Rearing of muga silkworms is linked up with the culture and tradition of the people of northeast region of India. Its economic potentiality had not been visualized earlier. Many countries of the South East Asia have taken up silk production, as they can earn a good amount of foreign exchange through silk export. In our country too, some southern states have shown great improvement in silk production. They have taken recourse to scientific methods of rearing of silkworm. In Assam, a good attempt is being now taken through Silk Board of India to improve production of muga silkworm. Its climate and the presence of host plants in wild state are unique features and therefore a little scientific input would improve the quality and quantity of muga silk produce in this region.

While all Research Stations in the country are engaged in study relating to improvement in quality of silkworm and improving their efficiency of silk production as well as improvement in the quality of host plants. It has not came to the notice of the author that the phylloplane flora of the host plant has been given due consideration in their effort to improve the nutrition of the silkworms which they get entirely from the leaves of the host plants. Although many researchers have studied the nutritional status of the of leaves of host plants, the spore and mycelial load of the leaves have not been taken care of. It is a recognized fact that the fungal spores and mycelia spread over the leaf surface may contribute critically on the nutrition of silkworms and hence this aspect can also be studied. Moreover the presence of different microflora may have many others implications also on their health and disease development.
The present study deals with some aspects relating to the role of host plants on the production of silk, the phylloplane microfungi of the host plants and the effect of feeding leaves of such host plants that carry phylloplane fungi, on the growth of the silkworm, their rearing performance and silk production.

The current study has many limitations and therefore it is not exhaustive, rather it is a prelude to opening a new frontier of study relating to phylloplane microflora of host plants of silkworm and their role in critical nutrition of silkworm and thereby their growth, development and silk production efficiency.

The muga silkworm is polyphagous, feeding on the leaves of Som (*Machilus bombycina*), Soalu (*Litsaea polyantha*), Mejankari (*Litsaea citrata*), and Digloti (*Litsaea salicifolia*). All these plants belong to the family Lauraceae. From the results of study of rearing performance of muga silkworms on these plants it was observed that muga silkworms prefers Som leaves more than the leaves of other two host plants (Table 6-11). This has reflected a strong influence of the food plants on the number of cocoons produced. This finding is in close resemblance with the findings of Rajkhowa and Gohain (1989) who had also observed that *Machilus bombycina* and *Cinamomum tamala* were relatively superior over *Litsaea polyantha* and *Litsaea salicifolia* as host plants when studied under Sibsagar (Assam) conditions. The effective rate of rearing (E.R.R) was also influenced by the environment. The results showed a higher E.R.R% was observed in April-May (Jethua), July-August (Bhodia), and September-October (Kotia) which indicated that optimum condition prevailed.
in these periods for rearing of muga silkworms. Choudhury (1981) also reported
that the prevailing optimum conditions for rearing of Muga silkworm under
Lakhimpur (Assam) conditions is May - June (Jethua) and October – November
(Kotia).

The moisture content of the leaves plays an important role in
quality and quantity of cocoons. The moisture content of the tender leaves of
Som (*Machilus bombycina*), and Soalu (*Litsaea polyantha*) and Mejankari
(*Litsaea citrata*) leaves was more than the semimatured and matured leaves
(Table-5). Similar results were also observed in tasar food plants (Jelly, *et al*.,
1974) and eri food plants (Pathak, 1998). The declining trend of moisture with
maturity of the leaves is congenial for feeding of tiny chowki and matured
muga silkworms, because tender leaves have been observed to induce virosis if
fed to mature worms, whereas over mature leaves cause bacteriosis. It remains
to be seen whether moisture content of leaves has any bearing with the
phenomenon.

Tender leaves of the *Machilus bombycina* and *Litsaea polyantha* were rich in nitrogen content. It declined gradually with increasing
maturity of the leaves (Table-5). Similar trend was also observed in Mulberry
leaves (Jaware, *et al*, 1981). The declining trend might be due to the mobile
nature of nitrogen in the plants, because in case of its deficiency, the older and
basal leaves lose nitrogen to younger and terminal leaves (Verma *et al* 1985).
As a result, the nitrogen deficiency first appears in matured leaves and then in
semimatured leaves. The increase in nitrogen content increases the chlorophyll
biosynthesis following its assimilation into the chlorophyll precursors. It also
increases the total soluble protein and free amino acids in the leaves. (Palamisamy and Vevekanandan, 1989).

The mean value of protein was higher in *Litsaea polyantha* in comparison to *Machilus bombycina*. Tender leaves were rich in crude protein and it declines gradually in the semimatured and matured leaves due to depletion in the nitrogen content (Table-5). Further depletion might be due to enhanced proteolytic activity and its possible utilization for their metabolic purposes. The protein content in different sericigenous plants is highly variable and is greatly influenced by environment and heredity. (Agarwal et al, 1980; Pathak, 1988).

The total sugar content was comparatively higher in *Machilus bombycina* in comparison to *Litsaea polyantha* and *Litsaea citrata*. Furthermore, it was an interesting observation that semimature leaves were higher in sugar content when compared with tender and mature leaves. Thus the semimatured leaves were within the stability limit for total sugar. However, sugars showed an increasing trend from tender to semimature leaves and a decreasing trend from semimature to mature leaves. (Table-5). The deficiency of sugar in mature leaves might be due to conversion of sugar into starch. Moreover, the starch content increases while the nitrogen content in matured leaves decreases. This is in conformity with the finding of Verma, *et al*, (1985). It is therefore been observed in the present study that total starch content showed an increasing trend with the age and maturity of the leaves in the three food plants. *Machilus bombycina* leaves were comparatively higher in starch content in comparison to *Litsaea polyantha* and *Litsaea citrata*. Much sugar produced in photosynthesis is converted to starch which is deposited in the plant tissues and functions as resume nutrient for the growth and development.
of the plant at the time of need. The starch content in nitrogen deficient leaf is comparatively more than the normal leaf (Verma, et al, 1989). The *Litsaea polyantha* leaves with more nitrogen content were found less in starch content in comparison to *Machilus bombycina*. This finding is in close agreement with findings of Verma, et al, (1985). It has been noted that accumulation of protein in larvae depends largely on the carbohydrates in the leaves they eat (Rangaswamy, et al, 1987). It might therefore be one of the reasons for better silk content in the cocoons of *Machilus bombycina* feed stock. (Yadav and Goswami, 1987; Barah, et al, 1989).

The tender leaves of *Machilus bombycina* were found to be rich in minerals too, which declined gradually on maturity (Table-5). The minerals were comparatively higher in *Machilus bombycina* leaves than those in *Litsaea polyantha* and *Litsaea citrata* leaves. The nutritional value of the leaves are determined by minerals content, which play an important role not only in higher yields of quality leaves but also of the cocoon crops. It can therefore be concluded that cocoons that feed on the leaves of *Machilus bombycina* have better silk content than the cocoons that feed on the leaves of *Litsaea polyantha* and *Litsaea citrata*. This finding is in conformity with the finding of Yadav and Goswami, (1987), Thangavelu and Sahu (1986) and Rangaswamy, et.al., (1987).

Present study showed that the temperature and relative humidity play crucial role in the success of silkworm rearing and cocoon yield (Table 14 & 15). Saratchandra, (1997) and Shivakumar, et.al, (1993) also observed similar phenomenon. The moderate temperature and humidity during spring (April-May/ Jethua) and autumn (Sept – Oct/Kotia) probably are well
PLATE NO. 5  5th stage of Muga silkworms.

PLATE NO. 6  "Jali" with cocoons.
suited for silkworm rearing, whereas summer, characterised by extreme high temperature is harsh. A temperature of 24°C–30°C has been found to be ideal for spinning worms. Higher temperature accelerates the speed of spinning while lower temperature retards the process. Too high or too low temperature probably affects the reelability to a great extent. From the physical observation also it was observed that higher temperature induced the silkworms to spin hurriedly, leading to formation of double cocoons. It made the cocoon shell loose which in turn made reeling difficult. Besides, higher temperature may also lead to high mortality of spinning larvae resulting in melting cocoons. Too low temperature leads to delay in spinning and pupation, undesirable cocoon colour, thickening of filament and increase in the number of naked pupa.

Humidity during spinning is also one of the important factors, which affects the cocoon and the silk quality. Higher moister leads to rapid multiplication of pathogens thereby increases mortality of larvae as well as pupa. Too low humidity also results in the formation of loose shell. As such, humidity of 65.5-88% and 68-93% was found to be ideal during spinning (Table 14 & 15).

From the Table 1, 2 and 3 it has been observed that ERR% and Dfl: Cocoons ratio increased from April to October and started decreasing from November to March. The larvae reared on Som plants produced more cocoons than in the other two food plants – Soalu and Mejankari. The effective rate of rearing is the highest in Som (91.05%) than the Soalu (77.38%) and Mejankari (63.00 %). This clearly indicates that host plants have great influence on the rearing performance.
PLATE NO. 7  "Khora" with full of Muga seed Cocoons.

PLATE NO. 8  Emergence of moths.
It has been observed that the cocoon weight, shell weight and silk percent in male and female vary when Som, Soalu and Mejankari plants were used as food plants. The silk-ratio in case of male cocoon in all the three crops was higher than in case of the females. The silk-ratio in case of Som plant was the highest (12.70% in male & 11.61% in female) than in Soalu (10.0% in male and 8.9 % in female) and Mejankari (9.86 % in male and 7.52 % in female). This shows that the silk-ratio in males in all the three host plants was comparatively higher (Table 12 &13).

The results of the cocoon assessment (Table 12 &13) showed that an appreciable variation took place due to the influence of environment on the silk ratio, filament weight and shell weight during different seasons. The Kotia (Sept – Oct) season was found to be superior for shell weight and silk percent followed by Jethua (April –May), Aherua (June-July), Bhodia (July-August), and Late-Jarua (Feb-March) seasons. The present study, therefore indicates that the conducive environmental conditions for rearing of muga silkworms are autumn (Kotia) and spring (Jethua). The quality of the reeling cocoons production was better in these seasons.

Choudhury (1981) also observed that maximum quantity of reeling cocoons could be harvested in Upper Assam on *Machilus bombycina* plant during autumn and spring due to such prevailing optimum environmental conditions during those periods. The present study supports the findings of Choudhury (1981). Baruah, *et al*, (1989) also reported that weight of muga cocoons (larvae reared on *Machilus bombycina*) produced during Kotia (under lower Assam conditions at Boko) was significantly higher than the cocoons
PLATE NO. 9  Female moths tied in "Khorika" for laying eggs.

PLATE NO. 10  Cellular rearing under net 3rd & 4th stage of Muga silkworms.
produced in all other seasons. This is in clear agreement with the present findings.

Fourteen types of fungi could be isolated from the leaf surface of Som (*Machilus bombycina*), Soalu (*Litsaea polyantha*) and Mejankari (*Litsaea citrata*) plants. The types of fungi which colonise the leaves at different stages of maturation, viz - tender, seminature and mature leaves are more or less the same. Of these *Alternaria alternata*, *Aspergillus fumigatus*, *Curvularia* sp and *Mucor* sp were found to be most dominant microflora in the three stages of leaf growth in all the three host plants (Table 20-37). The number and types of fungal population occurring in winter were the largest followed by autumn. In all stages of development of leaves and in both the surfaces *Aspergillus fumigatus* was the dominant fungal species. No work has been done earlier on phylloplane microfungi of host plants of muga silkworm.

The present study shows that the fungal population increased gradually from tender to mature stages of the leaves. The pattern of fungal population was not much different both in quality and quantity in the leaf surface of Som, Soalu and Mejankari plants. Next to *Aspergillus fumigatus*, *Alternaria alternata*, *Mucor* sp *Torula* sp were found to be dominant while *Curvularia* sp was co-dominant throughout the investigation period. A number of forms were infrequent with low percentage of occurrence viz – *Aspergillus flavus*, *Aspergillus candidus*, *Fusarium* sp, *Cladosporium* sp, *Trichoderma* sp and *Verticillium* sp. (Table 16-19).

The environmental factors, viz- atmospheric temperature, relative humidity and rainfall seem to play important role. Maximum number of fungi was observed when temperature of 15 °C–27 °C and relative humidity of
57-94% were present during winter (Table 24). The minimum number of mycoflora observed during the summer season may be due to unfavourable temperature. While working with other types of plants, Gregory (1961), Kumar and Gupta (1976), Pandey, et al, (1989), Sahu and Tiwari (1985 & 88), Tiwari (1977). Tiwari and Sahu (1989, & 87 & 89) and Sahu, et al, (1986 & 88) also observed that environmental factors were the most important physical factor which affected the total number of microorganisms present on the leaf surface.

In the present investigation it has been observed that the most abundant species were *Aspergillus fumigatus*, *Alternaria alternata* and *Mucor* spp which could be recorded throughout the year. The dominance of *Aspergillus* spp may be due to their prevalence in air in more number. This has been reported by Rajan, et al, (1952); Singh and Baruah, (1979) and Mishra and Sukla, (1989). Sandhu, et al, (1964) reported 17 spp from air over Delhi, Rati and Ramingam (1976) similarly reported 32 spp from Manas and Gangotri, Krammer, et al, (1960) reported 23 spp from Cambridge while Mishra and Kamal, (1971) reported 21 spp from Gorakhpur. No marked seasonal periodicity in leaves of the three host plants was seen in case of *Aspergillus* except for a slight increase during winter months, which probably is the result of their more prevalence in the air due to dry condition and that the spores after their fall on the leaf surface were not washed by rain. Fienberg, (1942); Aldoory, (1972); Agarwal, et al, (1969); Mishra, (1972) also could not record any marked seasonal periodicity for *Aspergillus* spp in other types of leaves.

reported *Alternaria alternata* and *Cladosporium* spp as the dominant species among leaf surface mycoflora. The present investigation supports their findings since *Alternaria alternata* has also been found as dominant species along with *Aspergillus fumigatus*.

It is well known that temperature, relative humidity and pH have varied influence on growth and development of all fungi. The growth of fungal mycelium in relation to its temperature requirement have been reported by Benarjee and Bakshi (1945), Nandi (1964), Gongopadhyay (1968), Chakraborti (1970), Samajpati (1970), Gosh (1970). Emerson (1968) stated that thermophilic fungi are those which have maximum temperature requirement for growth is at or above 50°C and a minimum is at or above 20°C. Griffin (1972) stated that physiophillic fungi are those which are able to grow at 0°C with a optimum below 20°C. There are two groups of fungi which remain active at two extremes, but there exists an intermediate groups called mesothermic fungi which have optimum temperature for growth at 25-40°C (George 1991). It is believed that maximum growth of all fungi takes place at their individual required optimum temperature (Miller and Golding 1949). There are ample evidences that phylloplane fungi differ greatly in their response to temperature and humidity; Jacose, *et al*, (1991) found that lower relative humidities at all temperature drastically decreased the conidial germination of fungi. In the present experiment it was found that the winter months were the most favourable period for growth of phylloplane fungi on the leaves of three host plants studied.

Fungi have been found to withstand a wide range of pH both in the acidic and in the alkaline sides. The wood rotting fungi exhibit maximum
metabolic activity at the acidic range of the grades in most cases (Melin, 1954; Jennison, et al, 1955; Reusser, et al, 1958; Litchfield, et al, 1963; Vardi and Lumomir, 1968; Srivastava and Bono, 1970; Boodziak, 1980; Hang, et al, 1981). On the other hand, Rennerfelt and Paris, (1953); Etheridge, (1955); Nandi, (1964); Gongopadhyay, (1968); Samajpati, (1970) and Chakravarti, (1970) have also shown that the fungi can grow well in the acidic side as well as alkaline side of the grade. Centrall and Dowler (1971) have reported that pH is especially important in fungal growth. Cochrane (1958) has reported that fungi grew maximally over a certain range of initial pH values of the medium and failed to grow at high and low extremes. In the present investigation it has been found that the leaf isolates showed preference for pH at the range of 6.0-7.5 (Table 39). The host plant by their metabolic activity probably offer an optimum pH range for the growth of phylloplane microfungi.

The results (Table 40) show that all the carbon sources tested have more or less stimulatory effect on the growth and sporulation of the organisms. Most of the workers including Tandon and Bilgrami (1957), Mishra (1960) have concluded that carbohydrates particularly oligosaccharides and polysaccharides support better fruting than monosaccharides. Of all carbon sources tested in the present study glucose, sucrose were found to be good for the growth and sporulation of these isolates.

Like carbon sources nitrogen is also used both for functional as well as structural purposes by fungi. Many recent studies suggested that the ammonium nitrogen become unutilizable for many fungi because of rapid fall of pH of the cultural medium. (Bilgrami and Verma 1981). Norkans (1950), Jennison et al (1955) Chakraborti (1970) and others have reported that ammonium salts are effective for vegetative growth of fungi. In the present
PLATE NO. 11  5\textsuperscript{th} stage of Muga silkworms

PLATE NO. 12  Untreated Som leaves after eating by Muga silkworms.
study all the three types of nitrogen sources tested (Table 41) showed positive result at 2 % level.

The results of feeding of the spores of the phylloplane fungi to the silkworms which had been sprayed over the leaves of the food plant showed that (Table 48-59) there exists a correlation between feeding of spores along with the host plant leaves on the cocoon-weight shell-weight and silk ration. Not all types of fungal spores showed significant increase but a few such as *Aspergillus fumigatus*, *A. candidus*, *Mucor* sp, *Rhizopus* sp, showed statistically significant increase in weight of cocoon, shell and silk-ratio in the three types of host plants. As *Aspergillus fumigatus* was always associated with phylloplane of the three types of hosts its impact was found to be more than the other fungi. Significant impact of other few species belong to genera *Rhizopus*, *Torula*, *Curvularia* have also been recorded.

Probably the present study relating to the effect of phylloplane fungi on the growth and development of cocoons and silk production may open up a new area of wider studies as no attempt has been made earlier in such relationship. The impact of fungal spores on the growth and development of the silkworms may probably be due to the fact that the fungal spores while taken with leaves provide nutrition to the silkworms which may range from protein to various trace elements, which the silkworms need in addition to what they obtain from leaves of the host plants.

The present investigation indicates that the phylloplane fungi probably have important bearing on rearing of silkworms and therefore further needs study relating to the association of not only fungi but also bacteria
PLATE NO. 13  Fungal spore treated leaves after eating by Muga silkworms.

PLATE NO. 14  Worms after eating fungal spores treated leaves in "Chaloni".
and other microflora with the leaves and their impact on the silkworms and the quality of the silk they produce. Although the present study involves only three host plants, there are more varieties of host plants and as such phylloplane fungi of such plants may be different. Moreover, development of specific types of phylloplane fungi depends upon many environmental factors as well as on the physiology of the plants and the interaction of the microorganisms among themselves. If scientifically exploited, the cocoon – phylloplane microorganisms relationship will be beneficial to the silk industry. This piece of work is only an attempt to draw attention to the new but prospective area of work relating to rearing of silkworms.