CHAPTER IX
DISCUSSION

Some of the conclusions may be stated as follows:

The possibilities of rearing of silk worms, particularly *Antheraea proylei* as a means to establishing the silk industry in Manipur are investigated to an extent from the point of view of the availability of the plant resources that can be used as food stuff to the silk worm, and the physiological characters of the silk worm in regard to growth and development, and yield of the silk fibre.

The three oak plants, viz., *Quercus serrata*, *Quercus dealbata* and *Quercus pachyphylla* which grow in abundance, appear to provide the nutrients for the silk worm. Their leaves may furnish the chief source of various nutritive elements required by the silk worms not only for their sustenance but also for yielding of good cocoons.

I. NUTRITIONAL QUALITIES:

1) Moisture source from the leaves: The chemical analysis of the foliage constituents of the three oak plants shows that the total percentage of moisture for the medium aged leaves of *Quercus pachyphylla*, *Q. dealbata* and *Q. serrata* is 58.63%, 55.13%, and 52.53% respectively.
2) **Protein and Nitrogen source from the leaves:** The results show that the constituents of the three fold plants are not significantly different from one another for protein and nitrogen as has been found in the case of *Terminalia tomentosa* and *Terminalia arjuna* (Kohli *et al.*, 1969). The average total percentages of nitrogen and protein in all the three oak plants are found to be 1.72% and 10.76% respectively.

3) **Amino acid source from the leaves:** Inspite of the variation in the concentration of amino acids in the three host plants, there is no qualitative difference in the compounds in the aforesaid plants. There were nineteen identified amino acids in common in the leaves of the first season (March/April). The leaves of the later season (November/December) however, showed considerable change in the amino acid content, suggesting thereby that the leaves at this time gradually become unsuitable to the silk worm. Another important feature is the presence of the aromatic compounds like histidine, tyrosine and proline, and sulphur containing compounds like cysteic acid and cystine. Such amino acids have also been reported in the case of *Lagerstroemia parviflora*, *Eugenia jambolana* and *Madhuca indica* (Agrawal and Sinha, 1972). Furthermore, taurine is also found in the present analysis of the three oak plants, Taurine has also been reported by Kohli *et al.*, (1969) in *Terminalia tomentosa*, a primary food plant of Tasar silk worms (Jolly *et al.*, 1966).
4) **Carbohydrate source from the leaves:** From the findings of carbohydrate content of the experimental plants, it may be suggested that the three types of carbohydrates detected, would supply the bulk of the nutritional requirements of *Antheraea pernyi*. The three types of carbohydrates are: aldohexose, ketohexose and glucose. There is no marked difference in the concentration of ketohexose between *Quercus dealbata* and *Q. pachyphylla*, although *Q. serrata* is distinct by its higher concentration of ketohexose. Again, it is also found that the concentration of aldohexose is the same in *Q. dealbata* and *Q. pachyphylla*, while it is comparatively higher in *Quercus serrata*.

The carbohydrate constituents of the leaves of the three host plants do not show pronounced qualitative difference.

II. **Physiological Effects (Analysis of Larval Haemolymph):**

The experimental results on the amino acid content of the haemolymph of the larvae showed the presence of twelve amino acids: aspartic acid, $\alpha$-amino adipic acid, $\alpha$-alanine, glutamine, histidine, leucine/isoleucine, lysine, proline, serine, threonine, tyrosine and valine, throughout the five stages of larval development. Glutamic acids could not be detected in the free state in the larval haemolymph. However, 4 more amino acids were found starting from the 5th instar.
and they were – taurine, cysteic acid, cystine and glycine. Of the sulphur containing compounds, viz., cysteic acid, cystine and methionine, which are commonly found in insects only methionine is absent here throughout. Agrawal and Sinha (1972) reported the presence of nineteen protein-bound amino acids in the larval and pupal haemolymph of *Antheraea mylitta* reared on *Terminalia tomentosa*, and these are – cysteic acid, aspartic acid, glutamic acid, serine, glycine, threonine, lysine, histidine, L-alanine, hydroxy-proline, tyrosine, phenyl alanine, thyroxine, cystine methionine, methionine sulphoxide, valine, proline, and leucine/isoleucine.

The present analysis shows the absence of methionine sulphoxide, asparagine, arginine in the larval haemolymph.

The results here suggest that the amino acids common in the three oak plants are invariably replicated in the intermediary pathways and that they play a particular role in the metabolism of the silk worm.

In the case of developing larvae, amino acid concentration may be either increased or decreased during and after molts. For instance, accumulation of histidine and cystine is intensive in the fourth moult of the larvae.
Jeuniaux (1961) reported that the histidine is much concerned in the osmo-regulation of the larvae. Duchateau-Bosson (1961) states that the increase in the amino acid concentration during larval moults is the consequence of histolysis, while decrease after moults is on account of their incorporation in the formation of larval tissues.

The presence of taurine in the three oak plants and its further detection in the haemolymph of the fifth instar larvae is an indication of its possible utilization during later embryo-genesis. This finding is in agreement with the findings of Narumi et al. (1950) and Sasaki et al. (1957), who reported the presence of taurine in Bombyx mori (Mulberry silk worm).

III. LARVAL FEEDING HABITS:

Certain variations in the feeding behaviour during different larval stages were observed with the growth of the larvae.

1) On the very day of mounting (on to the leaves) the period of "exploration" of the first instar was more than the later instars.

2) Each feeding time was shorter at the beginning of each instar and longer at the end of each instar. Sakurai (1931) reported that in the case of Mulberry silk worm, later instars consume more, and the number of feedings
during each instar was 60-80 times in the fourth instar and 183 times during the fifth instar. In *Antheraea pernyi*, the unit time for feeding at a stretch ranged from 11 minutes in the first day to 70 minutes in the fourth and fifth day of the first instar; in later instars it ranged from 1 to 2 hours.

3) In cutting and ingesting the food leaves, the insect mouth parts operate in the manner of opening and closing a door, and almost all the larvae stopped eating in the night time. Machida (1927) also reported that the silk worms did not eat in its sleeping time at night.

IV. LARVAL GROWTH CHARACTER.

Rearing silk worm under indoor by the "new technique" with the medium aged leaves of the three oak plants, caused increase in (a) rates of linear growth, (b) rates of widthwise growth and (c) rates of ponderal growth. In all the aspects studied, larval development was progressive (Fig.20-21). Increase in fecundity of the worms was observed from the fourth instar onwards for all the experimental sets. Larval mortality was low (13% in *Q. serrata*, 15% in *Q. albata* and 15.8% in *Q. pachyphylla*). However, larval development in the early stages was very slow and the mortality rate was high irrespective of the host plants, as has been reported for *Antheraea pernyi* (Mansingh, 1972). Death case observed is attributable to the change of the environment and the physical injuries inflicted during handling of the worms for taking weight and changing of food.
At 40-day feeding separately on *Q. serrata*, *Q. dealbata* and *Q. pachyphylla*, worms could attain a maximum average (a) linear growth rates of 98 mm., 95 mm., (b) a width-wise growth rate of 18.7 mm., 18 mm., and 17.8 mm and (c) a ponderal growth rate of 10558 mg., 10106 mg., and 10101 mg., respectively. Statistically, there are no significant differences in the growth characters.

**Table XXVII**

Comparative rearing results of *Antheraea proylei* fed on *Quercus serrata*, *Q. dealbata* and *Q. pachyphylla*

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Species</th>
<th>No. of worms</th>
<th>Larval period (days)</th>
<th>E.R.R. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Q. serrata</em></td>
<td>2 X 60</td>
<td>43</td>
<td>87</td>
</tr>
<tr>
<td>2</td>
<td><em>Q. dealbata</em></td>
<td>2 X 60</td>
<td>47</td>
<td>84</td>
</tr>
<tr>
<td>3</td>
<td><em>Q. pachyphylla</em></td>
<td>2 X 60</td>
<td>47</td>
<td>85</td>
</tr>
</tbody>
</table>

Data based on indoor rearing.

The larval duration was less by 4 days in serrata rearing; this may have some economic bearing on cocoon production.

The effective rate of rearing (E.R.R.) percentage in case of the worms fed on *Q. pachyphylla* (84%) almost coincides with those fed on *Q. dealbata* (84%) and *Q. serrata* (87%).
It is possible that the worms fed on different species of plants may show equal progress in growth in view of not much significant difference in the fundamental constituents like protein, nitrogen, amino acids and carbohydrates.

V. DEVELOPMENTAL MORPHOLOGY:

1) There are four moults with five stages (instars) of which only the first instar larva possesses some diagnostic morphological characters; the remaining other instars have no morphological distinctions except in size and colour of the body and setae.

2) The basic internal organs like digestive, respiratory circulatory, organs, and the nervous system and silk glands resemble those of mulberry silk worms.

3) The spinning behaviour of the worm is similar to that of Antheraea roylei or A. parvula, original parents but its cocoon is pendent like that of A. mylitta. The pupa resembles that of A. polyphemus but the moths are like those of A. mylitta.

VI. COCOON AND SILK QUALITIES:

The results show, in general, that the cocoons raised on the three oak plants are more or less of the same character in their (1) peduncle length, (2) cocoon weight, (3) shell weight, and (4) shell ratio. However the relative variance in the means
of (5) silk filament length is higher in the treatment of *Q. serrata* than in those of the other two plants. While the relative variation in (6) silk reelability percentage is lowest in the treatment of *Q. dealbata*, it is highest in *Q. pachyphylla* but the (7) weight of silk filament goes down in the case of *Q. pachyphylla*. (8) Average thickness of 20 pieces of silk filaments for serrata, dealbata and pachyphylla cocoons has been 70.29 μ, 70.40 μ, and 70.40 μ, respectively. (10) Compared to the length of silk filament, the number of filament breaks is relatively low and the number of non-breaking filament length is high in the case of *Q. pachyphylla*. (10) A tapering tendency of fibre occurs in all the analysis of cocoons on account of gradual diminution of denier.

The results further show that the sections of the silk filaments have maximum value at the beginning (6.6 for *Q. serrata*, 6.7 for *Q. dealbata* and 6.2 for *Q. pachyphylla*), and minimum value in the last sections (4.6 for *Q. serrata*, 3.5 for *Q. dealbata* and 3.4 for *Q. pachyphylla*).

There is a trend of denier variability. Choudhury and Ghose (1972) also reported the trend of denier variability in the filament length of cocoons of *Antheraea mylitta*. 
The final picture that emerges from a detailed analysis and interpretation of the data shows that the performance of *Quercus pachyphylla* is quite comparable either to *Quercus dealbata* or *Quercus serrata*, and that the worms of *Antheraea proylei* fed on these three host plants do not show much of significant differences in their physiology of growth and development, cocoon formation and yield of quality silk.

These oak plants may be used regularly and even simultaneously as 'primary' food plants of *Antheraea proylei* in Manipur.

Thus there appears to be scope for rearing of *Antheraea proylei* on the three oak plants: *Quercus serrata*, *Quercus dealbata* and *Quercus pachyphylla*, as a prelude to development of the Silk Industry based on indigenous resources.