containing intensely chromatic nuclei. Being an Orthopteran insect the cell boundary is maintained to some extent in the adult (Buys, 1922), though at some stages they are not clearly marked due to the abundance of stored reserves. A clear basement membrane is also noticed. Each nucleus contains 1 or more nucleoli which often divide and migrate into the cytoplasm. The globular configuration is seen as such in the fixed tissue. Between the central globules there are cytoplasmic strands and the peripheral globules are formed on these strands. In these strands dot-like mitochondria are noticed.

The trophocytes along with their nuclei and nucleoli, increase in size during the post embryonic periods of feeding becoming filled with reserves of fat or lipid, glycogen and protein. They change size during laying or by ovariectomy, castration or implantation of ovary or testis. All such changes have been observed as described in the following paragraphs:

i) Nymphs

In the newly moulted 5th stage nymph, the cells are
very small and narrow, consequently their number is quite large. The cell boundary is not clearly visible. However, the average diameter of the cell at this stage is 21 μ as shown in table I. Average size of nucleus is 14 μ, while that of the nucleolus is 1 μ.

At 3 days of age in the 5th stage nymphs, the cell size as well as the size of nuclei and nucleoli increases, but the cell size is comparatively slightly bigger in females than in males. In female 5th stage nymphs of 3 days, average diameter of the cell is about 39.5 μ, while the nuclear size and the size of the nucleolus are on an average 14.5 μ and 3 μ respectively. The average diameter of cells, nuclei and nucleoli in male nymphs is 39.6 μ, 16.4 μ and 3.1 μ respectively.

After 10 days of age in 5th stage nymphs, the cells become broader and they are slightly larger than those of the above stages. The cells are similar in male and female nymphs as far as the conditions of central and peripheral globules are concerned but are slightly bigger in male nymphs. Some nucleoli are seen budding and migrating to the cytoplasm in the female nymphs. The size of nuclei and nucleoli is given in table I.

In a 5th stage nymph, whether male or female, just
before moulting into the 6th stage i.e., 18 - 22 days, the cell size along with its nucleus increases but the nucleoli become smaller.

In a newly moulted 6th stage nymph, the size of the cells, on an average, is quite smaller than that before moulting. So is the case with the nuclei but the nucleoli are similar in size. Of course, the size is bigger than that of the newly emerged stage of the 5th stage nymph.

At 3 days of age, a 6th stage nymph is a dull stage. The cell boundary is not clearly visible though it can be made out that the cells have very slightly increased in size. The cytoplasmic area is much elaborated and the central globules are less in number. The nuclei have not changed their size from that in the newly emerged stage though the nucleoli are very slightly bigger. The details are shown in table I.

After 10 days in the female 6th stage nymph, the cell size increases a lot and is also slightly bigger than in the male nymph of the same age. The nuclei are, however, slightly smaller than those of the previous stages in nymphs of both the sexes.

During moulting into the adult stage, the size of adipose cells and their nuclei increases and the conditions
resemble those of the 5th stage nymphs before moulting to 6th stage (Table I; Fig. 1).

Table I

Changes in average diameter of Adipose Cells, Nuclei and Nucleoli in 5th and 6th stage nymphs* of P. pictus

<table>
<thead>
<tr>
<th>Age of Nymphs</th>
<th>Average size of cells in μ</th>
<th>Average size of nuclei in μ</th>
<th>Average size of nucleoli in μ</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th Stage Nymphs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newly moulted</td>
<td>20.80</td>
<td>13.70</td>
<td>1.04</td>
</tr>
<tr>
<td>3 days</td>
<td>39.52</td>
<td>14.56</td>
<td>3.30</td>
</tr>
<tr>
<td>10 days</td>
<td>45.76</td>
<td>20.32</td>
<td>5.20</td>
</tr>
<tr>
<td>Before moulting to 6th stage</td>
<td>70.72</td>
<td>24.96</td>
<td>2.08</td>
</tr>
<tr>
<td>6th Stage Nymphs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newly moulted</td>
<td>40.77</td>
<td>11.44</td>
<td>2.08</td>
</tr>
<tr>
<td>3 days</td>
<td>41.60</td>
<td>11.44</td>
<td>2.70</td>
</tr>
<tr>
<td>10 days</td>
<td>64.48</td>
<td>11.40</td>
<td>2.75</td>
</tr>
<tr>
<td>Before moulting to adult</td>
<td>75.92</td>
<td>12.06</td>
<td>2.08</td>
</tr>
</tbody>
</table>

* The values tabulated here are for the female nymphs as there is a negligible difference in these from the male nymphs.
ii) Image

**Females**

In a newly emerged female, the size of adipose cells and their nuclei is smaller but they are more in number than those of the nymphs.

At 3 days, cells and nuclei increase but there is a depletion in the nucleolus and it appears to be smaller, this size of the nucleolus remaining constant up to about 15 days.

The cells of the adipose tissue gradually increase in size up to 25 days and are smaller during egg laying. The changes in the nuclear and nucleolar size are shown in table II.

**Ovariectomised females** (Table II; Fig. 2A, B, C)

In ovariectomised females of all stages i.e., after 3 - 30 days of ovariectomy, the cytoplasmic area in the adipose or fat-cells is very much elaborated and it has big or small central globules. The average diameter of the cells is bigger or almost comparable to that of the normal females in most of the cases.

The nuclei increase in size in the ovariectomised females at 3 days as compared to those of a normal female of
of 3 days. 7 - 15 days after ovariectomy, the sizes of nuclei and nucleoli are almost similar to those of the normal females.

At 25 - 30 days of ovariectomy, the nuclei as well as the nucleoli increase in size and this is bigger than that of the normal females of the same age. In some ovariectomised females, particularly at 15 - 25 days after their ovariectomy, there are some nucleoli which get very much enlarged and vacuolated (Figs. 23, 24). But extrusions are not visible from such nucleoli.

**Females with testes implanted**

By implanting testes of a 2 day old male in a newly hatched female and observing after 5 days, it is seen that the cells as well as the nuclei are smaller than those of both the 5 day old female and 7 day old male. However, the nucleoli are larger than those in both the above stages. The cytoplasmic area is more than in a normal copulated female of 5 days and a male of 7 days.

By implanting testes of a 2 day old male in a female of 10 days and observing after 10 days, it is seen that the sizes of the cell, nucleus and nucleolus have increased a lot in comparison to those of a normal female of 10 days, of an
ovariectomised female of 10 days or even of a normal male of 12 - 15 days. However, the sizes of the cells and the nucleoli are comparable to those of a 20 day old normal (copulated) female.

**Males**

The changes in the size of cells etc. in male nymphs have been described earlier along with those of the female nymphs.

In a newly emerged adult male, the cells and nuclei are quite larger than in the female of the same stage. But nucleoli are smaller in size than in the female of the same age, whether copulated or virgin, as also in the nymphs of 6th stage.

In a 3 day old male, the size of the cell appears to be almost the same as that in the newly emerged male though it is still larger than that of the female of the same age. However, the nuclei and nucleoli increase in comparison to those of the newly emerged stage. The nuclei are bigger in size as compared to those of the females of 3 days.

After 7 days, the size of cell increases than that of a newly emerged and 3 day old male as well as of the female of 7 days. The nuclei are also bigger than those of the 3
day old male. However, the nuclei are bigger than and the nucleoli are almost of the same size as those of the normal copulated females of 7 days.

At 15 days, however, the cells as well as the nuclei appear to be smaller in size and remain as such for the rest of the life.

Castrated Males (Table III; Fig. 2A, B, C)

In a male, 3 days after castration, the cells are almost of the similar size or even smaller than those of a normal male of the same age i.e., 3 days. Some nuclei, however, get very much enlarged just as in some ovariectomised females and they contain quite big and vacuolated nucleoli.

The nucleoli, at every stage of castrated males are bigger in size in comparison to those of both the normal males and ovariectomised females of the same age.

As in the case of the normal male of 3 days, the cytoplasm has many central globules.

After 7 days of castration, the cells increase in size in comparison to those of the 3 day old castrated male, as also a normal male of 7 days. Similarly, the nuclei and nucleoli increase in size in comparison to those in the above mentioned stages.
After 15 - 19 days of castration, the size of the cell along with its nucleus increase enormously in comparison to those of the castrated males of 3 - 7 days. Thus the cells, nuclei and nucleoli are also larger than those of the normal males and ovariectomised females of the same age i.e., 15 - 19 days. The cells differ from those of the ovariectomised females in that the former have more central globules as compared to the latter. Nucleoli in some cells are very big in size and vacuolated.

**Males with ovary implanted**

By implanting ovary of a 3 day old copulated female in a mature male (7 days and older) after its castration and observing after 10 days, it is seen that the size of the cell decreases in comparison to those of both the castrated male and the normal female of 14 - 15 days. The nucleus is also smaller than that of a castrated male. However, it has definitely increased if compared to that of a 14 - 15 day old female. Nucleolus is also comparable in size to that of a 14 - 15 day old female.

By implanting ovary of a 15 day old copulated female in a mature male after its castration and observing after 10 days, it is seen that the cell size has decreased in comparison to that of a castrated male or a normal female of 25 days.
However, the size of nucleolus increases a lot and the nucleus is comparable to that of a castrated male.

In nymphs and sometimes in early stages of adults, branches of nuclei are seen penetrating the cytoplasm. But in later stages of adults, though nuclei are slightly convoluted, no branches are visible.

Nature of the globules in the cells of adipose tissue

The cytoplasm of the adipose or fat cells has two types of globules surrounding the nucleus as stated earlier—the bigger central and smaller peripheral globules. In osmium fixed ethyl gallate stained sections of fat body, it is clearly seen that both these types of globules are covered by delicate membranes. The arrays of the membrane surrounding the peripheral globules are continuous with the cytoplasmic area which is common with thin strands of cytoplasm. The cytoplasm has dot-like (granular) mitochondria. This has also been noticed in the fat cells of Schistocerca by Odhiambo (1967). The cytoplasmic strands become more prominent when the central globules become smaller in size and disappear. The bigger central globules open into one another, the membranes being broken at the point of union. The peripheral globules are also in relation to one another with the help of very thin delicate strands. It could not be observed whether the
central globules are connected to the peripheral globules but it was very clearly visible that the smaller central globules at the periphery of the cells have a crowding of peripheral globules round them whereas the bigger central globules in the centre of the cells are surrounded only by a few peripheral globules which are also smaller in size. Even in some cells a big central globule in the central parts has no peripheral globules.

In females during laying the globules almost disappear and only a few small central globules can be observed. In nymphs, the globules are smaller in size and larger in number than in the adults. Males have smaller central globules than females.

At all stages, the central globules stain for lipids while the peripheral globular stain for RNA, glycogen, proteins and some phospholipids.

**Other cytoplasmic inclusions**

- **Mitochondria**: By Osmium/ethyl gallate stained sections of fat tissue, mitochondria are observed at the periphery of the cells as numerous dot-like structures. These are seen approaching the peripheral globules which are also prominent at the outer edge of the cells.
An accurate count of these mitochondria could not be made due to overlying globules. However, it has been noted that their number changes only slightly during successive stages of development. Usually, dot-like mitochondria are observed crowded at the periphery of the cells as also in the cytoplasmic strands. These mitochondria appear most when the central globules are smaller but in a packed cell, the cytoplasmic area is quite obliterated, so mitochondria are noted sparsely. However, when peripheral globules are clearly visible, the mitochondria are also seen, but in both depleted and filled cells, mitochondria are plenty on the sides of the cells which face the haemolymph.

In the nymphs, there is an abundance of mitochondria. A mitochondrial transport has been observed in the 6th stage nymphs of both the sexes.

In adult females, the mitochondria are very abundant near the peripheral globules, in the central as well as in the peripheral parts of the cells. In females, mitochondria are abundant up to 25 days of age, being much elaborated during 15 - 20 days.

During 25 - 30 days when cells are packed with lipids, mitochondria decrease in number and during egg laying they are only a few. However, after egg laying, the cells are rich in it.
In adult males, on the other hand, mitochondria are less in number as compared to those in the females of the same age.

In ovariectomised females and castrated males, mitochondria are found to be abundant.

**Endoplasmic reticulum**

In spite of the presence and visibility of mitochondria in fat cells, any trace of endoplasmic reticulum could not be observed at any stage of the insect. However, with light microscopic studies, cytoplasmic area could be noticed.

**Golgi bodies**

From a study of Regaud fixed, iron/hæmatoxylin stained sections of fat body, it is concluded that Golgi element is very poorly developed in the fat cells of P. pictus, so that it could not be observed.
### Table II

Changes in average diameter of Adipose or Fat Cells, Nuclei and Nucleoli in Normal and Ovariectomised Females of *P. pictus*

<table>
<thead>
<tr>
<th>Age of Females</th>
<th>Normal (Copulated)</th>
<th>Females</th>
<th>Ovariectomised</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average diameter of cells in μ</td>
<td>Average diameter of nuclei in μ</td>
<td>Average diameter of nucleoli in μ</td>
<td>Average diameter of cells in μ</td>
</tr>
<tr>
<td>Newly emerged</td>
<td>41.60</td>
<td>10.40</td>
<td>2.60</td>
<td></td>
</tr>
<tr>
<td>3 days</td>
<td>43.34</td>
<td>12.50</td>
<td>2.08</td>
<td>41.60</td>
</tr>
<tr>
<td>7 days</td>
<td>53.04</td>
<td>14.60</td>
<td>2.08</td>
<td>54.92</td>
</tr>
<tr>
<td>15 days</td>
<td>55.96</td>
<td>15.40</td>
<td>2.08</td>
<td>57.70</td>
</tr>
<tr>
<td>20 days</td>
<td>52.70</td>
<td>15.90</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>25 days</td>
<td>61.40</td>
<td>18.09</td>
<td>2.90</td>
<td>62.70</td>
</tr>
<tr>
<td>30 days</td>
<td>57.90</td>
<td>19.50</td>
<td>2.08</td>
<td>59.30</td>
</tr>
<tr>
<td>During Egg laying</td>
<td>54.50</td>
<td>16.60</td>
<td>1.60</td>
<td></td>
</tr>
</tbody>
</table>
Table III

Changes in the average diameter of Adipose or Fat Cells, Nuclei and Nucleoli in Normal and Castrated Males of P. pictus

<table>
<thead>
<tr>
<th>Age of Males</th>
<th>Normal Males</th>
<th>Castrated Males</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average diameter of cells in μ</td>
<td>Average diameter of nuclei in μ</td>
</tr>
<tr>
<td>Newly emerged</td>
<td>43.60</td>
<td>12.90</td>
</tr>
<tr>
<td>3 day</td>
<td>43.52</td>
<td>16.02</td>
</tr>
<tr>
<td>7 day</td>
<td>54.08</td>
<td>18.30</td>
</tr>
<tr>
<td>15 day</td>
<td>45.76</td>
<td>13.70</td>
</tr>
</tbody>
</table>
Fig. 1  A graph showing changes in the average diameter of cells, nuclei and nucleoli of the adipose tissue of 5th and 6th stage nymphs of *P. pictus* with reference to age and moulting etc.

Fig. 2A  A graph showing changes in the average diameter of cells of adipose tissue of normal and operated (castrated or ovariectomised) imago of *P. pictus* with reference to age since its emergence from the 6th nymphal stage.
CHANGES IN THE AVERAGE DIAMETER OF CELLS IN THE IMAGO OF P. PICTUS WITH GROWTH AND CASTRATION

1

CHANGES IN THE AVERAGE DIAMETER OF CELLS NUCLEI AND NUCLEOLI IN 5TH AND 6TH STAGE NYMPHS OF P. PICTUS

2A
Fig. 2B  A graph showing changes in the average diameter of nuclei of adipose cells of normal and operated (castrated or ovariectomised) imago of *P. pictus* with reference to age since its emergence from the 6th nymphal stage.

Fig. 2D  A graph showing changes in the average diameter of nucleoli of adipose cells of normal and operated (castrated or ovariectomised) imago of *P. pictus* with reference to age since its emergence from the 6th nymphal stage.
Changes in the average diameter of nuclei in the imago of P. pictus with growth and castration.

Changes in the average diameter of nucleoli in the imago of P. pictus with growth and castration.
C. HISTOCHEMICAL OBSERVATIONS ON THE ADIPOSE TISSUE
OF P. PICTUS

Distribution of Nucleic acids

DNA

In carnoy-fixed tissue stained by Feulgen method, DNA is found to be confined only to the granular chromatin material inside the nucleus at every stage.

1) Nymphs

In a newly hatched 5th stage nymph male or female, the chromatin of the nuclei is quite dense and rich in DNA, though the male has smaller nucleus than that of female.

In a 3 day old 5th stage nymph, male or female, the chromatin of the nuclei is uniformly distributed and is granular. DNA is quite rich at this stage.

At 10 days, the nuclei increase in size, consequently, the intensity of DNA in the dense chromatin matter increases.

During moulting into the 6th stage nymph, DNA intensity is decreased though the chromatin matter is dense and granular like that in 10 day old nymphs. The nuclei are smaller in size but more in number.
In a newly moulted 6th stage nymph, the chromatin is dense and granular but DNA is less than that in the newly moulted 5th stage nymph.

At 3 days the conditions are similar to those in a newly moulted 6th stage nymph but after 10 days the number of nuclei as well as the intensity of DNA increase.

Though the chromatin is dense and granular, the intensity of DNA decreases in a 6th stage nymph, male or female, during moultng to adult.

ii) Imago

Females (Copulated and Virgin)

In a newly emerged female, the chromatin matter of the nucleus is dense and granular with DNA. In some cells, the nuclei are small like those of the nymph while in some others, they are a bit bigger in size.

After 3 - 7 days, in copulated females, the chromatin is dispersed. On the other hand, in virgin females of the same age, chromatin is not dispersed. The nuclei are bigger than in the newly emerged stage.

In 10 - 15 day old females, DNA is very intense and up to 30 days of age this does not change at all, except as
usual, for the distribution of chromatin and size of nuclei. It has been found that generally in virgin females chromatin is dense while in copulated ones it is dispersed.

Before egg laying, DNA intensity increases, nuclei increase in size and chromatin becomes dense in appearance.

Just after egg laying, the fat cells are seen to have very much reduced chromatin in the nuclei with very little DNA in them.

10 - 15 days after egg laying, nuclei increase in size with intense DNA in them and the conditions are comparable to those of 20 - 25 day old female.

Ovariectomised Females

In females after 3 to 30 days of ovariectomy, the nuclei are quite bigger than those of the corresponding stages of the normal females i.e., copulated or virgin females of 3 to 30 days of age. In all these ovariectomised females, the chromatin granules are quite dense and DNA is very intense.

Females with testes implanted

By implanting testes of a 2 day old male in a newly emerged female after removing its ovary and observing its
adipose tissue after 5 days, it has been found that chromatin granules are dense and rich with DNA. The conditions are comparable to those observed in a 5 - 6 day old female but not to any of those which are present in 2 - 7 day old male.

However, by implanting testes of a 2 day old male in a 7 day old female after removing its ovary and observing the fat tissue after 7 - 8 days, it is seen that the conditions are not comparable to those of a 15 day old female or an ovarietomised female of 7 days. On the other hand, the conditions are comparable to those of a male of 10 days i.e., chromatin dense at some places and dispersed at others with less intense DNA than in females.

By implanting testes of a 2 day old male in a 10 day old female after its ovarietomy and observing after 10 days, it is seen that DNA increased in comparison to that in both 20 day old normal female or a normal male of 12 days. On the other hand, it is comparable to that of a ovarietomised female of 10 days.

**Males**

In a newly emerged adult male, the conditions are comparable to those of a female of the same age, i.e., chromatin is dense. The nuclei are smaller in size in some cells like those in the nymph and bigger in others.
After 3 - 7 days, the nuclei increase in size, and chromatin granules become dispersed towards the periphery of the nucleus.

At 15 days of age, the nuclei increase further in size. Chromatin is dense in some cells and dispersed in others.

**Castrated Males**

After 3 days of the removal of testes of a male, it is seen that the nuclei increase in size and chromatin becomes dense as against dispersed chromatin of a normal male of 3 days. DNA is quite intense and the conditions can well be compared with those of an ovarietomised female of 3 days.

After 7 days of castration of a male, the conditions are similar to those of the above stage. However, nuclei are bigger and chromatin is dense than in the normal male of 7 days.

At 15 days of castration, the nuclei are as usual bigger than in the normal male of 15 days. However, they are smaller in size and larger in number than those in the castrated males of 3 and 7 days. Chromatin matter is very dense and very rich in DNA as against that of a normal male of 15 days.

After 19 days of castration, a male has, as usual, very big nuclei than the normal ones and also the castrated males of 3, 7 and 15 days. Chromatin is granular but not dense like that of a 15 day old castrated male. DNA is quite intense.
Males with ovary implanted

By implanting the ovary of a 15 day old copulated female in a 2 day old male after removing its testes and observing the fat body after 5 days, it is seen that chromatin has become very dense and more rich in DNA as compared to those of the normal female of 20 days or normal male of 7 days. The size of the nuclei is similar to those of 7 day old male.

By implanting the ovary of a 15 day old copulated female in an adult male after removing its testes and observing after 10 days, it is seen that the size of nuclei, distribution of chromatin as well as intensity of DNA are comparable to those of a copulated female of 25 days and not of a normal or castrated male. Though some nuclei are like those of a castrated male of 19 - 20 days but in them the DNA intensity is much less in comparison to that of a castrated male. On the other hand, it is comparable to that of a normal female of 25 days.

By implanting the ovary of a 3 day old copulated female in a mature male after removing its testes and observing after 11 days, it has been found that the chromatin granules are dispersed as in the case of copulated female of 15 days, but not at all like that of a normal or castrated male. Intensity of DNA is also like that of a copulated
female of 15 days but lesser than that of a normal or castrated male. The size of nuclei can be compared, in some cells, to those of a castrated male.

**Nucleic acids**

**DNA and RNA**

By staining the carnoy–fixed fat tissue by P/MG method, DNA has been found to be confined to the nuclei while RNA is distributed in peripheral globules, cytoplasmic strands in the cytoplasm and in the nucleoli. The distribution of chromatin and intensity of DNA as observed by Feulgen method has been confirmed by this staining. The variations in the size of nucleoli at different stages of development has been described earlier. The intensity of RNA in the nucleoli as well as in the cytoplasm increases or decreases with other metabolic activities. The size of nucleoli increases up to about 10 days in copulated and 15 days in virgin females when they also become vesiculate. Nucleolar extrusions are also visible at this period. These extrusions possibly migrate into the cytoplasm and increase its RNA content. They are seen passing at some stages, towards the periphery of the nucleus, although no emission bodies have been found passing out of the nuclear membrane. However, they can be seen protruding from the nuclear wall which covers them.
The intensity and distribution of RNA in the cytoplasm and peripheral globules is described in the following paragraphs:

1) Nymphs

The changes in the intensity of nucleic acids in the 5th and 6th stage nymphs are given in Table IV.

In newly moulted 5th stage nymphs, male or female, the peripheral globules in the cytoplasm are quite rich in RNA. However, in the male nymphs, nucleoli are more prominent and larger in size than in the female nymphs (Fig. 3).

Genocytes have less RNA than fat cells and their nucleoli have also lesser RNA.

At 3 days in the 5th stage nymphs of both sexes, central globules are reduced in number. Thus cytoplasmic area is more elaborated and with peripheral globules it has quite intense RNA. In the female nymph, the nucleolus increases in size with intense RNA while in the male nymph, it remains almost of the same size as at the newly moulted stage (Fig. 4). Thus, at 3 days the nucleolus of a male 5th stage nymph is smaller than that of a female nymph of the same age.
Table IV

Changes in the intensity of Nucleic acids, Proteins, Glycogen, Lipids etc. in 5th and 6th stage Nymphs* of

* P. pictus

<table>
<thead>
<tr>
<th>Age of Nymphs</th>
<th>Nucleic acids</th>
<th>Protein</th>
<th>Glycogen</th>
<th>Lipids</th>
<th>Unsaturated</th>
<th>Saturated</th>
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<tbody>
<tr>
<td></td>
<td>DNA</td>
<td>RNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th Stage Nymphs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newly moulted</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>3 day old</td>
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<td>++</td>
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<td>10 day old</td>
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<tr>
<td>Before moulting to 6th stage</td>
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<td>+ (+)</td>
<td>+(+)</td>
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<td>6th Stage Nymphs</td>
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<tr>
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<tr>
<td>Before moulting to adult</td>
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<td>+</td>
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+ Diffuse intensity, decrease; ++ Moderate intensity; +++ Greater intensity, decrease.

* The results tabulated here are mostly for female nymphs as there is a negligible difference in these between males and females.
In the oenocytes, RNA is quite intense on the periphery of the cells. The nucleoli in some of the cells are bigger in size than those of newly moulted nymphs and are seen to be budding.

After 10 days, central globules are more reduced in number while the cytoplasmic area is further increased with intense RNA in the peripheral globules (Fig. 5). Nucleoli increase in size, they are larger in female nymphs than those in the male nymphs and have intense RNA. Few of them are seen budding.

In 5th stage nymphs (Fig. 6), before moult ing into the 6th stage i.e., 18 - 22 days, the cytoplasm shows many central globules. RNA intensity decreases slightly than in the 10 day old nymphs. There is a depletion of RNA in some cells and synthesis in others. Nucleoli are not clearly visible and wherever visible, they are very small and are towards the periphery of the nucleus, ready to migrate in the cytoplasm. However, they have intense RNA.

In a newly moulted 6th stage nymph, male or female, the conditions are more or less similar to those in the newly moulted 5th stage nymphs except, of course, for the size of the cells (Fig. 7). The central globules are many in number and RNA is very intense in the peripheral globules. The
nucleoli are only slightly RNA positive and are smaller in size than in the 5th stage nymphs.

After 3 days in a female 6th stage nymph, the cell wall is not visible and cytoplasmic area is much elaborated (Fig. 8). The RNA is very intense in comparison to that of the newly moulted stage. The nucleoli are slightly bigger in size than those of the previous stages but are slightly RNA positive. Usually, there is one nucleolus on the edge of the nucleus.

At 10 days of age in 6th stage nymphs (Fig. 9), male or female, RNA intensity increases both in the peripheral globules and the nucleoli.

In the 6th stage nymphs before moulting to adult (20 - 22 days), the intensity of RNA decreases in the peripheral globules as also in the nucleoli (Fig. 10). Peripheral globules are less in number than the central globules. Thus this stage resembles the 5th stage nymph before moulting to the 6th stage.

In the oenocytes, RNA is intense in the cytoplasm as also in the nucleoli which are situated towards the periphery of the nuclei.
Fig. 3  
Section of adipose tissue of a newly moulted 5th stage nymph of *P. pictus* showing RNA positive peripheral globules. The chromatin matter in the nuclei is dense. Big central globules are also visible.  
(Pyronin/Methyl green X 450).

Fig. 4  
Section of adipose tissue of a 3 day old 5th stage nymph of *P. pictus* showing many RNA positive peripheral globules, chromatin in the nuclei is dispersed. In some, nucleoli are also visible.  
(Pyronin/Methyl green X 450).

Fig. 5  
Section of adipose tissue of a 10 day old 5th stage nymph of *P. pictus*. A faint cell membrane is visible. Cytoplasmic area is elaborated, cells and nuclei are big and peripheral globules have RNA. The nucleoli are clearly visible.  
(Pyronin/Methyl green X 450).

Fig. 6  
Section of adipose tissue of a 5th stage nymph of *P. pictus* before moulting to 6th stage. Showing a few RNA positive peripheral globules. Nucleoli are towards the periphery of the nuclei.  
(Pyronin/Methyl green X 450).
Fig. 7  Section of adipose tissue of a newly moulted 6th stage nymph showing RNA positive peripheral globules. Chromatin in the nuclei is dense, nucleoli are not visible. (Pyronin/Methyl green  X 450).

Fig. 8  Section of adipose tissue of a 3 day old 6th stage nymph showing elaboration of cytoplasmic area with intense RNA in peripheral globules. Chromatin is dispersed and nucleoli are visible. (Pyronin/Methyl green  X 450).

Fig. 9  Section of adipose tissue of a 10 day old 6th stage nymph with intense RNA in peripheral globules. Nuclear chromatin is dense. (Pyronin/Methyl green  X 450).

Fig. 10  Section of adipose tissue of a 6th stage nymph before moult ing into the imago showing only a few peripheral globules with very little RNA in them. Chromatin is dispersed and nucleoli are visible. (Pyronin/Methyl green  X 450).
11) **Imago**

The changes in the intensity of nucleic acids in the imago of *P. pictus* is shown in table V.

**Females (Copulated and Virgin)**

In a newly emerged female *P. pictus*, peripheral globules are more in number than in the nymphs and are RNA positive. Nucleoli are almost like those of the 6th stage nymph with little RNA in them (Fig. 11).

In a 3 day old virgin female, cytoplasmic area is very dense. Nucleoli are visible but are small in size. RNA intensity is more in the oenocytes than in the fat cells. There are 1 - 2 RNA-positive nucleoli in a nucleus, which at some places are found to be budding.

A copulated female of the same age i.e., 3 days, has much intense RNA in the peripheral globules than the virgin. Small RNA-positive nucleoli are clearly visible (Fig. 12).

After 7 days, both in the virgin and copulated females, cytoplasmic area increases and RNA is more intense. Nucleoli with RNA positive material in them are similar in size in both and differ only slightly from those of 3 day old females (Fig. 13).
Table V

Changes in the intensity of Nucleic acids in Normal and Operated Imago of *P. pictus*

<table>
<thead>
<tr>
<th>Age of the insect</th>
<th>Normal (copulated) Females</th>
<th>Ovariectomised Females</th>
<th>Females with testes</th>
<th>Normal Males</th>
<th>Castrated Males</th>
<th>Males with ovaries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DNA</td>
<td>RNA</td>
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<td>7 days</td>
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</tbody>
</table>

+ Diffuse intensity, decrease; ++ Moderate intensity; +++ Greater intensity, increase.
In a virgin female of 10 days RNA is prominent only round the nuclei. RNA positive nucleoli of the same size as those in 3 and 7 day old females are visible only in some cells.

As usual, the oenocytes have RNA on the peripheral parts and in this case the intensity is more in the oenocytes than in the fat cells.

A copulated female of 10 days has intense RNA (Fig. 14). Nucleoli with RNA are bigger in size than in the virgin female of the same age as also in comparison to those of 7 day old females.

After 15 days in a virgin female, there is a depletion of RNA in the peripheral globules. The nucleoli are slightly larger than those of the earlier stages of the virgin females. They have intense RNA and are very active, budding and migrating into the cytoplasm.

A copulated female of 15 days is very similar to the virgin female of the same age but has much intense RNA than the latter (Fig. 15). Nucleoli are smaller but are showing budding etc.

At 20 days of age, both in virgin and copulated females, the intensity of RNA increases (Fig. 16). Nucleoli
are RNA positive. They are seen budding and extrusions appear particularly in the copulated female.

In a virgin female of 25 days, RNA intensity is more than that of 20 days and nucleoli are rarely visible. Wherever seen, they are similar in size to those of a 20 day female having intense RNA.

In a copulated female of 25 days, cytoplasm has a few peripheral globules with intense RNA. Nucleoli are clearly visible (Fig. 17). Mostly there are two nucleoli in a nucleus, towards its centre or periphery. They are slightly bigger in size.

After 30 days (Fig. 18) and up to egg laying i.e., 32 - 37 days, RNA intensity increases gradually but just after egg laying, there is almost complete depletion of RNA in the cytoplasm as also in the nucleoli (Fig. 19A, B). However, 10 - 15 days after the egg laying, RNA intensity is again observed in the cytoplasm and the nucleoli (Fig. 20).

Ovariectomised Females

In females, 3 - 7 days after ovariectomy, the cytoplasm has quite a few central globules and the peripheral globules in it have very intense RNA as against those of 3 - 7 day old normal (copulated) females. Nucleoli are
Fig. 11  
Section of adipose tissue of a newly emerged female _P. pictus_ showing RNA positive peripheral globules, nucleolus, big central globules and dense chromatin in the nuclei. (Pyronin/Methyl green X 1000).

Fig. 12  
Section of adipose tissue of a 3 day old normal (copulated) female _P. pictus_ showing intense RNA in peripheral globules and nucleoli. Chromatin is dispersed. (Pyronin/Methyl green x 450).

Fig. 13  
Section of adipose tissue of a 7 day old normal female _P. pictus_ showing RNA positive peripheral globules and nucleoli. Chromatin is dispersed. (Pyronin/Methyl green X 1000).

Fig. 14  
Section of adipose tissue of a 10 day old normal female _P. pictus_ showing big central globules, RNA positive peripheral globules and nucleoli. Nuclei are big in size than those of 3 and 7 day old females. (Pyronin/Methyl green X 1000).
Fig. 15  Section of adipose tissue of a 15 day old normal (copulated) female *P. pictus* showing intense RNA in peripheral globules and budding nucleoli. Nuclear chromatin is dispersed. (Pyronin/Methyl green X 1000).

Fig. 16  Section of adipose tissue of a 20 day old normal female *P. pictus* showing intense RNA in peripheral globules and budding nucleoli. Nucleolar extrusion from a nucleus is also visible. (Pyronin/Methyl green X 1000).

Fig. 17  Section of adipose tissue of a 25 day old normal female *P. pictus* showing big central globules, a few RNA positive peripheral globules and budding nucleolus. (Pyronin/Methyl green X 1000).

Fig. 18  Section of adipose tissue of a 30 day old normal female *P. pictus* showing RNA positive peripheral globules and nucleoli, dispersed chromatin and central globules of moderate size. (Pyronin/Methyl green X 450).
Fig. 19A  Section of adipose tissue of a female *P. pictus* before egg laying. The cytoplasmic area is elaborated and peripheral globules have intense RNA. Nucleoli are very small in size.
(Pyronin/Methyl green X 450).

Fig. 19B  Section of adipose tissue of a female *P. pictus* just after egg laying, showing depletion of RNA in peripheral globules and nucleoli.
(Pyronin/Methyl green X 450).

Fig. 20  Section of adipose tissue of female *P. pictus* after 10 days of egg laying. Cytoplasmic area with central and peripheral globules is elaborated. Very small RNA positive nucleoli are visible.
(Pyronin/Methyl green X 450).
Fig. 21  
Section of adipose tissue of a female *P. pictus*, 3 days after ovarieectomy. The RNA in the peripheral globules is more intense round the nuclei. There are only a few central globules and cytoplasmic area is elaborated. (Pyronin/Methyl green X 450).

Fig. 22  
Section of adipose tissue of a female *P. pictus*, 7 days after ovarieectomy. The conditions are almost similar to those in a female 3 days after ovarieectomy (Fig. 21). (Pyronin/Methyl green X 450).

Fig. 23  
Section of adipose tissue of a female (15 days after ovarieectomy) showing intense RNA in peripheral globules and big nuclei. Chromatin is dense and central globules a few. (Pyronin/Methyl green X 450).
Fig. 24A  Section of adipose tissue of a female *P. pictus* (25 days after ovariectomy) showing very intense RNA in the peripheral globules and big nucleoli. Cytoplasmic area is much elaborated and nuclei are big with dense chromatin.
(Pyronin/Methyl green X 450).

Fig. 24B  The same in oil-emulsion (X 1000) showing a big nucleus with much enlarged and vacuolated nucleolus in it which has intense RNA.

Fig. 25  Section of adipose tissue of a female *P. pictus* (30 days after ovariectomy) showing elaboration of cytoplasmic area. RNA is quite intense in big nucleoli as well as in peripheral globules. Chromatin is dense and central globules only a few.
(Pyronin/Methyl green X 450).
larger in size and strongly positive for RNA as against those of normal females (Figs. 21, 22).

After 15 - 25 days of ovariectomy (Figs. 23, 24A, B), cytoplasm becomes very dense and peripheral globules are much intense in RNA. Some nucleoli are very big in size and strongly positive for RNA. All these conditions are in contrast to those of a normal females of 15 - 25 days.

In females 28 - 30 days after ovariectomy, the intensity of RNA in the peripheral globules slightly decreases. Nucleoli are bigger than those of the normal females of the same age and are strongly positive for RNA (Fig. 25).

**Males** (Table V)

A newly emerged male has much less RNA in the peripheral globules (Fig. 26) in comparison to that in the nymphs and in the newly emerged female. The nucleoli are slightly RNA positive. The oenocytes have more RNA than the fat cells.

At 3 days, there are big central globules unlike those in a 3 day old female but intensity of RNA is almost similar than in the female. There are one to two slightly RNA positive nucleoli in a nucleus (Fig. 27).
In a 7 day old male, there is a depletion of RNA in some cells and synthesis in others (Fig. 28). However, the intensity of RNA is less than in the 3 day old male and also in comparison to that in the 7 day old female.

After 15 days, the cytoplasm with peripheral globules (Fig. 29) has much more RNA than in 3 and 7 day old males. Nucleoli are also slightly bigger and thus this stage of the male is comparable to that of the female of the same age i.e., 15 days.

**Castrated Males**

In a male 3 days after castration, the intensity of RNA increases in comparison to that in a normal male of 3 days. Nucleolus is also strongly positive for RNA and bigger in size than that in a normal male (Fig. 30). Thus, the fat cells of a castrated male of 3 days is comparable to those of an ovariectomised female of the same age as far as the intensity of RNA is concerned. However, in the former, there are many central globules like those in a normal male.

After 7 days of castration, the conditions of a male are similar to those of a castrated male of 3 days i.e., intensity of RNA is more than that in a normal male (Fig. 31). The difference from the same stage of an ovariectomised
female is that here the cytoplasm has many central globules. In some cells, nucleoli are very big and strongly positive for RNA.

After 15 - 19 days of castration, also, the intensity of RNA increases in comparison to that of the above stages as well as of the normal males of 15 - 19 days (Fig. 32).

**Males with ovary implanted**

By implanting ovaries of 3 - 15 days in males after castration, the intensity of RNA has been found to increase. Otherwise, there is no difference from normal males and females.
Fig. 26  Section of adipose of a newly emerged male P. pictus showing big central globules, a few peripheral globules with a little RNA in them, small slightly RNA positive nucleoli and dispersed chromatin in the nuclei. (Pyronin/Methyl green X 450).

Fig. 27  Section of adipose tissue of a 3 day old male P. pictus showing big nuclei with dispersed chromatin, big central globules, RNA positive peripheral globules and nucleoli. (Pyronin/Methyl green X 450).

Fig. 28  Section of adipose tissue of a 7 day old male P. pictus showing more RNA positive peripheral globules. Chromatin is dispersed and small RNA positive nucleoli are visible. Central globules are small in size. (Pyronin/Methyl green X 450).

Fig. 29  Section of adipose tissue of a 15 day old male P. pictus showing elaboration of cytoplasmic areas which has intense RNA. RNA positive nucleoli are also visible. (Pyronin/Methyl green X 200).
Fig. 30A  Section of adipose tissue of a male P. pictus (3 days after castration) showing intense RNA in the peripheral globules and peripheral globules. nucleoli.
(Pyronin/Methyl green X 450).

Fig. 30B  The same in oil-emulsion (X 1000).

Fig. 31  Section of adipose tissue of a male P. pictus (7 days after castration) showing a big nucleus with much enlarged, vacuolated nucleolus in it. RNA is quite intense in the peripheral globules.
(Pyronin/Methyl green X 1000).

Fig. 32  Section of adipose tissue of a male P. pictus (15 days after castration showing elaboration of cytoplasmic with intense RNA in peripheral globules and nucleoli.
(Pyronin/Methyl green X 450).
Deposition and depletion of Proteins

By staining the sections of carnoy fixed fat tissue with Mercury/bromophenol blue method of Bonhag (1955), proteins are found to be present around the peripheral globules in the cytoplasm as also inside them. The chromatin matter of the nuclei also give positive reaction for this staining due to the presence of nucleoprotein in them. In general, the observations resemble those of Coupland (1957) for Schistocerca i.e., the reaction for proteins by the above staining is partly diffuse and partly granular.

1) Nymphs

In newly moulted 5th stage nymphs, male or female, the cytoplasmic strands and the peripheral globules round the nuclei have a diffuse deposition of proteins (Fig. 33). However, the intensity of staining is slightly lesser in the male nymphs. No granular deposition could be observed at this stage. Oenocytes are less stained than the fat cells.

At 3 days, in 5th stage nymphs of both the sexes, the intensity of distribution of proteins increases in comparison to that in newly moulted nymphs (Fig. 34), though in the male nymphs it is lesser than in the female ones. Oenocytes have less intense proteins than the fat cells.
After 10 days, the proteins increase in 5th stage nymphs of both the sexes (Fig. 35), though it is less in the male nymphs, as usual in comparison to that in the female ones.

Before moulting into the 6th stage, i.e., 18 – 22 days, protein deposition is almost of the same intensity as that of 10 days in same cells but there is a depletion in most of the cells (Fig. 36).

In newly moulted 6th stage nymphs of both the sexes, protein deposition is intense.

At 3 days in a 6th stage female nymph, there is an intense distribution of proteins in the cytoplasm but until at this stage there is no prominent granular deposition (Fig. 37).

At 10 days, the deposition of protein is ordinary but during moulting to adult stage i.e., 20 days, protein deposition is slightly depleted (Figs. 38, 39).

All the above changes are shown in table IV.

ii) **Imago**

**Females (Copulated and Virgin)**

In a newly emerged female, there is a little deposition
Fig. 33  Section of adipose tissue of a newly moulted 5th stage nymph of *P. pictus* showing a diffuse deposition of protein in the peripheral globules and this is more round the nuclei.  
(Mercuric-bromophenol blue X 450).

Fig. 34  Section of adipose tissue of a 3 day old 5th stage nymph of *P. pictus* showing intense deposition of protein in peripheral globules. Cell membranes are clearly visible, central globules are small and a few in number.  
(Mercuric-bromophenol blue X 450).

Fig. 35  Section of adipose tissue of a 10 day old 5th stage nymph of *P. pictus* showing intense deposition of protein in peripheral globules.  
(Mercuric-bromophenol blue X 450).

Fig. 36  Section of adipose tissue of a 5th stage nymph of *P. pictus* (before moult to 6th stage) showing depletion of protein deposition in some cells. The central globules are big and many in number.  
(Mercuric-bromophenol blue X 450).
Fig. 37  Section of adipose tissue of a 3 day old 6th stage nymph of *P. pictus* showing intense distribution of protein in the peripheral globules and cytoplasm.  
(*Mercuric-bromophenol blue X 450*).

Fig. 38  Section of adipose tissue of a 10 day old 6th stage nymph of *P. pictus* showing moderate distribution of protein in peripheral globules.  
(*Mercuric-bromophenol blue X 450*).

Fig. 39  Section of adipose tissue of a 6th stage nymph of *P. pictus* (before moulting into imago) showing depletion of protein deposition in the peripheral globules.  
(*Mercuric-bromophenol blue X 450*).
of protein in the peripheral globules (Fig. 40).

At 3 days, in a female, virgin or copulated, protein deposition increases in comparison to that in the newly emerged female (Fig. 41). Cytoplasmic strands between the central globules and nuclei also react positively for proteins. There is also a granular deposition in a slightly larger quantity at the edge of the cells.

Oenocytes have very little deposition, only round the nuclei.

After 7 days, a virgin or a copulated female shows intense proteins but there is a depletion of protein deposition at 7 days.

At 10 days, protein deposition is clearly visible in the peripheral globules. The amount and intensity is more than that of the 7 day old female (Fig. 42). The conditions are similar in virgin as well as copulated females.

In a 15 day old virgin female, there is a heavier deposition in numerous peripheral globules and in a copulated female of the same age, this is even more than in the virgin. There is also a granular deposition in the peripheral parts of the cells (Fig. 43).
After 20 days (Fig. 44), the conditions are comparable to those in 15 day old females i.e., intense deposition of protein is there. However, the peripheral globules are less in number. At the edge of the cells, there is a granular deposition.

At 25 days, in a virgin or copulated female, the protein deposition slightly increases. However, in a copulated female of the same age there is a depletion of the deposition (Fig. 45). Protein granules are visible at the peripheral parts of the cells.

After 30 days, the cytoplasm of the fat cells with peripheral globules is very much rich in protein (Fig. 46). However, during egg laying, protein deposition decreases immensely (Figs. 47, 48).

After 10-15 days of egg laying, protein is again deposited in the fat cells and increases gradually (Fig. 49).

**Ovariectomised Females**

In a female, 3 days after its ovariectomy, the concentration of protein deposition is slightly more than that in a normal 3 day old female (Fig. 50).

Similarly, in ovariectomised females of 7 and 15 days,
Fig. 40  Section of adipose tissue of a newly emerged female *P. pictus* showing a little deposition of protein in the peripheral globules. Central globules are of moderate size.  
(Mercuric-bromophenol blue × 450).

Fig. 41  Section of adipose tissue of a 3 day old normal (copulated) female *P. pictus* showing moderate deposition of protein in the peripheral globules.  
(Mercuric-bromophenol blue × 450).

Fig. 42  Section of adipose tissue of a 10 day old normal female *P. pictus* showing deposition of protein in peripheral globules. Nucleoli are also visible.  
(Mercuric-bromophenol blue × 450).

Fig. 43  Section of adipose tissue of a 15 day old normal female *P. pictus* showing intense deposition of protein in peripheral globules and also in granular form in the cytoplasm and cytoplasmic strands.  
(Mercuric-bromophenol blue × 450).
Fig. 44 Section of adipose tissue of a 20 day old normal (copulated) female of _P. pictus_ showing intense deposition of protein in peripheral globules and in granular form at the edge of the cells. Cell membrane is visible. (Mercuric-bromophenol blue X 450).

Fig. 45 Section of adipose tissue of 25 day old female _P. pictus_ showing depletion of protein deposition in the peripheral globules, but this is present in granular form at the edge of the cells. Cell membranes are very clearly visible. (Mercuric-bromophenol blue X 450).

Fig. 46 Section of adipose tissue of a 30 day old normal female _P. pictus_ showing elaboration of cytoplasm which along with peripheral globules has an intense deposition of protein. Central globules are very small and few in number. (Mercuric-bromophenol blue X 450).
Fig. 47  Section of adipose tissue of a female *P. pictus* (before egg laying) showing almost complete depletion of protein.
(Mercuric-bromophenol blue X 450).

Fig. 48  Section of adipose tissue of a female *P. pictus* (just after egg laying) showing very little deposition of protein in the peripheral globules which are a few in number.
(Mercuric-bromophenol blue X 450).

Fig. 49  Section of adipose tissue of a female *P. pictus* (10 days after egg laying) showing an elaborated cytoplasmic area which along with the peripheral globules is rich in protein. Central globules are a few in number and very small in size.
(Mercuric-bromophenol blue X 450).
Fig. 50  Section of adipose tissue of a female *P. pictus*, 3 days after ovariectomy, showing intense deposition of protein in peripheral globules. (Mercuric-bromophenol blue X 450).

Fig. 51  Section of adipose tissue of a female *P. pictus*, 25 days after ovariectomy, showing big central globules and an intense deposition of protein in peripheral globules. (Mercuric-bromophenol blue X 1000).

Fig. 52  Section of adipose tissue of a female *P. pictus*, 30 days after ovariectomy. The peripheral globules are rich in protein. (Mercuric-bromophenol blue X 450).

Fig. 53  The same in oil-emulsion (X 1000).
the concentration of protein deposition is more than that in the normal females of 7 and 15 days respectively.

After 25 - 30 days of ovariectomy, there is protein deposition in the peripheral globules which is more, as usual, than that of the normal females of 25 - 30 days respectively (Figs. 51 - 53).

**Females with Testes Implanted**

By implanting testis of a 2 day old male in a newly moulted female after its ovariectomy and observing its fat tissue of 5 days, it has been found that deposition of protein in the fat cells is comparable to that of a male of 7 days but it is slightly more than that of a female of 5 days, i.e., comparable to the protein deposition of a ovariectomised female of 5 - 7 days (Fig. 54A).

By implanting testes of 2 - 3 day old males in 7 - 10 day old females respectively after the removal of the ovaries of the latter, and observing their adipose tissue after 7 and 10 days respectively, it has been seen that protein deposition is comparable to that of ovariectomised females of 15 to 20 days. This can be also compared with the intensity of protein deposition in the males of 10 - 12 days but not in any way to that of the normal females of 15 - 20 days respectively (Fig. 54B).
Fig. 54A  Section of adipose tissue of a female P. pictus implanted with testes of 2 day old male and seen after 5 days. There is an intense deposition of protein in the peripheral globules and cytoplasm.
(Mercuric-bromophenol blue X 450).

Fig. 54B  Section of adipose tissue of a female P. pictus implanted with testes of 2 day old male and seen after 10 days. There is a moderate deposition of protein in the cytoplasm and peripheral globules.
(Mercuric-bromophenol blue X 450).
Males

In a newly emerged male, the intensity of protein deposition is comparable to that of a newly moulted female. However, as against in females, the deposition is seen here in the form of granules round the central globules (Fig. 55).

At 3 days, deposition of proteins in a male is almost comparable forever more than that in the female of the same age (Fig. 56).

After 7 days, also, the deposition of protein is almost comparable to that in the females of the same age as also to a male of 3 days (Fig. 57).

At 15 days, though the deposition of protein increases in a male in comparison to that in 3 and 7 day old males, it is as usual, comparable to that in the females of the same age i.e., 15 days (Fig. 58).

Castrated Males

In males, 3 to 7 days of castration, the deposition of protein increases in comparison to that in 3 - 7 day old normal males respectively (Figs. 59, 60).

After 15 and 19 days of castration, also, the protein deposition increases, as usual, in comparison to that in 15
and 19 day old normal males respectively. The deposition is also more in comparison to that of 3 and 7 day old castrated males (Figs. 61, 62A, B).

**Males with Ovary Implanted**

By implanting ovary of a 15 day old copulated female in a 2 day old male after its castration and observing its fat tissue after 5 days, it is found that the deposition of protein increases a lot. It can be compared to the protein deposition observed in a castrated male of 7 days, which is, of course, more in amount than that of a 20 day old copulated female (Fig. 63).

Similar results have been obtained after implantation of ovary of a 15 day old copulated female in a mature male after its castration and observing its fat tissue after 10 days. The conditions of protein deposition can be compared to those of both the 25 day old female and a castrated male.

On the other hand, by implanting ovary of a 3 day old copulated female in a male after its castration and observing its adipose tissue after 10 days, it is found that the protein deposition is less in comparison to that of both the normal female of 15 days and a castrated male.

All the above changes concerning imago have been tabulated in table VI.
<table>
<thead>
<tr>
<th>Age of the insects</th>
<th>Normal (copulated) Females</th>
<th>Ovariectomised Females</th>
<th>Females with testes</th>
<th>Normal Males</th>
<th>Castrated Males</th>
<th>Males with ovaries</th>
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<td>During egg laying</td>
<td>+</td>
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</tr>
</tbody>
</table>

* + Diffuse deposition, decrease; ++ Moderate deposition;
  +++ Heavy deposition, increase.*
Fig. 55  Section of adipose tissue of a newly emerged male *P. pictus* showing intense deposition of protein in the peripheral globules.  
(Mercuric-bromophenol blue X 1000).

Fig. 56  Section of adipose tissue of a 3 day old male *P. pictus* showing much intense protein in numerous peripheral globules. Central globules are a few in number.  
(Mercuric-bromophenol blue X 1000).

Fig. 57  Section of adipose tissue of a 7 day old male *P. pictus* showing moderate deposition of protein in peripheral globules and cytoplasmic strands. Cell membrane is visible at some places.  
(Mercuric-bromophenol blue X 450).

Fig. 58  Section of adipose tissue of a 15 day old male *P. pictus* showing moderate deposition of protein in peripheral globules.  
(Mercuric-bromophenol blue X 450).
Fig. 59  Section of adipose tissue of a male *P. pictus* as seen 3 days after castration. The peripheral globules and cytoplasmic strands are rich in protein. Central globules are small and only a few in number. (Mercuric-bromophenol blue X 450).

Fig. 60  Section of adipose tissue of a male *P. pictus* as seen 7 days after castration. Cell membrane is visible, central globules are of moderate size and peripheral globules have intense protein deposition. (Mercuric-bromophenol blue X 450).

Fig. 61  Section of adipose tissue of a male *P. pictus* as seen after 15 days of castration. Cytoplasmic area is elaborated, central globules are small and peripheral globules have intense protein deposition. (Mercuric-bromophenol blue X 450).
Fig. 62A  Section of adipose tissue of a male P. pictus (19 days after castration) showing much elaborated cytoplasmic area. This along with peripheral globules has very intense protein deposition. Central globules are only a few round the nuclei.
(Mercuric-bromophenol blue X 450).

Fig. 62B  The same in oil-emulsion (X 1000).

Fig. 63  Section of adipose tissue of a castrated male P. pictus implanted with ovary of a 15 day old female and seen after 5 days. Cytoplasmic area is elaborated and there is intense deposition of protein.
(Mercuric-bromophenol blue X 1000).
Deposition and depletion of Carbohydrates

By staining sections of Carnoy-fixed adipose tissue with Periodic acid/Schiff (PAS) method of McManus, cytoplasmic strands as well as the peripheral globules are found to contain large deposits of glycogen. At some stages, there are also PAS positive granules at the edge of the cells. After prevention of this reaction by Lillie's acetylation method or by treating with saliva, it was found that the reaction was blocked and there was no staining. However, treating the same blocked sections with 20% ammonia, the reaction was resumed. The PAS positive granules are, therefore, confirmed to be those of glycogen.

1) Nymphs

In a newly moulted female nymph of 5th stage, there is an intense deposition of glycogen in the peripheral globules. The deposition is more dense round the nuclei and at the edge of the cell (Fig. 64).

Genocytes have less deposition than fat cells.

In a male nymph of the same age, deposition of glycogen is less than that of the female and the distribution is not intense.

At 3 days, in a 5th stage nymph, male or female (Fig. 65),
there are very small peripheral globules in the cytoplasm and these have a deposition of glycogen like that in newly moulded nymphs.

After 10 days, both in the male and female 5th stage nymphs, the deposition of glycogen increases. The peripheral globules with glycogen are many in number and almost cover the surface of the peripheral globules (Fig. 66).

During moulting into the 6th stage i.e., 18 - 22 days (Fig. 67), the peripheral globules have glycogen but there is a depletion of the deposition.

In newly moulted 6th stage nymphs, male or female, intensity of glycogen deposition is slightly less than in the 5th stage nymphs (Fig. 68). Like the newly moulted stage of male 5th stage nymph, the fat cells of newly moulted male 6th stage nymph also stain at some places with PAS and some cells show no reaction.

At 3 days, in the male or female 6th stage nymphs, the deposition of glycogen is less in comparison to that of the newly moulted stage (Fig. 69). In the male nymph, as usual, some cells are stained while some are not. Peripheral globules are very few in number surrounding central globules of various sizes.
After 10 days, glycogen deposition is moderate (Fig. 70).

Before molting to the adult stage, the conditions of glycogen deposition are the same as that of the 10 day old nymph, but there is a depletion in most of the cells (Fig. 71).

All the above changes in nymphs of *P. pictus* have been shown in table IV.

11) **Imago**

**Females (Copulated and Virgin)**

In a newly emerged female, peripheral globules are very few in number as well as in size (Fig. 72). There is a diffuse deposition of glycogen in these globules as also on the cytoplasmic strands. The size and number of the peripheral globules and glycogen deposition in them is less than that in the 6th stage nymphs.

At 3 days, both the copulated and virgin female adipose cells have very little diffuse deposition of glycogen. Peripheral globules are not very prominent.

Oenocytes on the other hand, have less glycogen deposition than fat cells.
Fig. 64  Section of adipose tissue of a newly emerged 5th stage nymph of *P. pictus* showing intense glycogen deposition in the peripheral globules round the nuclei and at the edge of the cells.
(Periodic acid/Schiff X 450).

Fig. 65  Section of adipose tissue of a 3 day old 5th stage nymph of *P. pictus* showing very small peripheral globules with glycogen.
(Periodic acid/Schiff X 450).

Fig. 66  Section of adipose tissue of a 10 day old 5th stage nymph showing a large number of peripheral globules with intense glycogen deposition. The central globules are very small.
(Periodic acid/Schiff X 450).

Fig. 67  Section of adipose tissue of a 5th stage nymph of *P. pictus*, before moulting to the 6th stage, showing depletion of glycogen deposition. Big central globules are clearly visible.
(Periodic acid/Schiff X 1000).
Fig. 68  Section of adipose tissue of a newly emerged 6th stage nymph of *P. pictus* showing moderate deposition of glycogen in peripheral globules.
(Periodic acid/Schiff X 450).

Fig. 69  Section of adipose tissue of a 3 day old 6th stage nymph of *P. pictus*. There is a little deposition of glycogen in peripheral globules.
(Periodic acid/Schiff X 450).

Fig. 70  Section of adipose tissue of a 10 day old 6th stage nymph of *P. pictus* showing moderate deposition of glycogen in peripheral globules.
(Periodic acid/Schiff X 450).

Fig. 71  Section of adipose tissue of a 6th stage nymph of *P. pictus* before moulting into the imago. There is a depletion of glycogen deposition in the cells. Central globules are quite big while peripheral globules are small and a few in number.
(Periodic acid/Schiff X 450).
After 7 days, both in copulated (Fig. 73) and virgin females, peripheral globules packed with glycogen are very clearly visible. They are much more in number than that in the 3 day old females.

Oenocytes have less glycogen deposition.

After 10 days the conditions of glycogen filled peripheral globules and of the central globules in a virgin female are almost similar to those of a 7 day old female.

Oenocytes have still less deposition than fat cells.

In 15 day old copulated or virgin females, the number of peripheral globules increases a lot, each of them having a heavy glycogen deposition. In some cells, peripheral globules are so dense, particularly round the nuclei, that they almost cover the entire surface of the cell.

Oenocytes have less deposition, as usual, than the fat cells.

At 20 days, in a virgin or copulated female, the glycogen filled peripheral globules are exactly similar to those of a 15 day old female, or even more dense in some cells. At this stage, also, the oenocytes have less deposition (Fig. 74).
After 25 to 30 days, both in the copulated and virgin females, the glycogen deposition increases gradually and can well be compared with that of 15 day old females. Peripheral globules with glycogen are more dense round the nuclei (Figs. 75, 76).

During egg laying, i.e., 32 - 37 days of age, there is practically no glycogen deposition and the peripheral globules are rarely visible (Figs. 77, 78).

After 10 - 15 days of egg laying, glycogen is again deposited in the peripheral globules and can be compared with that of 15 - 25 day old females (Fig. 79).

**Ovariectomised Females**

In females, 3 - 7 days after ovariectomy, the glycogen deposition is more intense than that in the normal females of the same age, i.e., 3 - 7 days (Figs. 80, 81).

After 15 days of ovariectomy, intensity of glycogen deposition increases in comparison to that in 3 - 7 day old ovariectomised females and it is more than that in the 15 day old normal females (Fig. 82).

At 25 days of ovariectomy, the glycogen deposition increases further and it is, as usual, more than that of
Fig. 72  
Section of adipose tissue of a newly emerged female *P. pictus* showing a few small peripheral globules with a little glycogen in them. Central globules are clearly visible. (Periodic acid/Schiff X 1000).

Fig. 73  
Section of adipose tissue of a 7 day old normal (copulated) female *P. pictus* showing peripheral globules packed with glycogen deposition which is also seen on the cytoplasmic strands and the edge of the cells. (Periodic acid/Schiff X 1000).

Fig. 74  
Section of adipose tissue of a 20 day old normal female *P. pictus* showing many peripheral globules packed with glycogen deposition which is also visible at the edge of the cells. Central globules are less in number and small. (Periodic acid/Schiff X 450).

Fig. 75  
Section of adipose tissue of a 25 day old normal female *P. pictus* showing intense glycogen deposition in the cytoplasm and peripheral globules. (Periodic acid/Schiff X 450).
**Fig. 76**  Section of adipose tissue of a 30 day old normal female *P. pictus* showing many peripheral globules packed with glycogen. Cytoplasmic area is also elaborated and is rich in glycogen. *(Periodic acid/Schiff X 1000).*

**Fig. 77**  Section of adipose tissue of a normal female *P. pictus* (before egg laying) showing much elaborated cytoplasmic area in which there is practically no glycogen deposition. Central and peripheral globules are not clearly visible. *(Periodic acid/Schiff X 450).*

**Fig. 78**  Section of adipose tissue of a normal female *P. pictus*, just after egg-laying, showing very little glycogen deposition in the peripheral globules. *(Periodic acid/Schiff X 450).*

**Fig. 79**  Section of adipose tissue of a normal female *P. pictus* (10 days after egg-laying) with an elaborated cytoplasmic area and many peripheral globules which are quite rich in glycogen. *(Periodic acid/Schiff X 1000).*
Fig. 80  Section of adipose tissue of a female  
_P. pictus_ as seen after 3 days of ovariectomy.  
The peripheral globules and the cytoplasm are 
rich in glycogen. The nuclear chromatin is 
also stained.  
(Periodic acid/Schiff X 450).

Fig. 81  Section of adipose tissue of a female  
P. pictus as seen after 7 days of ovariectomy.  
The conditions are similar to those in a 3 day  
old ovariectomised female i.e., Fig. 80.  
(Periodic acid/Schiff X 1000).

Fig. 82  Section of adipose tissue of a female  
P. pictus as seen 15 days after ovariectomy.  
The cytoplasmic area is much elaborated and  
along with the peripheral globules. It is  
very rich in glycogen. Central globules are  
very small and a few in number.  
(Periodic acid/Schiff X 1000).

Fig. 83  Section of adipose tissue of a female  
P. pictus, after 25 days of ovariectomy,  
showing intense deposition of glycogen in  
the peripheral globules.  
(Periodic acid/Schiff X 450).
the normal females of 25 days (Fig. 83).

Similarly, after 30 days of ovariectomy, it has been found that there is an intense deposition of glycogen in the peripheral globules which are dense round the nuclei and at the edge of the cells (Fig. 84A, B). The condition can be compared with that of the 30 day old normal female or even more in some cells.

**Females with Testes Implantated**

By implanting the testes of a 2 day old male in a newly emerged female after removing its ovary, and observing its adipose tissue after 5 days, it has been found that there is an intense distribution of glycogen comparable to that in an ovariectomised female, but not to that in a normal male (Fig. 85).

By implanting testes of a 2 day old male in a 7 day old copulated female and observing its fat tissue after 7 days, it is seen that the deposition of glycogen in the peripheral globules is comparable to that in a 10 day old normal male and also to some extent to that in a 15 day old normal female but is more than that of an ovariectomised female of 7 days.

By implanting testes of a 2 day old male in a 10 day
Fig. 84A  
Section of adipose tissue of a female *P. pictus* as seen 30 days after ovariectomy. The cytoplasmic area is elaborated and along with peripheral globules it is rich in glycogen. The nuclear chromatin is also stained. (Periodic acid/Schiff X 450).

Fig. 84B  
The same in oil-emulsion (X 1000).

Fig. 85  
Section of adipose tissue of an ovariectomized female *P. pictus* implanted with testes of a 2 day old male and seen after 5 days. The cytoplasm and peripheral globules have an intense deposition of glycogen. The central globules are very small and a few in number. (Periodic acid/Schiff X 450).
old normal female after removing its ovary and observing its fat tissue after 10 days, it is seen that the deposition is comparable to that of an ovariectomised female of 15 days and to some extent to that of a normal male.

**Males**

In a newly emerged male, glycogen is deposited diffusely on the cytoplasmic strands on which a few peripheral globules are also visible. Thus at this stage, the deposition of glycogen is almost the same as that in the fat cells of newly emerged female, or slightly more in some cells (Fig. 86).

At 3 days, glycogen deposition is depleted and is almost comparable to that in the female of the same age (Fig. 87).

At 7 days, however, peripheral globules with glycogen deposition appear. The intensity of the deposition appears to be comparatively less than that in the fat cells of a 7 day old female because at this stage also glycogen is depleted in the male (Fig. 88).

In a 15 day old male, the deposition of glycogen increases than that in the 3 and 7 day old males and it is almost comparable or even more in some cells to that in a female of 15 days (Fig. 89).
Castrated Males

In a male, 3 days after castration, intensity of the glycogen deposition in the cytoplasmic strands as well as peripheral globules is more than that in the normal male of 3 days (Fig. 90).

After 7 days of castration, the intensity of glycogen deposition is more than that in a normal 7 day old male (Fig. 91).

Similarly, during 15 to 19 days of castration, there is a heavy deposition of glycogen (Fig. 92). The deposition is dense round the nuclei and in the central parts of the cells than in their peripheral parts. Numerous peripheral globules almost cover the entire surface of the cells. The intensity of deposition is naturally more than that in the fat cells of 3 - 7 day old castrated males and, as usual, than in the normal female of the same age, i.e., 15 days.

Males with Ovary Implanted

By implanting ovary of a 3 day old female in a mature male after its castration and observing its fat tissue after 10 days, it is seen that there is very little deposition of glycogen (Fig. 93). This stage is neither comparable to that of a castrated male nor of a normal female
of 13 - 15 days. However, it can be compared with that of a 3 day old normal female.

Similarly, by implanting the ovary of a 15 day old copulated female in a mature male after its castration and observing its fat tissue after 10 days, it has been found that there is practically no glycogen deposition in it. Thus, the condition is neither comparable to that of a castrated male nor of a normal female of 15 or 25 days.

On the other hand, by implanting the ovary of a 15 day old copulated female in a 2 day old male after removing its testes and observing the adipose tissue after 5 days, it is seen that there is a moderate deposition of glycogen in small peripheral globules.

All the above changes concerning the imago of *P. pictus* have been shown in Table VII.
Table VII
Changes in the Accumulation of Glycogen in Normal and Operated Imago of *P. pictus*

<table>
<thead>
<tr>
<th>Age of the insects</th>
<th>Normal (copulated) Females</th>
<th>Ovariectomised Females</th>
<th>Females with testes</th>
<th>Normal Males</th>
<th>Castrated Males</th>
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</table>

+ Diffuse deposition, decrease;  ++  Moderate deposition;
+++  Heavy deposition, increase;  0  Practically no deposition.
Fig. 36 Section of adipose tissue of a newly emerged male *P. pictus* showing intense deposition of glycogen in the peripheral globules. Central globules are of moderate size. (Periodic acid/Schiff X 450).

Fig. 37 Section of adipose tissue of a 3 day old male *P. pictus* showing depletion of glycogen deposition in some cells. (Periodic acid/Schiff X 450).

Fig. 38 Section of adipose tissue of a 7 day old male *P. pictus* showing depletion of glycogen deposition in the peripheral globules. (Periodic acid/Schiff X 450).

Fig. 39 Section of adipose tissue of a 15 day old male *P. pictus* showing intense deposition of glycogen in peripheral globules. (Periodic acid/Schiff X 1000).
Fig. 90  
Section of adipose tissue of a male *P. pictus* as seen 3 days after castration. The peripheral globules have intense glycogen deposition. Central globules are a few in number.  
(Periodic acid/Schiff X 1000).

Fig. 91  
Section of adipose tissue of a male *P. pictus*, 7 days after castration, showing intense glycogen deposition in peripheral globules.  
(Periodic acid/Schiff X 450).

Fig. 92  
Section of adipose tissue of a male *P. pictus*, after 15 days of castration, with intense deposition of glycogen in peripheral globules.  
(Periodic acid/Schiff X 1000).

Fig. 93  
Section of adipose tissue of a castrated male implanted with ovaries of a 3 day old female and seen after 10 days. There is very little deposition of glycogen and peripheral globules are very small.  
(Periodic acid/Schiff X 450).
Deposition and Depletion of Lipids

By adopting Osium/ethyl gallate method of Wigglesworth (1959), the lipids or neutral fats are found to be confined, mainly, to the central globules. The peripheral globules, mitochondria and the nucleolus also stain for lipids. The central globules consist of both unsaturated and saturated lipids. Unsaturated lipids are bound by osmic acid (Wigglesworth, 1957, 1964). Therefore, the structures containing unsaturated lipids are stained black by osmium/ethyl gallate staining. The empty central globules seen after osmium staining show that they contain saturated lipids which are normally extracted. The peripheral globules, mitochondria and nucleoli also contain unsaturated lipids. The cytological details of mitochondria and nucleoli have already been given (p. 28-40).

1) Nymphs

In newly moulted female 5th stage nymphs there is an abundance of saturated and unsaturated lipids. Peripheral globules are very clear containing unsaturated lipids (Fig. 94).

At 3 days in a 5th stage nymph, male or female, there is an elaboration and depletion of saturated lipids (Fig. 95). The central globules with lipids are smaller in size than
those in the newly moulted nymphs. However, the concentra-
tion of lipids is less in the male nymphs than in the females.

After 10 days, in a male or female 5th stage nymph, the
size of central globules decreases while their number increases
(Fig. 96). Unsaturated lipids are abundant as compared to the
saturated ones. The deposition is found to be more dense
round the nuclei than any other part of the cell. Peripheral
globules are clearly visible with unsaturated lipids.

During moulting to the 6th stage, i.e., 18 - 22 day old
5th stage nymphs, deposition of lipids is intense and this is
a dull stage. Only a little lipids are utilised.

In a newly moulted female 6th stage nymph, deposition
of lipids is intense but central globules are smaller in size
and many in number. Saturated lipids are more abundant than
the unsaturated ones (Fig. 97A).

In a male nymph of the same stage, the deposition is
less than in the female but otherwise similar to that in the
latter.

At 3 days, in male or female 6th stage nymphs, the
conditions are similar to those of the newly hatched stage
(Fig. 97B).
After 10 days, there is an elaboration of saturated lipids. Peripheral globules are very small in size as also in number and have unsaturated lipids (Fig. 98A).

During molting to the adult stage, there is an abundance of unsaturated lipids and the fat cells are dull (Fig. 98B), like those in the 5th stage nymph during molting to 6th stage.

All the above changes in nymphs of *P. pictus* are given in Table IV.

11) *Imago*

**Females (Copulated and Virgin)**

In a newly emerged female, there is an intense deposition of unsaturated lipids both in the central and peripheral globules (Fig. 99). A little saturated lipid is also present.

At 3 days, both in the virgin and copulated females, the deposition decreases in comparison to that in the newly emerged stage (Fig. 100). However, unsaturated and saturated lipids are present but mostly unsaturated lipids are there in the copulated female. Protein globules are present.

At 7 days, the deposition of fat further decreases both in the virgin and copulated females and is mainly confined
Fig. 94
Section of adipose tissue of a newly moulted 5th stage nymph of *P. pictus* showing abundance of saturated lipids (empty central globules) and unsaturated lipids (black central globules). Some central globules are seen opening into one another, their membranes being broken at the point of union. The peripheral globules are also very clear containing unsaturated lipids and proteins. Mitochondria are abundant at the edge of the cells.
(Osmium/ethyl gallate X 450).

Fig. 95
Section of adipose tissue of a 3 day old 5th stage nymph of *P. pictus* showing elaboration and depletion of lipids in central globules which are small in size. Mitochondria are abundant at the edge of the cells.
(Osmium/ethyl gallate X 450).

Fig. 96
Section of adipose tissue of a 10 day old 5th stage nymph of *P. pictus* showing abundance of unsaturated lipids in the central globules which are big near the nuclei. Cytoplasmic strands are very clearly visible on which there are very small peripheral globules.
(Osmium/ethyl gallate X 1000).
Fig. 97A  Section of adipose tissue of a newly moulted 6th stage nymph of P. pictus showing abundance of saturated lipids in small central globules. Mitochondria can be seen at the periphery of the cells. (Osmium/ethyl gallate X 1000).

Fig. 97B  Section of adipose tissue of a 3 day old 6th stage nymph of P. pictus showing abundance of unsaturated and some saturated lipids in central globules which are more dense near the nuclei. Mitochondria are present at the edge of the cells. (Osmium/ethyl gallate X 450).

Fig. 98A  Section of adipose tissue of a 10 day old 6th stage nymph of P. pictus showing elaboration of saturated lipids in central globules, some of which (black ones) also contain unsaturated lipids. Peripheral globules are clearly visible and have unsaturated lipids and proteins. (Osmium/ethyl gallate X 1000).

Fig. 98B  Section of adipose tissue of a 6th stage nymph before moulting into the imago. Unsaturated lipids are abundant. Cytoplasmic strands and peripheral globules are clearly visible. (Osmium/ethyl gallate X 1000).
round the nuclei. Both saturated and unsaturated lipids are seen in the fat cells. Protein globules are there (Fig. 101).

After 15 days, many central globules are visible in the fat cells of females; the cytoplasmic area with mitochondria is also seen. It appears that at this stage, there is a lot of elaboration of lipids. Both unsaturated and saturated lipids are present, the former being more abundant and more dense round the nuclei (Fig. 102).

In a copulated female of 20 days, a heavy deposition is found throughout the cells and it is not confined only to the peripheral parts of the cells as in the virgin female. The central globules are larger in size and saturated lipids are more abundant than the unsaturated lipids (Fig. 103).

After 25 days, both in virgin and copulated females, the deposition of fat is comparable to that in the fat cells of 20 day old female. The size of central globules is much bigger, the saturated lipids are more abundant than the unsaturated lipids, and the protein-globules also increase in size (Fig. 104).

At 30 days, although there is intense lipid deposition, the size of the central globules is decreased. Unsaturated lipids are abundant (Fig. 105). Both types of lipids are
present and the proteins are very much less in amount as compared to those of all the female stages described above.

During egg laying, i.e., 32 - 37 days, there is very little deposition of lipids. Only unsaturated lipids have been observed and the protein globules are in the process of formation, i.e., very much less (Fig. 106).

After 10 - 15 days of egg laying, the lipid deposition as well as the proteins are still very little in amount.

Ovariectomised Females

In females, 3 - 7 days after ovariectomy, the distribution and size of central globules are almost similar to those in normal females of 3 - 7 days. But at these stages, saturated lipids are more, i.e., most of the central globules are empty. Protein globules are as abundant as in normal females (Fig. 107).

After 15 to 25 days of ovariectomy, more saturated lipids are deposited than the unsaturated. This deposition is less in comparison to that in the normal females of 15 - 25 days of age (Fig. 108). The cells are big but there is no lipid intensity.

At 30 days after ovariectomy, there is a little deposition of unsaturated lipids round the nuclei (Fig. 109).
Thus, at this stage also no accumulation of lipids has been observed.

**Females with Testes Implanted**

By implanting testes of a 2 day old male in a newly emerged female after removing its ovaries and observing its fat tissue after 5 days, it has been noted that saturated and a little unsaturated lipids accumulate in the central globules. This can be compared to that in a male of 7 days.

By implanting testes of 2 day old males in females of 7 and 10 days after their ovariotomy and observing their fat tissues after 7 and 10 days respectively, an accumulation of saturated lipids has been found. A few globules also contain unsaturated lipids (Fig. 110). This is comparable to that in males of 10 - 15 days and to some extent to that in the ovariotomised females of 15 - 20 days.

**Males**

In a newly emerged male, lipid deposition is comparable to that in the similar stage of the female. Both saturated and unsaturated lipids are present at this stage but saturated lipids are more as compared to those in the female (Fig. 111). Proteins are abundant.

At 3 days, also, the deposition of unsaturated lipids
Fig. 99  Section of adipose tissue of a newly emerged female *P. pictus* showing abundance of unsaturated lipids in central globules, some of which open into one another, the membrane being broken at the point of union. Peripheral globules are also visible. (Osmium/ethyl gallate X 1000).

Fig. 100  Section of adipose tissue of a 3 day old normal (copulated) female showing unsaturated lipids in the central globules which are less in number and smaller than those in the newly emerged female (Fig. 99). Mitochondria are abundant near peripheral globules and cytoplasmic area is elaborated. (Osmium/ethyl gallate X 450).

Fig. 101  Section of adipose tissue of a 7 day old normal female *P. pictus* showing depletion of lipids. Cytoplasmic area is elaborated, central globules are small and seen only near the nuclei. Mitochondria and peripheral globules are visible at the edge of the cells. (Osmium/ethyl gallate X 450).

Fig. 102  Section of adipose tissue of a 15 day old normal female *P. pictus*. Both unsaturated and saturated globules are present in the central globules, the former being more abundant round the nuclei. Cytoplasmic area with mitochondria is also visible. (Osmium/ethyl gallate X 1000).
Fig. 103  Section of adipose tissue of a 20 day old normal female *P. pictus* showing abundance of saturated lipids in big central globules throughout the cytoplasm of the cells. (Osmium/ethyl gallate X 450).

Fig. 104  Section of adipose tissue of a 25 day old normal female *P. pictus* showing accumulation of saturated lipids in big central globules. (Osmium/ethyl gallate X 1000).

Fig. 105  Section of adipose tissue of a 30 day old normal female *P. pictus* showing intense accumulation of lipids (mostly unsaturated) in the central globules. (Osmium/ethyl gallate X 450).

Fig. 106  Section of adipose tissue of a normal female *P. pictus* before egg laying, showing a little deposition of lipids. Very small peripheral globules with protein and unsaturated lipids are visible. Mitochondria are seen at the periphery of the cells. (Osmium/ethyl gallate X 1000).
**Fig. 107** Section of adipose tissue of a female *P. pictus*, 3 days after ovariectomy, showing abundance of saturated lipids in most of the central globules. Peripheral globules are clearly visible.
(Osmium/ethyl gallate X 1000).

**Fig. 108** Section of adipose tissue of a female *P. pictus* as seen after 15 days of ovariectomy. There is a little deposition of saturated lipids in small central globules. Cytoplasmic area with mitochondria is much elaborated.
(Osmium/ethyl gallate X 450).
Fig. 109  Section of adipose tissue of a female P. pictus seen after 30 days of ovariectomy. There is a little deposition of unsaturated lipids in small central globules round the nuclei. (Osmium/ethyl gallate X 450).

Fig. 110  Section of adipose tissue of an ovariectomised female of P. pictus implanted with testes of 2 day old male and seen after 7 days. An accumulation of unsaturated lipids in small central globules can be seen. Small peripheral globules with protein and unsaturated lipids are also visible, at the periphery of the cells. (Osmium/ethyl gallate X 450).
is less than that of the 3 day old female. However, some central globules are large in size and contain saturated lipids which is more, as usual, than those in the female of the same age (Fig. 112A). Proteins increase in comparison to those in the newly emerged stage.

After 7 days, the conditions of lipids and proteins are similar to those in the 3 day old male (Fig. 112B). Unsaturated lipids are, as usual, less than those in the female of the same age. During 3 - 7 days, a little cytoplasmic area is visible in the male fat cells and central globules are small.

At 15 days, the lipid deposition has slightly increased than that in 3 and 7 day old males but it is, as usual, less than that in the female of 15 days (Fig. 113). The smaller central globules containing unsaturated lipids are more round the nuclei. Protein globules are comparable to those in a 15 day old female.

Castrated Males

In males after 3 - 7 days of castration, the deposition of lipid is less than that of normal males of 3 - 7 days (Figs. 114, 115). Unsaturated lipids appear in central globules which are very small in comparison to those of normal males of 3 - 7 days.
After 15 - 19 days of castration, the deposition of unsaturated and saturated lipids is more than that in 3 and 7 day old castrated males. However, at these stages, the deposition is comparable to that in the normal males of 15 - 19 days but in contrast to the latter, in castrated males unsaturated lipids are also seen. The size of central globules is bigger than that in the normal males (Fig. 116).

**Males with Ovary Implanted**

By implanting ovary of a 3 day old copulated female in a male after its castration and observing its fat tissue after 10 days, it is seen that the deposition is comparable to that of a 15 day old copulated female and also to some extent to that of a castrated male, i.e., unsaturated lipids are also deposited as against those in normal males. However, there is a depletion of the deposition at this stage (Fig. 117A).

By implanting the ovary of 7 day old copulated female in a male after its castration and observing the fat tissue after 10 days, it is found that at this stage, also, there is a depletion of saturated lipids which can be compared to that of a 15 day old female or a castrated male.

By implanting the ovary of a 15 day old female, either in a 2 day old male or in a mature male after its castration, it has been found that the deposition of lipids is comparable
Fig. 111  Section of adipose tissue of a newly emerged male *P. pictus* showing intense accumulation of saturated and unsaturated lipids. Peripheral globules with protein and unsaturated lipids are also visible. (Osmium/ethyl gallate X 1000).

Fig. 112A  Section of adipose tissue of a 3 day old male *P. pictus* showing accumulation of saturated lipids in most of the central globules. (Osmium/ethyl gallate X 1000).

Fig. 112B  Section of adipose tissue of a 7 day old male *P. pictus* showing saturated lipids in central globules which have decreased in size. There is a depletion of lipids at this stage. (Osmium/ethyl gallate X 1000).

Fig. 113  Section of adipose tissue of a 15 day old male *P. pictus* showing accumulation of unsaturated lipids round the nuclei. Some central globules also contain saturated lipids. Peripheral globules with protein and unsaturated lipids are also visible. (Osmium/ethyl gallate X 450).
Fig. 114  Section of adipose tissue of a male *P. pictus*, after 3 days of castration, showing a little accumulation of unsaturated lipids in the central globules. Peripheral globules and mitochondria are abundant at the edge of the cells. (Osium/ethyl gallate X 450).

Fig. 115  Section of adipose tissue of a male *P. pictus*, 7 days after castration, showing saturated lipids (empty globules) and some unsaturated lipids in the central globules. (Osium/ethyl gallate X 450).

Fig. 116  Section of adipose tissue of a male *P. pictus*, after 15 days of castration, showing accumulation of unsaturated (black) and saturated lipids in the central globules. Peripheral globules and mitochondria are also visible. (Osium/ethyl gallate X 450).
Fig. 117A  Section of adipose tissue of a castrated male, implanted with ovary of a 3 day old female and seen after 10 days, showing accumulation of unsaturated lipids. (Osmium/ethyl gallate X 450).

Fig. 117B  Section of adipose tissue of a castrated male, implanted with ovary of a 15 day old female and seen after 15 days. There is a deposition of unsaturated lipids round the nuclei. Some of the central globules have saturated lipids. (Osmium/ethyl gallate X 450).
to that of normal males. Saturated lipids are more and there is also a deposition of unsaturated lipids round the nuclei (Fig. 117B).

All the above changes in the imago of P. pictus have been shown in table VIII.

**Phospholipids and Acidic Lipids**

By staining Formol-calcium fixed fat tissue with a saturated solution of Sudan black B in 70% alcohol (McManus, 1946), it has been found that large sudanophilic droplets (central globules) are surrounded by a number of small, faint ones which were later observed to contain acidic lipids from the results by following Nile blue staining technique of Cain (1957). These observations tally with those of Odhiambo (1967) for *Schistocerca*. By osmium/ethyl gallate method described earlier, it has been found that the central globule is comprised of neutral fat. This fact is also confirmed by Sudan black B method whereby central globules took a dark colouration. Further confirmation has been made by Nile blue sulfate method in which the central globules took a pinkish colouration while peripheral globules were stained blue. The pink colour of the central globule is due to the oxazine form of the dye which is specific for neutral fats according to Baker (1958) and the blue colour of the peripheral
globules is due to the presence of acidic lipids in them. As phospholipids yield fatty acids on hydrolysis (Pearse, 1960), we may assume that the peripheral globules also contain phospholipids along with acidic lipids.

The distribution and concentration of neutral fats, throughout the nymphal, adult and the operated stage, are exactly similar to those observed by cæmum/ethyl gallocate method. Acidic lipids are less in amount throughout the life cycle of the insect in comparison to the neutral fats.

In 5th and 6th stage nymphs (Figs. 118, 119), lipids are abundant. Elaboration is there during 3 - 10 days and during moulting also, lipids are packed in the fat cells which are inactive. Lipid deposition appears to be less in male nymphs than that in the female ones.

In ovariecotomised females (Figs. 120 - 122) and castrated males (Figs. 124 - 126), cells are simply stuffed with lipids but there is no elaboration and utilisation.

In females with testes implanted (Fig. 123), saturated lipids are abundant as the unsaturated ones are utilised by the growing testes. On the other hand, in the fat cells of males implanted with ovaries (Fig. 127), unsaturated lipids are abundant, the saturated being taken up by the ovaries.
Table VIII

Changes in the Accumulation of Unsaturated and Saturated Lipids in Normal and Operated Imago of *P. pictus*

<table>
<thead>
<tr>
<th>Age of the insects</th>
<th>Normal (copulated) Females</th>
<th>Ovariectomized Females</th>
<th>Females with testes</th>
<th>Normal Males</th>
<th>Castrated Males</th>
<th>Males with ovaries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unsaturated</td>
<td>Saturated</td>
<td>Unsaturated</td>
<td>Saturated</td>
<td>Unsaturated</td>
<td>Unsaturated</td>
</tr>
<tr>
<td>Newly emerged</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>3 days</td>
<td>++</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>7 days</td>
<td>++</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>15 days</td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>20 days</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>25 days</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>30 days</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Before egg laying</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>After egg laying</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

+ Little deposition, decrease; ++ Moderate deposition; +++ Heavy deposition, increase; 0 Practically no deposition.
Fig. 118A  Section of adipose tissue of a newly moulted 5th stage nymph of *P. pictus* showing elaboration of lipids in central and peripheral globules. (Sudan black B × 450).

Fig. 118B  Section of adipose tissue of a 3 day old 5th stage nymph showing elaboration of lipids as in the newly moulted nymph (Fig. 118A) in central and peripheral globules. (Sudan black B × 450).

Fig. 118C  Section of adipose tissue of a 10 day old 5th stage nymphs of *P. pictus* showing intense accumulation of lipids in central and peripheral globules. (Sudan black B × 450).

Fig. 118D  Section of adipose tissue of a 5th stage nymph, before moultling to the 6th stage, showing cells packed with lipids. (Sudan black B × 450).
Fig. 119A Section of adipose tissue of a newly moulted 6th stage nymph of P. pictus showing elaboration of lipids in the cells. (Sudan black B X 450).

Fig. 119B Section of adipose tissue of a 3 day old 6th stage nymph of P. pictus with intense accumulation of lipids in peripheral globules. The central globules are also seen containing lipids. (Sudan black B X 450).

Fig. 119C Section of adipose tissue of a 10 day old 6th stage nymph showing accumulation of lipids round the nuclei. (Sudan black B X 450).

Fig. 119D Section of adipose tissue of a 6th stage nymph, before moultting into the imago, showing cells packed with lipids. (Sudan black B X 450).
Fig. 120. Section of adipose tissue of a female *P. pictus*, 7 days after ovariectomy, showing cells packed with lipids. (Sudan black B X 450).

Fig. 121. Section of adipose tissue of a female *P. pictus* as seen after 15 days of ovariectomy. The cells are stuffed with lipids. (Sudan black B X 450).

Fig. 122. Section of adipose tissue of a female *P. pictus* as seen after 30 days of ovariectomy. The cells are stuffed with lipids. (Sudan black B X 450).

Fig. 123. Section of adipose tissue of a female *P. pictus*, implanted with testes of 2 day old male and seen after 5 days. The central globules (empty) have saturated lipids. (Sudan black B X 450).
Fig. 124  Section of adipose tissue of a male
P. pictus as seen 3 days after castration.
The peripheral globules and some central
globules are packed with lipids.
(Sudan black B X 450).

Fig. 125  Section of adipose tissue of a male
P. pictus as seen 7 days after castration.
The central and peripheral globules are
stuffed with lipids.
(Sudan black B X 450).

Fig. 126  Section of adipose tissue of a male
P. pictus, 15 days after castration, showing dull cells packed with lipids.
(Sudan black B X 450).

Fig. 127  Section of adipose tissue of a castrated
male, implanted with ovaries of a 15 day old
female and seen after 10 days. There are
very small central and peripheral globules
packed with lipids.
(Sudan black B X 450).
D. BIOCHEMICAL OBSERVATIONS ON THE ADIPOSE TISSUE
OF P. PICTUS

Lipids and glycogen form the major components of the developing oocytes and they are also utilised by the growing testicular tissue in the males. These components are transferred to the gonads from the adipose tissue. So an attempt has been made to correlate the transfer of lipids and glycogen from the adipose tissue and their utilisation in the gonads (ovaries and testes).

Estimation of Lipids

Lipids were extracted and estimated by the methods of Lovern (1963) and Hodgson (1965) as described earlier (p. 14) from the fat body and gonads of nymphs, normal females and normal males. They were also extracted from the fat-bodies of ovariolectomised females and castrated males. At least 3 - 4 insects were used for each stage and the average value calculated for the same.

1) Nymphs

In a late 5th stage nymph, the percentage of the lipid of the fat-body is more than that in the gonad (ovary or testis).
In newly moulted 6th stage nymphs and during 3 - 15 days, the lipid content of the fat body as well as that of the gonads increases gradually. During molting to the adult, the lipids further increase both in the fat body and gonads.

11) Imago

**Females (Copulated: Normal)**

In a newly emerged female, there is a considerable amount of lipids in the fat body in comparison to that in the ovary (Fig. 128).

During 3 - 7 days, the percentage of lipid gradually decreases in the fat body and increases in the ovary in comparison to that in the fat body and ovary respectively of a newly emerged female.

At 15 days, the fat body has a high percentage of lipids as shown in the table. The ovary has much more lipids at this stage than the fat body and it is the maximum. After 15 days, there is a gradual decrease of the percentage of lipids in the fat body up to the period of egg laying (Table IX; Fig. 128). The ovary also loses its lipids content gradually after 15 days until egg laying, i.e., 32 - 37 days.
Table IX
Changes in the Lipid Component (gm/100 gm Fresh Weight) of Fat Body and Gonads in Normal and Castrated Imago of *P. pictus*

<table>
<thead>
<tr>
<th>Age of the insects</th>
<th>Lipid (gm/100 gm) in Fat Body (Adipose tissue)</th>
<th>Lipid (gm/100 gm) in ovary</th>
<th>Lipid (gm/100 gm) in Fat Body of ovariectomised Females</th>
<th>Lipid (gm/100 gm) in Fat Body of castrated Males</th>
<th>Lipid (gm/100 gm) in Testis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newly emerged</td>
<td>19.80</td>
<td>8.70</td>
<td>19.20</td>
<td>7.60</td>
<td></td>
</tr>
<tr>
<td>3 days</td>
<td>19.60</td>
<td>9.36</td>
<td>15.80</td>
<td>52.50</td>
<td>10.70</td>
</tr>
<tr>
<td>7 days</td>
<td>19.35</td>
<td>15.30</td>
<td>10.52</td>
<td>11.30</td>
<td>9.50</td>
</tr>
<tr>
<td>15 days</td>
<td>26.20</td>
<td>50.60</td>
<td>15.70</td>
<td>17.20</td>
<td>10.30</td>
</tr>
<tr>
<td>25 days</td>
<td>24.13</td>
<td>9.60</td>
<td>24.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 days</td>
<td>23.71</td>
<td>7.20</td>
<td>20.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>During egg laying</td>
<td>7.20</td>
<td>25.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ovariectomised Females

The fat-bodies of females, after 7, 15, 25 and 30 days of ovariectomy, contain less amount of lipids than those in the fat-bodies of the normal females of 7, 15, 25 and 30 days respectively (Fig. 128).

Males

In a newly emerged male, the fat body has less percentage of lipids than that in the fat body of a newly emerged female. On the other hand, the testis at this stage has more lipids than the ovary of a female of the same stage (Fig. 128).

At 3 days, the amount of lipids in the fat body of a male is less than that in a newly moulted male and also than that in a female of the same age, i.e., 3 days. On the other hand, there is a rapid increase of lipids in the testis of a 3 day old male. It is much more in amount than in the ovaries, not only of a 3 day old female but of a 15 day old female as well.

At 7 days again, there is a decrease of lipids in the male adipose tissue. This amount is also less than that in the fat-body of a 7 day old female. The testis also looses lipids at this stage as shown in table IX and Fig. 128.

At 15 days, the lipid content of the fat-body of a male
increases and remains constant for the rest of the life. However, this amount is less, as usual, than that in the fat-body of a 15 day old female. The testis has also less lipid than that in the ovary of a female of the same age.

**Castrated Males**

In 3 - 7 day old castrated males, the percentage of lipids is less than that in the fat-body of normal males of 3 - 7 days respectively. However, at 15 days of castration, the amount of lipid is almost the same as that in a 15 day old normal male.

All the above changes in the imago of *P. pictus* are given in table IX.

**Estimation of Glycogen**

Glycogen was estimated by the method given earlier (p. 14 - 15). Four to five insects were used for each extraction and average value for each stage calculated.

1) **Nymphs**

In a late 5th stage nymph, there is a considerable amount of glycogen in the fat body which is more than that in the gonad (ovary or testis).

In a newly moulted 6th stage nymph, the percentage of
glycogen is less in the fat-body while it increases in the gonad.

At 15 days, the glycogen content in the fat-body increases, though as usual, it is less in comparison to that in the gonad.

During moulting to the adult stage, the percentage of glycogen decreases both in the fat-body and gonads.

11) Imago

**Females (Copulated: Normal)**

In a newly emerged female, there is a considerable amount of glycogen which is comparable to that of the fat body of a newly emerged male.

At 3 - 7 days, the percentage of glycogen in the adipose tissue of females appears to be slightly more than that in the males while after 15 days, it is less than that in the fat-body of a male of the same age. Thus, the percentage of glycogen gradually increases from newly emerged stage, up to 15 days (Fig. 129).

In the ovaries of 3 - 7 day old females, the percentage of glycogen is more than that in the testes of males of the same age. After 15 days, the glycogen content in the
fat-body as well as in the ovary increases again as shown in table I. However, at this stage, the glycogen content of the fat-body is less and that of the ovary is more than the fat-body and testis respectively of a male of the same age.

At 25 days, the glycogen content of the fat body of a female is almost the same as that of a 15 day old female but it increases in the ovary.

At 30 days and up to the period of egg-laying, the percentage of glycogen gradually decreases in the fat-body as well as in the ovary, though it is always more in the fat-body than in the ovary.

Ovariectomised Females

In the adipose tissue of 7, 15 and 25 day old ovariectomised females, the percentage of the glycogen increases a lot as compared to that in adipose tissue of the normal females of 7, 15 and 25 days respectively. However, at 30 days of ovariectomy, the amount of glycogen is almost comparable to that in the fat-body of 30 day old normal female (Fig. 129).

Males

In the fat body of a newly emerged male, the amount of glycogen has been found to be almost the same as that in
the fat-body of a female of the same stage.

During 3 - 7 days, though there is a gradual increase, the amount of glycogen in the fat bodies of the males appears to be less than that of females of the same age.

At 15 days, the percentage of glycogen increases a lot in the fat-body of a male and it is more than that of a female of the same age (Fig. 129).

The amount of glycogen in the testes of males is always less than that in the ovaries of the females of corresponding ages.

Castrated Males

The percentage of glycogen in the fat-body of castrated males of 3, 7 and 15 days respectively is more than that in the fat bodies of normal males of the same ages.

All the above changes concerning the image of P. pictus are given in table X.
Table X

Changes in the Glycogen Component (gm/100 gm Fresh Weight) of Fat Body and Gonads in Normal and Castrated Imago of P. pictus

<table>
<thead>
<tr>
<th>Age of the insects</th>
<th>Normal Females</th>
<th>Glycogen (gm/100 gm) in Fat Body</th>
<th>Glycogen (gm/100 gm) in Ovary</th>
<th>Glycogen (gm/100 gm) in Fat Body of ovariectomised Females</th>
<th>Normal Males</th>
<th>Glycogen (gm/100 gm) in Fat Body of Castrated Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newly emerged</td>
<td>45.20</td>
<td>45.50</td>
<td></td>
<td></td>
<td></td>
<td>65.50</td>
</tr>
<tr>
<td>3 days</td>
<td>63.96</td>
<td>70.00</td>
<td>65.90</td>
<td></td>
<td>42.60</td>
<td>11.30</td>
</tr>
<tr>
<td>7 days</td>
<td>73.90</td>
<td>72.20</td>
<td>80.20</td>
<td></td>
<td>65.40</td>
<td>25.20</td>
</tr>
<tr>
<td>15 days</td>
<td>85.90</td>
<td>83.20</td>
<td>88.60</td>
<td></td>
<td>91.10</td>
<td>33.60</td>
</tr>
<tr>
<td>25 days</td>
<td>85.20</td>
<td>89.10</td>
<td>99.90</td>
<td></td>
<td></td>
<td>90.30</td>
</tr>
<tr>
<td>30 days</td>
<td>71.00</td>
<td>52.70</td>
<td>70.69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During egg laying</td>
<td>20.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig. 128  A graph showing changes in the lipid component (gm/100 gm fresh weight) of the adipose tissue and gonads of normal imago of *P. pictus* and that of the adipose tissue of operated (castrated or ovariectomised) imago with reference to age since its emergence from the last (6th nymphal stage).

Fig. 129  A graph showing changes in the glycogen component (gm/100 gm fresh weight) of the adipose tissue and gonads of normal imago of *P. pictus* and that of the adipose tissue of operated (castrated or ovariectomised) imago with reference to age since the emergence of the imago from last (6th) nymphal stage.
CHANGES IN THE LIPID COMPONENT OF THE ADIPOSE TISSUE AND GONADS IN THE IMAGO OF *P. PICTUS*

CHANGES IN THE GLYCOGEN COMPONENT OF ADIPOSE TISSUE AND GONADS IN THE IMAGO OF *P. PICTUS*
URIC ACID

Following Gomori's silver hexamine method, scattered deposition of uric acid is seen at all stages of the insect. However, the deposition is less in the nymphs than in the imago and increases with age.
B. OBSERVATIONS ON THE NEUROENDOCRINE COMPLEX AND NEUROSECRETORY CELLS OF CASTRATED P. PICTUS

Following Harker's and Ewen's Paraldehyde/fuchsin methods (p. 15) it has been found that the neurosecretory cells of the ovariectomised females of P. pictus are packed with neurosecretory material. The corpora cardiaca have a little neurosecretory material while the corpora allata are filled and hypertrophied (Figs. 130 - 132).

Similarly, the neurosecretory cells of castrated males are filled with neurosecretory material, the corpora cardiaca have a little of it and the corpora allata are hypertrophied (Fig. 133, A, B, C).

The corpora allata of males with ovary implanted are not hypertrophied and seem to be active (Fig. 133D).
Fig. 130A  Section of brain of a female *P. pictus*, 7 days after ovarietomy, showing neurosecretory cells filled with neurosecretory material. (Formaldehyde/fuchsin X 200).

Fig. 130B  Section through corpus cardiacum of the same, showing a little neurosecretory material in it. (Formaldehyde/fuchsin X 450).
Fig. 131A  
Section of brain of a female *P. pictus*, 15 days after ovariecotomy, showing filled neurosecretory cells.
(Paraldehyde/fuchsin X 200).

Fig. 131B  
Section through corpus cardiacum of the same showing a little neurosecretory material in it.
(Paraldehyde/fuchsin X 200).

Fig. 131C  
Section through the corpus allatum of the same showing hypertrophied and filled cells.
(Paraldehyde/fuchsin X 450).
Fig. 132A  Section of brain of a female P. pictus, 30 days after ovariectomy, showing filled neurosecretory cells. (Paraaldheyde/fuchsin X 200).

Fig. 132B  Section through the corpus cardiacum of the same showing a little neurosecretory material in it. (Paraaldheyde/fuchsin X 200).

Fig. 132C  Section through the corpus allatum of the same showing filled and hypertrophied cells. (Paraaldheyde/fuchsin X 450).
Fig. 133A  Section of brain of a castrated male P. pictus, showing neurosecretory cells filled with neurosecretory material. (Paraldehyde/fuchsine X 200).

Fig. 133B  Section through the corpus cardiacum of the same showing ordinary neurosecretory material in it. (Paraldehyde/fuchsine X 200).

Fig. 133C  Section through the corpus allatum of the same showing hypertrophied cells. (Paraldehyde/fuchsine X 450).

Fig. 133D  Section through the corpus allatum of a castrated male P. pictus, implanted with ovary showing active cells filled with secretory material. (Paraldehyde/fuchsine X 450).
GENERAL REMARKS

The adipose tissue of *P. pictus* has been studied in order to investigate the elaboration of nucleic acids and the metabolites like proteins, glycogen and lipids during their metamorphosis, growth etc. A brief survey of the biochemical quantitative estimations of glycogen and lipids has been made in order to study as to when and at what stage they are synthesized or accumulated in the adipose tissue and depleted or transferred to the gonads. The cytological changes during synthesis, storage and transport of reserves have been correlated with the histochemical and biochemical changes in the fat body.

Typically the small trophocytes of the nymphaeal and young stages contain few inclusions. During growth, cells increase at different rates with their nuclei and nucleoli also growing independently. Although, according to Butterworth (1967), growth is manifested to different extents in the cell and its components, in the present study, growth has simply been defined as an increase in cell size. In some cases, growth may be due to enormous amounts of lipids or in others due to increase of the background cytoplasm. It appears that the increase in lipids makes the cells inactive and dull while an increase in the background cytoplasm provides active source for functioning.

It has been observed that usually, cells along with their nuclei and nucleoli increase gradually in a given stage, i.e., 5th or 6th stage nymphs and adult males or females. But as a whole,
the cells of nymphs are larger than those of the adults in which the cells are more in number but smaller in size.

During growth, the cells increase in size as well as in number and become loaded with fat, protein and glycogen to the extent where their boundaries may be completely obliterated.

It may be mentioned here, that in the cells in which both synthesis and secretion are going on, cytoplasm as well as the vacuoles are visible but in the cells in which there is no secretion or transport of reserves, the cytoplasm is decreased and the cells are loaded with reserves in the globules. Also, the cells, in which neither synthesis nor transport of reserves is there, appear packed with reserves and they are inactive. In short, the growth of the fat body, elaboration and utilisation of reserves as well as their storage or synthesis can be followed as given below:

**Females**

In female 5th stage nymphs, the cells are narrow and elongated. They are large in number and their size increases gradually with age. At this stage, mitochondria are a few round the nuclei. Nucleic acids are intense and there is an elaboration of the reserves. However, of all the reserves, proteins are most diffusely deposited, while lipids and glycogen are packed up in the cells. During moulting, though the cell size is big, nuclei and nucleoli decrease in size. As a result, nucleic acids are also less. Mitochondria are only a few and not very active. Glycogen and proteins decrease
in amount, while lipids are abundant. The insect is thus dull at this stage and saturated lipids are stored as an energy reserve while glycogen and to some extent proteins and unsaturated lipids are utilised.

In 6th stage female nympha, the cells increase in number by division. Consequently, they are large in number but smaller in size. At this stage, mitochondria are abundant near the nuclei and between the peripheral globules on the cytoplasmic strands. The proteins in the peripheral globules are quite intense but a granular deposition is still not there. Unsaturated lipids are depleted at this stage. During moulting to the adult stage, the conditions resemble those of the 5th stage nymph during moulting to the 6th stage, i.e., glycogen and to some extent proteins and unsaturated lipids are utilised. Saturated lipids remain in the adipose tissue. Nucleic acids are also depleted.

Thus, during moulting the insect has a good amount of lipids in the adipose tissue as an energy reserve with a declination in the glycogen deposition. Nucleic acids decrease but proteins are only slightly utilised.

In adult females, the cells increase in number by division and consequently they are smaller in size than those of the nymphs. Nuclei and nucleoli increase in some cases
in comparison to those of the nymphs.

RNA increases during 3 - 30 days of age and becomes less intense during egg-laying. The cells and nuclei increase gradually with age up to 25 days while nucleolar size remains constant during 3 - 15 days after which it increases. The nucleoli are seen budding during 3 - 15 days and also give nucleolar extrusions during 10 - 25 days, particularly in the copulated females. These migrate out in the cytoplasm and become Feulgen and PAS negative but are stained by P/MG and HgBPP.

The mitochondria are very rich in fat cells of females up to 25 days of age. They are particularly dense round the nuclei and at the edge of the cells. However, they are also visible between the peripheral globules on the cytoplasmic strands.

The size and the number of peripheral globules vary with the physiology of the body. In the newly emerged females, they are very small and few in number. During 3 - 25 days, they are very conspicuous while they reduce in size in 30 day old females which are about to lay.

It has been concluded from the observations that in the females, proteins are abundant during 7 - 25 days of age
and after 25 days, they are stored up to 30 days. During egg laying, the proteins are again depleted. This suggests that proteins are synthesised in female fat cells with the help of nucleoli during 7 - 25 days. The nuclei and their branches also elaborate a mechanism in the cytoplasm for the synthesis of proteins. During this period, i.e., 7 - 25 days, proteins are synthesised as well as utilised by the growing oocytes and also in other metabolic processes. But during 25 - 30 days, there is no depletion of proteins and they accumulate in the fat cells.

Deposition of glycogen in the peripheral globules goes almost parallel with that of the proteins. However, it is stored in the fat cells during 15 - 25 days of age. During early periods of life, it is utilised. It is most elaborated during 15 days of age. The total glycogen in the fat body, as estimated biochemically, increases gradually from newly emerged stage up to 15 days. After this, there is a gradual depletion up to the period of egg laying.

From cytological studies, it is concluded that lipids are formed in the fat cells during 3 - 15 days of age. During this period, they are also consumed by the fat body. During 20 - 30 days, the lipids, specially the saturated ones, are deposited and stored in the fat cells. If not stored, at least they are not synthesised at this period. The total
lipid in the fat body, as estimated biochemically, appears to increase up to 15 days after which there is a gradual decrease up to 30 days. The reason may be the same, that is, at this period lipids are not synthesised.

During 25 - 30 days, i.e., in later stages of life, the feeding activity of the insect decreases and only a little synthesis goes on in the adipose tissue. Naturally, the reserves are mostly stored at this period to be consumed during egg laying and other metabolic activities. This may be the reason that biochemically, the total lipids appear to be less during late stages of the insect.

During egg laying, i.e., 32 - 37 days of age, the cell size along with the nuclei decreases. Nucleoli have already decreased in size after 25 days of age. It appears that in P. pictus, most of the metabolites — rRNA, protein, glycogen and lipids are depleted at the time of egg-laying of the females.

However, after 10 days of egg-laying, the cells as well as nuclei and nucleoli increase in size. The cytoplasmic area is much elaborated. The mitochondria again make their appearance. The protein globules are in the process of formation. There is, also, a little amount of lipid and glycogen at this stage.
After about 15 days of egg-laying, the fat cells again acquire a normal structure, with quite big cells, nuclei and nucleoli, intense nucleic acids and deposition of reserves. The insect prepares itself for second egg-laying.

In the virgin females, the activities are almost like those of the copulated females, except for the size of the cells which is slightly smaller in the former. Concentration of nucleic acids, proteins and lipids is negligibly less in the virgin females while glycogen deposition is almost like that of the copulated ones.

Thus, it is concluded that in *P. pictus*, the presence of mature males has no effect upon females' maturation as is the case in *S. gregaria*. The role of the mature males is only in copulation, which very likely allows the cells to synthesise and secrete a lot of neurosecretory material, discharge of which in the haemolymph enables successful development of the oöcyte (Seini, 1971) and perhaps stimulates general metabolism.

**Ovariectomised Females**

By studying the females after removing their ovaries, it has been concluded that the ovary regulates the size of fat cells and the proportion of reserves within them.
After removing the ovary from a newly emerged female and allowing them to grow, it has been seen that the cells hypertrophy in comparison to those of the normal females. In some cases, particularly, after 25 - 30 days after ovariectomy, the nuclei and nucleoli also increase in size, although budding or extrusion is not noted. However, distribution of nucleic acids and deposition of reserves except lipids, are definitely more than those in the normal females. The cytoplasmic area is also increased in the ovariectomised females and this may be the cause of the hypertrophy of the cells. Saturated lipids are abundant in the ovariectomised females.

Since we know that the reserves are passed to the haemolymph from the fat body and thence to the developing organs such as ovaries for utilisation, it is suggested from the observations that in the absence and inactivity of the ovary, the reserves are not utilised, the solute concentration in the haemolymph increases and consequently the fat cells hypertrophy.

It appears that the ovary regulates the uptake of nutrients from the adipose tissue which controls the concentration of solutes in the haemolymph. This, in turn, regulates the neuroendocrine complex, since it has been found that in ovariectomised females, the neurosecretory cells were
packed with secretion and the corpora allata were also hyper-
trophied and packed, i.e., they were inactive (Figs. 130–132)
as has also been observed by Highnam (1962). As such, ovary
has no direct effect on the metabolic activities of the adipose
tissue. If it has, that may only be on the synthesis of
lipids.

Mitochondrial activity cannot be observed in ovariec-
tomised females with testes implanted. The intensity of
nucleic acids and the deposition of proteins, glycogen and
lipids are almost like those of males. It is inferred,
therefore, that testes have a masculinizing effect on the fat
cells of females, though the cell size is larger than that of
normal males as has been compared by Butterworth (1968) in
Drosophila.

Males

In male nymphs of 5th and 6th stage, particularly the
latter, the cells as well as the nuclei are slightly larger
than those of the female nymphs. The cells increase gradually
in size from the 5th stage nymph up to the newly hatched stage
of the male.

The mitochondria are a few in the male nymphs, observed
only in 5th stage nymphs round the nuclei. Nucleic acids and
proteins are less intense in comparison to those of the female
nymphs. Unsaturated lipids and glycogen are almost similar to those in female nymphs.

During moulting, nucleic acids, glycogen and to some extent proteins and unsaturated lipids are depleted. Thus, it is concluded that during metamorphosis, most of the metabolites, i.e., RNA, glycogen, proteins etc. are utilised. However, lipids remain in the cells as an energy reserve. In horn fly (Pearnicolt, 1960) and silk moth (Gilbert and Schniderman, 1961), the total lipids increase after every moult. This has also been found in L. pictus but some unsaturated lipids are definitely utilised during moulting.

The large size of cells, in nymphs as well as in adult males of 3 - 7 days, may be due to the absence of ovary which has a restricting effect on the growth of female adipose cells as mentioned by Butterworth (1968). It appears that there must be some regulatory mechanism in males similar to that in the ovary of females or the male cells have a growth limit (Butterworth, 1968) because during 10 - 15 days, the cell size decreases and becomes constant.

The mitochondria are less in number than those in the female fat cells. Nucleic acids are intense during 3 - 7 days but appear to be depleted during 15 days. Proteins are found to be synthesised as well as depleted during 3 - 7 days.
while at 15 days, they are stored in the fat body.

Unsaturated lipids are very little in male adipose cells while saturated lipids are there. The total lipid, as estimated biochemically, is less in male than that in the female adipose tissue.

On the other hand, total glycogen in the fat cells of males is more than that of females during the time when there is no testicular development, i.e., at the newly emerged stage and after the time the males have become fully mature and there is no further sexual development, i.e., 15 days. Histochemically, also, it has been found that there is a depletion of glycogen during 3 - 7 days, very likely for the maturation of testes but at newly emerged stage and during 10 - 15 days, glycogen is accumulated in the fat cells and its amount is more than that in the females of the same ages.

Thus in males, there is only a little synthesis of metabolites which are utilised mostly during 3 - 7 days of age.

Castrated Males

In general, the cells hypertrophy in the castrated males. The nuclei and nucleoli, also, increase in size. In some cases, very big vacuolated nucleoli are seen but they do not appear to give out extrusions.
Mitochondria are quite a few in castrated males. Just as in ovariectomised females, the fat cells of castrated males accumulate reserve substances except lipids. The reason may be the same as in the case of females, i.e., due to the absence and inactivity of gonads, the fat cells hypertrophy, filling up with protein and glycogen and possibly loose the power of synthesising lipids.

By implanting ovary in males after removing their testes, the cell size decreases suggesting that this can also be regulated by the ovary. The nucleoli, however, increase in size and nucleic acids are quite intense. On the other hand, the deposition of reserves, i.e., proteins, lipids and glycogen is depleted if observed during 5 – 10 days of implantation. It is suggested that these reserves are synthesised and then they are utilised by the growing ovary within the body of the male. Mostly unsaturated lipids are found in the fat cells of such males showing that saturated lipids have been taken up by the growing ovary implanted in them. However, if observed after 15 – 16 days of implantation of a quite mature ovary, i.e., that of a 15 day old female, the fat cells of such males are found to be packed with reserves which is comparable to those of the normal males. This may be due to the fact that the ovary has attained its full growth and the reserves are not utilised by it, but are simply stored as in the fat cells of mature males.
Thus, in castrated males and ovariectomised females, the cells increase in size and the cytoplasmic area also increases. The deposition of glycogen and proteins is very intense. However, the lipids are found to be less. It is concluded, therefore, that possibly the gonads (Ovary and testis) in P. pictus have an effect on the cell size and on the synthesis of lipids in the adipose tissue. In castrated individuals, no stage of elaboration is noted. This shows that the gonads have an influence on the elaborating mechanism of the adipose tissue, specially, the elaboration of lipids.

It has been observed that in castrated individuals of P. pictus, the neurosecretory cells are filled and the corpora allata are hypertrophied and also filled with neurosecretory material. Most probably, the gonads control the physiology of the adipose cells either by ionic balance or by hormonal balance which acts as a feed-back for the neurosecretory material to be secreted or depleted. This is definite that the activity of the gonads has an effect over the secretory activity of the neurosecretory cells. It may be through the adipose tissue or directly from the blood. The filled neurosecretory cells and big degenerated corpora allata are the signs of dull activity as mentioned by Highnam (1962).
The fat body of Insects has been studied by various workers; specially, the histological and histochemical details have been studied in great detail by Buys (1923), Wigglesworth (1942), Zeller, Holland (in Wigglesworth, 1965), Kreuscher (1922), Schnelle (1923), Poisson (1924) Pérez (1920) (in Wigglesworth, 1965), Gilby (1965), Chefurka (1965) and many others. The cytology of the insect fat body has been studied by Bishop (1953), Von Gaudecker (1963), Wassermann et al. (1963), Locke & Collins (1965), Walker (1965) and Odhiambo (1967). But as far as the author is aware, detailed histochemical work on insect fat body are those of Coupland (1957) and Odhiambo (1967) for Schistocerca gregaria, Nair and George (1964) for Anthrenus larvae and Benson and Benson (1966) for Sarcophaga.

As far as the biochemical observations are concerned, the fat body of S. gregaria has been studied in great detail by Paillot (1926, 1937), Pardi (1939), Pfeiffer (1945), Weis-Fogh (1952), Kilby and Neville (1957), Desai and Kilby (1958), Shigematsu (1958), Zebe and Moshan (1959), Clements (1959), George and Kaper (1959), Young et al. (1959), Tietz (1961, 1962), George and Hegdekar (1961), George and Nair (1964), Levenbook (1961), Hearfield and Kilby (1959).
Hines and Smith (1963), Orr (1946), Chefurka (1965), Gilby (1965), Odhiambo (1967) etc.

Investigations on the present work show that the general structure of the fat body of *Poecilocerus pictus* is similar to that described by Coupland (1957) and Odhiambo (1967) for *Schistocerca*. The fat body of *P. pictus* has also the similar arrangement of peripheral portion attached to the overlying epidermis and a more central portion existing as a loose meshwork of tissue in the space between the gut and the body wall. The fat body cells, specially the peripheral ones are closely associated with large cells — the oenocytes as found in *Schistocerca* also. The function of the oenocytes, according to Richards (in Gilby, 1963), is more assumed than known. It is generally believed that they may be concerned with intermediary metabolism. According to Wigglesworth (1965), the oenocytes undergo a cycle of changes during molting and may be associated with the formation and secretion of lipoprotein required by the new epicuticle. The close association of oenocytes with fat cells may contribute to the function of fat cells.

The cell boundary is noticeable in early stages and with a good fixation in all the stages, though at some stages, where due to abundance of reserves the cell is distended, the
cell wall may not be visible. In this respect, i.e., visibility of the cell wall, the fat body of *P. pictus* is similar to that of other Orthoptera, some Coleoptera, Lepidoptera, posterior region in Hemiptera and Hymenoptera according to Buys (1923). However, it differs in this behaviour from Ephemeroptera, Trichoptera, anterior portion in Hemiptera, lower Diptera (Tipulidae, Chironomidae etc.) and some Coleoptera like *Anthrenus* (Hair and George, 1964), where the cell boundary is lost during embryonic development and the fat body appears as a syncytium. The fat cells of *Philosoman* are also syncytial (Walker, 1965).

The fat body of *P. pictus* shows similar cellular conditions, both in the peripheral and deeper zones. Further, it exhibits similar conditions in nymphs as well as adult stages i.e., the same nymphal tissue persists in the adult. Thus, it differs from other Diptera like *Phormia* (Orr, 1964), *Drosophila* (Butterworth and Bodenstein, 1965) etc., where the larval tissue degenerates and forms a small portion of adult adipose tissue.

As regards the general structure of the adipose tissue in *P. pictus*, the cell boundary and a clear basement membrane have been noted. The foldings of basement membrane have also been noticed by osmium/ethyl gallate preparations as by
Odhiambo (1967). The penetration of the basement membrane material has been observed. Odhiambo (1967) has mentioned that there is a frequent penetration of the basement membrane material into the fat body which is in excellent intercommunication with the haemolymph. Such communication has also been observed in the corpus allatum of Schistocerca by Odhiambo (1966).

Growth in the fat body of *P. pictus* is quite complex, as the cells, nuclei and nucleoli grow at different rates. After the nymphal stages, the cells become smaller in size and larger in number, the nuclei increasing or decreasing in size independently. During these stages, the background cytoplasm increases or decreases and the reserves are formed, accumulated or depleted according to the need of the insect. According to Butterworth *et al.* (1967), it appears that the cell and each of its components may be responding independently to growth stimulus and growth is manifested to different extent in the cell and its components. But, here, growth is simply defined as an increase in cell size as in *Drosophila* by Butterworth (1967). Growth may be due to enormous lipid deposition or due to an increase in the background cytoplasm, and cell growth is not always proportional to nuclear or nucleolar growth.
The cell nuclei are usually round or oval as found in *Schistocerca*. They are indented in some adult stages, whereas in nymphs and early stages of adults, they are branched; the branches extending into the cytoplasm between the globules. They are intensely chromatic as also described by Coupland (1957) in *Schistocerca*.

The general appearance of a fat cell is such that surrounding the nucleus, there are some globules. Usually, there is a big globule of neutral fat in the centre containing unsaturated or saturated lipid. This is surrounded by many smaller peripheral globules as described by Nair and George (1964) in *Anthrenus*. Such type of arrangement of globules has also been shown in *Schistocerca* by Odhiambo (1967). According to Nair and George (1964), these configurations behave as units during dissociation of fat-cells. Each of the peripheral globules is surrounded by a membrane, whose arrays are continuous with the cytoplasmic area, which is common with the thin strands of cytoplasm as also mentioned by Odhiambo (1967). The central globules are also covered by thin delicate membranes. These globules open into one another, the membranes being broken at the point of union. The peripheral globules are also connected with one another. This has not been observed by Nair and George (1964), neither by Odhiambo (1967).
However, they have mentioned a membrane round the big central globules, which does not appear around the lipid droplets of the vertebrate adipose tissue of rat (Napolitano, 1963). It could not be made out in the present work whether central globules are connected to peripheral ones, although it was very clearly observed that the smaller central globules at the periphery of the adipose cells had a crowding of peripheral globules round them, whereas the bigger central globules in the centre of the cells are surrounded by very small peripheral globules, which are also less in number than those in the periphery.

In between the nucleus, large lipid globules and small peripheral globules, there are thin strands of cytoplasm as has also been observed by Odhiambo (1967) by electron microscope studies in *S. gregaria*. These strands become prominent when large lipid globules become smaller in size or disappear. On the sides of the cells, there are crowded dot-like mitochondria. They are seen approaching the peripheral globules, which are also plenty and prominent at the edge of the cells.

Very likely, the mitochondria on the sides of the cells bring lipids from the haemolymph and they themselves transform into lipid-protein complex in the peripheral globules. The peripheral globules in turn, drain the lipids into the central globules. These increase in size by taking
up lipids and gradually move to the centre of the cells. They exhaust their reserves while coming to the periphery where they become small in size. Thus, there are big central globules in the centre of the cells and smaller ones at the periphery. Again, the mitochondria bring the reserves and form peripheral globules, which pass the lipids in the central globules. This process (Fig. 134) continues in an active cell, but it is not found in an inactive or hypertrophied cell.

As regards the central globules, they might have their origin de novo in the Golgi bodies at a very early stage of life, but it appears that during the latter period, they receive their fat-stores from the peripheral globules, which in turn, get it from the mitochondria. The mitochondria transform into proteins, lipids and glycogen into these special peripheral globules as has already been discussed. This process is clearly observed at the surface of the cells of the fat-body as has also been seen in the macrophages of mammals during the uptake of lipids and lipid-proteins (Casley-Smith and Day, 1966) and also in the young larvae of *Drosophila* (Von Gaudecker, 1963). This is also supported by the work of Paillot and Noel (1926), who have mentioned that droplets of reserve proteins are derived from the breakdown of mitochondria. Von Gaudecker (1963) has observed that the mitochondria turn into lysosomes, which incorporate glycogen and lipids to
Fig. 134  A diagram representing relationship of mitochondria, peripheral globules and central globules in a cell of adipose tissue of *P. pictus.*
produce the heterogeneous droplets of reserve protein. Similar observations have also been made by Walker (1966) in Philosomia and Wigglesworth (1967) in Rhodnius.

The peripheral globules can be compared with a group of 'catalysomes' described by Wigglesworth (1966). In that case, they receive the reserves by the transformation of mitochondria and further transform them into neutral fats which are passed to the central globules as mentioned by Nair and George (1964). In this way, a cellular process which is initiated at an early stage of life in the nucleus and Golgi bodies is carried on in the cytoplasm for the rest of the life.

The endoplasmic reticulum is not well developed in the fat cells of P. pictus as in Maberus (Walker, 1965). This condition can be compared to that in vertebrate fat-cells where endoplasmic reticulum is ill-developed (De Robertis et al., 1960; Wassermann and Mcdonald, 1963).

Histochemical studies on the adipose tissue of insects during growth, moulting and reproduction has not been made in detail except only by some authors like Wigglesworth (1942) on Aedes, Coupland (1957), Odhiambo (1967) and Osborne (1968) on S. gregaria, Nair and George (1964) on Anthrenus, Butterworth et al. (1965, 1967, 1968) on Drosophila, Benson

In general, the authors have agreed to the ideas of Nair and George (1964) regarding the pattern of the fat body - (1) with central globules surrounded by peripheral globules, (2) that this configuration is the functional unit of the fat body.

The chemical nature of the peripheral globules has not yet been fully defined. However, Walker (1966) has called them as albuminoid granules while Ishizaki (1965) as dark bodies. According to Benson and Benson (1966), these are depot of acid phosphatase while according to Locke and Collins (1965), there are deposits of proteins in these granules.

As far as the peripheral globules of P. pictus are concerned, RNA, protein, glycogen and also the lipids are found to be present or accumulated in them. But in insects like Aedes (Wigglesworth, 1942), Drosophila (Wigglesworth, 1947; Butterworth et al., 1965) as well as in Philosoma (Ishizaki, 1965), Sarcophaga (Benson and Benson, 1966) etc., the protein, lipid and carbohydrate granules are found separately in the cytoplasm. Similar observations were also made for Euboerus by Walker (1965).
Nucleic Acids

DNA is characteristically distributed over the chromatin granules of fat cells of _P. pictus_. The chromosomes do not appear; this has been observed by Butterworth et al. (1965). No DNA positive granule is noticed in the cytoplasm. This has also been pointed out by Coupland (1957). Figures of mitosis have been noticed in some stages as has also been described by Butterworth et al. (1965).

RNA - Distribution of RNA has been found in the nucleolus and cytoplasm of fat cells of _P. pictus_ as has also been mentioned by Nair and George (1964) in _Anthrenus_, Coupland (1957) and Odhiambo (1967) in _S. gregaria_ and Pemrick and Butz (1970) in _Tenebrio_.

RNA intensity in the nucleolus and changes in its size have been noted at different stages. Enlargement of nucleolus and changes in the intensity of pyranophilia has also been mentioned by Pemrick and Butz (1970), Butterworth et al. (1965) and Osborne (1968).

Nair and George (1964) have showed that there is very little RNA in the fat body and ribonucleases; saliva or acid trichloroacetic could not remove the pyranophilia in the cytoplasm of the adipose tissue of _Anthrenus_. They have concluded that it is some different phosphate group which gives the
reaction due to complex phosphate binding in these granules. It appears that in P. pictus, RNA is present over the cytoplasm as well as nucleolus and also in the peripheral globules. The intensity increases or decreases with other metabolic activities.

The histochemical studies show that the RNA intensity in the peripheral globules is somewhat cyclic in nature as has been observed by Mills (1966) for cockroach. There is a gradual increase in activity up to the time the ovary is developing. There is maximum intensity during 15 - 30 days in females when the oöcyte is taking up perhaps the greatest amount of protein. There is a decrease in the intensity of RNA during periods of laying. The nucleoli also contain RNA and show similar changes. Their size increases up to about 10 days in copulated and 15 days in virgin females when they also become vesiculate and extrusions are visible during 10 - 20 days. These extrusions perhaps migrate to the cytoplasm, increasing its RNA content — they are observed passing towards the periphery of the nucleus although no emission bodies have been found passing out of the nuclear membrane. However, they are found to be protuding from the nuclear membrane with the nuclear wall covering these protrusions. Ishizaki has also noticed several nucleoli of irregular shape and that in full grown larva, the nucleoli become vacuolated and each vacuole
contains eosinophilic bodies. The vacuolated profile of the nucleoli show that they are in inactive stage. In adult *Philosoma*, the apparent continuity between the nucleus and cytoplasm suggests the occurrence of material transfer between the nucleus and cytoplasm according to Walker (1966).

(Glycogen has been described in the vacoules by Wigglesworth (1942) in *Aedes* and in the cytoplasm in the fat cells of *Drosophila* by Butterworth *et al.* (1965). Coupland (1957) has described the distribution of glycogen in diffuse and granular forms in the adipose tissue of *Schistocerca*, while Odhiambo (1967) has found only granular deposition in the cytoplasm. Nair and George (1964) have mentioned the presence of glycogen in the peripheral globules. In *P. pictus*, the reaction is diffuse and glycogen has been found in the peripheral globules and over the cytoplasmic strands around them.

Proteins have been noticed in the form of granules, called protein vacoules in *Aedes* and *Drosophila* by Wigglesworth (1942, 1949). As regards *Rhodnius* fat cells, Wigglesworth (1947) has mentioned that protein is found as a condensed zone round the nucleus with filaments radiating outwards between the fat droplets and there is no discrete deposition of proteins. Coupland (1957) has noticed a diffuse reaction of protein throughout the non-fatty cytoplasm of the fat body of *Schistocerca*. It is partly diffuse and partly concentrated
in small cytoplasmic granules. Large plaques of protein are not present.

Odhiembo has not found discrete granules of proteins in the fat body of *Schistocerca* as found by Coupland (1957). Here, in *P. pictus*, also, no discrete granules have been noted in the cytoplasm, but a diffuse reaction in the cytoplasmic strands and in the peripheral globules have been found. It may be mentioned here that Butterworth has observed the protein granules appearing separately in the cytoplasm.

The histochemical studies for *P. pictus* agree with the observation of Benson and Benson (1966) that protein in the fat body is found in 4 regions of the cell: in the nucleolus, in association with the DNA of the nucleus, as a diffuse reticulum throughout the cytoplasm and as a component of the peripheral globules. Benson and Benson have also observed that the cytoplasmic protein is lysosomal in nature, while the diffuse basic protein of the cytoplasm associated with RNA is rich in histones as is the nuclear protein.

The behaviour of the nucleoli with reference to protein synthesis has been noted by Casperson (1950), Gresson (1931, 1960), Neth and Mohan (1929) and Sehini (1967). In every case, the nucleolar buds are observed. Butterworth and Bodenstein (1965) have noticed the vacoulsiation of the
nucleolus but they have not referred to the nucleolar buds. In insect fat body, the products of nucleoli are extruded through the nuclear membrane. They have been studied by Bishop (1922), Kremer (1917, 1925) and Peillot (1926, 1937). They spread outwards from the nucleus, increase in size and become eosinophilic (Schnelle, 1923); and the process is comparable with the formation of yolk spheres of the egg.

Wigglesworth (1967) has also shown that when the fully starved larvae of *Rhodnius* is given a meal of blood, the first change that becomes apparent is enlargement of nucleoli with accumulation of RNA. There is also a deposition of RNA round the nucleus.

Nucleic acid relationship with protein synthesis has been provided by Hogben (1920), Nath and Mohan (1929), Greson (1931, 1960), Bonhag (1958, 1959) and many others. According to Casperson (1950), histones from the nucleolus diffuse in the cytoplasm and induce the synthesis of ribonucleoprotein in the vicinity of the nuclear membrane. This, in turn, synthesises the cytoplasmic proteins (Brechet, 1957). The author fully agrees with this concept, but it seems definite that the nucleolar extrusions serve to transfer the RNA positive nucleolar material in the cytoplasm.
Lipids have been observed in the adipose tissue of insects in the form of small and big vacuoles by different authors. Wigglesworth (1942) has shown that in *Aedes*, there are minute droplets of fat, chiefly around the nuclei. Later, they pass outwards and enlarge becoming the most obvious of the inclusions of the fat body. Quite often, when the fat first becomes visible, it is in the form of a slender crescent applied to a spherical non-fatty cytoplasm. In *Rhodnius* (Wigglesworth, 1947), fat droplets of different sizes are noted throughout the fat bodies. Further, Coupland (1957) has noticed big vacuoles of fat in the cytoplasm of the fat body of *Schistocerca*.

Odhambo (1967) has found that each fat cell has several droplets of various sizes. Most of the fat body is occupied by neutral fat and a little acidic lipid. It may be mentioned here, that the fat found in the central globule of *P. pictus* consists of unsaturated lipids and saturated lipids. Unsaturated lipids are bound by osmic acid (Wigglesworth, 1964). Butterworth (1965) has also pointed out that osmium tetroxide so binds unsaturated lipids as to render them insoluble to most organic solvents; the empty droplets presumably contain relatively little proportion of saturated lipids which are normally extracted. An attempt has been made to investigate in *P. pictus*, which type of
lipid increases or decreases at which time.

Butterworth has not mentioned the peripheral globules in *Drosophila*, though he has shown various sizes of small and big lipid globules.

Nair and George (1964) were the first to point out that the central globules have neutral fat and around them are peripheral globules which perhaps contain acidic lipids. They have also noticed a diffuse staining of fat round the peripheral globules. In osmium/ethyl gallate treated fat tissue of *P. pictus*, the peripheral globules are found to contain only unsaturated lipids as against both types found in the central globules as stated above. Unsaturated lipids are also found in the dot-like mitochondria.

Walker (1966) has described (with the help of electron microscope) various types of albuminoid granules in the fat tissue of *Philosomia*. However, the vacuoles of *P. pictus* are only of two types: central and peripheral, and very likely, the latter type resemble the third type of granules of *Philosomia*.

Wigglesworth (1947) has shown that in *Rhodnius*, the glycogen of the fat body becomes depleted at the time of cuticle formation. Similarly, in *Drosophila*, the variability
in the fat body, glycogen occurs at the time of moulting which suggests that glycogen may be mobilised during cuticle formation. Further, many workers have found considerably less glycogen in one part of the fat body than in other parts, which has also been observed in the fat cells of *P. pictus*. Butterworth (1965) has suggested that the fat body cells in one region may be physiologically differentiated from that of the other and this view is supported by the observations of Rizki (1961, 1964), who showed that the cells in certain regions of the larval fat body of *Drosophila* behave differently with reference to kynurenine synthesis. Coupland (1957) has noted that the fat cells in first instar nymphs of *Schistocerca* contain large amounts of glycogen both in fat cells and oenocytes. Further, the glycogen content of the adult locust is less than that of the nymphs.

The work of Butterworth and Bodenstein (1968) are worth mentioning. They have pointed out that there is a biochemical difference of fat tissue in the presence of glycogen and lipids. The males contain more amount of glycogen and less amount of lipids; while, the females have larger amount of lipids as compared to glycogen.

In *P. pictus*, the glycogen content in 3 and 7 day old males is depleted in the fat cells, most likely for the
testicular development. But at newly emerged stage and during 15 days of age, glycogen is definitely more in male fat cells than that in the females as found by both histological and biochemical observations. However, in the nymphal stages, the intensity of glycogen deposition is more than that in the adult stages. This behaviour is the same as found in Schistocerca (Coupland, 1957). Further, it may also be mentioned here, that in nymphal stages, the intensity of glycogen decreases during moulting. Very likely, as mentioned by Wigglesworth (1957), it must be mobilised for cuticle formation.

In castrated males and females, there is great deposition of glycogen and the intensity is much more than in the normal males or females.

Usually, when ovaries were implanted in the body of castrated males, glycogen deposition decreased up to 10 days. Thus, it was lesser as compared to that of both normal males or females.

Similarly, when testes were implanted in the ovariec-tomised females, there was a diffuse deposition of glycogen during first 5 days of implantation. But after 10 days, the deposition increased and it was comparable to that of ovariec-tomised females.
The males containing ovary for 4 days, in Drosophila did show certain changes in Butterworth's experiments. The cells became smaller in size.

In P. pictus, there is a definite difference in the cell size of the fat cells of males and females. The male cells are definitely bigger than those of the females at least up to 7 days. The average cell size of the nymphs is bigger than that of the adult. In adult males, cell size increases up to about 7 days, after which it is depleted and the smaller size becomes constant. But in females, the cell size increases and changes up to 25 days. Then it decreases to some extent during laying.

Here, it may be said that Butterworth has noticed little change in the cell size of the ovary-containing males up to 2 days. Then after 15 days, it is same as that of females.

When ovary was implanted in the males, the glycogen deposition decreased in comparison to that of the normal males. The cell size also decreased. The nuclei were bigger as compared to those of normal males, but smaller than those of castrated males. Similarly, the ovary causes the male cells to become smaller and a decrease in glycogen deposition in Drosophila as observed by Butterworth (1968).
The glycogen has been depleted by the presence of ovary and it seems that the ovary has a definite feminising effect on the male adipose tissue. But when the castrated females are implanted with testes, the glycogen deposition persists in the fat cells of the female. This shows that the testes have not that effect over the fat body as the ovaries with reference to the elaboration of glycogen.

In the castrated females, the cell size, nuclear and nucleolar size have increased. Glycogen is more than that of the normal females. Total lipids are less, but histochemically it has been found that saturated lipids are more as compared to those of normal females, where the cells are packed with unsaturated lipids.

In general, the fat cells seem to hypertrophy. This happens due to accumulation of glycogen and protein and non-utilisation of lipids in \( P. \) pictus.

In Drosophila, as described by Butterworth et al. (1968), the cell size has increased, but the glycogen decreases. It appears that increase in cell size is not accompanied by a concomitant increase in the ability to store glycogen. However, lipid increases.

In \( P. \) pictus, on the other hand, glycogen increases. Thus, the cells of ovariectomised \( P. \) pictus hypertrophy, but in
no way these can be compared with those of the normal male cells which have lesser amount of glycogen. However, these can be compared with those of the castrated males which have also big cells and more amount of glycogen than the normal males. Bodenstein (1947) has also reported hypertrophy of male adipose cells in castrated males of *Drosophila virilis*.

As far as the deposition of lipids is concerned, the fat-cells are packed with unsaturated lipids in the nymphs, which are only slightly utilised during molting and appear to be like energetic stores as has also been observed by Wigglesworth (1950, 1965) in *Rhodnius*; otherwise, the total lipids appear to increase after every moult as in silk-moth (Gilbert and Schniederman, 1961) and horn-fly (Pearncolt, 1960).

The male fat cells are also packed with lipids but, here, saturated lipids form the major component. Butterworth (1967) has found more amount of lipids in females than in males as compared to the amount of glycogen. Such difference is not very clearly marked in *P. pictus* as observed by histochemical methods. By biochemical methods, however, it has been found that the glycogen component is more and lipid less in male than in the female adipose tissue during newly emerged stage and during 15 days. At 3 - 7 days, this difference
is not noticeable, most probably, due to utilisation of reserves in testicular development of males during this period.

Lipid movement, formation, accumulation, secretion etc. have been clearly noted (Fig. 135), especially in females. Very likely, these are related with ovarian metabolism. Unsaturated lipids are more in the fat cells of normal females, while in ovariectomised females, saturated lipids are there. Further, in ovariectomised females with testes implanted, intense deposition of saturated lipids in the fat cells appears. It is suggested from these observations that in the female, the ovary takes up more saturated lipids for oöcyte development. So, the normal females show a great deposition of unsaturated lipids in their fat cells, while ovariectomised females, of saturated lipids which are not utilised. Similarly, in ovariectomised females with testes implanted, the growing testes very likely take up the unsaturated lipids while the saturated ones remain in the fat cells. On the other hand, the testes in males take up more unsaturated lipids; so, the fat cells have a deposition of saturated ones. This is further confirmed when males are castrated and a lot of unsaturated lipids which are not utilised are seen in the adipose tissue. The castrated males with ovary implanted, also show deposition
Fig. 135A A diagram representing formation, accumulation, movement and depletion of lipids in the cells of adipose tissue of adult female *P. pictus* as seen during 1: newly emerged stage (accumulation), 2 - 4: 3 - 15 days respectively (gradual depletion and elaboration), 5 - 7: 20-30 days respectively (accumulation) and 8: before laying (almost complete depletion).

Fig. 135B A diagram representing formation, accumulation, depletion and movement of lipids in male *P. pictus* as seen during 1: newly emerged stage (accumulation), 2 - 4: 3 - 7 days respectively (elaboration and depletion) and 5: 15 days (accumulation).
of unsaturated lipids in the adipose tissue as the saturated lipids are used up by the growing ovaries.

From the above, it can be suggested that the ovary and the testes control the accumulation and depletion of saturated and unsaturated lipids respectively. The lipids utilised by the ovary are mostly saturated ones and those utilised by the testis are mostly unsaturated lipids. Such a phenomenon has not been described by Butterworth.

In castrated males, total lipids are less than those in the normal males, but glycogen is more. Similarly, in ovarioctomised females, total lipids decrease, while glycogen increases in comparison to those in the fat body of normal females. This also suggests the role of ovary and testis on the metabolism of lipids in the adipose tissue. It has been observed that in castrated males and ovarioctomised females of *P. pictus*, the neurosecretory cells are very much filled and the corpora allata are also filled and hypertrophied. It may be mentioned here, that although the gonads (testis and ovary) have a definite effect on the activity of the adipose tissue, it may not be hormonal as suggested by Dose (1961). But it appears that the concentration of the haemolymph is controlled by the gonads. This in turn, controls the activity of neurosecretory cells and neuro-endocrine complex which then regulate the synthesis and accumulation of metabolites.
in the adipose tissue.

It may, therefore, be said that the insect adipose tissue is rather different than that of the vertebrates because it not only accumulates the lipids, but also synthesises proteins, carbohydrates and lipids, more like the liver of vertebrates. The castration has a different effect. It does not permit accumulation of fats as in the vertebrates, but does affect the synthesis of metabolites, specially the lipids. Perhaps, such a process might be occurring in the liver of vertebrates, where the castration might be playing a role in such metabolism. It has already been noticed that castration has an effect on the synthesis, activity and function of the adipose cells in *P. pictus*.

Proteins appear in the third instar larva of *Drosophila*, and Butterworth (1967) has experimentally demonstrated its deposition in adipose tissue under hormonal control. But no such granules are noticed in the adult tissue. Coupland (1957) has noticed a diffuse as well as granular reaction in the fat body of *Schistocerca*, while Odhiambo (1967) has found only granules in the same insect. Pamrick and Butz (1970) have described that the synthesis of protein is a cyclic pattern which may be related to ovarian development. The incorporation of tritiated leucine into proteins of the fat body is lowest at emergence and steadily increases for the next 6 days for
both mated and unmated females. According to Hill (1962, 1965), protein synthesis is low before oöcyte production, increases during yolk deposition and drops again at the end of the oöcyte development in *Schistocerca gregaria*.

In the nymphs of *P. pictus*, proteins accumulate at 2 - 3 days after emergence at the beginning of the intermoulting period and decrease during moulting to the next stage.

Osborne et al. (1968) have observed in *S. gregaria* that protein rises up to 15 days in the adult female which synthesises new proteins. This is correlated with simultaneous rapid enlargement of the oöcyte. In *P. pictus*, if the nucleolar extrusions, the intensity of RNA and protein deposition are correlated; it appears that the process starts just after 10 days of the emergence of the imago. The proteins are synthesised and secreted from the fat-body cells for 10 - 25 days of life when the maximum development of the oöcyte takes place. During egg laying, protein deposition decreases considerably.

As regards males, there is a slow process of protein synthesis which is observed during 3 - 7 days. After this period, only accumulation is seen.
From histochemical account of the proteins, it is
difficult to judge their synthesis or accumulation. The
castrated males and ovariecctomised females accumulate proteins
in the adipose tissue, just like the accumulation of RNA
and glycogen, because these are not utilised.
In the present investigations, the histochemical and cytological studies on the adipose tissue of *Poecilocerus pictus* Fab. have been made.

The changes in the metabolites like proteins, carbohydrates and lipids during growth, metamorphosis and reproductive periods have been studied. The general picture of their localisations in the cytoplasm has been correlated with the growth of ovaries and testes. Further, the cytoplasmic inclusions like mitochondria etc. have been studied and interpreted. The cellular details — the changes in nuclear and nucleolar size have been investigated. The peripheral globules and their relationship with mitochondria on one hand and central globules on the other, have been specially observed with the help of osmium/ethyl gallate method (Wigglesworth, 1959) which fixes the unsaturated lipids and also shows protein granules.

The general histochemical details of proteins, carbohydrates and lipids in the peripheral globules have been compared to further explore the function of peripheral globules.

The adipose tissue of *P. pictus* continues from the
nymphal to the adult form and there is no larval fat body
as in some other insects. The fat body or the adipose
tissue of the nymph simply grows further and accumulates
more reserves after every moult period in the successive
moulting.

The cell boundaries are distinct in the early stages
and become obliterated when the cells increase in size and
get loaded with reserves. The cells of the males, whether
nymph or adult, are slightly bigger in size than those of
the females.

During the successive age and intermoult periods, the
cells increase in size in the 5th nymphal stage. They
decrease in size and increase in number by mitotic divisions
in the succeeding 6th nymphal stage and in the adult stages.

The growth of the cell size is independent of that
of the nuclear and nucleolar size in the cell. This is very
clearly exhibited in the adult forms.

The metabolites, like protein and glycogen, are actively
utilised at the period of moult and their intensity decrea-
ses. However, it appears that although lipids are not syn-
thesised during moult, some are definitely utilised at that
period. After every successive moult, the accumulation of
lipids increases in the cells of the fat body.

The adipose tissue synthesises proteins, carbohydrates and the lipids. The process of activity is noticed during the intermoult period when there is a lot of cytoplasmic area filled with peripheral globules and mitochondria. At this stage, the average size of central globules is moderate. On the contrary, in a packed cell which is rather inactive, the cytoplasmic area is not clearly seen and mitochondria are less. The central globules are very big and are surrounded by small peripheral globules which are not very clearly visible.

There is no doubt that there is a difference and dimorphism in the cell size and the cell contents of the fat body of males and females. The cells of the males are bigger and they have more glycogen and less lipids, while females have slightly smaller cells with more of lipids and less glycogen as compared to those of the males.

The cells of the male adipose tissue have more saturated lipids. It seems that the unsaturated lipids are taken up by the testes. Similarly, the cells of the female adipose tissue have more unsaturated lipids because, most probably, the saturated ones are utilised by the ovary.

In females, the proteins are definitely synthesised
in the cell which becomes apparent as the nucleoli become increased in size and budding and vacuolisation are noticed in them, during 10 - 25 days. The RNA and proteins are very much intense in the adipose tissue of females during 7 - 25 days.

It appears that the lipids are transported and synthesised in the adipose tissue during 7 - 20 days when the cytoplasmic area is very clearly visible along with the peripheral globules and moderate sized central globules. The mitochondria are few at the edge of the cells. They are also noticed in the cytoplasmic strands round the peripheral globules. As mentioned earlier, they bring the raw material from the haemolymph and they themselves transform into lipid-protein complex in the peripheral globules which also store glycogen.

The lipids, both saturated and unsaturated, are passed to the central globules, the glycogen and proteins being retained by the peripheral globules.

Thus, in P. pictus, lipids are mainly found in the central globules, glycogen and proteins in the peripheral globules and RNA in the peripheral globules, in the cytoplasm as also in the nucleoli. Glycogen increases with age reaching to a maximum intensity during 25 - 30 days.
All these reserves are taken up by the ovary and they decrease to a very great extent during the period of egg-laying. It seems that they are also utilised in the process of foam-production which forms a covering over the oöocytes in the genital chamber.

In males, the activity is similar as in females, but the duration is rather short. Nucleolar extrusions are not seen in the males. However, the carbohydrates and lipids appear to be synthesised, secreted and transported from the cell during 3 - 7 days. After this period, the cells become dull and no such activity is noticed. The reserves decrease after 15 days (the testicular development and activity in *P. pictus* takes place during 3 - 10 days).

The gonads of *P. pictus* are peculiar in the sense that they control the physiology of the adipose tissue — the accumulation of carbohydrates, proteins, nucleic acids and lipids in it. The castrated individuals have big cells which have big nuclei and nucleoli, increased cytoplasmic area and intense nucleic acids, glycogen and protein. But there is no accumulation of lipids. It appears that in *P. pictus*, gonads have a control over the synthesis of lipids in the adipose tissue. The synthesis decreases in the ovariecotomised females and castrated males.
It has also been found that the testes pick up more unsaturated lipids and leave the saturated lipids in the adipose tissue, while the ovary picks up both but a good quantity of saturated lipids are taken up; so, the female adipose cells have mostly unsaturated lipids and a little saturated lipids. This has been experimentally observed by implanting ovaries in castrated males and testes in ovarioctomised females.

The ovary, also, has a control over the cell size and the deposition of glycogen. It appears that in *P. pictus*, although the gonads (ovary and testis) do not produce any hormone, they regulate the concentration of the haemolymph which regulates the neurosecretory cells and neuro-endocrine complex which, in turn, control the synthesis of proteins, glycogen and lipids in the adipose tissue. In the castrated individuals, the neurosecretory cells are packed with secretion and corpora allata are hypertrophied. There is no secretory activity in the corpora cardiacs.

Scattered deposition of uric acid is also found in the adipose tissue of *P. pictus*. 