*MARDI Res. Bull. 6, 1 : (50 – 58)*

# REARING OF BIVOLTINE POLYHYBRID SILKWORMS (*BOMBYX MORI* L.) IN SERDANG, MALAYSIA

LOKE WAI HONG

*Accepted for publication on 24 January, 1978*

## RINGKASAN

Pemeliharaan 3 jenis ulat sutra iaitu jenis Cansiglio, Grappa dan Piave, kesemuanya 'polyhybrid bivoltine' boleh dipelihara dengan jayanya dibawah keadaan biasa. Didapati ada perbezaan diantara pengeluaran, berat 'cocoon', panjang dan 'title' filamen diantara 'polyhybrid-polyhybrid' tadi, tetapi perbezaan itu tidak 'significant'. Dengan membaiki dan menambahkan lagi kemudahan-kemudahan pemeliharaan serta pengurusanya, pengeluaran yang lebih baik telahpun dicapai apabila dibanding dengan pemeliharaan dahulu. Mutu 'cocoon' yang dikeluarkan adalah menggalakkan dan hasil jangkaan sebanyak 17–23 kilogram boleh diperolehi.

## INTRODUCTION

In 1972, interest in the rearing of the mulberry silkworm *Bombyx mori*, L. was reactivated in Malaysia. In order to assess and determine the feasibility of sericulture as a new agro-industry, foreign sericulturists were invited to carry out feasibility surveys. UMENO and AYUZAWA (1973) reported that the rearing environment of high temperature and humidity as in Malaysia's lowlands has rarely been experienced by advanced sericultural countries. As such, the rearing of bivoltine polyhybrids under such environmental circumstances is uncertain. Investigation into the growth performance of such polyhybrids under the local condition is thus of fundamental importance to more comprehensive studies. Of special significance is the survival of the old silkworm susceptibility to flacherie when subjected to high temperature and relative humidity.

In 1974, SARTORI (per. comm.) reported that there is potential for silkworm rearing in Malaysia. According to him rearing of "strong" silkworm varieties, sound construction of rearing facilities and good management can ameliorate that bad effects of sub optimal environmental conditions. This is especially important for sericulture in tropical areas.

## MATERIALS AND METHOD

Three Italian bivoltine polyhybrids (Cansiglio, Grappa and Piave) were mass-reared using the shelf system described by SARTORI (1974) (per. comm.) under ambient conditions. Incubation of the eggs was carried out with no artificial temperature control. However, adequate humidity was ensured by lining the incubation trays with moist tissue paper. In the present studies, 14 hours of light was provided. When the eggs reached the blue-spot stage, they were kept in total darkness for one day, after which they were reexposed to light.

Newly hatched silkworms were separated from their egg shells by means of perforated paper and the young stages (1st, 2nd and 3rd instars) reared under the paraffin paper system (DE BASTIANI, 1961). The 4th and 5th instars were reared on trays with gauze bottoms which were lined with clean newsprint paper. Feeding, bed-cleaning and enlargement of the rearing seats were done following the schedule described by KRISHNASWAMI, *et al.* (1973).

Throughout the rearing, the weights of the various instars prior to first feeding were taken. The durations of the various instars were also recorded. In the 5th instar, weighing was done daily until cocooning, while observations and recording of diseased and dead larvae were made in the 4th and 5th instars (Base number = 1000 larvae). All diseased and dead larvae were removed and destroyed.

On maturing, the 5th instar larvae were picked and mounted onto cellular cardboard frames. Cocoons were harvested on the 6th day after the initiation of sericposition and these were sorted, counted and weighed. The number of good cocoons per litre (volume) was measured using a graduated beaker. This volume measurement was replicated 3 times.

In cocoon assessments, 25 male and 25 female cocoons of each polyhybrid were randomly picked. This was done by cutting the cocoons longitudinally, extracting and sexing the pupae. The cocoon weight, pupal weight and cocoon shell weight were also taken. Cocoon shell percentages (R.S. Value) of each polyhybrid were calculated, and the filament length and denier rating of 50 cocoons of each polyhybrid measured.

## RESULTS AND DISCUSSION

### Incubation and hatchability

Incubation of eggs under ambient conditions (24° - 31°C and 80% R.H.) was noted to be satisfactory. The majority of the eggs attained the blue-spot stage at the same time. Subsequent incubation in total darkness for one day gave more than 95% hatchability within a period of 2 days. The results showed that the eggs did not suffer ill-effects during the 5 day transit period. TAKASHI (cited by CHAWLA, 1969) has found that poor transit conditions such as delay, high temperature, low humidity, jolting, vibration, lack of ventilation and bad odour could unfavourably affect hatchability and reduce the success of rearing.

### Growth Performance

The average thermohygrographic conditions of the rearing house recorded showed that minimum and maximum temperature were 23 - 24°C and 27 - 28°C respectively, and minimum and maximum relative humidity were 50 - 55% and 90 - 100% respectively. Generally, conditions of high temperature and humidity are considered not good for rearing of bivoltine silkworms as compared to conditions reported by *et al.* (1973). SARTORI, (1974) also pointed out that the wide fluctuations of temperature and humidity were sub-optimal factors.

Despite the sub-optimal conditions noted in the present studies, growth and moulting were quite uniform for the first 3 instars. This, largely was due to the use of the paraffin paper system which reduced wide fluctuations in micro-climate for the 'young' larvae. Although 'young' larvae are tolerant to high temperature and humidity (SHIMIZU, *et al.* 1972), KRISHNASWAMI, *et al.* (1973) and OMURA, *et al.* (1973) have pointed out that under tropical conditions, the use of the paraffin paper system may still warrant extra care particularly against muscardine diseases. However, in the present studies, no muscardine problems were observed.

Growth and moulting in the 4th and 5th instars were noted to be fairly uniform. Generally, most of the 5th instar larvae reached maturity after feeding for 8 days although some did not cocoon until the 11th day. From *Table 1* which shows the weights of each instar prior to first feeding and *Fig. 1* which illustrated the growth was substantial in the 5th instar.

Though Grappa strain lagged behind in weight gain in the first 3 instars, it showed a remarkable growth rate in the 4th and 5th instar, particularly in the 5th instar.

With regard to the average durations of the various instars, no difference was observed between the polyhybrids *(Table 2)*.

Generally, mature 5th instar larvae mounted in the afternoon did not spin cocoons immediately. However, by the following morning all had started spinning. It is possible that the delay in initiation of seriposition could be due to the temperature and humidity.

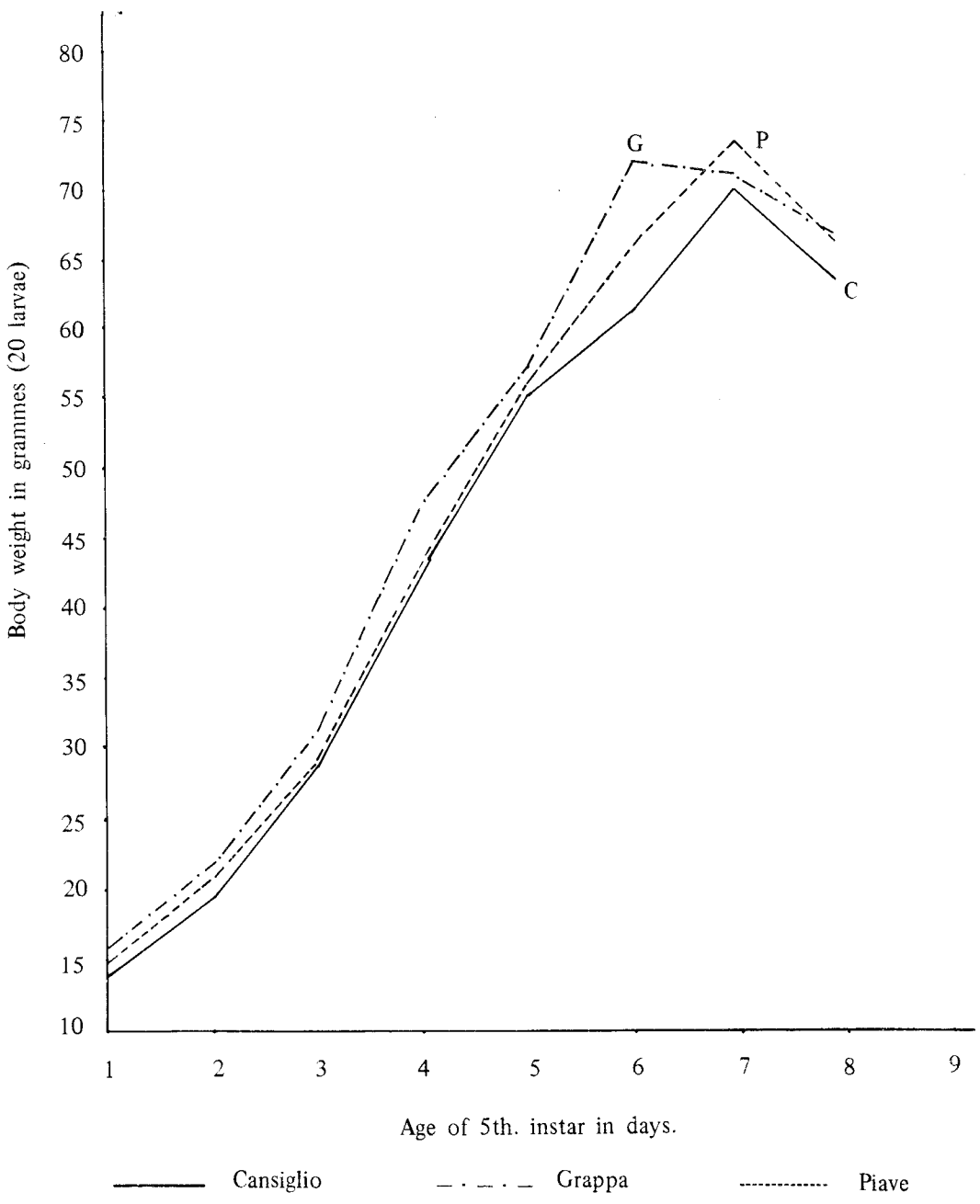
TABLE 1. AVERAGE BODY WEIGHT (MILLIGRAMS) OF EACH LARVAL INSTAR PRIOR TO FEEDING IN THREE SILKWORM VARIETIES

| Stage \ Variety | Cansiglio | Grappa | Piave |
|---|---|---|---|
| 1st. instar | 0.542 | 0.558 | 0.598 |
| 2nd. instar | 4.925 | 4.340 | 5.010 |
| 3rd. instar | 30.295 | 26.780 | 28.660 |
| 4th. instar | 704.155 | 801.220 | 746.195 |

TABLE 2. AVERAGE DURATIONS (DAYS) OF THE VARIOUS LARVAL INSTARS OF THREE SILKWORM POLYHYBRIDS

| Stage \ Variety | Cansiglio | Grappa | Piave |
|---|---|---|---|
| 1st. instar | 4 | 4 | 4 |
| 2nd. instar | 4 | 4 | 4 |
| 3rd. instar | 4 | 4 | 4 |
| 4th. instar | 5 | 5 | 5 |
| 5th. instar (pre-cocoon) | 8 | 8 | 8 |
| | 25 | 25 | 25 |

*Figure 1. Growth curve of fifth instar larvae of Cansiglio, Grappa and Piave silkworms.*



Incidence of diseases was negligible, less than 0.5%. In the 'young' larvae. Mortality in the 4th instar was laso insignificant (less than 1%). However, it increased substantially in the 5th instar *(Table 3)*. Among the silkworm varieties studied, Cansiglio suffered the highest mortality *(Fig. 2)*. For all 3 polyhybrids, the highest mortality was recorded on the 8th day, just prior to cocooning. This was consistent with the trends observed in past rearing. Generally flacherie and grasserie were the two main diseases causing mortality.

**Cocoon quality and yield**

*Table 4* shows the cocoon data obtained from measurements of 25 female and 25 male cocoons of the 3 polyhybrids. Statistical comparison of the cocoon data showed that cocoon weight, cocoon shell weight and pupal weight were significantly different ($P<0.01$) between Grappa versus Piave and Cansiglio versus Piave. There was however no significant difference for cocoon shell percentage between polyhybrids.

The results of mone-cocoon reeling showed that the filament lengths obtained were satisfactory, especially for Grappa *(Table 5)*. However, the thickness (title) of the filaments was low in comparison to that of filaments produced in temperate conditions. It is still uncertain whether high temperature conditions would cause silkworms to spin finer filaments.

In *Table 6* which shows the results of harvesting and sorting of cocoons of the 3 polyhybrids, Piave yielded the highest number of good or normal cocoons and Cansiglio the lowest. In all cases, there were very few double cocoons. Although many cocoons were completely formed, the larvae or pupae inside were observed to be dead and are thus considered sub-standard.

The results obtained indicated that Grappa and Piave were almost equally good in terms of overall yield, and both were better than Cansiglio *(Table 7)* TANAKA (1973 per. comm.), SARTORI (1974) and de BASTIANI (1976, pers. comm.) have estimated cocoon yields of bivoltine polyhybrids under tropical conditions to be about 27–30 kilograms. The projected yields when compared to the yields in temperate countries as well as the estimated yields under tropical conditions seemed to be low. Nevertheless, the results could be considered as promising as these were markedly better than those of previous rearings. Some of the factors that could have contributed to the low yields could be insufficient level of management, non-optimal environmental conditions and the untested quality of the mulberry leaves.

TABLE 3. PERCENTAGE MORTALITY IN THE 4th AND 5th INSTAR OF POLYHYBRID SILKWORMS DUE TO FLACHERIE AND GRASSERIE

| Stage \ Variety | Cansiglio | Grappa | Piave |
|---|---|---|---|
| 4th. instar | 0.8 | 0.3 | 0.9 |
| 5th. instar | 13.2 | 8.7 | 8.3 |

*Figure 2. Daily mortality of 5th. instar.*

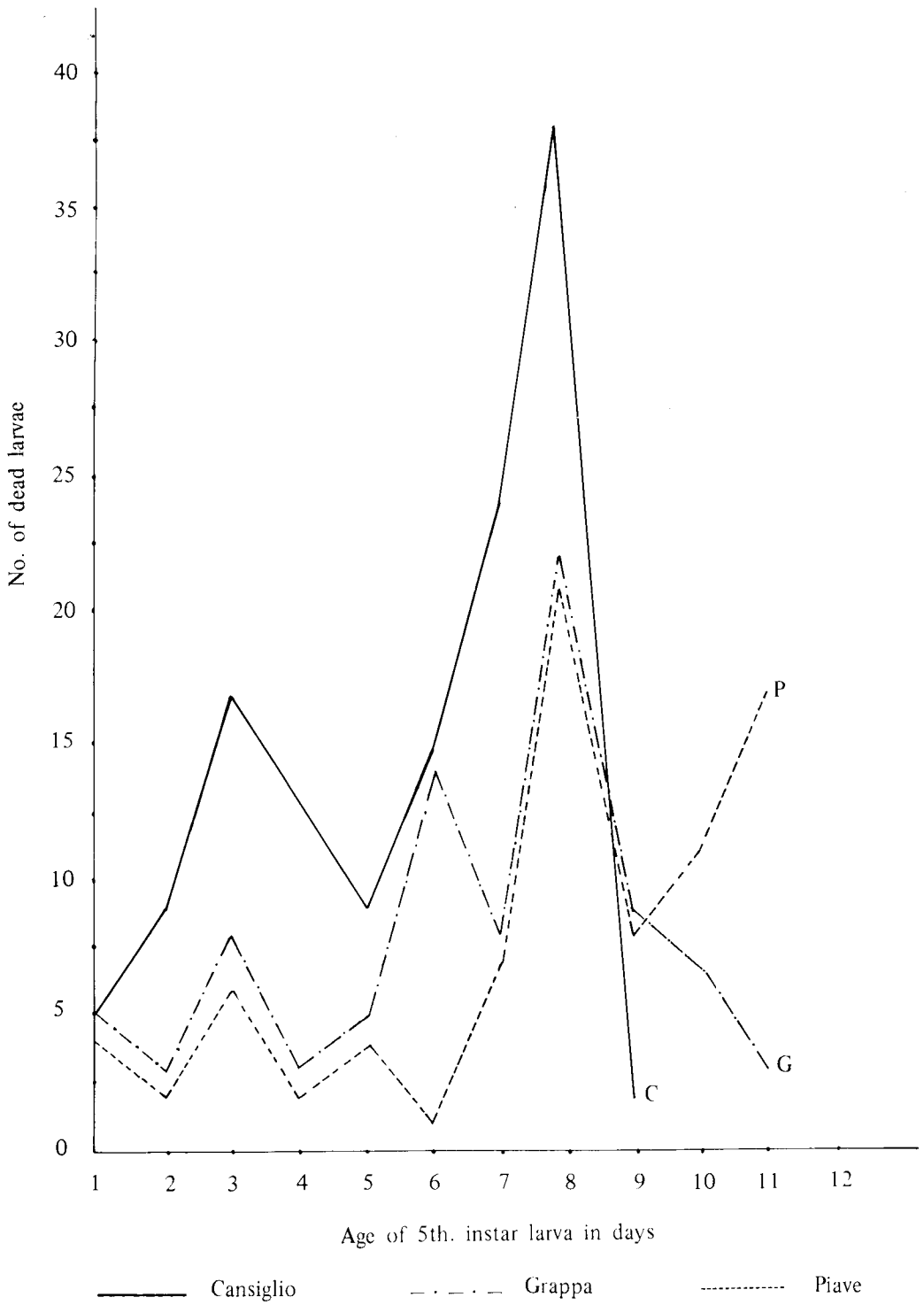


TABLE 4. AVERAGE VALUES OF COCOON WEIGHT, COCOON SHELL WEIGHT, PUPAL WEIGHT AND COCOON SHELL PERCENTAGE OF CANSIGLIO, GRAPPA AND PIAVE SILKWORMS

| | Cansiglio | | Grappa | | Piave | |
|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female |
| Cocoon weight (gm) | 1.552 ± 0.150 | 1.886 ± 0.165 | 1.535 ± 0.125 | 1.956 ± 0.146 | 1.423 ± 0.084 | 1.769 ± 0.15 |
| Cocoon shell wt. (gm) | 0.392 ± 0.050 | 0.416 ± 0.051 | 0.394 ± 0.062 | 0.422 ± 0.86 | 0.352 ± 0.054 | 0.391 ± 0.041 |
| Pupal weight (gm) | 1.152 ± 0.100 | 1.461 ± 0.128 | 1.132 ± 0.082 | 1.526 ± 0.138 | 1.062 ± 0.066 | 1.370 ± 0.121 |
| Cocoon shell % | 22.215 ± 1.265 | 22.032 ± 1.590 | 25.795 ± 1.592 | 21.608 ± 1.395 | 24.616 ± 2.489 | 22.100 ± 1.608 |

TABLE 5. MEASUREMENTS OF SILK FILAMENTS OF CANSIGLIO, GRAPPA AND PIAVE

| | Cansiglio | Grappa | Piave |
|---|---|---|---|
| Average filament length (m) | 1432 ± 79 | 1465 ± 60 | 1316 ± 79 |
| Average filament title (deniers) | 2.32 ± 0.24 | 2.25 ± 0.15 | 2.34 ± 0.28 |
| Average filament wt. (gms) | 0.37 ± 0.11 | 0.39 ± 0.09 | 0.34 ± 0.11 |

TABLE 6. YIELD AND SORTING OF COCOONS OF THREE SILKWORM VARIETIES

| | Silkworm variety | | |
|---|---|---|---|
| | Cansiglio | Grappa | Piave |
| Starting number (4th. instar) | 1000 | 1000 | 1000 |
| No. of larvae dead in 4th. instar | 8 | 3 | 9 |
| No. of larvae dead in 5th. instar | 132 | 87 | 83 |
| Good cocoons (normal) | 515 | 651 | 712 |
| Double cocoons | 2 (4) | 4 (8) | 2 (4) |
| Dead cocoons | 242 | 187 | 116 |
| Non-spinners and incomplete cocoons | 84 | 44 | 45 |
| Missing larvae | 15 | 20 | 31 |

TABLE 7. COCOON WEIGHT, NUMBER PER LITRE AND PROJECTED YIELD OF CANSIGLIO, GRAPPA AND PIAVE

| | Silkworm variety | | |
|---|---|---|---|
| | Cansiglio | Grappa | Piave |
| Weight of good cocoons (gms) | 878.64 | 1151.04 | 1153.60 |
| Average wt. of 1 cocoon (gms) | 1.68 | 1.76 | 1.60 |
| Average No. of cocoons/litre | 91.33 | 90.67 | 102.67 |
| Projected yield(kg)/20,000 eggs | 17.30 | 22.91 | 22.78 |

## SUMMARY

In a rearing with 3 bivoltine polyhybrids, namely, Cansiglio, Grappa and Piave, results obtained showed that bivoltine polyhybrids can be successfully reared to produce cocoons under lowland ambient conditions. Performance, cocoon weight, filament length and filament title differed between polyhybrids, but these are not significantly different. With improved rearing facilities and management, it was possible to obtain better results than in previous rearings. Cocoons produced were of encouraging quality and projected yields of 17–23 kilograms were obtained.

## REFERENCES

ANON. (1971). Sericulture – Overseas Technical Co-operation Agency, Tokyo.

CHAWLA, S.S. (1969). A Brief Review of the Research Work carried out in India on the mulberry silkworms, *Bombyx mori* L. Revue Du Ver A Soie – J. of Silkworms, Commision Sericole Internationale.

DE BASTIANI, D. (1961). Allevamento de baco da seta con il sistema della carta paraffinate. Centro Genetico ed Ecologico del Baco da Seta, San Giacomo di Veglia, Italia.

KRISHNASWAMI, S., NARASIMHANNA, M.N., SURYANARAYAN, S.K. and KUMARARAJ, S. (1973). Manual on Sericulture. Volume 2 – Silkworm Rearing. Agricultural Services Division, FAO, U.N., Rome, Italy.

OMURA, S., KUWANA, T., OJIMA, T., ITOI, S. and IWATA, E. (1973). Silkworm Rearing Techniques in the Tropics. Overseas Technical Co-operation Agency, Tokyo.

SHIMUZU, M. (Editor) (1972). Handbook of silkworm rearing. Fuji Publishing Co. Ltd., Tokyo.

UMENO, H. and C. AYUZAWA, (1973). Report of Feasibility Survey of Silkworm Culture in Malaysia. Overseas Technical Co-operation Agency, Tokyo.