REVUE DU VER A SOIE

(BOMBYX MORI L.)

JOURNAL OF SILKWORM

AVIS

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THE NUTRITIONAL VALUE OF CERTAIN MULBERRY VARIETIES.

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INTRODUCTION

The mulberry leaves are considered to be the lonely source for the nutrition of the silkworm Bombyx mori L. There are many varieties of the mulberry leaves, which differ so greatly in their nutritional value to the silkworm.

These studies have been conducted in The Faculty of Agriculture, Ain Shams University, and The Sericulture Research Section, Ministry of Agriculture, Egypt, and it was also carried in the Sericulture Research Station, Padova, Italy.

These determinations may lead us to select the most nutritive mulberry leaves to the silkworm Bombyx mori L.

These studies have chiefly contained the determination of the nutritional value of the different mulberry leaf varieties, with special reference to the Carbohydrate Fraction content, and the total nitrogen Content in different regions of the vegetative system of the mulberry tree and in different periods.

REVIEW OF LITERATURE

Pelligot (1852), made a study on the organic and inorganic elements in various products of sericulture, explaining from a chemical point of view the general process of the nutrition of the silkworm.

Kitazawa (1932), compared the chemical composition of the leaf of Quercus dentata with that of Quercus serata. He found that the water, ash, crude fat and crude protein were less in quantity in the former, and on the contrary, crude fiber, tanin and soluble nitrogen free extract were more.

Keiji Suda (1936), stated that non manure mulberry leaves when compared with the normally manured leaves contained smaller quantity of water, protein and ether extract, while the soluble nitrogen, free extract, soluble carbohydrate, crude fiber and crude ash were larger in quantity. Therefore the ratio of soluble carbohydrate to pure protein

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was large in the non manured mulberry leaves, also the nutritive ratio was wide. The ash of the non manured mulberry leaves contained acid radical in larger quantity, so alcalinity of these leaves was smaller than that of normally manured.

Evans (1939), described an accurate method of determining the amount of excreta in a caterpillar drived from a given amount of food. Analysis of food and excreta showed that about 60 % of the protein, 80 % of the soluble sugars, 60 % of the fats and 35 % of the ash were utilised. Pollysaccharides were not utilised. Nitrogen was excreted as ammonia and uric acid.

Kishi (1954), carried out studies on the soluble carbohydrates in the mulberry leaves, he stated that :

1 - The quantity of the soluble carbohydrate to be digested by the silkworm was very little in the youngest mulberry leave soon after sprouting, but it increased with the growth of them, and then diminished.

2 - The quantity of soluble carbohydrates digested by the silkworm was generally the same with that the cold water soluble carbohydrates converted by dilute hydrochloric acid, in 100 parts of the younger fresh mulberry leaves given in the stage of the young silkworm.

Kishi (1954), stated also that the more the quantity of soluble carbohydrates to be digested by the silkworms, the more healthy the silkworms became.

Kishi and Fukuma (1954), had carried out a practical method of selecting the younger fresh mulberry leaves given in the stage of the young silkworm by estimating practically the quantity of reducing sugars in those leaves.

Venereso (1957), made an examination on the leaves of new varieties of the mulberry tree, divided into three groups :

1 - Mulberry trees with large leaves.
2 - With medium sized leaves.
3 - Trees with small leaves.

She gave a brief description of the principal morphological of the leaves, the percentage of water, the dry substance, the total organic substances, the mineral substances and the crude fat. The authoress pointed out that the filippina and the Cattaneo showed high percentages of water and in consequence minimum quantities of total dry substances. The Restelli, the Arancina and the Sterile showed greater proportions of minor substance than Giazzola and Filippina. Only Morettiana showed an optimum total crude fatty substances. Was immediately followed by Giazzola and Rosa di lombardia.

The chemical composition of the leaves differed not only between one variety and another but between one group and another within the same variety.

From the biological point of view she noted that in the first period of growth the leaves of the mulberry-trees contained a great deal of water, organic substances and dry substances, the fatty substance generally increased during the leave cycle and this was explained by the fact that the plants accumulated reserved substances to be used during its rest period.

Martchenko (1960), stated that the improvement by fertilizers has a noticeable influence not only on the chemical composition of the leaves but also on their nutrient quality. The nitrogen contents, soluble sugars and ascorbic acid had raised. He also reported that the improvement of the chemical composition of the mulberry leaves had a positive influence on the silkworm alimentation ; and all the biological indices of the cocoon yield were improved.

Ito (1960), had showed that the feeding of the silkworm was strongly stimulated by sugars by the use of Agar - diet and the stimulation was largely different according to the different sugars. It was evident that there was no correspondence between the nutritive value of various sugars and performance between them.

Ito and Tanaka (1961), had shown that the nutritive effects of carbohydrates on the silkworms by determining their effects on longivity in per os administration of various carbohydrates. There was generally a good agreement in the kind of carbohydrates between the effects on the increase in trehalose and glycogen and those effects on longivity. It was concluded therefore that the difference of nutritive effects of carbohydrates was mainly caused by the difference in the utilisation among them. This method measuring the ratio of metabolism seemed to be useful for the evaluation of nutritive values of carbohydrates in insects.

MATERIAL

The mulberry leaf varieties used in these investigations were :

1959 & 1960				1961			
Morus alba	Var.		Morettiana	Morus alba	var.		Giazzola
"	"	"	Japanese L.	"	"	"	Florio
"	"	"	Selvatica	"	"	"	Selvatica
"	"	"	Rosa di lombardia (Balady)	"	"	"	Cattaneo
"	"	"	Roumi	"	"	"	Kokuso
"	"	"	Lhu	"	"	"	Morettiana.

METHODS

Preparations of materials for analysis :

The mulberry leaves were selected from the experimental varieties separated from their petioles, cut properly and mixed for feeding the different larval instars. A suitable quantity of these leaves was given to the worms, after weighing them. Samples of the mulberry leaves were taken each 15 days from different regions of the vegetative system of the mulberry tree "top, mid and base", in a ranamised manner. These samples were dried as soon as possible and immediately after collection in an electric oven with air draft at 70°C., for 24 hours. The dried samples were then finely grained, and kept in air tight glass tubes.

Determination of carbohydrate fractions :

A known weight (about one gram) from the finely ground powder was completely extracted by 80 % ethanol for six hours in a modified soxhelet "Nada and Hegazy 1956". The final alcohol extract was then transfered into a distilling flask for distilling off the alcohol under vaccum at a low temperature not exceeding 50°C. after neutralisation by N/10 NaOH with phenol red as indicator. When the distillation of the alcohol was complete, the contents of the distilling flask were then taken up using a little distilled. Clean acid washed sand was used to remove any material sticking to the glass walls. The water extract, the sand and washing were transfered into a beaker, neutralised to phenol red by means of basic lead acitate, the excess of which was precipitated using disodium phosphate. After filteration, the clear solution was then made up to volume and kept under toluene in a refrigirator for sugar analysis. All carbohydrates were determined in the form of reducing sugars by the Shaffer-Hartmann method (1921) and the data were expressed in term od glucose.

For total hexose determination, five ml. of the cleared extract were transfered into a sugar tube and 5 ml. of copper solution were added. The sugar tubes were then covered with condenser bulbs and transferred to boiling water bath for 15 minutes, after which the tubes were removed and cooled for three minutes in running tap water. Two ml. of 2 % potassium iodine solution and 2 ml. of 2N H_2SO_4 solution were added and well mixed. The iodine liberated was titrated against N/90 sodium thiosulfate using two drops of 1 % starch as an indicator. Two blanks were carried out with each set using 5 ml. of distilled water and following the same procedure.

For sucrose determination, 15 ml. of the water extract were hydrolysed by 5 ml. of 2 N HCl at 60°C. for half an hour, at the end of which the solution was neutralised by N NaOH to phenol red and then made up to 50 ml. The reducing power was determined using the previous method for total hexoses. The differences between the latter and the former gave the determination of sucrose.

For polysaccharides determination, a known weight of the dry alcohol residue (about 0, 5 grams) was hydrolysed with 15 ml. of N HCl for six hours under reflux in a boiling water bath. The solution was neutralised, cleared, made up to volume, then the resultant reducing sugars were determined as previously mentioned. The total polysaccharides were calculated as glucose.

Total Nitrogen Determination :

Pucher, Leavenworth and Vickery (1930), found that the Scovell salicylic acid-zinc method does not give the full amount of nitrogen in tobacco and other plants materials. They credit Olsen (1927), with priority in the determination of total nitrogen by reduction of nitrates with iron and wet combustion. The procedure is summarized as follows :

Reagents :

Boric acid solution 4 %.

Digestion mixture (3 parts by wt. of hydrous copper sulphate and one part of potassium sulphate).

Reduced iron.

Sodium hydroxide V/V (one volume concentrated acid diluted with equal volume of water).

Sulfuric acid N/70.

Apparatus :

Digestion rack.

Kjeldahl digestion flasks cap. 50 ml.

Ammonia distillation apparatus (parnas - Wagber modification) .

Analytical procedure :

Digestion :

A charge of 0. 02 gm. of the original dry finely powered sample weighed into a tared sheet of gum-free cigarette paper , was introduced into a dry digestion flask,a piece of reduced iron (weighing) 0. 1 gm. approx.) was added,followed by one ml. of V/V ammonia free sulforic acid and contents were shacken carefully. After a lapse of 10 min., the contents were boiled gently for 5 minutes then left to cool. At this point, 0.3 gm. of the digestion mixture (Gunning method as recommended by Pregel 1930), was added together with 5 ml. of V/V sulfuric acid. The digestion flask was first heated gently then boiled briskly until the oxidation of the carbon conpounds took place and the contents assumed a straw-yellow colour. Heating had been carried on for one hour more. The flasks were left to cool, when digestion came to an end.

Distillation :

The digest present in the flask was diluted with about 20 ml. of distilled water ; then transferred quantitatively to the micro-Kjeldahl distillation apparatus as modified by Parnas and Wagner (1931). The digestion flask was washed three times with few milliliters of distilled water. About 15 ml. of 40 % NaOH solution were added carefully to give a clear excess ; the alkali should settle at the bottom of the reaction chamber so that any ammonia freed would be re-absorbed by the layer of the acid above. A strong current of steam was let to pass and distillation of the liberated ammonia was carried out for a time sufficient to collect a distillate of 25 ml. (about 15 minutes). According to Winkler (1913), ammonia was received in a 100 ml. conical flask containing 10 ml. of the 4 % boric acid solution. The distillate was then titerated with N/70 sulfuric acid using the mixed methyl red-bromocresol green solution. The origin red colour was used as the titeration end point.

The result was substracted from the titration of a blank run made in the same way. The difference in these two sets of titeration represent milliliters of ammonia solution at the normality of the acid.

Calculation :

Since a normal ammonia solution contains one atomic equivalent of nitrogen, the weight of nitrogen may be calculated directly as follows :

Milligrams nitrogen = T x N x 14

where T = Depression of difference in ml. of the blank and sample titration.

N = Normality of sulfuric acid.

14= Atomic weight of nitrogen.

RESULTS AND DISCUSSION

Moisture percentage in the mulberry leaves :

The percentage of moisture of the plant reflects the moisture content of the environment of the plant as well as its physiological condition. However, both protein metabolism and carbohydrate metabolism influence the percentage of moisture considerably.

Data presented in Tables 1a - 2b indicate that the percentage of moisture of the mulberry leaves decreased with the advancing of age. It was also clearly shown that the percentage of moisture varied with the position of the leaves on the vegetative system of the mulberry tree, i.e. top, mid and base. Generally the percentage of moisture in the leaves of the top region of the vegetative system was higher than it was in the mid and basal regions.

The carbohydrate content :

The carbohydrate fractions of the plant could be expressed as percentage of the fresh and dry weights or as total weight per plant. The carbohydrate percentage reflects the physiological activity of the plant, whereas its total weight per plant represents the accumulated results of the metabolic activity.

The different carbohydrate fractions calculated as grams glucose per 100 grams dry weight.

Data presented in Tables 3 - 17 and graphically illustrated in Figs. 1 - 9 show the percentage of the reducing sugars, sucrose, total sugars, polysaccharides and total carbohydrates in the leaves of the different mulberry varieties in different regions of the vegetative system of the mulberry tree, i.e. top, mid and base, during the rearing periods of the years 1959, 1960 and 1961.

It is clearly shown from Tables 9, 11 and 16 significant differences in the percentage of the total carbohydrate content in the leaves of the different mulberry varieties which were used for feeding the silkworm during the three prementioned rearing seasons.

It is evident from Tables 11 and 16 that there has been no significant difference in the total carbohydrate content in the leaves of the different mulberry varieties in the different regions of the vegetative system and the change in concentrations were minor.

Table 12 clearly show that there has been no significant differences in the total sugar content of the mulberry leaves of the six varieties of mulberry used for feeding the silkworm during the rearing seasons 1959 and 1960. There has been also no significant differences in the total sugar content in the mulberry leaves as for their position on the vegetative system of the mulberry tree.

Data represented in Table 17 show that there was a highly significant difference in the total sugar content in the different mulberry leaf varieties, which were used for feeding the silkworm during the rearing season 1961, but it was in accordance with the other mulberry leaf varieties used for feeding in 1959 and 1960, as there was not significant differences in the total sugar content in the mulberry leaves in the different regions of the vegetative system of the mulberry tree.

Total nitrogen content :

Tables 18 - 25 and Figs. 8 and 9 demonstrate the total nitrogen content in the leaves of the different mulberry varieties in the different regions of the vegetative system of the mulberry tree during the rearing period of the silkworm. It is clearly shown that the total nitrogen content in the mulberry leaves had decreased by advancing of their ages. Percentage of total nitrogen had also decreased from the top to the basal regions of the vegetative system.

Table 18 and Fig. 8 represent the percentage of total nitrogen in the leaves of the variety Morettiana as it was in the leaves of the top region 6.91, 6.51, 6.51 & 4.07 in the different dates, and it was 6.78, 5.47, 4.94 and 3.62 in the leaves of the middle region, while it was 6.53 , 5.30, 4.89 and 3.59 in the leaves of the basal region at the same period.

As similarly, Table 18 indicates clearly the value of total nitrogen in the same variety during the rearing season of 1960. It was in the leaves of the top region 9.4, 9.0, 8.7 and 5.5 %. Total nitrogen in the leaves of the middle region was 8.1, 8.2, 8.2 & 5.4 % and 8.0, 8.0, 8.0 and 5.2 % in the leaves of the basal region.

Percentage of total nitrogen in the leaves of the variety Japanese L. during the rearing season of 1959 is recorded in Table 18 and illustrated in Fig. 8.

The value of total nitrogen in the leaves of the top region was 5.95, 5.06, 4.97 and 4.06 %. In the leaves of the middle region, percentage of total nitrogen was 5.76, 5.22, 3.90 and 3.22. In the leaves of the basal region, the value of total nitrogen was 5.75, 4.84, 4.33 and 3.81% at the same period.

During the rearing period of 1960, the amount of total nitrogen in the leaves of the top region was 8.9, 6.9, 5.6 and 4.3 %. The value of total nitrogen in the leaves of the middle region was 8.0, 6.2, 6.2 and 4.1 % and it was, 7.5, 5.7, 5.6 and 3.9 in the leaves of the basal region.

Table 19 and Fig. 8 clearly represent the value of total nitrogen in the leaves of the variety Selvatica, during the rearing season of 1959. Percentage of total nitrogen in the leaves of the top region was 5.41, 4.53, 5.09 and 3.95. In the leaves of the middle region the amount of total nitrogen was 5.24, 4.42, 5.42 and 3.51 % and it was 5.40, 4.59, 4.94 and 3.41 % in the leaves of the basal region.

During the rearing period of 1960, percentage of total nitrogen in the leaves of the top region were 6.4, 8.2, 8.7 and 5.3 and 7.2, 7.6, 8.3 and 5.2 They were 6.0, 7.4, 7.6 and 4.9 in the leaves of the basal region.

It is shown from Table 19 and Fig. 8 that the percentage of total nitrogen in the leaves of the variety Rosa di Lombardia (Balady) during the rearing period of 1959. The value of the total nitrogen in the leaves of the top region was 4.37, 4.81, 3.44 and 4.82 %. In the leaves of the middle region, the value of total nitrogen was 4.23, 4.62, 3.22 and 3.92 %, while it was in the leaves of the basal region 4.14, 4.27, 3.10, and 3.12 % at the same period.

During the rearing period of 1960, the value of total nitrogen in the leaves of the top vegetative region was 7.0, 7.4, 6.9 and 4.6 %, and 6.0, 6.6, 6.2 and 4.1 % in the leaves of the middle region. The value of total nitrogen in the leaves of the basal region was 6.3, 6.2, 5.6 and 4.4 % during the same period.

Table 20 and Fig. 8 represent the value of total nitrogen in the leaves of the variety Roumi, during the rearing period of 1959, as it was 5.89, 4.84, 4.80 and 3.97 % in the leaves of the top region. The value of total nitrogen in the leaves of the middle region was 6.08, 4.89, 4.26 and 3.30 % and it was 4.45, 4.40, 4.33 and 2.92 % in the leaves of the basal region of the vegetative system.

During the rearing period of 1960, the value of total nitrogen in the leaves of the top region was 6.6, 8.9, 7.8 and 5.3 % and it was 6.2, 7.8, 7.1 and 5.2 % in the leaves of the middle region. The percentage of total nitrogen in the leaves of the basal region was 6.0, 7.5, 6.9 and 4.9 % during the same period.

The value of total nitrogen in the leaves of the variety Lhu is represented in Table 20 and graphically illustrated in Fig. 8.

During the rearing period of 1959, the value of total nitrogen in the leaves of the top region was 5.86, 6.17, 4.33 and 3.49 %. In the leaves of the middle region, the percentage of total nitrogen were 5.23, 4.27, 3.99 and 2.98 % and 5.19; 4.77, 3.94 and 3.24 % in the leaves of the basal region.

During the rearing period of 1960, the value of total nitrogen in the leaves of the top region was 4.6, 5.7, 5.4 and 3.7 % and 4.5, 4.0, 5.6 and 2.8 % in the leaves of the middle region. The value of total nitrogen in the leaves of the basal region was 5.1, 4.3, 4.7 and 3.3 % during the same period.

Table 21 show that there was a highly significant difference in the value of total nitrogen in the leaves of the different mulberry varieties, which were utilized for feeding the silkworm during both years 1959 and 1960. There was also a highly significant difference in the amount of the total nitrogen in the leaves of the different regions of the vegetative system of the mulberry tree, i.e., top, mid and base. A highly significant difference was also found in the value of total nitrogen between the leaves of the top and basal regions, as it was clearly shown from the prementioned results, that the value of total nitrogen in the leaves had decreased from the top to the basal regions of the vegetative system of the mulberry tree. Percentage of total nitrogen had also decreased gradually from the beginning to the end of the rearing period of the silkworm Bombyx mori L.

Table 22 and Fig. 9 represent the value of total nitrogen in the leaves of the variety Giazzola during the rearing period of 1961. The value of total nitrogen in the leaves of the top region was 7.25, 4.46, 5.38 and 4.89 and 6.75, 4.59, 4.75 and 4.15 % in the leaves of the middle region. The value of total nitrogen in the leaves of the basal region was 6.52, 4.68, 4.43 and 4.21 % during the same period.

The value of total nitrogen in the leaves of the variety Florio is clearly shown in Table 22 and illustrated in Fig. 9. In the leaves of the top region, the value of total nitrogen was 7.46, 4.40, 3.52 and 2.82 %, while it was 7.43, 4.10, 3.46 and 2.76 % in the leaves of the middle region of the vegetative system, and 7.43, 4.32, 3.46 and 2.06 % in the leaves of the basal region, during the same period.

Table 23 and Fig. 9 represent the value of total nitrogen in the leaves of the variety Selvatica during the rearing period of 1961. The value of total nitrogen in the leaves of the top region was 7.92, 6.13, 4.77 and 4.40 % and it was 4.46, 5.98, 4.75 and 3.59 % in the leaves of the middle region. The value of total nitrogen in the leaves of the basal region was 7.43, 5.72, 4.59 and 3.27 % during the same period.

Table 23 and Fig. 9 represent the amount of total nitrogen in the leaves of the variety Cattaneo. The value of total nitrogen in the leaves of the top region was 6.93, 5.22, 4.60 and 5.25 % and it was 6.60, 5.05 4.32 and 4.96 % in the leaves of the middle region. The value of total nitrogen in the leaves of the basal region was 6.70, 5.04, 4.26 and 5.07 % during the rearing period of the silkworm.

The amount of total nitrogen in the leaves of the variety Kokuso is recorded in Table 24 and graphically illustrated in Fig. 9. It was 6.96, 5.54, 4.47 and 3.40 % in the leaves of the top region, while it was 6.81, 4.30, 4.03 and 3.32 % in the leaves of the middle region of the vegetative system. The value of total nitrogen in the leaves of the basal region was 7.4, 4.3, 4.15 and 3.20 % during the same period.

The value of total nitrogen in the leaves of the variety Morettiana is clearly shown in Table 24 and Fig. 9. It was 7.09, 4.49, 4.16 and 3.20 % in the leaves of the top region, while it was 6.52, 4.60, 3.99 and 3.20 % in the leaves of the middle region. The value of total nitrogen in the leaves of the basal region was 6.07, 4.33, 4.09 and 3.20 % during the same period.

Table 25 indicates that there was a highly significant difference in the value of total nitrogen in the leaves of the different mulberry varieties, utilized for feeding the silkworm during the rearing period of 1961. There was also a highly significant difference in the value of total nitrogen in the leaves in different regions of the vegetative system of the mulberry tree, i.e. top, mid, and base.

These results were in accordance with the results of the years 1959 and 1960.

Comparing the results, we can find out that the leaves of the variety Morettiana contained significantly the high value of total nitrogen, either in the top, mid, or basal region of the vegetative system of the mulberry tree during the rearing periods of the years 1959 and 1960, followed by the varieties Japanese L., and Selvatica during the rearing period of 1959, and followed by the varieties Selvatica and Roumi during the rearing period of the year 1960. Comparing the results of the value

of total nitrogen in the leaves of the different mulberry varieties utilized for feeding during the rearing period of the year 1961, it was clearly shown that the variety Selvatica contained significantly the high value of the total nitrogen than the other varieties, followed by the varieties Cattaneo and Kokuso. It took also the same trend for the value of total nitrogen in the leaves in the different regions of the mulberry tree, as it decreased gradually from the top to the basal regions of the vegetative system.

The statistical analysis of the carbohydrates fractions, proved that there was not significant difference in the total sugar content in the leaves of the different mulberry varieties except in the mulberry varieties utilized for feeding during 1961.

It is also clearly shown that there was only a highly significant difference in the amount of the total carbohydrates in the leaves of the different mulberry varieties.

There was significant difference in the amount of the polysaccharides in the different mulberry leaf varieties, which the silkworm does not utilize, and a highly significant difference in the value of total nitrogen in the different mulberry leaf varieties. The results clearly indicate that the protein source in the mulberry leaves is considered as the main factor in the case of comparing the nutritional value of the different mulberry leaf varieties. Even though, trials were carried to get out the correlation between the value of total nitrogen in the leaves of the different mulberry varieties and the yield of silk, but it was not significant and this may be due to the small number of observations taken in this experiment.

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RESUME

LA VALEUR NUTRITIVE DE CERTAINES VARIETES DE MURIERS

Le but de la présente recherche est d'étudier la valeur nutritive de certaines variétés de mûriers cultivées soit en EGYPTE soit en ITALIE, afin de sélectionner les variétés les plus adaptées à l'alimentation du ver à Soie Bombyx mori L.. Six variétés de mûriers cultivées en EGYPTE ont été utilisées en 1959 et 1960, et six autres variétés cultivées en ITALIE ont été utilisées en 1961.

Les recherches portent principalement sur la détermination du dosage d'hydrate de carbone et d'azote total.

Pourcentage d'humidité dans les feuilles de mûriers.

Il est montré que le pourcentage d'humidité a diminué avec l'avancement de l'âge et qu'il est variable avec la situation de la feuille sur la branche.

La teneur en hydrate de carbone.

Il y a de très notables différences dans le pourcentage d'hydrate de carbone total contenu dans les différentes variétés de feuilles de mûrier.

Il est aussi évident qu'il n'y a pas de notables différences dans le sucre (total) contenu dans les variétés de feuilles de mûrier de 1959 et 1960, tandis qu'il y a une grande différence dans le sucre (total) contenu dans les variétés de 1961.

Teneur en azote total.

Des variations prononcées ont été constatées dans la teneur en Azote total des différentes variétés. Il est évident que la teneur en azote total des feuilles de mûrier a diminué suivant l'avancement de leur âge. Le pourcentage d'azote total avait aussi diminué du haut aux parties basses (du système végétatif).

On remarque également une notable différence dans la valeur de l'azote total selon les différentes variétés.

Les recherches ont démontré que l'emplacement des feuilles de mûrier a un effet marqué sur la valeur nutritive de ses tissus.

Table 1 a

Moisture percentage in the leaves of the different mulberry varieties in different regions of the vegetative system during the rearing seasons 1959 and 1960.

Date	1959			Date	1960		
	Top	Mid	Base		Top	Mid	Base
			1. Var. Morettiana				
16.4.59	71.5	76.0	72.5	1.4.60	74.8	75.6	77.0
1.5.59	77.4	71.0	76.6	15.4.60	78.0	78.2	79.0
15.5.59	74.6	68.4	68.6	1.5.60	67.6	67.2	72.8
1.6.59	75.2	75.2	75.6	15.5.60	78.0	77.0	70.4
			2. Var. Japanese				
16.4.59	77.5	76.5	81.0	1.4.60	74.6	76.8	75.6
1.5.59	78.2	72.2	71.8	15.4.60	77.0	76.2	75.6
15.5.59	73.8	71.6	72.8	1.5.60	76.4	75.6	70.0
1.6.59	74.8	76.4	73.8	15.5.60	77.0	74.6	70.2
			3. Var. Selvatica				
16.4.59	79.5	79.0	76.0	1.4.60	78.6	78.0	77.7
1.5.59	77.4	71.8	69.2	15.4.60	76.2	76.8	77.2
15.5.59	75.0	71.6	74.6	1.5.60	75.4	76.2	71.2
1.6.59	76.0	77.0	76.2	15.5.60	74.0	75.0	66.0

Table 1 b

Moisture percentages in the leaves of the different mulberry varieties in different regions of the vegetative system during the rearing seasons 1959 and 1960.

Date	1959			Date	1960		
	Top	Mid	Base		Top	Mid	Base
			4. Var. Rosa di lombardia				
16.4.59	67.0	74.0	74.0	1.4.60	66.6	76.2	69.4
1.5.59	74.0	75.0	72.0	15.4.60	75.2	71.8	75.2
15.5.59	73.4	72.4	78.6	1.5.60	68.6	69.4	64.4
1.6.59	70.8	65.2	70.8	15.5.60	70.2	76.0	71.0
			5. Var. Roumi				
16.4.59	76.5	76.5	77.0	1.4.60	76.6	75.0	76.8
1.5.59	77.0	72.2	73.2	15.4.60	78.0	76.4	76.2
15.5.59	78.0	64.4	68.4	1.5.60	78.0	78.4	76.4
1.6.59	75.2	77.4	77.0	15.5.60	76.6	78.8	71.0
			6. Var. Lhu				
16.4.59	77.5	76.5	82.0	1.4.60	70.2	68.2	72.4
1.5.59	80.0	73.6	77.6	15.4.60	76.0	77.4	76.6
15.5.59	80.0	76.7	76.4	1.5.60	75.4	74.2	71.2
1.6.59	75.4	72.8	75.4	15.5.60	70.6	70.0	68.6

Table 2 a

Moisture percentage in the leaves of the different mulberry varieties in different regions of the vegetative system during the rearing season 1961

Date	Moisture percentage		
	Top	Mid	Base
	1. Var. Giazzola		
20.4.61	76.9	76.5	77.6
5.5.61	70.0	69.6	71.9
20.5.61	69.6	69.8	71.6
5.6.61	70.0	72.0	70.2
	2. Var. Florio		
20.4.61	76.2	75.6	77.1
5.5.61	71.8	71.8	73.3
20.5.61	69.6	69.8	71.6
5.6.61	68.3	71.7	70.8
	3. Var. Selvatica		
20.4.61	72.5	71.8	74.1
5.5.61	70.9	69.9	70.5
20.5.61	66.7	71.0	70.8
5.6.61	68.1	70.0	68.2

Table 2 b

Moisture percentage in the leaves of the different mulberry varieties in different regions of the vegetative system during the rearing season 1961

Date	Moisture percentage		
	Top	Mid	Base
	4. Var. Cattaneo		
20.4.61	76.3	76.3	76.8
5.5.61	71.3	71.3	72.0
20.5.61	65.2	68.9	68.8
5.6.61	76.1	68.6	68.3
	5. Var. Kokuso		
20.4.61	75.7	76.2	78.0
5.5.61	74.5	73.5	74.5
20.5.61	71.2	72.6	73.2
5.6.61	68.3	72.0	75.3
	6. Var. Morettiana		
20.4.61	89.3	74.2	77.2
5.5.61	68.0	68.7	70.0
20.5.61	66.3	66.3	68.5
5.6.61	65.8	65.0	70.0

Table 3

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing seasons 1959 and 1960, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						1. Var. Morettiana (1959)									
16.4.59	0.2	3.0	3.2	7.8	11.0	0.2	2.5	2.7	8.5	11.2	0.1	2.2	2.3	4.4	6.7
1.5.59	0.4	3.6	4.0	5.4	9.4	0.4	5.2	5.6	5.6	11.2	0.4	3.8	4.2	7.2	11.4
15.5.59	0.5	3.4	3.9	5.9	9.8	0.4	5.1	5.5	4.9	10.4	0.4	5.2	5.6	4.4	10.0
1.6.59	0.3	1.2	1.5	13.7	15.2	0.3	1.0	1.3	12.2	13.5	0.3	0.5	0.8	13.4	14.2
						(1960)									
1.4.60	1.8	3.1	4.9	7.8	12.7	1.1	1.9	3.0	7.9	10.9	1.9	3.0	4.9	6.9	11.8
15.4.60	1.7	3.7	5.9	5.3	10.7	0.8	2.4	3.2	6.5	9.7	2.7	3.4	5.6	5.4	11.0
1.5.60	1.4	0.9	2.3	9.1	11.4	0.2	5.5	5.7	4.4	10.1	0.4	6.1	6.5	4.5	11.0
15.5.60	2.5	6.7	9.2	0.8	10.0	3.4	6.7	10.1	2.3	12.4	2.8	7.8	10.6	6.8	17.4

N.B.

R.S. = reducing sugars
S. = Sucrose
T.S. = Total sugars
P.S. = Polysaccharides
T.C. = Total carbohydrates.

Table 4

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing seasons 1959 and 1960, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						2. Var. Japanese L. (1959)									
16.4.59	0.1	2.3	2.4	7.4	9.8	0.09	2.51	2.6	6.4	9.0	0.1	2.4	2.5	4.3	6.8
1.5.59	0.5	4.5	5.0	5.1	10.1	0.3	4.8	5.1	5.3	10.3	0.6	1.9	2.5	5.8	8.3
15.5.59	0.7	4.6	5.3	8.3	13.6	0.3	3.7	4.0	6.2	10.2	0.6	3.4	4.0	6.0	10.0
1.6.59	0.4	0.3	0.7	2.2	2.9	0.4	0.1	0.5	10.9	11.4	0.4	0.6	1.0	15.9	16.9
						(1960)									
1.4.60	3.8	7.3	11.1	0.5	11.6	2.1	7.2	9.3	1.3	10.6	1.8	4.5	6.3	4.2	10.5
15.4.60	1.5	3.6	5.1	5.7	10.8	1.4	2.0	3.4	7.1	10.5	1.0	3.7	4.7	5.3	10.0
1.5.60	0.5	2.3	2.8	13.0	15.8	0.8	2.3	3.1	10.2	13.3	1.3	2.3	3.6	8.9	12.5
15.5.60	2.0	6.1	8.2	3.5	11.7	1.8	6.6	8.4	3.2	11.6	1.4	7.2	8.6	2.6	11.2

Table 5

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing seasons 1959 and 1960, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						3. Var. Selvatica (1959)									
16.4.59	0.02	2.98	3.0	5.8	8.8	0.1	2.3	2.4	11.0	13.4	0.05	2.35	2.4	5.2	7.6
1.5.59	0.3	4.6	4.9	5.7	10.6	0.5	5.2	5.7	7.2	12.9	0.5	2.3	2.8	6.8	9.6
15.5.59	0.7	1.6	2.3	17.8	20.1	0.7	2.7	3.4	17.4	20.8	0.3	1.6	1.9	13.9	15.8
1.6.59	0.2	1.5	1.7	3.5	5.2	0.3	1.4	1.7	6.8	8.5	0.3	1.4	1.7	9.2	10.9
						(1960)									
1.4.60	3.7	1.3	5.0	11.2	16.2	2.0	3.5	5.5	11.9	17.4	2.3	5.6	7.9	10.5	12.4
15.4.60	0.8	4.6	5.4	15.6	21.0	1.4	1.8	3.2	15.8	19.0	1.2	4.4	5.6	13.5	19.1
1.5.60	1.3	1.1	2.4	19.5	21.9	1.8	0.7	2.5	16.6	19.1	1.9	1.5	3.9	15.7	19.1
15.5.60	3.2	6.4	9.6	21.4	31.0	2.6	7.5	10.1	4.4	14.5	4.1	6.5	10.6	10.0	11.6

Table 6

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing seasons 1959 and 1960, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						4. Var. Rosa di lombardia (1959)									
16.4.59	0.2	6.4	6.6	8.4	15.0	0.2	3.5	3.7	5.7	9.4	0.2	2.6	2.8	7.9	10.7
1.5.59	0.5	4.7	5.4	8.3	13.7	0.4	3.7	4.1	8.5	12.6	0.4	4.7	5.1	9.1	14.2
15.5.59	0.6	2.6	3.2	14.6	17.8	1.0	1.0	2.0	16.2	18.2	0.4	7.8	8.2	8.3	16.5
1.6.59	0.3	1.2	1.5	14.3	15.8	0.3	0.2	0.5	17.7	18.2	0.2	0.4	0.6	13.5	14.1
						(1960)									
1.4.60	4.7	1.6	6.3	8.0	14.3	5.4	1.1	6.5	4.5	11.0	4.8	3.2	8.0	3.9	11.9
15.4.60	1.2	2.1	3.3	8.5	11.8	0.8	5.2	6.0	7.6	13.6	1.5	3.8	5.3	8.6	13.9
1.5.60	1.3	5.9	7.2	17.4	24.6	1.1	5.9	7.0	13.5	20.5	0.8	5.7	6.5	16.0	22.5
15.5.60	1.8	5.3	7.3	16.6	23.9	1.6	4.1	5.7	18.0	23.7	2.7	3.0	5.7	14.7	20.4

Table 7

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing seasons 1959 and 1960, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						5. Var. Roumi (1959)									
16.4.59	0.6	2.5	3.1	5.4	8.5	0.5	4.1	4.6	5.6	10.2	0.5	4.8	5.3	6.0	11.3
1.5.59	0.5	2.8	3.3	7.4	10.7	0.4	3.7	4.1	6.1	10.2	0.2	3.3	3.5	7.4	10.9
15.5.59	0.7	1.2	1.9	15.6	17.5	0.03	1.57	1.6	11.0	12.6	0.03	1.77	1.8	15.6	17.4
1.6.59	0.2	0.1	0.3	18.1	18.4	0.2	0.2	0.4	9.8	10.2	0.2	0.2	0.4	18.1	18.5
						(1960)									
1.4.60	0.9	5.6	6.5	0.8	7.3	0.8	7.1	7.9	4.5	12.4	1.3	6.8	8.1	4.2	12.3
15.4.60	2.7	1.7	4.4	8.4	12.8	2.2	3.9	6.1	6.1	12.2	2.4	4.9	6.3	6.9	13.2
1.5.60	0.9	1.0	1.9	11.0	12.9	0.7	1.0	1.7	12.0	13.7	0.6	1.0	1.6	12.1	13.7
15.5.60	1.2	3.2	4.4	10.7	15.1	1.1	5.0	6.1	5.3	11.4	0.6	5.7	1.3	4.9	11.2

Table 8

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing seasons 1959 and 1960, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						6. Var. Lhu (1959)									
16.4.59	0.2	3.5	3.7	11.4	15.1	0.2	4.2	4.4	5.8	10.2	0.2	2.0	2.2	9.1	11.3
1.5.59	0.4	1.6	2.0	8.4	10.4	0.3	4.1	4.4	6.7	11.1	0.4	3.9	4.3	4.2	8.6
15.5.59	0.4	1.6	2.3	16.1	18.4	0.6	3.3	3.9	17.4	21.3	0.7	3.0	3.7	21.7	25.4
1.6.59	0.3	1.0	1.3	11.1	12.4	0.3	1.3	1.6	11.6	13.2	0.3	1.2	1.5	15.0	16.5
						(1960)									
1.4.60	1.6	4.3	5.9	7.5	13.4	1.1	8.5	9.6	3.3	12.9	1.2	7.3	8.5	2.4	10.9
15.4.60	2.7	1.1	3.8	14.9	18.7	2.2	3.4	5.6	4.8	10.4	2.4	3.9	6.3	6.5	12.8
1.5.60	1.7	1.1	2.8	7.2	10.0	0.9	2.6	3.5	9.1	12.6	0.8	4.0	4.8	8.8	13.6
15.5.60	2.6	5.9	8.5	17.0	25.5	2.4	5.9	8.3	19.6	27.9	2.0	5.8	7.8	15.7	23.5

Table 9

Analysis of variance regarding the quantity of total carbohydrates in the different mulberry leaf varieties and their position on the vegetative system.

(1959)

Source of variance	D.F.	Total S. square	Mean S. square	F.
Varieties	5	51.66	10.33	5.75 xx
Position	2	0.03	0.015	
Error	10	17.96	1.796	
Total	17	69.65		

Table 10

Analysis of variance regarding the quantity of total sugars in the different mulberry leaf varieties and their position on the vegetative system

Source of variance	D.F.	Total S. square	Mean S. square	F.
Varieties	5	1.98	0.396	1.13
Positions	2	1.21	0.605	1.73
Error	10	3.50	0.350	
Total	17	6.69		

xx Significant at the level 0.01

Table 11

Analysis of variance regarding the quantity of total carbohydrates in the different mulberry leaf varieties and their position on the vegetative system, (1960).

Sum of variance	D.F.	Sum square	Mean sum square	F.
Varieties	5	156.43	31.286	17.97 xx
Position	2	8.76	4.380	2.51
Error	10	17.41	1.741	
Total	17	182.60		

Table 12

Analysis of variance regarding the quantity of total sugars in the different mulberry leaf varieties and their position on the vegetative system.

Sum of variance	D.F.	Sum square	Mean sum square	F.
Varieties	5	9.87	1.974	1.48 xx
Position	2	0.75	0.375	
Error	10	13.35	1.335	
Total	17	23.97		

xx Significant at the level 0.01

Table 13

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing season 1961, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						1. Var. Giazzola									
20.4.61	0.5	6.2	6.7	10.0	16.7	0.1	6.1	6.2	17.8	23.0	0.3	4.2	4.5	14.6	19.1
5.5.61	1.4	6.5	7.9	23.7	31.6	0.7	5.3	6.0	20.0	26.0	1.8	4.3	6.1	18.7	24.8
20.5.61	1.9	7.0	8/9	13.3	22.2	3.0	6.2	9.2	11.9	21.7	2.2	7.4	9.6	11.7	21.3
5.6.61	7.4	2.9	9.3	14.4	2 3.7	3.5	5.5	9.0	13.0	22.0	2.8	6.1	8.9	12.6	21.4
						2. Var. Florio									
20.4.61	3.9	3.4	7.3	23.9	31.2	2.8	5.1	7.9	26.2	34.1	0.8	5.2	6.0	24.5	30.5
5.5.61	3.0	5.7	8.7	21.4	30.1	3.9	6.5	9.3	21.3	30.6	2.3	6.0	8.3	20.8	29.1
20.5.61	4.4	4.8	9.2	22.6	31.8	6.6	3.6	9.2	18.0	27.2	5.8	2.7	8.5	18.1	26.6
5.6.61	6.7	2.1	8.8	`24.0	32.8	6.1	2.9	9.0	17.9	26.9	5.6	3.5	9.1	20.4	29.5

Table 14

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing season 1961, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						3. Var. Selvatica									
20.4.61	1.9	6.8	8.1	15.6	23.7	1.8	7.7	9.5	13.8	23.3	1.9	6.9	8.7	15.9	24.6
5.5.61	1.4	7.2	8.6	15.1	23.7	0.7	7.9	8.6	13.7	22.3	1.8	6.3	8.1	15.9	24.0
20.5.61	1.4	8.2	9.6	13.7	23.3	1.2	7.0	8.2	11.0	19.2	1.6	7.1	8.7	10.5	19.2
5.6.61	6.0	4.2	10.2	15.7	25.9	6.3	2.7	9.0	15.8	24.8	5.9	4.3	10.2	15.4	26.6
						4. Var. Cattaneo									
20.4.61	4.0	0.5	4.5	23.8	28.3	3.2	1.7	4.9	25.5	30.4	1.4	2.3	3.1	30.0	33.1
5.5.61	3.0	1.3	4.3	31.4	35.7	1.4	4.6	6.0	24.2	30.2	3.8	3.2	7.0	22.4	29.4
20.5.61	1.2	4.7	5.9	26.1	32.0	2.2	6.8	9.0	15.3	24.3	1.2	6.6	7.8	17.3	25.1
5.6.61	1.3	3.2	4.5	18.3	22.8	1.3	4.4	5.7	13.0	18.7	1.1	4.8	5.9	12.5	18.4

Table 15

Carbohydrate fractions (as glucose units) in the mulberry leaves in different regions of the vegetative system during the rearing season 1961, calculated as percentage dry matter.

Date	Top					Mid					Base				
	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.	R.S.	S.	T.S.	P.S.	T.C.
						5. Var. Kokuso									
20.4.61	2.1	5.5	7.6	19.4	27.0	1.9	6.5	8.6	17.4	26.0	1.0	2.1	3.1	23.2	26.3
5.5.61	4.2	1.2	5.4	17.0	22.4	4.2	6.6	10.8	8.7	19.5	2.6	6.0	8.6	14.3	22.9
20.5.61	2.8	5.7	8.5	19.4	27.9	2.1	6.4	8.5	15.5	24.0	1.9	5.9	7.9	13.1	21.0
5.6.61	3.1	5.2	8.3	25.7	34.0	0.8	6.6	7.4	15.0	22.4	2.9	5.6	8.5	14.9	23.4
						6. Var. Morettiana									
20.4.61	1.7	3.7	5.4	24.6	30.0	2.2	5.1	7.3	23.2	30.5	2.3	2.2	4.5	25.0	29.5
5.5.61	3.5	4.1	7.6	34.3	41.9	1.8	6.1	7.9	30.1	38.0	2.9	7.0	8.9	28.7	37.6
20.5.61	3.1	6.5	9.6	19.0	28.6	4.1	5.6	9.7	17.3	27.0	3.8	5.6	9.4	16.6	26.0
5.6.61	5.1	5.6	10.7	22.2	32.9	3.2	5.7	8.9	20.3	29.2	2.4	4.7	7.1	22.7	29.8

Table 16

Analysis of variance regarding the quantity of total carbohydrates in the different mulberry leaf varieties and their position on the vegetative system.

Source of variance	D.F.	Total S. square	Mean S. square	F.
Varieties	5	212.60	42.52	15.30 xx
Position	2	11.06	5.53	1.98
Error	10	27.79	2.779	
Total	17	251.45		

Table 17

Analysis of variance regarding the quantity of total sugars in the different mulberry leaf varieties and their position on the vegetative system.

Source of variance	D.F.	Total S. square	Mean S. square	F.
Varieties	5	29.69	5.938	6.97 x
Position	2	0.50	0.250	
Error	10	8.51	0.851	
Total	17	38.70		

x Significant at the level 0.05

xx " " " " 0.01

Table 18

Percentage of total nitrogen in the different mulberry leaf varieties in different regions of the vegetative system during the rearing seasons 1959 and 1960.

Date	1959			Date	1960		
	Top	Mid	Base		Top	Mid	Base
			1. Var. Morettiana				
16.4.59	6.91	6.78	6.53	1.4.60	9.4	8.1	8.0
1.5.59	6.51	5.47	5.30	15.4.60	9.0	8.2	8.0
15.5.59	5.45	4.94	4.89	1.5.60	8.7	8.2	8.0
1.6.59	4.07	3.62	3.59	15.5.60	5.5	5.4	5.2
			2. Var. Japanese				
16.4.59	5.95	5.76	5.75	1.4.60	8.9	8.0	7.5
1.5.59	5.06	5.22	4.84	15.4.60	6.9	6.2	5.7
15.5.59	4.97	3.90	4.33	1.5.60	5.6	6.2	5.6
1.6.59	4.06	3.22	3.81	15.5.60	4.3	4.1	3.9

Table 19

Percentages of total nitrogen in the different mulberry leaf varieties in different regions of the vegetative systems during the rearing seasons 1959 and 1960.

Date	1959			Date	1960		
	Top	Mid	Base		Top	Mid	Base
			3. Var. Selvatica				
16.4.59	5.41	5.24	5.40	1.4.60	6.4	7.2	6.0
1.5.59	4.53	4.42	4.59	15.4.60	8.2	7.6	7.4
15.5.59	5.09	5.42	4.94	1.5.60	8.7	8.3	7.6
1.6.59	3.95	3.51	3.41	15.5.60	5.3	5.2	4.9
			4. Var. Rosa di lombardia				
16.4.59	4.37	4.23	4.14	1.4.60	7.0	6.0	6.3
1.5.59	4.81	4.62	4.27	15.4.60	7.4	6.6	6.2
15.5.59	3.44	3.27	3.10	1.5.60	6.9	6.2	5.6
1.6.59	4.82	3.92	3.12	15.5.60	4.6	4.1	4.4

Table 20

Percentage of total nitrogen in the different mulberry leaf varieties in different regions of the vegetative system during the rearing seasons 1959 and 1960.

Date	1959			Date	1960		
	Top	Mid	Base		Top	Mid	Base
			5. Var. Roumi				
16.4.59	5.89	6.08	4.45	1.4.60	6.6	6.2	6.0
1.5.59	4.84	4.89	4.40	15.4.60	8.9	7.8	7.5
15.5.59	4.80	4.26	4.33	1.5.60	7.8	7.1	6.9
1.6.59	3.97	3.30	2.92	15.5.60	5.3	5.2	4.9
			6. Var. Lhu				
16.4.59	5.86	5.23	5.19	1.4.60	4.6	4.5	5.1
1.5.59	6.17	4.27	4.77	15.4.60	5.7	4.0	4.3
15.5.59	4.33	3.99	3.94	1.5.60	5.4	5.6	4.7
1.6.59	3.49	2.98	3.24	15.5.60	3.7	2.8	3.3

Table 21

Analysis of variance regarding percentage of T.N. in the different mulberry leaf varieties and their position on the vegetative system, during the rearing seasons 1959 & 1960.

Source of variance	D.F.	Total S. square	Mean S. square	F.	
		(1960)			
Varieties	5	2.63	0.526	22.8	xx
Position	2	0.82	0.410	17.8	xx
Error	10	0.23	0.023		
Total	17	3.68			

L.S.D.V. at 1 % = 0.300 L.S.D.P. at 1 % = 0.479

		(1960)			
Varieties	5	17.12	3.706	154.4	xx
Position	2	1.63	0.815	33.9	xx
Error	10	0.24	0.024		
Total	17	18.99			

L.S.D.V. = Least significant difference between the varieties.
L.S.D.P. = Least significant difference between the position.
xx Significant at the level 0.01

Table 22

Percentage of total nitrogen in the different mulberry leaf varieties in different regions of the vegetative system, during the rearing season 1961.

Date	Leaf position		
	Top	Mid	Base
	1. Var. Giazzola (1961)		
20.4.61	7.25	6.75	6.52
5.5.61	4.46	4.59	4.68
20.5.61	5.38	4.75	4.43
5.6.61	4.89	4.15	4.21
	2. Var. Florio		
20.4.61	7.46	7.43	7.43
5.5.61	4.40	4.10	4.32
20.5.61	3.52	3.46	3.46
5.6.61	2.82	2.76	2.06

Table 23

Percentage of total nitrogen in the different mulberry leaf varieties in different regions of the vegetative system, during the rearing season 1961.

Date	Leaf position		
	Top	Mid	Base
	3. Var. Selvatica		
20.4.61	7.92	7.46	7.43
5.5.61	6.13	5.98	5.72
20.5.61	4.77	4.75	4.59
5.6.61	4.40	3.59	3.27
	4. Var. Cattaneo		
20.4.61	6.93	6.60	6.70
5.5.61	5.22	5.05	5.04
20.5.61	4.60	4.37	4.26
5.6.61	5.25	4.96	5.07

Table 24

Percentage of total nitrogen in the different mulberry leaf varieties in different regions of the vegetative system during the rearing season 1961.

Date	Leaf position		
	Top	Mid	Base
	5. Var Kokuso		
20.4.61	6.96	6.81	6.74
5.5.61	5.54	4.30	4.30
20.5.61	4.47	4.03	4.15
5.6.61	3.40	3.32	3.20
	6. Var. Morettiana		
20.4.61	7.09	6.52	6.07
5.5.61	4.49	4.60	4.33
20.5.61	4.16	3.99	4.09
5.6.61	3.20	3.20	3.20

Table 25

Analysis of variance regarding percentage of T.N. in the different mulberry leaf varieties and their position on the vegetative system, during the rearing season 1961.

Source of variation	D.F.	Total S. square	Mean S. square	F.
Varieties	5	2.83	0.566	70.6 xx
Positions	2	0.51	0.255	31.8 xx
Error	10	0.08	0.008	
Total	17			

xx Significant at the level 0.01

L.S.D.V. = 0.016

L.S.D.P. = 0.056

L.S.D.V. = Least significant difference between varieties.

L.S.D.P. = Least significant difference between positions.

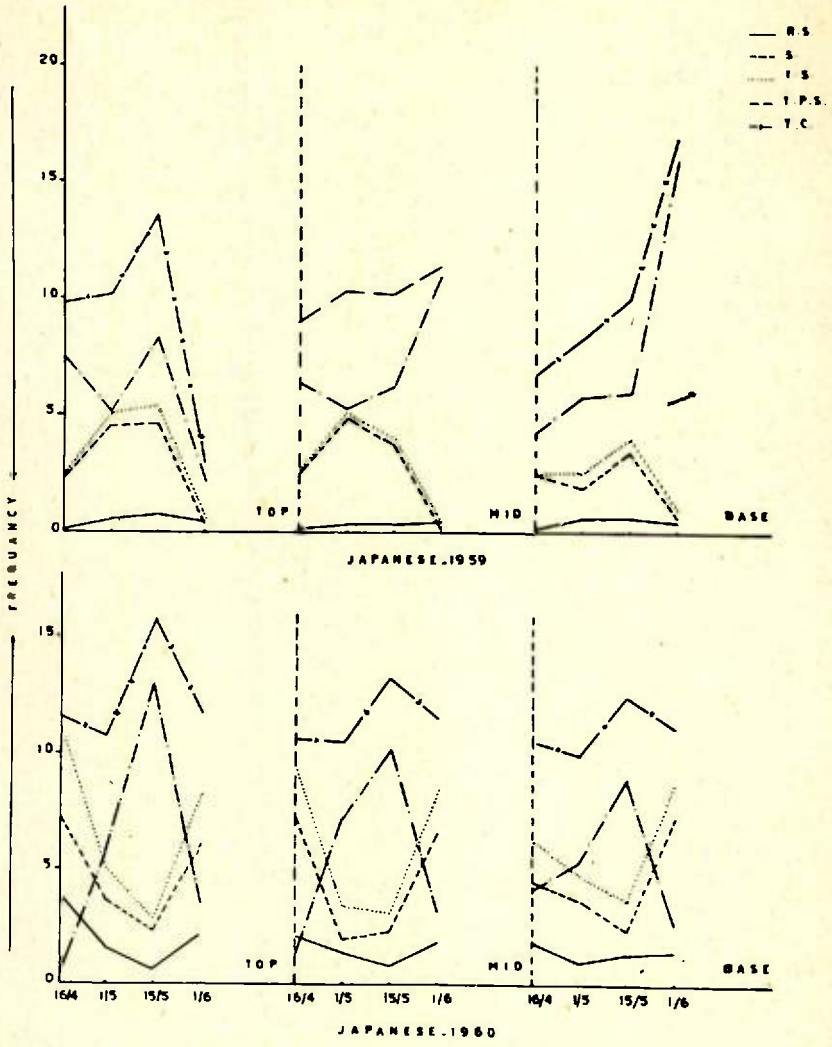

R.S
S
T.S
T.P.S.
T.C
FREQUANCY
20
15
10
5
0
TOP
MID
BASE
JAPANESE.1959
15
10
5
0
TOP
MID
BASE
16/4
1/5
15/5
1/6
JAPANESE.1960

Figure 1

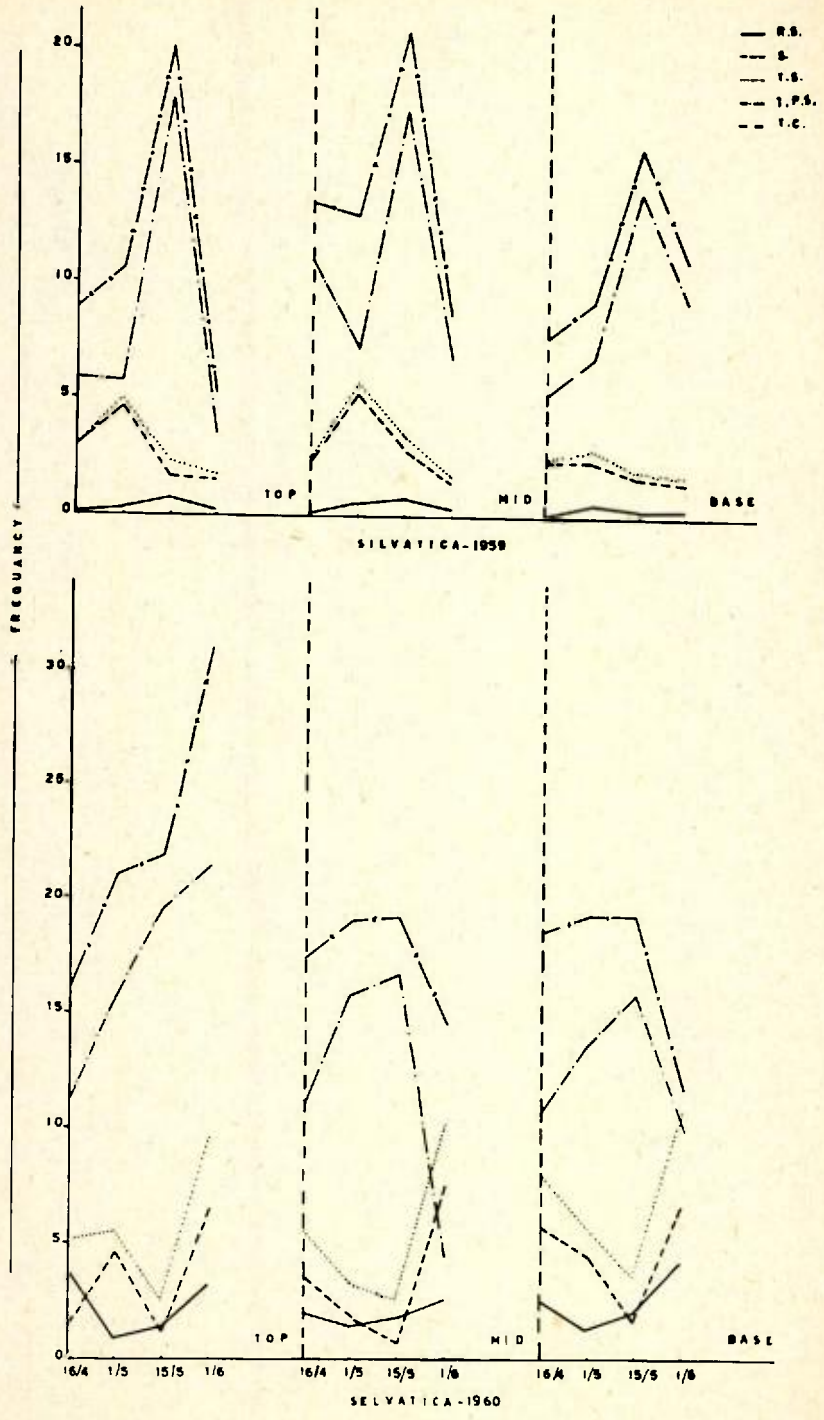

R.S.
S.
T.S.
T.P.S.
T.C.
FREQUENCY
TOP
MID
BASE
SILVATICA-1959
SELVATICA-1960
16/4
1/5
15/5
1/6

Figure 2

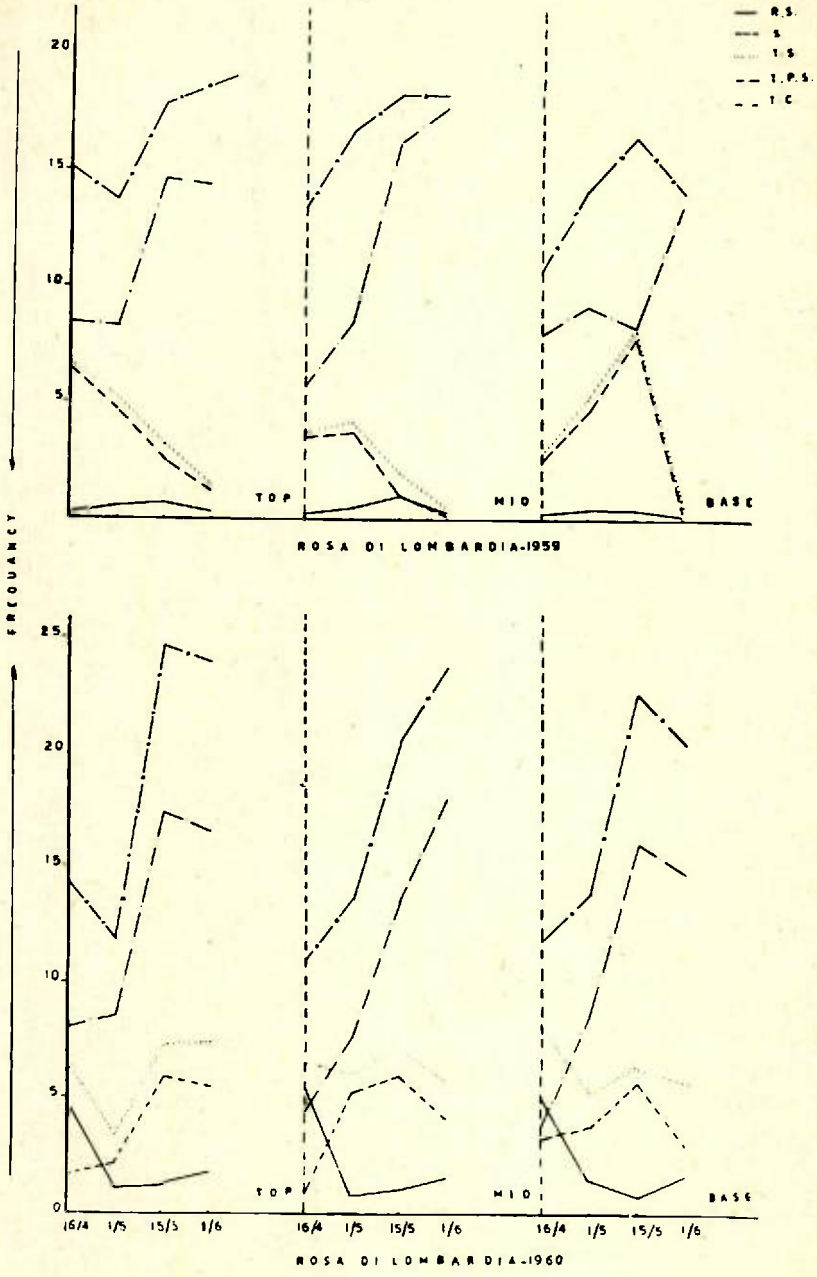

R.S.
S.
T.S.
T.P.S.
T.C.
FREQUANCY
20
15
10
5
TOP
MID
BASE
ROSA DI LOMBARDIA-1959
25
20
15
10
5
0
16/4 1/5 15/5 1/6
TOP
MID
BASE
16/4 1/5 15/5 1/6
16/4 1/5 15/5 1/6
ROSA DI LOMBARDIA-1960

Figure 3

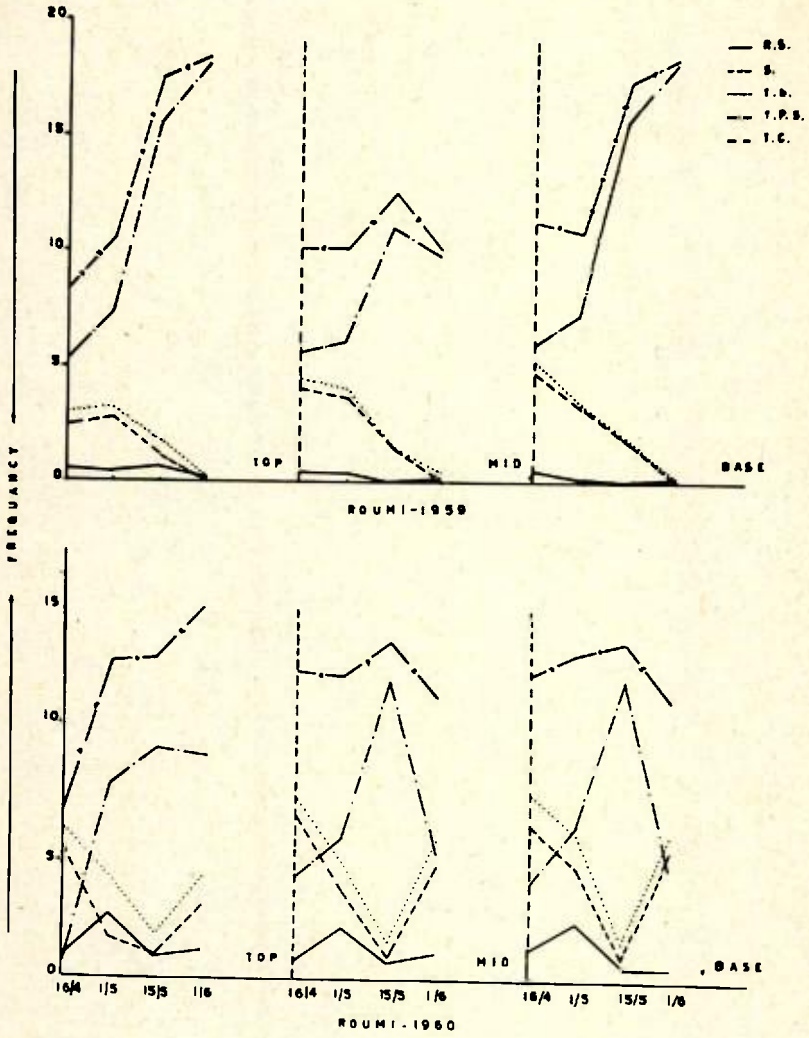
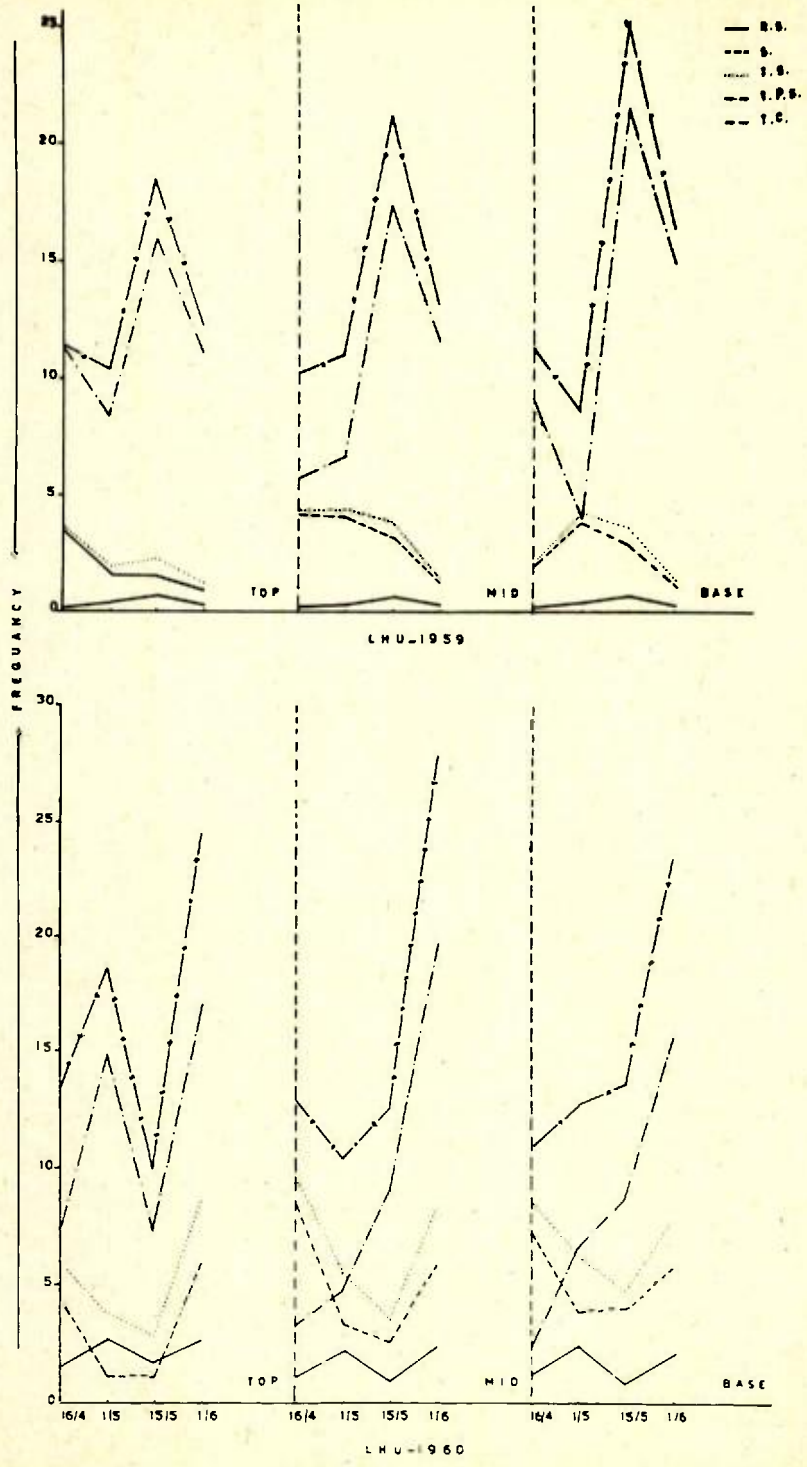

R.S.
S.
T.S.
T.P.S.
T.C.
FREQUENCY
20
15
10
5
0
TOP
MID
BASE
ROUMI-1959
15
10
5
0
TOP
MID
BASE
16/4
1/5
15/5
1/6
ROUMI-1960

Figure 4



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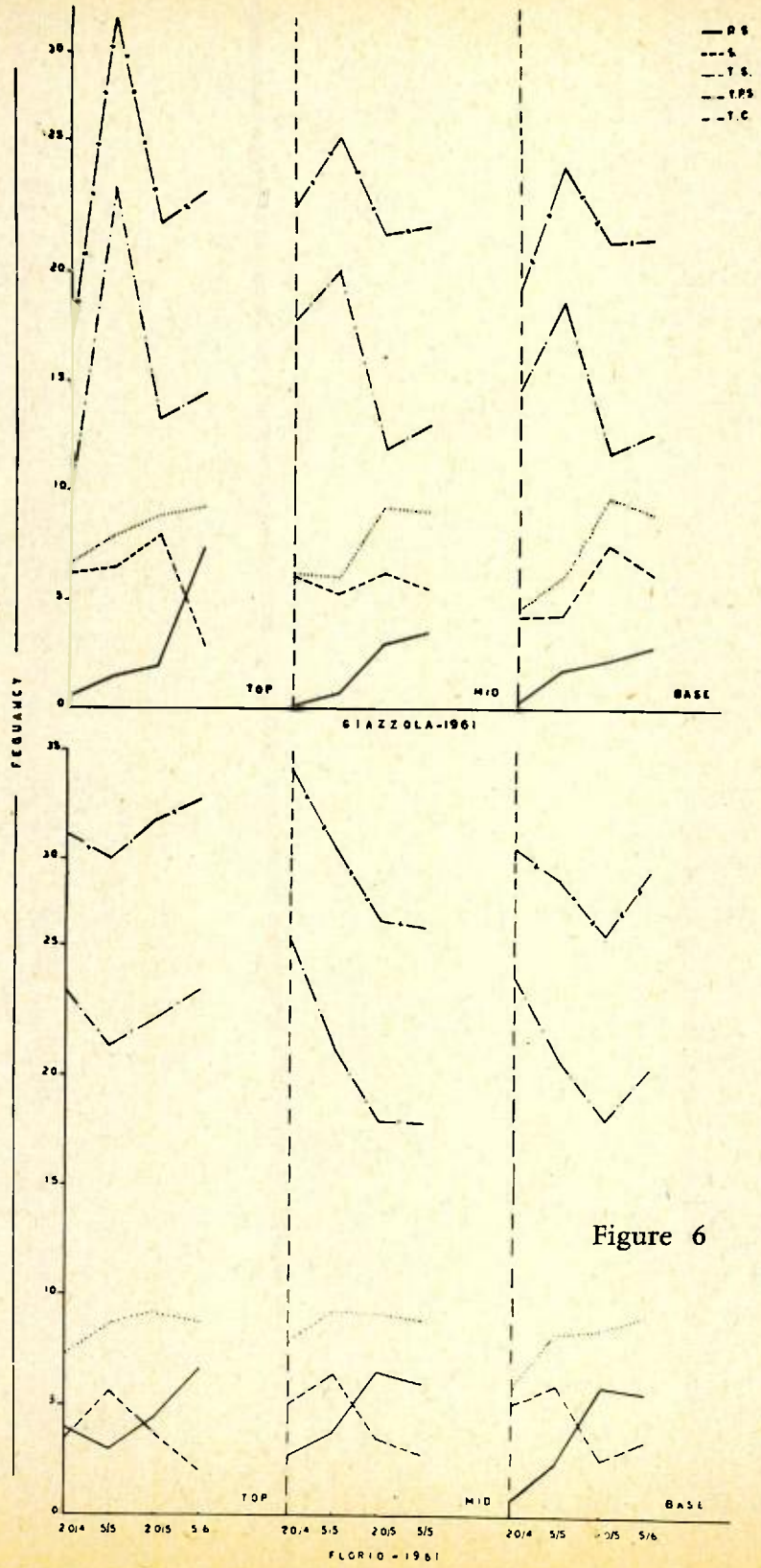
P.S
S.
T.S.
T.P.S
T.C
FEQUANCY
TOP
MID
BASE
GIAZZOLA-1961
TOP
MID
BASE
20/4 5/5 20/5 5/6
20/4 5/5 20/5 5/5
20/4 5/5 20/5 5/6
FLORIO - 1961

Figure 6

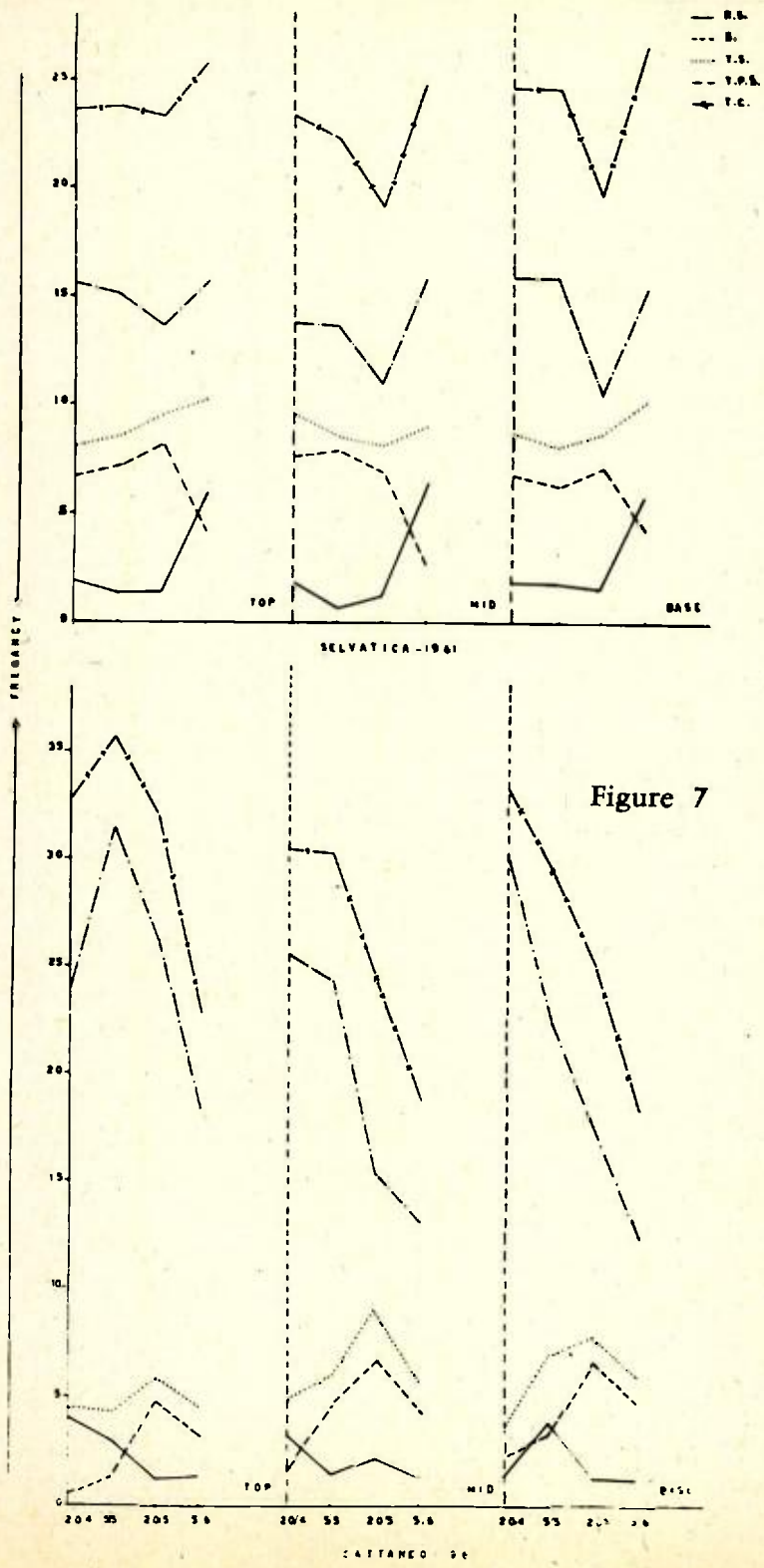

Figure 7

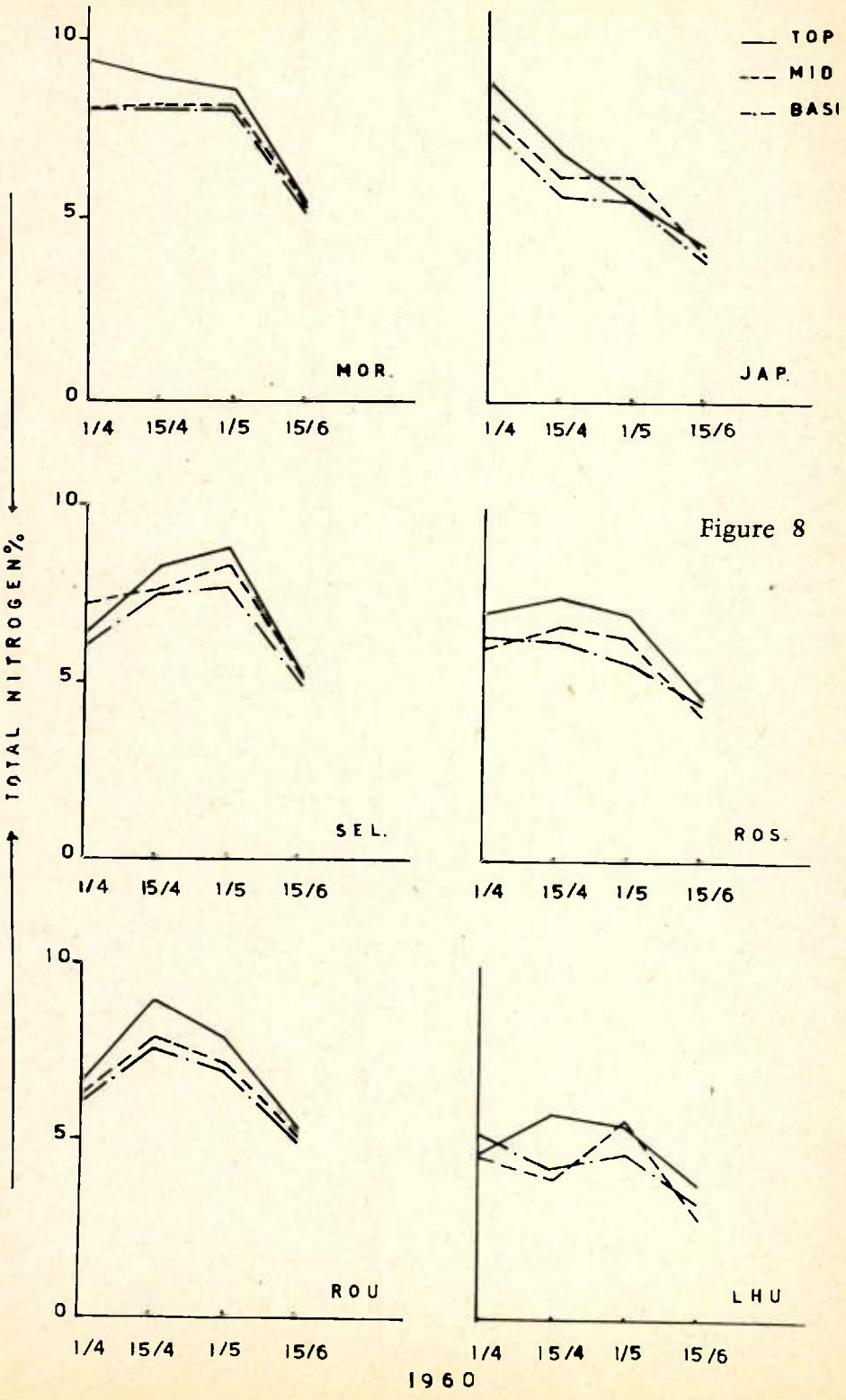
TOP
MID
BASI
TOTAL NITROGEN%
10
5
0
MOR.
JAP.
SEL.
ROS.
ROU
LHU
1/4
15/4
1/5
15/6
1960

Figure 8

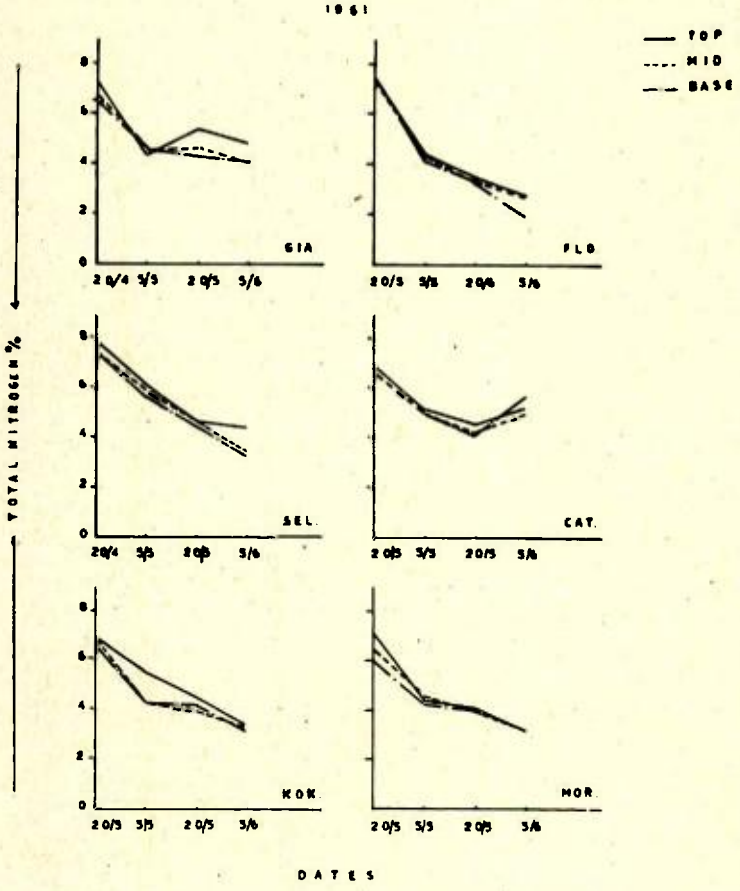
1961
TOP
MID
BASE
TOTAL NITROGEN %
GIA
FLO
SEL
CAT
KOK
MOR
DATES

Figure 9

REVUE DU VER A SOIE -- JOURNAL OF SILKWORM -- T. IV
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THE PHYSIOLOGICAL EFFECT OF FEEDING WITH DIFFERENT MULBERRY VARIETIES ON CERTAIN RACES OF THE SILKWORM (Bombyx mori L.)

By HASSANEIN M.H. and
EL SHAARAWY M.F. (Egypt, U.A.R.) (1)

INTRODUCTION

The silkworm Bombyx mori is a highly specialized phytophagous insect as it feeds only on the mulberry leaves.

There are many varieties of mulberry leaves, some of them are highly nutritive to the silkworm and some others are poor.

This work has been carried out in the Faculty of Agriculture, Ain Shams University, and the Sericulture Research Section, Ministry of Agriculture, and it was also conducted in the Sericulture Experimental Station, Padova, Italy.

This study has maintained, food consumption, food utilization, growth and metabolism, in the different instars of the silkworm, after feeding them on certain mulberry leaf varieties. This study may lead us to select the most nutritive mulberry leaf varieties, fit for feeding the silkworm so that it may help us in raising the silk production in the United Arab Republic.

REVIEW OF LITERATURE

Kellner (1884), proceeded to study the composition of food, mode of digestion, and growth of the body of the silkworm, as well as the chemical changes taking place during metamorphosis.

(1) Mr. HASSANEIN (M.H.), (Ph. D. London), Head of Plant Protection Department, Assiout University, ASSIOUT, and Mr EL-SHAARAWY (M.F.), (Ph. D. Ain Shams), Sericulture Research Department, Ministry of Agriculture, DOKKI.

Kawashim and Shimei (1902-1905), made observations on the amount of food ingested by the worm and came to a conclusion which, on the whole, is very similar to that of Kellner.

Kawase (1914), attempted a general observation on the nutrition of the silkworm with special reference to the heat value of the food stuffs and the utilization of energy by the worm.

Hiratsuka (1920), reported that the amount of food ingested each day in all the ages was 13 kg per thousand worms. When compared with the quantity of mulberry leaf usually known as the standard, the proportion actually eaten is only 12 % in the first instar, increasing as the age advance, but is never more than 65 % even in the fifth instar. He also found that during the so called period of great voracity in the fifth instar, although the worm ingested actually more food than in the proceeding days in this age ; relatively the amount was less in proportion to the weight of the body.

Evans (1938), carried out studies on the distribution of nitrogen in the casts of the wasp, Vespula germanica Fab. He discussed the distribution of nitrogen in the casts of the wasp at various stages of development. In the adult, most of the nitrogen is present in the skeletal and soluble protein fractions, in the prepupa little is found in the skeleton, but over 60 % is in the form of soluble protein. Just emerged wasps properly contain a reserved protein insoluble in water, which is utilised to complete the hardening of the skeleton. The fat body of the queens preparing hibernation weighed about 25 % of the body weight and contained about 1.3 % of nitrogen.

Evans (1938), estimated the distribution of nitrogen in the larva of meal worm, Tenebrio molitor L. He found that the cuticle of this insect contained about 60 % protein which easily soluble in water, dilute acids and alkalies.

Evans (1939), carried out studies on the utilisation of food by the larva of the meal worm, Tenebrio molitor L. He stated that this insect utilised nearly half of the food which it consumed. Gliadin, glutenin and K_2SO_4 soluble proteins were utilised. About 60 % of the total protein consumed was utilised and about half of this retained. Mono-, di- and pollysaccharides were utilised to different extents. Fatty acids were utilised to a greater extent than unsaponifiable matter. Only a small proportion of the ash was used. The larva did not utilise as much of the bran as do ruminants. The nutritive ratio of bran for T. molitor was similar to that of ruminants, but was very different from that determined for various lepidopterous caterpillars fed on leaves. The water content of the larva was maintained above that of its food since the larva retained metabolic water produced from the oxidation of carbohydrates utilised from food.

Evans (1939) had studied the food relationships of the larvae of Phalera bucephala, Aglias urticae, Smerinthus populi, Malacosoma neustria and Plieris brassicae. He stated that the coefficient of utilisation of food fell steadily during the first and second instars of P. bucephala ; during the third, fourth and fifth instars, it fluctuated irregularly. The consumption, utilisation and metabolism of food per gram of larva per day followed a similar course. The coefficient of growth increased until the middle of the third instar and then fluctuated irregularly. About 90 % of the water contained in the food was extracted during the first four days of larval life. The larva of the species studied, utilized and consumed food at very different rates. The amount of carbohydrates, fats and ash utilized per gram of larva per day differed very much in the four species. The nutritive ratio of the larvae was very much lower than that of certain growing mammals, i.e. cattles, sheep and pigs, and the difference seemed to be correlated with the chemical compositions of the tissues.

Legay (1951), studied the action of daily meals on the larval development of silkworm. He stated that with a number of meals lower to the optimum (4), the time of developing till the third moult, and it was afterwards practically unchanged ; in the first period the silkworm compensated a feable food by feeding for a longer period. Another compensation had been put in observation : a silkworm which ate six meals per day ate less each meal than a worm which ate two or four meals.

Legay (1952), reared silkworm in continual feeding and strictly controlled in order to appreciate the value of habitual check rearing (4 meals a day, 22°C.). The results mainly concerned : weight and time development, and it showed :

1 - Different individual reactions (worms are not equal between them).

2 - A certain independance about successive stages and compensation together between them.

3 - Continual feeding did not favour especially the worm growth ; however, some of them get to reel their cocoons three days before the first worms of the actual check-rearing.

Fraisse (1953), studied the effect of feeding with leaves in various ages in the larval growth, he reported that :

1 - In every meal, the worm absorbed the greatest quantity of feeding during the first half hour which followed the beginning of the meal, then it reduced afterwards especially when the leaf was not refreshed, and ate more when the leaf was younger.

2 - The worm growth raised more feeble at the first instar and enough constant at the following instars.

3 - There was a narrow relationship between : the leaf age expressed by the ratio R = (total N + P_2O_5) / CaO and :

A - The intensity of the growth.
B - The daily increase of the larval weight.
C - The maximum weight of the worm in each intermoult.
D - The duration of the larval cycle.
E - The average growth per meal.

It was observed that the maximum value was obtained in the lot fed with younger leaves.

4 - The feeding affected the relative growth at the first intermoult which showed adaptative period to the feeding diet, afterwards the growth limits were regular and almost constant.

5 - The worms fed all their life on leaves either too young or too ripe had a greater ability towards infection with the grasserie disease.

Fraisse (1953), studied the effect of feeding upon the growth of silk gland in the silkworm Bombyx mori L. during the last instar.

He stated that there was a narrow connection between : the age of the mulberry leaf and the following characters :

A - Absolute weight of the silk glands.
B - Average growth per meal.

It was shown that there was a significant correlation between the growth of the silk glands and the age of the leaf and the maximum growth obtained was that of the worms fed on young leaves of mulberry.

Maymone et al (1955), carried a comparative research on the digestibility of mulberry leaves in the larvae of Bombyx mori L. and in the higher animals, they mentioned that :

1 - The digestibility of mulberry leaves proved very high both for rams on which the test was made (crude protein 82.07 %, pure protein 87.89 %, crude fats 43.85 %, crude fibers 55. 53 % and N free extracts81.68 %), and for the larvae of Bombyx mori in the fourth stage (crude protein 81.17 %, pure protein 91.07 %, crude fats 36.45 %, crude fiber 58.37 % and N-free extract 77.77 %).

2 - Marked differences of digestibility was noted for the two races of Bombyx mori on which the test was made (verde Japanese and Bianco Europeo Novi) both in the fourth and fifth stages.

3 - A strong drop in the digestibility of organic substance (38 %), of crude fiber and of N free extract was noted during the fifth stage in both races tested, while the digestibility of the proteins and fats remained practically unchanged.

4 - The nutritive value of mulberry leaves gave very high results both for rams (about 63 starch units per 100 kg of dried substance, with about 17 % of digestible proteins) and for the larvae of Bombyx mori in the fourth stage (about 65 starch units per 100 kg of dried substance, with 18 % of digestible proteins). The results were considerably lower for the larvae of Bombyx mori in the fifth stage (about 11 starch units, with 17 % of digestible protein).

Veneroso (1955), studied the digested power of the larva of Bombyx mori L. The authoress, after having discussed the subject in a general way, citing the tests made by various research workers, gave in individual tables the analytic values obtained by her from the examination of excrement of the larva during the fifth stage, in regard to total nitrogen, crude protein, crude fats, organic substances and mineral substances. She discussed the results and concluded that the larva of Bombyx mori like all living organisms in addition to the substances which serve for the immediate metabolism, also assimilate those substances which serve as a reserve material for the period in which, through the atrophy of the digested tube they were no longer able to take nourishment.

Before beginning the nymph stage they free themselves of all that is harmeful and superfluous, particularly of large quantities of mineral salts.

Legay (1955), carried out studies on the feeding of the silkworm Bombyx mori L. (quantitative data on the physiology and the eating behaviour), he showed how much the feeding phenomenon was linked with series of inner and outer factors for the caterpillar. Briefly he stated the following facts :

1 - The conditions of nutrition of the silkworm had a fair influence on its food consumption, fasting as a very different effect according to the individuals ; on the other hand, if fasting was strict enough for the silkworm metabolism to be deeply changed for example utilizing the stores. It was stated that instead of whetting the appetite of the silkworm, it brought about the opposite phenomenon.

2 - The food consumption varied during one instar ; especially the consumption indice developed in a cyclic way (increasing then decreasing), it was more difficult to estimate the modifications occuring from one stage to another ; it seemed however that the consumption was the strongest when the worm was the youngest. At last, it could be estimated that about 10 grams of mulberry leaves were necessary for a worm to develop from birth to adult stage. The sex showed little influence on consumption indices ; on the contrary the variability of the latter was bigger for the females than for the males.
The average quantity of ingestion in a group of worms depended on the temperature (Q10 being 2.5 or so) moreover it was possible to analyse in detail how much a temperature variation influenced the individual alimentary behaviour.

The way of distribution the food (uninterrupted, interrupted nourishment, meal rythm) influenced the food consumption (ingested quantity and its distribution) ; the author took as an example the case of an uninterrupted feeding for 24 hours in order to evaluate in fresh and dry weight series of different characteristics linked to the food consumption and to define the importance of water metabolism in this determination.

Yoshitake (1955), demonstrated that the moulting rate in early fasting methods fluctuated according to the quality of the leaves on which they had fed in a definite period prior to fasting, the better the quality, the higher the rate. It was generally known that rearing with mulberry leaves of law quality results in the growth retardation of the larvae.

MATERIALS

Silkworm races :

The silkworm races used in the present study were the standard breeds reared in certain Mediterranean and the Far East countries of the world.

During 1959 & 1960 breading of the silkworm was carried out in the Sericulture section, Faculty of Agriculture Ain Shams University and the Sericulture Department, Ministry of Agriculture, Egypt, U.A.R. In 1961, breeding was carried out in the Sericulture Experimental Station, Padova, Italy.

The silkworm races used in these studies were :

- The race Var, considered as a local race and was reared in 1959.
- The cross-breed Yinhan x Huachiu was reared in 1960.
- The race 49 M was reared in the rearing season of 1961 in Italy.

Mulberry varieties :

The mulberry leaves used for feeding the silkworm were :

1959 & 1960	1961
Morus alba var. Morettiana	Morus alba var. Giazzola
" " " Japanese L.	" " " Florio
" " " Selvatica	" " " Selvatica
" " " Rosa di lombardia	" " " Cattaneo
" " " Roumi	" " " Kokuso
" " " Lhu	" " " Morettiana.

METHODS

Determination of the nutritional value :

The silkworm rearing was carried out in a wooden box with diameter of 75 cms length, 45 cms width and 5 cms deep and subdivided into 15 equal parts, with paper spread on the bottom in order to prevent

loss from the litters fig. 1. Each box was considered as a single unit with its replicates for feeding the silkworm on one mulberry variety. The boxes were put in a breeding room with regular temperature ranged from 23 - 25°C. and humidity from 70 to 75 R.H.

The mulberry leaves were cut properly and given to the worms after weighing them in sufficient quantities. The same weights of the mulberry leaves were made for calculating the natural loss of water.

The number of silkworm which were reared as a material for ascertaining body weight, for gathering of remnant leaves, for excreta and products was 450 larvae. Every 30 larvae were reared in every subdivision of the wooden box till the 4th instar.

In the 5th instar only 10 larvae were reared in every sub-division.

The worms were inspected daily from hatching to mounting and the sick larvae present were excluded and replaced from the reserve larvae which had been treated exactly in the same manner.

From the data obtained, a fairly complete account may be drawn up of the amount of food consumed and the amount utilised. Certain coefficients are designated and defined as follows, to facilitate discussion of the results.

$$\text{Coefficient of utilisation} = \frac{\text{Weight of food utilised}}{\text{Weight of food consumed}}$$

$$\text{Coefficient of growth} = \frac{\text{Increase in weight of larva}}{\text{Weight of food utilised}}$$

$$\text{Coefficient of metabolism} = \frac{\text{Weight of food utilised - increase in weight of larva}}{\text{Weight of food utilised}}$$

Weight of food utilised = Weight of food consumed - weight of excreta produced.

Division of whole life period :

The intervals from hatching up to the moment the worms resuming to take food after the first moult is termed the "first instar" ; this is subdivided into the casting period and the moulting period, the former being the interval from hatching up to the "fasting period" and the latter from the fasting period up to the moment when the worms cast their skins and begin to take food again. The silkworm at the beginning of the moulting period of the first instar is termed "the first fasting worm" ; and that at the end of the moulting period, "the first awake" or "fasting worm".

In the second, third and fourth instars respectively, the same designations are followed. The fifth instar covers an interval in which the worms begin to eat more and more until they reach the time of great voracity, after which their appetite decreases until they reach the mature stage. The pupal period is the one in which the metabolism is at its lowest grade (in ordinary cases this covers the interval between the 6th - 10th day after mounting), and the moth period is the interval from

emergence up to the completion of laying eggs. The interval between the mounting and the pupal periods is termed "pupating period"; and the interval between the pupal period and the moment of emergence "emerging period".

Preparations of materials for analysis :

When the litters become dry, excreta on the remnant leaves were removed by sifting. In the first and second instars, the masses of excreta were too small to be sifted off the fragments of the remnant leaves ; so that the excrement had to be picked up very carefuly with a pincette. Excreta and remnants were gathered at the end of every instar after the moulting period.

Silkworm larvae and faeces were taken at the end of each instar after fresh weights was ascertained, these materials were dried in an electric oven with air draught at 70°C., for 24 hours. The dried samples were then finely grained and kept in air tight glass tubes.

RESULTS & DISCUSSION

FOOD CONSUMPTION

Income and expenditure of matter :

It is very difficul to recognize with clearness either the physiological effect of any single nutrient on the silkworm or the relationship of many of these nutrients to each other. As the full growth of the silkworm seems to be attainable only with an adequate supply of mulberry leaf and not with other food stuffs or artificial mixtures of various nutrient as in the case of some domestic animals. Therefore the best that can be done with respect to the exchange of matter is to give a description of the mere outlines of the ingestion of food, its digestion and utilization. In the present work the amount of food was calculated from the quantity of mulberry leaves given to the worm less the quantity of the remained leaves ; the amount of food digested was calculated from the quantity thus obtained less the quantity of excreta ; the digested food was calculated in percentage of the total food ingested and was named by coefficient of utilization or digestibility.

Ingestion of food :

The average quantity of fresh mulberry leaves eaten by the silkworm at every instar differed so greatly in the different varieties of the mulberry leaves.

It is clearly shown from Table 1 and Fig. 1 that the quantity of the fresh leaves consumed by the larva of the race Var in the first instar was 0.320 gm. when it was fed on the leaves of the variety Morettiana, while it consumed 0.315 gm. fresh leaves of the variety Japanese L. and 0.305 gm. of leaves when fed on the variety Selvatica. The larva had consumed also 0.317 gm. when it was fed on the leaves of the variety Rosa di Lombardia "Balady", and 0.319 gm. from the leaves of the variety Roumi, while the quantity of the ingested leaves of the variety Lhu was 0.349 gm.

It is realized from these previous results that there was not a significant difference in the quantity of fresh leaves consumed by the larva in the first instar, when it was fed on the different mulberry leaf varieties, even though it is clearly evident that the worms of the race Var had consumed more quantity of leaves of the variety Lhu during the feeding period of the first instar.

In the second instar, the larva consumed 0.443 gm. from the leaves of the variety Morettiana and 0.319 gm. when the larva was fed of the leaves of the variety Japanese L., while it consumed 0.502 gm. of leaves of the variety Selvatica. The larva had also consumed 0.628 gm. fresh leaves of the variety Rosa di Lombardia "Balady" and it consumed 1.429 gm. from the leaves of the variety Roumi, while it had ingested 0.909 gm. when fed on the fresh leaves of the variety Lhu.

It is clearly shown from these results that there was a clear difference in the quantity of fresh leaves consumed by the larva from the different varieties of mulberry, and it was also shown from these results that the high quantity of fresh leaves consumed by the larva during the second instar was that of the variety Roumi, followed by the variety Lhu.

In the third instar the larva of the same previous race consumed 0.753 gm. fresh leaves of the variety Morettiana, and 0.514 gm. when fed on the leaves of the variety Japanese L., and it also consumed 0.618 gm. fresh leaves of the variety Selvatica. It also ingested 0.843 gm. fresh leaves of the variety Rosa di Lombardia, while it consumed 2.268 gms from the variety Roumi and 1.519 gms fresh leaves of the variety Lhu.

It is evident from these data that the high quantity of leaves ingested in the third instar was that of the variety Roumi, followed by the variety Lhu.

In the fourth instar the larva had consumed 4.621 gms fresh leaves of the variety Morettiana, 4.029 gms of leaves of the variety Japanese L. and it consumed 3.213 gms of leaves of the variety Selvatica. The larva had also consumed 3.680 gms of leaves of the variety Rosa di Lombardia and it ingested 6.896 gms when fed on the leaves of the variety Roumi, it also consumed 4.786 gms from the leaves of the variety Lhu. It is clearly shown that the high quantity of leaves consumed by the larva during the eating period of the fourth instar was that of the variety Roumi, followed by the variety Lhu.

In the fifth instar the larva ingested 15.230 gms fresh leaves of the variety Morettiana, 16.612 gms of leaves of the variety Japanese L. and 18.420 gms of leaves of the variety Selvatica. The larva had also consumed 18.212 gms of leaves of the variety Rosa di Lombardia , 15.349 gms of leaves of the variety Roumi and 17.032 gms of fresh leaves of the variety Lhu.

It is clearly evident from these previous results that the high quantity of fresh leaves consumed during the eating period of the fifth instar was that of the varieties Selvatica and Rosa di Lombardia, followed by the variety Lhu, and the minimum quantity of leaves consumed was that of the variety Morettiana.

In the rearing season of 1960 the worms of the cross breed Yinhan were fed on the same mulberry leaves of the rearing season of 1959. It is shown from Table 2 and Fig. 1 that the larva in the first instar had ingested 0.190 gm. of fresh leaves of the variety Morettiana , 0.158 gm. of leaves of the variety Japanese L. and 0.209 gm. of fresh leaves of the variety Selvatica. It also consumed 0.197 gm of leaves when fed on the leaves of the variety Rosa di Lombardia, 0.279 gm. of leaves of the variety Roumi and 0.293 gm. from the leaves of the variety Lhu.

It is evident from these prementioned results that the high quantity of fresh leaves consumed was that of the variety Lhu, followed by the variety Roumi.

In the second instar the larva consumed 0.045, 0.047 and 0.079 gm. of fresh leaves from the varieties Morettiana, Japanese L. and Selvatica, while it consumed 0.119, 0.113 and 0.174 gm. when it was fed on the fresh leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The high quantity of fresh leaves consumed by the larva during the eating period of the second instar was that of the variety Lhu.

In the third instar the larva consumed 0.341 gm. from the leaves of the variety Morettiana, 0.313 gm. of the variety Japanese L. and 0.371 gm. of the variety Selvatica. It also consumed 0.684, 0.829 and 1.208 gm. of fresh leaves from the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum weight of fresh leaves consumed during the eating period of this instar was that of the variety Lhu.

In the fourth instar the larva consumed 1/349, 1.482 and 1.539 gms fresh leaves of the varieties Morettiana, Japanese L. and Selvatica. It also consumed 2.323, 2.813 and 4.747 gms fresh leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The high quantity of fresh leaves consumed was that of the variety Lhu.

In the fifth instar the larva had consumed 13.240, 13.947 and 13.975 gms fresh leaves of the varieties Morettiana, Japanese L. and Selvatica. It had also consumed 14.393, 13.847 and 15.098 gms of fresh leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. It is indicated from the previous data that the maximum weight of fresh consumed during the eating period of the fifth instar was that of the variety Lhu, and the minimum quantity of leaves consumed was that of the variety Morettiana.

The larva of the race 49 M consumed 0.088, 0.089 and 0.085 gm. of fresh leaves of the varieties Giazzola, Florio and Selvatica. It had also consumed 0.082, 0.093 and 0.079 gm. fresh leaves of the varieties Cattaneo, Kokuso and Morettiana, during the eating period of the first instar, as shown from Table 3 and Fig. 1. It is evident from these results that there was not a clear difference in the quantity of fresh leaves consumed during the eating period of the first instar, as it has been also clear from the results obtained during the eating period of the first instar of the larvae of the races Var and Yinhan.

In the second instar the larva consumed 0.208, 0.221 and 0.297 gm. fresh leaves of the varieties Giazzola, Florio and Selvatica. It had also consumed 0.206, 0.209 and 0.280 gm. fresh leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

In the third instar the larva consumed 1.021 gms of the variety Giazzola, 0.969 gm. of the variety Florio and 1.762 gms of the variety Selvatica. The larva had also consumed 0.911, 0.787 and 1.080 gms of the varieties Cattaneo, Kokuso and Morettiana respectively. The maximum weight of fresh leaves consumed during this instar was that of the variety Selvatica.

The larva had consumed during the fourth instar 3.144 gms from the leaves of the variety Giazzola, 1.361 gms from the variety Florio and 5.116 gms fresh leaves of the variety Selvatica. It had also consumed 3.327 gms fresh leaves of the variety Cattaneo, 2.953 gms from the variety Kokuso and 3.500 gms fresh leaves of the variety Morettiana. The maximum weight of the mulberry leaves consumed during this instar was that of the variety Selvatica.

During the eating period of the fifth instar, the larva had consumed 11.486 gms of the mulberry leaves of the variety Giazzola, 11.693 gms of the variety Florio and 9.237 gms fresh leaves of the variety Selvatica. It had also consumed 14.415 gms fresh leaves of the variety Cattaneo, 13.450 gms from the variety Kokuso and 12.210 gms fresh leaves of the variety Morettiana. The maximum weight of fresh leaves consumed was that of the variety Cattaneo, and the minimum quantity was that of the variety Selvatica.

It is clearly recognized from the prementioned results that the quantity of fresh leaves consumed had increased gradually till the fourth instar, then raised suddenly in the fifth instar, and this was in accordance with the results of the consumed food by the larvae of the races Var and Yinhan.

Coefficient of food utilization :

It is apparent from Table 4 and Fig. 2 that the larva of the race Var had utilized 99.51 % from the leaves of the variety Morettiana during the first instar, it had also utilized 99.5 % from the leaves of the variety Japanese L and 99.80 % from the leaves of the variety Selvatica. The larva had also digested 99.6 % from the leaves of the variety Rosa di Lombardia, 99.60 and 99.66 % from the leaves of the varieties Roumi and Lhu respectively.

In the second instar the percentage of utilization decreased than that of the first instar and at the same time there was not a clear difference in the digestibility of these different varieties of mulberry during the first and second instars. The coefficient of digestion was 98.61 % by feeding the silkworm on the leaves of the variety Morettiana, 98.43 % by feeding on the leaves of the variety Japanese L. and 98.57 % when fed on the leaves of the variety Selvatica. The percentage of digestibility was also 99.06, 99.50 and 98.97 % by feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the third instar the percentage of digestibility decreased than that of the second instar, as it was 93.73, 91.70 and 93.88 % by feeding the worms on the leaves of the varieties Morettiana, Japanese L. and Selvatica respectively. It was also 94.94, 98.44 and 96.46 % by feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu.

During the eating period of the fourth instar the larvae of the silkworm had utilized 89.42 % from the leaves of the variety Morettiana, 91.56 % from the leaves of the variety Japanese L. and 90.45 % from the leaves of the variety Selvatica. It had also digested 92.96 % of the variety Rosa di Lombardia 87.20 % from the leaves of the variety Roumi and 93.60 % from the leaves of the variety Lhu.

In the fifth instar the percentage of the utilized food raised again than it was in the fourth instar. The coefficient of the utilised food was 95.39, 95.11 and 94.61 % by feeding on the leaves of the varieties Moret tiana, Japanese L. and Selvatica respectively. It was also 96.06, 95.28 and 97.28 % when the worms were fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu.

It is clearly evident from these results that the larvae of the silkworm Bombyx mori L. utilize in the early instars more of the food consumed than they do in the later instars.

In the rearing season of 1960, the larvae of the cross breed Yinhan were fed on the same mulberry leaves of 1959.

The data represented in Table 5 and graphically illustrated in Fig. 2 show the coefficient of the food utilized by the worms of the cross breed Yinhan under feeding with different mulberry varieties in the different instars.

In the first instar, percentages of the utilized food was 99.20, 99.05 and 99.35 by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 99.00, 99.26 and 99.35 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the second instar, coefficient of digestibility was 82.78, 80.26 and 88.34 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 93.60, 93.68 and 95.91 % by feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu.

In the third instar the coefficient of digestibility increased than it was in the second instar as it became 92.95, 89.75 and 92.97 % when the worms were fed on the leaves of varieties Morettiana, Japanese L. and Selvatica, and it was 96.04, 97.05 and 98.12 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the fourth instar coefficient of food utilization was 92.89, 90.96 and 91.90 % by feeding the larvae on the leaves of the varieties Morettiana, Japanese L. and Selvatica and it was 94.75, 94.86 and 97.49 % when the worms were fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the fifth instar coefficient of digestibility was 93.39, 92.71 and 94.58 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 95.71, 94.61 and 96.17 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. It is shown from the previous results that the larvae of the cross breed Yinhan utilize in the early instar, more of the food consumed than they do in the later instars.

In 1961 the race 49 M was fed on other six mulberry varieties in Italy. It is shown from Table 6 and Fig. 15 that the coefficient of food utilized in the first instar was 98.30, 98.30 and 97.57 % after feeding on the leaves of the varieties Giazzola, Florio and Selvatica, and it was 97.53, 98.06 and 98.09 % for the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana.

In the second instar, coefficient of utilization was 96.35, 96.23 and 97.53 % by feeding on the leaves of the varieties Giazzola, Florio and Selvatica. It was also 95.85, 95.89 and 96.31 % for the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana.

In the third instar, coefficient of utilization was 94.71, 94.47 and 96.59 % after feeding on the leaves of the varieties Giazzola, Florio and Selvatica. It was also 93.59, 93.03 and 94.69 % by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

In the fourth instar, coefficient of food utilization was 90.42, 97.53 and 93.73 % after feeding on the leaves of the varieties Giazzola, Florio and Selvatica, and it was 89.59, 89.88 and 91.93 % for the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana.

Coefficient of utilization in the fifth instar was 84.41, 80.15 and 83.85 % by feeding on the mulberry leaves of the varieties Giazzola, Florio and Selvatica. It was also 82.55, 77.43 and 78.63 % after feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

Growth :

The silkworm digests and absorbs the nutrients of mulberry leaves using a part of them in the building of its tissues and growth. The quantity of the preservation of matter is greatest before moulting after this the body weight decreases gradually as the quantity of mulberry leaf consumed decreases. In the present work, however, the interval from the beginning of taking food to moulting is considered as the eating period in every instar. The rapidity with which this process takes place and the greatest increase in weight that accompanies it is particularly evident in Tables 7 - 12 and graphically illustrated in Fig. 3. This increase in weight of the silkworm Bombyx mori L. varies according to racial, nutritional and other environmental factors.

Weight of larva :

The average weight of the silkworm of the different races after hatching was 0.5 milligram.

In the rearing season of 1959, the average weight of larva of the race Var in the first instar was 0.0033, 0.0044 and 0.0048 gm. after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 0.0041, 0.0046 and 0.0048 gm. for the worms fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. A comparison of the larval weight in the first instar after feeding on different mulberry leaf varieties Selvatica and Lhu were heavier in weight, and the minimum weight of larvae were after feeding on the leaves of the variety Morettiana.

In the second instar, the average weight of the larva was 0.025, 0.028 and 0.027 gm. by feeding on the mulberry varieties Morettiana, Japanese L. and Selvatica. It was also 0.022, 0.016 and 0.022 gm. by feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu.

In the third instar, the average weight of larva was 0.117, 0.110 and 0.099 gm. by feeding on the leaves of the varieties Morettiana , Japanese L. and Selvatica. It was also 0.084, 0.072 and 0.093 gm. after feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The heaviest weight of larva was that of the worms fed on the leaves of the variety Morettiana, and the minimum weight was of the larva fed on the leaves of the variety Roumi.

The average weight of larva in the fourth instar was 0.461, 0.475 and 0.444 gm. by feeding on the leaves of the varieties Morettiana , Japanese L. and Selvatica respectively. It was also 0.413, 0.348 and 0.427 gm. by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. The heaviest weight of larva was that of the worms fed on the leaves of the variety Japanese L. and the least weight was that of the larva fed on the leaves of the variety Roumi.

In the fifth instar, the average weight of larva was 3.132, 3.537 and 3.211 gm. after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 2.628, 2.775 and 2.535 gm. by feeding the worms on the leaves of the varieties Rosa di lombardia, Roumi and Lhu respectively. The heaviest weight of larvae was that of the worms fed on the leaves of the variety Japanese L. and the minimum weight was that of the worms fed on the leaves of the variety Lhu.

The average weight of the larvae of the cross bread Yinhan after feeding on the same mulberry leaves is clearly shown in Table 8.

The average weight of the first instar larva fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica was 0.0049, 0.0046 and 0.0045 gm. It was also 0.0038, 0.0040 and 0.0035 gm. after feeding on the mulberry leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

The heaviest weight of the larvae was that of the worms fed on the leaves of the variety Morettiana, and the lightest weight was that of the worms fed on the leaves of the variety Lhu.

In the second instar, the average weight of larva was 0.022, 0.020 and 0.022 gm. by feeding on the leaves of the varieties Morettiana , Japanese L. and Selvatica. It was also 0.017, 0.017 and 0.015 gm . after feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum weight of larvae was that of the worms fed on the leaves of the varieties Morettiana and Selvatica, and the minimum weight was of the worms fed on the leaves of the variety Lhu.

The average weight of the third instar larva fed on the mulberry leaves of the varieties Morettiana, Japanese L. and Selvatica was 0.111, 0.114 and 0.110 gm. It was also 0.088, 0.080 and 0.062 gm. by feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. The heaviest weight of larvae was that of the worms fed on the leaves of the variety Japanese L. and the lightest weight was that of the larvae fed on the leaves of the variety Lhu.

The average weight of the fourth instar larva fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica was 0.529, 0.562 and 0.525 gm. It was also 0.436, 0.436 and 0.409 gm. after feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The heaviest weight of larvae was that of the worms fed on the leaves of the variety Japanese L. and the minimum weight was of the larvae fed on the leaves of the variety Lhu.

The average weight of the fifth instar larva fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica was 3.136, 3.164 and 2.905 gms and it was 2.027, 2.552 and 1.791 gm. when fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The heaviest weight of larva was that of the worms fed on the variety Japanese L. and the minimum weight was that of the larvae fed on the leaves of the variety Lhu.

In the rearing season of 1961, the average weight of the first instar larva was 0.0042, 0.0038 and 0.0043 gm. by feeding on the mulberry leaves of the varieties Giazzola, Florio and Selvatica. It was also 0.0031, 0.0042 and 0.0037 gm. after feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana, as shown in Table 9.

In the second instar, the average weight of the larva fed on the leaves of the varieties Giazzola, Florio and Selvatica was 0.023, 0.012 and 0.022 gm. It was also 0.022, 0.025 and 0.022 gm. by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana.

In the third instar the average weights of the larva was 0.114, 0.112, 0.115, 0.111, 0.127 and 0.117 gm. after feeding on the leaves on the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively.

In the fourth instar, the average weights of the larva was 0.561, 0.515, 0.522, 0.541, 0.636 and 0.551 gm. after feeding on the leaves of the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively.

In the fifth instar, the average weights of the larva was 3.675, 3.104, 3.043, 3.209, 3.720 and 3.232 gm. after feeding on the leaves of the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively. The heaviest weight of the larvae was that of the worms fed on the leaves of the variety Kokuso, and the minimum weight was that of the larvae fed on the leaves of the variety Selvatica.

Coefficient of growth

Coefficient of growth of the larva of the race Var fed on different mulberry leaf varieties is recorded in Table 10 and illustrated in Fig. 4. It was 0.88, 1.24 and 1.41 % in case of feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 1.41, 1.29 and 1.24 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. The maximum coefficient of growth was that of the worms fed on the leaves of the variety Selvatica, and the minimum growth was of the larva fed on the leaves of the variety Morettiana .

Coefficient of growth of the worms in the second instar was 4.96, 7.54 and 4.47 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 2.62, 0.80 and 1.90 % by feeding the worms on the leaves of the varieties, Rosa di Lombardia, Roumi and Lhu respectively. The maximum coefficient of growth was of the worms fed on the leaves of the variety Japanese L. and the minimum was that of the worms fed on the leaves of the variety Roumi.

In the third instar, coefficient of growth was 12.98, 17.83 and 12.39 % after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 7.71, 2.50 and 4.90 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. The maximum coefficient of growth was of the worms fed on the leaves of the variety Japanese, and the minimum growth of the worms fed on the variety Roumi.

In the fourth instar, coefficient of growth was 8.05, 9.75 and 12.01% by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 9.58, 4.21 and 7.28 % after feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. The maximum coefficient of growth was of the worms fed on the leaves of the variety Selvatica, and the minimum growth was of the worms fed on the leaves of the variety Roumi. In the fifth instar, coefficient of growth was 18.37, 19.36 and 15.80 % in the case of feeding on the leaves of the varieties. Morettiana, Japanese and Selvatica, and it was 12.57, 16.58 and 12.72 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum growth was of the worms fed on the leaves of the variety Rosa di Lombardia, and the minimum growth was of the worms fed on the leaves of the variety Lhu.

Coefficient of growth of the larva of the cross breed Yinhan is clearly shown in Table 11 and graphically illustrated in Fig. 4.

In the first instar, coefficient of growth was 2.32, 2.62 and 1.92 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 1.73, 1.29 and 1.03 % after feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum coefficient of growth was of the worms fed on the leaves of the variety Japanese L. and the minimum growth was of the worms fed on the variety Lhu. In the second instar, coefficient of growth was 4.51, 3.92 and 2.47 % by feeding on the varieties Morettiana, Japanese L. and Selvatica. It was also 1.17, 1.23 and 0.68 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. The maximum growth was of the worms fed on the leaves of the variety Morettiana and the minimum growth was of the worms fed on the leaves of the variety Lhu.

In the third instar, coefficient of growth was 27.99, 33.22 and 25.73 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 10.76, 7.91 and 3.95 % by feeding on the

leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum growth was of the larva fed on the leaves of the variety Japanese L., and the minimum was of the larva fed on the leaves of the variety Lhu.

In the fourth instar coefficient of growth was 33.60, 33.20 and 29.33 % by feeding on the leaves of the varieties Morettiana, Japanese L., and Selvatica, and it was 15.65, 13.26 and 7.25 % in the worms fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. The maximum growth was of the larva fed on the leaves of the variety Morettiana, and the minimum growth was of the worms fed on the leaves of the variety Lhu.

Coefficient of growth in the fifth instar has decreased than it was in the fourth instar except in the worms fed on the leaves of the varieties Roumi and Lhu, as it was 21 07, 20.10, 18.04 % & 11.14 % by feeding on the leaves of the varieties Morettiana, Japanese L., Selvatica and Rosa di Lombardia, while it was 16.13 and 8.90 % by feeding on the leaves of the varieties Roumi and Lhu respectively. The maximum growth was of the worms fed on the leaves of the variety Morettiana and the minimum was of the worms fed on the leaves of the variety Lhu.

Coefficient of growth of the worms of the race 49 M reared in 1961 is recorded in Table 12 and graphically illustrated in Fig. 4. In the first instar coefficient of growth was 4.27, 3.77 and 4.55 % by feeding on the leaves of the varieties Giazzola, Florio and Selvatica, it was also 4.23, 4.05 and 4.47 % by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively. The maximum growth was that of the worms fed on the leaves of the variety Selvatica and the minimum was of the worms fed on the leaves of the variety Florio.

Coefficient of growth in the second instar was 9.39, 8.58 and 6.11 % by feeding on the leaves of the varieties Giazzola, Florio and Selvatica, and it was 9.08, 9.90 and 6.76 % in the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana. The maximum growth was of the worms fed on the leaves of the variety Kokuso, and the minimum growth was of the larva fed on the leaves of the variety Selvatica.

In the third instar, coefficient of growth was 9.34, 9.81 and 5.41 % by feeding on the leaves of the varieties Giazzola, Florio and Selvatica. It was also 10.42, 13.88 and 9.25 % by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively. The maximum growth was of the worms fed on the leaves of the variety Kokuso and the minimum was that of the worms fed on the leaves of the variety Selvatica.

In the fourth instar, coefficient of growth of the larva was 15.68, 38.16, 8.59, 14.28, 19.17 and 13.78 % by feeding on the leaves of the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively. The maximum growth was that of the worms fed on the leaves of the variety Florio, and the minimum growth was of the worms fed on the leaves of the variety Selvatica.

In the fifth instar, coefficient of growth was 32.15, 27.84 and 32.04 % after feeding on the leaves of the varieties Giazzola, Florio and Selvatica. It was also 21.96, 28.90 and 27.68 % by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively. The maximum growth was that of the worms fed on the leaves of the variety Giazzola, and the minimum growth was of the worms fed on the leaves of the variety Cattaneo.

It is clearly evident from the prementioned results that the coefficient of growth had increased gradually from the first instar and reached its maximum in the fourth and the fifth instars.

Coefficient of metabolism :

The silkworm feeds on the mulberry leaf, digests it and absorbs its nourishment so that it may partly build its own body with them and partly consume them for the support of its living state. These nourishments used for building the bodily tissues are conserved as potential energy, and those which are used for the support of the living state are burned up as fuel for the supply of energy necessary to the maintenance of life and for mechanical work, etc... The data concerning coefficient of metabolism during the larval period of the silkworm are recorded in Table 13 - 15 and illustrated in Fig. 5.

Coefficient of metabolism in the larva of the race Var during the first instar was 99.12, 98.76 and 98.59 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also, 98.86, 98.71 and 98.76 % in the larvae fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the second instar coefficient of metabolism was 95.01, 92.46 and 95.52 % in the worms fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 97.38, 97.31 and 98.09 % in the worms fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu.

In the third instar, coefficient of metabolism was 98.70, 82.17 and 87.61 % when the worms were fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica and it was 92.29, 97.50 and 95.11 % by feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu.

In the fourth instar, coefficient of metabolism was 91.95, 90.25 and 87.99 % in the worms fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 96.41, 95.79 and 92.69 by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu. In the fifth instar, the coefficient of metabolism was 81.63, 80.64 and 84.26 % in the larvae fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 87.43, 83.38 and 87.28 in the worms fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In 1960 the cross breed Yinhan was fed on the same mulberry leaf varieties utilized for feeding during the rearing period of 1959.

Coefficient of metabolism is recorded in Table 14 and illustrated in Fig. 5. It was in the first instar 97.68, 97.38 and 98.78 % in the larvae fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 98.27, 98.71 and 98.97 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. Coefficient of metabolism in the second instar was 54.86, 60.81 and 75.32 % in the worms fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 88.26, 87.72 and 93.15 % in the larvae fed

on the leaves of varieties Rosa di Lombardia, Roumi and Lhu respectively. In the third instar, coefficient of metabolism was 72.02, 66.78 and 74.27 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 89.24, 92.08 and 96.04 % in the worms fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu.

In the fourth instar, coefficient of metabolism was 58.21, 66.79 and 70.77 % for the worms fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 84.35, 86.74 and 92.75 % in the worms fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. In the fifth instar coefficient of metabolism was 78.93, 79.40 and 82.96 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica it was also 88.46, 83.87 and 91.09% by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

Coefficient of metabolism in the larvae of the race 49 M is recorded in Table 15 and illustrated in Fig. 5.

In the first instar, coefficient of metabolism was 95.72, 96.22 and 95.45 % by feeding on the leaves of the varieties Giazzola, Florio and Selvatica and it was 95.77, 95.95 and 95.87 % by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana.

In the second instar, coefficient of metabolism was 90.61, 91.42 and 93.89 % by feeding on the leaves of the varieties Giazzola, Florio and Selvatica, and it was 90.92, 90.09 and 96.94 % by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

In the third instar, coefficient of metabolism was 90.66, 90.19 and 94.59 % by feeding on the leaves of the varieties Giazzola, Florio and Selvatica. It was also 88.52, 85.98 and 90.75 % in the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

In the fourth instar, coefficient of metabolism was 84.31, 61.84 and 91.41 % by feeding on the leaves of the varieties Giazzola, Florio and Selvatica. It was also 85.72, 80.83 and 86.22 % by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

In the fifth instar, coefficient of metabolism was 67.85, 72.52 and 67.95 % after feeding on the leaves of the varieties Giazzola, Florio and Selvatica. It was also 78.04, 71.09 and 72.31 % by feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana. An inspection of the data in Tables 13 - 14 and 15 showed that the values of the coefficient of metabolism were similar in the different varieties of mulberry leaves introduced for feeding the silkworm of the different races during the first instar.

It was also interesting to notice that the coefficient of metabolism had gradually decreased from the first to the third instar, then it had obviously decreased in the fourth and fifth instars.

Moisture percentage in the larvae of the silkworm :

Moisture percentage in the larvae of the silkworm was determined after feeding on the leaves of different mulberry varieties.

It is shown from Table 16 that the moisture percentage in the larvae of the silkworm of the race Var had decreased by advancing in age of the silkworm from the first to the fifth instar. There was also an obvious decrease in the moisture per cent in the larvae during the third instar.

The moisture percentage in the larvae of the races Yinhan, and 49 M showed that there was only a decrease in the moisture per cent in the larvae during the fifth instar.

It is clearly shown that there has been no significant difference in the moisture percentage in the larvae after feeding on different mulberry leaf varieties.

Determination of total nitrogen in the larvae of the silkworm during the different instars :

Table 17 and Fig. 6 represent the percentage of total nitrogen in the larvae of the race Var during the different instars after feeding on different varieties of mulberry. It is clearly shown that the amount of total nitrogen in the larvae had increased till the third instar, decreased in the fourth instar, and slightly increased again in the fifth instar.

It is clearly shown from Table 18 and Fig. 6 that the percentage of the total nitrogen in the larvae of the races Yihhan and 49 M had decreased in the third instar, then raised up again in the fourth and fifth instars.

Data represented in Table 17 showed that there has been no significant differences in the amount of total nitrogen in the larvae of the race Var, after feeding on the leaves of different mulberry varieties, while there is a significance in the amount of total nitrogen in the larvae of the races Yinhan and 49 M in the different instars after feeding on the different mulberry leaf varieties.

The values of total nitrogen in the larvae of the race Yinhan in the first instar were 19.44, 19.88 and 23.65 % after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and were 25.12, 17.56 and 16.23 % in the worms fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the second instar, the percentage of the total nitrogen content in the larvae were 20.58, 24.31, 22.71, 22.55, 20.35 and 21.61 after feeding the worms on the leaves of the varieties Morettiana, Japanese L Selvatica, Rosa di Lombardia, Roumi and Lhu respectively.

The percentage of the total nitrogen in the larvae had decreased during the third instar as it became 14.65, 15.03, 16.37, 12.32, 13.83 and 17.41 after feeding the worms on the leaves of the varieties Morettiana, Japanese L., Selvatica, Rosa di Lombardia, Roumi and Lhu respectively.

In the fourth instar, percentage of total nitrogen were 12.24, 14.62, 16.50, 13.40, 13.78 and 15.06 in the larvae fed on the leaves of the varieties Morettiana, Japanese L., Selvatica, Rosa di Lombardia, Roumi and Lhu respectively.

Percentage of the total nitrogen in the fifth instar larvae were 15.46 16.59, 16.37, 15.10, 15.43 and 15.77 after feeding the worms on the leaves of the varieties Morettiana, Japanese L., Selvatica, Rosa di Lombardia, Roumi and Lhu respectively.

The percentage amount of total nitrogen in the larvae of the race 49 M is shown in Table 19 and graphically illustrated in Fig. 6.

In the first instar percentages of total nitrogen were 19.44, 20.66 and 20.12 % after feeding on the leaves of the varieties Giazzola, Florio and Selvatica and 18.21, 19.44 and 19.57 % in the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana.

In the second instar, percentages of total nitrogen were 37.47 , 20.87 and 18.23 by feeding on the leaves of the varieties Giazzola , Florio and Selvatica. The percentages were 26.30, 28.10 and 12.45 % in the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

In the third instar, percentages of total nitrogen had decreased except in the worms fed on the leaves of the variety Morettiana, as total nitrogen percentages were also 14.82, 12.56 and 17.29 % after feeding on the leaves of the varieties Giazzola, Florio and Selvatica, and 14.27, 16.24 and 25.18 % in the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana.

In the fourth instar, percentages of total nitrogen were 19.23 , 18.83 and 18.83 % in the worm fed on the leaves of the varieties Giazzola, Florio and Selvatica, and 15.24, 16.62 and 18.44 % in the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana. The amounts of total nitrogen in the larvae of the fifth instar were 14.84, 13.59 and 13.42 % in the worms fed on the leaves of the varieties Giazola, Florio and Selvatica, and 18.18, 13.23 and 14.36 % in the worms fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

Excretion :

The average quantity of the excreted faeces from the larva of the race Var, in the different instars after feeding on the leaves of different mulberry varieties is represented in Table 20.

In the first instar, the average quantity of the excreted faeces was 0.0014, 0.0014 and 0.0011 gm. after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 0.0011, 0.0009 and 0.0010 gm. by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. It is clearly evident from these prementioned results that there are no significant differences in the amount of faeces excreted from the larva after feeding on the leaves of the different mulberry varieties during the first instar.

In the second instar, the average quantity of the excreted faeces was 0.0056, 0.0059 and 0.0064 gm. by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 0.0057, 0.0051 and 0.0082 gm. after feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum quantity of faeces was excreted from the larva fed on the leaves of the variety Lhu.

In the third instar, the larva excreted 0.044, 0.045 and 0.037 gm. of faeces after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, while by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu, had excreted 0.039, 0.027 and 0.069 gm. of faeces. The maximum quantity of the excreted faeces was that of the larva fed on the leaves of the variety Lhu, and the minimum quantity was of the larva fed on the leaves of the variety, Roumi.

During the fourth instar, the larva had excreted 0.346, 0.284 and 0.341 gm. of faeces after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It has also excreted 0.246, 0.34O and 0.218 gm. of faeces by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum weight of faeces was excreted from the larva fed on the leaves of the variety Morettiana, and the minimum quantity was excreted from the larvae fed on the leaves of the variety Lhu.

During the fifth instar, the larva had excreted 0.692, 0.797 and 0.842 gm. of faeces by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it excreted 0.596, 0.715 and 0.464 gm. of faeces after feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum weight of faeces was excreted from the larva fed on the leaves of the variety Selvatica, and the minimum weight of faeces was excreted from the larva fed on the leaves of the variety Lhu.

It is clearly shown from these prementioned results that the average quantity of the excreted faeces had gradually increased from the first to the fifth instar.

The results shown in Table 21 indicate the average quantity of faeces excreted from the larva of the cross breed Yinhan in the different instars after feeding on the leaves of different mulberry varieties.

In the first instar, the average weight of the excreted faeces was 0.0014, 0.0013 and 0.0012 gm. after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it excreted 0.0017, 0.0018 and 0.0017 gm. of faeces after feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the second instar, the larva excreted 0.0069, 0.0077 and 0.0081 gm. of faeces after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It had also excreted 0.0066, 0.0071 and 0/0060 gm. of faeces after feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively. The maximum weight of faeces was excreted from the larva fed on the leaves of the variety Selvatica and the minimum weight of faeces was excreted from the larva fed on the leaves of the variety Lhu.

In the third instar, the larva excreted 0.023, 0.030 and 0.024 gm. of faeces after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, while it excreted 0.024, 0.024 and 0.019 gm. of faeces by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the fourth instar, the larva had excreted 0.095, 0.133 and 0.119 gm. of faeces after feeding on the leaves of the varieties Morettiana,

Japanese L. and Selvatica. It had also excreted 0.112, 0.129 and 0.101 gm. of faeces when fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the fifth instar, the larva had excreted 0.867, 1.001 and 0.748 gm. of faeces after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It had also 0.606, 0.732 and 0.572 gm. of faeces by feeding on the leaves on the varieties Rosa di Lombardia, Roumi and Lhu. The maximum weight of faeces was excreted from the larva fed on the leaves of the variety Japanese L. and the minimum weight of faeces was excreted from the larva fed on the leaves of the variety Lhu.

Table 22 represents the average quantity of faeces excreted from the larva fed on the different mulberry leaf varieties, during the rearing season of 1961.

In the first instar, the average weight of the excreted faeces was 0.0015, 0.0015 and 0.0014 gm. by feeding on the leaves of the varieties Giazzola, Florio and Selvatica. The larva had excreted 0.0016, 0.0017 and 0.0014 gm. of faeces after feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

In the second instar, the larva had excreted 0.0079, 0.0089 and 0.0071 gm. of faeces after feeding on the leaves of the varieties Giazzola, Florio and Selvatica. The larva had also excreted 0.0087, 0.0090 and 0.0092 gm. of faeces when it was fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

In the third instar, the larva had excreted 0.047, 0.052 and 0.044 gm. of faeces when it was fed on the leaves of the varieties Giazzola, Florio and Selvatica. It had also excreted 0.057, 0.052 and 0.053 gm. of faeces when it was fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana.

During the feeding period of the fourth instar, the larva had excreted 0.294, 0.305 and 0.380 gm. of faeces when it was fed on the leaves of the varieties Giazzola, Florio and Selvatica. It had also excreted 0.322, 0.287 and 0.306 gm. of faeces after feeding on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively.

The maximum weight of faeces was excreted from the larva fed on the leaves of the variety Selvatica and the minimum weight of faeces was excreted from the larva fed on the leaves of the variety Kokuso.

In the fifth instar, the larva had excreted 1.800, 2.270 and 1.370 gm. of faeces when it was fed on the leaves of the varieties Giazzola, Florio and Selvatica, and it excreted 2.260, 2.780 and 2.526 gm. of faeces when it was fed on the leaves of the varieties Cattaneo, Kokuso and Morettiana respectively. The maximum weight of faeces was excreted from the larva fed on the leaves of the variety Kokuso and the minimum weight was that of the larva fed on the leaves of the variety Selvatica.

Percentage of total nitrogen in the excreted faeces :

The amount of total nitrogen in the excreted faeces from the larva of different silkworm races during the different instars after feeding on different mulberry leaf varieties is shown in Tables 23 - 24 and 25 and graphically illustrated in Fig. 7, which had indicated that the amount of total nitrogen in the excreted faeces had generally decreased from the first to the fifth instars.

Comparing the results of the total nitrogen percentage in the excreted faeces from the larvae of the race Var, after feeding on the leaves of different mulberry varieties. It is shown from Table 23 and Fig. 7 that the percentage of total nitrogen in the faeces excreted from the larva during the first instar was 5.85, 5.05 and 5.47 after feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 5.11, 5.31 and 5.03 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

Percentage of total nitrogen in the excreted faeces had gradually decreased during the second instar as it was 4.99, 4.38, 4.69, 4.15, 2.36 and 4.19 after feeding on the leaves of the six utilized varieties respectively.

In the third instar, percentage of total nitrogen had increased again as it was 5.60, 4.93 and 4.64 in the faeces excreted from the larvae fed on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it was 4.84, 5.01 and 4.37 after feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the fourth instar, percentage of total nitrogen in the excreted faeces was 4.77, 4.69 and 5.34 by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 4.64, 3.34 and 5.01 in the excreted faeces of the larvae fed on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu.

Percentage of total nitrogen in the faeces excreted during the fifth instar was 4.50, 4.43 and 5.25 after feeding the larvae on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 4.27, 3.01 and 4.92 by feeding the worms on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

Table 24 and Fig. 7 represent the percentage of total nitrogen in the excreted faeces from the larvae of the cross breed Yinhan in the different instars.

Percentage of total nitrogen in the excreted faeces during the first instar was 7.94, 8.20 and 6.54 after feeding the worms on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It was also 7.21, 6.60 and 6.25 by feeding the larvae on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the second instar, percentage of total nitrogen in the excreted faeces had decreased and became 6.28, 5.21 and 5.98 after feeding the larvae on the leaves of the varieties Morettiana, Japanese L. and Selvatica. It decreased also up to 5.38, 4.87 and 4.90 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the third instar, the percentage of total nitrogen raised again and became 6.94, 5.26 and 7.72 % by feeding on the leaves of the varieties Morettiana, Japanese L. and Selvatica, and it became 5.24, 5.28 and 5.17 % by feeding on the leaves of the varieties Rosa di Lombardia, Roumi and Lhu respectively.

In the fourth instar, percentages of total nitrogen in the excreted faeces were 6.25, 4.53, 5.85, 5.15, 4.54 and 4.09 after feeding the larvae on the leaves of the varieties Morettiana, Japanese L., Selvatica, Rosa di Lombardia, Roumi and Lhu respectively.

Percentages of total nitrogen in the excreted faeces during the fifth instar were 5.02, 5.85, 5.46, 3.89, 4.33 and 3.48 by feeding the larvae on the leaves of the varieties Morettiana, Japanese L., Selvatica, Rosa di Lombardia, Roumi, and Lhu respectively.

Percentages of total nitrogen in the excreted faeces of the larvae of the race 49 M is represented in Table 25 and graphically illustrated in Fig. 7 .

In the first instar, percentages of total nitrogen in the excreted faeces were 6.43, 4.62, 6.45, 5.34, 5.36, and 4.19 by feeding the worms on the leaves of the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively.

In the second instar, percentages of total nitrogen in the excreted faeces were 5.96, 4.72, 6.36, 5.28, 5.16 and 4.86 after feeding the larvae on the leaves of the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively.

Percentages of total nitrogen in the excreted faeces during the third instar were 5.58, 4.59, 4.88, 4.81, 4.81 and 3.85 by feeding the larvae on the leaves of the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively.

In the fourth instar, percentages of total nitrogen in the excreted faeces were 4.32, 3.56, 4.44, 3.81, 3.66 and 3.46 after feeding the larvae on the leaves of the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively.

In the fifth instar, percentage of total nitrogen in the excreted faeces were 3.30, 3.49, 3.12; 4.41, 3.59 and 2.99 after feeding the worms on the leaves of the varieties Giazzola, Florio, Selvatica, Cattaneo, Kokuso and Morettiana respectively.

SUMMARY

The investigations deal mainly with the determination of the nutritional value of the different mulberry varieties in the different larval instars, with a view to compare them respecting food consumption , coefficient of food utilization, growth, coefficient of metabolism, percentage of total nitrogen in the different larval instars and the excreted faeces were also determined.

Ingestion of food :

The average quantity of the fresh mulberry leaves eaten by the larva of the silkworm at every instar differed so greatly in the different varieties of the mulberry leaves. It s also clearly recognized that the quantity of the fresh leaves consumed had increased gradually till the fourth instar, then raised suddenly in the fifth instar.

Coefficient of food utilization :

It is noticed that the larvae of the silkworm Bombyx mori L. utilize in the early instars more of the food consumed, than they do in the later instars.

Growth :

It is indicated that the increase in weight of the silkworm larvae varies according to racial and nutritional factors. The heaviest weight of mature larva of the race Var, was that of the worms fed on the leaves of the variety Japanese L., and it was the same as for the mature larva of the cross breed Yinhan. The heaviest weight of mature larva of the race 49 M was that of the worms fed on the leaves of the variety Kokuso.

Coefficient of growth :

It should be noted that the coefficient of growth had increased gradually from the first instar and reached its maximum in the fourth or the fifth instar.

Coefficient of metabolism :

It was noticed that the coefficient of metabolism had slightly decreased from the first to the third instar, then it had obviously decreased in the fourth and fifth instars.

Moisture percentage in the larvae of the silkworm :

The information obtained indicate that the moisture percentage in the larvae of the race Var had decreased by advancing in age from the first to the fifth instars. Moisture percentage in the larvae of the races Yinhan and 49 M had only decreased during the fifth instar. There had been no significant difference in the moisture percentage in the larvae of the different races after feeding on the different mulberry leaf varieties.

Percentage of total nitrogen in the larvae of the silkworm :

It is shown that the amount of total nitrogen in the larvae of the race Var had increased till the third instar, then decreased in the fourth instar, and slightly increased again in the fifth instar. Percentage of total nitrogen in the larvae of the races Yinhan and 49 M had decreased in the third instar, then raised up again in the fourth and fifth instars.

It was also recommended that there had been no significant differences in the amount of total nitrogen in the larvae of the race Var after feeding the worms on the different mulberry leaf varieties, while there was significant difference in the amount of total nitrogen in the larvae of the races Yinhan and 49 M after feeding the worms on the different mulberry leaf varieties.

Excretion :

It is recorded that the average quantity of the excreted faeces had gradually increased from the first to the fifth instars. The maximum weight of faeces excreted from the larva of the race Var during the fifth instar was that of the worms fed on the leaves of the variety Selvatica, while it was that of the variety Japanese L. in the worms of the race Yinhan during the same instar. The maximum weight of faeces excreted from the larvae of the race 49 M during the fifth instar was that of the worms fed on the leaves of the variety Kokuso.

Percentage of total nitrogen in the excreted faeces :

It is recorded that the amount of the total nitrogen in the excreted faeces had generally decreased from the first to the fifth instars.

RESUME

L'EFFET PHYSIOLOGIQUE D'UNE ALIMENTATION AVEC DIFFERENTES VARIETES DE MURIERS SUR CERTAINES RACES DE VERS A SOIE

Les recherches visent surtout à déterminer la valeur nutritive des différentes variétés de mûriers durant les différents âges larvaires. Elles seront comparées au point de vue : consommation de nourriture, coëfficient de nourriture utilisée, croissance, coëfficient du métabolisme, pourcentage d'azote total au cours des différents âges larvaires et excréments rejetés.

Ingestion :

La quantité moyenne de feuilles fraîches de mûrier mangées par la larve du ver à Soie à chaque âge varie assez grandement, selon les différentes variétés de feuilles de mûrier. Il est aussi clairement déterminé que la quantité de feuilles fraîches consommées a augmenté graduellement jusqu'au quatrième âge, ensuite elle diminue soudain durant le cinquième âge.

Coëfficient d'utilisation de la nourriture:

Les larves du ver à Soie Bombyx mori L. pendant les premiers âges utilisent plus de nourriture qu'elles ne le font dans les derniers.

Croissance :

L'augmentation du poids de la larve du ver à Soie varie selon les facteurs racial et nutritionnel. Le plus grand poids de la larve à maturité de la race Var était le fait de la nourriture des vers à partir de feuilles de la variété Japonaise L., et il en était de même pour la larve arrivée à maturité du croisement Yinhan. Le plus grand poids de la larve arrivée à maturité de la race 49 M venait du fait de la nourriture des vers avec les feuilles de la variété Kokuso.

Coëfficient de croissance :

Le coëfficient de croissance a augmenté graduellement depuis le premier âge et a atteint son maximum pendant le quatrième ou le cinquième âge.

Coëfficient du métabolisme :

Le coëfficient du métabolisme avait diminué légèrement du premier au troisième âge, ensuite il avait nettement décru au quatrième et au cinquième âge.

Pourcentage d'humidité dans les larves du ver à Soie :

Les renseignements obtenus montrent que le pourcentage d'humidité dans les larves de la race Var a diminué durant le développement du premier au cinquième âge larvaire. Le pourcentage d'humidité dans les larves des races Yinhan et 49 M a diminué seulement pendant le cinquième âge. Il n'y a pas de notable différence dans le pourcentage d'humidité chez les larves des différentes races après qu'elles aient été alimentées avec des feuilles de mûrier de diverses variétés.

Pourcentage d'Azote total dans les larves du Ver à Soie.

Il ressort que la quantité d'Azote total dans les larves de la race Var a augmenté jusqu'au troisième âge, puis a diminué dans le quatrième, et a légèrement augmenté à nouveau au cinquième âge. Le pourcentage d'azote total dans les larves des races Yinhan et 49 M a diminué au troisième âge, puis il a augmenté durant le quatrième et le cinquième âges.

Il est aussi démontré qu'il n'y avait pas de grande différence dans la quantité d'azote total chez les larves de la race Var après que les Vers aient été nourris avec les feuilles des différentes variétés, tandis qu'il y avait une différence marquée dans la quantité d'azote total chez les larves des races Yinhan et 49 M après l'alimentation avec des feuilles de mûrier de différentes variétés.

Déjections :

La quantité moyenne des matières fécales a peu à peu augmenté, depuis le premier âge jusqu'au cinquième. La quantité maximum des matières fécales rejetées par la larve de la race Var pendant le premier âge provenait de l'alimentation des vers avec la variété Selvatica, tandis qu'il s'agissait de la variété Japonaise L. pour les vers de la race Yinhan pendant le même âge. Le poids maximum de matières fécales rejetées par les larves de la race 49 M pendant le premier âge était le fait de l'alimentation des vers avec des feuilles de la variété Kokuso.

Pourcentage d'Azote total dans les matières fécales.

La quantité d'azote total dans les matières fécales a généralement diminué du premier au cinquième âge.

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Table 1

Mean weight of food consumed by the larva of the race Var, in the different instars, after feeding on different mulberry leaf varieties, during the rearing season (1959).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	0.320	0.443	0.753	4.621	15.230
Japanese L.	0.315	0.319	0.514	4.029	16.612
Selvatica	0.305	0.502	0.618	3.213	18.420
Rosa di lombardia	0.317	0.688	0.843	3.680	18.216
Roumi	0.319	0.429	2.268	6.896	15.349
Lhu	0.349	0.909	1.519	4.786	17.032

Table 2

Mean weight of food consumed by the larva of the race Yinhan, in the different instars, after feeding on different mulberry leaf varieties, during the rearing season, (1960).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	0.191	0.045	0.341	1.349	13.240
Japanese	0.158	0.047	0.313	1.482	13.947
Selvatica	0.209	0.079	0.371	1.579	13.975
Rosa di lombardia	0.193	0.119	0.684	2.323	14.393
Roumi	0.274	0.115	0.829	2.813	13.847
Lhu	0.293	0.174	1.208	4.747	15.098

Table 3

Mean weight of food consumed by the larva of the race 49 M, in the different instars, after feeding on different mulberry leaf varieties, during the rearing season (1961).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Giazzola	0.088	0.208	1.021	3.144	11.486
Florio	0. 089	0.221	0.969	1 .361	11.693
Selvatica	0.085	0.297	1.762	5.116	9.237
Cattaneo	0.082	0.208	0.911	3.327	14.415
Kokuso	0.093	0.219	0.787	2.953	13.450
Morettiana	0.079	0.280	1.080	3.500	12.210

Table 4

Coefficient of food utilization in the different instars of the race Var, after feeding on the different mulberry leaf varieties, during the rearing season (1959).

Mulberry variety	Instars				
	Ist	2nd	3rd	4th	5th
Morettiana	99.51	98.61	93.73	89.42	95.39
Japanese L.	99.50	98.43	91.70	91.56	95.11
Selvatica	99.58	98.57	93.88	90.45	94.61
Rosa di lombardia	99.60	99.06	94.94	92.96	96.06
Roumi	99.60	99.50	98.44	87.20	95.28
Lhu	99.66	98.97	96.46	93.60	97.28

Table 5

Coefficient of food utilization in the different instars of the race Yinhan, after feeding on the different mulberry leaf varieties, during the rearing season 1960.

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	99.20	82.78	92.95	92.89	93.39
Japanese L.	99.05	80.26	89.75	90.96	92.71
Selvatica	99.35	88.34	92.97	91.90	94.58
Rosa di lombardia	99.00	93.60	96.04	94.75	95.71
Roumi	99.26	93.68	97.05	94.86	94.61
Lhu	99.35	95.91	98.12	97.49	96.17

Table 6

Coefficient of food utilization in the different instars of the race 49 M, after feeding on the different mulberry leaf varieties, during the rearing season (1961).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Giazzola	98.30	96.35	94.71	90.42	84.41
Florio	98.30	96.23	94.47	97.53	80.15
Selvatica	97.57	97.53	96.59	93.73	83.85
Cattaneo	97.53	95.85	93.59	89.59	82.55
Kokuso	98.06	95.89	93.03	89.88	77.43
Morettiana	98.09	96.31	94.69	91.93	78.63

Table 7

Mean weight of larva of the race Var, in the different instars, per gm. after feeding on different mulberry leaf varieties, during the rearing season (1959).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	0.0033	0.025	0.117	0.461	3.132
Japanese L.	0.0044	0.028	0.110	0.475	3.537
Selvatica	0.0048	0.027	0.099	0.444	3.211
Rosa di lombardia	0.0041	0.022	0.084	0.413	2.628
Roumi	0.0046	0.016	0.072	0.348	2.775
Lhu	0.0048	0.022	0.093	0.427	2.535

Table 8

Mean weight of larva of the race Yinhan in the different instars per gm. after feeding on different mulberry leaf varieties, during the rearing season (1960).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	0.0049	0.022	0/111	0.529	3.136
Japanese L.	0.0046	0.020	0.114	0.562	3.164
Selvatica	0.0045	0.022	0.110	0.525	2.905
Rosa di lombardia	0.0038	0.017	0.088	0.436	2.027
Roumi	0.0040	0.017	0.080	0.436	2.552
LHu	0.0035	0.015	0.062	0.409	1.791

Table 9

Mean weight of larva of the race 49 M in the different instars, per gm. after feeding on different mulberry leaf varieties, during the rearing season (1961).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Giazzola	0.0042	0.023	0.114	0.561	3.675
Florio	0.0038	0.022	0.112	0.515	3.104
Selvatica	0.0043	0.022	0.115	0.522	3.043
Cattaneo	0.0039	0.022	0.111	0.540	3.209
Kokuso	0.0042	0.025	0.127	0.636	3.720
Morettiana	0.0037	0.022	0.117	0.551	3.232

Table 10

Coefficient of growth per cent in the larva of the race Var, in the different instars, after feeding on the different mulberry leaf varieties (1959)

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	0.88	4.96	12.98	8.05	18.37
Japanese L.	1.24	7.54	17.83	9.75	19.36
Selvatica	1.41	4.47	12.39	12.01	15.80
Rosa di lombardia	1.14	2.62	7.71	9.58	12.57
Roumi	1.29	0.80	2.50	4.21	16.58
Lhu	1.24	1.90	4.90	7.28	12.72

Table 11

Coefficient of growth per cent in the larva of the race Yinhan, in the different instars, after feeding on the different mulberry leaf varieties (1960).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	2.32	4.51	27.99	33.60	21.07
Japanese L.	2.62	3.92	33.22	33.20	20.10
Selvatica	1.92	2.47	25.73	29.23	18.04
Rosa di lombardia	1.73	1.17	10.76	15.65	11.54
Roumi	1.29	1.23	7.91	13.26	16.13
Lhu	1.03	0.68	3.95	7.25	8.90

Table 12

Coefficient of growth per cent in the larva of the race 49 M in the different instars, after feeding on the different mulberry leaf varieties (1961)

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Giazzola	4.27	9.39	9.34	15.68	32.15
Florio	3.77	8.58	9.81	38.16	27.48
Selvatica	4.55	6.11	5.41	8.59	32.04
Cattaneo	4.23	9.08	10.42	14.28	21.96
Kokuso	4.05	9.90	13.88	19.17	28.90
Morettiana	4.47	6.76	9.25	13.78	27.68

Table 13

Coefficient of metabolism per cent in the larva of the race Var, in the different instars, after feeding on different mulberry leaf varieties (1959).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	99.12	95.01	98.70	91.95	81.63
Japanese L.	98.76	92.46	82.17	90.25	80.64
Selvatica	98.59	95.52	87.61	87.99	84.26
Rosa di lombardia	98.86	97.38	92.29	90.41	87.43
Roumi	98.71	97.31	97.50	95.79	83.38
Lhu	98.76	98.09	95.11	92.69	87.28

Table 14

Coefficient of metabolism per cent in the larva of the race YInhan, in the different instars, after feeding on different mulberry leaf varieties (1960).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	97.68	54.86	72.02	58.21	78.93
Japanese L.	97.38	60.81	66.78	66.79	79.90
Selvatica	98.07	75.32	74.27	70.77	82.96
Rosa di lombardia	98.27	88.26	89.24	84.35	88.46
Roumi	98.71	87.72	92.08	86.74	83.87
Lhu	98.97	93.15	96.04	92.75	91.09

Table 15

Coefficient of metabolism per cent in the larva of the race 49 M, in the different instars, after feeding on different mulberry leaf varieties.

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Giazzola	95.72	90.61	90.66	84.31	67.85
Florio	96.22	91.42	90.19	61.84	72.52
Selvatica	95.45	93.89	94.59	91.41	67.95
Cattaneo	95.77	90.92	88.52	85.72	78.04
Kokuso	95.95	90.90	85.98	80.83	71.09
Morettiana	95.87	96.94	90.75	86.22	72.31

Table 16

Percentage of moisture content in the larva of the different races, in the different instars, after feeding on different mulberry leaf varieties during the rearing seasons 1959, 1960 and 1961.

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
			(1959)		
Morettiana	94.8	78.6	73.7	86.7	83.5
Japanese L.	94.0	78.8	75.4	87.5	84.4
Selvatica	95.7	77.7	74.3	87.6	84.8
Rosa di lombardia	94.4	75.4	66.9	86.9	82.8
Roumi	94.6	69.1	55.6	85.9	81.9
Lhu	95.1	83.7	76.4	87.3	84.1
			(1960)		
Morettiana	83.3	86.9	86.5	85.6	82.7
Japanese L.	85.1	84.9	86.7	86.1	82.5
Selvatica	84.0	87.6	86.8	85.7	81.5
Rosa di lombardia	79.5	84.4	85.5	84.5	83.1
Roumi	81.5	85.2	85.5	85.1	82.9
Lhu	85.1	86.4	87.3	86.8	85.8
			(1961)		
Giazzola	85.1	86.0	86.0	85.5	85.0
Florio	84.0	83.3	86.2	85.0	76.0
Selvatica	82.0	86.3	84.1	85.0	80.0
Cattaneo	84.0	87.0	86.3	84.5	81.1
Kokuso	86.0	87.7	86.6	87.0	81.6
Morettiana	82.0	86.7	86.3	86.3	79.3

Table 17

Percentage of total nitrogen in the larvae of the race Var, in the different instars after feeding on the different mulberry leaf varieties, (1959).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	12.89	13.70	16.13	12.12	14.13
Japanese L.	12.94	14.78	16.56	12.40	14.12
Selvatica	13.63	14.17	16.16	13.14	14.45
Rosa di lombardia	12.56	13.35	15.12	12.94	13.90
Roumi	13.18	13.47	16.22	12.61	13.92
Lhu	12.85	13.91	15.87	12.34	14.52

Table 18

Percentage of total nitrogen in the larvae of the race Yinhan, in the different instars after feeding on the different mulberry leaf varieties , (1960).

Mulberry variety	% of T.N. in the different instars				
	1st	2nd	3rd	4th	5th
Morettiana	19.44	20.58	14.65	16.24	15.46
Japanese L.	19.88	24.31	15.03	14.62	16.59
Selvatica	23.65	22.71	16.37	16.50	16.37
Rosa di lombardia	25.12	22.55	12.32	13.40	15.60
Roumi	17.56	20.35	13.83	13.78	15.43
Lhu	16.23	21.61	17.41	15.06	15.77

Table 19

Percentage of total nitrogen in the larvae of the race 49 M, in the different instars after feeding on the different mulberry leaf varieties, (1961).

Mulberry variety	% of T.N. in the different instars				
	1st	2nd	3rd	4th	5th
Giazzola	19.44	37.47	14.82	19.23	14.84
Florio	20.66	20.87	12.56	18.83	13.29
Selvatica	20.12	18.23	17.29	18.43	13.42
Cattaneo	18.21	26.30	14.27	15.24	18.18
Kokuso	19.44	28.10	16.24	16.62	13.23
Morettiana	19.57	12.45	25.18	18.44 $\frac{1}{2}$	14.36

Table 20

Mean weight of faeces excreted by the larva of the race Var, in the different instars, after feeding on the different mulberry leaf varieties, (1959).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	0.0014	0.0056	0.044	0.346	0.692
Japanese L.	0.0014	0.0059	0.045	0.284	0.797
Selvatica	0.0011	0.0064	0.037	0.341	0.842
Rosa di lombardia	0.0011	0.0057	0.039	0.246	0.596
Roumi	0.0009	0.0051	0.027	0.340	0.715
Lhu	0.0010	0.0082	0.069	0.218	0.464

Table 21

Mean weight of faeces excreted by the larva of the race Yinhan, in the different instars, after feeding on the different mulberry leaf varieties (1960).

Mulberry variety	Weight of faeces in the different instars				
	1st	2nd	3rd	4th	5th
Morettiana	0.0014	0.0069	0.023	0.095	0.867
Japanese L.	0.0013	0.0077	0.030	0.133	1.001
Selvatica	0.0012	0.0081	0.024	0.199	0.748
Rosa di lombardia	0.0017	0.0066	0.024	0.112	0.606
Roumi	0.0018	0.0071	0.024	0.129	0.732
Lhu	0.0017	0.0060	0.019	0.101	0.572

Table 22

Mean weight of faeces excreted by the larva of the race 49 M in the different instars, after feeding on the different mulberry leaf varieties, (1961).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Giazzola	0.0015	0.0078	0.047	0.294	1.800
Florio	0.0015	0.0089	0.052	0.305	2.270
Selvatica	0.0014	0.0071	0.044	0.380	1.370
Cattaneo	0.0016	0.0087	0.057	0.322	2.260
Kokuso	0.0017	0.0090	0.052	0.287	2.780
Morettiana	0.0014	0.0092	0.053	0.306	2.526

Table 23

Percentage of total nitrogen in the excreted faeces from the larvae of the race Var, in the different instars, after feeding on the different mulberry leaf varieties (1959).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	5.85	4.99	5.60	4.77	4.50
Japanese L.	5.05	4.38	4.93	4.69	4.43
Selvatica	5.47	4.69	4.64	5.34	5.25
Roumi	5.11	4.15	4.84	4.64	4.27
Rosa di lombardia	5.31	2.36	5.01	3.34	3.01
Lhu	5.03	4.19	4.37	5.01	4.92

Table 24

Percentages of total nitrogen in the excreted faeces from the larvae of the race Yinhan, in the different instars, after feeding on the different mulberry leaf varieties (1960).

Mulberry variety	Instars				
	1st	2nd	3rd	4th	5th
Morettiana	7.94	6.28	6.94	6.85	5.02
Japanese L.	8.20	5.21	5.26	4.53	5.85
Selvatica	6.54	5.98	7.72	5.85	5.46
Rosa di lombardia	7.21	5.38	5.24	5.15	3.89
Roumi	6.60	4.87	5.28	4.54	4.33
Lhu	6.25	4.90	5.17	4.09	3.48

Table 25

Percentage of total nitorgen in the excreted faeces from the larvae of the race 49 M, in the different instars, after feeding on the different mulberry leaf varieties (1961).

Mulberry variety	% of T.N. in the faeces in the different instars				
	1st	2nd	3rd	4th	5th
Giazzola	6.47	5.96	5.58	4.32	3.30
Florio	4.62	4.72	4.59	3.56	3.49
Selvatica	6.45	6.36	4.88	4.44	3.12
Cattaneo	5.34	5.28	4.81	3.81	4.41
Kokuso	5.36	5.16	4.81	3.66	3.59
Morettiana	4.19	4.86	3.85	3.46	2.99

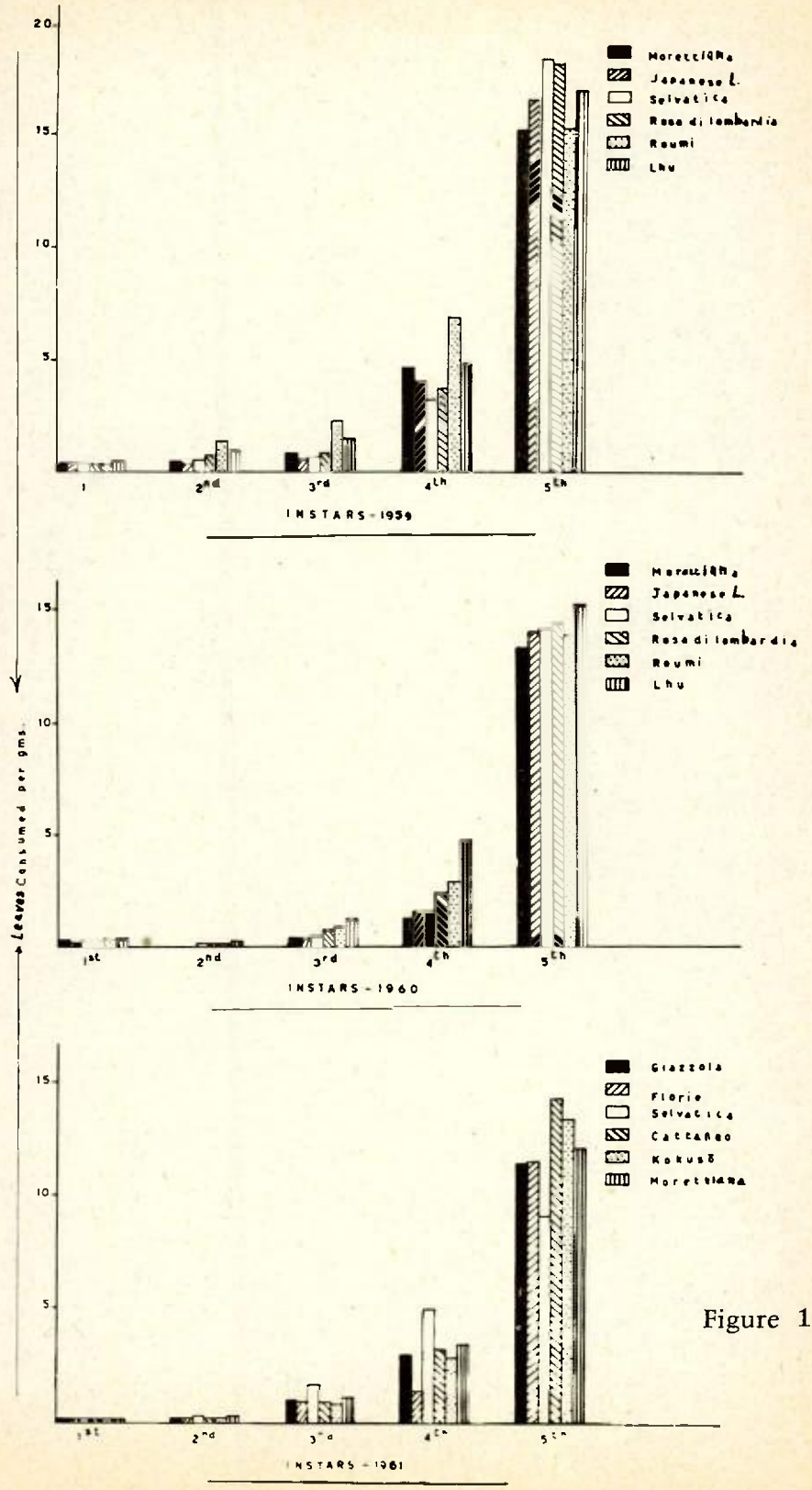
Leaves Consumed per gms.
20
15
10
5
Moretti@Na
Japanese L.
Selvatica
Rosa di lombardia
Roumi
Lhu
1
2nd
3rd
4th
5th
INSTARS - 1959
1st
INSTARS - 1960
Giazzola
Florie
Cattaneo
Kokusō
Morettiana
INSTARS - 1961

Figure 1

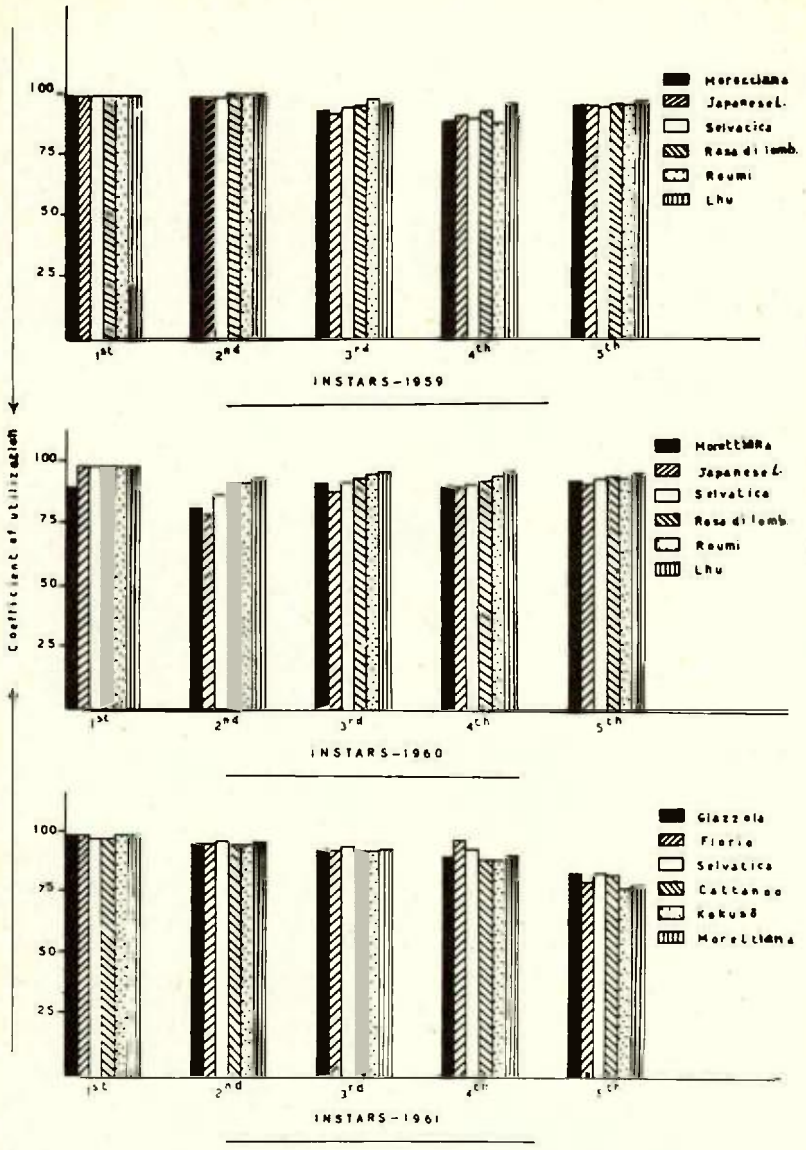
Coefficient of utilization
100
75
50
25
Moreschiana
Japanese L.
Selvatica
Rasa di lomb.
Reumi
Lhu
1st
2nd
3rd
4th
5th
INSTARS-1959
Morettiana
Japanese L.
Selvatica
Rasa di lomb.
Reumi
Lhu
INSTARS-1960
Glazzola
Fiorio
Selvatica
Cattaneo
Kakuso
Morettiana
INSTARS-1961

Figure 2

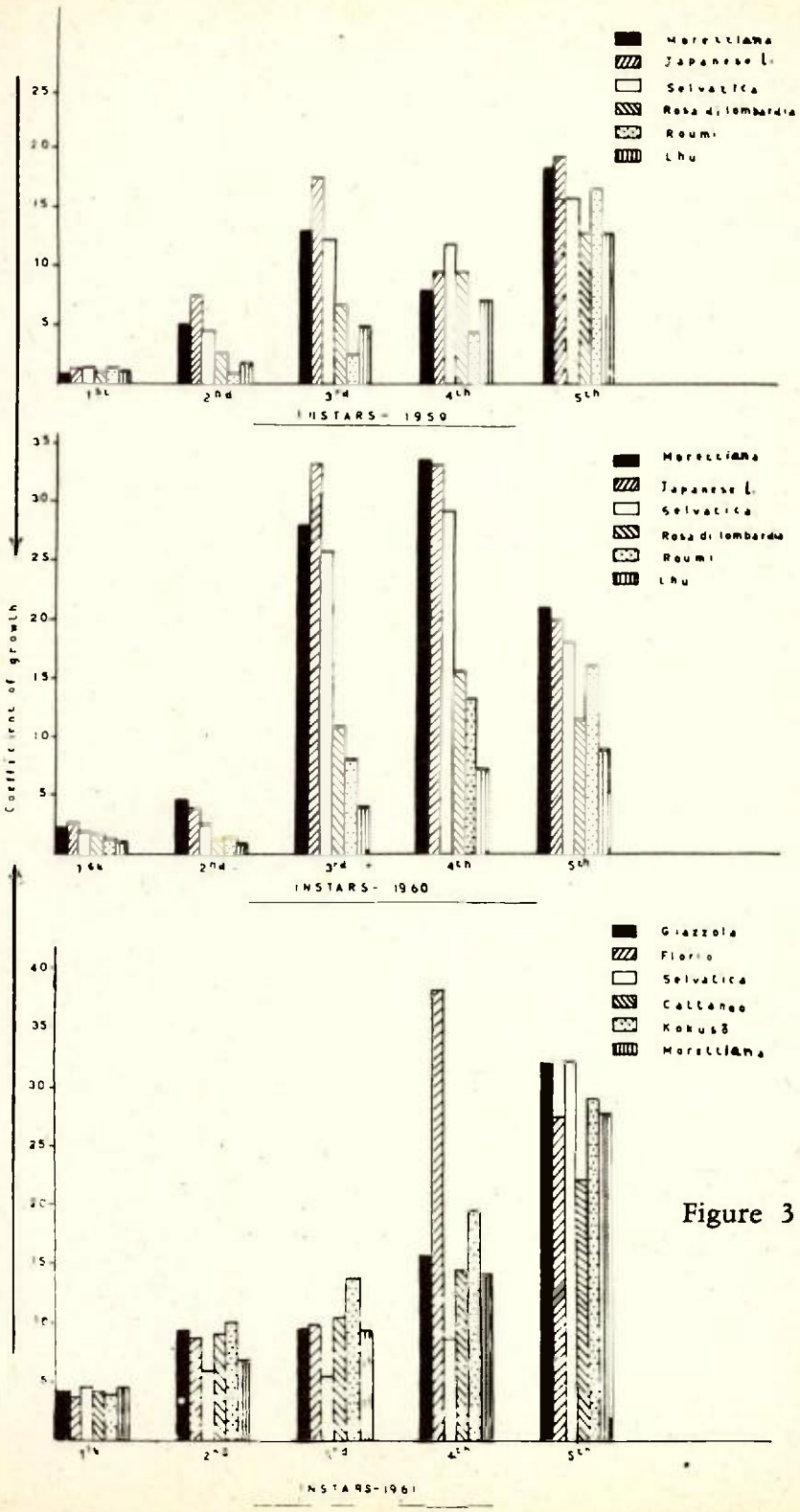
Moretti.ma
Japanese l.
Selvatica
Rosa di lombardia
Roumi
Lhu
INSTARS - 1959
INSTARS - 1960
Coefficient of growth
Grazzola
Fiorio
Selvatica
Callango
Kokus8
Moretti.ma
INSTARS-1961

Figure 3

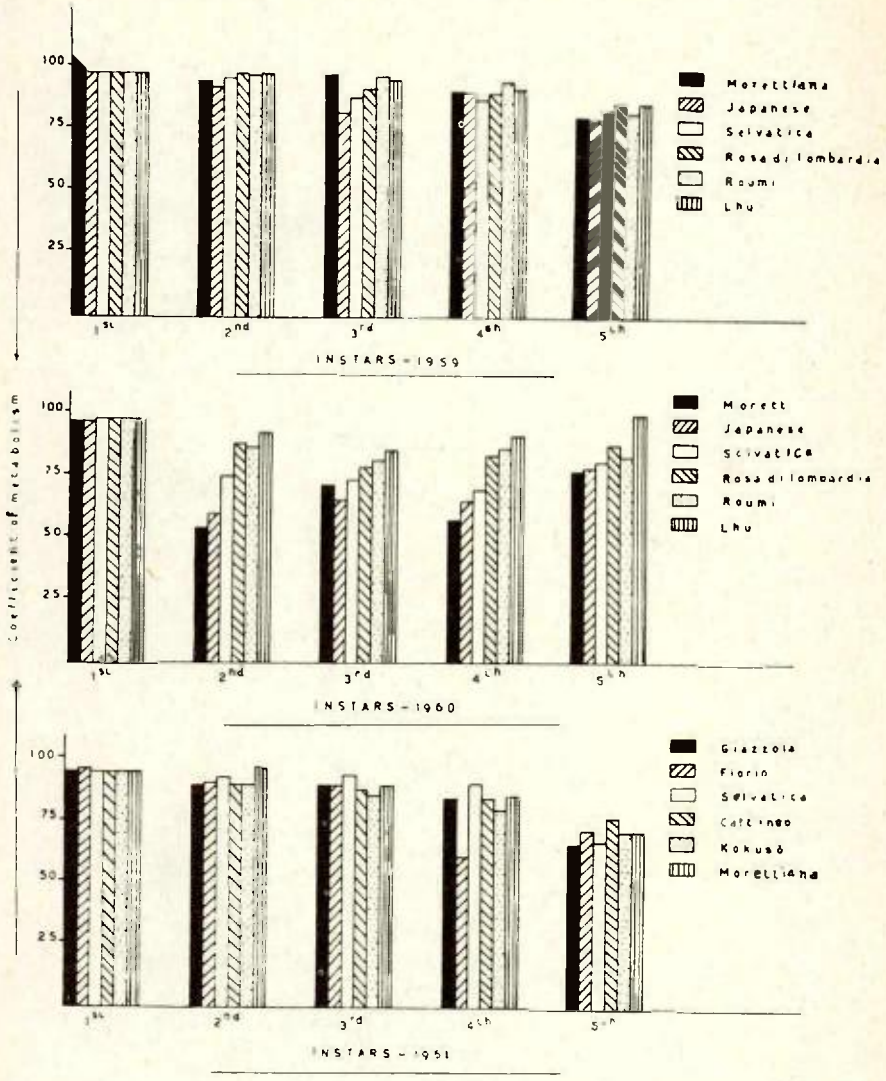
100
75
50
25
1st
2nd
3rd
4th
5th
INSTARS - 1959
Morettiana
Japanese
Selvatica
Rosa di lombardia
Roumi
Lhu
Coefficient of metabolism
INSTARS - 1960
Morett
Japanese
Selvatica
Rosa di lombardia
Roumi
Lhu
Grazzola
Fiorin
Selvatica
Cattineo
Kokusô
Morettiana

Figure 4

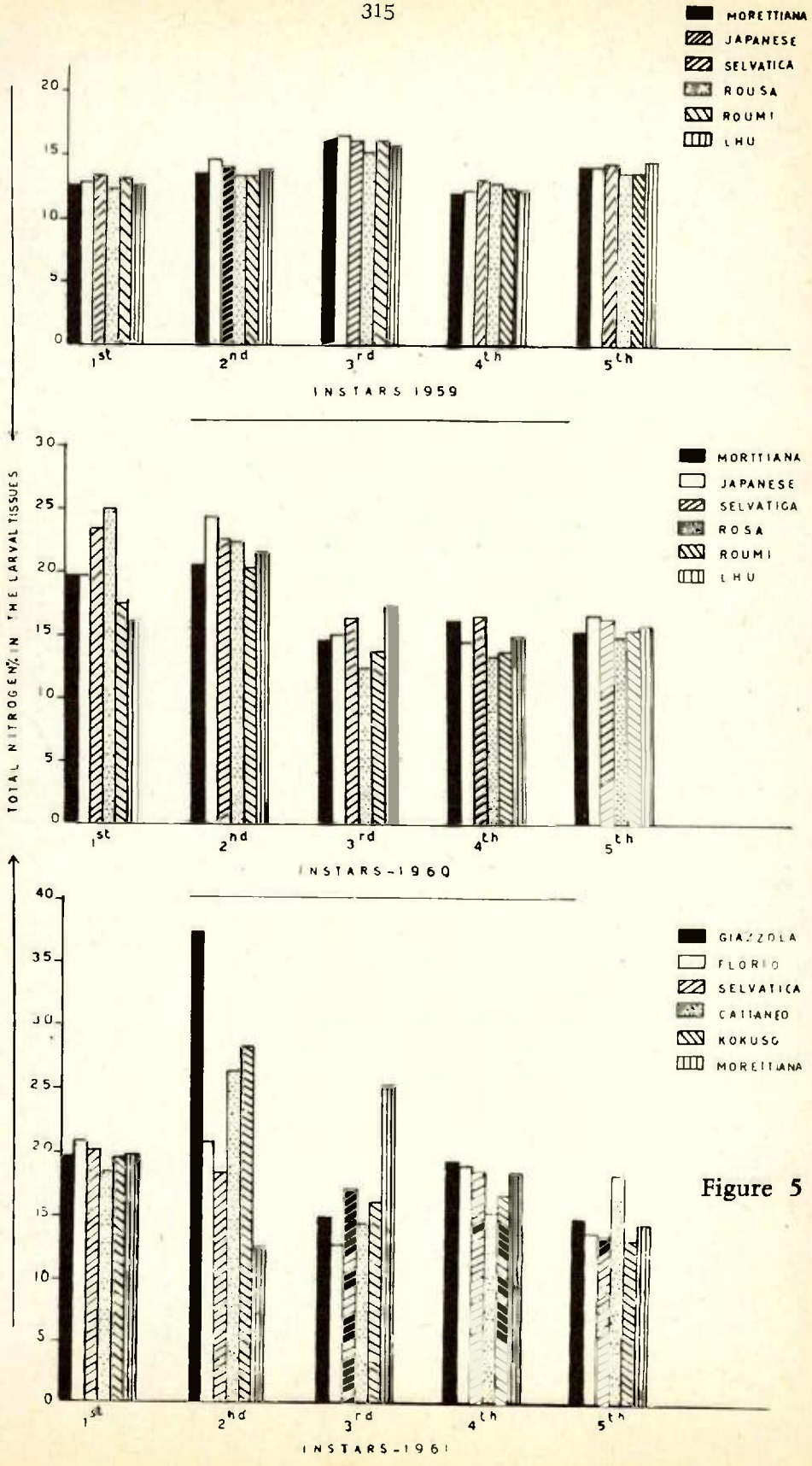
MORETTIANA
JAPANESE
SELVATICA
ROUSA
ROUMI
LHU
20
15
10
5
0
1st
2nd
3rd
4th
5th
INSTARS 1959
MORTTIANA
JAPANESE
SELVATICA
ROSA
ROUMI
LHU
30
25
20
15
10
5
0
TOTAL NITROGEN% IN THE LARVAL TISSUES
INSTARS-1960
GIAZZOLA
FLORIO
SELVATICA
CATTANEO
KOKUSO
MORETTIANA
40
35
30
25
20
15
10
5
0
INSTARS-1961

Figure 5

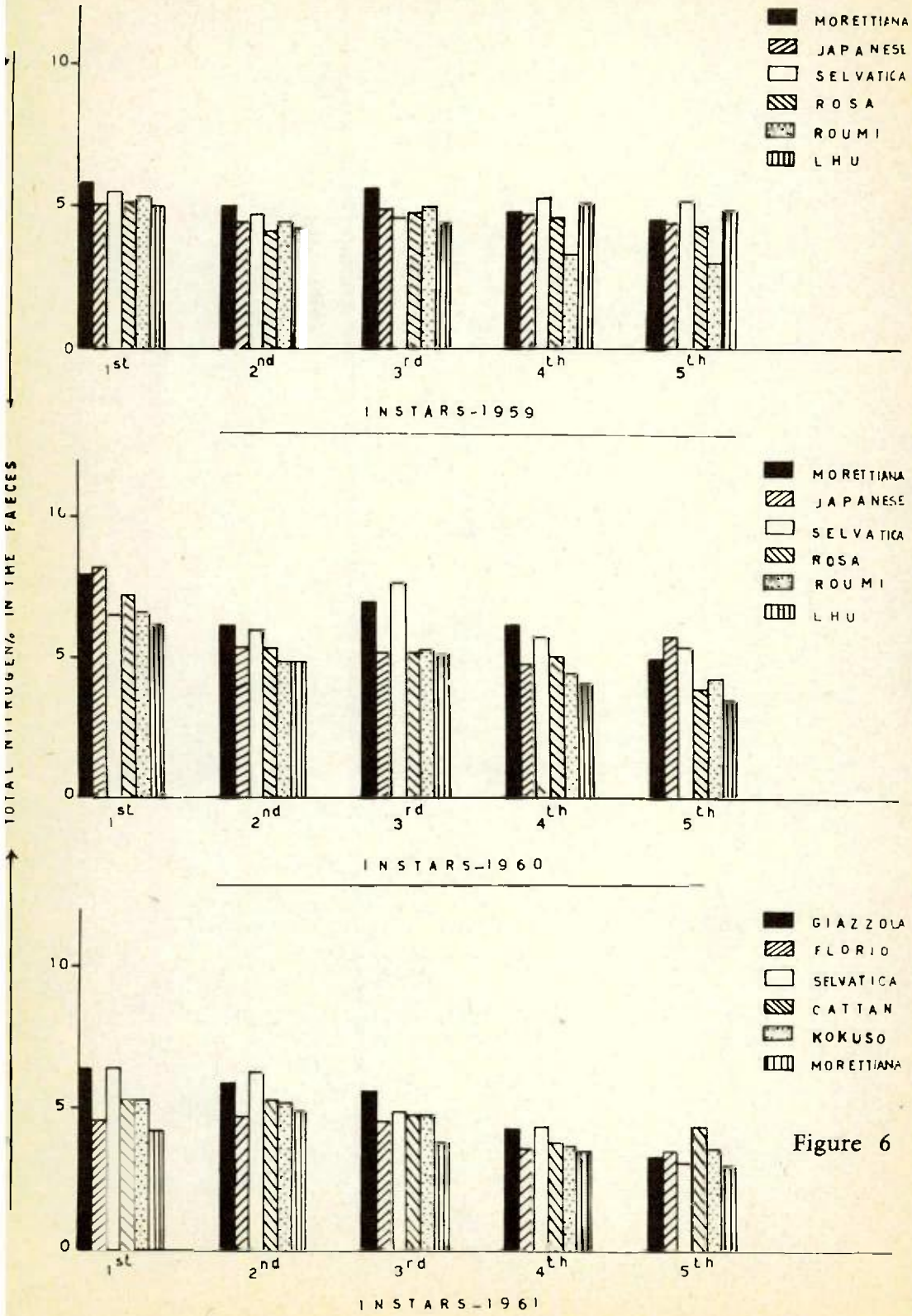
MORETTIANA
JAPANESE
SELVATICA
ROSA
ROUMI
LHU
10
5
0
1st
2nd
3rd
4th
5th
INSTARS-1959
TOTAL NITROGEN% IN THE FAECES
MORETTIANA
JAPANESE
SELVATICA
ROSA
ROUMI
LHU
10
5
0
1st
2nd
3rd
4th
5th
INSTARS-1960
GIAZZOLA
FLORIO
SELVATICA
CATTAN
KOKUSO
MORETTIANA
10
5
0
1st
2nd
3rd
4th
5th
INSTARS-1961

Figure 6