

sericologia

Journal of Silkworms

Revue des Vers à Soie

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XIIIe Conférence de la Commission séricicole internationale**13th Conference of the International Sericultural Commission****3-6 décembre 1990 - Paris / 3-6 December 1991 - Paris**

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INTRODUCTION

La XIII^e Conférence statutaire de la Commission séricicole internationale, qui s'est tenue en Décembre 1990 et dont l'objet était, pour les Etats-membres, de faire les divers bilans des trois dernières années, de voter les orientations des trois années futures et d'élire le Bureau et le Secrétaire général, a été élargie, à la demande du Comité exécutif, de telle manière que des exposés de conjoncture ou techniques et scientifiques puissent être présentés et discutés par les délégués d'Etats-membres ou non membres ainsi que par des Membres associés.

Ceci a été décidé lorsqu'il est apparu que le Congrès international triennal, pendant lequel se tient habituellement la Conférence statutaire, ne pouvait être organisé. Le congrès est, rappelons-le, le rassemblement de toutes les personnes concernées dans le monde par la sériciculture sur les plans techniques, scientifiques et économiques. Il a rassemblé, en 1988, plus de 150 personnes en Thaïlande et plus de 250 personnes, en 1985, en Inde.

La décision de ne pas s'en tenir à la seule partie statutaire lors de la XIII^e Conférence avait donc pour but de faire le point sur un certain nombre de questions d'ordre technique et scientifique avec un plus petit nombre d'initiés. Malgré l'annonce tardive de cette invitation, nous avons eu le plaisir d'accueillir près de 50 délégués représentant 18 pays.

Ce numéro de *Sericologia* est consacré aux exposés présentés par ces délégués lors des quatre demi-journées de réunions qui se sont tenues à Paris les 3, 4 et 6 décembre 1990, les documents administratifs concernant la Conférence statutaire et le Comité exécutif qui se sont tenus les 5 et 6 décembre étant destinés aux seuls Etats-membres.

Pour des raisons de place, et donc de budget, les exposés ne sont pas publiés de manière bilingue mais seulement dans la langue originale de présentation. Seules, les questions et les discussions ont été traduites et sont présentées en anglais et en français.

De plus, la publication un peu tardive de ce compte-rendu est liée au fait qu'un certain nombre d'exposés n'étaient pas écrits et ont dû être transcrits à partir des enregistrements magnétophoniques des réunions.

Je suis sûr que vous voudrez bien excuser le secrétariat de la Commission séricicole internationale pour ces aléas.

Ces journées ont été très fructueuses. Elles nous ont permis de rencontrer des personnes habituées des réunions de la CSI et qui ont toujours beaucoup de plaisir à se retrouver, mais également, et dans une assez forte proportion, de découvrir des visages nouveaux.

Vous pourrez constater, à la lecture des exposés et des discussions, que la sériciculture est plus que jamais à l'ordre du jour dans le monde. De nombreux projets voient le jour en Afrique, en Amérique du Sud, en Asie et le développement de la sériciculture est annoncé également dans de nombreux pays déjà producteurs. On a pu constater que des résultats récents permettaient d'envisager de nouvelles perspectives dans des zones où se pose le problème du remplacement de la culture du pavot ou de la coca par d'autres productions. Le développement pose des problèmes techniques et scientifiques désormais classiques tels que celui de produire ou d'obtenir des graines de vers à soie appropriées et performantes ou des variétés de mûriers adaptées.

Mais deux questions nouvelles de grande importance ont été soulevées lors de cette conférence.

Tout d'abord, le rôle et l'impact de nouveaux produits de lutte contre les insectes sur la sériciculture. Ce problème, exposé par les délégués italiens et français, concerne l'utilisation de molécules qualifiées (à tort, peut-être) de mimétiques d'hormones. Les dégâts enregistrés et les études en cours dans ces deux pays permettent, dès aujourd'hui, de mettre en garde contre l'utilisation de ces produits dans les zones de sériciculture.

Ensuite, le projet international ver à soie, présenté par Marian Goldsmith, chef de ce projet et qui a vu le jour lors du 1er Atelier de Biologie moléculaire des Lépidoptères qui s'est tenu en Crète (Grèce) en 1988 et dont la CSI organise la deuxième édition. Il s'agit de construire une carte génétique moléculaire de *Bombyx mori*, dont l'existence, à terme, peut permettre de faire un saut qualitatif dans les méthodes d'obtention de souches de vers à soie performantes en sériciculture.

Dans ces deux cas, il ressort que la coopération internationale est absolument nécessaire pour aboutir à des résultats qui concernent tous les pays producteurs de soie. Il a été conclu que la Commission séricicole internationale était, aujourd'hui, le meilleur cadre pour induire cette collaboration internationale et pour diffuser les résultats de ces travaux. Ces deux projets doivent être défendus, encouragés et supportés par la CSI et inscrits dans les travaux futurs de notre organisation, avec l'aide de tous les membres, organismes, instituts, universités...

La coopération et l'entraide ont d'ailleurs été, selon moi, ce qui a caractérisé l'esprit de la XIIIe Conférence. Cela est dû à la richesse des contributions des participants et à leur volonté de faire partager leurs connaissances et leur expérience.

Au nom de tous, je les remercie.

Gérard CHAVANCY,
Secrétaire général.

INTRODUCTION

The 13th Statutory Conference of the International Sericultural Commission, which was held in December 1990 and whose purposes were for the Member States to assess the situation for the past three years, to vote on the main policies for the next three years and to elect the Board and the Secretary-General, was extended, at the Executive Committee's request, so that economic or technical and scientific reviews might be presented and discussed by the delegates of Member and non-member States as well as by Associate Members.

This was decided when it was realized that the Triennial International Congress, during which the Statutory Conference is normally held, could not be organized. It should be remembered that the congress consists in gathering together all the persons technically, scientifically and economically involved in sericulture worldwide. It brought together more than 150 people in Thailand in 1988 and more than 250 people in India in 1985.

The decision not to restrict the 13th Conference solely to the statutory part was therefore aimed at taking stock of a certain number of questions of a technical or scientific nature with a reduced number of specialists. Although the invitations were sent late, we had the pleasure of welcoming almost 50 delegates representing 18 countries.

This issue of *Sericologia* is devoted to the reviews presented by these delegates during these four half-day meetings which were held in Paris on 3rd, 4th and 6th December 1990. The administrative documents relating to the Statutory Conference and Executive Committee which were held on 5th and 6th December are intended for the Member States only.

Due to a lack of space resulting from a lack of funds, the reviews are not published in a bilingual version but only in the original language of presentation. Only the questions and discussions are translated and presented both in English and in French.

Furthermore, the somewhat late publication of the proceedings is due to the fact that some of the reviews were not written out and had to be transcribed from the taped proceedings of the meetings.

I trust that you will forgive the secretariat of the International Sericultural Commission for these shortcomings.

These days were most profitable. They gave us the opportunity to meet the people who are accustomed to the ISC meetings and who always take much pleasure in gathering together again; we also met quite a number of new faces.

You will note, from the reviews and discussions, that sericulture is more than ever a topical issue. Many projects are coming into being in Africa, South America, Asia and the development of sericulture is also announced in a number of already producing countries. It was noted that recent results gave rise to new prospects in those areas where the problem arises as to replacing poppy or coca cultivation by other crops. Development raises now classic technical and scientific problems such as that of producing or obtaining suitable and high-yield silkworm eggs or adapted mulberry varieties.

In addition to these, two new questions of great importance were raised during this conference.

First of all, the role and impact of new insect control chemicals on sericulture. This problem, set out by the Italian and French delegates, concerns the use of molecules called (perhaps wrongly) hormone mimetic. In view of the damage reported and of the studies in progress in these two countries, a strong warning can be given here and now against the use of these chemicals in sericultural areas.

Also, the silkworm international project, presented by Marian Goldsmith, head of this project which was born during the 1st International Workshop on the Molecular Biology of Lepidoptera held in Crete (Greece) in 1988, whose second edition the ISC is now organizing. It is aimed at constructing a molecular genetic map of *Bombyx mori*, the existence of which could eventually lead to a qualitative jump forward in the methods for obtaining high-yield silkworm strains in sericulture.

In both cases, it appears that international cooperation is an absolute prerequisite for obtaining results which affect the whole of the silk producing countries. It was concluded that the International Sericultural Commission was at present the best framework for inducing this international cooperation and for circulating the results of this work. These two projects must be defended, encouraged and supported by the ISC and included in the future work of our organization, with the help of all the members, bodies, institutes, universities...

Cooperation and mutual help were what I think characterized the spirit of the 13th Conference. This was due to the richness of the participants' contributions and to their willingness to share their knowledge and experience.

On behalf of everyone, I thank them.

Gérard CHAVANCY,
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H. BOUVIER

Secrétaire général, Commission séricicole internationale, 25, quai Jean-Jacques Rousseau,
69350 La Mulatière, France.

C'est pour moi un grand plaisir d'accueillir et de souhaiter la bienvenue :

- aux Délégations des Etats-membres : Brésil, Egypte, France, Inde, Japon, Madagascar, Roumanie, Thaïlande, Tunisie.
- aux représentants ou Membres associés des Etats non membres :
 - d'Europe : Bulgarie, Espagne, Grèce, Italie, Pays-Bas,
 - d'Afrique : Côte d'Ivoire, Ouganda, Zambie,
 - d'Amérique : Bolivie, Colombie, USA,
 - d'Asie : Chine, Indonésie, Papouasie Nouvelle Guinée.

Après les Congrès séricicoles internationaux qui se sont tenus en Inde et en Thaïlande en 1984 et 1987, nous comptons bien pouvoir organiser un congrès au Brésil. Après avoir reçu un avis favorable du Chef de la Délégation brésilienne, nous avons été informés, il y a à peine plus d'un an, que le Gouvernement brésilien ne pouvait envisager, dans la situation actuelle, l'organisation d'un tel congrès.

Nous avons pensé alors pouvoir nous réunir en Afrique, compte tenu des différents projets séricicoles en cours sur le continent. Nos demandes n'ont pas connu le succès que nous espérions ; et c'est un peu normal car il est bien difficile d'organiser une réunion de cette importance en quelques mois, et nous étions tenus par nos statuts, en l'absence d'un Congrès, de réunir la Conférence en 1990.

Nous aurions pu nous contenter de recevoir au siège un Comité exécutif et une Conférence réduite aux seules délégations des Etats-membres pour régler et officialiser les décisions administratives de notre organisation.

En faisant cela, nous n'aurions pas totalement rempli notre rôle qui est essentiellement de permettre les contacts et la communication, non seulement entre les Etats-membres, mais aussi avec les pays et les personnes intéressées par le développement de la sériciculture dans le monde.

Nous sommes donc particulièrement reconnaissants à la Délégation et au Gouvernement français d'avoir bien voulu organiser cette conférence élargie. Ce ne fut pas chose facile, le changement de date et de lieu en furent la preuve.

Conformément aux usages de notre organisation, la présidence du Comité exécutif et de la Conférence statutaire est assurée par le Chef de la Délégation du pays où se tiennent ces réunions.

Monsieur Bonnemaire, Conseiller du Ministère de l'Agriculture, représentant du Gouvernement français, présidera notre réunion de ce matin.

WELCOMING ADDRESS

H. BOUVIER

Secretary-General, International Sericultural Commission, 25, quai Jean-Jacques Rousseau,
69350 La Mulatière, France.

It is a great pleasure for me to receive and wish welcome to :

- the delegations of the Member States : Brazil, Egypt, France, India, Japan, Madagascar, Rumania, Thailand, Tunisia.

- the representatives or Associate Members of non member States of :

Europe : Bulgaria, Spain, Greece, Italy, the Netherlands,

Africa : the Ivory Coast, Uganda, Zambia,

America : Bolivia, Colombia, the USA,

Asia : China, Indonesia, Papua New Guinea.

After the international sericultural congresses held in India and in Thailand in 1984 and 1987, we were hoping to organize a congress in Brazil. After meeting a favourable reception from the Head of the Brazilian delegation, we were informed hardly a year ago that the Brazilian Government, in view of the present situation, could not consider organizing such a congress.

We then thought it possible to convene in Africa, given the various sericulture projects in progress on this continent. Our requests did not meet with the expected success and this is a little normal since it is quite difficult to organize a meeting of this importance within a few months' time and we were statutorily bound to hold the Conference in 1990, even without the congress.

We could have contented ourselves with organizing, at the seat, an Executive Committee and a Conference restricted to the Delegations of the Member States to settle and officialize the administrative decisions of our organization.

But by doing this, we would not have totally filled our role which is essentially to allow contacts and communication, not only among the Member States but also with the countries and the people concerned in the development of sericulture worldwide.

We are therefore most grateful to the French Delegation and Government who accepted to organize this extended Conference. This was not an easy thing as was proved by the change of date and venue.

In accordance with our organization's custom, the chairmanship of the Executive Committee and Statutory Conference is ensured by the Head of the Delegation of the country where these meetings are held.

Mr Bonnemaire, the Advisor to the Minister of Agriculture and representative of the French Government, will preside over our meeting this morning.

DISCOURS D'OUVERTURE

L. BONNEMAIRE

Conseiller auprès du Ministre, Ministère de l'Agriculture, 78, rue de Varenne, 75700 Paris.

C'est un grand honneur pour la France d'accueillir aujourd'hui à Paris la XIII^e Conférence de la Commission séricicole internationale.

La présence de nombreuses délégations composées d'experts de grande qualité témoigne de l'intérêt que portent de plus en plus de gouvernements à la sériciculture.

A cela, plusieurs raisons :

La demande mondiale de soie grège, matière première issue du dévidage des cocons de vers à soie, est supérieure à l'offre.

L'écart peut être estimé à 3 000 tonnes, la production totale s'élevant à 500 000 tonnes de cocons, soit 64 000 tonnes de soie grège.

Cette production est assurée, pour l'essentiel, par la Chine, l'Inde, le Japon, l'URSS et le Brésil. Il faut ajouter que l'exportation de soie grège dépend, presque en totalité, de la Chine, l'immense majorité des pays producteurs étant également importateurs.

Dans ce contexte, le développement de la production de soie, qui assure un revenu monétaire aux populations rurales les plus défavorisées est à l'ordre du jour dans de nombreux pays en voie de développement.

Parfois, l'intérêt des gouvernements pour cette activité est accru par la nécessité d'assurer à ces populations des revenus susceptibles de remplacer ceux qui proviennent de la culture du pavot ou de la coca.

C'est le cas dans plusieurs pays d'Amérique du Sud et de l'Asie du sud-est.

C'est dire l'importance des activités de la Commission séricicole internationale dont le but est d'encourager et de favoriser sur les plans technique et scientifique toutes les activités qui concernent la sériciculture.

Les échanges entre spécialistes, que s'efforce de multiplier la CSI, sont de plus en plus utiles car de nombreuses questions posées par la production de soie ne sont pas résolues.

Par exemple, l'exportation de soie grège ne peut se concevoir que si la soie produite est d'excellente qualité car les principaux pays importateurs sont des pays très industrialisés qui utilisent des métiers à tisser très performants et sont, de ce fait, très exigeants quant à la qualité du fil.

C'est le cas du Japon (1^{er} importateur) et des pays européens tels que l'Italie, la France, la Suisse, l'Allemagne et la Grande Bretagne, ces pays européens ayant importé environ 5 000 tonnes de soie grège en 1989.

La qualité dépend de plusieurs facteurs : la filature des cocons, les conditions d'élevage et les caractéristiques génétiques des mûriers et des vers à soie utilisés.

On sait, par exemple, que les souches polyvoltines bien adaptées aux conditions tropicales sont peu performantes quant à la quantité et à la qualité de soie comparées aux souches mono ou bivoltines qui, en revanche, sont plus sensibles aux maladies infectieuses, en particulier dans les conditions climatiques tropicales.

La coopération scientifique internationale est indispensable pour espérer aboutir à des lignées de vers à soie "idéaux" dans un délai raisonnable.

L'échange d'informations et de résultats concernant les modes de production eux-mêmes doivent se poursuivre. Ils sont très divers et demandent à être adaptés aux conditions physiques et socio-économiques des différentes régions du globe.

On peut constater, dans ce domaine, une variété extraordinaire. La production des oeufs de vers à soie est assurée, dans certains cas, par les agriculteurs qui pratiquent les croisements consanguins ; dans d'autres cas, les polyhybrides sélectionnés sont obtenus dans des centres de grainages parfaitement contrôlés.

L'élevage lui-même peut s'effectuer à même le sol ou sur des supports artisanaux et traditionnels très divers ou encore dans de véritables "usines" presque entièrement automatisées.

Enfin, la filature va du simple "tirage" manuel du fil du cocon à l'utilisation de machines automatiques en passant par un grand nombre de techniques intermédiaires.

La sériciculture, qui a vu le jour il y a 5 000 ans en Chine, a été une activité très importante en Europe dans les siècles passés.

L'apogée se situe à la fin du XIXe siècle. L'Italie produisait alors 65 000 tonnes de cocons, la France 25 000 tonnes, l'Espagne 9 000 tonnes, la Turquie 5 000 tonnes et la Grèce 5 000 tonnes.

Il y a eu en France, à cette époque, jusqu'à 200 000 sériciculteurs. Le déclin est dû à trois causes principales :

- l'apparition et l'extension de la pébrine dans les élevages. Cette maladie qui causa des ravages fut étudiée, à la demande du gouvernement français, par Louis Pasteur, pendant cinq ans. Il identifia l'agent pathogène et proposa une méthode de lutte, le grainage cellulaire, utilisée aujourd'hui dans le monde entier.

- l'ouverture du canal de Suez qui permit l'arrivée en Europe de la matière première orientale à des prix compétitifs.

- Enfin, l'apparition des fibres textiles continues synthétiques qui "prétendaient" imiter la soie. Alors que, pendant des millénaires, l'homme n'avait disposé que de la soie comme fibre continue, il pouvait maintenant produire de longues fibres obtenues chimiquement à un coût faible.

Aujourd'hui, la production européenne est tombée à un niveau faible : pour l'Italie et la France, elle ne représente qu'une centaine de tonnes de cocons.

En raison du caractère traditionnel de cette production qui fait partie du patrimoine culturel de la France et de l'importance et du savoir-faire de l'industrie de transformation de la soie française, nous avons tenu à garder une unité de recherche - à l'Unité nationale séricicole - en Rhône-Alpes à Lyon. Cette unité sert depuis plusieurs années de support logistique à la CSI dont la France assure le secrétariat.

La recherche et le développement associés au ver à soie s'inscrivent dans une tradition française. Sans remonter aux illustres travaux de Louis Pasteur puis à ceux menés à la station d'Alès au voisinage immédiat des lieux principaux de la sériciculture française d'il y a quelques décennies, il est nécessaire de mentionner la continuité de ces travaux aujourd'hui conduits, comme chacun le sait, dans la région lyonnaise.

Le ver à soie n'a d'ailleurs pas qu'un intérêt séricicole.

C'est, sur le plan biologique, un modèle, un animal de laboratoire dont l'intérêt est grandissant.

Il sert en effet de référence pour les études de type physiologique pour le mode d'action d'hormones, génétique (c'est l'animal le mieux connu après la drosophile) et moléculaire grâce à la glande séricigène, cet organe hyperspécialisé dans la production des protéines de la soie.

Le ver à soie est en passe de devenir un véritable outil biotechnologique et grâce aux méthodes de génie génétique, d'être utilisé pour produire des molécules d'intérêt économique autres que la soie.

Cette science du ver à soie, dénommée bacologie, est d'ailleurs reconnue dans la convention qui institue la Commission séricicole internationale. Dans cette convention, la CSI se fixe pour objectif de soutenir la recherche bacologique au même titre que la sériciculture.

C'est pour cela que l'Unité nationale séricicole (UNS) poursuit des activités nombreuses et variées, notamment sur la transgénie chez le ver à soie et la sélection de souches, tout en maintenant son rôle de conseil et de référence ouvert à la fois sur des partenaires français et étrangers. Ces démarches ne sont pas isolées : elles s'appuient sur des collaborations anciennes et d'autres renouvelées avec le milieu universitaire de Lyon, l'Institut national de la Recherche agronomique (INRA), le Centre national de la Recherche scientifique (CNRS) mais aussi avec les structures professionnelles motivées par la diversification des productions qui souhaitent donner un nouvel élan à la sériciculture. Bien entendu les travaux menés suscitent intérêt chez les industriels qui se trouvent principalement dans la région lyonnaise.

Enfin, le fait que la CSI ait son siège dans les bâtiments de l'UNS accentue le caractère international des démarches en faisant d'un site au demeurant fort agréable, un lieu de rencontre privilégié.

Compte tenu des enjeux scientifiques et techniques et de la qualité reconnue des travaux, des établissements publics de recherche ont récemment décidé, avec l'appui des professionnels et industriels, d'accroître notablement leurs participations.

Cette démarche est originale à deux titres :

- Elle associe, sous la responsabilité de l'INRA, tous les partenaires intéressés sous la forme d'un groupement d'intérêt scientifique (GIS)

- Elle veut aborder les questions à traiter sous un angle délibérément intégré avec coexistence d'activités de recherche, de développement, de formation et de coopération internationale.

Cette approche, qui n'a de valeur qu'en se situant au meilleur niveau du moment, suppose un partenariat efficace.

Elle se développe principalement selon les orientations suivantes :

- Etude de la physiologie du développement et de la génétique moléculaire du ver à soie,
- Amélioration des techniques d'élevage par une approche physiologique de la nutrition avec d'éventuelles conséquences sur la robotisation des élevages,
- Appui croissant à la formation et aux relations internationales avec les pays et structures cherchant à utiliser et valoriser les compétences de l'Unité.

En résumé, la France qui a l'honneur d'accueillir la conférence 1990, a choisi une stratégie de développement de ses recherches sur le ver à soie, c'est dire l'intérêt qu'elle porte à *Bombyx mori*, à la fois objet et modèle intéressant.

OPENING SPEECH

L. BONNEMAIRE

Advisor to the Minister, Ministry of Agriculture, 78, rue de Varenne, 75700 Paris, France.

It is a great honour for France to host the 13th Conference of the International Sericultural Commission today in Paris.

The presence of many delegations composed of experts of great quality shows the interest of a growing number of Governments for sericulture.

There are several reasons for this :

The world demand for raw silk, a raw material obtained from the reeling of silkworm cocoons, exceeds the supply.

The gap is about 3,000 tonnes, total production amounting to 500 000 tonnes of cocoons, that is to say 64,000 tonnes of raw silk.

Production is mostly ensured by China, India, Japan, the USSR and Brazil. It should also be noted that raw silk export almost totally depends on China, as the majority of the producing countries are also importers.

In this context, the development of silk production, which ensures monetary income to the most underprivileged rural populations, has become topical in a number of developing countries.

Sometimes, the interest of the Governments in this activity is increased owing to the need to secure income for these population in order to replace that earned from poppy and coca cultivation.

This is the case in several South American and South East Asian countries.

This shows the importance of the activities of the ISC whose aim is to encourage and further all the activities concerning sericulture scientifically and technically.

The exchanges between specialists, which the ISC endeavours to multiply, are more and more useful because many questions raised by silk production are as yet unanswered.

For example, raw silk export can be envisaged only if the silk produced is of an excellent quality because the major importing countries are much industrialized countries which utilize high-performance weaving machines and are very demanding as to the quality of the thread.

This is the case of Japan (1st importer) and of European countries such as Italy, France, Switzerland, Germany and Great Britain, these European countries imported about 5,000 tonnes of raw silk in 1989.

Quality depends on several factors : cocoon reeling, rearing conditions and genetic characteristics of the mulberries and silkworms used.

It is known, for instance, that polyvoltine strains, which are well adapted to tropical conditions, have a low yield in terms of quality and quantity of silk as compared to mono or bivoltine strains which, on the contrary, are more sensitive to infectious diseases, in particular under tropical climatic conditions.

The exchange of information and results concerning the methods of production must be continued. These are quite varied and have to be well adapted to the physical and socio-economic conditions of the various regions of the globe.

It can be noted that a tremendous variety prevails in this domain. Egg production is ensured, in some cases, by the farmers who practice inbred crosses, in some other cases the polyhybrids selected are obtained in perfectly monitored grainage centres.

Rearing itself can be carried out on the floor itself or on homemade and varied traditional stands or in actual 'factories' which are nearly totally automated.

Lastly, reeling includes mere manual 'pulling' of the cocoon thread as well as the use of automated machines and a large number of intermediate techniques.

Sericulture, which was born 5,000 years ago in China, was a very important activity in Europe in past centuries.

The climax was at the end of the 19th century. Italy then produced 65,000 tonnes of cocoons, France 25,000 tonnes, Spain 9,000 tonnes, Turkey 5,000 tonnes and Greece 5,000 tonnes.

There were up to 200,000 sericulturists at that time in France. The decline is due to three major causes :

- the occurrence and spread of the pebrine disease in the rearings. On the French Government's request this disease, which caused so much damage, was studied by Louis Pasteur for five years. He identified the pathogene and put forward a method of control, the cellular bag method, which is used nowadays throughout the world.

- the opening of the Suez Canal which allowed eastern raw material to come to Europe for a competitive price.

- lastly, the occurrence of synthetic continuous textile fibres which 'claimed' to imitate silk. Whereas for thousands of years, mankind had had only silk as a continuous fibre, they could now produce long fibres chemically obtained at a low cost.

Today European production has dropped to a low level. For France and Italy, it represents only about one hundred tonnes of cocoons.

Owing to the traditional feature of this production which is part of France's cultural heritage and to the importance and know-how of the French silk processing industry, we wanted to maintain a research unit (the *Unité nationale séricicole*) in the Rhône-Alpes region in Lyon.

For several years, this unit has been used as an organizational support to the ISC whose secretariat is entrusted to France.

The association between research and development and silkworms is in keeping with a French tradition. Without going back to the illustrious work of Louis Pasteur then to those conducted at the station of Alès in the immediate vicinity of the principal centres of French sericulture of a few decades ago, it is necessary to mention the continuation of this work today conducted, as everyone knows, in the region of Lyon.

In addition, the silkworm is not only interesting in terms of sericulture.

In terms of biology, it is a model, a laboratory animal, the relevance of which keeps increasing.

In fact, it serves as a reference in terms of physiological study for the working of hormones, in terms of genetic studies (it is the second best known animal after *drosophila*) and at the molecular level with the silk gland, this organ which is hyperspecialized in the production of silk proteins.

The silkworm is poised to become a proper biological tool and, with the help of genetic engineering methods, to be used for producing molecules of economic interest other than silk.

This silkworm science, called *bacology*, is recognized in the Convention instituting the International Sericultural Commission. In this convention, the ISC has laid down as an objective to support *bacological* research in the same way as sericulture.

For this reason, the *Unité nationale séricicole* (UNS) pursues numerous and varied activities, in particular on transgenation in the silkworm and strain selection while maintaining its role of advisor and reference opened both on French and foreign partners. These procedures are not isolated : they are backed up by long-standing and renewed collaborations with the university community of Lyon, the Institut national de la Recherche agronomique (INRA), the Centre national de la Recherche scientifique (CNRS) and also with professional organizations motivated by the diversification of production and wishing to give sericulture a fresh boost. Of course the work conducted raises the interest of the industrialists who are mostly found in the region of Lyon.

Lastly, the fact that the ISC has its headquarters inside the buildings of the UNS enhances the international character of the procedures by turning what is a very pleasant setting into a privileged meeting place.

In view of the scientific and technical stakes and of the recognized quality of the work, public research organizations have recently decided to increase noticeably their participation with the support of professionals and industrialists.

This procedure is an original one on two accounts :

- it associates, under the responsibility of INRA, all the interested partners in a scientific interest organization (GIS) ;

- it aims at tackling the questions to be treated from a deliberately integrated angle, which includes the co-existence of research, development, training and international cooperation activities.

This approach, which is valuable only if placed at the highest level, implies an efficient partnership.

It is developed mainly according to the following orientations :

- study of the development physiology and of silkworm molecular genetics ;

- improvement of rearing techniques through a physiological approach of nutrition with possible consequences for the automation of rearings ;

- increasing support for training and international relations with those countries and organizations which seek to use and enhance the competence of the UNS.

To sum up, France, which has the honour of hosting the 1990 Conference, has chosen to develop its research on the silkworm. This shows its commitment to *Bombyx mori*, which is both an interesting subject and a model.

DISCOURS DE REMISE DES PRIX LOUIS PASTEUR

H. BOUVIER

Secrétaire général, Commission séricicole internationale, 25, quai Jean-Jacques Rousseau,
69350 La Mulatière, France.

Ce prix a été créé à l'initiative de Monsieur A. Schenk, Secrétaire général fondateur de la Commission, afin d'honorer les personnalités qui, par leurs oeuvres et leur travail scientifique ou technique, ont contribué au développement de la sériciculture dans le monde ou dans leur pays ; prix Pasteur en hommage à Louis Pasteur dont les travaux sur les maladies du ver à soie ont marqué le départ d'une sériciculture scientifique et aussi le début de la médecine moderne.

Bien que purement honorifique, c'est probablement une des distinctions les plus rares puisque 10 personnalités seulement ont déjà reçu ce prix jusqu'à ce jour et qu'il n'est attribué qu'à trois personnes tous les trois ans.

Je demande à notre Président de séance de bien vouloir remettre le diplôme et la médaille du Prix Pasteur à :

- Monsieur le Docteur Keio AIZAWA du Japon, représenté par le Chef de la Délégation japonaise.

Agé aujourd'hui de 63 ans, le Dr Aizawa, dès sa sortie de l'Université de Tokyo en 1950, a rejoint la station expérimentale de sériciculture de Tokyo où il se spécialisa dans la pathologie du ver à soie et, plus spécialement, sur les maladies à virus. Au cours d'une carrière de quarante années consacrée à la pathologie du ver à soie et des insectes, il a participé, et participe encore, aux activités de nombreuses sociétés et organisations scientifiques nationales et internationales.

- Monsieur le Docteur Krishna SENGUPTA de l'Inde.

Agé de 56 ans, le Dr Sengupta a débuté en 1957 au Centre de Recherches Séricicoles de Berhampore, où il se consacre à la pathologie et à la culture des tissus d'insecte. Il s'occupe ensuite du grainage en région tempérée puis de sélection en région tropicale. Pendant près de dix ans, il travaille sur les séricigènes non mûrier et, à ce titre, préside la section séricigènes sauvages aux Congrès de Bangalore et de Pattaya. Ces différentes expériences lui ont donné une vision très globale des différents aspects de la sériciculture et lui ont permis d'accéder tout naturellement à la direction du Centre de Recherche et de Formation séricicole de Mysore.

- Monsieur Sompoti AKAPANTHU de Thaïlande

Agé de 50 ans, Mr Akapanthu, dès son diplôme obtenu en 1964, rejoint la station expérimentale séricicole d'Ubol où il travaille sur le mûrier et ses maladies. Il s'attache par la suite à tous les problèmes au Centre de Recherche séricicole de Korat puis à l'Institut de Recherche séricicole de Bangkok, prenant une part active au développement de la sériciculture en Thaïlande.

Chef de la Délégation thaïlandaise au Congrès de Pattaya, membre du Comité exécutif depuis 1986, il participe activement au fonctionnement de notre organisation.

LOUIS PASTEUR PRIZE PRESENTATION SPEECH

H. BOUVIER

Secretary-General, International Sericultural Commission, 25, quai Jean-Jacques Rousseau,
69350 La Mulatière, France.

This prize was created on the initiative of Mr A. Schenk, the founding Secretary-General of the ISC, to honour the key figures who, through their achievements and their scientific or technical work, have contributed to the development of sericulture worldwide or in their own countries. This Pasteur Prize is a tribute to Louis Pasteur whose work on silkworm diseases was a landmark in the launching of scientific sericulture and in the onset of modern medicine.

Although it is purely honorary, it is probably one of the rarest distinctions since, to this day, it has been awarded to 10 personalities and since it is presented to three persons only every three years.

I now request our Session Chairman to present the Pasteur Prize diploma and medal to :

- Dr Keio AIZAWA from Japan, represented by the Head of the Japanese Delegation.

After completing his course at Tokyo University, Dr Aizawa, now aged 63, joined Tokyo Experimental Sericultural Station where he specialized in silkworm pathology and, more particularly, in viral diseases. During a forty-year career given over to silkworm and insect pathology, he participated, and is still participating, in the activities of a number of national and international scientific organizations and societies.

- Dr Krishna SENGUPTA from India.

Dr Sengupta, now aged 56, started out in 1957 at the Central Sericultural Research and Training Institute of Berhampore, where he studied pathology and insect tissue culture. He subsequently dealt with egg production in temperate regions then with selection in tropical regions. For almost 10 years, he worked on non mulberry silkworms and, on this account, presided over the wild silkworms section at the Congresses of Bangalore and Pattaya. These varied experiences gave him a very comprehensive view on the various aspects of sericulture and enabled him quite naturally to be appointed Director of the Central Sericultural Research and Training Institute of Mysore.

- Mr Sompoti AKAPANTHU from Thailand.

Just after graduating in 1964 Mr Akapanthu, now aged 50, joined the Experimental Station of Ubol where he studied the mulberry and its diseases. He subsequently became involved in all the problems at Korat Sericultural Research Centre then at the Institute of Sericultural Research of Bangkok, dedicating himself to the development of sericulture in Thailand. Head of the Thai Delegation at the Congress of Pattaya and member of the Executive Committee since 1986, he actively participates in the functioning of our organization.

SESSION I

Président - Chairman : Mr Tsuneo TODOROKI (Japon - Japan)

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LA SERICICULTURE ET LA RECHERCHE SERICICOLE EN FRANCE

A. DASSONVILLE

Direction de la Production et des Echanges, Ministère de l'Agriculture, 3, rue Barbet-de-Jouy,
75700 Paris, France.

Comme vous l'a indiqué ce matin M. Bonnemaire, le représentant du Ministre, c'est évidemment un grand honneur pour la France de vous recevoir et nous, le Ministère de l'Agriculture qui sommes chargés du dossier sériciculture, manifestons aussi notre grande satisfaction de voir un grand nombre de pays répondre à notre invitation.

Pour cet après-midi, nous avons prévu de faire intervenir, après moi, M. Mauchamp, que je vais présenter, ainsi que Mme Barrière. En effet, ce que je voudrais dire, surtout, c'est que l'Unité séricicole, qui fonctionne à Lyon et qui se trouve être le siège de la Commission séricicole internationale, est une structure technique qui avait besoin de se trouver renforcée en raison du grand nombre de demandes de coopérations techniques formulées par beaucoup d'Etats à travers le monde qui font de la sériciculture ou qui désirent accroître leur production de soie. Ces demandes, formulées par les Etats eux-mêmes ou formulées par des organisations les relayant, ne pouvaient plus être honorées dans les structures que nous connaissions.

C'est la raison pour laquelle, confiants dans l'intérêt de répondre à cette demande, les pouvoirs publics français ont demandé à notre grand organisme de recherche agricole et agronomique, l'Institut national de la Recherche agronomique (INRA), de prendre à son compte cette discipline et d'étoffer l'équipe de Lyon.

Ceci devrait pouvoir se traduire par une capacité de répondre à un plus grand nombre de questions, par une capacité de recevoir des stagiaires (et l'on sait que les demandes sont nombreuses), par une capacité supplémentaire d'expertise sur les projets financés par les organisations internationales, à commencer, d'ailleurs, par les projets financés par la Communauté européenne et, c'est surtout ceci que nous voulions vous dire, pour vous exprimer à la fois notre confiance et notre volonté d'investir de manière plus approfondie dans le domaine de la sériciculture.

Je vais donner la parole à M. Mauchamp, chercheur à l'INRA, qui va vous indiquer les domaines dans lesquels il va développer ses recherches dans le cadre de la nouvelle structure.

LES PROGRAMMES DE RECHERCHE A L'UNITE NATIONALE SERICICOLE*

B. MAUCHAMP

Laboratoire de Physiologie de l'Insecte, Station de Phytopharmacie, CNRA, Route de St-Cyr,
78000 Versailles, France.

Jusqu'à présent dépendante du CEMAGREF, l'Unité Nationale Séricicole (UNS) devient une structure appartenant à l'INRA. L'UNS est localisée à La Mulatière à la sortie sud de Lyon, juste au droit du confluent du Rhône et de la Saône. La direction scientifique est confiée à B. Mauchamp, DR2 jusqu'alors directeur du Laboratoire de Physiologie de l'Insecte sis à Versailles. L'UNS constitue un laboratoire propre avec ses programmes de recherche, ses chercheurs et son équipement. Cependant, l'UNS, pour augmenter ses capacités, entend intégrer ses recherches au contexte à la fois scientifique et économique de la région. C'est la raison pour laquelle, dès sa mise sous tutelle INRA, l'UNS a suscité la création d'un groupement d'intérêt scientifique (GIS) regroupant pour l'instant l'Unité Nationale Séricicole, la Station de Pathologie Comparée de Saint-Christol-lès-Alès, le laboratoire de Biologie Appliquée de l'INSA et le Centre de Génétique Moléculaire et Cellulaire de l'Université Claude Bernard Lyon I.

L'Unité Nationale Séricicole héberge en outre dans ses locaux le secrétariat de la Commission Séricicole Internationale dont le secrétaire général est G. CHAVANCY.

C'est dans ce contexte que s'inscrivent les activités de l'UNS. L'UNS a pour mission d'explorer en terme de Recherches et Développement toutes les potentialités du ver à soie *Bombyx mori*. Elle doit donc repenser, avec les connaissances récentes acquises sur le ver à soie, la sériciculture et proposer de nouvelles utilisations.

L'UNS est l'exemple type d'une structure de recherche fonctionnant sur des programmes de recherches fondamentales et de recherches finalisées. Des débouchés nouveaux sont à exploiter mettant à profit les atouts biotechnologiques du ver à soie.

Le programme de l'UNS peut être brièvement formulé en ces termes :

Quelles recherches sur le ver à soie et pour quels développements ?

Les activités de l'UNS se situent à deux niveaux :

- des activités de recherche et développement,
- des activités de formation.

I. ACTIVITES DE RECHERCHE

Les recherches à développer ont pour finalité l'exploitation de l'"Usine à soie" qu'est le ver à soie et d'utiliser les infrastructures de cette usine pour fabriquer autre chose que de la soie.

La soie est synthétisée par la glande séricigène. La synthèse s'accompagne d'un stockage échelonné sur une période de quelques jours. Vient ensuite le filage. A cette période, le poids de la glande séricigène peut atteindre 40 % du poids du ver. La séquence de ces événements cellulaires est parfaitement établie et résulte d'une régulation très précise du fonctionnement de la glande ou plus précisément de l'expression des gènes de la soie.

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Fax : 78 86 09 57.

Les recherches à mettre en place devront porter sur les mécanismes de contrôle de production de la soie et sur les gènes faisant l'objet de ces contrôles. L'acquisition de données sur ces mécanismes et l'amélioration de la "technologie du ver" peuvent aboutir à relancer dans des conditions économiquement satisfaisantes l'élevage du ver à soie.

La stratégie des recherches proposées à l'Unité Nationale Séréricole repose sur trois orientations :

- Physiologie du développement du ver à soie.
- Génétique moléculaire du ver à soie.
- Technicité du ver à soie : Physiologie de la nutrition.

A. Physiologie du développement du ver à soie.

De nombreux travaux ont été réalisés sur le ver à soie, contribuant à une meilleure connaissance de la physiologie du développement. Ce qui nous importe au niveau de l'Unité est de répondre à la question de savoir quelle est l'incidence des facteurs de développement sur la différenciation et l'activation des gènes de la glande séréricigène.

En terme de croissance, au cours du développement larvaire, la glande séréricigène est fonctionnelle dès le premier stade larvaire. Cette capacité de synthétiser de la soie reste très limitée pendant tous les stades larvaires à l'exception du dernier. Il faut attendre la fin du dernier stade larvaire pour voir un accroissement considérable des synthèses dans la glande séréricigène.

Les facteurs hormonaux impliqués dans ces contrôles sont maintenant bien définis. PTTH (hormones du cerveau), hormones de mue et hormones juvéniles sont les trois catégories d'hormones impliquées au cours du développement des vers (actions au cours des mues et de la métamorphose) et de la différenciation de la glande séréricigène. L'incidence directe des hormones de mue et des hormones juvéniles sur les gènes de la soie est encore imprécisément connue et nécessite de plus fines investigations. Il est certain qu'hormones de mue et hormones juvéniles sont les hormones clés, car les altérations de leurs productions entraînent des conséquences directes sur la physiologie des glandes. La découverte, ces dernières années, de substances agonistes ou antagonistes constitue une approche nouvelle dans l'étude du mode d'action de ces hormones. De telles substances, appelées régulateurs de croissance des insectes, sont des outils pour décrypter le fonctionnement des glandes séréricigènes et la régulation des gènes qui sont à l'origine de la synthèse des protéines de la soie.

Un point important à comprendre pour optimiser le fonctionnement de cette glande est l'activité différentielle dans l'espace et dans le temps des gènes de la soie. Pourquoi ces gènes, vraisemblablement présents dans toutes les cellules, ne s'expriment que dans les cellules des glandes séréricigènes et pourquoi ces gènes ne s'expriment de façon aussi importante qu'à des moments précis du développement de l'insecte ? Ces questions fondamentales ne trouveront pas rapidement et simplement de réponses et, tant qu'il n'en sera pas ainsi, toute expression dans des systèmes *in vitro* ne se fera qu'avec de mauvais rendements. Il restera donc toujours nécessaire de passer par le ver entier pour bien comprendre le fonctionnement de la glande séréricigène et l'expression des gènes de la soie avant d'introduire des gènes étrangers pour en obtenir l'expression en même temps que les gènes de la soie.

Ainsi modifiée, la glande séréricigène se révèle comme un système privilégié pour obtenir, au même titre que la soie, l'expression de gènes recombinés codant pour des protéines étrangères d'intérêt pharmaceutique, agrochimique ou vétérinaire.

L'utilisation des substances régulatrices de croissances montre qu'il est possible de réguler les capacités de synthèse des glandes séréricigènes et d'augmenter les rendements en production de soie.

La maîtrise du contrôle du développement du ver a une importance capitale dans la mesure où le ver, via la glande séréricigène, peut être utilisé comme vecteur pour l'expression de gènes étrangers capables de coder pour d'autres protéines de haut intérêt économique.

Ceci nous amène à considérer le ver à soie comme modèle biologique support des biotechnologies du 21ème siècle.

B. Génétique moléculaire du ver à soie.

Cette approche a pour but de comprendre comment s'expriment les gènes des protéines de la soie pour mieux aborder la transgénèse du ver à soie. Pour répondre à cette interrogation, plusieurs

approches sont possibles et en cours d'exploitation dans différentes équipes et sur divers matériels biologiques. La transgénie chez les insectes a déjà été réalisée chez la *Drosophile* et devrait être possible chez le ver à soie. Des études seront poursuivies à la fois sur des systèmes *in vitro* de cultures de cellules de ver à soie et sur le ver entier.

La transformation tant des cellules que des vers nécessite l'utilisation de vecteurs appropriés ou d'injection directe d'ADN.

Dans le cas des cultures de cellules, des résultats prometteurs ont déjà été obtenus par l'intermédiaire de baculovirus modifiés capables d'infester les cellules. L'utilisation d'un tel vecteur peut s'envisager sur le ver entier dans la mesure où ce type de virus est strictement inféodé au ver à soie. Toutefois une telle contamination se traduit par une forte mortalité avant la nymphose.

La perspective d'obtenir des lignées transformées est donc un enjeu important. Pour obtenir une telle transformation, il est nécessaire que l'insertion des gènes soit faite dans la lignée germinale. Réalisé chez la *Drosophile*, ce transfert n'a pu encore être obtenu chez le ver à soie. Le choix de la forme de l'ADN à injecter et la période d'injection sont des éléments à tester pour obtenir le transfert et en optimiser les chances de réussites.

Des injections dans les oeufs de *Bombyx* d'ADN plasmidien ont été tentées et réussies. Malheureusement les lignées obtenues présentant la capacité d'exprimer les transformations induites n'ont pu être maintenues à cause d'une très faible viabilité.

Ces recherches de transfert de gènes, outre l'aspect fondamental dans la connaissance des mécanismes de régulation du fonctionnement des gènes, peuvent présenter un intérêt biotechnologique de premier plan pour la production de protéines d'intérêt économique. Des moyens mis en oeuvre pour ces expériences dépendent les chances de succès et les retombées futures ouvrant des voies nouvelles dans l'utilisation du ver à soie.

La transformation du ver à soie peut également avoir des conséquences inattendues en générant des souches nouvelles pouvant avoir des caractéristiques plus marquées en vue de recherches fondamentales ou appliquées.

A long terme, et si l'Unité voit ses moyens augmenter, il n'est pas déraisonnable d'envisager des études plus poussées sur le génome du ver à soie.

Un ver à soie transformé, capable de produire plus de soie ou des protéines à haute valeur ajoutée, devra être élevé dans des conditions optimales à moindre coût, d'où la nécessité de repenser les techniques d'élevage et, en particulier, les modalités d'alimentation. Ceci nous impose la prise en compte, au niveau de l'Unité de programmes plus techniques.

C. Technicité du ver à soie : physiologie de la nutrition.

Une des particularités du ver à soie est sa stricte dépendance pour son alimentation au mûrier. Les meilleures pratiques d'élevage consistent à nourrir directement les vers sur les feuilles de mûrier. Pour ce faire, des variétés de plantes ont été sélectionnées pour réduire les charges inhérentes à l'approvisionnement en feuilles. Malgré tout, les contraintes restent importantes et n'autorisent pas une production toute l'année. Des milieux artificiels ou semi-artificiels sont disponibles mais ils ne présentent pas l'efficacité des feuilles de mûrier.

On voit que les études en terme d'alimentation du ver à soie présentent plusieurs intérêts, à savoir : amélioration des connaissances sur la physiologie de la nutrition du ver, amélioration des performances des milieux disponibles conduisant à terme à la possession de milieux permettant des élevages toute l'année.

Ces études seront possibles grâce à l'existence d'une méthodologie adaptée à l'étude de la nutrition des insectes et à une bonne expérience d'élevages de lépidoptères sur milieu artificiel présente au laboratoire de Biologie Appliquée de l'INSA. Les milieux artificiels existants (milieux japonais) permettent les élevages en laboratoire, c'est-à-dire qu'ils assurent le développement du ver. Toutefois, les vers sont très sensibles aux maladies, ce qui rend aléatoire un élevage de masse. Il faut donc comprendre la différence entre feuilles fraîches et milieu contenant de la poudre de feuille, et les réactions de vers face à ces deux situations. Les études à faire doivent avoir un caractère dynamique en vue de montrer le devenir des intrants et d'en quantifier leur utilisation. Ceci passe par une caractérisation de la satisfaction nutritionnelle de la feuille de mûrier et en estimant le besoin des vers. La même démarche est transposable aux milieux artificiels. La mesure de l'efficacité digestive par

quantification de marquages radioactifs permet de décrire et de modéliser, sur des bases statistiques, l'ensemble des transformations s'opérant entre ingestion et utilisation, dans un contexte strictement physiologique. Ces études, plus faciles à mettre en oeuvre sur milieu artificiel, donnent une image exacte du devenir métabolique de chacun des acides aminés et de l'importance de protéines susceptibles de servir de base alimentaire. Outre les critères purement efficacité nutritionnelle, devront être pris en compte des critères de développement comme la résistance aux maladies, la vitesse de développement ou la fécondité, des critères relatifs à la production de soie comme la quantité ou la qualité et aussi des critères d'ordre économique comme le coût de l'élevage des vers.

Les recherches sur la physiologie du développement ont révélé une grande sensibilité des vers à des substances mimétiques ou antagonistes d'hormones, se traduisant par une interférence sur les capacités de synthèse et de tissage de la soie. L'ajout de telles substances dans des milieux artificiels et la mise à disposition de ces milieux dopés à des périodes bien déterminées peut permettre un contrôle de l'expression des gènes de la soie.

Par ailleurs, certaines observations (activités β -galactosidasiques) laissent à penser que les vers à soie pourraient héberger des micro-organismes symbiotiques. Leur régime phytophage strict pourrait ainsi bénéficier de métabolismes supplémentaires (synthèse de protéines par exemple).

Il est primordial, dans le cadre d'une étude nutritionnelle, de préciser ce point, à savoir existe-t-il ou non de telles symbiontes ? Dans le cas où l'on ne trouverait pas de micro-organismes, il resterait à expliquer le pourquoi de ces réactions β -galactosidasiques. L'une des possibilités serait un transfert naturel de gènes à partir d'anciennes bactéries symbiotiques.

II. ACTIVITES DE DEVELOPPEMENT

Les recherches proposées ont une place importante dans l'acquisition des connaissances en biologie mais trouvent souvent, de par le choix du modèle biologique, des débouchés importants. La maîtrise des capacités de synthèse des glandes séricigènes à synthétiser de la soie ou d'autres protéines peut redonner à l'élevage du ver à soie un nouvel essor. La maîtrise des élevages sur milieux artificiels facilitant la robotisation peut justifier le redémarrage de magnaneries destinées à la production de différents types de soie ou de protéines à haute ajoutée.

L'Unité séricicole se doit d'être impliquée dans ces programmes de développement.

III. ACTIVITES DE FORMATION

L'Unité a pour but la transformation du ver à soie pour optimiser ses productions. Elle est déjà experte dans la conduite de l'élevage des vers à soie et dispose d'un grand nombre de souches. C'est à ce titre que, via l'existence du siège de la Commission Séricicole Internationale, les compétences de l'Unité sont sollicitées pour aider les organismes des pays désireux de promouvoir la sériciculture. L'Unité se doit de répondre aux besoins de ces pays. Des programmes de collaboration sont déjà en place mais restent limités. Il ne faut pas sous-estimer ce rôle de formation qui peut aussi se traduire par l'accueil de chercheurs de haut niveau (post-doctorants).

CONCLUSION

L'Unité Nationale Séricicole dispose d'atouts majeurs justifiant l'intérêt que peut lui porter l'INRA.

Le ver à soie est le modèle idéal pour trouver des solutions à des questions de biologie du développement. Le ver à soie est depuis toujours un modèle en matière de biotechnologie. Les perspectives d'utilisation nouvelles sont nombreuses et, grâce à l'acquis sur cette espèce, la valorisation des transformations introduites peut être très rapide.

De plus, l'Unité bénéficie d'un environnement très favorable pour le développement de ses activités. Les recherches seront conduites avec les compétences des laboratoires de l'Université Claude Bernard Lyon I avec les équipes de J-C. Prudhomme et P. Couble et du laboratoire de biochimie de l'INSA dirigé par P. Nardon.

La vocation traditionnelle de la région de Lyon constitue un soutien justifiant l'implantation et le développement de l'Unité Nationale Séricicole. La présence du siège de la Commission Séricicole Internationale est une ouverture sur le monde des activités de l'Unité.

QUESTIONS

M. Todoroki ouvre la discussion sur les deux exposés précédents.

Mr Todoroki opened the discussion on the preceding two contributions.

M. Chavancy souhaite simplement intervenir en tant que Directeur de l'UNS pour remercier le Gouvernement français et le Ministère de l'Agriculture qui ont joué un rôle déterminant dans le développement de l'UNS. En effet, le potentiel de l'UNS va être nettement augmenté avec les objectifs indiqués. L'UNS travaille déjà depuis longtemps en collaboration avec d'autres laboratoires lyonnais et a acquis une expérience dans le domaine de la biologie moléculaire et de la sériciculture. Il se félicite que les moyens de recherche soient enfin augmentés et permettent de mener à bien ce programme de transformation génétique du ver à soie (transgénie) car il doit aboutir à des résultats de grande importance dans l'avenir, aussi bien pour l'utilisation du ver à soie comme outil biotechnologique afin de produire des molécules diverses et variées que pour le développement de la sériciculture. En effet, par les mêmes méthodologies et technologies du génie génétique, on peut espérer à terme produire des souches de ver à soie qui ont tous les avantages que l'on souhaite que ce soit en performance de production de soie ou que ce soit en résistance aux maladies, etc.

Il remercie à nouveau le Ministère de l'Agriculture et l'INRA - future tutelle de l'UNS. Ceux qui viendront nous voir en 1991 verront un développement des activités de recherches. Nous disposerons des atouts nous permettant de devenir compétitifs et d'assurer nos missions de formation de chercheurs et de techniciens à différents niveaux.

Mr Chavancy only wished to speak as the Director of the Unité Nationale Séricicole to thank the French Government and the Ministry of Agriculture who played a dominant role in the development of the UNS. The potential of the UNS would indeed be significantly increased in view of the aims indicated. The UNS had been working for some time in collaboration with other laboratories of Lyon and acquired some experience in the field of molecular biology and sericulture. He was very pleased that research means were at last increased, thereby enabling this genetic transformation (transgenation) programme to be carried out because it was to lead to results of great importance in the future, both in terms of the use of the silkworm as a biological tool in order to produce diverse and varied molecules and in terms of sericulture development. In fact, with the same genetic engineering methodologies and technologies, new silkworm strains were expected to be produced eventually, strains with all the desirable advantages whether they be in silk production performance, disease resistance, etc.

He thanked again the Ministry of Agriculture and INRA - the UNS future supervising body. Those who would visit us 1991 would see the development of research activities. We would then have the assets that would allow us become competitive and to ensure our task of training scientists and technicians at various levels.

M. Persoons demande à M. Mauchamp s'il a obtenu par traitement au fénoxycarbe des stades surnuméraires chez le ver à soie comme on l'a observé pour d'autres insectes. Y a-t-il des larves qui montrent un 6^e stade larvaire ?

Mr Persoons asked Mr Mauchamp whether he could obtain supernumerary stages by fenoxycarb treatment in the silkworm as was observed in other insects. Were there larvae which showed a 6th larval stage ?

M. Mauchamp :

"Non. Ce phénomène a été observé chez d'autres insectes et d'autres lépidotères en particulier, mais pas ici."

"No. This phenomenon was observed in other insects and in Lepidoptera in particular, but not in this case."

M. Persoons :

"Avez-vous fait un traitement continu au fénoxycarbe ?"

'Did you perform a non-stop fenoxycarb treatment ?'

M. Mauchamp :

"Deux types d'expériences ont été faites. L'animal présenté sur la diapositive à gauche correspond à un traitement au 5e âge larvaire. Sur la droite, une application topique a été faite au 3e âge larvaire. Le développement est normal jusqu'au 5e âge et c'est seulement au 5e âge qu'il y a un arrêt du développement de la glande séricigène."

'Two types of experiments were made. The animal shown on the left-hand slide corresponds to a 5th instar treatment. On the right a topical application was made in the 3rd instar. Development is normal until the 5th instar and there is a discontinuation in the silk gland development only in the 5th instar.'

LA PRODUCTION SERICICOLE EN FRANCE

C. BARRIERE

Syndicat national séricicole, B.P. 39, 26110 Nyons, France.

Sans remonter aux origines de la découverte de la soie, que l'on situe traditionnellement vers l'an 2600 avant notre ère en Chine, on peut dire qu'en France, c'est surtout avec Olivier de Serres que la sériciculture prendra son véritable essor en 1599. L'âge d'or de la sériciculture française se situe en 1853 avec une production de 26 000 tonnes sur 63 départements. Mais, après cette date, la production n'a cessé de baisser d'abord à cause de l'apparition de la pébrine, puis de la concurrence étrangère et enfin de la découverte des fibres artificielles.

En 1947, cette production est de 500 tonnes et en 1985 seulement 4 tonnes. Qu'en est-il aujourd'hui ? Peut-on parler d'une sériciculture française ? Quel est son avenir ?

Après les chiffres cités, 26 000 tonnes en 1853, 500 tonnes en 1947 et 4 tonnes en 1985, on pourrait conclure que la sériciculture française se meurt doucement... Ce serait sans compter avec un certain nombre de sériciculteurs qui, en 1977-78 dans le Gard, 1983 dans le Var, 1986 dans la Drôme, sans oublier l'Isère et l'Ardèche et enfin, en 1990, au sein d'un Syndicat National Séricicole, s'organisent pour que cette activité non seulement ne meure pas mais se développe à nouveau dans les campagnes françaises d'où le mûrier, "l'arbre d'or", n'a pas disparu !...

Le 23 janvier 1990, est donc né, à Nîmes, dans le Gard, le Syndicat National Séricicole dont vous avez devant vous la Présidente. Ce Syndicat National concrétise la volonté des sériciculteurs français de développer la sériciculture en aidant à la fois les sériciculteurs en place et les agriculteurs qui souhaiteraient créer une activité séricicole au sein de leur exploitation pour diversifier leur production.

Il a donc à la fois un rôle de lien entre les sériciculteurs, de coordonnateur, d'appui technique, d'outil de formation et de production, son action se voulant culturelle, technique et économique auprès des sériciculteurs dont il est l'émanation directe.

Aujourd'hui, ce Syndicat achète au Japon les graines nécessaires aux élevages de printemps et d'automne et les redistribue aux éleveurs.

Les cocons produits sont vendus à SERICA à Monoblet, pour être filés dans la seule filature qui existe en France actuellement. Ces cocons sont payés 75 FF le kg aux éleveurs pour le 1er choix et 50 FF pour le 2ème choix. La CEE accorde une prime à la boîte qui permet de porter à 105 FF le kg de cocons.

SERICA effectue filage, tissage, confection et commercialisation du produit fini, maîtrisant ainsi l'ensemble de la filière du sol au tissu. A ce jour, une trentaine de sériciculteurs ont planté environ 40 000 mûriers sur une quinzaine d'hectares.

Cependant la production n'est pas ce que l'on pourrait en attendre, des problèmes ayant surgi depuis 4 ans au moment des élevages de printemps. On constate en effet, outre un mauvais état de santé des vers, des problèmes de non filage très préoccupants, paraissant dus à l'utilisation d'un nouvel

insecticide sur la vigne et les arbres fruitiers. Les sériciculteurs s'organisent pour réaliser de plus importants élevages d'automne afin de pallier ces échecs d'élevages de printemps.

Si l'on regarde la production de soie française récente, on s'aperçoit qu'après avoir repris jusqu'en 87, elle a diminué ces trois dernières années, mais elle s'apprête à augmenter à nouveau car les nouvelles plantations vont donner leur plus grande production dans les années à venir. D'ailleurs, le département de la Drôme est l'image de cette conclusion - en ayant une production croissante de 1987 à 1990 alors que la production globale française décroît dans le même temps.

Globalement, en France on passe de 1 164 kg en 1983 à environ 900 kg en 1990. Dans la Drôme : 120 en 1987 et 209 en 1990, ceci avec une petite partie des vergers en production et d'autres plantations non encore réalisées.

On est loin, bien sûr, d'une production pouvant satisfaire les besoins des industriels de la soie, mais la filière intégrée de SERICA à Monoblet dans le Gard permet aux sériciculteurs d'avoir un débouché assuré pour leurs cocons, la filature pouvant en traiter jusqu'à 20 tonnes.

De plus, la fourniture de plants *in vitro* Kokuso par la société Microplants Cévennes permet d'avoir des vergers possédant une résistance exceptionnelle aux accidents climatiques, une grande productivité dès la 2ème année, une facilité de cueillette de la feuille permettant un gain de temps non négligeable.

On pourrait, grâce à cela et malgré les faibles chiffres de production avancés tout à l'heure, parler aujourd'hui sans rêver de la possibilité d'une production française de 10 à 15 tonnes de cocons d'ici 1993 si une véritable politique de relance se mettait en place.

Il existe d'ailleurs divers projets qui pourront contribuer très efficacement à ce "renouveau de la soie" si on leur en donne les moyens rapidement.

1) Projet de station de grainage qui pourrait se situer sur la région Rhône-Alpes et plus précisément au Pradel, en Ardèche, haut-lieu historique de la sériciculture française passée. Ceci permettrait, du fait des résultats déjà acquis par la recherche de l'amélioration des souches de vers à soie, d'éviter un surcoût dû au transport de ces graines depuis le Japon, d'assurer surtout l'indépendance des sériciculteurs français mais aussi de couvrir des demandes internationales dans ce domaine.

2) Projet de ferme expérimentale (Projet Chaîne) qui prévoit par l'expérimentation d'élevages modernisés, hautement mécanisés et avec une automatisation très poussée, la possibilité de produire en grande quantité une soie très compétitive sur le marché international.

3) Projet de centre technologique de Puechlong, lié à la production de mûriers *in vitro* de "Cévennes Microplants", prévoyant l'expérimentation de mûriers à fruits, la formation et la recherche technologique aux différents stades de l'élaboration du fil de soie.

4) Soutien à l'amélioration et au développement de l'existant par :

- la plantation de mûriers : sur Rhône-Alpes, seulement 10 000 Kokuso ont été plantés avant 1988, 2 000 en 1990, plus de 5 000 sont en projet.

- Installation de magnaneries : 7 sont prévues sur la Drôme seule, à réaliser ou aménager pour une plus grande production.

Tout ceci pour multiplier la production sachant qu'il est possible d'aller au moins jusqu'à saturation de la filature de Monoblet, c'est à dire 20 tonnes.

Ce développement de l'existant présente un intérêt non négligeable pour les agriculteurs des zones de moyenne montagne qui désirent diversifier leur production et acquérir ainsi un supplément de ressources.

Tout ceci est en outre lié à un intérêt touristique très net de ces mêmes zones où l'essor d'un "tourisme rural" passe, c'est évident, par le maintien des populations en place et surtout des agriculteurs, souvent "petits" mais toujours garants de la préservation d'un environnement accueillant où le mûrier trouve très naturellement sa place.

On espère que, grâce à de nouveaux moyens mis en oeuvre, une solution satisfaisante sera trouvée rapidement aux problèmes de non filage du printemps, condition *sine qua non* d'un développement rapide de la sériciculture.

Enfin, et ce sera mon dernier mot, reprenant ici l'espoir d'André Schenk, le "Pape de la Soie française" souhaitons "l'apothéose réussie du Grand Renouveau de la production de la soie", sous toutes les formes valables économiquement, aussi bien dans les Cévennes que dans tout le Sud-Est et dans tout l'hexagone, comme il y a 150 ans, car la roue tourne en faveur des produits naturels, d'une part, et de la maîtrise globale de leur filière, d'autre part.

Le Syndicat National Séricicole s'est fixé comme but ce Grand Renouveau qui favoriserait sans nul doute la remontée démographique des zones rurales de moyenne montagne par la création d'activités agricoles et artisanales valorisantes et aurait en outre une résonnance considérable.

Comme cela a déjà été réalisé dans le Gard, l'Hérault et la Lozère, et comme c'est en projet dans l'Ardèche et la Drôme, les Chemins de la Soie conduiront, au-delà des musées, vitrines du passé, vers les lieux vivants de la renaissance de la soie et même vers les laboratoires de l'invention.

Mais, pour que se réalise cette perspective, il est indispensable que, dès maintenant, la production de soie française, rénovée, reçoive son label politique, c'est-à-dire que ce créneau économique reconnu et adopté regionalement soit intégré par le Gouvernement.

QUESTIONS

M. Todoroki ouvre la discussion.

Mr Todoroki opened the discussion.

M. Persoons :

"C'est au sujet du phénomène de non-filage au printemps. Quel type d'insecticide mettez-vous en cause ? Quelle preuve avez-vous que c'est cet insecticide qui est responsable du phénomène ?"

'About this non-spinning phenomenon in spring, what type of insecticide do you call into question ? What proof have you got that this particular insecticide caused the phenomenon ?'

Mme Barrière :

"On ne peut affirmer que l'insecticide supposé qui est "l'Inségar" soit effectivement cause des problèmes de non-filage au printemps, mais on a de fortes présomptions parce qu'il a été utilisé dans les régions voisines des élevages et on n'a pas d'autre explication que celle-là. Ce non-filage a pour cause un blocage de l'hormone juvénile qui correspond tout à fait à ce dont se vante cet insecticide."

'It cannot be asserted that the alleged insecticide, which is 'Insegar' is actually the cause of these non-spinning problems in spring, but we have strong presumptions because it has been used in the regions neighbouring the rearings and we have no other explanation. This non-spinning is due to a blocking of the Juvenile Hormone, which entirely tallies with what this insecticide boasts of.'

M. Chavancy complète la réponse en revenant un peu en arrière : "La piste de cet insecticide a été découverte par les travaux de l'UNS.

1) On avait constaté en effet que, depuis 1986 en France, il y avait des problèmes de non-filage des cocons uniquement au printemps. Ensuite, avec nos amis italiens et notamment M. Candiani ici présent, nous avons constaté qu'à partir de 1989, il y avait le même phénomène en Italie, de façon massive : 90 % des élevages ne filaient pas de cocons et donnaient des vers énormes qui demeuraient longtemps au dernier stade larvaire.

La première chose faite a été de déterminer de façon formelle que les vers concernés étaient saturés d'Hormone Juvénile, c'est-à-dire qu'ils en avaient une quantité anormalement élevée pendant cette période de la fin du 5e stade larvaire. Cela expliquait les phénomènes de non-filage, de non-métamorphose, etc.

2) On avait constaté qu'un produit commercialisé sous le nom d'"Insegar" et qui contient comme formule active le fénoxycarbe, sur lequel travaille d'ailleurs M. Mauchamp, avait été utilisé pour la première fois en 1986 en France et, en 1989, en Italie.

C'est la convergence de ces éléments, puisque le fénoxycarbe est censé agir par un procédé de type hormonal, qui nous a amenés à émettre l'hypothèse qu'il pouvait bien s'agir de l'utilisation de ce produit. Il n'est, en outre, utilisé sur les arbres fruitiers, la vigne, etc. qu'une seule fois par an et au printemps. Or les élevages d'automne sont tout à fait normaux. Ce produit est résistant pendant environ deux mois après son utilisation. Nous essayons donc de démontrer qu'il y a une relation directe entre l'utilisation de l'Insegar et le phénomène de non-filage observé. Pour l'instant, cette démonstration est très difficile. Ce n'est pas parce que l'on ne trouve pas de fénoxycarbe sur les feuilles de mûrier à un moment donné sur un lot donné qu'il n'y en a pas suffisamment alors qu'il est accumulé par l'animal et que le phénomène peut être déclenché. Il est arrivé, en 1989, que sur des feuilles prélevées en Italie, on détecte effectivement du fénoxycarbe sur les mûriers alors que ce produit n'était pas utilisé à l'endroit même.

Voilà où en est l'état nos travaux. Nous avons actuellement un programme de recherches franco-italien qui va tenter de décider si c'est bien ce produit qui est en cause. Manifestement, c'est un phénomène de ce type."

Mr Chavancy complemented the answer by a short review : 'The track of this insecticide was found by the UNS.

1) It was indeed noted that since 1986 in France there were non-spinning problems solely in spring. Then, with our Italian friends and in particular Mr Candiani here present, we could note that from 1989 onwards there was the same phenomenon in Italy, in massive proportions : 90 % of therearings would not spin their cocoons and would give huge larvae which remained for very long in the fifth instar.

The first thing to be done was to determine formally that the larvae concerned were saturated with Juvenile Hormone, that is to say that they had an abnormally high quantity of it for this late 5th instar period. This could explain the non-spinning, non-metamorphosis phenomena, etc.

2) It was noted that a product marketed under the name of 'Insegar' and containing fenoxycarb as an active formula, on which Mr Mauchamp is currently working, was used for the first time in 1986 in France and in 1989 in Italy. It was the convergence of these elements, since fenoxycarb is supposed to act by means of a hormonal type process which led us to put forward the hypothesis that the use of this product could be the cause. Furthermore, it is used on fruit-trees, vines, etc., only once and in spring, whereas autumn rearings are quite normal. This product is resistant for about two months after it has been used. This is why we are trying to demonstrate that there is a direct relation between the use of Insegar and the non-spinning phenomenon observed. At present, this demonstration is very difficult. The fact we do not find fenoxycarb on mulberry leaves at a given time on a given batch does not mean that there is not enough of it for the animal to accumulate it and for the phenomenon to be started. In 1989, fenoxycarb was actually detected on mulberry leaves collected in Italy whereas this product was not normally used in this very region.

This is where our work stands. At present we have a Franco-Italian research programme whose aim is to try and determine whether this product is in fact responsible. Undeniably, it is this type of phenomenon.'

M. Mauchamp complète alors cet exposé en précisant que des expérimentations consistant à traiter des vers avec du fénoxycarbe mis dans une pièce où d'autres vers se développaient sans traitement, entraînaient le fait que la totalité des vers présentaient les mêmes symptômes, donc des larves géantes, incapables de tisser, alors que la plupart de ces vers n'avaient reçu aucun traitement.

Ces expériences ont eu lieu au Japon, et ses collègues japonais étaient désespérés de voir que tous les élevages qui étaient dans cette même pièce subissaient un effet non prévu.

Mr Mauchamp then complemented this review by stipulating that experiments consisting in treating larvae with fenoxycarb reared in a room where other larvae were reared without any treatment caused the whole of the larvae to present the same symptoms, i.e. giant larvae unable to spin, whereas most of these worms had had no treatment.

These experiments took place in Japan and his Japanese colleagues were desperately sorry to see that all the rearings that were in this same room underwent an unexpected effect.

M. Todoroki, avant de présenter son exposé, prie l'assemblée de bien vouloir excuser le Dr Ohtsuki (Department of Insect Genetics and Breeding, National Institute of Sericultural and Entomological Science, Morozi) qui n'a pu se rendre à cette conférence et ne pourra donc pas présenter la communication qui était prévue.

Mr Todoroki before reading his paper asked the audience to excuse Dr Ohtsuki (Department of Insect Genetics and Breeding, National Institute of Sericultural and Entomological Science, Morozi) who could not attend this conference and would therefore be unable to read the report that was scheduled.

THE PRESENT SITUATION OF SERICULTURE IN JAPAN

T. TODOROKI

Sericulture Division, Ministry of Agriculture, Forestry and Fisheries, Kasumigaseki, Tokyo 100, Japan.

1. On behalf of the Japanese delegation, I would like to express my sincere thanks to the French Government and to the I.S.C. Secretariat for the effort in the operation of the I.S.C. and in the preparation and operation of the present Conference.

2. Then I would like to explain the present situation of sericulture in Japan.

At present, Japan is an important cocoon and raw silk producing country as well as the major consumer and importer of silk.

3. In this situation, the trend of domestic consumption of raw silk in Japan is continuing to decline due to the decreasing demand for 'Kimono' and other traditional Japanese wear. The demand for raw silk decreased from 191,000 bales in 1984 to 144,000 bales in 1989.

4. On the other hand, sericulture in Japan, that is to say, the number of sericulture households, the area of mulberry fields, the cases of silkworm eggs used, cocoon production etc., in Japan have declined as a whole. Especially cocoon production has decreased rapidly in recent years. It was 47,000 tonnes in 1985 but fell to 27,000 in 1989.

Table I. General situation of sericulture in Japan.

Tableau I. Situation générale de la sériciculture au Japon.

Year <i>Année</i>	No. of sericulture households		Area of mulberry fields		Cocoon production	
	No. × 1,000 <i>Nb. d'exploitations séricicoles</i>	Index	× 1,000 ha <i>Surface de mûraies</i>	Index	× 1,000 t <i>Production de cocons</i>	Index
	<i>Nb × 1 000</i>	<i>Indice</i>	<i>× 1 000 ha</i>	<i>Indice</i>	<i>× 1 000 t</i>	<i>Indice</i>
1985	99.7	100	96.8	100	47.3	100
1986	86.9	87	88.5	91	41.5	88
1987	74.4	75	79.2	82	34.7	74
1988	62.4	63	70.4	73	29.6	63
1989	57.2	57	64.2	66	26.8	57

Table II. Scale of operation of sericulture households and cocoon production in Japan.

Tableau II. Données sur le rendement des exploitations séricicoles et la production de cocons au Japon.

Year <i>Année</i>	Per sericulture household				Cocon production /10 a.	
	Mulberry field area		Cocoon production		kg/10 a. <i>Production de cocons pour 10 acres</i>	Index
	a	Index <i>Par exploitation séricicole</i>	kg	Index		
	<i>Surface de mûriers</i>		<i>Production de cocons</i>			
	a	Indice	kg	Indice	kg/10 a.	Indice
1985	97	100	474	100	49	100
1986	102	105	477	101	47	96
1987	107	110	467	99	44	90
1988	113	116	474	100	42	86
1989	112	115	469	99	42	86

Table III. Raw silk supply and demand.

Tableau III. Offre et demande de soie grège.

Year <i>Année</i>	Production		Import		Domestic consumption	
	× 1 000 bales <i>Production</i>	Index	× 1 000 bales <i>Importation</i>	Index	× 1 000 bales <i>Consommation domestique</i>	Index
	× 1 000 balles	Indice	× 1 000 balles	Indice	× 1 000 balles	Indice
1985	160	100	35.0	100	191	100
1986	139	87	32.6	93	152	80
1987	131	82	24.3	69	156	82
1988	114	71	32.6	93	206	108
1989	101	63	34.1	97	144	75

Such a decrease seems to have been brought about by the following reasons.

i) First of all, the urbanization in the chief producing districts of cocoons has proceeded, so that the mulberry fields have been ruined.

ii) Second, the inheritors of sericulture households have reduced in number.

iii) Third, the household members engaged in sericulture have advanced in age and so on.

5. As mentioned above, both the demand and production of raw silk in Japan have tended to decrease in recent years, therefore the present situation of sericulture in Japan has become severe. On the other hand, the needs of consumers in Japan have been diversified and high-grade oriented, furthermore it was discovered that the excellent quality of silk as a natural fibre had new merits.

When looking at the demand and supply of raw silk, according to the sharp decrease in domestic raw silk production as well as the increasing anxiety due to uncertain supply from foreign producing centers, the balance of demand and supply of raw silk in Japan has become unstable after 1987.

6. Under such circumstances, it had been needed to cope with such a situation and to strive for the stable supply of excellent cocoons and raw silk, therefore we intended to stop the tendency toward decrease of production.

In 1989, we made efforts for maintaining cocoon production with all concerned persons, as a result of this, the decreasing tempo of domestic cocoon production slightly slowed down. Continuously we have been making efforts this year.

To put it more concretely, we intend to promote the next four countermeasures positively.

i) First of all, in order to promote low-cost sericulture, we intend to advance positively every measure for the improvement of land and labor productivity according to the situation of each area.

ii) Second, we intend to promote the production of cocoons for special use, which is expected to bring about new demand in the future.

iii) Third, we intend to promote the organization of raw silk production, strengthening the function of producing center, and bringing up core farm households raising silkworms in the chief producing district of raw silk.

iv) Fourth, we intend to strengthen the activity of organization of the sericulture extension work.

7. Further, in Japan, mulberry has been an important component of the cropping systems in upland crop field areas. Moreover, sericulture has contributed to play a major role in regional agricultural development as well as in farm household economy in the mountain villages.

We consider that it is necessary to strive for the development of a major producing cocoon center by bringing up core sericultural farm households which have a high productivity.

8. At this opportunity, we would like to express our heart-felt thanks to the present Conference of the I.S.C. for awarding the honorable Louis Pasteur Prize to Dr Keio AIZAWA who is a representative Japanese scientist in the field of sericulture.

Thank you for your kind attention.

QUESTIONS

Mr Chavancy :

"In your review you mentioned the development of special purpose cocoon production. What are these purposes?"

"Vous avez indiqué dans votre exposé un développement de la production de cocons à usages spéciaux. De quels usages s'agit-il?"

Mr Todoroki :

"These are cocoons intended for kimonos as well as for food wrapping or socks, for instance."

"Il s'agit de cocons pour les kimonos mais aussi pour des enveloppes alimentaires ou des chaussettes, par exemple."

Mr Todoroki asked Mr Ralambofiringa to present his review.

M. Todoroki demande à M. Ralambofiringa de bien vouloir présenter son exposé.

LA SERICICULTURE A MADAGASCAR

A. RALAMBOFIRINGA

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A Madagascar, l'usage de la soie naturelle pour la confection de costumes d'apparat et de lincools remonte à des temps immémoriaux. Jusqu'en 1850, époque de l'introduction en Europe de *Bombyx mori*, la soie utilisée était tirée uniquement de divers séricigènes vivant à l'état sauvage dans les forêts du plateau central, de la partie sud-ouest et de la zone nord-ouest de l'île.

De nos jours supplantées par la soie mûrier dans la confection de costumes, d'écharpes et de tissus d'ameublement, les soies sauvages sont reléguées au deuxième plan et sont uniquement utilisées dans le tissage des lincools.

La transformation de la soie est entreprise à Madagascar seulement par un artisanat très florissant, qui s'occupe à la fois de la filature et du tissage. On peut estimer le besoin annuel de cet artisanat à 200 tonnes de fil de soie toutes origines confondues ; ce besoin est malheureusement encore loin d'être satisfait par la production séricicole nationale.

A ce propos ont été entreprises diverses actions visant tout spécialement à développer la sériciculture mûrier, qui trouve son terrain de prédilection sur les hauts plateaux malgaches à climat proche du tempéré. Dans cette frange centrale de l'île, il est possible de mener plusieurs élevages de vers à soie 7 à 8 mois sur 12.

Après un bref aperçu sur les séricigènes sauvages qui s'adaptent à des conditions climatiques et édaphiques plus variées, l'exposé portera sur la situation de cette sériciculture mûrier vieille seulement de 150 ans et esquissera les perspectives du développement de la production de la soie à Madagascar.

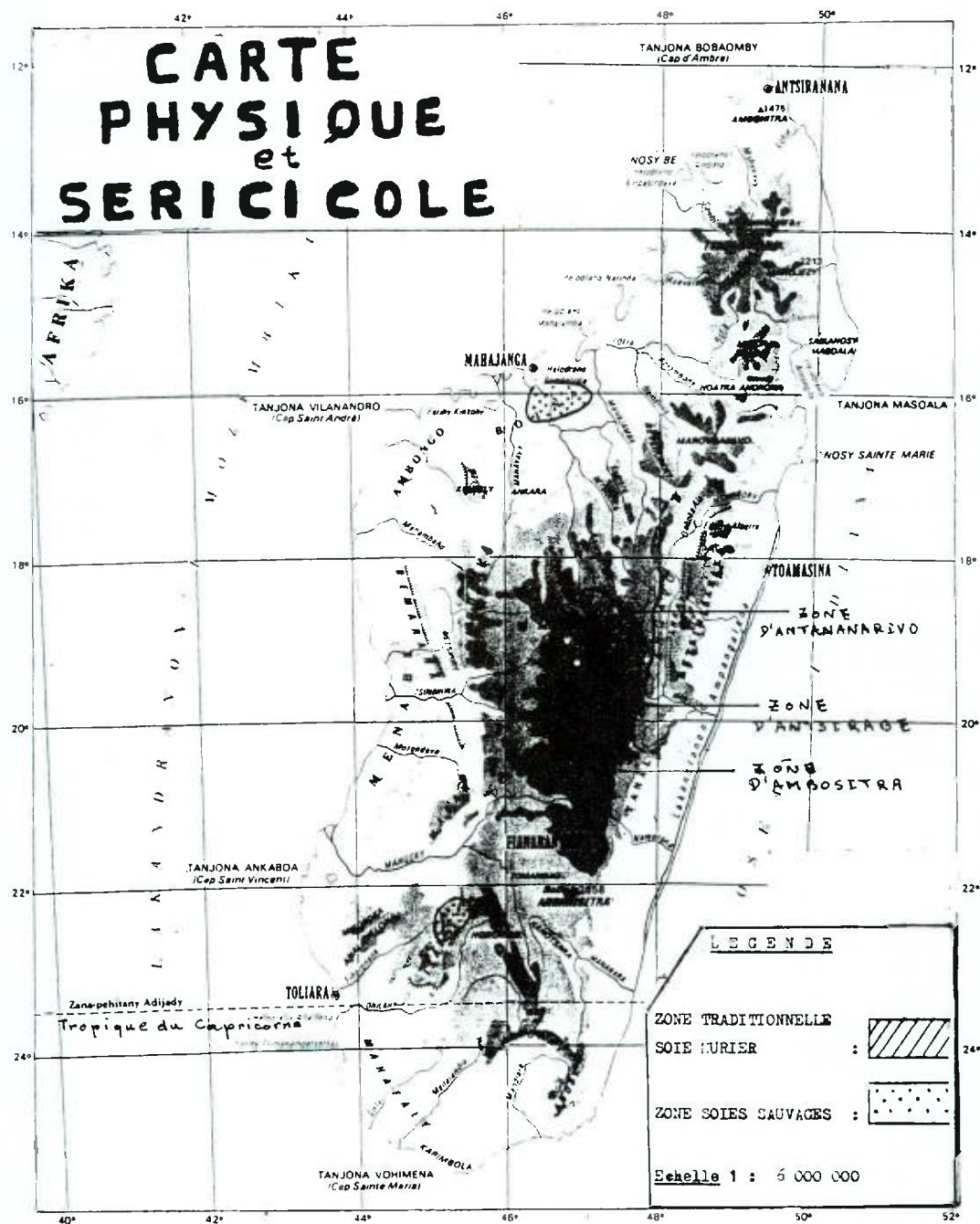
I. LES SERICIGENES SAUVAGES A MADAGASCAR

On trouve à Madagascar plusieurs séricigènes sauvages dont la soie de couleur grisâtre, qui est plus solide que la soie mûrier, est utilisée essentiellement dans le tissage de lincools, tissus artisanaux servant à envelopper les morts avant de les inhumer. Landibe est le nom vernaculaire des chenilles de ces séricigènes dont le plus important est *Borocera madagascariensis*.

Le Landibe est un ver polyphage qui s'adapte à des conditions climatiques très variées. On l'élève en grand à Isalo, dans la partie sud-ouest de l'île, on le retrouve à Ambatofinandrahana, à Antsirabe-Betafo et Arivonimame, sur les hautes terres, ainsi qu'à Morovoay, près de la côte, dans la partie nord-ouest de Madagascar.

Borocera madagascariensis est exploité à grande échelle dans l'Isalo. Situé entre 22° et 23° Lat. S et 45° et 46° Long. E et à une altitude comprise entre 510 m à 1270 m, dans la province de Fianarantsoa, l'Isalo est couvert par une forêt pluviale dévastée annuellement par les feux de brousse, ne laissant subsister que les essences forestières pyrophyllées comme le *Tapia* ou *Uapaca bojeri*.

Les feuilles de *Tapia* constituent, dans cette zone, l'aliment presque exclusif de *Borocera*. On les trouve en allant plus au nord à Ambatofinandrahana, zone située entre 20° et 21° Lat. S et 46° et 47° Long. E, à une altitude de 1800 m au col de *Tapia*, à Antsirabe entre 19° et 20° Lat. S et 47° et 48° Long. E, à une altitude de 1500 m ainsi qu'à Arivonimamo, à une quarantaine de kilomètres d'Antananarivo, la capitale, située entre 18° et 19° Lat. S et 47° et 48° Long. E et culminant à 1500 mètres d'altitude.



Physical and sericultural map of Madagascar

Le Tapia, ou *Uapaca bojeri*, est un arbre à croissance lente, à cime arrondie et pouvant atteindre plus de cinq mètres de haut ; ses feuilles sont ovales et entières, vertes en dessus avec des nervures un peu plus claires, la face inférieure est d'une teinte pâle.

Les feuilles ont un port dressé presque vertical ; le Tapia a des branches tortueuses, recouvertes d'une écorce finement ciselée et le fruit qu'il produit est une baie comestible.

Borocera est par ailleurs présent à Marovoay, zone située entre 16° et 17° Lat. S et 46° et 47° Long. E, près de la côte ouest, et à une altitude de 20 à 60 mètres ; dans cette zone, le Tapia n'existe pas et c'est l'Afiaty ou Palétuvier blanc qui sert de plante nourricière à *Borocera*.

L'Afiaty est un arbuste de moyenne taille, ramifié depuis la base, croissant au milieu de palétuviers ordinaires ou palétuvier rouge à cause de la couleur de son bois.

En dehors de l'Afiaty et du Tapia, *Borocera* se nourrit de feuilles de Tsitoavana ou *Dodonea madagascariensis* de la famille des sapindacées et de feuilles d'Ambrevade ou *Cajanus indica* de la famille des légumineuses papillonacées.

L'Ambrevade a des feuilles composées, imparipennées et stipulées, c'est une plante cultivée comme engrais vert.

Le Tsitoavana a un feuillage très léger, vert clair et composé de feuilles très découpées comparables à une petite foliole lanceolée. Il peut atteindre 3 mètres de haut ; il est rustique, peu exigeant et a une croissance relativement rapide.

Les plantes servant à élever *Borocera* influent sur l'aspect et la couleur des cocons ; les vers élevés sur le Tsitoavana produisent des cocons légèrement rougeâtres, ils sont grisâtres sur le Tapia, il en est de même sur l'Ambrevade qui donne cependant des cocons plus petits.

Parmi tous ces végétaux, actuellement c'est le Tapia qui est le plus utilisé dans l'élevage du Landibe.

La méthode d'élevage du Landibe reste primitive et n'a pas réellement évolué ; les essais d'élevage en magnanerie n'ont pas donné de résultats probants, c'est pourquoi ils se font toujours en plein air.

Les éducations sont précédées par le choix des cocons reproducteurs les mieux conformés, la femelle est attachée à un petit bâtonnet sur lequel elle dépose les oeufs fécondés, cette ponte se fait le plus souvent à l'intérieur des habitations ; à l'éclosion, qui se produit quinze à vingt jours après la ponte, les chenilles sont transférées à l'extérieur et déposées directement sur les plantes nourricières où elles sont livrées à elles-mêmes pendant toute la durée de leur vie larvaire, qui dure 70 à 90 jours selon la température, et durant l'encoconnage. Les seules interventions de l'éleveur consistent à les protéger contre les oiseaux prédateurs et à surveiller les chenilles qui tentent d'outrepasser les canaux servant de frontières entre deux parcelles d'élevage.

Le Landibe file son cocon soit sur les branches d'arbre, soit au milieu des touffes d'herbes sèches disséminées sur le sol.

Les cocons sont alors récoltés une dizaine de jours après l'encoconnage ; on les dépose au soleil sur une natte pendant deux jours, en prenant soin de les remuer vivement avec une baguette dans le but de faire tomber les épines qui les recouvrent. Comme *Borocera* est bivoltin, cette récolte de cocons se fait deux fois par an : au mois de juin et au mois de décembre. Aucun procédé n'a été encore mis au point pour dévider les cocons de Landibe, leur transformation consiste à les ouvrir et à enlever les chrysalides.

Les coques obtenues sont ensuite retournées et empilées les unes à l'intérieur des autres par lot de quatre à cinq, on les fait bouillir dans de l'eau contenant des cendres, c'est la première phase de l'opération de décreusage qui doit être complétée par une deuxième, qui est en fait une macération dans l'eau pendant une semaine.

Une fois l'opération de décreusage terminée la soie est lavée à grande eau, puis séchée au soleil, on obtient alors une sorte de bourre grisâtre.

Ce décreusage se fait le plus souvent sur les lieux même de collecte des cocons de vers à soie sauvages, la bourre est ensuite acheminée et vendue à des artisans des hauts plateaux (Antananarivo et Fianarantsoa), au prix de 13 000 FMG à 15 000 FMG le kg en 1990 (1 FF = 270 FMG).

La filature proprement dite se fait avec une sorte de fuseau appelé Apela, le fil de soie obtenu est grossier et de titre irrégulier, il varie entre 130 et 160 deniers. Deux kilogrammes et demi de cette

matière sont nécessaires pour confectionner un linceul de 2,30 m sur 2,20 m, cette pièce se négocie en 1990 autour de 72 000 FMG.

Pour le revenu moyen des salariés malgaches, ce prix semble être élevé, des velléités d'utilisation d'autres matières textiles comme le coton, le paka ou les fibres synthétiques se sont manifestées. Ces tentatives de remplacement n'ont jamais pu remplacer la soie en général et les soies sauvages en particulier. Apprécies non seulement pour leur solidité, le dévolu qu'on jette sur les linceuls en soies sauvages provient du fait que ces derniers semblent mieux conserver les dépouilles mortuaires et pour une durée relativement longue ; ce point, qui peut paraître anodin pour des non initiés, est important pour tout Malagache un tant soit peu aisé qui considère comme un devoir sacré d'envelopper et de réenvelopper dans des linceuls en soie la dépouille de ses proches parents.

A cause de cet usage et du prix assez élevé (72 000 FMG la pièce de 2,30 x 2,20 m) les linceuls en soies sauvages sont aussi considérés comme des produits de luxe au même titre que la soie mûrier qui, du fait de la relative facilité de son élevage et de sa filature, attire beaucoup plus les sériciculteurs et les artisans.

II. LA SOIE MURIER A MADAGASCAR

Par opposition au Landibe, espèce endémique, le ver à soie mûrier est appelé à Madagascar Landikley (petit ver à soie) ou Landy Vahiny (ver à soie étranger). Contrairement à *Borocera*, *Bombyx mori* est en effet une espèce nouvellement introduite à Madagascar par les européens, il s'est bien adapté au climat tempéré des hautes terres malgaches ; les expériences passées ont montré qu'à Madagascar son élevage est possible de 800 m à 2 000 m d'altitude ; en dessous de 800 m, les excès de chaleur sont mal supportés par les variétés de *Bombyx mori* utilisées à Madagascar ; au dessus de 2000 mètres, l'élevage des vers est possible mais pour une saison très limitée à cause essentiellement de la chute précoce des feuilles de mûrier.

Le ver à soie mûrier est élevé par tradition dans trois zones bien distinctes : Antananarivo, Antsirabe et Ambositra.

La zone séricicole d'Antananarivo comprend les environs immédiats de la ville d'Antananarivo, la capitale, le Fivondronana ou Préfecture d'Ambohidratrimo, ainsi que celle d'Arinvonimamo, de par l'existence de forêt de Tapie ce dernier est aussi une zone d'élevage de *Borocera*.

La zone séricicole d'Antananarivo est située entre 18° et 19° Lat. S et 47° et 48° Long. E ; elle culmine à une altitude comprise entre 1 000 et 1 300 mètres et a un sol ferralitique peu fertile à pH acide de 4,5 à 5.

Le climat de cette zone présente une température maximale de 27° pendant le mois le plus chaud (décembre) et une température minimale du mois le plus froid (juillet) de 9° ; c'est une zone moyennement arrosée, elle reçoit 1350 mm de pluies pour 160 jours par an ; 90 % de cette pluie très mal répartie tombent au cours de la période allant du mois de novembre au mois de mars de l'année suivante ; pendant la période allant du mois de juin à septembre la précipitation est insignifiante, 12 mm pour 11 jours de pluie ; la carence hydrique du sol alliée à une baisse de la température nocturne occasionne la chute des feuilles de mûrier, qui reste en dormance pendant les mois de juillet - août ; le débourrement commence à partir de la dernière décade du mois d'août, mais, sans irrigation, les feuilles n'arrivent à maturité que vers fin octobre. Compte tenu de ces conditions agro-climatiques, la zone d'Antananarivo ne peut commencer qu'au début d'octobre la campagne séricicole, qui dure sept mois.

Ce cas de figure se présente aussi pour la zone d'Ambositra qui est toutefois moins arrosée, elle reçoit 1020 mm de pluie par an ; cette zone est située entre 20° et 21° Lat. S et 47° et 48° Long. E, elle culmine à une altitude de 1 400 à 1 800 m.

Se trouvant entre ces deux zones, celle d'Antsirabe, située entre 19° et 20° Lat. S et 46°30' et 47°30' Long. E à une altitude de 2000 m, a un climat plus froid ; la température maximale du mois le plus chaud (novembre) y est de 25,6° C, la température minimale du mois le plus froid (juin) est de 5,2° C ; cette zone est moyennement arrosée par 1 330 mm de pluie pendant 150 jours par an. Ces conditions relativement défavorables limitent la campagne séricicole à moins de six mois, cependant la zone d'Antsirabe a un sol volcanique très fertile qui favorise une croissance et un développement rapides des plants de mûriers.

Sur le plan moricole, ces trois zones séricicoles traditionnelles sont caractérisées par l'entrée en dormance des mûriers à partir du mois de juin, cet état de choses se manifeste très peu à des altitudes plus basses, de 800 à 1 000 mètres : c'est le cas de la zone du moyen-ouest, située entre 18°30' et 20°30' Lat. S et 46° et 47° Long. E, ainsi que de la partie moyenne du versant est de l'île arrosée par plus de 2 000 mm de pluie par an et située grosso modo entre 17° et 20° Lat. S et 48° et 48°30' Long. E. Des élevages de *Bombyx mori* entrepris dans ces zones ont montré que l'élevage du ver à soie y est possible presque toute l'année à condition toutefois de bien identifier les variétés de ver à soie adaptées aux microclimats de ces zones d'extension très propices à la culture de mûrier.

Les variétés de mûrier existant à Madagascar ont toutes été à l'origine importées soit d'Europe, soit de l'Extrême-Orient. Dans les zones séricicoles traditionnelles des hauts plateaux, toutes ces variétés sont au repos végétatif pendant l'hiver austral, du mois de juin au mois d'août.

On a recensé jusqu'à maintenant une vingtaine de variétés dont huit sont couramment utilisées.

Il s'agit de variétés appartenant aux trois lignées : *Morus alba*, *Morus bombycis* et *Morus lhou*. Les mûriers les plus anciens sont au nombre de deux et portent les noms vernaculaires suivants : Andrazina vavy ou mûrier femelle et Andrazina lahy ou mûrier mâle ; ils appartiennent à la lignée *Morus alba*.

Ils sont donc de ce fait considérés comme mûriers malgaches, ce sont des variétés rustiques qui résistent assez bien aux quelques rares maladies qui sévissent à Madagascar. Ces deux variétés se distinguent par la grosseur de leurs feuilles, les feuilles lobées du mûrier mâle sont plus petites que celles non lobées du mûrier femelle.

Comparées au Kokuso 27, mûrier importé du Japon, ces variétés locales donnent un rendement en feuilles deux fois moindre, cependant elles ont un débourrement précoce et se multiplient facilement par bouturage.

Ce qui n'est pas le cas du Kokuso, dont la multiplication ne peut se faire que par greffage sur racine, méthode de multiplication que les sériciculteurs malgaches ont du mal à adopter.

Sur le plan rendement, la variété Kokuso 27 est suivie par une variété dénommée *Chinensis*, importée de Chine Formose, de la lignée *Morus bombycis*.

Quatre variétés européennes sont également couramment utilisées, il s'agit des variétés Valenciennes, Multicaule, Lhou rose et Lhou blanc toutes de la lignée *Morus alba*. Parmi ces huit variétés le Multicaule est le moins apprécié à cause de la minceur et du caractère gaufré de ses feuilles.

De plus, avec l'aide de la FAO, le Service public chargé du Développement de la Sériciculture vient d'importer de l'Inde cinq nouvelles variétés de mûrier : le Kanva 2, le Sunjapur 54, le Sunjapur 34, le Kokuso 21 et le Kokuso 27, ces nouvelles variétés introduites au début de l'année 1990 sont sous observation et en cours d'adaptation et ne font pas encore l'objet de diffusion auprès des sériciculteurs, leur bonne reprise laisse cependant augurer un bon comportement aux conditions agro-climatiques de Madagascar, qui disposera de ce fait d'une panoplie moricole suffisante permettant d'entreprendre un développement harmonieux de l'élevage du ver à soie.

Sur le plan phyto-pathologie, il faut remarquer que les mûriers malgaches sont relativement très peu touchés par les maladies et les parasites.

Quatre insectes parasites attaquent le mûrier à Madagascar. En premier lieu, il convient de citer *Callimima venustum* qui est un longicorne rouge et blanc, ce parasite commet de graves dégâts dans les mûraies tant à l'état larve qui est lignivore que sous forme d'insecte parfait, ce dernier s'attaque de préférence aux jeunes pousses.

Une sorte de charançon, ou *Alcides excavatus*, de couleur grisâtre parasite aussi le mûrier à Madagascar, ce charançon coupe les jeunes rameaux en voie de développement et les feuilles.

La cochenille, ou *Pseudolacapsis pentagona*, parasite également les mûriers à Madagascar, les deux mûriers malgaches résistent mieux à cette maladie que les nouvelles variétés importées.

Le quatrième et dernier parasite identifié est l'oïdium, ou *Phyllastinia moricola*. Ce parasite couvre la face inférieure des feuilles d'une végétation cryptogamique blanchâtre, diminuant la valeur nutritive des feuilles, les mûriers malgaches sont les plus sensibles à cette maladie.

Parmi les calamités naturelles, il est enfin à mentionner la gelée blanche qui peut tuer les jeunes pousses de mûrier au cours des mois d'août et septembre.

Dans les régions à saison froide plus marquées, la gelée blanche peut compromettre la première éducation de ver à soie qui se fait au cours du mois d'octobre.

En matière de races de ver à soie, Madagascar dispose, au niveau des 3 stations séricicoles d'Etat, de 28 variétés : 10 variétés polyvoltines, 11 variétés bivoltines et 7 variétés monovoltines qui sont toutes originaires d'Europe et d'Asie.

Il est important de faire remarquer que les 11 variétés polyvoltines ont été formées depuis quinze ans. Comparées à d'autres souches polyvoltines d'autres pays, les polyvoltines malgaches sont très différentes, leurs caractères se rapprochent plutôt de ceux des bivoltines. La couleur des oeufs, qui éclosent 11 à 12 jours après la ponte, évolue de la même façon que la couleur des oeufs bivoltins. Après quelques années de sélection, les cocons ont soit la forme ovale, soit la forme cacahuète à bouts arrondis, ils sont de couleur blanche ou crème et ont une assez bonne aptitude à la filature.

Comme le montre le tableau qui suit les performances des polyvoltins malgaches varient pour le poids de coque de 0,22 g à 0,31 g contre 0,10 g à 0,15 g pour les polyvoltins de l'Inde.

Tableau I. Performances des races polyvoltines malagasy.

Table I. Rearing performance of Malagasy polyvoltine races.

Variétés <i>Varieties</i>	Poids du cocon (g) <i>Cocoon weight (g)</i>	Poids de la coque (g) <i>Shell weight (g)</i>	Richesse soyeuse (%) <i>Silk ratio (%)</i>	Titre (denier) <i>Size (denier)</i>	Forme cocon et couleur <i>Cocoon shape and colour</i>
MA	1,76	0,306	17,53	2,21	Cacahuète blanc <i>Peanut white</i>
MC	1,79	0,310	17,43	2,30	"
MB	1,49	0,227	15,15	2,19	Ovale blanc <i>Oval white</i>
MH	1,60	0,282	17,69	1,64	Ovale crème <i>Oval cream</i>
MF	1,69	0,288	17,17	2,15	"
MD	1,56	0,275	17,29	1,78	Ovale blanc <i>Oval white</i>
MBm	1,83	0,284	17,11	2,06	"
MHB	1,44	0,239	15,60	2,41	"
MCSm	1,58	0,271	17,16	1,77	Cacahuète blanc <i>Peanut white</i>
CFm	1,39	0,257	16,76	1,87	Ovale blanc <i>Oval white</i>

Ces 10 variétés ainsi que les autres variétés bivoltines et monovoltines sont entretenues et élevées en lignées pures par le Centre national de Sériciculture de Mahitsy qui entreprend aussi des essais d'hybridation.

Les races vulgarisées sont toutes en effet des hybrides, soit de l'hybride simple de MA × MC, soit du trihybride = (MA.MC) MH.

Tableau II. Performances des hybrides polyvoltins malagasy.

Table II. Rearing performance of Malagasy polyvoltine hybrids.

Variétés <i>Varieties</i>	Richesse soyeuse (%) <i>Silk ratio</i> (%)	Titre fil (denier) <i>Thread size</i> (denier)	Rendement par boîte de 20 000 oeufs (kg) <i>Yield per 20,000 egg</i> <i>box (kg)</i>
MA × MC	17,40	2,23	22
MH	17,69	1,64	21
(MA.MC) M	16,50	1,81	15

Les performances de MA × MC et MH sont celles obtenues en Station et celles de (MA. MC) MH en élevage paysan.

Ce sont des trihybrides indemnes de pébrine et préalablement désinfectés au formol qui sont cédés aux éleveurs.

Durant la campagne 1989-90, quelques 1 200 foyers séricicoles ont ainsi reçu 140 000 cellules de ver à soie réparties sur 3 ou 4 élevages.

La productivité des élevages paysanais est encore moyenne et n'a jamais dépassé les 15 kg/boîte, cette faiblesse serait due au faible taux d'éclosion des graines, à une mauvaise conduite de l'élevage surtout pendant le jeune âge et, parfois, à l'insuffisance d'alimentation ainsi qu'aux maladies.

Plusieurs maladies attaquent le ver à soie à Madagascar, elles sévissent surtout pendant la période de pluies cycloniques (décembre, janvier et février) mais malheureusement au moment où les feuilles de mûrier sont abondantes et de bonne qualité.

Les maladies les plus courantes sont au nombre de trois : les flacheries, la grasserie et la muscardine blanche ; quelques rares cas de muscardines roses ont été aussi observés sur des races bivoltines.

Ces quatre types de maladies du ver à soie apparaissent très rarement dans les trois Centres Séricicoles d'Etat qui ont beaucoup plus de facilités pour entreprendre les opérations de désinfection avant et en cours d'élevage.

Pour lutter contre ces maladies en milieu paysan nos vulgarisateurs se sont attelés à inculquer à nos sériciculteurs des méthodes simples de désinfection : lavage à l'eau courante et séchage au soleil des matériels d'élevage, fumigation des chambres et matériels d'élevage avec la fumée d'aiguilles de pins, badigeonnage à la chaux des chambres d'élevage, saupoudrage des corps des vers en mue avec de la chaux et des balles de riz grillées et espacement suffisant des éducations pour assurer un minimum de vide sanitaire ; c'est ainsi qu'on préconise aux éleveurs de ne mener dans les conditions actuelles que quatre éducations par campagne de sept mois.

Le nombre d'élevage par campagne ainsi que la productivité peuvent être augmentés à condition de bien maîtriser la prophylaxie.

Ce qui est réalisable avec des élevages en commun des jeunes vers dans des magnaneries faciles à désinfecter avec des produits chimiques et à micro-climat facile à maîtriser.

C'est dans ce but qu'on a été menés depuis une année des essais d'élevage en commun des jeunes vers, ces essais ont déjà permis de porter le rendement par boîte de 20 000 oeufs de 15 kg à 20-21 kg de cocons frais.

Inciter nos paysans à se grouper au sein d'associations de sériciculteurs de 25 à 30 membres et à faire l'élevage des jeunes vers en commun constituent l'une des grandes tâches auxquelles s'attellent actuellement nos vulgarisateurs.

Quelques associations ont déjà exprimé par ailleurs le besoin de se passer du service d'intermédiaires et de négocier directement avec les artisans de filature la vente de cocons frais. En 1989/90, le kg de cocons frais s'achète à 3 000 FMG chez les producteurs et est revendu à 4 000 FMG aux artisans (1 FF vaut 270 FMG).

La transformation des cocons frais se fait à Madagascar de deux manières.

Un premier procédé, utilisé par les artisans du Faritany de Fianarantsoa, consiste à transformer les cocons frais de ver à soie mûrier comme les cocons de Landibe.

Le second, mieux élaboré, se rapproche du Gharkha indien et produit des fils de grège grossiers et à titre irrégulier, le titre du fil obtenu peut atteindre 110 à 120 deniers ; le matériel de filature, qui n'a ni croisure, ni tavelettes, est constitué d'une grosse marmite en fonte et d'une manivelle qui entraîne une guindre sur laquelle vient s'enrouler le fil de grège de titre irrégulier et d'aspect plat. Ce procédé de filature curieusement appelé Foly Tspay ou filature espagnole produit des flottes standard de 250 à 300 g, qui est le poids de fil nécessaire au tissage d'une écharpe traditionnelle vendue par l'artisan au prix de 40 000 FMG en 1989 (1 FF = 270 FMG).

Si, dans le Faritany de Fianarantsoa, l'éleveur est aussi l'artisan de filature et de tissage, dans le Faritany d'Antananarivo existe une certaine spécialisation régionale des activités de la soie ; les zones d'élevage sont ainsi séparées des zones de filature et ce depuis 1850.

Cette séparation des zones d'activités aurait été dictée par le souci des développeurs d'éviter au maximum la prolifération des maladies du ver à soie.

Pour la région d'Antananarivo les filateurs et les tisserands de la soie se trouvent concentrés à Avaradrano, à une trentaine de kilomètres au nord d'Antananarivo ainsi qu'autour d'Arivonimano, à une quarantaine de kilomètres à l'ouest de la capitale.

A elles seules, ces deux localités comptent dans les 2 000 tisserands travaillant la soie mûrier et les soies sauvages et quelquefois de la bourrette de soie importée puisque la production nationale n'arrive pas encore à couvrir les besoins de cet artisanat.

Devant les fortes potentialités de production de soies, l'abondance d'une main d'oeuvre relativement bon marché et l'existence d'un débouché local et extérieur pour les produits de qualité le Gouvernement de la République démocratique de Madagascar a décidé de mettre en oeuvre un projet de développement de la production de la soie.

C'est un projet qui s'est déroulé sur deux phases :

- une phase d'exploration de 1983 à 1985 ;
- et une seconde phase de 1987 à 1990 dont les activités ont été focalisées sur le développement proprement dit de la sériciculture traditionnelle.

Cette deuxième phase consistait :

1) en la mise en place des infrastructures d'un Service Public de recherches et d'Encadrement séricicoles rattaché au Ministère de la Production animale (Elevage et Pêche) et des Eaux et Forêts.

Les infrastructures comprennent le Centre national de Sériciculture de Mahitsy situé à une trentaine de kilomètres d'Antananarivo, la capitale, et, respectivement à 170 km et à 260 m au sud de celle-ci, les Centres de Vulgarisation séricicoles d'Antsirabeet d'Ambositra.

Ces trois centres ont pour mission :

- l'expérimentation et la mise au point de nouvelles techniques de production ;
- la sélection et l'entretien des souches parentales de vers à soie ;
- la production de graines hybrides F1 indemnes de maladies et de plants de mûrier améliorés ;
- la formation et l'encadrement des sériciculteurs ainsi que des artisans de filature.

2) en la formation à l'extérieur d'un noyau de techniciens d'encadrement dans différents pays tels que la Chine et la France.

Ces investissements ont été effectués avec l'aide du PNUD (Programme des Nations Unies pour le Développement) et la FAO et ont été complétés par des dons en matériels du Gouvernement japonais.

Les actions menées jusqu'à maintenant ont concerné presque exclusivement le ver à soie mûrier, les séricigènes sauvages n'ayant fait l'objet que de quelques travaux de prospection qui ont permis cependant de dégager l'énorme potentialité de la sériciculture sylvicole représentée par au moins un millier d'ha de *Tapia* ou *Uapaca bojeri*.

Aussi, à l'avenir, le développement de la production de la soie concernera-t-il à la fois les deux espèces :

Pour la soie mûrier : nous projetons de renforcer les infrastructures et les moyens de recherches et d'encadrement des éleveurs ; la capacité de graineage des Stations séricicoles gérées par le Service Public d'encadrement sera ainsi augmentée pour permettre de produire d'ici deux ans 5000 boîtes de graines F1 par an, la capacité technique du personnel d'encadrement sera aussi renforcée grâce à la formation à l'extérieur de cadres techniques de haut niveau dans le domaine de :

- la génétique et de la sélection du ver à soie ;
- la pathologie du ver à soie ;
- la moriculture et l'alimentation du ver à soie ;
- la filature de la soie mûrier et des soies sauvages.

Pour les soies sauvages : il importe d'établir un Plan Directeur de développement et d'exploitation des séricigènes sauvages. Ce qui nécessiterait entre autres :

- l'approfondissement des connaissances actuelles sur la biologie, la vie et les mœurs de ces séricigènes ;
- l'inventaire et l'évaluation des surfaces actuelles couvertes par les plantes nourricières ;
- des essais de transformation semi-industrielle des cocons ;
- l'étude du marché extérieur potentiel.

Telles sont les actions que Madagascar se propose de mener à l'avenir et pour lesquelles nous sollicitons la contribution des pays ou organismes étrangers. A ce titre, nous aimerions connaître dans quelle mesure la Commission séricicole internationale pourra apporter sa contribution, notamment en matière de formation de nos futurs chercheurs et dans l'étude de l'exploitation des soies sauvages.

QUESTIONS

M. Todoroki demande s'il y a des questions.

Mr Todoroki asked whether there were any questions.

Mme Goldsmith : "Quel est votre système pour maintenir la qualité de vos souches locales ? Les oeufs sont-ils produits par les paysans ou bien avez-vous un système de contrôle de production ?

'What system do you use to preserve the quality of your local strains ? Are the eggs produced by the farmers or do you have a production control system ?'

M. Ralambofiringa passe la parole à M. Andriamahenina qui est le spécialiste de la délégation malgache.

Mr Ralambofiringa handed over to Mr Andriamahenina, the specialist of the Madagascan delegation.

M. Andriamahenina : "Nous avons actuellement trois stations séricicoles gérées par le Ministère de la Production animale. Ce sont elles qui entretiennent et font la sélection des souches parentales, font des essais de croisement et d'obtention d'hybrides.

Ce sont ceux qui ont donné des résultats probants qui sont cédés aux éleveurs.

Donc, la production de graines n'est faite que par les stations d'Etat. Les paysans en font de temps à autre, mais on leur déconseille d'en faire car ils n'ont pas les connaissances ni le matériel pour le faire."

'At present, we have three sericultural stations under the supervision of the Ministry of Animal Production. These preserve and select the parental strains, conduct crossing experiments to obtain hybrids. Those which gave positive results are handed to the rearers.'

So seed production is only done by Government stations. Farmers do some from time to time but they are advised against it as they have neither the knowledge nor the equipment for this.'

M. Chavancy : "Avez-vous indiqué la quantité de soie produite par les deux systèmes, c'est-à-dire *Bombyx mori* et Landibe ?"

'Did you indicate the quantity of silk produced with the two systems, that is to say Bombyx mori and Landibe ?'

M. Andriamahenina : "Pour la soie sauvage, nous n'avons pas les chiffres car c'est une production encore rudimentaire. La quantité est appréciable. En soie mûrier, 50 à 55 tonnes de cocons frais sont produits actuellement à partir de graines distribuées par le Ministère à des paysans encadrés."

'For wild silk, we do not have the figures because it still is a rudimentary production. The quantity is appreciable. In mulberry silk, 50 to 55 tonnes of fresh cocoons are currently produced with the seeds distributed by the Ministry to the farmers under supervision.'

M. Chavancy souhaite revenir sur l'exposé de M. Todoroki et lui demande quelle est actuellement la quantité et la provenance des cocons importés au Japon.

Mr Chavancy wished to come back to Mr Todoroki's review and asked him what was at present the quantity and origin of the cocoons imported to Japan.

M. Todoroki : "Pour 1990, le Japon a importé 1 100 tonnes de cocons secs. Principalement de Chine."

'For 1990, Japan imported 1,100 tonnes of dry cocoons. Mostly from China.'

M. Guigou : "Je voudrais savoir quels sont les critères de qualité utilisés pour les cocons importés au Japon".

'I would like to know what criteria of quality are used for the cocoons imported to Japan.'

M. Todoroki : "Les cocons importés sont essentiellement utilisés pour fabriquer les kimonos mais seulement la trame car il faut de la très haute qualité pour la chaîne."

'Imported cocoons are essentially used for making kimonos, but only the weft as the warp requires very high quality silk.'

SERICULTURE IN EGYPT

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The development of sericulture is of great economic significance in promoting agricultural production, meeting the needs of the people and increasing the income of jobless and landless farmers of rural areas.

In Egypt although the silk woven carpets which are exported abroad have gained a good reputation and income, yet the weavers face the lack of raw silk produced. The production annually does not exceed 5 tonnes while the country consumes more than 200 tonnes which satisfy the local market. It is considered that the main bottle-neck that faces the spread of silk production in Egypt is the unavailability of adequate technology allowing cultivation of mulberry as a crop.

AGRO-CLIMATIC CONDITIONS

The climate in Egypt is temperate with distinct winter and summer seasons. Spring and autumn are usually brief and variable. The winter season lasts about three months with an average temperature of 18° C and low annual rainfall (not exceeding 25 mm). Summer is hot with an average temperature of 34.5° C, but it is reasonable due to the absence of rainfall and low humidity owing to the surrounding deserts. Mulberry starts to sprout from the middle of February and grows so fast with harsh leaves owing to the long day light and active rapid photosynthesis. The vegetation period lasts about 280 days till 15th November.

SOCIO-ECONOMIC CONDITIONS

Egypt has only 2,855,000 ha of arable land (2.87 % of the total land), while the rest is almost desert, the population grows slowly but irreductably. Due to that, the total population is now above 50 million including 50 % of the total as agriculture labour force. The pressure on the limited cultivated land has emphasized the need to increase the productivity of an already intensive crop production system and to create more jobs. Family ownership patterns are very small and the population densities in some Governorates are 1,000/sq. km. Thus there is presumably a labour surplus in rural areas. The seasonal and marginal labours migrated from rural areas to seek out opportunities for work in the Arab countries. But because of the Gulf crisis, most of them returned jobless and desperate. As silk production and processing are part of the small and cottage industry area and have recently come back into prominence as a potential rural based industry, it is worthy to build it in Egypt. The government from its side has planned for the promotion of silk and spread of the activity but till now it has been modest.

DATA OF MULBERRY SURFACE

The major farm crops cultivated in Egypt are cotton, corn, wheat, rice, broad-bean and sugar cane, among which the most cash crop is cotton. It is a significant export product. The crops are cultivated in a following plan and are provided with an organized net of streams and canals for irrigation. So it is considered that the potential costs of land are very high and the only place to grow mulberry as trees are on the banks and embankments of canals or on the sides of roads in rural areas.

The mulberry trees, unfortunately, are in natural form without any pruning or manuring. It becomes an arbour with disordered stems and branches and it is harvested once a year for spring rearing. The number of trees scattered all over the country reaches approximately 4 million mostly found in Delta Governorates. Not all of them are used for worms' feeding, they are mainly cultivated for shade and for fixing the soil of stream banks.

Not less than 20 varieties of mulberry are known in the country carrying local names, yet the most popular and recommended ones are Rumi (Kanva-2) and Japanese (Ishnoise). The mulberry tree suffers in Egypt from few types of diseases and pests, like powdery mildew and mealy bug, but they are not serious and are under control.

Concerning mulberry field, recently some investors began mulberry plantation in their reclaimed lands and it has succeeded till now, giving high production of leaf crop and giving a sign of prosperous future.

SILKWORM BREEDING AND REARING

As the investments of the Government in the field of sericulture are weak, the sericultural section could not begin the commercial egg production plan in spite of the existence of indigenous parents. That was due to the lack of well-trained personnel, shortage of equipments and the non-existence of good administration.

Still, Egypt imports annually egg cases from other countries and the sericultural section distributes them to rearers in the rural areas under the supervision of extent agents. The rearer hatches the eggs by himself and rears the worms on reed shelves in his house. Healthy young larvae rearing is not practised and the larval period lasts for 30-35 days. The average yield of fresh cocoons is about 24 kg per case (a case = 12 g). One case can provide a rearer with almost a net income of about 110 EL. The harvested cocoons are dried in the sun for 3 days, and stired for auction time.

Reelers obtain their raw material (cocoons) from auctions held by the Government in the rearing governorates at reasonable prices. Manual rearing is an activity practised by old families in rural areas who yield a fine quality of raw silk. It is accepted by carpet manufactures which used to count on imported silk from China and Korea. The present production is about one metric tonne while the requirements of the country industry to weave manual rugs and carpets alone is said to be 100 metric tonnes. The silk carpet industry as a whole produces rugs of high quality which are very similar in style to the old antique ones. The produced rugs are often sent abroad to Japan, Europe and the United States of America, reaching a price of as much as US \$1,200 a square meter.

Also, the villagers of Akhmim (a village in Upper Egypt) gained a good reputation as weavers of silk fabrics and they recently opened up an export outlet in Germany for their bright purple and red scarves. But again, they rely on imported material of silk threads - a factor which could easily limit further expansion. Also, the silk textile is practised in Alexandria where a modern equipped mill was founded.

The silk industry in Egypt is small but its potential for development and expansion is significant and promising. The future plans will depend to a large extent on the government. Farmers in Egypt are very much bound to plant what the Government wants them to plant. In the newly reclaimed lands the Government intends to plant mulberry fields with the aim of encouraging the domestic silk producing industry, especially that the related secondary industries relying on silk do exist and have shown potential with a bit of effort in the right direction, the dream of domestic silk industry in Egypt can come true to be a reality.

QUESTIONS

Mr Tayade :

'What is the annual rainfall in the regions you mentioned ?'

"Quelle est la pluviométrie dans les régions dont vous nous avez parlé ?"

Mrs Kotby :

'Very low, not more than 25 mm.'

"Très faible, pas plus de 25 mm."

Mr Todoroki handed over to Mr Tayade.

M. Todoroki passe la parole à M. Tayade.

THE DEVELOPMENT AND PROMOTION OF SERICULTURE IN MAHARASHTRA STATE

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Sericulture has emerged as an economically viable, modern industry spreading over 58 countries in the world, mostly in the tropical belt. The growth of sericulture industry in India itself, in the past 20 years, has been encouraging and outstanding. In the 1950s and 1960s, sericulture was confined to three major states, viz. Karnataka, West Bengal and Jammu & Kashmir. Till the 1970s sericulture was confined only to the traditional South Karnataka and its bordering districts of Andhra Pradesh and Tamil Nadu in the South, West Bengal in the North-East and Jammu & Kashmir in the Northern regions of India. The improved tropical sericultural technology developed by Central Silk Board helped in the spread of sericulture to the warmer and non-traditional areas. A dynamic growth phase of seri-industry during the past 20 years can be visualised by the increased production of raw silk from 2,046 mt. in 1971-1972 to 9,500 mt. in 1988-89. During these years, the area under mulberry cultivation has increased from 1,04,885 hectares to 2,55,000 hectares; the export earnings out of raw silk products jumped from Rs 7.52 crores⁽¹⁾ to Rs. 330.54 crores. Foreign exchange earnings of the Indian silk industry during the year 1989-1990 touched a peak of Rs 400.61 crores.

Maharashtra State was considered as non-traditional for sericulture until 1977-78. In the same year, Marathwada Agricultural University proved the feasibility and profitability of silkworm rearing in the Marathwada region. The Aurangabad division of Maharashtra State, known as 'Marathwada' consists of seven districts, namely Aurangabad, Jalna, Beed, Parbhani, Nanded, Osmanabad and Latur. It is one of the six administrative divisions of Maharashtra State since May 1960. Geographically, the region is situated between 17°35' N and 20°40' N latitudes and 74°40' E and 78°15' E longitudes. The total geographical area of the region is about 64 lakh hectares⁽²⁾ (64,525 sq. km.), out of which a 53 lakh hectare area is under cultivation. The Marathwada region has 97,48,000 total population, out of which 79,67,000 is rural and 17,81,000 is urban population. The total population of Maharashtra State is around 6.28 crores. The total cropped area is 199 lakh hectares. There are 41,833 villages in the State. There is considerable scope for the development of sericulture in Maharashtra and particularly in the Maharashtra region as a fact that the adjoining Karnataka State is sericulturally the most advanced in the country. The State Government has entrusted the work of sericulture development to the Maharashtra State Khadi and Village Industries Board (MSKVI Board). Although the MSKVI Board initiated the work on sericulture during 1957 the industry did not spread beyond the borders of Satara district till 1977-78. Marathwada Agricultural University (Parbhani) acted as catalyst to the MSKVI Board for spreading this industry in the State. Now, 24 districts out of 30 districts of the States are practising sericulture, including all seven districts of the Marathwada region. However, the MSKVI Board has developed a network of extension and input services from 1989. Marathwada Agricultural University is engaged in research and educational programme on sericulture.

During 1989-90, 2,336 acres additional new plantation of mulberry have been brought under cultivation with a total mulberry plantation of 3,001 acres (Table II). The share of the Marathwada

(1) 1 crore = 10,000,000.

(2) 1 lakh = 100,000.

Table I. Development of sericulture in Marathwada region and Maharashtra State (India) in 1988-89 (up to 31st March 1989).

Tableau I. Développement de la sériciculture dans la région de Marathwada et dans l'Etat du Maharashtra (Inde) en 1988-89 (jusqu'au 31 mars 1989).

Sl. no.	District of Marathwada region	Mulberry plantation (acres)			Total farmers	No. of farmers trained	Total no. of DFLs supplied	Total cocoon production (kg)
N ^o de série	District de la région de Marathwada	Old*	New	Total	Nombre total de fermiers	Nombre de fermiers formés	Nombre total de pontes saines fournies	Production de cocons (kg)
		Anciennes*	Récentes	Total				
1	Aurangabad	6.10	21.00	27.10	36	28	2,168	472
2	Jalna	4.20	19.20	24.00	22	22	1,925	161
3	Beed	-	32.30	32.30	43	43	2,205	48
4	Parbhani	11.10	19.30	31.00	34	34	1,735	104
5	Nanded	30.00	11.10	41.10	39	39	8,842	666
6	Osmanabad	11.20	18.20	30.00	36	13	4,496	815
7	Latur	-	22.30	22.30	29	26	1,600	187
	Total	63.20	145.20	209.00	239	205	22,971	2,493
	Maharashtra State	367.23	986.35	1354.18	1511	1259	2,17,705	34,626

* Existing plantation during June 1988 / *Plantation antérieure à juillet 1988.*

Table II. Development of sericulture in Marathwada region and Maharashtra State (India) in 1989-1990 (up to 31st March 1990).

Tableau II. Développement de la sériciculture dans la région de Marathwada et dans l'Etat du Maharashtra (Inde) en 1989-90 (jusqu'au 31 mars 1990).

Sl. no.	District of Marathwada region	Mulberry plantation (acres)			Total farmers	No. of farmers trained	Total no. of DFLs supplied	Total cocoon production (kg)
N ^o de série	District de la région de Marathwada	Old*	New	Total	Nombre total de fermiers	Nombre de fermiers formés	Nombre total de pontes saines fournies	Production de cocons (kg)
		Mûraies (en acres)						
		Anciennes*	Récentes	Total				
1	Aurangabad	11.15	11.20	22.35	32	26	6,267	578.223
2	Jalna	17.00	15.20	32.20	31	15	4,230	381.875
3	Beed	10.30	48.00	58.30	82	42	13,512	535.160
4	Parbhani	14.10	49.10	63.20	60	52	6,692	1225.909
5	Nanded	28.10	70.00	98.10	97	70	20,047	1741.420
6	Osmanabad	13.00	34.20	47.20	41	33	8,981	1841.400
7	Latur	12.20	32.20	45.00	50	36	9,270	1909.900
	Total	107.05	261.10	368.15	393	274	68,999	8213.887
	Maharashtra State	664.37	2336.10	3001.16	3,408	-	7,73,957	1,22,968.510

*Existing plantation during June 1989 / *Plantation antérieure à juin 1989.*

region is 368 acres. In the preceding year (1988-89) the total area was only 1,354 acres wherein the Marathwada region contributed only 209 acres (Table I). The total number of farmers who have taken sericulture 3,408. A total of 7.74 lakh DLFs were distributed and 122 tonnes of cocoons produced. The corresponding figures for the previous year are 2.18 lakh layings and 34 tonnes cocoon production respectively. Thus there has been a 3.5 time increase in laying consumption and four fold increase in cocoon production (Kasivishwanathan, 1990).

Table III. Mulberry plantation in Marathwada region during 1990-91.

Tableau III. Plantations de mûriers dans la région de Marathwada en 1990-91.

Sl. no.	District	Mulberry plantation (acres)		
		Old*	New	Total
		Plantations de mûriers (en acres)		
N° de série	District	Anciennes*	Récents	Total
1	Aurangabad	17	6	23
2	Jalna	27	-	27
3	Beed	53	118	171
4	Parbhani	64	146	210
5	Nanded	89	223	312
6	Osmanabad	42	70	112
7	Latur	45	70	115
	Total	337	633	970

* Existing plantation during June 1990 / *Plantation antérieure à juin 1990.*

During 1989-90, a total 368 acre mulberry plantation was undertaken by 393 farmers in the Marathwada region. The farmers produced 8,617.409 kg cocoons valued at Rs 519,717. During the year, 44.5 tonnes of cocoons were reeled in five cottage basins, 3,566 kg silk obtained with 12,52 renditta and the corresponding figures for the previous year were 15 tonnes cocoons, 1,067 kg silk and 14,43 renditta, respectively (Kasivishwanathan, 1990).

In the present year (1990-91) a new mulberry plantation of 633 acres has been undertaken by 650 farmers of the Marathwada region, bringing the total of 970 acres. However, the total mulberry plantation has increased from 3,001 acres to 9,060 acres in the State. Though the industry is scattered throughout the State, Solapur, Satara, Ahamadnaar, Dhule, Nanded, Parbhani and Akola districts are the major ones.

By the end of VIIIth Five Year Plan (1994-95) the State will have 40,000 acre mulberry plantation and utilize 3.25 crores disease-free layings. The State as such has been free from uzifly and pebrine infections so far.

The expansion activities of sericulture, though started with full enthusiasm and interest, could not be stabilized and many farmers started uprooting their mulberry gardens within a span of two or three years and, in some cases, in the next year only. Dandin (1990) has analysed the situation and

extracted the reasons of this disappointing trend of farmers in new areas. The author is in full agreement with the thoughts of Dandin which are quoted below :

- a. Inadequate rearing space and appliances in relation to leaf yield.
- b. Non-supply of chawki reared worms/eggs in an appropriate time.
- c. Poor technicological know-how and non-adaptability of improved rearing technology by the farmers.

d. Insufficient extension support and lack of proper crop supervision and guidance.

e. Non-supply of rearing material to the farmers.

f. Poor marketing facilities and non-remunerative rates offered for the cocoons produced.

As a result, farmers could not harvest good cocoon crops and all assurances/promises made by the development agencies were not fulfilled. Hence, farmers lost interest and started uprooting mulberry gardens. The reasons for such a large-scale failure of the new programme and disappointment may be found in the following facts :

- Sudden expansion and target for covering large areas in a short period.
- Inadequate technical manpower to man the implementation programme.
- Poor training facilities to train farmers and other grass-root workers.
- Poor co-ordination in arranging the supply of seed material, rearing appliances, chawki worms/eggs and disposal/marketing of cocoons.

Table IV. Overview of sericulture in Maharashtra during 1982-83 and 1987-88.

Tableau IV. Etude d'ensemble de la sériciculture dans le Maharashtra en 1982-83 et 1987-88.

Sl. no. N° de série	Particulars Caractéristiques	1982-83	1987-88
1	Total no. of villages in the State / Nb. total de villages dans l'Etat	36,033*	41,833**
2	Sericultural villages / Villages séricicoles	167	751
3	Mulberry plantation (ha) / Mûraies (ha)	150	751
4	DFLs supply / Fourniture de pontes saines	53,000	1,31,000
5	Cocoon production (tons) / Production de cocons (tonnes)	6	33
6	Raw silk (kg) / Soie grège (kg)	330	1,000
7	Waste silk (kg) (during reeling)	-	2,000
7	Déchets de soie (kg) (au cours du dévidage)		
8	Tasar DFLs supply / Fourniture de pontes saines tasar	20,000	5,68,000
9	Tasar cocoon production / Production de cocons tasar	Neg	4,000 kahan
10	Tasar raw silk (tons) / Soie grège tasar (tonnes)	-	4
11	Filature / Filature	No	No
12	Cottage basin / Bassine artisanale	5	11
13	Charkha / Charkha	No	12
14	Handlooms for silk weaving / Métiers à la main pour le tissage de la soie	140	225
15	Tasar silk reeling / Filature de la soie tasar		
	a. Handlooms / Métiers à la main	8	} 180
	b. Powerlooms / Métiers mécaniques	8	
	c. Spinning machines / Machines à filer	85	

*, ** As per the 1971 and 1981 censuses, respectively / D'après les recensements de 1971 et 1981, respectivement.

ROLE OF MARATHWADA AGRICULTURAL UNIVERSITY

The first problem tackled by MAU (Parbhani) was to start the feasibility and profitability of silkworm rearing under Marathwada conditions and to prove that sericulture could be commercially exploited from July to March and even in April with little modification in rearing house conditions. The input:output ratio worked out was 1:3.08. In addition, the following research findings were drawn by Marathwada Agricultural University, Parbhani.

1. Kanva-2 (M-5) and S-54 mulberry varieties not only gave higher leaf production but were also superior as food to the silkworm growth and development in comparison to other varieties under collection.

2. S-54 mulberry variety yielded 40,000 to 45,000 kg leaves/ha. at a spacing of 90 × 60 cm, although Kanva-2 was tolerant to insect pests and diseases yielding 35,000 to 40,000 kg leaves/ha. with 90 × 90 and 60 × 60 cm spacing, slightly less than S-54.

3. The cross-breds of multivoltine × bivoltine mulberry silkworms were useful for higher cocoon production.

4. Kanva-2 (M-5) mulberry variety should be planted 90 × 90 cm in Maharashtra in view of the soil type and irrigation facilities.

5. Two diseases, viz. flacherie and grasserie observed in the State could be managed with paraformaldehyde and 'Resham kit oushad' as bed disinfectant.

6. The eggs of multivoltine race could be preserved up to 30 days at 5 °C temperature in refrigerator under emergency.

7. The application of weedicides, viz. fluchloralin (Basalin), Oxidiazon (Ronstar) and pendimethalin (stamp) gave significantly higher leaf yield of mulberry over the application of diuron (Haxaxine).

8. To enrich the germplasm of mulberry, MAU collected 28 mulberry varieties, viz. Kanva-2, S-3, S-13, S-14, S-30, S-34, S-36, S-41, S-54, BER-1, BER-763, BER-776, BER-799, Sujanpur, Mizoswa, LM₁, LM₂, Mysore Local, LMP, p-1, p-4, p-16, p-21, T-5, T-6, T-7, A-1 and Kosen.

9. Undergraduate and post-graduate teaching programme.

10. Extension education programmes for farmers training and other higher level trainings.

CONSTRAINTS

1. The sericulturist need be given higher rates for raw cocoons on the lines of the major silk producing states of the country.

2. Regional grainages should be established for quick and timely supply of egg layings to the farmers.

3. The grainages should be handled by qualified and experienced staff for production of quality silk seed.

4. Establishment of Kanva-2 and S-54 mulberry multiplication farms on different Taluka Seed Farms of the Government and basic stock be maintained at four agricultural universities in the State.

5. Establishment of training centres for farmers.

6. Providing trained extension staff.

7. Establishment of a Post-Graduate Department of Sericulture to generate the required technical manpower.

8. Formulation of research schemes to solve the need based problems of the farmers and attending other regional work of applied interest.

FEED-BACK FROM OTHER EXTENSION AGENCIES

1. Due to the constraints, the farmers are reluctant to take up mulberry cultivation in the next year.

2. Heavy admixture of mulberry varieties has been noted in the farmers' gardens.

3. Payment of cocoons is not made promptly.

4. Irregular and untimely supply of high quality silk seed.

5. Whether mulberry cultivation can be undertaken in rainfed conditions.

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KASIVISHWANATHAN K. (1990), The role of the State Khadi and Village Industries. Indian Silk, 29(4), 15-18.

QUESTIONS

Mr Chavancy :

'What are the silkworm strains used in this region ?'

"Quelles sont les souches de ver à soie utilisées dans cette région ?"

Mr Tayade :

'These are the Pure Mysore strains, other local multivoltine strains and various Chinese and Japanese polyvoltine varieties. We are in the process of establishing new bivoltine varieties (the Central Silk Board's NB7). In the last case, bivoltine $\times$ multivoltine hybrids were used.

"Il s'agit des souches Pure Mysore, d'autres souches polyvoltines locales et de diverses variétés polyvoltines de Chine et du Japon. Nous sommes en train d'établir de nouvelles variétés bivoltines (NB7 du Central Silk Board). Dans le dernier cas, des hybrides bivoltins $\times$ polyvoltins ont été utilisés."

Mr Akapanthu was given the floor to present the situation in Thailand.

La parole est donnée à M. Akapanthu pour exposer la situation en Thaïlande.

THE STATE OF SERICULTURE IN THAILAND

S. AKAPANTHU

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I. INTRODUCTION

Thai silk is a material mostly hand-woven by Thai people. 1,397 tons of warp and weft silk were produced by 400,000 households of silkworm farmers. However, the requirements of warp and weft silk for total national consumption were 2,428 tons in 1989 so 1,031 tons had to be imported. The Royal Government plays an important role in the research and development programme to raise both warp and weft output for import substitution. From 1969 to 1977, a research and development programme was assisted by the Japan International Co-operation Agency (JICA) and, as a result, 45,000 kg of cocoons were grown by 1985.

II. ROLE OF SERICULTURE IN THE NATIONAL ECONOMY

Trends in sericultural output

Despite the fact that Thai sericulture existed continuously for a thousand years, the industry was not supported by the Government until 1901. Then, with the Japanese assistance an experimental sericulture station was established at Korat. From 1901 onwards, sericulture activities, including silkworm rearing, reeling and training, were intensified. By 1913, however, Thai Government extension activities were devoted to other agricultural crops and the silk extension programme at Korat was discontinued. Government-supported sericulture activities began again in 1936 and expanded over the years. At the present time, there are 3-4 established private silk reeling factories collecting cocoons from the silkworm farmers to produce silk yarn and dupion silk.

Incidence of sericulture on employment

About 400,000 households of silk farmers averaging three persons per household or 1.2 million persons practising sericulture, earn their living from three main lines of occupation.

i. Producing cocoons for silk reeling. This is done by specialized farmers who use bivoltine hybrid silkworm races.

ii. Producing silk yarn for silk weaving. There are more than 7,500 hand-loom in operation. Early in the 1910's the Government started a programme designed to increase silk textile production through widespread introduction of modern sericulture techniques. Substantial manpower and financial resources were committed to the programme but the long-term impact on raw silk output and the level of local sericulture are negligible. The weaving factories continued to collect most raw silk from the farmers, who produce two to six cocoon crops throughout the year. The number of crops and quality of output mainly depend on the intensity of rainfall. Most silk farmers produce silk to weave traditional clothes for casual or ceremonial garments and sell all the excess cocoons to ambulant brokers who sell in turn to provincial dealers or weavers for hand-weaving into fabrics for tourists and export.

iii. Production of fabrics in farmers' households creates self-employment. Raw silk reeling and weaving is done by hand. Thai silk hand-reeled yarn has an uneven, wavy appearance and a certain loftiness in its structure, which gives it a unique texture. Thai sericulture can benefit the country more

only if production of polyvoltine filament is so improved as to increase productivity and its quality to meet the requirements of the weaving industry. Thai sericulture is extremely labour-intensive.

Importance of sericulture for export

Thai raw silk production faces severe competition from synthetic fibers. Determined research efforts are needed to overcome major technical problems. Queen Sirikit created an Arts-and-Crafts Programme for Thai farmers to help poor peasants to increase their production of raw silk and home-woven fabrics in order to provide supplementary income for over half a million families. The programme has greatly deepened the public awareness of possible applications of silk fabrics and stimulated domestic consumption. Current exports of hand-woven silk fabrics gradually increased to about 12 million baht annually and there are many tons or millions of baht more in tourists purchases from local markets as a handicraft product, if produces high Value Added, mainly from direct labour costs and quality enhancements.

III. GOVERNMENT INSTITUTIONS INVOLVED IN THAI SERICULTURE

Organizations, scope and functions

The initial Government involvement in the silk industry early in this century was aimed at reforming the methods and techniques of production. Currently there is a wide range of institutions involved directly and indirectly in the Thai sericulture industry. Among these are :

- Ministry of Agriculture and cooperatives :

- i. Within the Department of Agriculture there is the Sericulture Research Institute primarily responsible for all aspects of sericulture research in Thailand (mulberry, silkworm and silk reeling). The Institute also plays an important role in technology transfers to farmers, Government extension and the private sector. Research by the Sericulture Research Institute covers mulberry breeding, mulberry cultivation including all aspects of cultural practices relating to production, insect, pest and disease control, silkworm breeding, silkworm egg production, silkworm rearing technology, silkworm diseases, cocoon drying, cocoon cooking and silk reeling technology.

- ii. In addition, there are a number of Royal, governmental, semi-governmental and private organizations involved in the promotion of sericulture. There are projects initiated and supported by the Queen promoting sericulture as a cottage industry in poor rural households, the Thai Silk Promotion Committee, consisting of Government agencies and the private sector, the Thai Silk Association representing mainly private sector interests associated with silkweaving, import and export businesses, the Silk Reeling Factories Association whose members purchase cocoons from farmers for reeling, etc.

- At the level of educational institutions, three universities, Kasetsart, Khon Kaen and Chulalongkorn, and a number of Agricultural Vocational colleges, currently undertake basic research courses. Options in sericulture are also offered to students following other main lines of specialization.

Research

The Sericulture Research Institute is under the Department of Agriculture, which is responsible in all aspects of sericulture research from mulberry cultivation to silk reeling processing and cocoon marketing. The Institute is divided into three research centres and four experimental stations under each centre.

Marketing

Marketing and market production are assisted by the Ministries of Industry and Commerce, in association with the Thai Silk Promotion Committee.

- 1. Nakornrachasima carrying out bivoltine research.

- Khonkhen Experimental Station, local trials and production of silkworm eggs for farmers and governmental agents.

- Chiangmai Experimental Station, local trials and production of silkworm eggs.

- Mukdhaharn Experimental Station, local trials and egg market production.

- Ubolrachathani Experimental Station, local trials and egg market production.

2. Udornthani Research Centre, carrying out polyvoltine and bivoltine cross-breeding activities.
 - Burirum Experimental Station, local trials and market production of eggs.
 - Lee Experimental Station, trials and market production.
 - Sakolnakorn Experimental Station, trials and egg production.
3. Srisaket Research Centre, polyvoltine Research.
 - Roi-ed Experimental Station, trials and egg production.
 - Chaiyaphum Experimental Station.
 - Phuttaisong Experimental Station.
 - Surin Experimental Station.

The Department of Agricultural Extension is responsible for general extension services, training of farmers to produce cocoons, raw silk and fabrics. The Department of Cooperatives Promotion trains farmers to run their business on a cooperative basis to maximise direct returns and services. The Department of Public Welfare establishes farmer groups in Land Settlement areas to set up cooperative silkworm rearing houses ; young silkworms are later transferred to individual silkworm rearing houses for cocoon production.

IV. PROGRESS IN THE LAST DECADE (1974-84)

Mulberry cultivation

More than 50 cultivated varieties are in use, three of which are widely planted. Propagation usually uses transplantation of cuttings. From 1969 onwards, research in cultivation of mulberry is carried out under the following aspects : Advance investigation on location site, soil fertility, etc. Mulberry fields are divided into lots of a certain size and agricultural roads installed to facilitate access to fields for cultivation and harvesting. Prior to the planting of cutting slips or saplings, the soil is ploughed deeply, the surface soil is levelled, manure, compost, etc., are applied to improve soil fertility where drainage is bad in the rainy season, the drainage plan is made and outlets installed. A plan on inter-ridge and inter-tree distances which are suitable for fields is drawn up and cutting slips or saplings are planted. Mulberry is trained in low-cut or middle-cut, old branches pruned at the base at least once a year to renew the vitality of trees and the leaf crop increased.

The spacing of trees in interridges from 1 to 3 meters and intertrees of about 0.75 meters depends on the machinery used. Fertilizer is used in the form of compost of about 10 tons/ha and 3 tons of animal droppings or half of the annual dosage of chemical fertilizer per ha. Three kinds of training are practised, namely low cut, medium and high cut. Harvesting usually combines the method of 6 rearings/year-system. Two mulberry fields must be prepared and each field harvested three times by middle-cutting mulberry branches, shootlet cutting and secondary shootlet cutting. This is done by the middle of June and continues through early August, middle September, early November, middle December and early February. Presently the recommended varieties of mulberry are Noi, averaging yields from 9-12.5 tons/ha. 57,600 ha of mulberry fields in Thailand are under Noi.

Silkworm breeding, races in use, seed production

The Government now promotes breeding of new bivoltine races from Japan instead of polyvoltine land-races which cannot produce good cocoon qualities. At first we tested practical properties of many pure bivoltine races imported from Japan. The results showed that they were not significantly superior in cocoon productivity, but fertile enough to be reared in Thailand. As we have plans to breed new bivoltine races, hybrids from Japan with high productivity were picked up for cross-breeding hybrids. Our breeding programme started in 1971 by cross-breeding hybrids from Japan. In breeding, batch selection was repeated. We selected new strains by concentrating on uniformity in growth, stoutness indicated by cocoon and sound pupa. At present the recommended bivoltine races are three varieties known as Nakornrachasima 1, Nakornrachasima 2 and Nakornrachasima hybrid 1. The silkworm-breeding programme is conducted by the Nakornrachasima Sericultural Research Centre and four satellite stations.

Collection of all currently used Thai polyvoltine races from several sericultural experimental stations in order to compare their properties under the same rearing conditions was started in October 1969, the results of which were reported yearly from 1971 to 1973 and further surveyed in June to

October 1973 and January 1974. The results will be shown later. There are many recommended varieties of polyvoltine races, which all depend on climatic factors. The polyvoltine breeding programme is carried out by the Srisaket Research Centre and four satellite stations, Thuttaisong, Roi-ed and Surin. The silkworm propagation for the farmers' use is carried out by the Sericultural Research Centre and four satellite stations under the management of the Sericultural Research Institute, Department of Agriculture.

The last stage of development is the Thai hybrid silkworm. It tries to combine the properties of bivoltine and polyvoltine races. The programme is run by the Udomthancee Sericultural Research Centre and four satellite experimental stations. Its outstanding result is the F1 hybrid, a cross between bivoltine and polyvoltine races. The Udomthani Centre and its satellite stations produce F1 hybrid eggs to farmers, similar to Thai polyvoltine and F1 polyvoltine races.

Cocoon cooking and reeling, quality control and the technical aspects of silk production

Silk reeling techniques always require high work efficiency as prerequisite to good product quality. Temperatures of the reeling bath were tested after September 1973. There was quite large fluctuation in different seasons as well as different localities. The percentage of eliminated cocoons was lower than 10 % in the cocoon selection performed by the farmers themselves. There are two kinds of silk reeling in Thailand for warp and weft. Warp silk is now usually imported from other countries, mainly China. Research on warp silk produced more than 10 papers each year. The production of warp silk attained 40 tons in 1986 while the target is 310 tons. Weft silk is usually produced by farmers from polyvoltine races with an output of 800 tons of weft a year. Because of standard fluctuation, cocoon flow to silk-reeling factories for weft should rise to 8,000 tons, but variety improvement should be recommended.

Technologies in use to be shared with other countries

Exchanges of mulberry and silkworm varieties should be organized. Pathology of rootrot disease should be solved. Expertise on silkworm mass production both in polyvoltine and bivoltine are required. Silk reeling technologies should be exchanged, especially on standard weft silk for weaving.

QUESTIONS

As there was no question, **Mr Todoroki** closed session I and thanked all the participants for their help.

En l'absence de questions, M. Todoroki clot la session I et remercie tous les participants de leur aide.

SESSION II

Président - Chairman : Prof. LIU Shi-Xian (Chine - China)

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DEVELOPMENT AND PRESENT STATUS OF SILKWORM PRODUCTION IN BULGARIA

E. GENOVA

Higher Institute of Zootechnics and Veterinary Medicine, Stara Zagora 6000, Bulgaria.

1. DEVELOPMENT OF SILK-COCOON PRODUCTION IN BULGARIA

According to the available historical data silkworms were reared in Bulgaria as early as the 6th century. Silkworm production reached a boom in the 19th century. The first silk-reeling plants in this country are founded at that time. During the period 1886-1901 silk-cocoon production is about 1,000 t, showed a steady increase thereafter, reached 1,968 t in 1927 and a top production of 3,000 t in 1953. After that time the production decreased to 2,500 t in 1970.

By silk-cocoon production per capita of the population Bulgaria is graded one of the first in Europe and the world (Yankov, 1987).

However, recently silk-cocoon and silk production has significantly decreased and now it does not cover the demands of the country (Table I, Table II). This decline is a result of the decreasing number of silkworm feeders, reduction of the mulberry plantations and their bad state, worse maintenance and exploitation.

Table I. Production of silkworm cocoons.

Tableau I. Production de cocons de vers à soie.

Year <i>Année</i>	Cocoon production (tonnes) <i>Production de cocons (tonnes)</i>
1980	1,408
1983	1,581
1984	1,690
1985	1,443
1986	1,275
1987	796
1988	736
1989	1,013

Statistics annual report of P.R. Bulgaria
Rapport annuel de statistiques de Bulgarie.

Table II. Raw silk and wastes.

Tableau II. Soie grège et déchets.

Years <i>Années</i>	mt (metric tons) <i>Tonnes</i>
1979-1981	199
1985	206
1986	199
1987	170

2. ORGANIZATION OF PRODUCTION

The main part of silk-cocoon production comes from the private households (over 95 %). The silkworm egg hatches in common houses (in 1988 95 hatcheries) (N. Petkov *et al.*, 1988). Silkworms are reared in living quarters or in other adaptable spaces, rather than in special breeding rooms. The conditions of feeding are unfavourable. There are no special equipment and mechanization to facilitate human labour. This work is of low efficiency because it is done by old people, children or housewives. Young and active people are not engaged in silkworm feeding.

Only 10 % of all silk cocoons are produced by cooperatives in the vicinity of Harmanli and Svilengrad (Iv. Maslarov, 1987). These cooperate feeders have at their disposal modern intensive mulberry plantations, modern automatized silkworm breeding rooms for the first age stages (equipped with Japanese automatic lines "Malbi") and separate rooms for the last stages of silkworms. The productional cycle is closed.

The state producers' society "Sirma" founded in Plovdiv, is the co-ordinator of a system of productional units from all over the country and controls the process of breeding, silkworm-egg quality and the production of raw silk. Since 1989 the state organization changed into three firms - Plovdiv, Haskovo and Svilengrad.

The Government takes special care of sylviculture. Silkworm feeders are given mulberry trees, hatched eggs for rearing, disinfecting chemicals and perforated paper free of charge. The specialists of the firms are in permanent contact with silkworm feeders as methodical advisers.

Exact and fast qualifying and prices related to cocoon quality are still a problem to be solved by this branch of agriculture. Raw cocoons are still graded according to the state standard organoleptically and not exactly. The mechanized grading and payment according to the quantity of silk (silkness) in the cocoon is much better but unfortunately it is not applied yet.

3. STATE AND EVALUATION OF THE FEED RESOURCES

Cultivated mulberry sorts

The enlargement of the mulberry plantations and the improvement of the varieties depend mostly on the produced planting material. The local wild mulberry plant which is grown from seeds by natural pollination and the hybrid mulberry plant grown from seeds at a seed-preoducing garden are the most common varieties used in Bulgaria. In the last two or three decades some valuable highly producing Bulgarian and imported species of mulberry trees have been introduced. However, their reproduction is not successful and their part in the whole mulberry resources is not significant. Many sorts are obtained by Bulgarian selectionists (No 3, 24, 26, Vratsa 1, Vratsa 18, Trakya 6, Veslets, Hybridna 96, Hybridna 78 etc.). Many varieties were imported from Japan, China, the USSR and Italy. The highest economical results are obtained from No 106, Kinriu, Kokuso 27, Kokuso 21,

Tbilisuri, Harkovska 3 etc. At the moment 7 local and imported sorts are registered and approved for large scale application (N. Petkov, 1989).

Mulberry plants in our country are grown in plantations or one by one. More than 95 % of the plantations belong to the co-operatives. The single trees numbering about 2 mln are private. There are not cultivated and low productive.

The future development of silkworm production is related to the application of artificial feeds. Now, for us, this is a problem of scientific and field studies. Their success will be of great benefit to silkworm production. We also try to develop and use artificial diets.

Kanarev and Peeva (1981) at the Higher Institute of Agriculture in Plovdiv during the period 1978-1980 carried out experiments on feeding of silkworms on 6 kinds of artificial diets.

In 1980-1982 at the Experimental Station of Sericulture in Vratsa, Petkov *et al.* (1986) studied the possibilities for rearing silkworms in different life-stages on artificial diets containing dried green algae *Chlorella* and *Scenedesmus*.

In 1982-1983 at the Station of Silkworm Examinations and Control in Harmanli, Karaivanov *et al.* (1987) tried to feed silkworms on artificial feed "Vita-silk" obtained from Japan. The experiment was made in the laboratory and on the field with the hybrid Asahi × Tokai.

Nutritional experiments (for awarding a Ph.D.) have been carried out under the instruction of L. Ovesenska at the Higher Institute of Zootechnics and Veterinary Medicine since 1988. They have been aimed at studies on diets of various mulberry meal content and their practical efficiency when fed to the first life stages of some Bulgarian strains and hybrids.

4. APPLICATION OF DIFFERENT STRAINS AND HYBRIDS AND SELECTION OF SILKWORMS

Recently the selection of the silkworm has been quite successful. The new crosses are characterized by good biological, economical and technological qualities compared to the world-known hybrids.

The following strains fed during the spring or summer/autumn seasons are used in practice : Super 1, 157 K, Hesa 1, Hesa 2, Hebar 1/18, Hebar 2/1 ; and the hybrids : Super 1 × 157 K, Hesa 1 × Hesa, Super 1 × Hesa 2, Shunrei × Shugetsu, Asahi × Tokai, Hebar 1/8 × Hebar 2/1, Kinshu × Showa and the reciprocal crosses.

4.1. Organization of the breeding work

The breeding work is in close relation to the dimensions of Bulgaria and according to the standards of the countries with advanced silkworm production. In the last 10 years the introduction of new, highly productive lines and hybrids has been guaranteed by the system of research stations with a central one in Vratsa as well as by the experimental laboratory at the Research Institute of Animal Breeding in Kostinbrod, the Higher Institute of Zootechnics and Veterinary Medicine in Stara Zagora and the Higher Institute of Agriculture in Plovdiv.

The instructions for selection, rearing and introduction of new strains and hybrids of silkworms require that the first trials be carried out by the experimental unit which has created them. The new strains and hybrids applying for registration undergo two-year stationary trials at the Station of Silkworm Examinations and Control in Harmanli. Then the registered new or improved local and imported hybrids in relation to their correct distribution have to pass an official competitive and productional examination. This examination lasts for three years and is carried out at the Station of silkworm examinations and control in Harmanli. The productional trial is carried out at the experimental silkworm breeding rooms of the station with those hybrids which have shown the highest values of the main indices during the first year of the competitive examination. The productional trail begins in the 2nd year and finishes at the same time as the competitive examination. The State Commission of Sorts considering the examination results registers and distributes all strains and hybrids.

The Research Station of Sericulture in Vratsa coordinates the breeding work with the silkworm (N. Petkov, 1979).

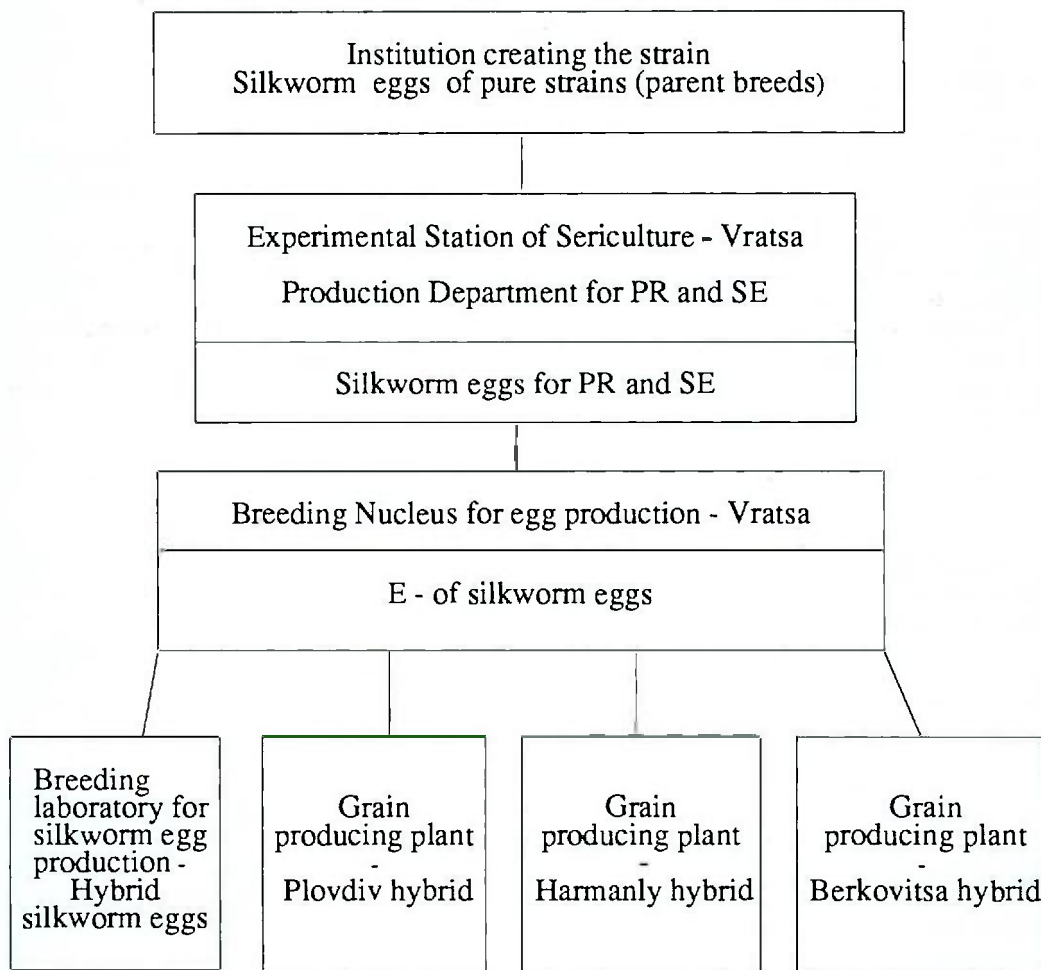


Fig. 1 : Organization of silkworm selection in P.R. Bulgaria.

Fig. 1 : Organisation de la sélection des vers à soie en Bulgarie.

In Vratsa as branches to the station function a department of preliminary reproduction (PR), department of super elite (SE), breeding nucleus for egg production and egg producing plants in Berkovitsa, Plovdiv and Harmanly (Fig. 1). The production of selected and hybrid silkworm egg during 1981-1988 increased from 28855 to 40252 boxes (N. Petkov *et al.*, 1988).

5. RESEARCH INSTITUTIONS

The creative forces in the Bulgarian sericulture are the research workers. The first research institution of sericulture was the Experimental Silkworm Station founded in 1896. Today it has developed into a big research and productional centre of sericulture, mulberry cultivation and silkworm-egg production with a staff of 8 researchers. The main problems studied by the centre in 1990 are : selection of the silkworm (3 research workers) ; genetics (1), mulberry cultivation (1), silkworm-egg production (1) and diseases of silkworms (1). More than a hundred of new highly productive hybrids were selected here.

The Station of Silkworm Examination and Control was founded in Harmanly in 1937 as a branch to the Experimental Silkworm Station. The station was occupied in examination of local and imported strains and hybrids of silkworms and of the mulberry tree, as well as in control on silkworm eggs - produced in the country or imported.

The results obtained in the station are the only index for geographical distribution through the country. Five research workers are engaged with : breeding examinations of silkworms and control of silkworm egg (1) ; technology of silkworm feeding (1) ; growing and agrotechnics of mulberry trees (1) ; mechanization of silkworm production and mulberry cultivation (1) ; genetics and selection of the mulberry tree (1).

The specialists and technicians in sericulture are trained at the Higher Institute of Agriculture in Plovdiv and the Higher Institute of Zootechnics and Veterinary Medicine in Stara Zagora. At the moment in Plovdiv as an instructor in sericulture works one assistant, who is engaged in researches on the selection of the silkworm ; in Stara Zagora - one professor (selection and technology), one assistant (selection) and one post-graduate student (nutrition).

At the Research Institute of Animal Breeding in Kostinbrod, Department of Sericulture, work two scientists (selection). The total number of Bulgarian scientists working in sericulture is 19. Studies are carried out on all important problems. Less attention has been paid to the economics of this branch of agriculture.

QUESTIONS

Mr Liu welcomed all the delegates and asked for their kind co-operation to carry this particularly heavy session through. He opened the discussion.

M. Liu souhaite la bienvenue aux délégués et leur demande leur coopération pour mener à bien cette session qui est très chargée. Il ouvre la discussion.

Mr Chavancy :

'What type of artificial diet do you use ? Is it imported from Japan or made in Bulgaria ?'

"Quelle est l'alimentation artificielle que vous utilisez ? Est-elle importée du Japon ou fabriquée en Bulgarie ?"

Mrs Genova :

'This diet is only used for experimental purposes in our institute. My thesis dealt with the efficiency of this diet on the early larval stages. We mainly use our diet although we also try the Japanese one but ours is better !...'

"Cette alimentation est utilisée seulement en laboratoire, dans notre institut. Ma thèse a porté sur l'efficacité de cette alimentation sur les premiers âges larvaires. Nous utilisons principalement notre aliment mais nous essayons également l'aliment japonais ; le nôtre est meilleur !..."

Mrs Kotby :

'Is it a fully or a semi artificial diet ?'

"S'agit-il d'un aliment artificiel total ou semi-artificiel ?"

Mrs Jaksheva Peletkova :

'It is a semi-artificial diet because it contains about 50 to 60 % of mulberry powder, soya flour as well as minerals and vitamins.'

"C'est un aliment semi-artificiel car il contient de la poudre de mûrier (50 à 60 %), de la farine de soja, des minéraux et des vitamines."

Mr de Micheaux :

'Can you give us some details on the utilization of silk threads and cocoons in Bulgaria ?'

"Pouvez-vous nous donner des détails sur l'utilisation du fil de soie (et des cocons) en Bulgarie ?"

Mrs Genova :

'I am only a scientist working on artificial diet and I have no economical data.'

"Je suis seulement une scientifique travaillant sur le milieu artificiel et je n'ai pas de données économiques."

Mr Chavancy :

'Can you nevertheless give us the data of raw silk production today ?'

"Pouvez-vous néanmoins nous donner la production de soie grège aujourd'hui ?"

Mrs Genova :

'From 1985 to 1987 it was as follows : 206 t, 199 t and 170 t.'

"De 1985 à 1987 elle était de 206 t, 199 t, 170 t."

Mr Liu thanked Mrs Genova and asked Mr Tascon to present sericulture in Colombia.

M. Liu remercie Mme Genova et invite M. Tascon à présenter la sériciculture en Colombie.

SERICULTURE IN COLOMBIA

F. TASCON RECIO

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1. HISTORICAL BACKGROUND

Silk in Colombia is believed to have been present since the colonization era. Nevertheless, the first references we know date from 1868 when the physician Vicente de la Roche introduced silk in the west of the country, promoting the cultivation of silkworms and mulberry plants, but his efforts vanished with his death. During the first 30 years of this century there have been notices of intents of sericulture in various departments without having reached a stable introduction.

The National Coffee Growers' Federation within the framework of its diversification program during the seventies started investigating the possibility of cultivating mulberry plants and silkworms, of its adaptation, its behaviour and technical aspects in various areas of the country. As soon as positive answers were obtained, the promotion of sericulture started with the farmers of the Departments of Risaralda, Caldas, Valle and Cauca.

In 1987 the program of the Coffee Growers' Federation included 118 growers who had sown 110 ha. In addition to this, 14 ha existed on the farms La Catalina in Risaralda and La Campina in Cauca, totalling to 124 ha sown in the country at that time. Furthermore, in 1985 a small pilot reeling plant was installed in Timbio, Cauca, with 60 ends, which gave the scarce Colombian exports during the last years.

In the search for overcoming the pilot phase of Colombian sericulture, the Coffee Growers' Federation at the beginning of the year 1988 started to look for a collaboration with various Government entities like The National Rehabilitation Plan - PNR, an office to the President of the Republic, the Export Promotion Fund - Proexpo, the Industrial Promotion Institute - IFI, and other entities on the department level.

2. ACTUAL SITUATION

On the basis of the information mentioned above, the Colombian sericulture has started to grow from the pilot phase of 1987 into an industrial scale by the construction (actually in process) of drying and reeling plants with the help of the Coffee Growers' organization and the State through PNR, IFI and Proexpo.

President Barco's trip to Korea in 1987 led to talks about a Colombian-Korean joint venture, which is currently under development in Popayan (Cauca) and will have the following capacity: annual production of 200 tons of raw silk thread on 2,000 reeling machine ends, obtained from 1,080 tons of cocoons, produced by small and medium scale farmers on 600 hectares of mulberry plantations. This enterprise, named COSEDA, has a capital composition of 50 % Korean and 50 % Colombian (20 % IFI's and 30 % private investors).

Immediately following this first project, another Korean investor came forth, in order to promote a project of the same magnitude, with a 75 % Korean and 25 % Colombian private capital composition, and recently at Pereira (Risaralda) it was inaugurated bearing the name of COKOSILK.

Two smaller projects have evolved since the emergence of these enterprises : the first case located in Popayan is 100 % Korean-owned by a single investor whose entire production is concentrated on large farms, under the name of COSILK, and plans to cultivate 200 hectares of mulberry in order to export dry cocoons or sell them to COSEDA. The other case is in Pereira, where it is planned to cultivate between 100 and 200 hectares, the capital is 100 % Colombian and is made up of an association of medium breeders that under the name of CAPULLOS S.A. would sell the production to COKOSILK.

A group of medium-scale producers from Cauca have formed a fifth enterprise named PROSEDA importing a dryer machine to process their cocoons and the production of small farmers, up to a goal of 200 hectares of mulberry. This group is negotiating a possible joint venture with Japanese investors.

At this moment, are sown all over the country about 700 ha of mulberry plants, 400 ha at a radius of 50 km around Pereira and 300 ha at a similar radius with its center at Popayan. The principal current target is to reach as a minimum 800 ha in each of these regions.

It is worthwhile mentioning that in the case of the Cauca there have been installed women groups dedicated to the spinning and weaving on a handicraft level on the basis of the cocoons which can not be processed with industrial proceedings.

3. COMPARATIVE ADVANTAGES

The present surge of sericulture in Colombia is based on the experience acquired over the past twenty years, which can be summed up as follows :

Adaptation of hybrids from bivoltine silkworms to Colombia's climate without seasonal changes, achieving average production rates of 30 kilograms of cocoons per box of 20,000 eggs.

Average densities of 30,000 mulberry plants per hectare on rough undulating countryside, which produce an average between 30 and 40 tons of leaves per hectare/year in three harvests. In the north of Cauca region, as much as 60 tons have been obtained in four yearly harvests.

Because of Colombia's tropical location, ten silkworm breeding cycles are possible in a one-year period, which multiplies the effects of the foregoing advantages. This means that six boxes can be bred in each cycle by hectare.

Taking into consideration these three factors : kg of cocoons per box of eggs, annual quantity of mulberry per ha, and the number of annual breed we will obtain the principal indicator for silk production : kg of cocoons per ha and year with a minimum of 1,200 and an average of 1,800. These three factors have a common tendency in the various regions of the country, specifically in the area between 900 m and 800 m of altitude due to the fact that in Colombia the Andes Cordillera splits into three ranges comprising 3,420,000 ha and is distributed between the equator and 12° latitude north.

In this area vast zones exist where small farms with a family and cheap labor force structure are of a further advantage. The same structure can be found in marginal coffee growing areas and is an excellent alternative for the substitution of coca growing.

4. PROMOTION

In view of the preceding facts, the Colombian Government is implementing a policy to promote sericulture by financing 100 % of the technical assistance required by small landowners and providing lines of credit at low interest rates, respective the devaluation rate versus the US dollars (28 % annual).

Technical assistance has been promoted by Government entities, in the case of Risaralda by the local Government whereas in the Cauca it is financed by the National Rehabilitation Plan through an Agreement with the Coffee Growers' Committee. They have been working with two credit lines : the first for Coffee Growers' Federation with an interest rate of 18 % and the second for Proexpro at 32 %.

5. COSTS

At present, the cost of establishing one ha of mulberry plants sown, the rearing house and other necessary components rise up to US\$2,900 which are distributed as follows : US\$1,245 for the seed, US\$1,265 for the rearing house, and US\$390 for equipment.

In regard to the sericulture operation, the average time for producing one kg of fresh cocoons in Colombia is two hours and 24 minutes. This is due to the fact that the production process is not mechanized either at the recollection phase of the mulberry leaves or the distribution of the feed. Taking into account that our rural minimum wages reach US\$0.38 per hour, one can see that the incidence of time in the operation costs is not very high.

The actual breeding cost of one box of 2,000 worms is US\$78 including the financial costs, they will be produced to US\$63 if financial costs are not included, and they are distributed as follows : US\$27 for labor cost, US\$20 for raw materials, US\$16 for eggs, and US\$15 financial costs.

On the basis of the output of 30 kg of cocoons per box we reach at a production cost per kg of US\$2.60 including financial costs, and US\$2.10 without them.

Taking an average of the different qualities, the price which is actually paid by established firms amounts to US\$3.20 per kg of fresh cocoons.

6. NEW PROJECTS

Considering the comparative advantages of Colombia and the estimated production of the two spinning factories under construction (400 tons), we can see that there are great possibilities in Colombia for the expansion of silk industry. There exists actually about a dozen ideas for new sericulture developments in various departments of the country for which it could eventually be interesting to attract foreign capital. At the mulberry crop stage, there are the following new projects :

1. Department Norte de Santander, promoted by the Chamber of Commerce.
2. Santander del Sur, promoted by the Servicio de Pastoral Social of the San Gil diocese.
3. North of the Cauca Department, promoted by the PNR,
4. East of the Cauca Department, promoted by the Fundacion Antropologica de Tierradentro in collaboration with a Chinese promotor.

Furthermore, they are developing other ideas for possible projects in the following departments : Antioquia, Caldas, Cundinamarca, Huila, Meta, Narino, Santander, Tolima, and Valle del Cauca.

7. INVESTMENT NEEDS AND EXTERNAL COOPERATION

In the development of sericulture in Colombia, both Government provided technical assistance from industrialized nations and an increase in foreign investment sources will play a major role.

The diversification of foreign investment sources is also indispensable in order to create alternatives as far as foreign trade partners are concerned. It would be interesting to evaluate the possibility of joint investment projects between Colombia, in which the first stages of silk production prevail, and countries with advanced silk industries. Such a combination would enable sericulture to be developed extensively in Colombia.

At present, Italian, Japanese, and new Korean groups, the three principal importers of raw silk, are evaluating the possibility of participating in the production of our sericulture in regard to some of the new projects and ideas mentioned above.

It is a basic task for the development of sericulture in Colombia to develop our investigations in mulberry and silkworms.

Nowadays, Colombia is trying to establish a sericulture research public agency, through an international technical cooperation project requested by the Agricultural Colombian Institute (ICA) and the National Rehabilitation Plan (PNR), to the European Community, for research on developing genetically pure races from which Colombian worms can be produced, with 100 % of adaptability ; moreover to improve the mulberry quality.

QUESTIONS

Mr Liu opened the discussion.

La discussion est ouverte par M. Liu.

Mr Chavancy :

'Thank you for this comprehensive report on the situation in your country. Can you give us the current quantity of raw silk production in Colombia?'

"Je vous remercie pour cet exposé très complet sur la situation en Colombie. Pouvez-vous donner la production de soie grège en Colombie aujourd'hui?"

Mr Tascon :

'Since 1985 exports have been of about 8 t of raw silk in the small experimental station I mentioned. A few months ago we inaugurated the first industrial unit with an output of 200 t of raw silk. It has just carried out its first export which at present only amounts to 20 t of raw silk.'

"Depuis 1985 les exportations s'élèvent à 8 tonnes de soie grège dans la petite station expérimentale que j'ai citée. Il y a quelques mois, nous avons inauguré la première station industrielle pouvant produire 200 tonnes de soie grège, elle vient de réaliser sa première exportation qui n'est pour l'instant que de 20 tonnes de soie grège."

Mr Candiani :

'You said that the cost of one kg of cocoons rose from \$2.60 to \$3.20. I do not understand why?'

"Vous avez dit que le coût du kilo de cocons passait de 2,60 \$ à 3,20 \$, je ne comprends pas pourquoi?"

Mr Tascon :

'The price of \$2.60 includes the production and financial costs. But \$3.60 is the price currently paid by the established firms for one kg of fresh cocoons. This is a way of inducing people to produce.'

"Le prix de 2,60 \$ comprend le coût de production et le coût financier. Par contre, les 3,60 \$ correspondent au prix payé actuellement par les entreprises en place pour le kg de cocons frais. C'est une façon d'inciter les gens à produire."

Mrs Goldsmith :

'Have you encountered any major problems with diseases with either the mulberry or the silkworm?'

"Existe-t-il des problèmes majeurs de maladies, aussi bien pour les mûriers que pour les vers à soie en Colombie?"

Mr Tascon :

'We have had a few diseases due to the humidity of some regions, but we have not recorded any severe epidemic up to now either on silkworms or on mulberries.'

"Nous avons eu certaines maladies dues à l'humidité dans certaines régions, mais nous n'avons connu jusqu'à présent aucune épidémie importante, ni sur les vers ni sur les mûriers."

Mr Guigou :

'I would like to know the altitude and climatic conditions (in particular the rainfall) under which you recorded the best results you reported of 30 kg of cocoons per box?'

"J'aimerais savoir quelles sont l'altitude et les conditions climatiques (pluviométrie en particulier) pour lesquelles vous avez obtenu les meilleurs résultats dont vous avez parlé de 30 kg de cocons par boîte?"

Mr Tascon :

'The best results were obtained at an altitude of 1,050 m and with a rainfall of approximately 2,800 mm a year. It was noted that at lower and medium altitudes (between 900 and 1,800 m) mulberries were dense but had a low protein content whereas at a height of above 1,800 m mulberries were less dense but richer in proteins. Rainfall indices range from 1,500 to 3,000 mm.'

"Les meilleurs résultats ont été enregistrés à 1 050 m d'altitude avec une pluviométrie d'environ 2 800 mm par an. On constate qu'à basse et moyenne altitude (entre 900 et 1 800 m), on obtient un nombre important de mûriers mais ayant une faible teneur en protéine alors qu'à plus de 1 800 m les mûriers sont moins denses mais plus riches en protéines. Les indices de pluviométries varient entre 1 500 et 3 000 mm."

Mr de Micheaux :

'Have you got any information on the nature of the soils used, do they have a volcanic origin ?'

"Avez-vous des éléments sur la composition des sols utilisés ? Sont-ils d'origine volcanique ?"

Mr Tascon :

'I do not know the exact composition of the soils as they are quite varied. In Popayan where we are working at present, at an altitude of 1,800 m the soil is indeed volcanic but the densely planted mulberry area which is located in the low region is not volcanic. I will forward the information on the nature of the soil to Mr Chavancy as soon as I come back.'

"Je n'ai pas la composition exacte des sols. Il y a en effet des sols très différents. A Popayan où nous travaillons actuellement, à plus de 1800 m d'altitude le sol est effectivement un sol volcanique, mais la région à forte densité de mûriers située dans la partie basse ne possède pas un sol volcanique. Je ferai parvenir les éléments sur la composition du sol à M. Chavancy à mon retour."

As there were no further questions **Mr Liu** asked Mr Babacauh to present his report on sericulture in the Ivory Coast.

Plus aucune question n'étant posée, M. Liu demande à M. Babacauh de présenter son exposé sur la sériciculture en Côte d'Ivoire.

PROJET SERICICOLE DE LA COTE D'IVOIRE

BABACAUH K. D.

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I. INTRODUCTION

Le Continent africain, malgré l'influence de l'Europe méditerranéenne au nord et de l'Asie dans les régions orientales, est resté en marge de la sériciculture pendant des millénaires. Cependant, les traditions d'utilisation de soie sauvage existent notamment au Burkina Faso (Dembélé, 1987) à Madagascar et en Ouganda (Jacob et Sengupta, 1990).

En Côte d'Ivoire, d'après Seydou Dembélé (1987) les récoltes de soie sauvage ont contribué à l'approvisionnement du marché traditionnel burkinabé. Mais il n'existe pas une véritable tradition séricicole. L'idée de pratiquer la sériciculture dans ce pays est née de la volonté de diversifier les productions agricoles et des perspectives intéressantes qu'offraient le marché de la soie, suite au retrait de cette production des pays industrialisés.

La présente note rappelle les acquis des expériences passées et les nouvelles orientations de relance de la sériciculture depuis 1988 par la Compagnie ivoirienne pour le Développement des Textiles (CIDT).

II. HISTORIQUE

Déjà en 1963, au lendemain de l'indépendance et dans le courant politique d'alors qui affichait une volonté farouche de diversifier l'agriculture, l'idée de pratiquer la sériciculture n'a pas échappé aux planificateurs ivoiriens.

La date de l'introduction du mûrier en Côte d'Ivoire n'est pas connue avec précision.

Des observations conduites par M. Aka Oka de nationalité japonaise (technicien de la FAO, en agriculture et pêche) à titre privé, et Dem Abib, Chef de l'Agrostologie au centre fourrager de Koumassi, ont montré le bon comportement du matériel végétal dans les conditions climatiques du sud de la Côte d'Ivoire.

En 1971, M. Aka Oka, aidé de M. Andoh Nicolas, lance une expérimentation à Anyama sur 3,5 ha ; les boutures provenaient du Centre fourrager de Koumassi et des 80 mûriers plantés dans la concession de M. Aka Oka. Ces mûriers seraient introduits du Japon, du Ghana et de la République centrafricaine (Nichimen C. Ltd Osaka, 1974).

Intéressée par les résultats, la Société japonaise Nichimen demande à poursuivre les expérimentations sur des superficies plus importantes avec possibilités d'extension à 250 ha. Les autorités ivoiriennes acceptent et, en 1974, se crée la Société Séricico avec la participation de l'Etat ivoirien. Binao abrite les plantations de "Séricico" et, en 1979, la mûraie de cette nouvelle société couvrait 108 ha.

En 1977, un noyau d'encadrement séricicole est créé au sein du service autonome d'Agrostologie du Ministère de la Production animale et est chargé de promouvoir le développement de la sériciculture en milieu villageois.

La Séricico, conduite en régie, est chargée de la fourniture de jeunes vers aux éducateurs villageois, de la collecte des cocons et de l'exportation de ceux-ci. La Séricico, face à des difficultés

financière, ne peut honorer ses engagements vis-à-vis des éducateurs et de la Banque nationale pour le Développement agricole (BNDA).

Le 31 décembre 1979, elle est mise en liquidation, les producteurs villageois découragés abandonnent à leur tour après avoir vaillamment tenté de se prendre en charge.

Les enseignements :

Dans l'ensemble et dans les conditions du sud de la Côte d'Ivoire, la conduite des plantations n'a pas posé de sérieux problèmes. Les variétés de mûriers Kanva II et Bambari I sont bien adaptées (25 T de feuilles par ha). De même, la variété Kinshu-showa du ver à soie (*Bombyx* sp.) est bien adaptée au point de vue du rendement et de la qualité de la soie.

Les techniques recommandées aux sériciculteurs, le planning des opérateurs et l'intégration des activités de fournitures des vers et d'achats de cocons aux sériciculteurs se sont révélés possibles grâce à la formation et à une organisation adéquate.

Les conflits nés de l'existence de deux structures, la "Séricico" et la "Section séricicole", renseignent sur les erreurs à ne pas commettre et appuient l'idée d'une intégration de l'opération.

Ces résultats, encourageants dans leur ensemble, ont servi de point d'ancrage à l'activité séricicole de la CIDT.

III. PROJET SERICICOLE DE LA CIDT

A l'inverse de la zone forestière qui abrite au moins huit cultures de rente (café, cacao, banane, ananas, palmier à huile, cocotier, hévéa et cultures florales ...), la région de savane n'en produit qu'une : le coton. Pour atténuer chez le producteur de coton les risques de monoculture d'exportation et lui procurer des revenus complémentaires, la CIDT tente, à travers ce projet, d'introduire la sériciculture en région des savanes, en tenant compte des réalités du milieu rural ciblé, fait de petits paysans et de l'organisation en place de la CIDT.

Le projet de programme élaboré se propose donc, sur une période de 10 ans (1990 - 2000), d'atteindre une production de 180 T de soie grège, soit 1 200 T de cocons frais ; l'activité devant impliquer à temps plein ou partiellement 10 000 familles. Ce programme connaît une phase intérimaire de trois ans (1990 - 1992) précédée de 2 années d'exploration et d'expérimentation.

L'exploration :

Elle s'est traduit par des missions d'experts (Proffit, 1988), qui ont abouti à l'élaboration du projet de développement de la sériciculture en Côte d'Ivoire, et par la collecte de tout ce qui restait de matériel végétal de l'ancien projet. Ce matériel a permis d'établir une pépinière à Bouaké. Une partie du matériel (étouffoir et cadres tournants japonais de coconnage) de la Séricico a été récupérée. Des missions de prise de contact à l'Unité nationale séricicole de Lyon (rencontre avec MM. Chavancy et Bouvier) ont permis de bénéficier de très utiles conseils techniques.

L'expérimentation, qui a démarré en 1989, se poursuit à trois niveaux :

- création d'un Centre expérimental séricicole situé à Bouaké qui se compose d'une mûraie de 2 ha, d'une unité d'élevage et d'un centre de formation pour les paysans ;
- installation d'un groupe de 10 paysans pilotes qui ont réalisé 2,5 ha de mûraies, rendant possible les premiers élevages villageois ;
- création de parcelles d'observations de 200 m² de mûriers localisés sur 11 points d'observation (PO). Il s'agit sur ces PO d'étudier le comportement des diverses variétés de mûriers tout au long de l'année et à travers toutes les zones écologiques de la savane.

Cette phase expérimentale devra se terminer en 1992.

Le programme intérimaire est planifié comme suit :

Années :	1990	1991	1992
Nombre de paysans :	10	60	300
Nombre de boîtes de graines :	30	260	1 320
Production de cocons en tonnes (T) :	0,6 T	5,2 T	26,4 T

En l'an 2000, les besoins en boîtes de graines seront de 60 000 si chaque sériciculteur élève une boîte à la fois.

Au cours de l'année qui s'achève (1990), une dizaine de paysans ont effectué leurs premiers élevages.

Les vers sont nourris jusqu'au 3ème âge au niveau du complexe séricicole de Bouaké puis livrés aux paysans après le premier repas du 4ème âge. Le nourrissage des vers chez les paysans se fait au rameau, sur des claies de 16 m² par boîte.

Le nourrissage dure en moyenne 23 jours dont 11 pour les trois premiers âges et 12 pour les deux derniers chez les paysans. Un paysan peut élever 2 boîtes de vers avec 1/8 d'ha de mûriers. Les productions de cocons frais varient entre 23 kg et 32 kg par boîte. Les tests de filature effectués à l'Unité nationale séricicole de Lyon ont donné des résultats satisfaisants.

Ainsi, le poids moyen de cocon frais obtenu est de l'ordre de 2,2 g. Des richesses soyeuses de 25 % ont été également obtenues.

Au niveau du paysan, le fait de pouvoir produire régulièrement sans trop d'effort des cocons (4 à 6 fois par an) et donc de percevoir constamment des revenus substantiels semble le résultat le plus attractif.

Ces premiers résultats encourageants ont été obtenus grâce à une formation adéquate, aussi bien des paysans que des sériciculteurs.

Au niveau des agents CIDT, 4 responsables du projet de niveau ingénieur ont été formés pendant 3 mois à l'Unité nationale séricicole de Lyon.

Ceux-ci ont la charge de conduire les premiers élevages expérimentaux et d'assurer la formation de tous les encadreurs.

La formation des futurs sériciculteurs se fait d'une part au centre séricicole de Bouaké pendant 2 ou 3 jours au cours desquels le paysan se familiarise avec les conditions optimales d'élevage et les précautions sanitaires à observer. Une deuxième formation a lieu ensuite chez le paysan dans sa propre magnanerie. Il est alors assisté d'un encadreur.

IV. CONCLUSIONS

Les résultats préliminaires obtenus au cours des deux années de moriculture et d'une saison d'élevage aussi bien chez une dizaine de paysans qu'au centre séricicole nouvellement installé à Bouaké permettent de conclure :

- au comportement satisfaisant du mûrier dans le centre et le nord de la Côte d'Ivoire ;
- au bon déroulement des élevages chez le paysan comme au centre expérimental avec des résultats satisfaisants ;
- à l'acceptation par les paysans ciblés de cette nouvelle activité.

La sériciculture apparaît donc comme une alternative possible, en régions des savanes en Côte d'Ivoire.

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QUESTIONS

M. Babacauh remercie le Président et les organisateurs de l'occasion qu'ils donnent à la Côte d'Ivoire de participer pour la première fois à la Conférence et de venir apprendre auprès d'experts, de spécialistes et de chercheurs qui ont beaucoup plus d'expérience.

Mr Babacauh thanked the Chairman and the organizers for the opportunity they gave the Ivory Coast to participate, for the first time, in the Conference and to come and learn from experts, specialists and researchers who were much more experienced than themselves.

M. Candiani :

"Jusqu'à quelle distance pouvez-vous aller entre la nourricerie et les fermes d'élevage ?"

'What is the maximum distance between the stock-farm and the rearing farms ?'

M. Babacauh :

"On a conçu un système modulaire. Nous envisageons par module environ 500 paysans autour du centre séricicole. La distance ne dépassera pas 50 km.

'We have devised a modular system. Each module will include about 500 farmers around the sericultural unit. The distance will not exceed 50 km.'

M. Candiani :

"Combien de temps de transport ?"

'What will the travelling time be between the two places ?'

M. Babacauh :

"Au maximum, 2 heures, mais le plus souvent 30 à 40 minutes."

'2 hours at the most, but generally 30 to 40 minutes.'

M. de Micheaux :

"Quelles sont les conditions de paiement accordées aux paysans aujourd'hui et celles envisagées pour l'avenir ?"

'What terms of payment are granted to the farmers at present and what are they planned to be in the future ?'

M. Babacauh :

"On achète les cocons frais à hauteur de 700 F (CFA) le kg. C'est la phase intérimaire. On verra par la suite, cela dépendra de l'environnement international."

'We buy fresh cocoons for CFA F 700 per kg. This is an intermediary phase. As for the future, we will see, it will depend on the international situation.'

M. de Micheaux :

"A quel moment se fait le règlement aux paysans ? Lors de l'apport des cocons ou après quelques mois et selon quel type de contrat ?"

'When exactly is payment made to the farmers ? When they bring their cocoons or after a few months and according to what type of contract ?'

M. Babacauh :

"Nous utilisons la structure de la CIDT ; elle est basée sur le fait qu'il faut ramasser toute la production de coton chez les paysans dans des délais assez raisonnables pour éviter de les décourager. C'est ce système que nous essayons de mettre en place.

Nous n'avons pas encore de moyens autonomes de financement au niveau de cette tentative d'implantation de la sériciculture en Côte d'Ivoire. C'est donc le coton qui sert de ressource et, compte

tenu de la dimension faible de cet essai, c'est en fait la filière coton qui préfinance ce démarrage. On paye à l'enlèvement des cocons chez le paysan. Lorsque les quantités vont grossir, il faudra envisager des systèmes qui permettront de ne pas faire durer le délai de règlement. Par exemple, pour le coton, on arrive à un mois de délai de règlement mais des sommes très élevées sont en jeu et le système bancaire et la trésorerie nationale font qu'on ne peut faire mieux. Ce système intégré fait que le délai ne relève pas de notre propre initiative. Donc, on peut préfinancer les petites quantités de cocons actuellement, mais on ne peut rien garantir en ce qui concerne l'avenir."

'We use the structure of the CIDT (Ivory Coast Company for the Development of Textiles) which consists in collecting all the farmers' cotton production within a reasonable lapse of time to avoid discouraging them. We are trying to implement this system.'

We do not have our own financial means for this attempt at introducing sericulture in the Ivory Coast. As cotton serves as a source of income and, given that this experiment is carried out on a small scale, it is in fact the cotton channel which pre-finance this operation. The farmer is paid when the cocoons are removed. When quantities get larger, systems will have to be considered so as to avoid delay in the payment. For instance, for cotton, there is a waiting period for payment of up to 4 months but very high amounts of money are involved and the bank system and public revenue department are so designed that nothing better can be done. Owing to this integrated system, the waiting period is beyond our control. Consequently we can pre-finance small quantities of cocoons at present, but nothing can be guaranteed as far as the future is concerned.'

M. Mauchamp :

"Comment sont localisées les plantations de mûriers par rapport aux plantations de coton ?"

'Where are the mulberry fields in relation to the cotton fields ?'

M. Babacauh :

"Les élevages ont lieu au village, à côté des maisons, et il ne faut pas que les gens se déplacent sur de longues distances pour aller chercher les feuilles de mûriers. Les plantations de mûriers sont autour des villages. Ce sont des "cultures de cases".

Les cotonniers, eux, sont loin des villages pour éviter, entre autres, que les animaux en divagation n'aillent les détruire. Il y a séparation nette entre les cotonniers et les mûriers. Au départ, l'idée était d'introduire la sériculture en zone de savane ou de culture cotonnière, dans les défrichements réalisés pour le coton, notamment pour mieux occuper les anciens. Mais on s'est vite rendu compte que cela n'allait pas. De plus, on utilise des pyrèthrénoïdes contre les vers des cotonniers et les deux cultures ne peuvent aller ensemble.

La présence des mûriers près des villages permet en outre aux personnes âgées, aux enfants de récolter pendant que les bras plus valides sont aux champs. Le problème qui reste cependant est celui des animaux en liberté. Il reste des cabris et il y a incompatibilité entre les cabris et les mûriers, malgré les clôtures, cela reste insuffisant."

'The rearings are maintained in the village, next to the houses because villagers should not walk long distances to collect the mulberry leaves. Mulberry fields are scattered around the villages. These are 'hut crops'. The cotton fields are far from the villages, among other things, to prevent wandering animals from ruining them. Cotton plants and mulberries are clearly separated. In the beginning the idea was to introduce sericulture in the savannah or in cotton plantation areas and lands cleared for cotton cultivation, in particular, to give some occupation to the elders. But it was soon realized that this would not do. Furthermore, pyrethroids are used against cotton field worms and the two crops are not compatible.'

The fact that mulberries are close to the villages also enables old people and children to collect the harvest while the more able-bodied workers work in the fields. There still remains, however, the problem of wandering animals, there are still kids, and mulberries and kids are incompatible, as the existing fences are not sufficient.'

M. Candiani repose la question du prix des cocons payé aux paysans.

"C'est 700 CFA, soit 14,00 F français est-ce bien cela ?"

Mr Candiani asked again the question of the price paid to the farmers for the cocoons.

'It is CFAF 700, that is to say FF 14.00, is that correct ?'

M. Babacauh :

"Oui"

'Yes'

Mme Barrière :

"Combien pouvez-vous faire d'élevages par an ?"

'How many rearings a year can you keep ?'

M. Babacauh :

"On peut dire six. Il y a la saison sèche et, si on plante les mûriers à grande profondeur, il est peut-être possible d'avoir des feuilles en cette saison. C'est un objectif à moyen terme. Pour l'instant, on table sur six élevages au maximum."

'About six. There is the dry season and if we plant the mulberries deep enough, it may be possible to have leaves in that season. It is an objective in the medium term. For now, we are reckoning on six rearings at the most.'

SERICULTURE IN GREECE

K. RAMMOU

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In Greece, sericulture is confined to certain regions of the country where, according to tradition, silkworms are raised, such as in Evros, Serres, Larissa and Crete.

Recently, annual production of fresh cocoons has significantly been reduced to about 500 tons in 1972, to 65 tons in 1982 and to about 30 tons today.

This reduction is due to the keen competition between silk and synthetic fibers, the instability of prices resulting from the peculiarity of fresh cocoon marketing and to land disposal to dynamic crops, which was previously covered by mulberry-trees.

However, in the above-mentioned regions, recently producers' interest has increased for the following two reasons : due to the fact that silk has started to regain ground in the national market and due to the implementation of a modern sericultural technique which enables sericulture to compete with the other agricultural performances, especially in areas marginal for other crops.

The Ministry of Agriculture makes every possible effort to develop sericulture by applying modern silkworm raising methods. To this end, the Ministry of Agriculture is closely cooperating with the other countries and more specifically with Japan and China by exchanging experts.

QUESTIONS

Mr de Micheaux :

'Are there reeling factories in Greece and what are the grades of the threads that are produced today ?'

"Y a-t-il des filatures en Grèce et quels sont les catégories des fils qui sont produits aujourd'hui ?"

Mrs Rammou :

'No, we do not reel cocoons in Greece because the quantity of cocoons produced is too small, it would not be economically profitable.'

"Non, nous ne dévidons pas les cocons en Grèce car il y a une trop petite quantité de cocons produits et ce ne serait pas rentable économiquement."

ITALIAN SERICULTURAL PROJECTS - PROBLEMS RAISED BY THE USE OF 'NEW' INSECTICIDES

G. CANDIANI

Riccardo Mantero S.A., Via Volta 74, 22100 Como, Italy.

First of all, as a representative of a non member State, I would like to thank you for the opportunity you gave me to attend this meeting.

Silk is extremely important for Italy, as everybody knows, and we are more and more aware that although we do not produce silk anymore, we must pay attention to the first steps of silk production, namely silkworm rearing and silk reeling, even though these steps are performed on a large scale only by low labour cost countries.

A few years ago, Italy started co-operating with cocoon and silk producing countries. This cooperation is still carrying on today. As regards China, the main producing and exporting country, a few Italian silk companies have set up a cooperation with Chinese factories, a cooperation based on technology transfer and/or equipment supply under buy-back or joint-venture schemes concerning mostly weaving, dyeing and printing, no cooperation has so far been set up with reeling factories or for cocoon production. As you certainly know, while the silk cloth is commercialized by the Provincial Silk Cooperation, raw silk trade is centrally controlled, or should be centrally controlled, by Beijing. This is the main problem.

Nevertheless, a first significant cooperation has been started between a major Italian silk company and a good-quality Chinese reeling mill in Zhejiang in order to receive raw silk instead of hangs and most of all to receive electronically cleaned silk.

This is a cooperation based on equipment supply and buy-back. This cooperation subsequently aims to lead to a cooperation in the reeling itself. We have installed automatic silk reeling machines in a few spots in China where cocoon quality allows it. Actually there are only very few spots at the moment. Cocoon quality, as a matter of fact, is a major problem in China as Mr Huang Jianmo himself said in Helsinki. Central and local silk corporations are aware of cocoon quality deterioration and, as we have personally seen, they are trying very hard to improve cocoon quality and to introduce, as an experiment, Japanese-style cooperative young silkworm rearings and to distribute silkworms instead of eggs to the farmers, which would certainly allow an important improvement in cocoon quality.

A second step for consumer countries (Italy and France) should therefore be to cooperate with the Chinese provincial silk corporations in order to set up cooperative young silkworm rearings.

In particular, Sichuan Province, the largest province of China (more than 100 million inhabitants) and largest cocoon producing province, is opened to this kind of cooperation and asking for it. Also, a better silkworm egg rearing technology is required, I mean, cooperation in this field is required by Sichuan. I think that, in a rather short time, some Italian companies will be involved in this kind of cooperation.

In addition, it is already known that the Italian Government is granting an \$18 million soft loan to Vietnam for a sericultural project. It will finance a silkworm egg producing plant, evolved technology and assistance and all the equipment for five reeling mills to a total of 14 automatic reeling Nissan-made machines of 320 ends each. The production target is 400 tonnes of raw silk per year. The quality is expected to be good provided that the silkworm egg plant is correctly operated and that the silkworms rearings are correctly supervised. Both problems are of course very difficult to anticipate and it is therefore difficult to foresee the level of quality of the silk, or rather, the possibility of commercializing the silk.

At the third point, production of very good quality cocoons started two years ago with Italian support in Zimbabwe. Two main Zimbabwean companies are interested. A private company grouping together many commercial farmers, as they call themselves, that is to say farmers with a tremendous quantity of land (for instance, one of these farmers owns 24 thousand hectares in one single piece) and a cooperation partly State-owned and partly private-owned. Silkworm eggs are polyhybrid Kinshu Showa and Shonrai Shugetsu Japanese strains supplied by us and no local production has been planned so far. But of course, as production will grow to consequent levels, egg production will be introduced probably starting from first crossings, what I mean is that we will keep the pure races and make the first crossings which we will give to this plant.

Next spring, in March, the first reeling machine (Japanese made) will be installed by the State and private owned company in Arara. Southern Africa raw silk, high quality silk in our opinion, will be sent to Italy as from next summer. No definite production target has been stated as yet neither by the private company nor by the State and private owned company. During the first years, most of the cocoons will be sold to Japan where the first batches have been judged as very satisfactory. Back to production target, I would like to remind you that I am rather concerned about who will actually buy all the silk coming from the projects we have heard about and from the two projects I have just mentioned, namely Vietnam and Zimbabwe. Who will buy and, second problem, who will do the certificates for selling it, I mean reliable certificates. We know of course that Japan and Korea are cutting down their cocoon production. We also know that a few provinces in China, the more industrialized provinces of China, Zhejiang or Guangzhou, will probably cut down their production of cocoons and raw silk.

Back to the project of Zimbabwe, I must say that we are aware of the fact that the cocoons are really wonderful. We have to allow for the possibility of developing diseases in the next years.

Last but not least, I would like to remind you of the project of the large Italian silk company in cooperation with an Italian State research organization called ENEA, in the field of artificial sericulture. This \$3 million project aims at investigating the problems of an artificial diet rearing until the fifth instar in a fully controlled atmosphere, that is to say, investigating the economic and health problems involved, the quality and reliability of the cocoons produced and the quality of the eggs. This artificial diet is based on new recipes which are not Japanese and it does not contain mulberry leaves. As everybody knows, in Japan, the majority of silkworms are bred with artificial diet in the first and second instars and a few until the third instar with very good results. However, breeding on artificial diet until the fifth instar is not only extremely expensive but the chrysalids are normally too big, the silk is poor and the moth does not lay good eggs. Anyway, irrespective of the isolated results the project will achieve, the study will bring to a better knowledge of the problems of artificial diet when carried on until the fifth instar. The same study group, which comprises many Italian university laboratories responsible to the Ministry of Agriculture office superintending the authorization for distributing insect-controlling products, has recently achieved important results in the investigation of the terrible impact of fenoxycarb on the silkworm hormonal and general behaviour. The results are being brought in officially to the Italian governmental offices concerned. The next official steps will be agreed with the French Unité nationale séricicole to take a common action on governments both at European level and worldwide. On this point we need a common action affecting not Italian or French responsible offices but a general action preventing other countries from using hormonal products. Mr Chairman, while I am ready to give further information about the said projects to the persons interested, I would like to conclude by saying that it has only been a short time since Italy has been made aware of the importance of sericulture and of the need of a regular supply of quality silk in the years to come and I think that my country will try to give its contribution to the investigations of the problems involved and, since there are no good results without cooperation, my country will apply for membership to the International Sericultural Commission.

Thank you.

QUESTIONS

Mr Mauchamp :

'On what crops was fenoxycarb used in Italy ?'

"Sur quelles cultures le fénoxycarbe a-t-il été utilisé en Italie ?"

Mr Candiani :

'This product is known to have caused the same problem in Italy for the past two years as in France earlier. This small 100 t cocoon production achieved in the region of Treviso was ruined this year and last year for the same reason. This is why since June 1990 some experiments have been carried out. They consisted in preparing smaller and smaller fenoxycarb (Insegar) solutions that were sprayed on the leaves, then we measured the increase in the weight, that is to say the quantity of solution left on the leaves which were subsequently fed to silkworms. The quantity of leaves, therefore of fenoxycarb ingested, was measured. This was very costly and required much work from many laboratories. We thus managed to detect that the quantity of fenoxycarb ingested, about 5×10^{-14} mg, was totally effective, 90 % of the silkworms would not spin (were juvenoid). In other words, a low number of molecules (160 000 active fenoxycarb molecules per worm) was sufficient to initiate the hormonal disorder. At the same time, trials were made with untreated leaves and we came to a definite conclusion. The meeting at which these results were presented was held last week and we have not yet had the opportunity to give them to the Unité séricicole.

A meeting on this issue is to take place very shortly in Lyon at the Unité séricicole. We are considering taking action with the Government to stop the distribution of this product - and of other products of the same kind which could made subsequently.

This result was obtained on the basis of a sericulture study which was not originally intended for this aim. We do not think that artificial diet is the right solution but we need to make further studies on this topic and to use the knowledge acquired elsewhere, in other countries, without forgetting to work by ourselves.'

"Au sujet de ce produit, on sait qu'on a le même problème en Italie depuis deux ans que celui observé en France auparavant. La petite production de 100 t de cocons réalisée dans la région de Trévise a été détruite cette année et l'année passée pour la même raison. Aussi a-t-on, depuis le mois de juin 1990, réalisé quelques expériences en préparant des solutions toujours plus faibles de fénoxycarbe (Insegar), en arrosant les feuilles et en mesurant l'augmentation du poids, c'est-à-dire la quantité de solution qui restait sur les feuilles, et en les donnant ensuite à manger aux vers à soie. La quantité de feuilles, donc de fénoxycarbe absorbé, a été mesurée. Ce fut très coûteux et demanda beaucoup de travail dans de nombreux laboratoires. On est arrivé ainsi à détecter que la quantité de fénoxycarbe absorbé, de l'ordre de 5×10^{-14} mg, entraînait un effet complet, c'est-à-dire que 90 % des vers ne filaient pas (étaient juvénoides). Autrement dit, un nombre faible de molécules (160 000 molécules de fénoxycarbe actif par ver) était suffisant pour déclencher le désordre hormonal.

Parallèlement, les essais ont été effectués avec des feuilles non traitées et on est arrivé à une certitude. La réunion où ces résultats ont été annoncés a eu lieu la semaine passée et on n'a pas encore eu la possibilité de les donner à l'UNS.

Une réunion doit avoir lieu très prochainement à Lyon à l'UNS à ce sujet. On pense à une action auprès du Gouvernement pour bloquer la distribution de ce produit et d'autres produits du même type qui pourraient suivre. Il s'agit d'un résultat obtenu à partir d'un sujet d'étude de sériciculture non défini pour ce but au départ. On ne croit pas que l'alimentation artificielle soit la bonne solution, mais il faut cependant en connaître plus à ce sujet et s'appuyer sur les connaissances acquises ailleurs, dans d'autres pays.... sans oublier de travailler soi-même."

M. Diaz interroge **M. Candiani** sur les projets au Zimbabwe et au Vietnam.

Mr Diaz questioned **Mr Candiani** on the projects in Zimbabwe and Vietnam.

Mr Candiani :

'In Vietnam, the cocoons obtained at present are unusable, absolutely unfit for automatic reeling. We hope to produce cocoons that will be reelable on automatic machines. A large station has already been built for egg production. The staff should be competent after a training course in China. This project is financed by the Government, we are involved only as technology suppliers. I am uncertain about what is going to happen as regards quality.

For Zimbabwe, the situation is altogether different. We manage to obtain excellent results from some Japanese eggs we purchased. They were Kinshu Chowa and Shunrai shu getzu, both these varieties give almost equally good results and an output of 34 kg of cocoons per box can normally be reached. Of course, future diseases are to be feared as it is only the first result. The cocoon analyses were done at the Unité séricicole and the most consequent batches were sent to Japan, they do fine. From March onwards, we will send out the parts of an automatic Nissan machine on which small production will be started. As cocoon production is to increase rapidly, most of it will be exported to Japan. To this end, contracts have been signed between two firms and a major Japanese import company. But the production place is quite distant from the sea. As cocoons cannot pass in transit through Mozambique, they will have to go through South Africa to reach a port.

When it comes to raw silk, the matter will be easier as it is a much smaller volume. As private and mixed companies are involved, we expect good results shortly. In Vietnam it is more difficult to say, there are financial means, machines, buildings but the quality of the cocoons is unpredictable.'

"Au Vietnam, les cocons obtenus actuellement sont inutilisables, absolument pas filables à la machine automatique. On espère produire des cocons dévidables à la machine automatique. Déjà, une grande station a été construite pour le grainage. Le personnel devrait être expert après des cours en Chine. Il s'agit d'un projet financé par l'Etat, nous y sommes seulement comme fournisseurs de technologie. J'ai peur de ce qui va s'y passer au point de vue qualité.

Pour le Zimbabwe, le discours est tout à fait différent. On a obtenu des résultats formidables à partir d'oeufs japonais que nous avons achetés. Il s'agit de Kinshu Chowa et de Shunrai shu getzou, les deux variétés donnant de très bons résultats sans grande différence et on arrive à 34 kg de cocons par boîte normalement. Certes, les maladies à venir sont à craindre car il s'agit d'un premier résultat. Les analyses des cocons ont eu lieu à l'Unité séricicole et les lots les plus importants ont été envoyés au Japon, ils sont très bien. A partir de mars, il va y être expédié les pièces d'une machine Nissan automatique sur laquelle sera commencée une petite production. La production de cocons devant augmenter rapidement, la plupart seront exportés au Japon. Des contrats ont été passés entre les deux compagnies et une grande firme japonaise d'importation pour cela. Mais la production est très éloignée de la mer. Les cocons ne pouvant transiter par le Mozambique, ils devront passer par l'Afrique du Sud pour atteindre un port.

Lorsqu'il s'agira de soie grège, le problème sera plus facile car le volume est bien moins important. S'agissant de compagnie privée et de compagnie mixte Etat-privé dynamiques, on espère arriver rapidement à des bons résultats. Au Vietnam, c'est plus difficile à dire, il y a les moyens financiers, les machines, les bâtiments, mais la qualité des cocons est imprévisible."

Mrs Goldsmith :

'I would like to ask a question on fenoxycarb. This is a second generation pesticide which shows advantages if you are not practising sericulture in the neighbourhood. What alternatives would be available if this kind of pesticide were to be banned in those areas where farmers need some way of control for other kinds of crops ?'

"J'ai une question sur le fénoxycarbe. Ce produit est un insecticide de la deuxième génération qui présente des avantages si l'on ne pratique pas la sériciculture dans le voisinage. Au cas où il serait interdit, quelle alternative existe-t-il à l'utilisation de cet insecticide pour les fermiers qui doivent de toute façon disposer d'un moyen de lutte pour d'autres productions."

Mr Candiani :

'I think it is a difficult matter. Farmers are quite satisfied with Insegar and with other hormone-based homogenous insecticide products such as fenoxycarb. I do not know what turn things are going to take. Anyhow, we do not know how to tackle the problems with the silkworms, but they

are probably just as important for other moths. We do not check them because they are unimportant and we know nothing about them. This is a problem that has to be solved. How will they manage without it? The product has been distributed for two years in Italy and four years in France and the problem is more acute in France than in Italy.

I think that after all the problem is neither that of France nor Italy but rather that of China, Zimbabwe or Vietnam tomorrow. That is the chief problem. We cannot actually speak of cocoon production in France or Italy, we are interested in keeping small-scale experimental production so as to be involved in these problems and to support experimental stations. These problems affect especially producing countries. China is the largest producing area. The use of hormonal products such as ecdysone, so that all the silkworms mount at the same time, is possible. They have not yet encountered our problems, but it may happen. Should this product be distributed there, the consequences would be terrible. We cannot check the effect of fenoxycarb. Is the silk made of fenoxycarb then ecdysone treated silkworms up to standards? Silkworms may be able to spin their cocoons but they are unfit for reeling.

"C'est un sujet difficile selon moi. Les fermiers sont très satisfaits de l'Insegar et des autres produits insecticides homogènes à base d'hormones comme le fénoxycarbe. Je ne sais pas comment les choses vont évoluer. De toute façon, nous ne savons pas comment aborder les problèmes avec les vers à soie, mais ils sont probablement aussi importants pour les autres papillons. Nous ne les contrôlons pas car ils ne sont pas importants et nous ne connaissons rien sur eux. C'est-là un problème à résoudre. Comment pourront-ils s'en passer? Le produit est distribué depuis deux ans en Italie, quatre ans en France et le problème est plus aigu en France qu'en Italie.

Je pense que le problème n'est finalement pas celui de la France ou de l'Italie mais plus celui de la Chine, du Zimbabwe ou du Vietnam demain. C'est-là le problème principal. Nous ne pouvons pas parler de production réelle de cocons en France ou en Italie; nous sommes intéressés par le fait de garder une petite production expérimentale afin d'être impliqués dans ces problèmes et de supporter des stations expérimentales. Ces problèmes concernent surtout les pays de production. La Chine est la plus vaste région productrice. L'utilisation de produits hormonaux comme l'ecdysone, afin que les vers à soie montent tous ensemble, est possible. Ils n'ont pas encore les problèmes que nous avons, mais cela peut arriver. Si le produit arrivait à être distribué là-bas, ce serait terrible. Nous ne pouvons pas contrôler l'effet du fénoxycarbe. La soie qui vient des vers traités au fénoxycarbe puis à l'ecdysone est-elle correcte? Les vers peuvent alors faire leur cocon, mais ils ne sont pas bons pour le dévidage."

Mrs Jaksheva-Peletkova :

'I am extremely satisfied with this most exhaustive report. You said that the use of artificial diet would bring a solution to many problems. Nevertheless do you not think that such a method is too expensive for your country?'

"Je vous exprime ma grande satisfaction pour ce rapport très complet. Vous dites dans votre rapport que l'utilisation de l'aliment artificiel apporterait une solution à de nombreux problèmes. Néanmoins, ne considérez-vous pas qu'une telle utilisation soit trop onéreuse pour votre pays?"

Mr Candiani :

'Absolutely. It is not an economic answer to the problems of sericulture. It is far too expensive. We do not think that it is a solution for sericulture, but it is a step towards a better knowledge of silkworm behaviour. However, it can be a solution for stations, young silkworm rearing cooperatives and it is already in use in Japan. I am not sure of the figure but I think that 60 % of Japanese silkworms in the early instars are reared on artificial diet. But all the experiments to keep artificial diet until the fifth instar have met with the problem of food cost. This cost cannot be borne in the developed countries. Only a low labour cost and a traditional system at the end are possible. Naturally, rearing first or second instar larvae on artificial diet, as shown by Japanese experiments, gives a better silk and makes the silkworms healthier. The silk imported from China now has been 4A for 3 or 4 years; we require a better quality silk, we would like to buy 5A (an extra US\$1.5, which is not much), but we cannot find any in China. The silk issued from automatic reeling machines and good cocoons is not sufficient to obtain the light garments we will weave in the future.

We are turning towards lighter garments and the demand for quality thread increases. This is why we are trying to co-operate with Nissan in order to obtain a better and more reliable reeling on the reeling machine ; we are seeking to obtain an electronic reeling.

This is the project we are conducting with Nissan. We are not satisfied with the quality of the garments and this brings us back to what was said earlier. We are afraid of this quantity of silk that is going to be put on the market from all the programmes we have heard of today, programmes in which we are involved as regards Zimbabwe and Vietnam, for what can we do with this low quality silk ? For my part, this is the major problem.'

"Absolument. Ce n'est pas une réponse économique aux problèmes de la sériciculture. C'est beaucoup trop cher. Nous ne pensons pas qu'il s'agisse d'une solution à la sériciculture, mais c'est une étape pour une meilleure connaissance du comportement des vers à soie. Cependant, elle peut être une solution pour les centres, les coopératives d'élevage de jeunes vers à soie et c'est ce qui est déjà fait au Japon. Je ne suis pas sûr du chiffre mais je pense qu'environ 60 % des vers à soie du Japon sont élevés aux premiers âges avec de l'aliment artificiel. Mais toutes les expériences pour arriver jusqu'au 5ème âge ont buté sur le problème du coût alimentaire. Je pense que la soie ne peut supporter le coût de l'alimentation artificielle. Il n'est pas possible de supporter la charge de ce coût dans les pays développés. Ce n'est qu'un faible prix de main d'oeuvre et un système traditionnel à la fin qui sont possibles. Naturellement, l'élevage du premier ou du deuxième âge avec l'alimentation artificielle, comme l'indiquent les expériences japonaises, permet d'obtenir une meilleure soie et une meilleure santé pour les vers à soie. La soie arrivant de Chine maintenant est de 4A depuis 3 ou 4 ans ; nous avons besoin d'une soie de meilleure qualité, nous aimerions acheter que de la 5A (1,5 \$ US en plus, ce n'est pas grand chose), mais nous n'en trouvons pas en Chine. La soie venant de la filature automatique de bons cocons, n'est pas suffisante pour obtenir des vêtements légers que nous tisserons dans l'avenir.

Nous nous orientons vers des vêtements plus légers et la demande pour du fil de qualité augmente. C'est la raison pour laquelle nous essayons de coopérer avec Nissan dans le but d'obtenir un dévidage meilleur et plus fiable sur la dévideuse ; nous cherchons à obtenir un dévidage électronique.

Voilà le projet que nous menons avec Nissan, nous ne sommes pas satisfaits de la qualité des vêtements et cela nous ramène à ce que nous disions auparavant. Nous avons peur de cette quantité de soie qui va arriver sur le marché issue de tous ces programmes dont nous avons entendu parler aujourd'hui, programmes dans lesquels nous sommes impliqués avec le Zimbabwe et le Vietnam, car que pouvons-nous faire avec cette soie de basse qualité ? C'est-là selon moi, le premier problème."

Mr Persoons :

'To what chemical group does fenoxycarb belong ?'

"De quel groupe de produits chimiques le fénoxycarbe fait-il partie ?"

Mr Candiani :

'To carbamates.'

"Des carbamates."

Mr Persoons :

'Then it is an usual effect of carbamates. They interfere with the production of juvenile hormone or whatever substance it is.'

"Alors c'est un effet inhabituel des carbamates. Ils agissent en interférence avec la production d'hormone juvénile ou autre."

Mr Candiani :

'I cannot answer. Mr Chavancy will be in a better position than me to explain the effects of fenoxycarb.'

"Je ne peux répondre, M. Chavancy peut, mieux que moi, expliquer les effets du fénoxycarbe."

Mr Chavancy :

'Yes, this effect of fenoxycarb was observed in other insects and larvae, in particular in Lepidoptera. This is well known and has even been studied by the manufacturer and the dealer of the product used in agriculture. So, many of the effects of this product on Lepidoptera are known and not only on these insects. In addition, there is also an effect in stages other than larval. For instance, in bees fenoxycarb acts on the eggs, on the brood-comb. In adults, there is no effect, but when they bring back fenoxycarb to the hive, a high percentage of eggs do not hatch. Mr Mauchamp will complete this. In scientific literature many papers now appear concerning the experimentation of fenoxycarb on a number of insects. There are variations according to the insect family, to types quantitatively or qualitatively. It is basically a hormone-type effect. I personally think that the silkworm can serve as an alarm. Given its characteristics, selection and domestication, it has become a very sensitive insect as compared to others. The effects observed in silkworms can be determined by minute doses, as Mr Candiani reported, whereas in other insects these doses would surely be ineffectual.'

"Oui, cet effet du fénoxycarbe a été observé sur d'autres insectes et d'autres larves et, en particulier, chez les lépidoptères. Cela est très connu et a même été étudié par le fabricant et le commerçant du produit utilisé en agriculture. Donc, on connaît beaucoup d'effets de ce produit sur les lépidoptères mais pas seulement chez eux. Ce qui existe aussi, c'est un effet à d'autres stades que celui de la larve. Par exemple, chez l'abeille, le fénoxycarbe agit sur les oeufs, le couvain. Chez les adultes, il n'y a pas d'effet, mais lorsqu'ils ramènent du fénoxycarbe à la ruche, il y a un fort pourcentage d'oeufs qui n'éclosent pas. M. Mauchamp pourra compléter. Il apparaît maintenant dans la littérature scientifique de nombreux articles concernant l'expérimentation du fénoxycarbe sur un grand nombre d'insectes. Il y a des variantes selon les familles d'insectes, selon les types sur le plan quantitatif ou sur le plan qualitatif. Fondamentalement, c'est un effet de type hormonal. Pour moi, le ver à soie est un animal qui peut jouer le rôle de signal d'alarme. Compte tenu de ses caractéristiques, de sa sélection, de sa domestication, il est devenu un insecte très sensible par rapport aux autres. Les effets observés chez les vers à soie peuvent être déterminés par des doses infimes, comme l'a dit M. Candiani, alors que pour d'autres insectes ces doses seraient sûrement inefficaces."

Mr Mauchamp :

'I would like to make a remark. The structure of the chemical molecule of fenoxycarbe proves that it is a carbamate. These carbamates work at the level of the nervous system. But in the family of carbamates you find chemicals with both fungicidal and herbicidal properties and now these new chemicals with insecticide properties. The chemical family cannot therefore be inferred from the way the chemical works. Unlike neurotoxic type products, the action appears several days, several weeks or even several generations after the application. It can be said that when insects which have been treated either at larval or adult stage develop, an effect is found in the next generations.

If, for example, you treat adult females with relatively low quantities of products, there is no apparent effect. But the effects will appear at the egg stage and kill the embryo or sometimes, after the hatching, at the 1st, 2nd or 3rd instar. What we find very difficult to study, measure or evaluate are the residues of these products because the effects appear when the product is no longer present. These products alter cell differentiation which only expresses much later, when the product is totally absent. Similar effects are likely to be obtained with fungicidal and herbicidal type molecules. The treatment of plots of mulberry or other crops with these carbamates can have a more or less obvious incidence on the physiology of insects, which is most worrying.'

"Je voudrais faire une observation. La structure de la molécule chimique du fénoxycarbe prouve qu'il s'agit bien d'un carbamate. Le mode d'action de ces carbamates a lieu au niveau du système nerveux. Mais, dans la famille des carbamates, on trouve aussi bien des produits à propriétés fongicides, qu'herbicides et maintenant ces nouveaux à propriétés insecticides. La famille chimique ne peut donc pas se prévaloir sur le mode d'action du produit. Ce qui est beaucoup plus préoccupant, c'est que ces produits ont une efficacité à moyen et à long terme. Contrairement aux produits de type neurotoxiques, l'efficacité apparaît plusieurs jours, voire plusieurs dizaines de jours ou même plusieurs générations après l'application. On peut dire que, lorsque des insectes traités aussi bien au stade larvaire qu'au stade adulte se développent, on retrouve un effet sur les générations suivantes."

Si on traite, par exemple, des femelles adultes avec des quantités relativement faibles de produits, il n'y a pas d'effet apparent. Mais les effets se traduisent au niveau de l'oeuf en tuant l'embryon ou parfois, après éclosion, sur les 1er, 2ème ou 3ème stades larvaires. Ce qui est très difficile pour nous à étudier, mesurer ou évaluer, ce sont les résidus de ces produits car les effets apparaissent au moment où le produit n'est plus présent. Ces produits modifient la différenciation cellulaire, qui ne s'exprime que beaucoup plus tard, lorsque le produit est complètement absent. Il est vraisemblable que l'on puisse atteindre des effets similaires avec des molécules de type fongicide et également herbicide. Le traitement de parcelles de culture de mûriers ou d'autres cultures avec ces carbamates peut avoir une incidence plus ou moins cachée sur la physiologie des insectes, et cela est très préoccupant."

Mr Liu thanked Mr Candiani.

M. Liu remercie M. Candiani.

SILK IN THE NINETIES

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INTRODUCTION

Although it is perhaps not widely realised, there are at present over 50 silk-producing countries in the world. These range from very small producers such as France, with around 400 kg per annum, up to China which produces 40 000 tonnes of raw silk.

In any discussion of the place of silk in the world textile market, the first thing to bear in mind is the extreme rarity of this fibre, which accounts for barely 0.17 % of total world textile fibre production, in volume terms. (In terms of value, the picture is a little different, as one kilo of standard grade raw silk is priced at US\$45).

Silk production is at present undergoing a return to its sources. From its origins in China, silk was produced extensively in a number of Middle-Eastern and European countries in the last century as well as in Japan, South Korea, Thailand, etc.

However, silk production is highly labour-intensive, so that industrialised countries which used to produce silk (France, Italy, Spain) have almost totally given it up and the same trend is now taking place in Japan and South Korea. This means that today over 90 % of the world's raw-silk production is to be found in other Asian countries, where silk originated over 4 500 years ago.

RAW-SILK SUPPLY

Total world production of raw silk in 1990 was about 70 000 tonnes, with China alone producing 40 000. The other major producers in order are India, Japan, the Soviet Union, Brazil, North Korea, South Korea and Thailand.

The great majority of raw-silk producing countries are also consumers and even net importers of raw materials. Japan, for example, produces just over 6 000 tonnes of raw silk and imports a further 2 000 or so from China.

One of the most critical aspects of the world silk market is that there are only two countries, China and Brazil, which at present export raw silk for processing in Europe, Japan, the United States etc., and of these two China accounts for over 90 % of raw-silk exports.

Apart from the uncomfortable situation of being almost totally dependent on one major supplier, the raw-silk importing countries have to contend with the fact that China is increasingly moving up-market, exporting more and more fabrics and made-up articles. This means that the share of raw silk in China's overall exports of silk materials and products is declining. At the same time, Japan is compensating for the decrease in her domestic production of raw silk by increasing her imports from China.

Despite the fact that China has repeatedly given reassurances to her foreign raw-silk customers that supplies will be maintained, there are some fears among importers that the drain on Chinese supplies, from domestic and foreign industrial users, will one day outstrip any increases in production.

It is precisely for this reason that a large number of countries, in Asia, Africa and Latin America, are studying or actually implementing sericultural projects, essentially aimed at exporting raw silk or dry cocoons at least initially. Although silk is traditionally a product of temperate areas, progress in

the fields of silkworm genetics, varieties of mulberry-tree, soil management, irrigation etc. has made sericulture an attractive and viable activity for countries with a sub-tropical or tropical climate. The mulberry-tree which grows in temperate zones gives leaves only twice a year (and consequently allows for two cocoon 'harvests') while the newly developed strains adapted to hot climate can provide food for the silkworm all the year round. An additional advantage of hotter countries is that they are also, generally speaking, countries with favourable socio-economic characteristics for silk production : low wages, large rural populations who are often dexterous enough to undertake silk reeling, local or international interest in subsidising a lucrative agricultural activity such as sericulture.

However, it takes time for a new sericultural country to reach international standards of raw-silk quality. A country which has no experience of sericulture and is starting from scratch as a potential exporter of raw silk should count on at least ten years to reach the quality of raw silk required by technologically advanced silk-processing countries such as Italy. This development period will obviously be shorter for countries which are building on a sericultural tradition, such as Vietnam, Thailand, Indonesia, Brazil etc.

For the moment, there is a good overall balance between supply and demand. But, as we will see later, the difficulty in reliably estimating future demand should make some countries hesitate before committing large-scale investments to sericulture. This is certainly one of China's preoccupations, namely the fear of over-producing cocoons and thus having to subsidise Chinese farmers for a product which may not see its demand increase very quickly.

Similarly, it would probably be unwise for a fledgling silk-producing country to envisage raw silk solely as an export commodity. Its future raw-silk production should be used partly to supply a small local silk industry working for the domestic market, where there is one, or turning out characteristic silk products for the export market. This industrial objective would help to improve the quality of silk yarns for future export and at the same time offer another outlet, less subject to the uncertainties of the international market.

PRICES

As far as raw-silk prices are concerned, there is no world price as such, given that the supply situation is almost totally under the control of one country. However, the emergence of other suppliers such as Brazil, Vietnam, Colombia etc., will almost certainly lead to a diversification of prices.

For the past fifteen years, China has been pursuing a policy of price-stability as far as raw silk is concerned. After the turbulent years of 1974-76, when prices were swinging wildly from one extreme to another, this policy has led to a considerable degree of tranquillity among raw-silk users and has undoubtedly contributed to a wider use of silk throughout the world. There have been only one or two storms in these otherwise calm waters, in 1988 when China abruptly increased prices on contracts already signed (for internal political reasons) and in September 1990, when Chinese raw-silk prices were dropped by almost 12 % in an attempt to stimulate a market which had become very sluggish for reasons other than price.

Since January 1984, when China started quoting raw-silk prices in US\$ instead of RMBY, the standard 3A 20/22 denier price has moved from \$28 to today's price (December 1990) of \$45. What fluctuations there have been over this period can be attributed to the rise and fall in the dollar conversion-rate against other currencies, rather than to prices at origin.

The big question-mark about future prices of Chinese raw silk concerns the ability of the central authorities in China to control illicit export sales of raw silk from the silk-producing provinces of Sichuan, Jiangsu and Zhejiang. It was these exports, through Hong Kong, and the consequent non-availability of 'official' supplies, which sparked off the price crisis of June 1988 and led to a certain amount of speculation.

The situation as regards supply is now back to normal and raw-silk importers are hoping that there will be no political developments within China to disturb this new-found equilibrium.

Up until now, we have been discussing only raw silk but of course silk exchanges are not confined to raw material.

While raw silk continues to be imported by countries such as Italy, Japan, South Korea, France etc. for processing into fabrics and made-up goods, these two categories of products are also the object

of a considerable trade volume. A country like Italy, for example, which imports around 4 500 tonnes of raw silk per year, also imports over 2 800 tonnes (1989) of silk fabrics and more than 360 tonnes (1989) of made-up goods.

The United States, which today has only a small silk-processing sector, imported in 1989 \$1 425 million's worth of silk fabrics and garments/accessories.

In addition to 2 050 tonnes of raw silk, Japan imported over 10 000 tonnes of other silk products in 1989, making this country the world's largest consumer of silk, all categories of products included.

Germany is also a very large importer of silk fabrics, including furnishing fabrics.

PRODUCTS AND DEMAND

In developed countries, notably in the west, silk has traditionally been associated with luxury. The fame of the French and Italian silk industries is due to their production of haute couture fabrics based on many decades of technical innovation and artistic creativity.

When Europeans think of silk, it is generally this image which comes to mind. Today, however, more and more silk goods are available at acceptable prices for different sectors of the market.

European-made ties, scarves, dresses and imported blouses, suits, skirts etc. are finding ready outlets among consumers in every age-group. There can be no doubt that the continued presence of silk in the collections of the top fashion designers has helped to maintain this almost mythical image of silk and stimulate demand for silk articles in other market segments. Consequently, all silk-producing and exporting countries can be grateful to French and Italian weavers (among others) for preserving the desirability of silk despite the advent and the development of synthetic and artificial fibres. When these fibres started to flood the market during and after World War II, it was confidently predicted then that silk was doomed to disappear. In fact, more raw silk is produced today than in 1938 (70 000 tonnes as against 56 000).

When silk professionals talk about silk products, and about the characteristics of these products, they tend to split into two camps. On the one hand, there are those who claim that silk can no longer depend on a relatively narrow market and must therefore become more 'democratic'. This view is strongly opposed by those who reject the very notion of 'popularity', not only because (as they say) it would destroy the image of silk as we know it today, but for a more down-to-earth reason: there is already barely enough raw silk to satisfy the needs of today's consumers. If silk were suddenly to achieve a much wider appeal, there would not be nearly enough to go round. (If every adult woman in China and in western Europe bought just one silk scarf, world production would be totally absorbed).

Nevertheless, this ongoing debate does point to a quite legitimate concern, namely that silk is relatively badly known by younger consumers. Among the many myths attached to silk, there are two which are obstacles to its development: 'it's very expensive' and 'it's too difficult to look after'. The recent influx of ready-made silk articles from China, Hong Kong etc. has proved that silk need not be so expensive, as many of these goods are actually cheaper than a good-quality equivalent made from polyester.

The question of care is another matter and another source of almost theological discussion among silk professionals. Given that many modern working women will refuse to buy a silk blouse if it cannot be washed in a washing machine, the obvious reaction is to seek finishing treatments which will make it machine-washable. The purists will then respond by saying that it is technically possible to make some silk-garments machine-washable, but these garments then lose their characteristic silk 'hand' and wearing properties.

Perhaps all of this is a false debate. Synthetics have their own characteristics, notably ease of care, which have made them immensely popular. Silk has its specific qualities, in particular its comfort in wearing, which have made it the 'star' of all fibres. But is it possible to have everything?

There is a new silk product which has succeeded in attracting young customers, namely sandwashed fabrics. These fabrics are a breakaway from the traditional, glossy, up-market silks. They look dull, slightly 'distressed', couldn't-care-less. But they have a very soft hand and are reputed to wear extremely well. Their appeal is of course partly due to their being made from a natural fibre,

presented in an acceptable fabric norm for today's consumers. But they are not cheap, in either sense of the term.

The debate about the respective qualities of natural and synthetic fibres is an endless one. Suffice it so say that so far no synthetic fibre has been developed with all the qualities of silk. Some synthetics, notably micro-fibres, may have succeeded in reproducing some of the characteristics of silk, but as the old American promotional slogan used to say, 'Only silk is silk'.

Generally speaking, it is very difficult to make any serious estimates about future supply and demand for silk. Any fibre which is so closely tied to fashion, i.e. to change, will have its relatively unpredictable ups and downs. Silk, as we already said, is such a small fibre in terms of volume that it will be extremely sensitive to even minute changes in supply and demand.

There are two factors which will largely determine what the future supply-and-demand situation will be. One is China's capacity to maintain or even increase supply of raw materials at steady prices. The other is the role of Japan. This country is by far the world's largest consumer of silk, accounting for almost 25 % of total world production. The vast majority of Japan's silk uses is for the kimono, but it is a garment which is going out of favour, so the questions are : will Japanese women switch from the kimono to western-style silk garments made of silk ? Will Japan continue to weave large quantities of silk or will it become more profitable to import from countries such as South Korea ?

If Japan continues to import increasing quantities of raw silk from China, will there be enough left for the other raw-silk importing countries ? How soon will new sources of supply come on-stream and at what prices ?

Among so many uncertainties, there are at least two things we can be reasonably sure about. The first is that silk will continue to enjoy a unique position in people's imagination and consequently the top couturiers will include silk, in varying proportions, in their high-fashion collections.

The second is that silk has to adapt to modern economic conditions. This means that there must be a much greater promotional activity devoted to silk as a fibre, as distinct from specific silk products, in other words generic promotion.

There are those who claim that silk does not need promotion, that it is sufficiently well-known in its own right, that it is not really in competition with artificial and synthetic fibres, etc. But in its own particular market segment, silk is facing severe competition if not from synthetic fibres then from other luxury products. The real competition for silk comes from perfume, jewellery, leather goods etc. which are all fighting for the same customers. If gold, diamonds, leather goods are all making their presence felt there is no reason why silk should remain absent from the battle.

However, there is not only no generic promotion of silk, there is no real information about the fibre available to customers. Where does it come from ? What are its unique selling points ? What types of silk exist for what end-uses ? How to look after it ? There is an enormous and as yet unsatisfied need for education about silk especially for younger consumers, whose grandmothers certainly knew a lot more about it.

CONCLUSION

Despite the various problems facing silk, the uncertain supply situation, the vagaries of fashion, the lack of satisfactory generic promotion and so on, we can be generally optimistic for the future of silk. It enjoys an immense capital of interest and attraction among many sectors of the public and it has certain unique properties to offer. It is still the reference fibre, even for synthetics, otherwise they would not claim, as they consistently do, to be offering 'silk-like' qualities. It is a natural fibre, with a chemical composition close to that of the human skin, in other words it is one of the healthiest things to wear.

What is required is for one of the world's most ancient fibres, and certainly the most glamorous, to start using modern marketing and advertising techniques to remind people, or teach them, all it has to offer.

QUESTIONS

Mr de Micheaux :

'I would like to make two remarks :

- Silk agricultural production causes hardly any pollution since little insecticide is used.
- Energy consumption when manufacturing silk is also negligible and competitive with other fibres. Consequently, general concern about environment and agricultural and industrial production problems could maybe give some kind of answer. Although it is not likely to answer the whole of the questions tackled, it is a track worth considering.'

"Je voudrais faire deux remarques :

- La production agricole de soie se fait sur des bases peu polluantes puisqu'on utilise peu de pesticides.*

- La consommation d'énergie en fabrication de soie est également peu importante et compétitive avec celle d'autres fibres. En conséquence, les préoccupations générales sur l'environnement et sur les problèmes de pollution agricole et industrielle devraient peut-être fournir aussi des éléments de réponse. Cela peut constituer une piste de réflexion, non susceptible de répondre à l'ensemble des questions abordées."*

Mr Currie :

'It is true that silk is an attractive product on many accounts. It is an ecological product for both producers and consumers. One of the reasons for this interest in silk lies precisely in the growing power of the ecomovement, within which people are more interested in natural products than in synthetic products. Silk is also an extremely interesting product on the sociological level, insofar as in the developing countries, it gives a substantial income while fixing rural populations to their lands.

In addition, according to some figures quoted, particularly by Mr Candiani, one must allow 11 hours of work to produce 1 kg of raw silk, 8 of which for production of the required volume of cocoons and 2-3 hours for the time necessary to their reeling. These 11 hours of labour explain that the future of sericulture production can only exist in low income countries, having populations that are ready to work and skilful at this kind of production.'

"Il est vrai que la soie est un produit séduisant à beaucoup de points de vue. C'est un produit écologique, aussi bien pour les producteurs que les consommateurs. L'une des raisons de cet intérêt pour la soie est précisément la puissance croissante du courant écologique au sein duquel les gens s'intéressent plus aux produits naturels qu'aux produits synthétiques. La soie est également un produit très intéressant sur le plan sociologique, dans la mesure où, dans les pays en voie de développement, elle permet d'offrir un revenu intéressant tout en fixant les populations rurales sur place.

Par ailleurs, d'après certains chiffres cités, notamment par M. Candiani, il faut compter 11 heures de travail pour produire 1 kg de soie grège, dont 8 heures pour la production du volume de cocons nécessaires et 2 à 3 heures pour le temps nécessaire à leur filature. Ces 11 heures de main d'oeuvre expliquent que l'avenir de la production séricicole ne peut exister que dans des pays à revenus faibles qui ont des populations disponibles et habiles pour cette production."

Mrs Kotby :

'What advice can you give to developing countries as far as silk production is concerned, to stop or to develop ?'

"Que pouvez-vous conseiller aux pays en voie de développement en ce qui concerne la production de soie, d'arrêter ou de se développer ?"

Mr Currie :

'That is what the Americans call the 64 000 dollar question ! I do not know what to say. I certainly would not advise a developing country to launch massively into sericulture if they are thinking about exporting raw silk. If, on the other hand, they are thinking about silk on a home consumption basis, provided at the same time that silk has integrated into a complete textile circuit within the country, then this would be a more secure answer than producing raw silk for export because there are too many uncertainties.

You know that silk production in industrialized countries declined and in some cases disappeared because of the increase in labour cost. This is what happened in the European countries, it is happening in Japan, in Korea, it will also happen in China. It is already happening within China, as Mr Candiani pointed out, where the traditional producing areas - which are often the coastal areas in China - are becoming more rapidly industrialized, and this is why Sichuan Province is now the major producer of raw silk within China, it is going inland, because the coastal areas are becoming industrialized. But how quickly this will happen, we do not know. How soon will it happen that China will be producing less silk for the same reasons as the European countries, Japan and Korea? So there is a kind of timing we have got to look at. The time it takes for a new silk producing country to reach exportable quality of raw silk might be the same time-scale as that at which China is declining as a raw silk exporter. And this is talking in terms of 20 or 25 years or more. But I certainly would not think that it is advisable for a country to invest heavily in silk production with the sole objective of exporting raw silk.'

"C'est ce que les Américains appellent une question à 64 000 dollars ! Je ne sais quoi dire. Je ne voudrais certainement pas leur conseiller de plonger massivement dans la sériciculture si leur objectif final est d'exporter de la soie grège. Par contre, s'ils envisagent la production de soie en termes de consommation intérieure tout en intégrant la soie dans un circuit textile complet à l'intérieur du pays, alors ce serait une réponse plus sécurisante que celle de vouloir produire de la soie grège pour l'exportation. Je pense que ce serait beaucoup plus fiable, car il y a de trop nombreuses incertitudes.

Vous savez que la production de soie dans les pays industrialisés diminue et dans de nombreux cas disparaît à cause du coût croissant de la main d'oeuvre. C'est ce qui s'est passé dans les pays européens, au Japon, en Corée et peut-être dans quelques temps en Chine. C'est ce qui est en train de se passer en Chine même où, comme l'a fait remarqué M. Candiani, les régions traditionnelles de production - qui sont souvent les régions littorales en Chine - s'industrialisent très rapidement et c'est la raison pour laquelle la Province de Sichuan est maintenant le principal producteur de soie grège. La tendance est vers l'intérieur, du fait de l'industrialisation du littoral. Mais à quelle vitesse cela va-t-il se passer, nous ne pouvons le dire. Quand la Chine produira-t-elle moins de soie pour les mêmes raisons que les pays européens, le Japon et la Corée ? Aussi nous faut-il tenir compte d'une sorte de calendrier. Le temps nécessaire à un nouveau pays producteur de soie pour atteindre un niveau de qualité de soie grège exportable pourrait être le même que celui auquel la Chine disparaîtra en tant que pays exportateur de soie grège. Bien entendu, par temps nécessaire nous entendons 20, 25 ans, voire davantage. Mais je déconseillerais certainement à un pays d'investir en grandes quantités dans la production de soie avec pour seul objectif l'exportation de la soie grège.

Mrs Cazalère :

'Mr Currie has presented a report on the evolution of the balance between supply and demand over the past 3 years, insisting on the fact that during these 3 years, we have had a substantial demand followed in 1990 by a decrease in this demand. Can you observe variations on a much longer period of time and is there a cyclic phenomenon in the evolution between supply and demand?'

"M. Currie a fait un exposé sur l'évolution de l'équilibre entre l'offre et la demande pendant les 3 dernières années, en insistant sur le fait que, pendant ces trois ans, nous avons eu une demande importante suivie, en 1990, par une régression de cette demande. Pouvez-vous observer des variations sur un temps beaucoup plus long et existe-t-il un phénomène cyclique dans l'évolution entre l'offre et la demande?"

Mr Currie :

'Thank you for asking this question which concerns everybody. There surely is a cyclic phenomenon but the cause is not known. What can be noted is that after 2 or 3 year's increase in consumption, there is going to be a 3rd or 4th year's decrease, simply because circuits get saturated.

This year, 1990, will be a decrease year in Europe after 3 good years : 1987, 1988 and 1989. In France, in 1989, 750 tonnes of raw silk were imported whereas the utilization of this raw material is on average 600 tonnes. 1990 will necessarily be a slack year. But what is different this time is that 1990 is worse than expected. I gave some of the reasons for this in my review : the overall depression

in textile, the American economic situation, the fall of the dollar, the Gulf crisis which affected even the weavers of Lyon who produced in large quantities for the Middle East and who saw their trade come to a complete stop. This is, however, fitful. Noone could anticipate that business would be so slack this year. But there certainly is a cyclic phenomenon. One prefers to consider silk statistics in five year brackets. Going back to 1965, for example, you can see that, in brackets, there is a global increase in demand. But in each of these brackets, there are ups and downs which cancel each other out. However, this global increase is weak. There is not at present a shortage of 20,000 tonnes of silk in the world as was pretended. I do not know how this figure was worked out.

This is not specific to silk, but it is said in the economic world that we are more and more led to manage the uncertain. For example, at present one of the rare silk products that sell well is sand-washed silk. These silk materials were subjected to a treatment that gives them an extraordinary and characteristic feel and which for purists represent a kind of heresy because you damage the silk deliberately, you beat it up, you attack it but it is just as well it exists because for the time being it sells well. Mr Candiani will agree with me to say that we do not really know what is done to this poor silk. It is hurt and all of the harmful effects are not known. This is a new product that could refine the problem, whereas only 2, 3 or 5 years ago noone could foresee the existence of such a product, which affects more the younger populations, different consumers for silk. This is an unpredictable factor which turns any prediction into a wager.'

"Merci de poser cette question qui concerne tout le monde. Il y a sûrement un phénomène cyclique mais on ignore la cause. Ce qu'on peut constater, c'est qu'au bout de 2 ou 3 années d'augmentation de la consommation, il va y avoir une 3ème ou une 4ème année de baisse, simplement parce que les circuits seaturent.

Cette année, 1990, sera une année de baisse en Europe après 3 bonnes années 1987, 1988 et 1989. En France, en 1989, on a importé 750 t de soie grège, alors que la moyenne d'utilisation de cette matière première est d'environ 600 t. 1990 sera automatiquement une année plus faible. Mais ce qui est différent cette fois-ci, c'est que 1990 est plus mauvaise qu'on ne l'avait prévu. Il y a quelques explications dans mon exposé : la déprime générale dans le textile, la situation de l'économie américaine, la baisse du dollar, la crise du Golfe qui a touché même des tisseurs lyonnais qui fabriquaient des quantités importantes pour le Moyen-Orient et qui ont vu leurs commerces s'arrêter totalement. Cela est cependant ponctuel. On n'imaginait pas que l'activité serait aussi faible cette année. Mais il y a certainement un phénomène cyclique. Lorsque l'on regarde des statistiques sur la soie, on préfère prendre des tranches de 5 ans. En remontant jusqu'en 1965, par exemple, on constate que, par tranche, il y a une augmentation globale de la demande. Mais dans chacune des tranches, il y a des hauts et des bas qui s'annulent. Cependant, cette augmentation globale est faible. Il ne manque pas actuellement 20 000 t de soie dans le monde comme on a pu le dire. Je ne sais comment on a pu arriver à ce chiffre.

Ce n'est pas propre à la soie, mais on dit dans le monde économique que nous sommes de plus en plus amenés à gérer l'incertitude. Par exemple, actuellement un des rares produits de soie qui se vend bien est la "soie vieillie" ou "soie lavée" ou "sand-washed" ; ce sont des tissus de soie qui ont subi un traitement qui leur donne un "toucher" extraordinaire, très typé et qui, pour les puristes de la soie, représentent une espèce d'hérésie, car on abîme la soie volontairement, on la matraque, on l'agresse.... mais heureusement qu'elle existe car, pour l'instant, elle se vend bien. M. Candiani sera d'accord avec moi pour dire que l'on ne sait pas exactement ce qu'on lui fait à cette pauvre soie. On lui fait mal, sans connaître tous les effets néfastes ; voilà un nouveau produit qui pourrait un peu changer les données du problème, alors qu'il y a 2, 3 ou 5 ans on ne pouvait prévoir l'existence d'un tel produit qui a un effet plus large chez des populations plus jeunes, des consommateurs différents pour la soie. C'est-là un facteur imprévisible qui rend toute prévision très hasardeuse."

Mr Mas :

'You said that there no longer is any silk promotion for the moment, since China has not financed it for two years. At the level of the authorities who gather every now and then with silk manufacturers representing most of the countries, why is it that no goodwill or funds can be found to take up this silk promotion ?'

"Vous disiez qu'il n'y a plus de promotion de soie pour l'instant, puisque la Chine ne la finance plus depuis deux ans. Dans les instances réunies de temps en temps avec les industriels de la soie représentant la plupart des pays, pourquoi n'arrive-t-on pas à regrouper des bonnes volontés et des crédits pour reprendre cette promotion soie ?"

Mr Currie :

'Mr Mas, do not ask me why ! I assure you that it is impossible. That is a little like the wealth tax. Everybody agrees to it, provided that this tax starts slightly above what one has got. As far as silk promotion is concerned, everybody agrees on the fact it is necessary, up to the time when one says "How to do it ?". Anyway, it cannot be done on a voluntary basis. It is obvious that if you base a contribution to promotion on volunteering, 10 % of the processors or producers will participate and 100 % will profit by it. There is therefore an unfairness at the start.

When we tackle this problem at ISA, Woolmark is often quoted as an example. Why not do like the International Wool Secretariat ? Yes but people are often unaware of the fact that Woolmark is financed by a compulsory contribution. Every Australian or New Zealand farmer contributes to 5 % of their turnover in the form of a tax as a support to the International Wool Secretariat and to the promotion of Woolmark. It works because it has got a source of guaranteed and stable income, an annual budget in the region of 150 million dollars. Consequently all the silk-producing countries would have to accept participating to a total of a little percentage of the value of the fabrics processed. But this can work only if it is worldwide, in particular for problems of time. In the beginning, it can be decided to start with the largest producers. The largest Italian producers will probably accept to contribute. But after 2 or 3 years, seeing that their efforts are not followed by the other producers and that they nearly alone finance a promotion which is profitable to the others, they will not be long withdrawing. That is what China did with the European Commission for Silk Promotion. It participated for 15 years and then decided to withdraw. It could have continued if it had not been the only country to pay. But how to guarantee that we are not the only ones ? This is a technical problem difficult to solve.'

"M. Mas, ne me demandez pas pourquoi ! Je vous assure que c'est impossible. C'est un peu comme l'impôt sur les grandes fortunes. Tout le monde est d'accord là-dessus, à condition que cet impôt commence un peu au-dessus de ce que l'on a soi-même. En ce qui concerne la promotion soie, tout le monde est d'accord sur la nécessité de faire la promotion soie, jusqu'au moment où l'on dit "comment faire ?". De toute manière, cela ne peut être quelque chose de volontaire. Il est évident que si l'on fonde une contribution à la promotion sur le volontariat, il y a 10 % des transformateurs ou producteurs qui y participent et 100 % qui en bénéficient. Donc il y a une injustice au départ.

Lorsqu'on aborde ce problème à l'AIS, on nous cite souvent en exemple la "Woolmark". Pourquoi ne pas faire comme le "secrétariat international de la laine ?" Oui, mais les gens ignorent souvent que la Woolmark est financée sur une participation obligatoire. Chaque fermier australien et néozélandais contribue pour 5 % de son chiffre d'affaires sous forme d'impôt au soutien apporté au Secrétariat International de la Laine et à la promotion de la Woolmark. Elle fonctionne car elle a une source de revenus garantis et stables, un budget annuel avoisinant les 150 millions de dollars. En conséquence, il faudrait que tous les pays producteurs de soie acceptent de verser une part de la valeur de la soie grège qu'ils produisent et que tous les pays transformateurs acceptent de participer à la hauteur d'un petit pourcentage de la valeur des tissus qu'ils transforment. Mais cela ne peut fonctionner que si c'est universel, notamment pour des problèmes de temps. Au début, on peut décider de commencer avec les plus grands. Les plus gros producteurs italiens accepteront sans doute de contribuer. Mais au bout de 2 ou 3 ans, en constatant que leurs efforts ne sont pas suivis par les autres, et qu'ils financent quasi seuls une promotion qui bénéficie aux autres, ils ne tarderont pas à se retirer. C'est ce qu'a fait la Chine avec la Commission Européenne de Promotion Soie. Elle a participé pendant 15 ans puis a décidé de se retirer. Elle aurait continué si elle n'avait pas été la seule à payer. Mais comment garantir que nous ne sommes pas les seuls ? c'est là un problème technique difficile à résoudre.

Mr Liu thanked Mr Currie for his report as well as all the contributors.

M. Liu remercie M. Currie pour son rapport ainsi que tous les intervenants.

Lastly **Mr Currie** indicated that the people interested in the world silk market could obtain the publication 'Silk review 1990' from by the International Trade Centre (ITC, Palais des Nations, Geneva 10, Switzerland). It gives a good overview of the situation and is available either in English or in French.

M. Currie indique, pour finir, que les personnes intéressées par le marché mondial de la soie peuvent se procurer la publication "Silk review 1990" publiée par l'International Trade Center (ITC, Palais des Nations 1-11, Genève 10, Suisse). Elle offre un très bon survol de la situation et est disponible soit en anglais soit en français.

Mr Liu closed session II.

La session II est close par M. Liu.

SESSION III

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INDO-DUTCH CO-OPERATION ON THE CONTROL OF THE UZIFLY, AN ENDOPARASITE OF THE SILKWORM

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The uzifly (*Exorista sorbillans*, Tachinidae) is a larval parasitoid of mulberry silkworms. This parasite has been known to occur in South East Asia since a long time (China, Thailand, North East India), where silk production still plays an important role.

However, silk production in India is concentrated in the Southern States of the country (Karnataka, Tamil Nadu and Andhra Pradesh).

Until 1980, this sericultural area was untouched by the uzifly. In May 1980, however, the first signs of this parasite were found in Karnataka, due to the import of infested cocoons from West Bengal.

Yearround rearing and lack of control measures have caused a rapid spread of the uzifly, culminating in average losses of 25 % in 1981/82. Despite the use of nylon nets to ward off uziflies, present losses still amount to 15-25 % at a value of US \$80 million.

To tackle the problem of the uzifly, a joint Indo-Dutch project was started in 1987, financed by the Netherlands Minister for Development Co-operation.

The main objectives of the project are :

- to analyze and synthesize those compounds involved in the host-finding behaviour of the uzifly (= kairomone) ;
- to search for suitable hyperparasites/pathogens than can affect the uzifly ;
- to carry out detailed biological studies, viz. alternate hosts and reproductive biology.

The institutes involved in the project are :

- The Karnataka State Sericulture Development Institute, Bangalore, India.
- The University of Agricultural Sciences, Bangalore, India.
- The Indian Institute of Chemical Technology, Hyderabad, India.
- TNO Division of Technology for Society, Department of Biology, TNO, Delft, The Netherlands.

QUESTIONS

Mr Tayade thanked Mr Persoons for setting out the problem of the uzi fly in a clear manner, a particularly acute problem in South India. He opened the discussion.

M. Tayade remercie M. Persoons d'avoir présenté de manière claire le problème de la mouche uzi, particulièrement crucial dans le sud de l'Inde. Il ouvre la discussion.

Mr Mauchamp :

'You hardly mentioned sexual pheromonal communication. Is it because these pheromones are not yet isolated ?'

"Vous avez très peu parlé de la communication phéromonale sexuelle. Est-ce parce qu'on n'a pas isolé ces phéromones ?"

Mr Persoons :

'I have presented what was done within the context of the programme. These attraction problems will be studied during the next two years.'

"Je vous ai présenté ce qui a été fait dans le cadre du programme. Ces problèmes d'attraction seront étudiés dans les deux années qui viennent."

Mr Mauchamp :

'The simultaneous attraction of males and females by the silkworms could result in the adult flies concentrating in a confined space and facilitate mating.'

"L'attraction simultanée des mâles et des femelles par les vers à soie pourrait entraîner une concentration des mouches adultes dans un espace restreint et favoriser l'accouplement."

Mr Persoons :

'Females mate, lay their eggs, mate again (polyandry). The function of the compounds contained in the silkworms is a dual one : the females have to locate the silkworms, the males have to find out the place where the females are. This could be an explanation. But when you test these compounds, you do not obtain any response.'

"Les femelles s'accouplent, pondent leurs oeufs, s'accouplent à nouveau (polyandrie). La fonction des composés contenus dans les vers à soie est double : pour les femelles, il s'agit de localiser les vers à soie, pour les mâles, de situer le lieu où sont les femelles. Ceci peut être l'explication. Mais si vous testez ces composés, vous n'obtenez aucune réaction."

Mr Tayade :

'Does the uzi fly exist outside Southern India and in what countries ?'

"La mouche uzi existe-t-elle ailleurs que dans le sud de l'Inde, et dans quels pays ?"

Mr Persoons :

'It has been reported in China as well as the Philippines, Thailand and Northern India for a long time from where it spread to the south as from 1981.'

"En Chine, sûrement, ainsi qu'aux Philippines, en Thaïlande et dans le nord de l'Inde depuis longtemps d'où elle a été transportée à partir de 1981 dans le sud."

Mr Akapanthu :

'What is the scientific name of the uzi fly ?'

"Quel est le nom scientifique de la mouche uzi ?"

Mr Persoons :

'This question has been settled recently : *Exorista sorbillans*.'

"Cette question a été tranchée récemment : Exorista sorbillans."

Mrs Kotby :

'Did you try male sterilization ?'

"Avez-vous tenté la stérilisation des mâles ?"

Mr Persoons :

'The population is low outside, therefore sterilization is difficult ; higher populations are found in the cocoon markets. Recently, we have used an insecticide : Dimilin. If the pupae are treated, the females mate, lay their eggs but cannot develop. Gamma ray sterilization can also be tried at this stage.'

"La population à l'extérieur est faible, aussi la stérilisation est difficile ; on rencontre une forte population dans les marchés aux cocons. Récemment, nous avons utilisé un insecticide : le Dimilin. Si on traite les pupes, les femelles s'accouplent, pondent leurs oeufs mais ne se développent pas. La stérilisation par les rayons gamma peut être tentée aussi à ce moment-là."

THE PRATICAL EFFECT OF THE PREVENTION AND CONTROL OF PEBRINE DISEASE OF SILKWORM BY ARTIFICIAL HATCHING WITH HCl IN HIGH TEMPERATURE JUST AFTER OVIPOSITION

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This paper deals with the application of the technology of artificial hatching with acid treatment in high temperature just after oviposition to examine the practical effect of the prevention and control of the silkworm pebrine disease. The experiment was conducted inside the laboratory of the Academy of Agricultural Sciences of Guangdong Province in 1980. The intermediate test and popularization of the experimental method were conducted in the sericultural regions in Nanhai County, Guangdong Province, in 1981-83. The test silkworm races used were the current popularized polyvoltine, white cocoon races, viz. 'Guang Nong 3' and 'Guang Nong 4'. The results of the experiment were as follows: the 10-12 hr aged pebrinized eggs were used as materials, their average infection rate by the pebrine disease during the 3rd instar was 87.8 %, the eggs were treated with hydrochloric acid, of which the specific gravity was 1.05 and temperature was 47°C, for 10-20 minutes. In comparison with the control (check) of the eggs of the same moth (i.e. acid treatment by the ordinary method), the rate of disease coefficient of the treated one was decreased by 97.1-100 %, and the effect of disease prevention and control was quite significant during 1981-83, the above mentioned technology was applied to 297,688 boxes of silkworm eggs in Nanhai County, Guangdong Province. As a result, the harvest of cocoons was stable, the pebrine disease was significantly decreased, the rate of diseased silkworms was greatly decreased and the pebrine disease was effectively under control.

FOREWORD

Guangdong Province is a major tropical sericultural region in China, since there are 7-8 crops of silkworms continuously in a year over there, so it is difficult to control the silkworm pebrine disease completely. Hence, beside the strict conduction of the conventional disease-control measures, research on the physical and chemical therapy of the pebrine disease also has to be undertaken. This paper mainly deals with the studies of the effect of the prevention and control of the pebrine disease by acid treatment in high temperature.

There has been a definite foundation in the history of Guangdong Province for therapy of the pebrine disease of the silkworm by adopting high temperature. In the book 'Sericultural Manual in Guangdong Province' written by Chen Qi Yuan (1866), it was said that silkworm eggs with hot water treatment was effective in controlling the pebrine disease. According to the experiment done by the Sericultural Department of South China Agricultural College and Sericultural Department of the Academy of Agricultural Sciences of Guangdong Province, it was proved that the hot water treatment of silkworm eggs was effective in decreasing the occurrence of pebrine disease to some extent. In the USSR, according to Payalkov's experiment (1939), it was discovered that hot water treatment of the silkworm eggs would greatly increase their resistance to the pebrine disease. Hahanov (1956) also made a study on this aspect and discovered that under high temperature the meront and the unmaturred spores were induced to death by caryokinesis correspondingly, the theoretical basis was thus provided for the hot water treatment therapy of the pebrine disease. Ovenesyan *et al.* (1958) pointed out that

if the eggs were soaked in acid at 46 °C for 40 minutes, the effect was significant in curing the pebrine disease. According to the studies of Astaurov *et al.*, if the eggs were soaked in 46 °C acid for over 30 minutes, 96-98 % of the pebrine diseased eggs could be cured. In 1961-1967, Georgia SSR utilized the above mentioned acid-treatment method to deal with altogether 200,000 boxes of silkworm eggs, as a result the silkworm rearing was successful.

Table I. Influence of various treatments upon the occurrence of the pebrine disease.

Tableau I. Effet de divers traitements sur l'apparition de la maladie de la pébrine.

Silkworm races	Acid treatment	Rate of pebrine disease infection (%)	Coefficient similar to left side	Number of spores for each field of vision	Coefficient similar to left side
<i>Races de vers à soie</i>	<i>Traitement à l'acide</i>	<i>Taux d'infection par la pébrine (%)</i>	<i>Coefficient similaire au côté gauche</i>	<i>Nombre de spores par champ de vision</i>	<i>Coefficient similaire au côté gauche</i>
Chou 303	47 °C 10'	0	0	0	0
	Conventional	69.7	100	20.4	100
	47 °C 20'	2.4	2.9	0.2	0.8
	Conventional	83.8	100	24.8	100
137	47 °C 10'	0.6	0.7	0.04	0.1
	Conventional	90.1	100	21.5	100
	47 °C 20'	1.9	1.9	0.55	2.6
	Conventional	98.9	100	21.5	100
42	47 °C 10'	0	0	0	0
	Conventional	89.9	100	21.3	100
	47 °C 10-20'	0.6	0.6	0.03	0.1
	Conventional	94.6	100	23.1	100
Average <i>Moyenne</i>	47 °C 10-20'	0.92	1.0	0.13	0.55
	Conventional	87.82	100	23.3	100
T value / <i>Valeur t</i>		21.452		18.066	

I. LABORATORIAL RESULTS

In 1980, 672 items of preliminary hatching of various ages of eggs, specific gravity of hydrochloric acid, temperatures, periods of time for acid treatment were conducted in the laboratory of our research institute, on the basis of various experiments, which had better hatching results, formal tests on the comparative effects of the pebrine disease prevention and control were conducted. The

Table II. Results of the rearing of ultra-pebrinized silkworm eggs in comparison with that of the qualified silkworm eggs in the same household.

Tableau II. Résultats comparés de l'élevage des oeufs de vers à soie sur-pébrinisés et des vers à soie sains élevés dans la même exploitation.

Year	Treatment	Number of eggs cards	Rate of pebrine disease infection of silkworm eggs (%)	Cocoon output for each egg card (kg)	Cocoon output for 100 kg of mulberry leaves (kg)
<i>Année</i>	<i>Traitement</i>	<i>Nombre de feuilles de ponte</i>	<i>Taux d'infection des oeufs par la pébrine (%)</i>	<i>Production de cocons par feuille (kg)</i>	<i>Production de cocons pour 100 kg de feuilles de mûriers (kg)</i>
1981	Ultra-pebrinized eggs with high temperature and acid treatment <i>Oeufs sur-pébrinisés traités à la chaleur et à l'acide</i>	21.4	1.50-2.05	30.14	9.60
	Qualified eggs with conventional treatment <i>Oeufs sains traités de façon conventionnelle</i>	30.8	0-0.94	23.74	7.86
1982	Ultra-pebrinized eggs with high temperature and acid treatment <i>Oeufs sur-pébrinisés traités à la chaleur et à l'acide</i>	20	1.70-3.33	20.44	8.74
	Qualified eggs with conventional treatment <i>Oeufs sains traités de façon conventionnelle</i>	20	0-0.1	23.36	8.60
1983	Ultra-pebrinized eggs with high temperature and acid treatment <i>Oeufs sur-pébrinisés traités à la chaleur et à l'acide</i>	66.2	1.19-5.47	23.53	8.85
	Qualified eggs with conventional treatment <i>Oeufs sains traités de façon conventionnelle</i>	0-0-94	22.06	8.56	

Note : 4 batches for 1981, 3 batches for 1982, 12 batches for 1983 / 4 lots ont été utilisés en 1981, 3 lots en 1982, 12 lots en 1983.

method was like this, during the beginning of the 5th instar, the solution of pebrine spores with the concentration of 10,000/ml was fed to the larvae ; the moths' eggs suffering from the disease were then sorted out, the diseased eggs of each moth were divided equally into two parts, one of which was treated with high temperature and acid (test), while the other half was treated as usual (control). After hatching, the larvae were reared in separate batches, three duplications were used for the test and control respectively, during the 3rd instar, microscopic examination was conducted to check the rate of pebrine disease infection and the degree of infection. The test silkworm races were 'Chou 303',

'137' and '42'. The results of the experiment were such as in Table I. In the control batch, the average infection rate was 87.82 % if the 12-10 hr silkworm eggs were treated with hydrochloric acid of specific gravity 1.05, under 47 °C for 10-20 minutes, the average infection rate was 0.92 % only, in comparison with the control batch of the same moth, the coefficient of pebrine disease infection was decreased by 97.1-100 %. The average decrease was 99 %, the average number of spores for the field vision was 0.13 only, while in the control it was 23.3. For the examination of the *t* value, the difference of the two indices of the test and control batches mentioned above was much over the extreme significant value 0.01.

II. RESULTS OF THE INTERMEDIATE TEST

In 1981-83, an intermediate test was conducted in Shatou, Nanzhuang, Nanhai County, etc. The test silkworm races were the current ones viz. 'Guang 3' and 'Guang 4'. The methods of intermediate test were of two types : the first type was conducted in Shuinan, Xiqiao and Luonan villages, several silkworm rearing households were selected and silkworm rearing was undertaken in the similar household, room and time, and contrasts were made for the rearing.

Table III. Comparative results of qualified silkworm eggs of various treatments in the silkworm rearing household.

Tableau III. Résultats comparés de divers traitements d'oeufs de vers à soie sains dans la pièce d'élevage.

Treatments	Number of egg cards	Rate of pebrinized silkworm eggs (%)	Rate of pebrine infection in late molting larvae (%)	Cocoon output of each egg card	Cocoon output for 100 kg of mulberry leaves (kg)
<i>Traitement</i>	<i>Nombre de feuilles de ponte</i>	<i>Taux d'oeufs pébrinés (%)</i>	<i>Taux d'infection au dernier âge larvaire (%)</i>	<i>Production de cocons par feuille</i>	<i>Production de pour 100 kg de feuilles de mûrier (kg)</i>
High temperature and acid treatment <i>Traitement à la chaleur et à l'acide</i>	52.2	0-0.71	4.9	24.30	8.60
Conventional hot water treatment <i>Traitement conventionnel à l'eau chaude</i>	70.7	0-0.48	20.6	22.14	8.51
Coefficient			23.78	109.7	101.5
Value of <i>t</i> / <i>Valeur de t</i>				2.667	

Note : 9 batches altogether, $p = 0.05$, $t = 2.306$ / Total de 9 lots, $p = 0,05$, $t = 2,306$.

Table IV. Comparative results of the ultra-pebrinized silkworm eggs treated with high temperature and acid and the qualified conventional eggs reared in the same production team.

Tableau IV. Résultats comparés du traitement à la chaleur et à l'acide des oeufs de vers à soie sur-pébrinisés et des oeufs sains conventionnels élevés par la même équipe de production.

Year	Types of experiment	Number of egg cards	Rate of pebrinized silkworm eggs (%)	Rate of pebrine infection in late molting larva (%)	Cocoon output of each egg card	Cocoon output for 100 kg of mulberry leaves (kg)
<i>Année</i>	<i>Type de traitement</i>	<i>Nombre de feuilles de ponte</i>	<i>Taux d'oeufs pébrinisés (%)</i>	<i>Taux d'infection dernier âge larvaire (%)</i>	<i>Production de cocons par feuille de ponte</i>	<i>Production de cocons pour 100 kg de feuilles de mûrier (kg)</i>
1981	Ultra-pebrinized eggs / <i>Oeufs sur-pébrinisés</i>	22	119	1.21-7.41	30.44	10.18
	Qualified eggs / <i>Oeufs sains</i>	31	244	0-0.94	28.44	10.19
1982	Ultra-pebrinized eggs / <i>Oeufs sur-pébrinisés</i>	59	741	1.46-5.74	17.52	7.74
	Qualified eggs / <i>Oeufs sains</i>	80	1,041	0-0.1	18.61	7.78
1983	Ultra-pebrinized eggs / <i>Oeufs sur-pébrinisés</i>	59	724	1.61-3.52	21.89	9.29
	Qualified eggs / <i>Oeufs sains</i>	46	617	0-0.48	22.02	9.39
Statistics / <i>Statistiques</i>	Ultra-pebrinized eggs / <i>Oeufs sur-pébrinisés</i>	140	1,584	1.21-7.41	20.49	9.07
	Qualified eggs / <i>Oeufs sains</i>	157	1,902	0-0.94	20.97	9.12
T value / <i>Valeur t</i>					1.057	1.889

Note : $p = 0.05$, $t = 4.303$.

In order to have significant differences, for the test district, some ultra-pebrinized silkworm eggs were used (i.e. those with about 1.2-7.4 % pebrinized eggs) for high temperature and acid treatment : for the control batches, the conventional method of hot water or acid treatment for the qualified silkworm eggs was used (rate of pebrine infection of them was 0-0.94 %), the results are shown in Table II. At the same time, in order to compare the qualified silkworm eggs treated with high temperature and acid with those treated with acid conventionally, 9 batches reared in the same household and rooms were compared with each other, the results are recorded in Table III. For the

second type, silkworm rearing was conducted in the same site and at the same time as the first type within the three villages mentioned above. The ultra-pebrinized silkworm eggs treated with high temperature and acid were taken as the test batches and the qualified seeds treated with hot water or acid were used as control batches, the results are in Table IV.

From the data in Table II, it was known that the output for each egg card in the years 1981 and 1982 were either high or low alternatively, so the differences were not significant, that is, after high temperature and acid treatment of the ultra-pebrinized silkworm eggs, their output of silkworm rearing could reach the production level of those of the qualified silkworm eggs (generally, those ultra-pebrinized ones having a rate of infection of 3 % in comparison with the conventional ones, the harvest crop from the former was only 1/3 of the latter, and the output value was 1/4 of the latter). In the experiment in 1983, the output value from the ultra-pebrinized silkworm rearing treated batches was a bit higher than that of the qualified one (control batches).

From Table III, it was known that for the existing qualified silkworm eggs, if they were treated with high temperature and acid, the infection rate of pebrine disease during the larval stage was significantly lower than that of the control ones (conventional hot water treatment of qualified silkworm eggs), the *t* value was in great difference; hence, the output of each qualified egg card treated with high temperature and acid was higher than that of the conventional acid treatment qualified eggs by 9.7 % and there was a significant difference in the *t* value.

The results in Table IV further verified that those ultra-pebrinized silkworm eggs (rate of pebrine infection 1.21-7.41 %) being soaked in acid with high temperature treatment would have a stable yield and the economic output could reach that of the normal level of qualified silkworm eggs.

III. EFFECT ON PRODUCTION

In 1981-1983, testing the effect of the experiment, Nanhai County tried gradually this high temperature acid treatment method in silkworm egg production, within three years 297,688 egg cards were tested. Among them, in May-Oct. 1983, 128,813 qualified egg cards were treated with high temperature and acid, the average output of each egg card was 20.44 kg, the yield of rearing crop was quite stable and the pebrine disease was significantly decreased. By estimation, for each egg card, a 2 kg cocoon loss could be decreased, as for the 300,000 egg cards tried for the whole country, there would be an increase in benefit of 600 tonnes of cocoons.

In recent years, since the high temperature and acid treatment system was conducted all over Nanhai County, the level of pebrine disease infection in the parent silkworm eggs was greatly lowered, the density of pollution of the source of pebrine disease was also greatly decreased, so that the rate of infection of the disease in the parental silkworm egg district and silkworm egg production farm and station was also decreased gradually year after year. For example: the amount of eliminated ultra-pebrinized silkworm egg cocoons was decreased from 16,254 kg in 1981 to 4,035 kg in 1983, hence the silkworm qualities were greatly enhanced and the loss by ultra-pebrinized cocoons and silkworm eggs were greatly reduced.

IV. CONCLUSION

As to the existing commercial races like 'Guang 3', 'Guang 4', etc., if their eggs were treated with the measures of acid and high temperature treatment, the effect of pebrine disease prevention and control could reach as high as over 97 % while the egg diapause was relieved. After the tests in the intermediate experiment and in production, it has been verified that the application of this method to the silkworm eggs having a small amount of pebrine disease would cause a significant result in pebrine disease prevention and control. Hence, on the basis of the maintenance of the ordinary preventive work of examining the disease, high temperature and acid treatment is one item of new measures for its prevention and control. In fact, it is a practical method applicable to the epidemic area of the pebrine disease.

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QUESTIONS

Mr Liu asked for questions to be transmitted in writing so that he could answer them later owing to his difficulties in understanding English.

M. Liu demande que les questions lui soient transmises par écrit afin qu'il y réponde ultérieurement en raison de ses difficultés à comprendre l'anglais.

Mr Tayade handed over to Mr Guigou who thanked Mr Chavancy for inviting him to this conference.

M. Tayade donne la parole à M. Guigou qui remercie M. Chavancy de l'avoir invité à cette conférence.

LES EXPERTISES INTERNATIONALES ET LA COORDINATION DES ACTIONS

J. GUIGOU

7, place Carnot, 69002 Lyon, France.

Mesdames, Messieurs,

Je veux d'abord ici remercier votre Secrétaire général adjoint qui m'a invité à prendre la parole bien que je ne sois membre de votre organisation qu'à titre personnel, ne représentant que moi-même.

En tant qu'expert textile travaillant sur le marché international, j'ai été amené, en liaison avec la Commission séricicole internationale, à effectuer différentes missions dans divers pays.

C'est à ce sujet et dans un but de plus grande efficacité que je voudrais me permettre de faire quelques remarques.

Il est arrivé, par exemple, dans un pays qui n'est pas membre de notre organisation, qu'une mission concernant le développement de la production de soie soit organisée à la demande d'un ministère par une grande organisation internationale sans que la CSI ait été mise au courant par l'organisation en question. Seule, une démarche fortuite de l'expert choisi a mis la CSI au courant. Il convient de noter que, dans ce cas précis, la collaboration entre l'expert et la Commission a été particulièrement fructueuse, tant avant le départ de l'expert qu'après son retour et a permis la rédaction d'un rapport avec des propositions beaucoup mieux adaptées.

Dans un autre cas, des sociétés de conseil et d'engineering gravitant autour d'un organisme de développement, après avoir été mises au courant d'un projet, se livrent à une véritable chasse aux experts et souvent proposent toutes, à quelques variantes près, les mêmes experts à l'organisme en question. Une fois terminée la chasse aux experts, la CSI n'entend plus parler de rien alors que c'est bien le moment à partir duquel elle pourrait jouer un rôle pour le bien de toutes les parties et pour le développement de la soie qui fait l'objet de tous ses soins.

Il semble donc qu'un contact direct entre la CSI et les grands organismes de développement soit souhaitable dès la naissance des projets et tout au long de leur vie. On peut penser que l'efficacité des projets en serait certainement accrue.

D'autre part, les rapports non plus ne lui sont pas communiqués, même simplement à titre d'information. A ma connaissance, il n'existe pas d'organisme qui centralise ceux-ci dans une bibliothèque, ou mieux, une banque de données.

Quels services ne pourrait pas rendre une telle centralisation, même des plus sommaires : la mise à disposition des professionnels d'un état permanent de tout ce qui est fait pour le développement de la soie.

Je voudrais maintenant dire aussi quelques mots sur une lacune qu'il me semblerait souhaitable de voir combler. C'est celle du manque total d'informations au plan mondial sur le commerce et la négociation des cocons. On sait souvent après coup qu'il y a eu des transactions, sans qu'on en connaisse souvent très exactement le cours. Il existe, dans le monde, un marché et un cours pour un grand nombre de matières premières destinées à être transformées, comme le cacao, le pétrole, le soja, la laine en balles, etc., pourquoi pas pour le cocon ?

Il est notoirement connu de tout le monde que, maintenant, les technologies utilisées pour la fabrication des tissus en soie exigent un fil absolument parfait que les utilisateurs se plaignent souvent de ne pas trouver facilement quand ils en ont besoin.

Beaucoup d'utilisateurs ne veulent plus utiliser pour la trame les fils de soie grège de qualité plus basse que l'on utilisait autrefois.

Il y a, dans le monde, des régions ou des endroits où d'excellents cocons sont souvent mal filés ou mal déroulés par suite du manque de machines adéquates et de personnel compétent. Le fil obtenu à partir de ces bons cocons n'est pas exportable et cela représente un manque à gagner pour les économies des pays en question.

Exportés dans les pays possédant des machines ultra-modernes, ces mêmes cocons permettraient de produire du fil de grande qualité. Ils pourraient même être vendus plus cher que sur les marchés locaux et ainsi, de l'éleveur de vers à soie à l'utilisateur de fil de grège, tout le monde y trouverait son compte.

Il me semble que cela devrait être une des tâches de notre organisation que de se pencher, dans les années qui viennent, sur ce problème qui intéresse également l'AIS.

Peut-être pourrait-on envisager la constitution d'un groupe de travail commun qui effectuerait un premier travail d'exploration et ferait en quelque sorte l'inventaire de tous les problèmes à résoudre en vue de la constitution d'un tel marché dans un avenir plus ou moins lointain.

Mesdames, Messieurs, je vous remercie de votre attention.

QUESTIONS

M. Chavancy désire joindre un commentaire à ce que vient de dire M. Guigou.

"Dans la première partie, il fait clairement allusion aux problèmes qui se posent en matière d'informations sur les projets séricicoles et sur le développement de la sériciculture. Depuis plusieurs années, on constate effectivement une sorte d'anarchie dans ce domaine où des organismes internationaux financent des expertises demandant les conseils de la CSI en matière d'experts, voire d'évaluation d'experts, alors que l'on n'a aucune information par la suite sur ces projets, ni par les organismes internationaux, ni par les Etats dans lesquels ils se déroulent. Ceci est aussi vrai pour les Etats-membres que pour les Etats non membres.

Aussi, je souhaite, à cette occasion, lancer un appel aux Etats présents : la CSI est là et souhaite être là pour, justement, enregistrer et diffuser les projets à l'étude dans les différentes régions et les résultats des expertises et de ces projets. La CSI a les moyens de stocker cette information et de la rendre disponible puisque, à travers Sericologia, elle peut communiquer cette bibliographie de manière permanente.

Avec M. Currie de l'AIS, nous sommes friands de ces informations et souhaiterions qu'elles puissent être centralisées. Il serait possible de se partager les tâches : l'AIS est au point pour les aspects statistiques, elle arrive à obtenir des informations pratiquement complètes au niveau des productions et des échanges internationaux ; la CSI devrait obtenir toute la documentation et toutes les informations concernant les projets qui ont, le plus souvent, un aspect technique et scientifique de sériciculture. Aussi, tenez-nous au courant de ce qui se passe dans votre propre pays concernant la sériciculture."

Mr Chavancy wished to add a comment to Mr Guigou's speech.

'In the first part, he clearly alluded to the problems arising on the subject of information on sericultural projects and sericulture development. Over the past few years, a kind of anarchy has been noted in this domain. International bodies finance surveys and ask for the ISC's advice as regards experts, or even expert evaluations. Subsequently we obtain no information on these projects, neither from the international bodies nor from the States in which they are conducted. This is true for both Member-States and non-member States.

This is why I would like to take this opportunity to make an appeal to all the States present : the ISC exists and is here to record and circulate the projects under study in the various regions and the results of expert evaluations and of these projects. The ISC has the means to stock this information and to make it available since, through Sericologia, it can spread this bibliography on a regular basis.

Mr Currie, of ISA, and I are fond of this type of information and would like it to be centralized. The tasks could be shared : ISA has finalized its method for the statistical aspects, it manages to obtain nearly full information as regards production and international trade ; the ISC should obtain all the literature and all the information relating to projects which most of the time concern the technical and scientific aspects of sericulture. So please keep us informed of what is going on in your own country on the subject of sericulture.'

REPORT ON THE ACTIVITIES OF TOYO SANGYO CONSULTING, INC.

J.G. KATAOKA

Toyo Sangyo Consulting Ltd., no. 608, Laurel Nagatacho Bldg., no. 17-5, 2-Chome, Nagata-cho,
Chiyoda-ku, Tokyo 100, Japan.

Under the supervision of the Ministry of Agriculture, our company was specially established more than 30 years ago and affiliated with all silk egg producers in Japan and silk machinery makers to concentrate the handling of all sericulture items and silk industry machines and equipment such as mulberry saplings, seeds, silkworm eggs, sericulture equipment, rearing machines, silk reeling machines, drying machines, throwing machines, weaving machines, dyeing finishing machines, raw silk, thrown silk, silk wastes, cocoons, silk fabric, tie materials, silk garments, kimono fabrics, etc. for export and import all over the world wherever the mulberry tree is planted and sericulture is being made.

Also in connection with the dealing of the above items, we have been extending technical collaboration with countries as to egg production, cocoon rearing, silk reeling, weaving upon request from customers.

For instance, we have been exporting Japanese polyhybrid silkworm eggs all over the world, to such countries as Korea, North Korea, China, the Philippines, Vietnam, Burma, Laos, Thailand, Bangladesh, India, Pakistan, Iran, Iraq, Syria, Lebanon, Turkey, Greece, Yugoslavia, Bulgaria, Rumania, Hungary, Poland, the USSR, France, Italy, Spain, Morocco, Algeria, the Ivory Coast, Togo, Egypt, South Africa, Zimbabwe, Nairobi, Nigeria, Brazil, Paraguay, Colombia, Venezuela, Costa Rica, etc.

Of course, we do not only export these eggs but we also import their products of cocoon, raw silk thrown silk, silk waste, fabric, etc.

The most important thing we do is to send technicians from Japan to teach the breeding of silkworm eggs to improve egg quality and produce better quality of cocoon.

We also send different technicians to teach how to make industrial rearing, to save labour and to improve the quality of cocoons as with this industrial system of automatic rearing machines, 3 people can rear 1,000 cases of silkworm eggs up to the 3rd stage.

For the 4th and 5th stage rearing, different machines can be used. Usually one machine for the 4th and 5th stage can rear 10 boxes only, but labour requires also 2 or 3 staff whose main job is to gather mulberry leaves out of the mulberry field. In order to propagate this system we have been sending many technicians and machinery abroad.

Especially, Rumania and Bulgaria have adopted this system and they have succeeded in having their farmers to increase their income in this way, so that their cocoon production can be kept at the same level although many other countries have been facing the big problem of decreasing cocoon production.

In Japan, to make a uniform growth from the 1st stage to the 3rd stage, instead of feeding mulberry to silkworms, almost 40 % of farmers use artificial food which was recently developed. By this way of artificial food feeding, farmers can save labour charge much and also illness and mortality of silkworms become much lower so that out of one case of silkworm eggs, cocoon yield becomes higher and higher.

However, although artificial food cost is a little high Japanese sericulturists use artificial food for young larvae and for the 5th stage, they feed mulberry branches. To gather mulberry leaves, most

farmers now use Mulberry Harvester, which can save much labour and makes mulberry harvesting easier.

However, recently a new race has been developed. This race can eat even apple and any food like soya bean, etc., so with this race all the stages can be reared with artificial food.

Also there are many different systems of machinery and a different system of rearing by artificial food has been developed. So that we are trying to propagate all over the world these up-to-date modern techniques developed in Japan.

All these machineries are not like regular production cars but are made customerly so that the cost is quite high. But in Japan farmers have made a co-operative system to instal these machines. If three farmers jointly make a co-operative, considerable financial help can be obtained from the Government as well as the Municipal Government.

This help covers 50 % of the cost by the Government and 25 % by the Municipal Government which recommends the bank to loan balance of 25 % in 10 year instalments at the interest of 5.5 %. This means that the farmers need not pay anything but they can instal these machines and buildings.

In spite of this substantial help, Japan has faced difficulties and could not increase cocoon production. In order to keep world production, our company has propagated these techniques and the machinery throughout the world. However, we feel that the machine cost is too high in comparison with the cocoon production capacity.

There is a way of helping developing countries, for instance Japan Aids, FAO, UNIDO have extended their help to these countries. In order to make FAO activity we collaborate with the FAO and send many technicians to various places according to the FAO's request to us. Also material has been sent by us upon the FAO's request.

The above is our activity and we hope that you will also kindly extend your help to our activity for the development of world sericulture industry.

QUESTIONS

Mr Chavancy :

'It is both a comment and a question I would like to ask Mr Kataoka. Obviously, Japan is well advanced in the technological domains of sericulture and reeling. It would be interesting, especially if Mr Kataoka wishes these techniques to have a wide circulation, if in the near future a meeting - which is one of the ISC's objects - was held in Japan on these modern techniques of sericulture, automation and utilization of artificial diets.

Therefore, I will put forward the proposal, on Thursday morning during the Conference, as it will be the time and place, to organize a technical and scientific meeting, which does fall within the ISC's scope, on this topic of modern sericulture. It is both a comment and a question I am addressing to Japan, knowing that we will not have the answer today.

It must be thought over.'

"C'est à la fois un commentaire et une question que je vais poser à M. Kataoka.

A l'évidence, le Japon est à un niveau très élevé dans les domaines technologiques de la sériciculture et de la filature. Il serait intéressant, surtout si M. Kataoka souhaite que ces techniques soient diffusées largement, que, dans un avenir prochain, on puisse avoir une réunion, c'est là un des objets de la CSI, au Japon sur ces techniques modernes de sériciculture, d'automatisation et d'utilisation des milieux artificiels.

Je ferai donc la proposition jeudi matin, lors de la Conférence puisque cela en sera le lieu et le moment, d'organiser au Japon une réunion technique et scientifique qui rentrera bien dans les objets de la CSI, sur ce thème de la sériciculture moderne. C'est un commentaire et une question que j'adresse au Japon en sachant bien que l'on n'aura pas la réponse aujourd'hui.

Il faut y réfléchir."

Mr Tayade :

'Thank you, Mr Chavancy. It is an interesting proposal to hold this meeting in Japan which is the country where technology is the best developed.'

"Merci M. Chavancy, c'est une bonne proposition de faire cette réunion au Japon qui est le pays où la technologie est la plus développée."

Mr de Micheaux :

'I have heard that the Japanese Ministry of Agriculture has recently set up a large programme of support for sericulture.'

"Je crois savoir que le Ministère de l'Agriculture du Japon a récemment mis en oeuvre un programme d'aides importantes à la sériciculture."

Mr Kataoka :

'I am not a spokesman of the Ministry of Agriculture and I cannot tell you what it does. I am sure that the Ministry of Agriculture helps Japanese farmers, but I do not know in what respects. Maybe the Japanese delegation will be able to give an answer.'

"Je ne suis pas un porte-parole du Ministère de l'Agriculture et je ne peux pas vous dire ce qu'il fait. Je suis sûr que le Ministère de l'Agriculture aide les fermiers japonais, mais j'ignore à quels sujets. Peut-être la délégation japonaise pourra-t-elle vous répondre."

CURRENT STATUS OF STUDIES ON HORMONES IN *BOMBYX* SILKWORM

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For forty years, I have been involved in research pertaining to several biological fields, including biochemistry, using various materials. Although I have carried out studies mainly in the field of insect endocrinology with emphasis placed on lepidopterous species, I have also dealt with subjects other than entomology.

Here, I would like to discuss various aspects relating to the hormones of the silkworm.

HORMONAL CONTROL OF GROWTH AND DIFFERENTIATION

The hormonal control of several physiological phenomena in insects has been studied since the 1910s (Kopeck, 1922). As a result, three endocrine centers, brain, prothoracic glands, and *corpora allata* were found to control insect moulting and metamorphosis.

In the silkworm, *Bombyx mori*, larval moulting and metamorphosis are controlled by the equilibrium between the reaction of the juvenile hormone (JH) from *corpora allata* and ecdysone from prothoracic glands activated by the prothoracicotropic hormone produced in the neurosecretory cells of the brain. Also, the younger the larval instar, the higher the activity of *corpora allata*. When a sufficient amount of JH is present in the larval body, if ecdysone is secreted from the prothoracic glands in the same larva, the insect develops into the next larval instar after larval moulting.

Generally, in the last larval instar the activity of the *corpora allata* suddenly decreases and when ecdysone is secreted from the prothoracic gland, the larva moults as pupa.

Also, under these conditions, in *Manduca sexta* the fluctuations of the synthetic activity of JH in *corpora allata* are controlled by two neuropeptides, allatotropin and allatohibin. The former stimulates the secretion of JH from *corpora allata*, while the latter inhibits it.

At the pupal stage of the *Bombyx* silkworm, the activity of *corpora allata* decreases and when ecdysone is secreted from the prothoracic gland, imaginal differentiation is induced and the pupa emerges as moth.

According to Rountree *et al.* (1987), in the prothoracic gland of the tobacco hornworm, *Manduca sexta*, the prothoracicotropic hormone secreted by the neurosecretory cells in the brain is conjugated with the cell membrane of the prothoracic gland and free Ca^{2+} in the haemolymph is incorporated actively into the prothoracic gland cells while the activity of protein kinase depending on cAMP increases and promotes ecdysone synthesis.

In the lepidopterous insects, the eclosion is controlled by a hormone secreted from the brain. The time of release of the eclosion hormone, which depends on the light conditions, is controlled by the circadian pacemaker in the brain.

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Generally, the diapause in insects occurs at different stages in their life cycle. In the silkworm, the diapause occurs at the egg stage. Also the egg diapause in the silkworm is induced by the diapause hormone (DH) secreted from the suboesophageal ganglion at the pupal stage.

The diapause hormone in the silkworm acts on the ovary in pharate-adult of the silkworm and activates trehalase in insect. Finally, after egg laying, the concentration of sorbitol and glycerol increases in the diapause egg.

This fact suggests that the anti-freezing and super-cooling depression capacity in the egg increases by the action of polyhydric alcohol, such as sorbitol and glycerol for hibernation. Also, concentrated polyhydric alcohol induces the decrease in the level of free-water in the diapause egg and, as a result, the velocity of biochemical reactions in the egg decreases.

Based on these data, it is suggested that these mechanisms of metabolic regulation play an important role as biochemical systems which protect insects against unfavorable environmental conditions such as cold temperature in winter, for example.

CHEMICAL NATURE OF INSECT HORMONES

Moulting hormone (Ecdysone) :

Butenandt and Karison (1954) crystallized and characterized partially ecdysone. They extracted ecdysone from *Bombyx* pupae. The chemical structure of ecdysone was determined by Hüber and Hoppe (1965).

Until now, 15 molecular forms of ecdysteroids have been isolated from insects and identified as C₂₇-sterols with different characteristics from those of steroid hormones in the mammals.

Juvenile hormone (JH) :

Röller *et al.* (1967, 1968) isolated JH from male pupae of *Cecropia* silkworm and identified its chemical structure. Five molecular forms of juvenile hormones were identified in insects. JH belongs to the sesquiterpene group (C₁₅-compounds), which, in insects, is used as a hormone unlike in mammals.

Prothoracicotropic hormone (PTTH) :

Kobayashi and Kirimura (1958) extracted the hormone from the brain of *Bombyx* pupa. PTTH differs from both ecdysone and juvenile hormone, and it belongs to the peptide hormone group (see review, Kobayashi, 1990).

Recently, 30kDa-PTTH has been isolated from the head of *Bombyx* moth and its chemical structure was identified by the Ishizaki group (Kawakami *et al.*, 1990). It is active in the brainless pupae of *Bombyx mori*, but does not act in the Eri-silkworm, *Samia cynthia ricini*.

Furthermore, this group of researchers isolated another neuropeptide from the head of *Bombyx* moths which they designated as bombyxin (5kDa-PTTH) and which is active in the Eri-silkworm, *Samia cynthia ricini* but not in *Bombyx* silkworm.

Bombyxin is very interesting because its chemical structure shows a homology with the insulin-family peptides, which was first demonstrated directly in non-vertebrate organisms. This fact suggests that in the Carboniferous period, a gene of a peptide of insulin-group family, bombyxin was present in insects through the evolution process.

Eclosion hormone (EH) :

Morohoshi and Fugo (1977) extracted the hormone from the head of *Bombyx* moths. Recently, a gene encoding EH has been synthesized chemically. In this study, Kono *et al.* (1990) succeeded in transferring the *Bombyx* EH gene in *Escherichia coli* and purified the hormone.

Diapause hormone (DH) :

Hasegawa (1957) extracted the hormone from the brain-suboesophageal ganglion complex in the silkworm. Two molecular forms of DH were isolated as DA-A (MW ca. 3,000) and DA-B (MW ca. 2,000). Further studies are currently being carried out by Yamashita.

In conclusion, I believe that regulation systems of physiological activities in insects are reflected in reproduction, physiological colour change, locomotion, regeneration, water metabolism, etc. in addition to the growth and development reviewed in the present paper. I hope that further progress in research in this field will contribute to the promotion of the sericultural science and techniques.

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LE MODE D'EXPRESSION DES GENES DES PROTEINES DE LA SOIE EN SYSTEME DROSOPHILIEN

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A ce jour, cinq gènes codant pour des protéines de la soie ont été clonés. Trois d'entre eux -celui de la grande et de la petite fibroïne et celui de la protéine P25- sont exprimés sélectivement dans la partie postérieure de la glande séricigène tandis que les gènes des sérícines 1 et 2 sont actifs dans des territoires distincts de la partie moyenne de l'organe (Suzuki et coll., 1986 ; Michaille et coll., 1990). Les restrictions temporelles et territoriales de la transcription de ces gènes et/ou de l'épissage de leur transcrits primaires aboutissent à édifier l'architecture complexe du fil de soie dans la lumière de la glande séricigène (Fig. 1).

Le taux élevé de transcription, les spécificités cellulaires et de développement ainsi que la coordination intergénique de l'expression qui caractérisent le fonctionnement de ces différents gènes découlent probablement de leur sollicitation par plusieurs types de transactivateurs. Elucider la nature de ces transactivateurs et déterminer en quoi leur association peut rendre compte des fonctions spécialisées de l'organe constitue l'objectif de plusieurs groupes de recherches qui ont adopté ce système modèle, dont le nôtre.

Dans ce cadre, nous avons choisi de focaliser notre étude sur les gènes de P25 et de la fibroïne, car la concertation de leur expression se manifeste de façon particulièrement évidente. Ces deux gènes sont en effet soumis à une régulation temporelle qui se traduit par la production de leur mRNA en quantité équimoléculaire pendant l'intermue et par l'arrêt simultané de cette transcription à chaque mue larvaire (Suzuki et Suzuki, 1988). Les mRNA des deux gènes codent d'ailleurs pour deux polypeptides de la soie liés entre eux par des liaisons disulfure.

Des approches *in vitro* du mode de leur fonctionnement (menées conjointement par le groupe de Y. Suzuki (Suzuki et coll., 1988, et le nôtre), on retiendra que des éléments homologues stimulateurs de la transcription ont été délimités dans les régions 5' flanquantes des deux gènes et qui interagissent avec au moins un type de transactivateur commun. Nous faisons l'hypothèse que ce complexe participe à la co-régulation de la transcription. Néanmoins, l'existence d'interactions DNA-protéines multiples dans le domaine des 400 paires de base proximales du gène de P25 suggère la coopération d'autres éléments en cis (Drevet, Durant et Couble, non publiés).

Afin d'établir par un test *in vivo* l'importance fonctionnelle des diverses séquences ainsi mises en évidence, nous avons entrepris d'étudier l'expression de ces promoteurs après leur insertion dans le génome de la Drosophile. Utilisant un vecteur approprié nous avons étudié des lignées transgéniques comportant des séquences promotrices des gènes de *Bombyx* fusionnées avec le gène de β -galactosidase d'*E. coli*. Dans ces conditions, la détection *in situ* de l'activité β -galactosidase et la quantification biochimique de cette activité sont les critères de fonctionnalité des transgènes.

Une première série de montages comportait des régions du promoteur du gène de P25 à -1453, -732, -441 et -165 par rapport au site d'initiation de la transcription. Les trois premières conduisent à une expression spécifique du transgène dans les cellules antérieures de la glande salivaire de la Drosophile, l'organe analogue à la glande séricigène du ver à soie et ce, au cours des trois stades larvaires (Fig. 2) ; la dernière construction n'induit pas d'expression de la séquence fusionnée. Ces expériences montrent que le promoteur de P25 est reconnu par la machinerie transcriptionnelle de la

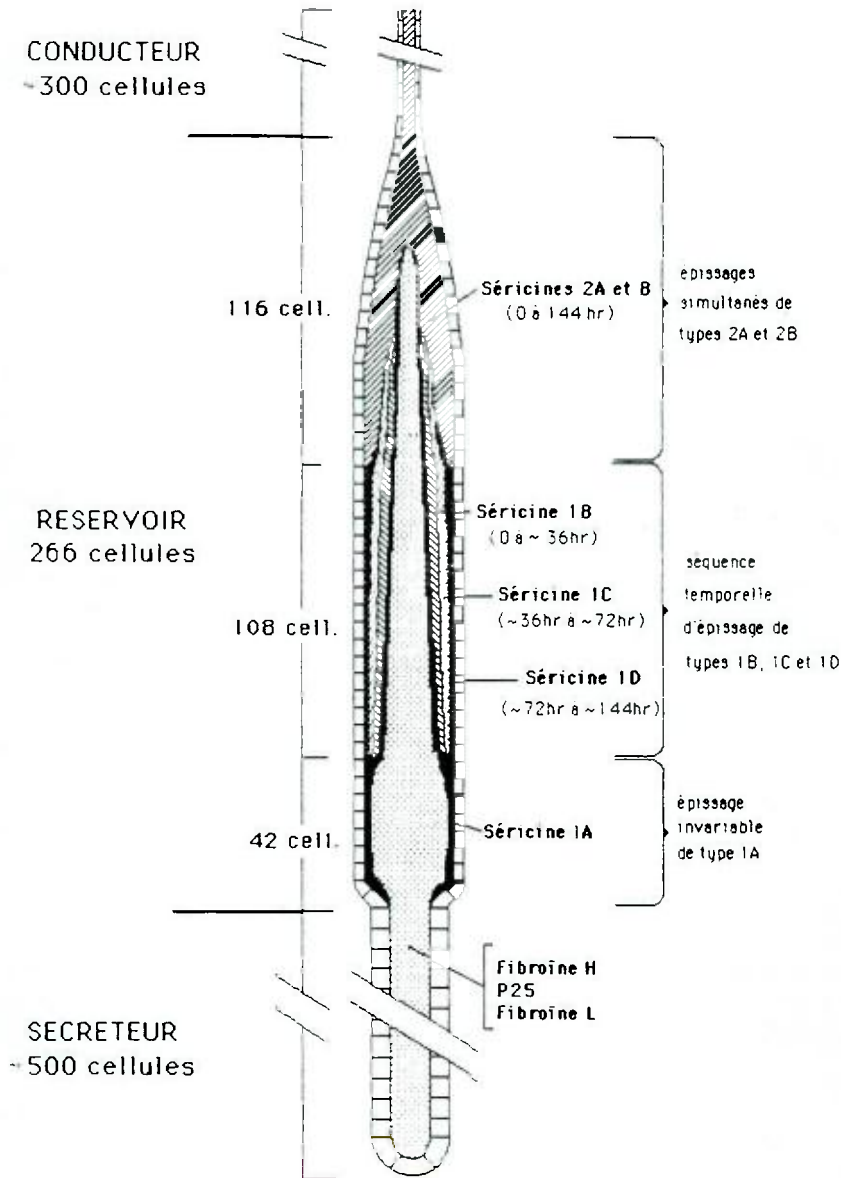


Fig. 1 : Représentation simplifiée des propriétés d'expression et d'épissage des différents territoires de la glande séricigène du ver à soie.

Fig. 1 : Simplified diagram of the expression and splicing properties of the various territories in *Bombyx mori* silkgland.

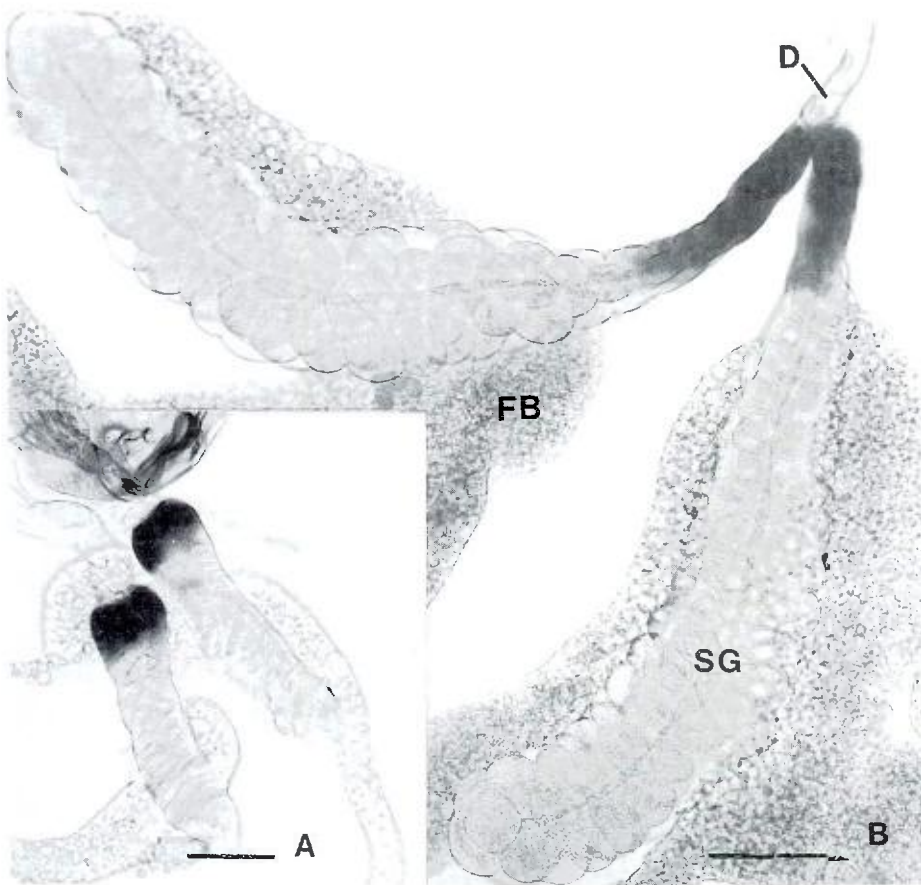


Fig. 2 : Coloration β -galactosidasique *in toto* dans les cellules antérieures de glandes salivaires de *Drosophiles* transgéniques.

L'activité enzymatique repérée au 1^{er} (A) et au 3^{ème} (B) stade larvaire découle du fonctionnement du promoteur du gène de la protéine de la soie P25. Les barres des clichés A et B correspondent respectivement à 0,30 et 0,15 μ m.

Fig. 2 : *In toto* β -galactosidasic colouring in the anterior cells of salivary glands in transgenic *Drosophilas*.

The enzymatic activity spotted in the first (A) and third (B) instars results from the working of P25 silk protein gene promoter. The lines of plates A and B correspond to 0.30 and 0.15 μ m respectively.

Drosophile et qu'il porte, dans le domaine de séquences de - 441 à - 165, des éléments déterminant une stricte spécificité tissulaire (Bello et Couble, 1990). Il est remarquable que, comme chez *Bombyx*, l'expression soit limitée aux stades larvaires et à une sous-région de l'organe.

Un second type de montage comprenait la région promotrice (1150, + 1) du gène de la fibroïne greffée avec le même gène rapporteur que précédemment. De façon contrastée avec le cas précédent, aucune des huit lignées obtenues n'exprime d'activité β -galactosidase dans la glande salivaire de la

Drosophile, mais de manière reproductible, dans d'autres tissus de la larve (téguments, pharynx, ébauche testiculaire) et de l'adulte (testicule en particulier). Ceci montre que le promoteur du gène de la fibroïne est reconnu par le système de transactivation drosophilien, mais qu'il n'induit aucune spécificité tissulaire restreinte à la glande salivaire. Confrontée aux résultats obtenus avec le promoteur du gène de P25, cette observation suggère que les éléments cis pertinents sont absents du domaine de séquence du gène de la fibroïne exploré jusqu'ici.

Un troisième type de construction comprenait la région de - 1453 à 51 du gène de P25 greffée à la région proximale (en deçà de - 95) du gène de la fibroïne, ces séquences étant placées là encore en amont de la séquence codante du gène bactérien. Les lignées établies avec cette construction ont la particularité d'être exprimées dans la glande salivaire des animaux transgéniques, mais néanmoins dans un territoire distinct de celui décrit pour le gène de P25 intact. En effet, celui-ci correspond au pseudo-disque imaginal de la glande salivaire adulte ; en conséquence, d'ailleurs, la β -galactosidase est produite par les cellules de l'organe adulte. Ce résultat remarquable montre que le promoteur mixte ainsi constitué possède, dans la glande salivaire, un nouveau type de régulation territoriale et temporelle de l'expression.

Ces résultats ne permettent pas encore de dégager un tableau cohérent des régulations mises en jeu, mais ils montrent cependant, dans le cas du gène de P25, que le domaine de séquences proximales de -441 à + 1 rassemble les éléments cis nécessaires et probablement suffisants à l'expression conforme du gène dans son contexte naturel. Ils soulignent aussi la complexité du système en accord avec l'analyse des interactions DNA-protéines chez *Bombyx*.

L'ensemble de cette approche illustre une nouvelle fois l'efficacité de l'étude de l'expression des gènes par la stratégie de transformation de la lignée germinale. La réalisation de telles expériences chez le ver à soie lui-même est pour l'instant liée au problème de la nature du vecteur de transfert chromosomique. Il est clair qu'en plus de son intérêt fondamental concernant le mode d'expression génique, la transgénèse chez *Bombyx*, en profitant de la connaissance du fonctionnement des gènes de la soie, pourrait aussi aboutir à la production biotechnologique de protéines d'intérêt.

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QUESTIONS

M. Candiani :

"Pour nous, le problème reste la composition du fil de la soie. Les microfibrilles qui ont tendance à s'échapper du fil de soie restent une difficulté et le problème de la soierie est soit de les enlever, soit de les laisser afin d'avoir de la soie lisse brillante. Comment sont-elles tenues ? Peut-on les libérer pour les faire sortir ou les faire tenir mieux au fil de soie ?"

'As for us, the problem still lies in the composition of the silk thread. The microfibrilles which tend to escape from the silk thread remain a difficulty and the problem of silk-processing is either to remove them or to leave them in order to have a smooth and glossy silk. How do they stick ? Can they be released or be made to stick better to the silk thread ?'

M. Couble répond en disant qu'il s'intéresse peu à la connaissance macroscopique du fil de soie.

"L'apport que nous avons fait à la connaissance de la structure du fil de soie n'est pas dû à une connaissance plus approfondie des protéines de la soie, mais à l'observation des gènes. Il y a cinq gènes bien connus qui codent pour les protéines de la soie et aucun d'eux ne donne le phénomène indiqué, c'est-à-dire celui des microfibrilles. Cela ne rentre pas dans les fonctions codées par ces gènes. Par contre, dans notre laboratoire, nous avons pu cloner des gènes qui n'ont pas encore été étudiés, qui sont exprimés dans la partie médiane de l'organe et dont on sait que, dans ces régions, on peut voir, sur la surface du fil de soie, des choses assimilées à des gouttelettes, des cires et qui ont une structure toute particulière.

Il est possible que ces gènes donnent l'effet dont vous parlez. En extrapolant, on peut imaginer que, par la connaissance de la génétique contemporaine, on puisse améliorer, sur les plans quantitatif et qualitatif, la production de la soie. Il est imaginable de penser qu'un jour on puisse connaître la composition protéique du fil idéal et adapter le génotype du ver à soie à cette composition idéale.

En ce qui nous concerne, ce n'est pas notre objectif immédiat et nous travaillons en retrait."

Mr Couble answered that he was little concerned by the macroscopic knowledge of the silk thread.

'Our contribution to the knowledge of the silk thread structure is not due to a thorough knowledge of silk proteins, but to the observation of the genes. There are five well-known genes encoding silk proteins, none of which give the phenomenon indicated, i.e. that of microfibrils. This does not fall into the functions encoded by these genes. However, in our laboratory we succeeded in cloning genes which have not yet been studied, which are expressed in the median part of the organ and which, in these regions, are known to show on the surface of the silk thread items which are likened to droplets, wax and have a quite distinctive structure.

These genes may give the effect you mentioned. If we extrapolate, through the knowledge of present genetics, silk production may conceivably be improved quantitatively and qualitatively. In theory, one day the protein composition of the ideal thread may be known and the silkworm genotype may be adapted to this ideal composition.

As far as we are concerned, this is not our immediate objective and our work is a little aside.'

M. Currie félicite M. Couble de son exposé, intéressant même un profane.

"Vous avez indiqué que la sérécine n'était pas uniforme, or l'une des opérations les plus délicates en industrie est le décreusage. Cette découverte peut-elle avoir des conséquences utiles pour celui qui va décreuser le fil de soie afin de le faire mieux, plus délicatement et plus complètement que maintenant ?"

Mr Currie congratulated Mr Couble on his speech which was interesting even to the lay person.

'You said that sericin was not even, whereas one of the most delicate processes in industry is degumming. Can this discovery have useful consequences for the person who degums the silk thread so that they may do it better, more delicately and more thoroughly than now ?'

M. Couble :

"C'est-là une question intéressante du point de vue fondamental et pratique. Ce que nous avons appris, c'est qu'il y avait plusieurs types de sérécines synthétisées au même endroit et qui étaient superposées.

La couche la plus profonde, déposée la première sur le fil de soie, a des propriétés d'adhésivité à la fibroïne, d'interactions avec la soie textile qui sont très fortes. A priori, on peut penser que les problèmes liés au décreusage relèvent de cette première couche et non des couches qui sont au-dessus. Or cette première couche est faite à partir d'un gène particulier.

Les trois couches de sérécine superposées sont commandées par un seul gène en forme de cassette. On prend telle ou telle cassette du gène pour faire différentes protéines. Et c'est la combinaison de différentes cassettes qui fait que telle protéine a telle propriété.

Nous n'en sommes pas au point où il est possible de relier la structure exacte de la protéine connue d'après le gène à des propriétés physico-chimiques globales. Mais il serait souhaitable que des gens qui sont plus en contact avec la séréciculture et connaissant bien les protéines puissent s'intéresser à savoir quels sont les éléments décisifs dans cette protéine qui font qu'elle est fermement

attachée à la fibroïne, donc au fil de soie textile. On pourrait imaginer de modifier ces régions-là de façon à faire que les liaisons soient moins fortes, par exemple, ou de mettre au point un système qui permette un décreusage plus efficace, connaissant la protéine elle-même."

"This is an interesting question from the basic and practical viewpoints. What we have learned is that there are several types of sericin which are synthesized in the same place and superposed.

The lowest layer, deposited first on the silk thread, has properties of adhesivity to fibroin, of interactions with textile silk which are very strong. A priori it can be thought that these problems relating to degumming are due to this first layer and not to the upper layers. In fact, this layer is made out of one particular gene.

The three stacked sericin layers are governed by one single cassette-shaped gene. You take one cassette or the other from the gene to make various proteins. It is the combination of the various cassettes which causes a protein to have a given property.

We have not yet reached the stage where we can link the exact structure of the protein determined by the gene to general physico-chemical properties. But it would be desirable that people that are more involved in sericulture and that know proteins well should take an interest in finding out what decisive elements in this protein cause it to be strongly bound to the fibroin, hence to the textile silk thread. It may become possible to modify these particular regions in such a way as to make the links weaker, for instance, or to work out a system which would enable a more efficient degumming, using the knowledge acquired on the protein itself.'

M. Babacauh :

"Avez-vous l'intention, dans vos recherches, de vous orienter vers les questions des maladies du ver à soie qui posent de sérieux problèmes et qui, par la voie génétique, peuvent peut-être trouver des solutions ?"

"Do you intend, in your research, to turn towards the issues of silkworm diseases which pose serious problems and to which a solution could be found using genetic means ?"

M. Couble :

"C'est une question très intéressante qui soulève un problème complexe. Il n'est pas du tout certain que, par exemple, la résistance à une maladie soit héritée d'un gène unique. Elle peut mettre en cause un ensemble de gènes. Par la communication qui va suivre vous serez tout à fait convaincu de cela.

Il y a donc une approche globale de la connaissance du patrimoine génétique du ver à soie qui doit être réalisée pour savoir quelles sont les régions du génome qui sont pertinentes vis-à-vis de la résistance aux maladies. Dans un second temps, on peut intervenir, exacerber certaines fonctions, comme les fonctions immunologiques. C'est tout à fait pertinent pour un biologiste moléculaire. Mais il faut auparavant débrouiller le génome, c'est-à-dire la distribution sur les chromosomes des gènes qui entrent dans la résistance aux maladies, la résistance à la température, problème crucial dans les pays tropicaux.

"This is a very interesting question which raises a complex problem. It is not sure at all that, for example, disease resistance is inherited from a single gene. It can involve a set of genes. You will be convinced of this by the following review.

So, an overall approach to the knowledge of the silkworm genotype must be achieved to find out the regions of the genome which are relevant as far as disease resistance is concerned. Secondly, one can intervene, exacerbate certain functions, such as immunological functions. This is quite relevant for a molecular biologist. But the genome has to be sorted out, i.e. the distribution on the chromosomes of the genes which go into disease resistance and temperature resistance, a crucial problem in tropical countries.'

M. Chavancy :

"Il est clair que, à terme, on peut envisager par les techniques mises en oeuvre à Lyon, de transférer des gènes de résistance aux maladies dans des souches très productrices de soie... Mais il faut d'abord identifier ces gènes de résistance. Or ceci nécessite un travail considérable fait par plusieurs équipes au niveau international et, ce que dira Mme Goldsmith va justifier ceci, pendant un

temps relativement long. Ce qui sera le plus long sera d'identifier et d'isoler les gènes de résistance, ce qu'on ne peut faire à Lyon. Ensuite, il faudra opérer les transferts d'une souche à une autre."

"It is clear that, using the techniques worked out at Lyon University, one could eventually consider transferring disease resistance genes to high silk-producing strains. But these resistance genes must first be identified. This requires considerable work achieved by several teams on the international level and this on a relatively long period of time as Mrs Goldsmith will demonstrate. What will take longest will be to identify and to isolate the resistance genes, which cannot be done in Lyon. Then, the transfers from one strain to the other will have to be done."

M. Candiani revient au sujet traité par M. Currie :

"Le problème du décreusage est extrêmement important, il n'est pas seulement nécessaire d'arriver à décreuser à fond, mais il faut plutôt arriver au point voulu et ne pas le dépasser afin de ne pas libérer les microfibrilles qui sont dans la bavelle.

Est-ce qu'il y a une structure scientifique en France qui pourrait s'occuper de ce problème de structure macroscopique de la bavelle afin d'en savoir plus sur la structure même de la soie et permettre ainsi de maîtriser mieux les processus de transformation surtout le décreusage, le moulinage et, d'une façon générale, ces problèmes relatifs aux microfibrilles ?"

Mr Candiani came back to the subject tackled by Mr Currie :

"The degumming problem is extremely important, it is not only necessary to manage to degum thoroughly, but one also has to reach the desired point and not to go beyond it so as to avoid releasing the microfibrilles that are in the filament."

Is there a scientific organization in France which could deal with this problem of filament macroscopic structure so as to know more about the silk structure itself and thus enable the processing techniques, especially degumming, throwing and generally all the problems relating to microfibrilles to be better mastered ?"

M. Chavancy :

"C'est un paradoxe que vous me posiez cette question car nous sommes en train de monter un projet avec un laboratoire italien que vous connaissez bien, la Stazione sperimentale per la Seta de Milan, qui doit travailler ce problème. Nous n'avons pas, en France, de spécialiste de l'étude physico-chimique de la soie.

On aurait pu penser que l'Institut textile de France se serait intéressé à cette question mais, en fait, il ne travaille plus sur la soie, du moins sous cet angle-là. Ce projet regroupera le laboratoire de M. Couble, le mien, celui du Dr Freddi et on espère qu'il aura l'aval de la CEE. Il devra développer les recherches sur la physico-chimie du fil de soie, les interactions entre les différentes protéines et les propriétés physiques qui en résultent. Donc, dans un avenir plus ou moins lointain, certaines réponses seront apportées aux questions posées."

"It is quite paradoxical that you should ask me this question because we are currently setting up a project with an Italian laboratory that you know well, the Stazione Sperimentale per la Seta of Milan, which is to work on this problem. We do not have a specialist in the physico-chemical study of silk in France."

We could have imagined that the Institut textile de France would have been interested in this question but in fact it no longer works on silk, at least from this angle. This project will group together Mr Couble's laboratory, mine, Dr Freddi's and we hope that it will obtain the EEC's support. It will have to develop research on the physico-chemistry of the silk thread, on interactions between the various proteins and the resulting physical properties. So, answers will be provided eventually to the questions raised."

SILKWORM BREEDING FOR THE '90's : NEW MOLECULAR AND GENETIC TOOLS TO MEET THE CHALLENGE OF THE TROPICS

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Silkworm Breeding for the '90's

Meeting the Challenge of the Tropics

Immediate Goals:

- Combine bivoltine and multivoltine traits

Productivity, silk quality, hardiness

Strategy:

- Gene-tagged breeding

Molecular gene map, QTL analysis

Long-term Goals:

- Genetic engineering

Gene isolation, gene transfer technology

I would like to thank you for giving me the opportunity to lecture to you. I will talk about some highly academic matters but I hope that I can teach you enough about it so that you can appreciate the message that I am trying to bring.

Dr Couble has given a wonderful introduction to the concepts that I am trying to explain to you.

I think that we can agree at least that the foundations of sericulture are the mulberry and the silkworm. A lot of work that you are doing and that you have explained depends on good rearing techniques and good situation for good raising techniques, good soil conditions etc. for these two components which contribute to the production of silk.

However, my message today is that the first foundation is the silkworm. You must have a very good variety of silkworms which can grow well under your conditions and can produce well in order to have good starting materials for final production.

So, I will talk today about genetic system or genetic approach, which is not an entirely new approach, but an extension of a traditional approach using molecular tools, which I believe is very important to use in sericulture.

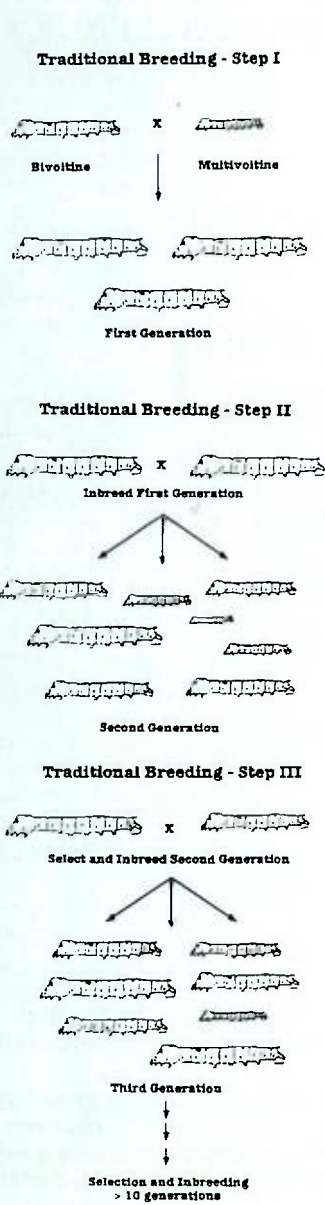


Figure 1

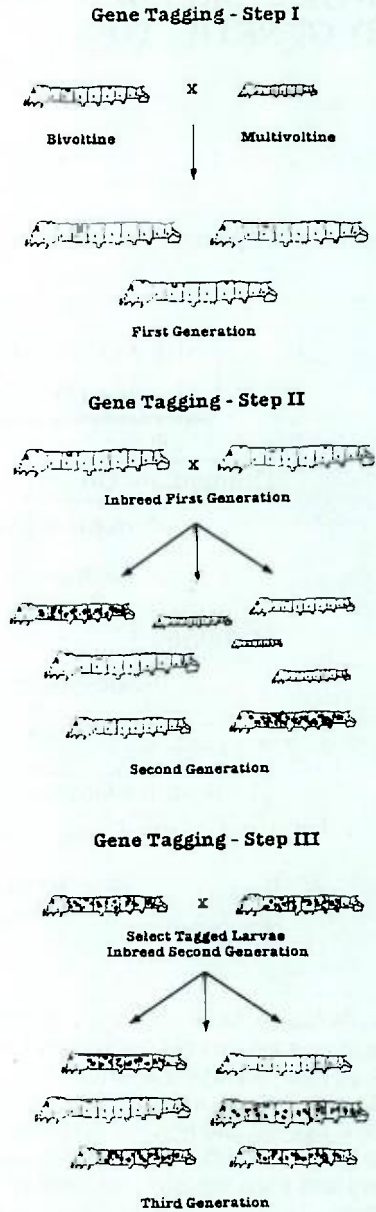


Figure 2

90 % of the world silk is produced in Asia. Of course, we know that most of this comes from China but there are other tropical countries which produce silk or try to produce silk. The tropics therefore present a serious problem for sericulture and the problem is as follows : what are the genetic materials that we have for sericulture ?

There are two main types of stocks, as I think you are aware. One of them is the bivoltine strains, in which I would also include the monovoltines, and the other is our polyvoltine, or tropical multivoltine strains. In terms of production, the bivoltine strains, that have been improved genetically over many years of work primarily in China, Japan and Korea where the climate is temperate and where the yields of silk, the quality of the silk in many measures, are really excellent. But if you try to transplant these strains into tropical conditions without proper training or special facilities, you find that, in fact, the silk worm quality is poor, with low cocooning rates, poor disease resistance, poor growth during the hottest season etc. Also, the life cycle of these strains tends to be long and this makes it a much heavier burden on the agricultural system.

In addition, the traditional silk-producing countries of the tropics have evolved their own strains, the multivoltine, which are very hardy under these conditions. They have short life cycles so they are efficient and their overall biological qualities are very good. Recently, for example, we have seen reports in *Sericologia* in which Indian researchers have done careful testing of these strains which showed much higher resistance to fungal and bacterial diseases.

Furthermore, with these multivoltine strains, although they will give a crop reliability, the silk yields are low and the silk must be reeled by hand due to the poor quality. I think that the goal of genetic work should be to combine the two best qualities of these two strains. In other words, we need the high silk quality of bivoltines and the high biological qualities, the hardiness of the tropical strains. This kind of work has been done using traditional genetic approaches for many years in Thailand, as you have heard, in India and, no doubt, in some other countries as, for instance, China. There has been some success in combining these strains, primarily by making crosses between them and selecting the ones that contain the best qualities.

Our goal is identical. It is to combine the best traits of the multivoltine and bivoltine strains for sericulture. I will explain what kinds of breeding approaches, in my opinion, can improve the old techniques. The strategy is a new one and I personally call it gene tagging or gene-tag breeding, this is my terminology to make it understandable to you.

There are two foundation studies which must be accomplished to make this happen : one is the construction of a molecular gene map and I will show you an outline of this, the other is to analyze the quantitative traits which are these complex genes that Dr Couble has mentioned. I will say a little more about them briefly. I should say that, with this strategy, there is always the long-term goal of accomplishing the ability to carry out genetic engineering, which is taking place in parallel in laboratories in various parts of the world.

Quantitative traits are complex characters which would be the targets of breeding ; for example, disease resistance, heat tolerance, quality of the silk, productivity of the larva. These are all characters which, we could say hypothetically from our experience with the multivoltine and bivoltine strains, are inherited reliably by the strains ; at some level they must be coded by the genes. These represent genetic differences.

Now why can we not go ahead and select the genes ?

The problem is that there are very many of these genes. We presume that many genes are involved in each of these characters and each one probably contributes a small effect to the overall animal, so that it may take 5, 10 or 20 genes which will affect productivity. It may also be - as is beginning to show in other economically important crops like corn - that the number of genes involved in these characters may not be so great. So this is a question but the assumption underlying my quest for this approach is that there may be many genes but not an impossibly large number. In any case, the difficulty then lies in identifying and tracking these genes.

For inbreeding, the major problem is that you must start with genetically pure parents and, as we all know, this can be extremely difficult to obtain. So my solution is genetic tagging.

Figure 1 is an illustration of the problem with classical breeding and with breeding with quantitative traits - traits that have many genes contributing to their effect.

On the upper left, you can see a bivoltine strain, on the right, a multivoltine and between the two you can see the hybrids made by crossing these two parents. What you can see is part of our goal, the hybrid is bigger, the silk yield will be higher and the quality of the silk will combine the qualities of both parents. This is a technique which is used very successfully in hybridization for combining gene properties and we should continue to test different strain combinations for this purpose. However, there are a couple of problems, one of them is that you dilute the characters of each of the parents. Consequently if a multivoltine is highly disease-resistant, when we combine it with the genes of the bivoltine, we may lose some of this resistance. Another problem is that, as you well know, we cannot breed these for another generation, we always must retain the parent lines and make the cross because if we go to the next generation, we get some of the original parental types, we find some tiny ones like the old parents, some good fat new ones, what you actually get is a whole mixture. You have to select the best you can find, cross them again and try to stabilize your new combination. This is really a problem.

In the traditional breeding I have just shown you, we cross bivoltine and multivoltine, the first generation is very uniform, often quite vigorous, having better traits than either parent. In the second generation, we cross the first generation larvae and we find a mixture and these tiny ones come out. So what we must do is select the best and we may choose several of these types and try those combinations.

What happens in the next breeding ?

It is better but it is never perfect. You still find those weak ones and you must go on and on, collecting the best and trying to inbreed until you can stabilize the stock so that you get the best characteristics, which may take 10 generations. Now, in the tropics that might take two years of breeding, but on the average, it probably takes three years or more. Then you have to do field testing etc. Furthermore, you are working in the dark, in a sense, because you actually do not know, even if these larvae look better, whether they contain those many gene combinations that will work very well ; so all this implies a great deal of testing.

Now, let us contrast the idea of gene tagging (Fig. 2). Stage 1 looks the same, so I will go through it briefly. What I have not depicted on Figure 2 is that before we start this experiment we have analyzed these two stocks so that we actually know the genetic composition of these quantitative genes we are interested in, at least to a first approximation.

In the second generation (we have just crossed again, bred again the first generation) we are able to choose, by virtue of these gene tags, the larvae, at least theoretically, which carry the traits that we are interested in, which carry the disease resistant genes that we want and maybe the ones which influence the quality of the silk yield. We do not have to test these because we know, from our DNA testing, from our molecular testing, that they are not good enough on the genetic level to work with, so we can throw them out. This means that we do not need to test such a large population in the next generation.

It follows that, in the next generation, we can choose the ones which are marked. In fact, we should get a much better success in the next generation. We have targeted exactly what we want in terms of characters of the larvae, for instance, and we should find, when we test the tagging system that a greater portion of the offspring carry the gene combination that we are interested in.

This is theoretically the concept of gene tagging.

Now, I would like to demonstrate that this kind of thing has actually been done in *Bombyx mori* but not for the same purpose. First of all, let me show you what the gene tags look like. They are called, in our jargon, and if you read the New York Times you will certainly see it, RFLP's which stand for Restriction Fragment Length Polymorphisms. These are DNA patterns which we have obtained from different silkworms. The idea is that you have a gene which has been isolated, or a piece of DNA that you have isolated, and we call each type of gene a probe. You extract the DNA from the larvae from different silkworm stocks, then you test the DNA with different probes and what you can see in each of the lanes (1, 2 and 3) of figure 3 comes from three different strains. Actually, one was European, one was Japanese and one was Chinese ; you can see that the patterns are very

different from these three strains. These are tags, they can identify genes from different strains. If we test with a different probe we see completely different patterns. So, this represents (Fig. 3) the same strain 1, strain 2 and strain 3 and you can see that the patterns are quite distinctive. These are the tags that we propose to track in the different silkworms.

This was the first part of our approach, the first foundation that we must use in order to map these quantitative genes or to be able to track them. But first we tag the chromosomes. If we were able to tag them directly, that is to say if we knew where these genes were, we could choose them and move them around by irradiation or by genetic engineering, then we could go at it directly.

DNA Differences at the Molecular Level

RFLPs

Restriction Fragment Length Polymorphisms

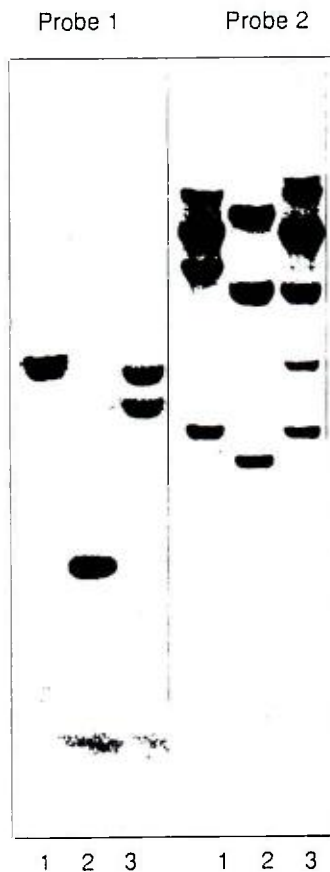


Figure 3

Unfortunately, today we do not have a good method yet for direct gene tagging or for injecting a new gene, integrating a new gene or a new tag into the site of a known gene. So we must take a chromosome map in which every chromosome has some of these gene tags, some of these RFLP markers.

This is the first step of what we must do in order to track these quantitative traits : first we have to construct a molecular gene map so that we have a map of all the chromosomes and then we have to find the quantitative traits in relation to those gene tags which we now have oriented all over the map.

It is as if you went to a new country and you had road signs but you did not know which town was by the road sign. First you have to put up your road markers and then you can put the name on the marker of what town is nearby.

The procedure for making a molecular gene map is really an extension of ordinary genetic mapping. The goal for genetic mapping would be, at the beginning, to put three or four tags on every chromosome. This is enough to begin looking for the quantitative genes in the neighbourhood. It is a great deal of work, but it is not impossible. The procedure is quite simple actually ; first we have to screen our strains. Firstly, we must choose the right stocks to work with because we must make sure that the stocks have these physical differences between them and we must look for stocks that are as uniform as possible. Because if we start with impure lines it will be very difficult to interpret the data. That kind of screening work is beginning now at the National Institute of Sericultural and Entomological Sciences of Tsukuba in Japan. We must also identify the DNA probes and for the purposes of the initial studies we need perhaps 100. Experience with other organisms tells us that probably we will have to test three times as many to get 100 that work well. We need markers whose patterns are not too complicated, so that we can follow them through genetic crossings, through the different progenies.

It may sound technical and complex but nowadays it is very routine work, it is only hard labour. We make standard genetic crosses ; for those of you who are familiar, we make F_1 's, we can make F_2 's or we can make back crosses. My laboratory has started some of that and we extract the DNA from each individual silkworm, which is easy. Then we simply test each one, one by one, for these different probes. Then we just put together the map, it only takes ordinary pencil and paper and probably a data base eventually to hold on to all the information. As I said, this procedure is well worked out and in fact it is so easily used that it is being done now, or has been done already, for virtually every major crop organism in the West. This is what I could remember just from my memory but you can see that all the major crop organisms are in the process of doing this. In addition, a few insects that I know are beginning to work at this level, including mealworm, honeybee and budworm, and probably some other insects that I am not aware of.

I think that one message to this group is that the silkworm has to get on the track. We are behind and we must keep up. But this work has been accomplished in many organisms. It is also a target of the human genome project and many of you are aware of that. The difference in the target, by the way, is that the silkworm genome size is about one sixth the size of a human's, which means that they have about 6 to 10 times as much work. Our goal now is more limited because it is just to put some genes on those chromosomes, some tags, enough so that we start the quantitative work.

However, in the long term, we would like to make a more dense map, more like the one you saw for the traditional characters because, as I said, this will enable us later to choose these genes using by now very well-worked out techniques so that when genetic engineering becomes possible we may be able to isolate those genes directly and find out how they affect the organism.

But for now our target is very limited. So the first problem is to get the molecular map. Now I will just show briefly what could happen : the next stage would be to map these quantitative characters, to localize the quantitative characters in relation to those molecular gene tags.

According to our jargon, this is called Quantitative Trait Locus mapping or QTL mapping, so we have RFLP's and QTL's. They take advantage of the natural genetic differences and enable more efficient breeding strategies. Essentially, we make the cross between the parents, first we screen the strains to find out which ones are uniform, then we make the standard genetic crosses. In this case we score the offspring first for the quantitative characters, this is just traditional genetics. You cannot score disease resistance so easily because you may kill the larva so that is actually quite a problem,

at least I have not solved it (we have another trick for that). But, in any case, you score these quantitative characters, for instance the length of larval life or silk yield would be easy to do. Then after you have scored their quantitative characters you choose the ones which are the largest extremes, the ones resembling most the parents, and you score those for molecular gene tags. Then you use statistical analysis which has been worked out first for human gene mapping, actually for human linkage analysis where we cannot do controlled crosses but we have to rely on statistical inference to determine the genetic relationships, the linkage relationships between the genes. In the last two or three years, some beautiful theoretical work was done using the tomato as a model to show that they could apply this human statistical approach to map quantitative traits in relation to these tags.

Now I would like to show what the data, the map would look like. This is from the tomato work and it is actually quite beautiful to look at because it looks very simple. Each chromosome has its own map, so what these people did was that they took tomatoes, they did the crosses (they had the molecular map already), they scored the plants for certain characters, among which sugar content and acidity which are important characters for breeding tomatoes. They then scored the best plants and the worst plants, they scored for these molecular tags and then they did the statistics and made a map. On the bottom of figure 4, you can see the gene tag for this chromosome 10, so each of these numbers corresponds to one of their probes. The ordinate axis gives you the statistical score for each of these characters and they set a cut-off point, following the normal statistical method and decide that if the value is above 2.5 or 3, then they will accept that there is a high probability that there is a gene influencing the genetic characters they have measured. You can see a major peak, which happens to be for pH; it coincides with the marker CD34A, so this is the probe which shows that in this piece of chromosome, very close to this part of the chromosome, there is a gene which has a powerful effect on pH. If you look at the other quantitative traits that they measured, you find that in this chromosome there are no major genes which affect this character. In this way, altogether they found perhaps 3 or 4, I think about 6 genes, which influence pH value and now they can use these gene tags to track those genes in different crosses, as I said before.

Stage 2: QTL Mapping - Probability Data

based on statistical methods

developed for human linkage analysis

L.O.D. SCORES

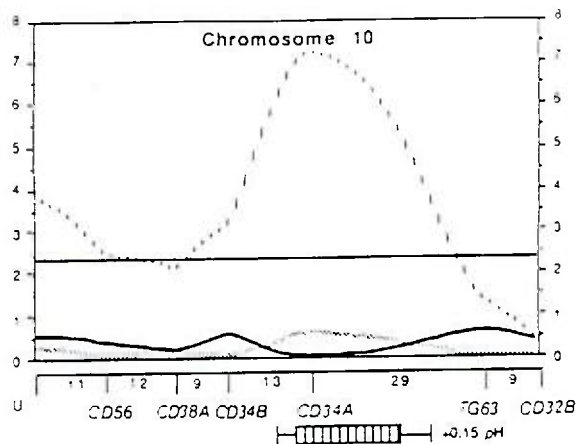


Figure 4

So you can actually take these tomatoes, breed them the next generation and look for the presence of this tag and you can test your hypothesis : does the presence of that tag correlate with the pH value that you expect ? In fact, very interestingly, in the tomato work they have found in some cases their theory held up and in other cases, as we might expect, the genetic background has a powerful effect and where they might expect to find an acid effect from one part of the chromosome in one genetic background, it is neutralized in another one because there is another gene. It is a very complex system, there is another gene that is neutralizing its effect.

The basic work of doing the RFLP map is rather easy and straightforward, as Dr Chavancy has indicated, the work of doing the QTL, the quantitative trait mapping is the tough part but I think we have tried it because, in a sense, it is the best way in which genetics can help the silkworm at this point. I think we must continue with traditional breeding methods but we must also take advantage of this and the first goal will be to choose some very simple pilot genes such as duration of larval life, where we already know that there are some major genes which influence this and say 'can we map those genes by these techniques ? Can we find influence of other genes that we did not know about by this technique ?' We will use a simple pilot system.

Now I want to highlight that the RFLP map has several uses which are very important and, I think, important for sericulture. Not only can it be used for these quantitative genes but it is a very good way of stock identification. It is being used again in the plant world. I was told recently that some of the seed companies became interested when they realized that they could protect their products by being able to identify the source of seed using these molecular fingerprints.

So it can be those kinds of gene patterns that I showed you. These are being used also in human medicine. Some scientists have been able to identify probes that are specific for individual human beings and they can be used to identify people by the smallest drop of blood or by a single hair. So it is not beyond the possibility of doing stock identification and, because I am aware that there are plans to establish gene banks, particularly for developing countries, in FAO and perhaps other international organizations, I want to emphasize that one of the chief problems of these gene banks is to know which are duplicates, which are really original and which ones are really unique. You get into a huge problem. This kind of approach can help you to evaluate your stock and find out how closely related they are, whether they are worth keeping or whether you should throw them out. As a geneticist, I can assure you that I am a major collector and I really have to convince myself to get rid of things, but I think that this must be done. It may also be possible to identify some unexpected sources of these quantitative genes because of their distinctive patterns on the DNA level. So if we find a tag in the vicinity of a gene, we may be able to then quickly screen a lot of stocks and say 'these are all the same, we do not need to breed with those but this one is different, we had better take that one and test it.' It could save a lot of time and energy.

I would like to mention my pet project.

I should say that, in a sense, as a concept and a talking point, a number of scientists who met for the Lepidoptera meeting in Crete two years ago, devised the concept of the international gene project which was first revolving around the idea of a cooperative venture to make an RFLP map. It has thus expanded to these other areas and I should also say that we believe strongly that the quantitative trait work should be done in collaboration with the people in the countries which need very much to do the practical breeding. We are not practical breeders, we are interested in the technical transfer and, in it, giving you the tools so that you can take this material home and develop it for your own local needs.

I will give you a time-table on a pilot project (Fig. 5). We estimate, from the work that was done in tomatoes and in corn and with some optimism, that it might take as little as three years to make a reasonable RFLP map starting with no information. In fact, we are starting, from a very good foundation at this point, the QTL analysis for a pilot project to completed at the end of this two-year period. The breeding itself will not take very long. I think that what will take a long time is the discovery of probes - the actual screening of the progeny again can be made very routine. As for expenses (Fig. 6), I project that the expense for a laboratory like mine, which is well equipped, just to have personnel to carry this on, is not that expensive as a pilot. It would be on a grand scale where we really begin to look at a lot of different quantitative traits and begin to screen a lot of individuals ;

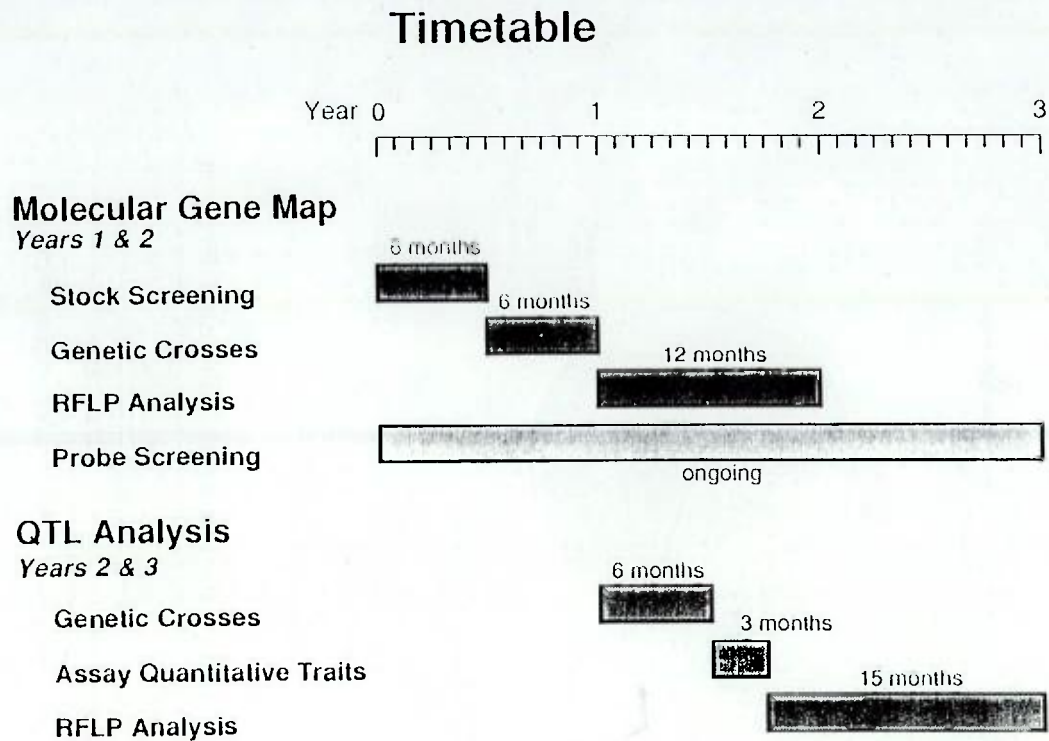


Figure 5

but for a pilot you can see that it is quite reasonable on an industrial scale, just to give you a sense of the practicability.

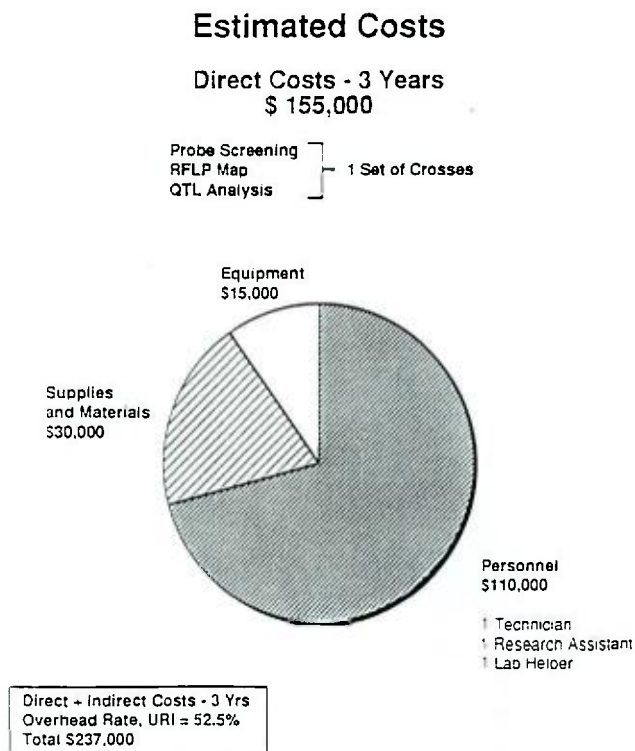


Figure 6

The International Silkworm Project



- Stage 1: Molecular gene map
- Stage 2: Quantitative trait map
- Stage 3: Breeding with tagged genes
- Stage 4: Recombinant Inbred lines
- Stage 5: Genetic engineering

So to summarize, I think that silkworm breeding from the '90's has to incorporate the traditional approaches but must begin a serious effort in using, taking advantage of these molecular tools which are now being used for virtually every other economic organism and, in that sense, we are not forging new territories, we are using tools that are available. I think that this is an essential foundation to make effective use of the long-term goals of genetic engineering when this becomes possible.

Thank you for your kind attention.

QUESTIONS

Mr Chavancy :

'Mrs Goldsmith's project is of paramount importance in the medium term for sericulture, and it concerns both the producing and the consuming countries, since this basic project is aimed at having tools for obtaining high-performance silkworm strains, both quantitatively and qualitatively.

This project must concern the ISC and its members as well as the non-members. Almost one century ago, the goal of international sericulture congresses was to set up a common action involving all the sericultural countries : the control of the pebrine disease which mobilized many countries and eventually led to the creation of the ISC in 1948.

Since then, there has been no such large-scale and momentous project arousing worldwide interest. It could consequently be an opportunity for gathering together efforts and, at least, obtaining support from the ISC and its members. I think the ISC must help in the development of this project, in raising funds, in supplying the context required for expressing scientific exchanges and results. That is my wish. It will be put on the agenda of Thursday's conference.

This is most important for the future. Not only will the results of this project be interesting for everyone, but everyone must also collaborate to obtain these results. It will be necessary to compare strains which are scattered over several countries, which have different genetic characteristics and the collaboration of the international community is an absolute necessity.

It is indeed the ISC's duty to further the birth and the pursuit of this project.'

"Le projet de Mme Goldsmith est d'une très grande importance à moyen terme en sériciculture, et ceci concerne aussi bien les pays producteurs que les consommateurs, puisqu'il s'agit finalement, au bout de ce projet fondamental d'avoir des outils pour obtenir des souches performantes de vers à soie, sur le plan de la quantité et aussi de la qualité.

Ce projet doit concerner la CSI et tous ses membres ainsi que les non-membres. Il y a près d'un siècle, les congrès internationaux de sériciculture avaient pour but une action commune qui concernait tous les pays séricicoles : c'était la lutte contre la pébrine, qui avait mobilisé de nombreux pays et aboutit finalement à la création de la CSI en 1948.

Depuis, il n'y a pas eu de projet d'une telle importance, d'une telle ampleur, qui concerne le monde entier. Il pourrait donc être l'occasion du regroupement des efforts et, au moins, d'une caution de la CSI et de ses membres. Je pense que la CSI doit aider à ce que ce projet puisse se développer, à trouver les financements, à donner le cadre d'expression des échanges scientifiques et des résultats. Tel est mon souhait. Il sera mis à l'ordre du jour de la conférence de jeudi.

Cela est très important pour l'avenir. Non seulement les résultats de ce projet seront intéressants pour tout le monde, mais il est nécessaire que tout le monde collabore pour obtenir ces résultats. Il faudra comparer des souches qui sont dispersées dans différents pays, qui ont des caractéristiques génétiques différentes et la collaboration de la communauté internationale est une nécessité absolue.

C'est donc bien la mission de la CSI que de favoriser l'éclosion et la poursuite de ce projet."

Mr Tayade closed the session and thanked the participants for their co-operation.

M. Tayade clôt la session et remercie les participants de leur coopération.

Mr Chavancy then thanked Mr Tayade for presiding over this most important session.

M. Chavancy remercie alors M. Tayade d'avoir présidé cette séance très importante.

SESSION III

2ème partie - Part II

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THE AFRICAN CONTINENT : A PROSPECTIVE AREA FOR SERICULTURAL DEVELOPMENT

K. SENGUPTA* & PRADIP KUMAR**

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Bounded by the latitudes 35° N and 35° S and longitudes 40° W and 70° E, Africa is the second largest continent of the world. With a vast area of about 30,300,00 sq. km, it covers about one-fifth of the total land surface of the earth. The continent has on the North the Mediterranean sea, on the South the mingling waters of the Atlantic and Indian Oceans, on the East the Red Sea and the Indian Ocean and on the West the Atlantic Ocean. North to South it stretches over about 8 thousand km and East to West it covers about 7,360 km. Off the coast of Africa there are a number of islands of which Madagascar in the Indian Ocean is the largest. While from North to South the continent is cut almost equally into two by the equator, from East to West, the 0° longitude passes through it. It has the largest number of countries (nations) being around 52.

TOPOGRAPHY

The whole of Africa can be considered as a vast plateau rising steeply from narrow coastal strips. The surface is higher in the South-East and tilts downwards towards the North-East. It has a number of rifts, valleys, basins and lakes. In tropical Africa, where the rainfall is heavy, many rivers originate and fall into the sea. The most important ones are the Nile, the Congo, the Niger and the Zambesi. It has a number of high mountains also, the highest of them being Mount Kilimanjaro rising to 5,890 meters.

SOIL AND CLIMATES

The major soil types of Africa are sandy and red brown laterite. While the former supports the xerophytic growth, the latter is suitable for a wide range of vegetation.

The climates of Africa are dominated by positions. Temperatures are high in certain Northern and Southern tropical zones. At higher altitudes, however, temperatures are modified by the height of the mountains. This is specially so for the mountains of East Africa. The zones which lie outside the tropics experience more moderate temperatures and a milder climate. The climate of the continent is further modified by the influence of ocean currents. Desert conditions prevail in certain areas while in some parts the rainfall is quite heavy.

DEMOGRAPHY

Despite the fact that it is the second largest continent having about 1/5th of the land surface of the world, it contains only about 10 % of the total world population and can therefore be described as thinly populated. It has a population density of about 30 persons per sq. mile (2.6 sq. km) almost equal to the Americas and the U.S.S.R. and considerably less than Europe and Asia both having about

120 per sq. mile (1971). This is partly due to desert regions, the Sahara alone covering about one quarter of the entire continent. There are other areas also having low populations. The greatest concentrations of population are found in Nigeria, Ethiopia and around the shores of the East African lakes.

BIOLOGICAL RESOURCES

The biological resources of Africa are very rich, consisting of an immensely varied vegetational cover, vast insect populations and diverse animal life. Of the total area, 20 % is covered by general forest and 40 % by savannas while the rest 40 % forms the desert.

AGRICULTURE

The agricultural produce of tropical Africa includes such commodities as palm-oil, ground-nuts, cocoa, cotton and rubber. Most of them were introduced/developed by the colonial powers for export. No doubt, most African countries have now attained freedom but the pattern continues and the prices they get are still determined to a great extent by the more developed and industrialized nations. The tropical fruits of Africa include mainly bananas, pineapples and dates. The areas with a Mediterranean climate produce large quantities of grapes, oranges, other fruit and vegetables. As local food plantain and cassava are also grown widely in certain regions.

SERICULTURE

Not being in the silk-road Africa had no occasion to master the art of mulberry sericulture and silk production. Nonetheless, being a country with good rainfall and intense vegetation it has supported the growth of a large number of non-mulberry (wild) silks. They are *Anaphe* silk, *Gonameta* silk, *Fagara* silk, *Coan* silk and *Spider* silk. All of them except the last one are of insect origin. From a commercial point of view, the former two are of major importance while the latter three are of minor significance. They are described below.

Anaphe silk :

This silk is produced in Southern and Central Africa by various species of the insect belonging to genus *Anaphe* of the family Notodontidae. *Anaphe* species are widely distributed in the inter-tropical regions of continental Africa mainly in Nigeria, Uganda, Cameroon, the Congo and Togo. Most species are polyphagous. Twenty-two food plants of *Anaphe* have been reported from different African countries. During the Second World War when this silk was used for parachute making, its production reached a peak of about 100 metric tons.

Anaphe silkworm :

Adults :

The adults of *Anaphe* show distinct sexual dimorphism, females being usually larger and heavier than males. The female measures about 2.4 cm in body length as against 2.1 cm in males. Forewings are generally creamy white or butter colour with a metallic brown vein running through them. Adults do not feed and have an average lifespan of 2-6 days. Newly emerged adults exhibit pre-mating courtship. Mating adults remain in copula for 5-24 hours. Oviposition occurs shortly after mating which lasts for 8-20 hours.

Eggs :

Eggs are laid on the undersurface of the leaf of the host plant. Just before oviposition the female clings tightly to the underside of the leaf of the food plant and starts rubbing the tip of the abdomen to construct a covering layer by means of the golden brown hairs on its abdominal extremity. The eggs are then laid in clusters of 250-350. Each cluster is covered with golden brown velvety setae

before the successive batches are laid. This covering protects the eggs from natural enemies. The incubation period ranges between 30-45 days depending upon climatic conditions.

Larvae :

Larvae are polyphagous with seven instars. The average larval period is of 70 days ranging between 65-75 days. The newly hatched larvae are gregarious and remain on the underside of the leaves. In advanced stages, they voraciously feed upon the leaves of the host plant and almost denude the food plant. Each of the final instar larvae is about 39.4 mm in length, 4.2 mm in width and weighs 791 mg at maturity. A single larva consumes nearly 30 g of foliage from hatching to maturity. The larvae always cluster in groups and form procession during feeding and pupation. They seem to have a very high level of co-ordination as a small group of missing larvae is able to locate the others without losing track. The larval stage is followed by a prepupal stage lasting for about a month.

Cocooning behaviour :

The maximum distance covered by the larvae before cocooning is about 30 feet. Most of them move towards the tip of the host branches before cocooning, probably towards the light. A few of them also move towards the bottom of the branches. Some disperse into the vegetation away from the host plant while some remain on the food plant for cocooning.

Cocoon formation :

The larvae cast off their long setae which are used to spin the enclosed case of a communal cocoon. Inside this, the individual cocoon is papery and tough. Collectively spun, cocoons have a large nest-like appearance, usually ferruginous brown, 10-20 cm long 5-15 cm wide and 5-20 cm thick. The size varies with the number of silkworms involved in the formation of the nest which most frequently ranges between 80-250.

Cocoon :

Each cocoon nest has three layers :

- a) an outer fibrous mass ;
- b) an inner hard shell ;
- c) the individual cocoon.

The silk obtained from the individual cocoon is superior to that of the shell.

Pupae :

The pupa is oblong and its average length and breadth are about 2.30 cm and 0.65 cm respectively. The total pupal period lasts about 200 days, indicating a long resting phase. The pupae are cryptic being enveloped in individual and communal cocoons of various sizes.

Voltinism :

Anaphe spp. are generally univoltine. The adults emerge from April to July, eggs are laid between late June and early August, larval stages are observed between early August and mid-October and the pupae from October-May.

The cardinal points in *Anaphe* silkworm rearing are sufficient food, ample shed and minimum disturbance. Once food is unlimited and there is no disturbance to the larvae, they eat well and grow.

Silk :

The physical properties of *Anaphe* silk (spun) are comparable to that of mulberry silk. According to a recent study the bundle strength of the hand-spun yarn of *A. venata* is similar to that of mulberry silk. Such an advantage in physical property indicates that with the application of appropriate modern technology, *Anaphe* silk can be used to produce light clothing and dress material. However, in order to achieve this goal several years of active research may have to be undertaken.

According to a study, the larvae are very nutritious possessing a comparatively higher percentage of crude protein and mineral elements than are contained in beef, fish and poultry resources. They are, therefore, also consumed by the native population of Africa.

Gonometa silk :

In Botswana, during 1986, cocoons spun by an insect belonging to genus *Gonometa* (family : Lasiocampidae) caught the attention of the native persons interested in silk. This genus is represented by two species *G. postica* and *G. fulvida*. *G. postica* is widely distributed throughout the African savanna (tropical grass land). The cocoons spun by this insect are collected by the native population of Botswana from different species of trees of various areas. Most of the cocoons were collected from the bush around the land of the people of different villages.

The moths of this insect are commonly called 'Egger moths'. The larvae are polyphagous. However, maximum cocoons are found on the trees of *Acacia* spp., especially on *Acacia tortilis* which is most widely distributed in Botswana. As the cocoons of *G. postica* are spun with the support of leaves, deep surface impressions of the material are found on the surface of the cocoons. The cocoons are elongated, ellipsoidal in shape and measure about 3.5-5 cm in length. On an average a single cocoon weighs 3-5 g.

The cocoon shell layer is actually a protective layer of the living pupae. From inside, it is very hard with a compact rough surface. The hard nature of the cocoon shell is due to the presence of a gummy substance called sericin. Each cocoon shell weighs 0.8 to 0.9 g. The ratio of cocoon shell to the total weight of the cocoon is about 22 %. The sericin content (45-55 %) is higher in the cocoon of *Gonometa* as compared to other commercial sericigenous insects such as *Bombyx mori* (25-30 %) and *Antheraea mylitta* (18-25 %). The deep impressions of the leaves on the cocoon and very high quantity of sericin render the cocoons unreelable. However, the degummed (sericin removed) cocoons can be converted into valuable and lustrous spun silk. Each cocoon yields about 0.4-0.5 g of spun silk.

This genus has remained obscure economically, probably because of its wild distribution. Serious efforts may be required to exploit this newly found silk for commercial production.

OTHER NON-MULBERRY SILKS

The other varieties of non-mulberry silks known in Africa are fagara silk, coan silk and spider silk. These varieties of silk appear to be of limited interest. Authoritative documents on these silks are also not available. Limited and patchy information indicate that fagara silk and coan silk are inferior to the other varieties of non-mulberry silks of Africa, whereas due to high cost of production spider silk is not used in the textile industry.

Fagara silk :

In Africa, Sudan is inhabited by the giant silk, *Attacus atlas* L. (Family : saturniidae). Thirteen species of genus *Attacus* are known to produce fagara silk. Cocoons are light brown in colour and measure about 6 cm in length with peduncles of varying lengths (2-10 cm).

Coan silk :

The larvae of genus *Pachypasa* feed primarily on trees such as pine, cypress, juniper and oak. Coan silk is known to be produced by two species, namely *P. otus* D. and *P. lineosa* Vill. which are reported from Mauritania and Morocco. Cocoons are white in colour, each measuring about 8.9 × 7.6 cm.

Spider silk :

This is a non-insect variety of silk. The silk is not only soft and fine but also strong and elastic. Three species of spider, namely *Nephila madagascarensis*, *Miranda auerentia* and *Epeira* spp. are known in Madagascar to produce spider silk.

PROSPECTS OF SERICULTURE IN AFRICA

The development of sericulture in Africa requires a two-pronged approach :

- a) Introduction of mulberry sericulture, which is always more stable and remunerative but has hitherto been almost unknown to the continent ;
- b) The development of non-mulberry sericulture which has a tradition in Africa but has not been developed as it should have.

With regard to the former, though some plantations of mulberry and mulberry silkworm rearing were taken up on an experimental scale in some African countries like Nigeria, Zambia, Ethiopia, Kenya and Uganda and some success was also achieved, it could not establish itself as a commercial activity due to a number of reasons, both technical and commercial. Sericulture is a composite industry starting with the mulberry cultivation and ending in fabric production and marketing. These jobs are generally done by different groups of specialized people and accordingly if the industry has to develop, a total linkage with strong point-to-point linkages are essential which are often lacking. In addition, each of them is a job of a highly technical nature for which adequate infrastructure and technically trained manpower are needed. These elements have been lacking in Africa, at least with regard to mulberry silk. Consequently, if it has to develop in a systematic manner, a holistic view may have to be taken towards its development in the continent and necessary actions taken. This could perhaps be done more effectively by some international bodies like FAO/UNIDO.

Coming to the non-mulberry silks, though they have been existing in a number of countries of Africa like Nigeria, Uganda, Cameroon, Congo and Togo, no attempt has been made individually or collectively to utilise their full potential which till now remains untapped, though the climate and flora are highly promising for their commercial production. The other significance of the development of non-mulberry sericulture could be the conservation of forests which is becoming a matter of great concern to each country. It is estimated that nearly 10 million ha of the world's tropical forests are destroyed every year. Forests of Africa are by no means spared. The development of non-mulberry sericulture with a consequent development of non-mulberry host plants, which are mostly forest trees could go a long way towards the preservation of forest. Generation of income in the rural area could further prevent the migration of population from the rural to the urban area which is also an international problem.

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QUESTIONS

Mr Mauchamp thanked Mr Sengupta for his speech. He reminded the audience that Mr Sengupta was one of the three awardees of the 1990 Pasteur Prize which, being absent, he could not received on the opening day and asked the participants to applaud him.

'This was the first review on wild silkworms. I think that the wild silkworm will become more and more the subject of studies as to silk production. The term wild is quite misused, it is used as opposed to the domesticated silkworm but for a very long time these species have been the subject of research in this field. The discussion is open.'

M. Mauchamp remercie M. Sengupta pour son exposé. Il rappelle que M. Sengupta est l'un des trois lauréats du Prix Pasteur 1990 qu'il n'a pas pu recevoir le jour de l'ouverture car il était absent et demande aux participants de l'applaudir.

"C'est le premier exposé qui nous parle des vers à soie sauvages. Je pense que, de plus en plus, le ver à soie sauvage fait l'objet d'études quant à la production de soie. Le terme sauvage est très mal employé. C'est une opposition au ver à soie domestique mais, depuis très longtemps, ces espèces font l'objet de recherches dans ce domaine. La discussion est ouverte."

Mr Chavancy :

'Mr Sengupta's speech confirms that we made the right choice when we proposed India for dealing with the non mulberry silkworms section. I think that nobody will question it any further now.

I would like to ask him a question more specifically on his review. From what I gathered, and contrary to what I thought, it seems fagara silk is still produced in Botswana, in other words, it seems that *Attacus* is still being exploited. Can you confirm this and do you have any information on this fagara silk in other African countries ?'

"L'exposé de M. Sengupta confirme que nous avons fait le bon choix ce matin en proposant que l'Inde s'occupe des vers à soie non mûriers. Je pense que plus personne n'en doute maintenant.

Je voudrais lui poser une question plus précisément sur son exposé. D'après ce que j'ai compris et contrairement à ce que je croyais, la soie fagara serait encore produite au Botswana, c'est-à-dire qu'*Attacus* serait toujours exploité. Pouvez-vous me le confirmer et avez-vous, éventuellement, des informations sur cette soie fagara dans d'autres pays africains ?"

Mr Sengupta :

'In fact, it is not fagara silk but *gonometa* silk. Botswana produces substantial quantities of *gonometa* silk. This species gives cut cocoons and about 27-28 % of silk per cocoon.'

"En fait, ce n'est pas la soie fagara dont il s'agit, mais de la soie *gonometa*. Le Botswana produit en grandes quantités la soie *gonometa*. C'est une espèce qui donne des cocons coupés et environ 27 à 28 % de soie par cocon."

Mr Persoons :

'Is fagara silk produced anywhere else in Africa ?'

"La soie fagara est-elle produite dans d'autres pays africains ?"

Mr Sengupta :

'Yes, Sudan is inhabited by the giant silkworm, *Attacus atlas*. Thirteen species of *Attacus* are known to produce fagara silk. The cocoons are brown in colour and 6 cm in length, their pedicels vary from 2 to 10 cm. It is in Sudan that fagara silk is produced by *Attacus atlas*.'

"Oui, au Soudan, on trouve le papillon géant *Attacus atlas*. On connaît treize variétés d'*Attacus* qui produisent la soie fagara. Les cocons sont de couleur marron, d'une longueur de 6 cm et leurs pédicules mesurent de 2 à 10 cm. C'est au Soudan que la soie fagara est produite à partir d'*Attacus atlas*."

Mr Bouvier :

'Some decades ago, in 1928 to be precise, French and Belgian firms were set up to study the marketing possibility of anaphe silk in the Congo (nowadays the Central African Republic) and in the Belgian Congo (nowadays Zaïre). These two firms, which operated independantly, started with exploiting anaphe silk and this marketing very rapidly lead to the scarcity of silk stocks. Both these societies subsequently turned over to mulberry cultivation and *Bombyx mori* rearing.

Have you heard of these experimentations and what do you think of them ?'

"Il y a quelques décennies, en 1928 exactement, des sociétés, française d'une part et belge d'autre part, avaient été créées pour étudier les possibilités de commercialisation de la soie anaphe au Congo (aujourd'hui, République centrafricaine) et au Congo belge (aujourd'hui, Zaïre). Ces deux sociétés, qui ont opéré indépendamment l'une de l'autre, ont commencé par exploiter la soie anaphe et cette commercialisation a abouti très rapidement à une raréfaction totale des bourses soyeuses et les deux sociétés se sont ensuite reconverties vers la culture du mûrier et l'élevage de *Bombyx mori*.

Avez-vous eu connaissance de ces expérimentations et qu'en pensez-vous ?"

Mr Sengupta :

'During World War II, when there was an urgent need for silk for parachute making, there was a big push in anaphe silk production and it went up to 100 tonnes. But later, for lack of a systematic development of sericultural methods, this production almost disappeared.'

"Pendant la deuxième guerre mondiale, lorsque la soie était très recherchée pour la fabrication des parachutes, des efforts de production ont permis d'obtenir jusqu'à 100 tonnes de soie anaphe. Mais, par la suite, du fait de l'absence d'un développement systématique des techniques séricicoles, cette production a pratiquement disparu."

Mr Babacauh :

'I would like to know whether, with the experience acquired in India, it is possible to domesticate or to improve this non mulberry silk production.'

"Je voudrais savoir si, avec l'expérience connue en Inde, il est possible de domestiquer ou d'améliorer la production de cette soie non mûrier."

Mr Sengupta :

'This is a complex question. In other countries, for example in China or in India, artificial diet was experimentally used on non mulberry silk. However, no success was achieved in producing silk on a commercial scale with any of the wild or domesticated species, except for *Antheraea proylei* which is partly domesticated. But this requires a lot of manipulation. Normally, wild silkmths grow, and prefer to grow, under natural conditions with the accompanying hazards of predators, pests, bad weather, etc. That is the problem with wild silkmths. For mulberry silk, 80 % of the silk is recovered and 20 % is lost whereas for non mulberry silk about 70 % is lost and hardly 30 % is recovered. This situation continues even with the non mulberry silk that has been cultivated for a long time.'

*"C'est-là une question complexe. Dans d'autres pays, par exemple en Chine ou en Inde, l'alimentation artificielle a été utilisée sur les vers à soie non mûrier au niveau expérimental. Cependant, on n'est parvenu à produire de la soie à l'échelle commerciale avec aucune des espèces sauvages ou domestiquées à l'exception d'*Antheraea proylei* qui est partiellement domestiqué mais cela demande beaucoup de manipulations. Normalement, les vers à soie sauvages se développent mieux, et préfèrent se développer, dans les conditions naturelles, ce qui comprend les risques liés aux prédateurs, aux parasites, au mauvais temps, etc. C'est-là que se trouve le problème avec les vers à soie sauvages. Pour la soie mûrier, on récolte 80 % de la soie et on en perd 20 % alors que, pour la soie non mûrier, on perd à peu près 70 % de la soie et on en récolte à peine 30 %. Cette situation continue même avec la soie non mûrier cultivée depuis très longtemps."*

As no further question was asked, **Mr Mauchamp** handed over to Mrs Jaksheva-Peletkova for her review.

Aucune autre question n'étant posée, M. Mauchamp passe la parole à Mme Jaksheva-Peletkova pour son exposé.

DAILY INGESTION AND UTILIZATION OF VARIOUS KINDS OF NUTRIENTS IN MULBERRY LEAVES BY THE SILKWORM, *BOMBYX MORI* L.

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INTRODUCTION

The contents of various kinds of nutrients in mulberry leaves and in the feces excreted by the larvae of the silkworm, *Bombyx mori* L., were determined, together with the daily amount of ingestion and utilization of protein, energy, lipids, carbohydrates and ash in the larvae.

The amount of energy ingested and absorbed daily by the larvae was 0.854 and 0.428 kcal/g of body weight and the amount of protein, lipids and nitrogen-free extract were 32.2, 6.7 and 47.1 mg/g of body weight, corresponding to 0.189 kcal ; 0.060 kcal and 0.179 kcal/g of body weight, respectively.

These calorific values of protein, lipids and nitrogen-free extract corresponding to approximately 44 %, 14 % and 42 % of the total energy absorbed daily per gram of body weight of the larva. The contents of various kinds of nutrients in mulberry leaves and the daily amount of nutrients ingested and absorbed by the larvae were discussed in relation to the quantitative requirements of nutrients in the silkworm.

There are a lot of reports concerning the consumption and utilization of food by insects (e.g. Waldbauer, 1968 ; Scriber and Slansky, 1981). However, little attention has been paid to the ingestion and utilization of various kinds of nutrients, particularly, to the daily nutrient requirements in the silkworm.

In the previous papers the ingestion, absorption and utilization of nutrients in the silkworm, *Bombyx mori* L., have been discussed in relation to the metabolism and energy requirements throughout the life cycle of the silkworm (Horie and Watanabe, 1969 ; Horie *et al.*, 1976, 1978). More recently, the daily consumption and utilization of dry matter (Horie and Watanabe, 1983), energy (Horie and Watanabe, 1985), phosphorus (Nakamura *et al.*, 1982), amino acids, minerals, vitamins and sterols (Horie, Nakasone *et al.*, 1985) in mulberry leaves by the silkworm were determined.

The present study was undertaken to determine the daily ingestion and utilization of various kinds of nutrients in mulberry leaves by the silkworm and to analyse the daily requirements of some nutrients in the larvae of the silkworm.

MATERIALS AND METHODS

The silkworm larvae (Kinshu × Showa, hybrid) were reared on mulberry leaves from hatching to the end of the 4th instar. Fifty male larvae newly ecdysized were used for the experiment during the 5th instar, and they were reared on mulberry leaves. The amount of dry matter ingested and digested was measured according to the method reported previously (Horie *et al.*, 1976) and the approximate digestibility was calculated. In order to minimize the effect of mortality and individual variations in weight, unhealthy larvae were replaced with healthy ones of a similar size reared as a reserve batch in the same manner as the test batch.

The body weight of the larvae was measured every day and the average body weight for every 24 hr was calculated. For the analysis of individual nutrients contained in mulberry leaves, remains of mulberry leaves and feces, these materials were dried.

The chemical analysis of each nutrient was carried out in double using the samples from the same materials.

- **The calorific contents** in mulberry leaves, remains of mulberry leaves and feces were calculated on the assumption that energy contents of protein, lipids and carbohydrate are respectively 5.86 kcal, 8.96 kcal and 3.8 kcal/g (Horie and Watanabe, 1985).

- **The nitrogen contents** in mulberry leaves, remains and feces were determined by the Kjeldahl method using 2 g of each sample and the contents of crude protein were calculated by multiplying the nitrogen content of each sample by 6.25.

- **The crude lipid content** in each sample was analysed by extracting 5 g of each sample with ethyl ether in a Soxhlet apparatus for 24 hr twice. The combined extracts were evaporated to dryness and the crude lipid content was determined by weighing.

- **The crude fiber content** in mulberry leaves, remains and feces was analysed by heating 5-6 g of each sample in 50 ml 8.4 % (w/w) H_2SO_4 solution, followed by washing with distilled water and by heating in 50 ml 8.4 % (w/w) NaOH solution according to the conventional method by Heneberg and Shtomann. After washing with distilled water several times and with ethanol, followed by washing with ethyl ether, the residues were dried completely and thereafter they were weighed.

- **The crude ash content** was analysed by oxidizing one gram of each sample in a muffle furnace at 500° C for 5 hr and the ash content was determined by weighing.

- **The nitrogen-free extract content**, per cent dry matter was estimated by calculation, 100-(crude protein, % + crude lipid, % + crude fiber, % + crude ash %), for each sample. The coefficient of apparent digestibility and the daily amounts of ingestion and absorption of each constituent of food were calculated from the following formulae :

$$\text{Apparent digestibility} = (I_A - F_A) \times 100 / I_A$$

$$\text{Daily amount of ingestion} = I_A / (T \times W)$$

$$\text{Daily amount of absorption} = I_A - F_A / (T \times W)$$

Where,

I_A is the amount of constituent A ingested by a single larva during the 5th instar ;

F_A is the amount of constituent A excreted in the feces by a single larva during the 5th instar ;

T is the duration of the feeding period in the 5th instar (days) ;

W is the average fresh body weight of the larva throughout the 5th instar.

RESULTS AND DISCUSSION

As shown in Table I, the body weight of the larva increased logarithmically in the 5th instar with time, reaching the maximum value of 5.028 g on the 6th day. The average body weight throughout the 5th instar (w) was calculated to be 3.452 ± 7.572 g. The total amount of dry matter ingested during the 5th instar was 3.671g, which was a little smaller than that reported previously (Horie and Watanabe, 1985), probably because the experiment was carried out in autumn. The average amount of dry matter ingested daily by a single larva was 0.612 ± 0.128 g throughout the 5th instar, and the average amount of dry matter ingested daily was 0.216 ± 0.113 g/g of fresh body weight, being in fair agreement with the previous results (Horie and Watanabe, 1985).

The total amount of dry matter digested by a single larva during the 5th instar was 1.668 and the average apparent digestibility of dry matter was approximately 45.4 %. The average amount of dry matter digested daily by a single larva was 0.278 ± 0.109 g and the daily amount digested was 0.098 ± 0.051 g/g of fresh body weight.

The amount of each nutrient ingested and absorbed by a single male larva during the 5th instar and the daily amount of each nutrient ingested and absorbed per gram of body weight are shown in Table II and Table III respectively. The amount of energy ingested and absorbed by a single larva was approximately 14.5 and 7.3 kcal and the utilization rate of energy was 50.6 % (Table II), while

the daily amount of energy ingested and absorbed was 0.854 and 0.428 kcal/g of fresh body weight (Table III), respectively. These values of energy were slightly smaller than those reported previously (Horie and Watanabe, 1985).

Table I. Larval growth and daily ingestion and digestion of dry matter by the 5th instar larva of the silkworm.

Tableau I. Croissance larvaire et ingestion et digestion journalières de matière sèche par le ver à soie au 5ème stade larvaire.

Day in the 5th instar	Body weight	Average daily body weight	Dry matter ingested/ larval day	Dry matter ingested per body wt. g per day	Dry matter digested/ larval day	Dry matter digested per body wt. g per day
<i>Jour au 5ème âge</i>	<i>Poids du corps</i>	<i>Poids moyen du corps par jour</i>	<i>Matière sèche ingérée par journée larvaire</i>	<i>Matière sèche ingérée /g de poids du corps/jour</i>	<i>Matière sèche digérée par journée larvaire</i>	<i>Matière sèche digérée /g de poids du corps/jour</i>
	(g)	(g)	(g)	(g)	(g)	(g)
1st day / 1er jour	0.778	1.062	0.456	0.429	0.197	0.185
2nd day / 2ème jour	1.345					
3rd day / 3ème jour	2.895	2.120	0.533	0.251	0.226	0.107
4th day / 4ème jour	3.962	3.429	0.572	0.167	0.305	0.089
5th day / 5ème jour	4.722	4.342	0.747	0.172	0.411	0.095
6th day / 6ème jour	5.028	4.875	0.787	0.161	0.390	0.080
7th day / 7ème jour	4.741	4.885	0.576	0.112	0.141	0.029
Total			3.671		1.668	
Average / Moyenne		3.452 ± 1.572	0.612 ± 0.128	0.216 ± 0.113	0.278 ± 0.109	0.098 ± 0.051

The crude protein content in mulberry leaves was 20.55 %, and the amount of crude larva was 0.80 and 0.54 during the 5th instar. The digestibility of protein was 67.5 % (Table II), and this value was in good agreement with those reported previously - 67 % (Horie and Watanabe, 1985) - but slightly higher than those reported by Hiratsuka (1917) - 67 %, Nakano and Housi (1968) - 60 % Horie *et al.* (1978) 63 %. The daily amount of protein ingested and digested was 47.5 and 32.2 mg/g of fresh body weight (Table III). This quantity of 32.2 mg protein absorbed daily contains 0.189 kcal on the basis of the calorific value of casein - 5.86 kcal/g of dry weight, corresponding approximately to 44% of the energy absorbed daily i.e. 0.428 kcal/g of fresh body weight.

The crude lipid content in mulberry leaves was 4.6 % and the amount of crude lipid ingested and digested by a single larva during the 5th instar was 0.17 and 0.13 g. The digestibility of lipid was 60.95 % and this value was in good agreement with that reported by Horie *et al.* (1985), but was a little higher than that reported by Hiratsuka (1917) (Table II). The daily amount of crude lipid ingested and absorbed was approximately 10.2 and 6.7 mg/g of fresh body weight (Table III). This amount of 6.7 mg absorbed daily contains 0.060 kcal on the assumption of the calorific value of triglyceride

8.95 kcal/g, this quantity of 0.060 kcal corresponding to approximately 14 % of energy absorbed daily i.e. 0.428 kcal/g of body weight.

Table II. Amount of each nutrient contained in the mulberry leaves ingested and absorbed by a single male larva during the 5th instar.

Tableau II. Taux de substances nutritives contenu dans les feuilles de mûrier ingérées et absorbées par une seule larve mâle au cours du 5ème âge.

Nutrients <i>Éléments nutritifs</i>	Content			Amount/larva in the 5th instar			Digestibility (%)
	Mulberry leaves	Remains of mulberry leaves	Feces	Ingested	Excreted	Absorbed	
	<i>Feuilles de mûriers</i>	<i>Restes de feuilles de mûriers</i>	<i>Fèces</i>	<i>Quantité/larve au 5ème âge</i>	<i>Quantité/larve au 5ème âge</i>	<i>Quantité/larve au 5ème âge</i>	<i>Digestibilité (%)</i>
				<i>Ingérée</i>	<i>Excrétée</i>	<i>Absorbée</i>	
Dry matter <i>Matière sèche</i>	-	-	-	3.671	2.003	1.668	45.44
Energy <i>Energie</i>	3.945 cal/g	3.940 cal/g	3.580 cal/g	14.49	7.160	7.330	50.59
Crude protein <i>Protéines brutes</i>	20.55	19.86	12.91	0.797	0.259	0.538	67.50
Crude lipid <i>Lipides brutes</i>	4.57	4.52	3.36	0.169	0.066	0.130	60.95
Crude fiber <i>Fibres brutes</i>	8.67	11.69	15.38	0.122	0.354	-0.232	-
Nitrogen-free extract <i>Extrait sans azote</i>	52.67	50.69	51.00	2.068	1.021	1.047	50.63
Crude ash <i>Cendres brutes</i>	13.61	13.28	19.27	0.527	0.395	0.132	25.05

The crude fiber content in mulberry leaves was 8.7 % and that in the feces was about 1.8 times that of the content in mulberry leaves. The amount of crude fiber ingested by a single larva during the 5th instar was 0.12 g. The amount of crude fiber excreted by a single larva during the 5th instar was 0.35 g. In other words, the whole amount of crude fiber ingested was excreted in the feces without any digestion and absorption. The inability of digesting fibers in the silkworm had already been demonstrated by Hiratsuka (1917).

The content of nitrogen-free extract in mulberry leaves was 52.7 %. This fraction together with the fraction crude fiber represent the carbohydrates. The amount of nitrogen-free extract ingested and absorbed by a single larva during the 5th instar was approximately 2.07 and 1.05 g and digestibility was 50.6 %. The daily amount of nitrogen-free extract ingested and absorbed was 120 and 47 mg/g of fresh body weight (Table II and Table III), and 47 mg of nitrogen-free extract absorbed are estimated to contain 0.179 kcal of energy on the assumption that the energy content of carbohydrate absorbed is 3.8 kcal/g. That 0.179 kcal correspond to approximately 42 % of the daily amount of energy absorbed per gram of fresh body weight i.e. 0.428 kcal/g.

Table III. Daily ingestion and absorption of the nutrients contained in mulberry leaves by the 5th instar larva (male)

Tableau III. Ingestion et absorption journalière des éléments nutritifs contenus dans les feuilles de mûrier par une larve mâle au 5ème âge.

Nutrients <i>Éléments nutritifs</i>	Daily ingestion (Amount/g of body wt./day) <i>Ingestion journalière (Quantité/g de poids du corps/jour)</i>	Daily absorption (Amount/g of body wt./day) <i>Absorption journalière (Quantité/g de poids du corps/jour)</i>
Dry matter / <i>Matière sèche</i>	0.216 g	0.098 g
Energy / <i>Energie</i>	0.854 cal	0.428 cal
Crude protein / <i>Protéines brutes</i>	47.5 mg	32.2 mg
Crude lipid / <i>Lipides brutes</i>	10.2 mg	6.7 mg
Crude fiber / <i>Fibres brutes</i>	6.5 mg	0.0 mg
Nitrogen-free extract / <i>Extrait sans azote</i>	120.4 mg	47.1 mg
Crude ash / <i>Cendres brutes</i>	32.2 mg	10.0 mg

The content of crude ash in mulberry leaves was 13.6 %. The amount of crude ash ingested and absorbed by a single larva during the 5th instar was 0.527 and 0.132 g and the apparent digestibility of crude ash was 25 %. It has been reported that several kinds of inorganic substances including Ca, P, K and Mg were actively absorbed in the first half of the 5th instar, and that thereafter a large part of these substances was excreted in the latter half of the 5th instar because of the loss of water, in particular immediately before the maturation of the larva (Nakamura *et al.*, 1982 ; Nakamura and Horie, 1982). This secondary excretion of minerals lowered apparent digestibility of crude ash and the amount of crude ash absorbed, therefore, appeared to be negligible.

In this experiment the ingestion, excretion and utilization of the main nutrients (dry matter, protein, lipids, nitrogen-free extract and ash) required for the growth of the silkworm, *Bombyx mori* L., were analysed. These data should be useful for understanding the physiology of nutrition and metabolism not only of the silkworm but also of other species of insects.

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QUESTIONS

Mr Mauchamp :

'In table II, a component was measured 0.122 g in ingestion and 0.350 g in excretion, how do you explain this difference ?'

"Dans le tableau II, on trouve un composé mesuré en ingestion à 0,122 g et excrétion à 0,350 g, comment expliquez-vous cette différence ?"

Mrs Jaksheva-Peletkova :

'This result was obtained in other experiments. I think it is due to the silkworm's inability to ingest crude fibres. This level of absorption corresponds to a mistake in the analyses.'

"Ce résultat a été obtenu dans d'autres expériences. Je pense qu'il s'agit de l'inaptitude pour les vers à soie à absorber des fibres brutes. Ce niveau de l'absorption correspond à une erreur dans les analyses."

Mr Mauchamp :

'Did you pursue these studies using different silkworm strains ?'

"Avez-vous poursuivi ces études en utilisant différentes souches de vers à soie ?"

Mrs Jaksheva-Peletkova :

'Yes, we would like to have this possibility but in Bulgaria the only species used is *Bombyx mori*. It would be useful in the future to continue these experiments with other insect species.'

"Oui, nous souhaiterions en avoir la possibilité mais, en Bulgarie, la seule espèce utilisée est Bombyx mori. Il serait utile, dans le futur, de continuer ces expériences avec d'autres espèces d'insectes."

UTILISATION DE L'ELECTROPHORESE DES PROTEINES POUR L'IDENTIFICATION DES MURIERS EN COLLECTION

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1) INTRODUCTION

L'acquisition de la collection de Porquerolles :

La constitution de cette collection a débutée en 1978 afin de sauvegarder le matériel végétal menacé de disparition dans les diverses collections françaises.

Elle se présente sous la forme d'un verger d'un hectare environ dans lequel les arbres sont plantés à une densité de 416 arbres/hectare.

Pour chaque clone ou variété, on a implanté un minimum de cinq arbres.

Le matériel végétal réuni provient d'origines diverses :

- de la collection de l'ancienne station séricicole de St Christol-les-Alès ;
- de l'ancienne collection de l'école d'Agriculture de Montpellier ;
- d'un échantillonnage des mûriers présents dans l'ancienne station séricicole des Arcs ;
- de pied-mères de variétés fruitières de mûriers anciennement conservées par des pépiniéristes français réunis par Pierre Meynadier ;
- de matériel végétal directement reçu de la station séricicole de Padoue (Italie).

Lors de l'évaluation de cette collection, de nombreuses erreurs d'identification des variétés collectées ont été mises en évidence. C'est pourquoi il a été fait appel à l'électrophorèse des protéines pour confirmer les résultats des observations macroscopiques.

1.1) Principe et intérêt de l'électrophorèse

L'électrophorèse consiste à placer dans un champ électrique des broyats contenant des protéines. Chaque protéine, en un temps donné, migrera plus ou moins vite en fonction de sa charge et de sa taille. Les enzymes sont les protéines les plus faciles à détecter car on les révèle en les mettant en présence de leur substrat et d'un colorant. Il apparaît donc des taches uniquement là où se trouve l'enzyme choisie pour l'étude, les autres protéines n'intervenant pas. Les enzymes choisies sont des isoenzymes qui peuvent avoir des structures moléculaires variées, donc des vitesses de migration variées. Si l'on place sur le gel des broyats de différentes variétés d'arbres, leur contenu en isoenzymes est différent et on obtiendra un ensemble de taches différent pour chaque variété.

L'électrophorèse permet donc, à partir d'extraits bruts n'ayant subi aucune purification préalable et contenant des milliers de protéines différentes, de caractériser quelques types moléculaires possédant la même activité catalytique, ou isozymes (= isoenzymes). Chez chaque organisme, le nombre d'isozymes ayant une activité catalytique donnée (estérase, peroxydase) est généralement faible, et un petit nombre de bandes colorées apparaît sur les gels (on parle alors de zymogramme).

Chaque bande correspond à une protéine distincte dont la synthèse est contrôlée par un, deux ou plusieurs gènes. Les phénotypes enzymatiques observés sur les zymogrammes peuvent donc être traduits en terme de génotypes, de gènes et d'allèles.

Le but de la présente étude n'est pas de reconstituer le génôme des arbres de la collection mais seulement de montrer comment on peut distinguer les espèces et éventuellement les variétés de mûrier d'après leur contenu enzymatique.

1.2) Analyse bibliographique

Toutes les électrophorèses réalisées à ce jour sur le mûrier n'ont utilisé qu'une isoenzyme : la peroxydase.

En 1975 : Hirano identifie 10 zones d'activité peroxydase (soit 10 bandes correspondant à 10 isozymes de peroxydase) à partir de 240 variétés de mûriers. Ces 10 bandes sont distinguées d'après leur position sur le gel et sont nommées C1, A1, A2, A9. Les zymogrammes diffèrent d'une variété à l'autre, mais on peut les classer en cinq types généraux. Par exemple, le type I regroupe les zymogrammes caractérisés par une bande foncée A7 et deux bandes claires A6 et A8.

En 1978 : Hirano et Naganuma traduisent les types I, II et III en terme de génotype. Les bandes A6, A7, A8 et A9 sont contrôlées par le gène $Px1$.

L'allèle $Px1^1$ commande le zymogramme A6, A7, A8. L'allèle $Px1^2$ commande le zymogramme A7, A8, AA9. L'hétérozygote $Px1^1 Px1^2$ commande le zymogramme A6, A7, A8, A9.

De plus, l'étude tente d'établir des corrélations entre les types I, II et III et les caractères morphologiques des mûriers. Il apparaît qu'il n'y a pas de différence statistique entre les 3 types pour les caractères suivants :

- longueur de la feuille,
- largeur de la feuille,
- rapport longueur sur largeur de la feuille,
- longueur de l'entre-noeud,
- phyllotaxie,
- forme de la feuille,
- vigueur de l'arbre et résistance au mildiou.

La seule différence significative entre les types concerne la longueur du pétiole.

En 1979 : Hirano, Inokuchi et Nakajima étudient les relations entre les isozymes de peroxydase et le contenu en acides aminés des mûriers. Ils montrent que la valeur nutritive de la feuille a beaucoup d'influence sur la croissance des vers à soie, surtout la qualité et la quantité de protéines. L'électrophorèse des isozymes peut donc remplacer de laborieuses et chères analyses chimiques.

Il ressort de l'étude que les types I et III sont plus riches en un certain nombre d'acides aminés que le type II. La corrélation entre le contenu enzymatique et la quantité d'acides aminés est attribuée soit au pleiotropisme* des gènes des isozymes de peroxydase, soit au fort linkage entre ces gènes et des gènes contrôlant le contenu en acides aminés. Dans certaines limites, la sélection des plants ayant une composition voulue en acides aminés peut donc s'effectuer par électrophorèse.

En 1988 : Sengupta entreprend pour la première fois l'électrophorèse des isozymes de peroxydase sur des mûriers triploïdes. Ceux-ci diffèrent de leurs parents (tétraploïdes et diploïdes) par leur morphologie et leur zymogramme.

Bien que le rôle physiologique exact soit encore obscur étant donné la multiplicité de leurs fonctions, l'activité des peroxydases a souvent été corrélée avec la croissance, le développement et l'activité hormonale (Shannon, 1968).

La variabilité observée dans les zymogrammes peut être : soit l'effet primordial des gènes, la variation morphologique ne constituant qu'une conséquence, soit une conséquence secondaire de la mutation.

Enfin, en 1989 : Sumardjito, Hirano *et al.* établissent une relation entre le type de zymogramme et la structure micromorphologique de la surface des feuilles (forme des idioblastes).

* Le fait qu'un gène commande plusieurs facteurs sans rapport entre eux.

L'étude se limite à quatre espèces de mûriers de Java : *Morus australis* Koidz., *Morus multicaulis* Perr., *Morus nigra* L. et *Morus cathayana* Koidz.

Selon le zymogramme de peroxydases, ils attribuent :

- au Type I : *cathayana* et *nigra*,
- au Type II : *australis* et *multicaulis*.

Selon le zymogramme de protéines, ils constatent que beaucoup de bandes sont communes aux quatre espèces. Ils obtiennent cependant une tache spécifique pour *M. australis*, ce qui recoupe que *M. australis* diffère des 3 autres espèces par la forme de ses idioblastes.

Il est à noter que ces résultats concordent avec la classification adoptée par Koidzumi :

- *M. cathayana* et *M. nigra* sont classés dans la même série,
- *M. multicaulis* est dans la même sélection (niveau hiérarchique supérieur à la série) que ces deux derniers.
- *M. australis* est dans une section différente.

1.3) Intérêt de l'utilisation du phast system pour une identification rapide des mûriers

Matériel et méthode

Présentation du matériel :

L'électrophorèse a lieu à l'intérieur du "Phast System", appareil récent de la marque "Pharmacia", qui permet de reproduire exactement les conditions de voltage, ampérage, puissance, durée et température à chaque électrophorèse. Un microprocesseur permet de programmer la valeur de ces paramètres pour chaque phase de la migration des protéines.

La méthode choisie étant enregistrée par l'intermédiaire du clavier, ces paramètres seront contrôlés et régulés par le microprocesseur afin de reproduire les mêmes conditions à chaque électrophorèse.

L'utilisation du Phast System apporte, outre un gain de temps, une totale garantie de reproductibilité de l'expérience.

L'électrophorèse se fait sur gel de polyacrylamide dont la porosité suit un gradient 8/25 (la concentration en polyacrylamide augmente de 8 % à 25 %), donc le réseau se resserre au fur et à mesure que les protéines migrent vers l'anode. Ce gradient a pour but d'obtenir une meilleure résolution des protéines en fonction de leur taille.

Mode opératoire - principe :

* Les feuilles sont cueillies juste avant la manipulation et sont immédiatement mises dans de la glace pilée.

* Les feuilles sont broyées en chambre froide avec un tampon à pH neutre dans lequel se solubilisent les protéines.

* Le broyat est placé dans des tubes à centrifuger et la centrifugation s'effectue pendant 40 minutes à 12 500 tours/min., à la température de 4 °C.

* Une goutte de surnageant additionné d'un colorant permettant de suivre la migration est déposée sur le gel. Celui-ci peut recevoir 8 dépôts, on peut donc tester 8 variétés à la fois.

* Le gel est placé dans le Phast System avec les bandelettes de tampon assurant le contact entre les électrodes et le gel.

* La migration s'effectue à 4 °C et dure environ 1h30.

* Le gel est retiré du Phast System et trempé dans une solution tampon, puis dans cette solution additionnée du substrat de l'isoenzyme choisie.

* Un colorant spécifique de la réaction catalysée par l'isoenzyme est additionné au bain.

* Le gel portant les zymogrammes, une fois recouvert d'un film, sèche et se conserve à l'air ambiant.

Enzymes étudiées :

Quelques essais ont été faits avec les peroxydases, mais les résultats se sont avérés moins bons. Il apparaît donc que les estérases, qui n'avaient jamais été utilisées sur les muriers, sont des isoenzymes très intéressantes à exploiter pour l'étude de cet arbre.

2) RESULTATS ET DISCUSSIONS

2.1) Présentation des zymogrammes caractéristiques des 5 espèces

Nous ne ferons pas état des électrophorèses de peroxydases étant donné leur moindre intérêt par rapport aux estérases.

En comparant les zymogrammes des arbres de la même espèce, on peut faire apparaître des caractéristiques communes. On établit alors un "zymogramme type", à partir des bandes rencontrées. Les bandes sont caractérisées par leur position.

2.2) Discussion

2.2.1) Attentions spéciales à apporter à l'exécution du mode opératoire :

Les conditions de la migration ne peuvent subir aucune variation au sein du Phast System, mais les étapes antérieures ou postérieures à la migration peuvent ne pas être reproduites à l'identique.

L'analyse critique des manipulations fait apparaître les faits suivants :

* La qualité du zymogramme dépend en partie du soin apporté au broyage des feuilles.

Certains zymogrammes sont beaucoup plus nets que d'autres. Pour être révélés, les moins nets doivent subir un temps de coloration plus long (pour faire apparaître les bandes), d'où brouillage du fond (qui se colore aussi).

* Les bandelettes assurant le contact entre les électrodes et le gel doivent impérativement reposer à plat sur le gel. Dans le cas où la bandelette adhère moins d'un côté, la migration dérive vers le côté opposé.

Une attention particulière doit être apportée au mode de coloration sous peine de mauvais résultats, en particulier pour les bandes supérieures qui peuvent être indiscernables les unes des autres. Il est préférable de tremper le gel dans un mélange de substrat et de colorant, plutôt que de le mettre dans un premier temps au contact du substrat (d'où fixation de l'enzyme sur son substrat), puis d'ajouter le colorant spécifique de la réaction.

La coloration est dans ce cas trop intense et les bandes se confondent.

* La congélation des extraits (surageant après centrifugation) est à éviter car après quelques jours (environ 5 jours) le zymogramme est très imprécis.

Le manque d'intérêt des peroxydases semble dû au type de gel utilisé. Les bandes étant concentrées dans la zone médiane du gel de gradient 8/25. L'utilisation d'un gel uniforme de porosité 12,5 % n'a pas amélioré.

Il est à noter qu'Hirano a obtenu de bons résultats en séparant les peroxydases par électrofocalisation en couche mince, technique d'électrophorèse qui consiste à séparer les enzymes d'après leur pH.

2.2.2) Limite à l'identification des variétés par électrophorèse :

Nous avons vu qu'à l'intérieur d'une même espèce, les différents cultivars et variétés ont chacun des zymogrammes différents. Cependant, il n'a pas été possible d'établir le zymogramme caractéristique de chaque cultivar ou variété à partir d'un seul type d'isoenzyme.

* Les zymogrammes des feuilles d'un même arbre varient avec la saison. Ainsi, il n'est plus possible de continuer les électrophorèses à partir du moment où les feuilles ont commencé à jaunir : les zymogrammes deviennent flous et très différents de ceux obtenus en plein été. Le contenu enzymatique des feuilles change avant même le jaunissement, ce qui explique les légères différences qui pourraient être observées pour des arbres identiques.

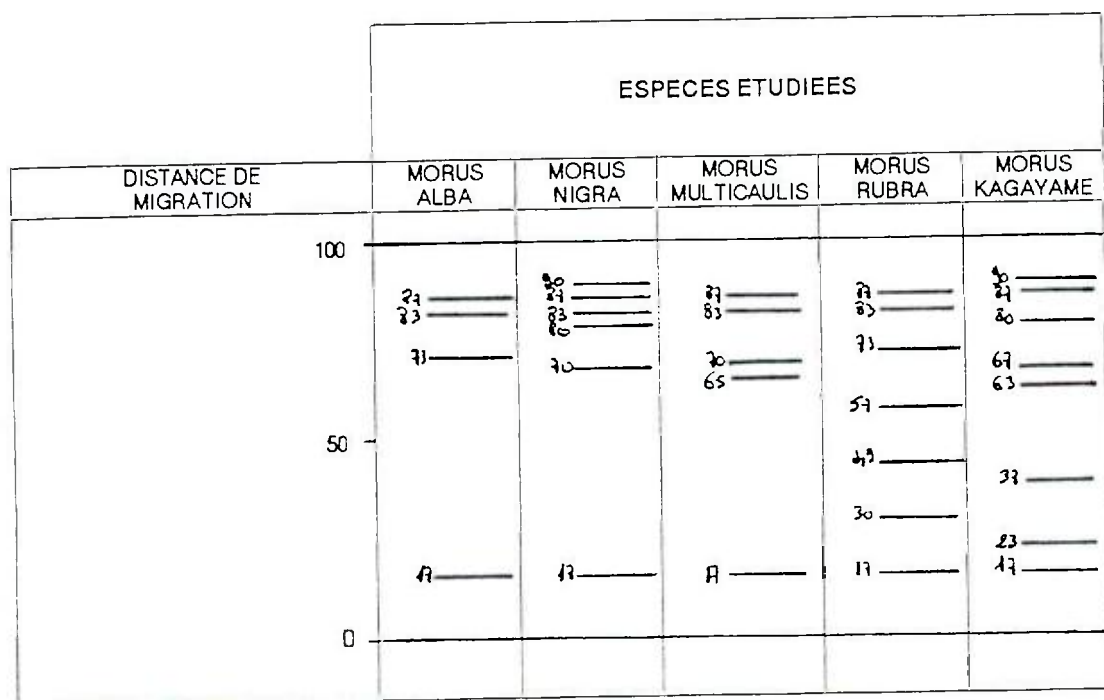


Fig. 1 : Schématisation des zymogrammes obtenus pour cinq espèces de mûriers sur les estérases.

Fig. 1 : Diagram of the zymogrammes obtained for five mulberry species on esterases.

* Des extraits provenant d'arbres différents appartenant au même clone présentent des zymogrammes identiques s'ils sont électrophorés lors de la même manipulation. Les différences s'observent donc d'un gel à l'autre et non à l'intérieur d'un même gel.

Si l'on considérait comme éliminés les variations causées par la congélation, la pose des bandelettes et la coloration, il semble que le même tampon d'extraction est sujet à variation et donc susceptible de modifier l'ensemble des zymogrammes d'un même gel. En effet, le tampon doit être préparé avant chaque manipulation car il ne se conserve pas. Il peut donc légèrement varier d'une manipulation à l'autre notamment sur les points suivants :

* L'homogénéité : Les produits qui composent le tampon sont peu miscibles entre eux et le mélange a tendance à être granuleux. Il a pu être remédié à cet inconvénient en dissolvant tous les composants dans de l'eau distillée sauf le PVP et la BSA, puis en versant le mélange liquide sur ces deux poudres, dans un bécher large pour faciliter l'agitation.

* La conservation : Le tampon étant préparé le matin avant la cueillette des feuilles et leur pesée, il reste en attente plus ou moins longtemps dans la chambre froide. En outre, si le mélange se fait mal, le tampon peut rester environ 1 heure sur l'agitateur magnétique à température ambiante, ce qui peut l'altérer.

3) CONCLUSION

sur la collection de Porquerolles qui servait de support à cette étude

Ces électrophorèses ont permis :

- d'une part d'établir une identité entre des arbres portant à tort des noms différents. Ces arbres s'étaient révélés identiques à l'analyse multicritère de l'observation de caractères macroscopiques, l'électrophorèse a apporté une preuve complémentaire de leur identité.

- d'autre part, de confirmer le nom d'espèce pour des cultivars où elle était inconnue :

- * *Morus* "Thonsend" a pu être rattaché à un *Morus rubra* L. (cv "Towsend").

- * *Morus* "Far Bibay" doit être rapporté à un *Morus rubra* L. (cv. "Far Bibay").

- enfin, de faciliter l'identification des arbres inconnus.

L'électrophorèse des protéines est désormais largement utilisée dans le cadre des programmes de recherches en génétiques et en amélioration des plantes. Au vu des services qu'elle peut rendre, elle est sans aucun doute destinée à devenir un des moyens d'investigation essentiel des conservatoires et des organismes qui constituent des collections variétales.

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QUESTIONS

M. Chavancy :

"Merci pour cet exposé et ce travail, car il règne une très grande confusion dans la classification et la systématique des mûriers. Il est déjà difficile de différencier les espèces et, bien sûr, encore plus les variétés dans les espèces.

Les techniques d'électrophorèse utilisées sont les seules, alliées sans doute à des techniques d'identification d'ADN, qui pourront permettre d'établir une classification à peu près sûre des différentes espèces et variétés.

Mais il reste une question sur la valeur ou la sécurité des résultats. Vous avez dit qu'il était très difficile, à partir d'électrophorégrammes semblables à un étalon, de dire que l'arbre étudié faisait partie de la même espèce. Les étalons ont-ils été établis, pour une espèce donnée, à partir de plants provenant de différents endroits, ou est-ce que, par malheur, les plants étudiés proviendraient de la même multiplication végétative d'origine ?"

'Thank you for this review and this work, as confusion often prevails over the classification and systematics of mulberries. As it is, differentiating species is difficult so distinguishing the varieties inside the species is of course even more difficult.'

The electrophoresis techniques used are the only ones, probably combined to DNA identification techniques, which will allow a nearly reliable classification of the various species and varieties.

However, a question remains as to the value or the reliability of these results. You said that it was very difficult, using standard-like electrophoregrammes, to say whether the tree studied belonged to the same species. For a given species were the standards drawn up after plants originating from various places or did the plants studied come from the same original vegetative propagation ?'

Mme de Rafelis :

"Les électrophorèses ont été faites uniquement à partir des arbres qui se trouvaient à Porquerolles mais, pour chaque espèce ou variété, il existait plusieurs arbres, au moins cinq de chaque variété.

On a donc fait l'étude sur un nombre assez conséquent d'arbres de la même espèce provenant de la même parcelle, mais n'ayant pas la même origine génétique. La collection de Porquerolles vient de plusieurs collections françaises et de Padoue en Italie et on a au moins cinq origines différentes dans cette collection.

Donc, les cinq plants étudiés n'ont pas la même origine."

'Electrophoreses were carried out only from trees which were in Porquerolles but for each species or variety there were several trees, at least five for each variety.'

The study was therefore done on a rather substantial number of trees of the same species issued from the same plot, but which did not have the same genetic origin. Porquerolles collection originates from several French collections as well as from Padua (Italy) and there are at least five different origins in this collection.

So the five plants studied do not have the same origin.'

M. Mauchamp :

"Avez-vous constaté des différences au niveau des zymogrammes en fonction du stade phénologique de la plante ?"

'Did you notice differences in the zymogrammes according to the phenological stage of the plant ?'

Mme de Rafelis :

"On a observé des différences à l'approche de l'automne, mais très peu de différences en fonction de l'âge des feuilles cueillies au même moment sur le même arbre. A l'approche du jaunissement des feuilles (septembre), le contenu enzymatique commence à varier, les zymogrammes ne sont plus interprétables."

'We observed differences at the approach of autumn, but there were very few differences according to the age of the leaves collected at the same time on the same tree. When the leaves are about to turn yellow (in September), the enzymatic content starts to vary, the zymogrammes are no longer interpretable.'

M. de Micheaux :

"Pouvez-vous nous éclairer sur l'importance et la durée du programme des travaux entrepris ?"

'Could you give us details on the importance and the duration of the work undertaken'.

Mme de Rafelis :

"Au niveau de l'étude pigmentaire, ce programme n'est pas lié au Conservatoire botanique de Porquerolles. Il nous a été demandé par les Industriels des Colorants et Arômes alimentaires de Grasse. Il sera poursuivi par eux, en comparaison avec le sureau, par exemple.

En ce qui concerne l'étude botanique et les électrophorèses, elle est pour l'instant terminée, puisque je ne travaille plus au Conservatoire botanique. Il faudrait la reprendre et la poursuivre. Elle a été faite dans le cadre d'un stage de huit mois de fin d'études d'ingénieur, ce qui explique sa durée limitée."

'As regards the pigment study, this programme was not initiated by the Conservatoire botanique de Porquerolles. It was ordered by the Food Colouring and Flavouring Industrialists of Grasse. They will continue it using the elder-tree as a control.'

The botanic study and electrophoreses are suspended for the time being, since I no longer work at the Botanic Conservatory. It will have to be taken up again and continued. It was achieved within the context of an eight-month training completing an engineer's course, which explains its short duration.'

M. de Micheaux :

"Les résultats en matière tinctoriale seront-ils communiqués ou publiés ou resteront-ils dans le domaine privé ?"

'Will the results concerning dye be circulated or published or will they remain in private ownership ?'

Mme de Rafelis :

"Les premières études ayant un caractère d'étude générale, on peut diffuser les résultats du rapport établi. Par contre, les étapes ultérieures seront confidentielles."

'As the first studies are of a general nature, the results of the report can be circulated. However, the subsequent stages will be confidential.'

M. Sengupta :

"Actuellement, nous établissons en Inde une collection de mûriers. Il est très difficile de choisir ce qu'il faut prendre ou non dans le stock. Aussi, si nous étudions par zymogrammes les différences entre les espèces ou les variétés différentes morphologiquement, ceci pourrait être d'un grand secours. Pouvons-nous avoir la communication de vos résultats ?"

'We are currently establishing a mulberry bank in India. It is very difficult to choose, from this stock, what must be kept or not. So if we study the differences between species or morphologically differing varieties, this could be very helpful. Could we have a copy of your results ?'

Mme de Rafelis :

"Je peux vous donner une copie du document global pour votre étude."

'I can give you a copy of the global document for your study.'

Mme Goldsmith :

"Connaissez-vous les enzymes qui sont impliquées dans la formation de pigments dans les fruits ? Elles pourraient être utilisées comme marqueurs génétiques puisqu'il existe des différences très marquées entre les variétés."

'Is anything known about the enzymes which are involved in the pigment formation ? They may be quite useful as genetic markers, since there are such differences between varieties.'

Mme de Rafelis :

"Oui, ce serait une autre façon de distinguer les espèces et variétés. Mais les pigments sont des anthocyanines, et ce sont des pigments très communs dans les fruits rouges. Je ne connais pas le système enzymatique qui les dirige, mais je suppose qu'il est bien connu."

'Yes, this could be another way of distinguishing species and varieties. But pigments are anthocyanins and these are very common in red fruit. I do not know the enzymatic system which governs them but I suppose it is well known.'

M. Mauchamp :

"Je regrette que ce travail ne soit pas poursuivi de la même façon. En effet, d'ici quelques années, on verra apparaître des mûriers transgéniques et il serait bon de savoir si les gènes introduits vont s'exprimer et si, éventuellement, ils provoquent des modifications à d'autres niveaux."

'It is unfortunate this work is not pursued in the same way. Within a few years, transgenic mulberry will appear and it would be relevant to know whether the genes introduced will be expressed and whether they may cause alterations at other levels.'

Mme de Rafelis précise que ce n'est ni du fait de sa mauvaise volonté ni de celle du Conservatoire si ce travail s'arrête :

"Le Conservatoire est tout à fait disposé à poursuivre cette étude d'autant plus qu'il dispose d'un matériel d'électrophorèse très moderne et performant et inutilisé qui permet de faire ce genre de travail de façon très rapide."

Mrs de Rafelis pointed out that this work being suspended was neither owing to lack of goodwill on her part nor on the Conservatory's :

'The Conservatory is quite willing to pursue this study, all the more so since it has a very modern and high-performance electrophoretic equipment which is unused and which enables this type work to be done very rapidly.'

SERICULTURE DEVELOPMENT IN INDONESIA

A. SUDRADJAT

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Indonesia is an agrarian country, which has abundant resources such as forest ($\pm$ 143 million hectares), agricultural land ($\pm$ 25 million hectares) and population (in 1986 $\pm$ 170 million). These resources can be wisely utilized for national development and to support sericultural potential development.

The sericulture activities in Indonesia had been initiated in 1960, and became successful in 1971. However there was a serious loss of production due to the pebrine disease in 1972, and thus sericulture in Indonesia was going down.

Some efforts to overcome these problems have been started in 1978 in cooperation with the Government of Japan (ATA-72 project). One of the efforts is to control pebrine diseases through the introduction of a bivoltine race. This has several advantages, such as high cocoon production, and also it is easy to control pest and disease comparing with polyvoltine. Since the National Development Plan has started the activities of sericulture have centralized in South Sulawesi. In fact, up to now 90 % of the sericultural activities in Indonesia were located in South Sulawesi, and only 10 % were located in other provinces.

To support the development of sericulture in the country, in 1984 the Sericultural Development Centre was established in South Sulawesi which has national scope, and in the near future some sub-centre will be established in other provinces based on each priority.

To increase the efficiency of sericulture activities, the Ministry of Forestry has refunctionalized, covering three functions :

1) The Directorate General Reforestation and Land Rehabilitation has function in field trial, extension and technical assistance, pest and disease control, eggs silkworms certification.

2) The Forestry Research and Development Agency has a function in research in all aspects of sericulture activities.

3) The Forestry Estate (Perum Perhutani) has functions in providing eggs, reeling facilities, and marketing of the sericulture products.

The management scheme would be developing in Indonesia based on 4 patterns : a) Farmers group pattern. b) Cooperative pattern c) Private or and State-enterprise pattern d) Nucleus Estate Small holder pattern.

The Sericulture Development policy up to the fifth National Development Plan based on the priority in South Sulawesi and other potential provinces to fulfil a production target of 2,000 tons of

raw silk. To realize the production target mentioned above, the Government has prepared an action programme covering short-term and long-term programmes.

I. INTRODUCTION

Indonesia is an agrarian country, characterized by a vast natural environment, comprising resources of forest land (143 million hectares approximately) and agricultural land (25 million hectares) in particular. It had a ± 170 million population in 1987. These are an important basis for establishing the Indonesian National Development Plan. The tropical climate is favourable for forestry and agriculture activities. In fact, the first priority of the Indonesian National Development is in agriculture and forestry sectors.

Indonesia has succeeded in self-supporting rice production, so besides maintaining its rice production, it has been doing in commodity diversification. One of the efforts in commodity diversification is through sericulture activities. Sericulture has been known for a long time by the farmers and it has become an important source of income for these people.

Sericulture activities proved to have a significant role for creating job opportunities in agriculture, forestry, industry, and trade, due to labour intensive, simplicity of techniques, highly economic value, and suitability for rural development. Therefore, the Government of Indonesia decided to increase activities in developing sericulture.

Sericulture activities began in 1960, started in Java by using polyvoltine (local) races. They have been developed by the farmers in South Sulawesi as well, the highest production of raw silk was reached in 1971 (± 140 tons). However, the production decreased due to the pebrine disease and to a severe drought season in 1972.

In 1978, the Government made an effort to solve these problems by establishing a technical cooperation with the Government of Japan (ATA-72 Sericulture Development Project). This project introduced a new bivoltine race which has been used throughout the country.

Nowadays the development of sericulture in the country has been concentrated in South Sulawesi (90 %) and the remaining (10 %) are distributed to other islands such as Java, Sumatra and Bali. Due to the increasing demand for raw silk in the country, the Government set up the highest priority in South Sulawesi as a region to develop sericulture, which can be expanded to the other provinces in Indonesia.

II. BRIEF HISTORY OF SERICULTURE DEVELOPMENT

1. The period prior to the first Five-Year Development Plan.

Sericulture has been introduced to the farmers in 1960, at the same time weaving factories and silk industry were established in Bandung (1961), and then in Yogyakarta (1966). To support these activities, some universities including Gajah Mada University have conducted research in this field.

In 1963, the Ministry of Veteran and Demobilization constructed a new silk reeling factory in order to create job opportunities for Veterans. Unfortunately, the factory broke down in 1968 due to the lack of cocoon (raw material). At that time, the Directorate General of Forestry also started sericulture activities in order to increase income for the farmers surrounding the forest.

In 1957, Mr Soedjarwo (the Minister of Forestry of the Republic of Indonesia) had an important role in developing sericulture in the country, especially in Yogyakarta, when he was in charge as the Chief of Regional Forestry of Yogyakarta Province. He stimulated the people surrounding the forest area to produce cocoons or raw silk during the season when the forestry activities were low.

Initially, he established a collaboration with Gajah Mada University and modified the curricula of Forestry Faculty by adding sericulture as a field of study. In 1962, sericulture was introduced in South Sulawesi Province (Soppeng District) through elementary school to train the community informal leaders. In 1966, the total area of mulberry plantation reached 1,500 ha; silk factories were concentrated in Sengkang (Wajo District).

2. The period during the Five-Year Development Plan.

In accordance with the Government policy, the development of sericulture, which centralized in South Sulawesi, has developed very well.

An evaluation in South Sulawesi revealed a positive response from the farmers. Hence, the Directorate General of Forestry performed some extension courses to raise the motivation of the farmers through the establishment of a Sericultural Development Project in 1970.

The highest production of raw silk, approximatively 140 tons, occurred in 1971. However, pebrine disease reduced raw silk production down to 25 ton in 1972. The Government gave some aids by establishing two units of silkworm egg production in Soppeng and Enrekang and four units of semi-automatic silk reeling in Soppeng, Wajo, Sidrap, and Enrekang, to encourage the farmers to raise production. The silk reeling machines have shown to improve the quality of cocoons in raw silk processing.

In order to increase the skill of the farmers and to increase production, a cooperation project between the Government of Indonesia and Japan (ATA-72) was implemented in South Sulawesi. This project, started in 1978, was terminated in February 1985, after a two-year extension.

The outcomes of the project are :

a) Transfer of sericultural technology by training 25 participants in Japan to become domestic sericulture experts.

b) Recommend three species of mulberry plant such as *Morus alba*, *Morus cathayana* and *Morus multicaulis* which are suitable for tropical environment. In addition, a new hybrid variety of mulberry BNK3 (Bili-bili, Nigra Kakusho) was successfully presented, a hybrid between local and Japanese varieties.

c) Provide a stock of fifteen parents to produce commercial silkworm hybrid seeds.

d) Some suitable techniques in controlling pest and diseases, particularly pebrine.

Because the demand is always increasing, as reflected by substantial amount of imported raw silk, the Government has been trying domestically to increase production. This is done by the application of sericulture development programmes, effective technology, provision of experts, parent stocks, and investment in other related aspects.

III. GOVERNMENT POLICIES AND PROGRAMME IN SERICULTURE DEVELOPMENT

1. Policy of development.

As mentioned, sericulture activities have developed in South Sulawesi Province since 1960, and it has become the main culture and economic activity of the people, especially in the rural area. In fact, sericulture has a social and economical role and creates job opportunities for the farmers.

Referring to its success, this particular province determined to become a centre of development in 1985. Other provinces which will be developed with respect to sericulture such as West Sumatra, Bengkulu, West Java, Yogyakarta, Central Java and East Java. The aim of this development is to increase income of rural people and to control environmental aspects.

2. Implementation.

a. Expansion of mulberry plantation :

Mulberry plantation serves as the main food supply for silkworms. In South Sulawesi the total area of mulberry plantation is only 2,650 ha scattered in several districts. To meet the production target of silk, this coverage must be expanded to other provinces. The source of fund in expanding mulberry plantation comes from the community, the local authority and the national authority.

b. Egg production :

The most important step in silkworm rearing is the production of good quality silkworm eggs, free from diseases and sufficient in quantity.

There are two egg production units located in Candirotto (Central Java) and in Soppeng, Enrekang (South Sulawesi).

The maximum capacity from these units is 35,000 boxes per annum. The Government is considering another egg production unit in West Sumatra. The location of those egg production units will be close to the farmers, thus the quality of the eggs can be maintained properly and will be distributed easily to the farmers.

c. Cocoon / raw silk production :

As mentioned before, during the first Five-Year Development Plan period sericulture in the country has developed very well since 1971. Unfortunately, the pebrine disease destroyed the production of raw silk. The remedies include :

- c.1. Using bivoltine eggs which have higher production and are resistant to pest and diseases.
- c.2. Provision of relevant information and technology in the rural areas.
- c.3. Stimulating a favourable environment for private sector investments.
- c.4. Coordinating the activities of the National Sericulture Development Board (NSDB) and of the Government Ministries related to the sericulture programme.

d. Marketing :

There is a trend of inclining need of raw silk which averages approximately ± 400 ton per annum, but the domestic production is only 90 ton per annum. The shortage has to be filled by imported goods.

To minimize raw silk import and to meet the self-supporting raw silk, it is needed to encourage farmers and private sectors to develop sericulture, to produce good quality of raw silk suitable for the market demand. PT Kermianiaga is appointed to be the sole supplier of imported raw silk.

3. Research.

Sericulture research has covered all aspect of sericulture activities, including mulberry cultivation and management, silk rearing, breeding of mulberry and silkworms, pest and disease control, silk reeling and spinning, and minimizing the socio-economic problems.

To reach the objective of the research activities some steps have been taken, such as :

1. Increasing the research activities
2. Providing research facilities, equipment, and other conveniences.
3. Enlarging the number of researchers.

4. Extension.

Sericultural extension has been performed by the Land Rehabilitation and Soil Conservation Centre, in coordination with the Sericulture Development Centre. The technical recommendations and sericulture technical packages for extension emanated from the Sericulture Development Centre, after successful field trials.

As we know that sericulture activities are an integrated form, composed of culture, moriculture, filature and marketing, hence it should be integrated with the Agencies and Ministries. Here, the extension should be done in coordination with others.

To ensure the successful extension of activities, some facilities are needed, such as demonstration units, training programme for the farmers, and competition to create motivation for them.

5. Management scheme.

It has been mentioned above that sericulture activities are integrated, covering mulberry cultivation, silkworm rearing, cocoon processing, and marketing of raw silk, so the management scheme could be described as follows :

a) Farmers group pattern :

One of the objectives of grouping the farmers, which is to develop and to transfer sericulture technology to the farmers, could be done easily and continuously and this group would be the smallest production unit of sericulture.

Each unit could make an effort in sericulture activities based on the condition and farmer's group needs.

Each group could implement such activities as mulberry cultivation, silkworm rearing, silk reeling, silk processing, weaving, marketing.

b) Cooperative pattern :

The farmers who have one or more sericulture activities will unite and become members of the Sericulture Cooperative.

The Cooperative will serve all the members' needs covering supporting material for production, and marketing, and also providing hardware, technical assistance and capital.

c) Private or state enterprise pattern :

The private/state enterprise which will take activities in the field of sericulture could have one or complete aspect. And it is suggested that the private/state enterprise should work together with the group of farmers, and it should not compete with the farmers' activities.

d) Nucleus Estate small holder pattern :

It consists of nucleus and plasma activities, the nucleus should be private or state enterprise and the farmers as a plasm.

In this pattern, the nucleus will help the farmers in processing products and marketing in order to maintain the price and good income to the farmers.

In general, farmers are weak in capital, so the nucleus could support capital and also give assistance for getting infrastructure and technology.

In this pattern, hopefully, both will get benefit, on the one hand farmers (plasm) will develop the activities and on the other hand the nucleus will get some economic benefit.

6. Organization.

a. Institution :

Up to now, the institution responsible for sericulture is the Directorate General of Reforestation and Land Rehabilitation, Ministry of Forestry.

The background of this institution responsible for sericulture activities for a long time when Forestry was under the Ministry of Agriculture, and at that time one of the Directorates General in the Ministry of Agriculture was the Directorate General of Forestry.

Since the First Five-Year Development Plan the Government in Agriculture decided to increase food production by self-support, especially for rice production so sericulture activities could not be done by the Directorate General of Food Crops. And then, sericulture activities fell under the Directorate General Forestry, in fact under its responsibility sericulture has developed successfully.

In 1983, there was a re-organization, where the Directorate General of Forestry become the Ministry of Forestry. Sericulture activities are still under the responsibility of Ministry of Forestry, eq. the Directorate General of Reforestation and Land Rehabilitation (RLR).

In connection with the organization development, the Directorate General of Reforestation and Land Rehabilitation has established 12 centres, among which the Land Rehabilitation and Soil Conservation Centre and the Sericulture Development Centre.

The Sericulture Development Centre is located in South Sulawesi which has national scope, and in the near future other sub centres will be established in other provinces.

Further development of sericulture in order to increase sericulture activities within the Ministry of Forestry has been strengthened of each function as follows :

a.1. Directorate General Reforestation and Land Rehabilitation : field trial and formulation of a technical package of practices, certification of silkworm eggs production, extension and transfer of technology, pest and disease control.

a.2. Forestry Research and Development Agency : research on moriculture, sericulture, silkworm breeding and selection, and socio-economic aspects.

a.3. Forestry State Enterprise (Perum Perhutani) : silkworm eggs production and its distribution, silk reeling and its marketing, supporting equipment and material for production.

b. Coordination :

Technical guidance and development of sericulture in the country have various aspects and complexity, so it is very difficult to manage by the Ministry of Forestry only. Within the Ministry of Forestry each function professionally has been strengthened.

For having integrated sericulture activities in other provinces, the Sericultural Development Board has been established at the national level through a letter of decision of the Ministry of Forestry no. 146/Kpts-V/1986 dated May 1986, stating that it will be followed by regional level with each priority, members of this Board are representatives of each Ministry concerned.

For day to day activities such as technical guidance and work plan of sericulture this Board has a Secretariat.

7. Sericulture Development Programme.

The Secretariat of the National Sericultural Development Board has prepared the Sericultural Development Programme as follows :

a) Fifth five-year development plan :

This programme contains a sericulture development plan during the five-year development plan (1988/1989 - 1993-1994). This programme will increase raw silk production up to 2,000 tons for this five-year period. The development priority beside strengthening technical guidance and increasing the ongoing activities also tries to develop new potential areas.

b) Long-term programme :

This programme contains a sericulture development plan for the sixth five-year development plan period and the following years. The programme will stabilize raw silk production during these periods, with special attention to export quality. The development priority will continue the area development during the fifth five-year development activities and try to develop other new potential areas.

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QUESTIONS

Mrs Goldsmith :

'Is there any work going on at the university level in sericulture ?'

"Y a-t-il des travaux concernant la sériciculture dans les universités ?"

Mr Sudradjat :

'There used to be some research at Gajah Mada University. But I have not heard of any work regarding sericulture in the other universities.'

"Il y en a eu par le passé à l'Université de Gajah Mada. Mais pour les autres universités, je n'ai entendu parlé d'aucun travail concernant la sériciculture."

Mrs Goldsmith :

'Sericultural research is done now only at those major stations you reported, Sulawesi, Java... Are your projects based on a definite programme or are they just general guidelines ?'

"La recherche séricicole se fait donc seulement dans les stations dont vous avez parlé : Sulawesi, Java... Vos projets sont-ils supportés par des recherches définies ou s'agit-il seulement d'idées à mettre en oeuvre ?"

Mr Sudradjat :

'We intend to extend mulberry plantation to 15 provinces. But our first priority is to extend this cultivation first to southern Sulawesi, then Sumatra and lastly eastern and western Java. The other provinces will follow. It is quite important to give these provinces an opportunity to develop their sericultural activity. This is our priority.'

"Nous voulons étendre les cultures de mûriers dans 15 provinces. Mais nous prévoyons en priorité d'étendre cette culture en premier lieu au sud du Sulawesi, ensuite à Sumatra et enfin à l'ouest et l'est de Java. Les autres provinces suivront. C'est très important d'offrir à ces provinces une possibilité de développer leur activité séricicole. C'est-là une priorité."

Mr de Micheaux :

'You said that during the '70s, the pebrine disease caused serious damage to silkworm rearings. Did you manage to control this pathology ? I gathered you did insofar as the five-year plan which is to end in 1993 plans a production of 2,000 tonnes of raw silk, that is to say about 10,000 tonnes of cocoons.'

"Vous avez dit que, au cours des années 1970, la pébrine avait fait de graves dégâts dans les élevages de vers à soie. Etes-vous parvenu à maîtriser cette pathologie ? J'ai cru comprendre que oui dans la mesure où le plan quinquennal qui se terminera en 1993 prévoit une production de 2 000 tonnes de soie grège, soit environ 10 000 tonnes de cocons."

Mr Sudradjat :

'Thank you for this good question. Until my country set up a cooperation with the Japanese Government, the pebrine disease was controlled by the sericultural station of Bilibili, in southern Sulawesi. Maybe Mr Guigou will be able to explain the problem of the pebrine disease, as he visited this station two years ago. I think that at present there is no problem with the pebrine disease.'

"Merci de cette bonne question. Jusqu'à ce que mon pays entame une coopération avec le Gouvernement japonais, la maladie de la pébrine a été contrôlée par le centre de sériciculture de Bilibili, dans le sud du Sulawesi. Peut-être M. Guigou pourra-t-il expliquer le problème de la pébrine car il y fit un voyage il y a deux ans. Je pense que, pour le moment, il n'y a pas de problème avec la pébrine."

Mr Guigou :

'I indeed visited the station of Bilibili two years ago. It was the most marvellous station I had ever seen in all my assignments. The staff there is perfectly equipped and competent to control the pebrine. But popularization has to follow up and when I went to Indonesia two years ago there were follow-up and popularization problems. I hope that by now this has been improved.'

"J'ai effectivement visité, il y a deux ans, le centre de Bilibili. C'était le centre le plus merveilleux que j'ai jamais vu dans aucun de mes voyages. Ils sont là parfaitement équipés et compétents pour éliminer la pébrine. Mais il faut aussi que la vulgarisation suive et, lorsque je suis allé en Indonésie il y a deux ans, il y avait des problèmes de suite et de vulgarisation. Maintenant j'espère que cela s'est amélioré."

Mr Sudradjat :

'I quite agree with you on the need to improve the extension of these activities in order to improve production through the implementation of pebrine control. This is included in my Government's projects.'

"Je suis d'accord avec vous sur la nécessité d'améliorer l'extension de ces activités afin d'améliorer la production par la mise en oeuvre de la lutte contre la pébrine. Cela fait partie des projets de mon Gouvernement."

Mr Mauchamp :

'This was the last review of the session. I wish to thank all the contributors for the content of their reports and for the importance of the results they have reported.

Thank you also to all the other participants for their intellectual contribution during these three days.'

"Ceci était la dernière communication de la session. Je tiens à remercier tous les conférenciers pour les contenus de leurs communications et l'importance des résultats qu'ils nous ont transmis.

Merci aussi à tous les autres participants qui ont apporté leurs connaissances pendant toutes ces journées."

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IMPACT OF ADOPTION OF PACKAGE OF PRACTICES IN SERICULTURE FOR HIGH PRODUCTIVITY IN JAMMU AND KASHMIR STATE

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The temperature climate of Jammu and Kashmir is quite suitable for univoltine/bivoltine rearing. In spite of this sericulture could not flourish here as in other parts of the country. Raw silk production has fallen from 98 tonnes (in 1961) to 33 tonnes (in 1987). Low yielding silkworm breeds and crude traditional rearing techniques have been identified as two of the main reasons responsible for this decline. Rearers in the vicinity of the sericulture campus of the university were adopted. The improved rearing technology and its impact on cocoon crop was demonstrated to them. They were persuaded to adopt package of practices in sericulture. F1 chawki worms of newly evolved bivoltine silkworms lines (known as Skuast lines) reared under village conditions were distributed among the farmers. The scientists provided technical know-how to rearers by door to door visit throughout the rearing till harvesting of cocoons. An average cocoon crop of 68.95 kg was obtained in the last 5 years from the high yielding breeds through adoption of package of practices as against 25-26 kg of cocoons being obtained from one ounce of seed on average in the state. The data of the last 5 years obtained at field level are given in the paper.

The Jammu and Kashmir State, because of its temperate climate, is quite suitable for rearing univoltine/bivoltine silkworms breeds to produce high quality silk. In spite of this, sericulture did not flourish here as in other parts of the country. The average cocoon yield of 25-26 kg obtained from one ounce of seed is hopelessly low.

Many farmers have given up sericulture as they do not find this as a remunerative profession. The quantity of seeds distributed to silkworm rearers has reduced from 55,000 ounces (1947-48) to around 33,000 ounces at present. With the result there has been a fall in production of raw silk from 98 tonnes in 1961 (Khan, 1988) to 33 tonnes in 1987 (Anonymous, 1989) whereas in the whole of the country during the same period there was more than a 4 time increase in raw silk production from 2,046 tonnes in 1971 (Krishnaswamy, 1988) to 8,455 tonnes in 1987-88 (Anonymous, 1989). In the total production of mulberry silk, the share of bivoltine silk is less than 3 % and Jammu and Kashmir State contributes only 0.39 %.

Realising the fact that the bivoltine silk alone has potential to compete in the world market, serious attention was given in the past two decades in India to popularise rearing of bivoltine silkworms to increase their silk production in order to earn foreign exchange. The Jammu and Kashmir State being already familiar with univoltine/bivoltine rearing, initiated some priority programmes for upliftment of industry in the State. Under these programmes a need was felt by the Government to have a sound research base which could provide R & D support to sericulture. Thus Sericulture Research Centre (redesignated as Division of Sericulture in University) was established. After thorough survey in the State, it was observed by the scientists that the farmers rear the low yielding F1 or P1 silkworms of local races through traditional methods.

Some rear worms on floors in a part of their dwelling houses or at the roof top of the houses which are open on sides or in cattle sheds which are often damp and without provisions for proper

ventilation. Others have rearing rooms without doors and windows. Such types of accommodation do not get disinfected effectively. The rearers are neither fully conversant nor serious about the types of leaves and hygrothermic conditions suitable for different stages. Proper attention is not given to the cleaning of unconsumed leaves and excreta, which often leads to disease outbreak. Due to inadequate supply of leaves, the worms suffer from starvation. Soiled semi-dry and long-stored leaves are fed to the worms untimely.

The silkworms are reared in high population density. This does not allow a uniform growth due to underfeeding of most of the worms. Unripe worms are forced to go for spinning of cocoons. The cocoons thus produced are of inferior quality and low grade. With the result that even under the most congenial natural climate, a low productivity of 25-26 kg of cocoons per ounce of seed is obtained. To sum up, the following factors were identified to be mainly responsible for low cocoon production and productivity :

1. Lack of productive breeds for commercial exploitation.
2. Non-availability of adequate mulberry leaves proportional to the size of rearing.
3. Rearing of silkworms through traditional methods in unsuitable/unhygienic accommodation.

The sericulture scientists conducted field oriented research in different disciplines. High yielding bivoltine strains were evolved. Rearing techniques were evaluated to identify the ones suited to our conditions. The preventive/curative measures were worked out to check the menace of diseases. Suitable technology has been developed to propagate mulberry through cuttings and also increase leaf yield per unit area in the temperate climate. During the last 5 years, the University adopted silkworm rearers in the vicinity of sericulture campus under the lab to land programme initiated by Indian Council of Agricultural Research.

Table I. Quantity of worms distributed among adopted rearers and the cocoon crop obtained in different years

Tableau I. Quantité de vers distribués aux éleveurs pilotes et récolte obtenue au cours des différentes années.

Year <i>Année</i>	No. of rearers adopted <i>Nb. d'éleveurs pilotes</i>	Quantity of worms distributed (DFLs) <i>Quantité de vers distribués (DFLs)</i>	Total crop obtained (kg) <i>Récolte totale obtenue (kg)</i>	Average crop per 100 DFLs (kg) <i>Récolte moyenne pour 100 DFLs (kg)</i>
1986	19	1950	1668.000	85.538
1987	23 (Kashmir) 43 (Jammu)	2550 2300	1151.000 1124.600	45.137 48.895
1988	25	2100	1607.000	76.523
1989	25	1700	1398.000	82.235
1990	15	1075	815.400	75.351
Total	150	11675	7764.000	68.946

Note : Low yield in the year 1987 because of the bad weather during rearing. / *Le rendement faible de 1987 est dû au mauvais temps au cours de l'élevage.*

The rearers were invited to visit Division of Sericulture for about a week and were introduced to the various aspects of improved rearing technology and results thereof. They were persuaded to adopt package of practices for high cocoon productivity and production. In a few seasons each rearer was provided sericulture inputs costing Rs. 500/-. The rearing space was disinfected 3-4 days before the rearing started. Incubation and chawki rearing was done in the village itself for two reasons. Firstly

to raise the healthy stock of worms under the farmer's conditions and secondly to demonstrate to the rearers that in their conditions optimum environment can be manipulated for incubation and young age rearing. The F1 chawki worms of high yielding Skuast silkworm lines evolved in the SK University of Agricultural Sciences and Technology were supplied to the rearers free of cost (Trag *et al.*, 1990).

The sericulture scientists of the division visited daily or on alternate days to provide technical know-how to farmers by door-to-door visit throughout the rearing season till harvesting of cocoons. The farmers were advised to adopt shelf rearing in place of floor rearings. They were educated about the importance of ventilation and how to provide it in their rearing rooms and about the dangers of high humidity during the last two instars. They were shown practically the right schedule of spacing, frequency of cleaning, feeding and types of leaves suitable for the last 3 instars and the way of maintaining hygrothermic conditions. They were impressed to follow the proper procedure and time for leaf harvesting and not to pluck excess leaves which become semi-dry and unsuitable for rearing due to long storage. As regards outbreak of diseases, they were demonstrated how to take preventive and curative measures. They were impressed to mount ripe worms only in the spinning materials like linseed hay and mustard hay being locally available with them. Besides Kisan Mela and Kisan Goshti were organised at the Division of Sericulture during rearing. The mela was attended by a large number of rearers and field officers of Sericulture Development Department. There was free exchange of information between scientists of the university, rearers and field staff of the department. The rearers acquainted the scientists with various problems they face during rearing and the scientists suggested solutions to the technical problems on spot.

The number of rearers adopted in each year, quantity of worms distributed and cocoon crop obtained is given in Table I.

On average 68.946 kgs of cocoons were obtained from 100 DFL's of Skuast silkworm lines in the 6 trials during last 5 years as against 25-26 kgs/ounce of seed. It was encouraging to notice that the rearers are convinced now about the benefits of packages of practices in sericulture. The high productivity and production is attributed to :

1. High quality of F1 worms from newly evolved genotypes.
2. Improved know-how provided timely to the rearers.
3. Maintenance of optimum hygrothermic conditions during rearing.
4. Hygienic conditions in rearing rooms.
5. Preventive measures against diseases.

The high yields obtained in different years have shown the tremendous potential of bivoltine rearing under temperate climate.

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SERICULTURE IN CHINA

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I. DEVELOPMENT OF SERICULTURE

1. Sericulture in China has a history of nearly 5,000 years. As early as 200 B.C. China was called the "Silk Country". It has long been the largest silk producer and silk exporter in the world. However, due to the influence of intermittent wars during the Second World War, sericulture in China suffered quite a lot of disasters. At the end of 1949, cocoon production for the whole country was only 31,000 tons, which was less than 1/7 of 228,000 tons, the record-high production in Chinese history. Since the establishment of the People's Republic of China, a lot of policies and technical measures concerned were adopted by the government to assist greatly the development of sericulture, which was quickly recovered. Up to the mid-1960s, there was a zigzag route for development over a decade of years. Up to 1965, the total cocoon production was 66,000 tons, i. e. 1.14 times increase as compared to that of 1949. In the same year, the sericulture situation in the world was greatly changing. Japan, a major silk producing country, had an abrupt decline in silk production, while in China, although there was some decrease in amount in some individual years, in general, the total amount was going up continuously. In 1970s, the development was rather fast. In 1970, the output of cocoons reached 122,000 tons, an increase by 84.85 % as compared to that of 1965, cocoon yield ranked first in the world. In 1980, cocoon yield was 250,000 tons, nearly more than double the amount of 1970. Within the past decade, the average yearly increase was 10.49 %. After 1980, the increase in production was maintained at a higher velocity. In 1989, the cocoon output was 434,800 tons, 73.92 % higher than that of 1980, i.e. the average yearly increase rate was 8.2 % within 9 years. The increase rates in the different periods of time mentioned above were much higher than that of the world total cocoon output. The proportion of silk-production in China is continuously increasing among the total world's production. The silk production in 1989 was 42,700 tons, it has now accounted for about 60 % all over the world.

2. Sericulture now spreads all over China. With the exception of Qinghai Province and Tibet Autonomous Region, all the provinces and cities have silk-production, but most of them are situated in temperate zone, in Yangtze River Valley in particular. Especially in Sichuan, Zhejiang and Jiangsu provinces, their total output accounts for over 80 % of the gross amount all over the country.

Another type of sericulture region in China is in the Pearl River Valley, including the Guangdong province and Guangxi Autonomous Region. These regions belong to tropical and subtropical regions. The silkworm and mulberry races, the silkworm rearing and mulberry planting techniques over there all have their indigenous characteristics. The climate conditions and techniques are comparatively similar to most of the region in South-east Asia.

3. In recent years, there have been about 17,000, 000 farmers undertaking silkworm rearing as their occupation or side-line occupation. As to the organizations in sericulture, there are grand-parent egg production farms, parent egg production farms, F1 egg production farms, cocoon purchasing and drying stations etc. set up in every province concerned.

As regards silk industry in China, there are about 857 factories and enterprises, with about 730,000 workers and staff, 1,900,000 ends of reeling machines, and 170,000 sets of silk weaving machines. Production has been mechanized and the potential for further development is rather great.

II. PROFILE OF THE UNITS OF EDUCATION AND RESEARCH ON SERICULTURE.

In order to promote the development of sericulture, the Chinese Government lays stress on the cultivation of technical personnel and plays an active role in furthering science and research in this field.

1. Education :

All over the country, there are nine agricultural institutes and universities opening sericulture discipline, besides, there are 2 silk textile engineering institutes. In these institutes of high education, doctor's degree, master's and bachelor's degree are conferred. In recent years, about 400 graduates and post graduates got their degrees in sericulture every year. Research departments are also set up in the respective institutes and universities mentioned above. Education combined with scientific research is widely practised.

For the training of mid-level professional personnel, there are now 11 secondary technical schools of sericulture, in which hundreds of students graduate yearly. The number of professionals trained in the above institutes of high education and secondary schools can meet the needs of technical personnel of different levels in the development of sericulture in China.

2. Research institutes :

Besides the National Sericulture Research Institute, which is under the Chinese Academy of Agricultural Sciences, there are also 20 provincial sericulture research institutes in various provinces such as Zhejiang, Sichuan, Guangdong, Anhui, Shandong etc. In all these research institutes, research topics including applied ones and basic ones are both arranged to solve some problems in production. And these research work play an active role in promoting sericultural development.

III. IMPROVEMENT IN SERICULTURAL TECHNIQUES IN PRODUCTION

Silk-production in China has made great progress in the above mentioned period, in addition to such measures as setting up good policies and arrangement of prices of silk and cocoon to stimulate the activities of the producers, there are also some other reasons, such as the developing of education and scientific research work. In the past years, there has been a great improvement in techniques in production, which includes in the following aspects :

1. Sericultural production

1) Breeding and popularizing quality race. During the early days of establishment of the People's Republic of China, the project of state-controlled grand-parent eggs was first set up. Silkworm eggs were dispatched in unification by the State. All the national and provincial sericulture research institutes took the breeding and popularizing of quality silkworm races as their research topics. New races which were adaptable to be reared in different localities had been bred from time to time. Some polyhybrid races were utilised and popularized, and silkworm races were changed continuously year after year, in order to enhance the silk qualities and the raw silk percentage of cocoons. According to the statistic data by the Ministry of Textile Industry of China, the cocoon output of the country in 1980 was 2.05 times that of 1970, while the raw silk increased to 1.257 times for the same period. The extent for the increase in raw silk was larger than that of cocoon, it means that the breeding and popularizing of good quality silkworm races give rise to higher raw silk percentage of cocoon gradually. In mulberry side, the techniques of hybridization were also used, and some quality breeds were bred and popularized.

2) To popularize the technique of adequate close planting of mulberry and planting of 'four-side mulberry'. In the past, in the major sericulture regions like Zhejiang, Jiangsu, mulberry trees were trained to middle-stem type, 7,500-9,000 plants/ha were planted, and leaf-yield was about 6 to 8 tons/ha. Since the 1970's, 'trunkless mulberry and adequate close planting' has been popularized in many places, about 22,000 to 27,000 plants were planted per hectare. At the same time, by the improvement of manuring and culturing measures reasonable harvesting and pruning, leaf-yield was greatly increased and the increased amount was nearly double. Different localities make use of the scattered lands to plant mulberry, such as the four-side planting-mulberry' (road side, mountain-side, field embankments, river bank). Just for Sichuan alone, the scattered mulberries reached the number 1.6 billions. Since then silk cocoon output of the province has had an abrupt rise, and has become the first place in the whole country.

3) Improvement of silkworm rearing techniques Silkworm cocoon yield is closely related to climatic conditions, mulberry leaf qualities, silkworm rearing techniques, etc. Rearing techniques, in particular, must be delicate, especially during the young larval period. There is a saying 'well fed young silkworm larvae equals to having harvested half of the cocoon crops'. For this reason, co-operative rearing of young silkworms is undertaken in the major sericulture regions in China, specialized teams are formed, co-operative rearing rooms are established. In this way, the survival rate of larvae is greatly increased, and the larvae become stronger. At the same time, various rearing techniques are mostly popularized, such as : plastic membrane cover rearing, hot bed rearing, shallow-ditch rearing and floor-rearing, 'scarce' rearing, application of insect hormone analogue, etc. In this way, silk cocoon harvest has been enhanced a great deal.

4) To strengthen the prevention and control of silkworm and mulberry diseases and insect pests. For the past decades of years, composite technical measures, such as 'Prevention of diseases by sterilization', have been undertaken, a meticulous sanitary system has thus been set up. At the same time, the research on the important diseases and insect pests of silkworm and mulberry is focused on, and great achievement has been obtained and some chemicals used to prevent and control various silkworm diseases have been investigated, and sorted out, thus the rate of attack to the silkworms by diseases and insect pests is greatly reduced.

2. Silk industry

1) Modernization of machines and improvement of printing and dyeing of silk fabrics.

Since the 1970s, raw silk reeling has been basically mechanized, automatic and semi-automatic reeling machines have been widely used. The sophisticated shuttleless loom is also used in some of the weaving factories. The Chinese newly-invented printing, dyeing and calendering machines of new model etc. are used to replace the out-of-date machinery, these new equipments thus enhance the techniques of printing and dyeing, and also improve the colour, fastness and lustre of the silk fabrics. The research on the shrinkage and crease reduction of the fabrics is also breaking through. Some new products are starting to hit the market.

2) New pattern designs and new product varieties of silk fabrics.

According to the needs of the marketing, some new pattern designs of the new product varieties of silk fabrics have been made, and some new fashionable garments made of these fascinating silk fabrics are also designed by some professionals. At the same time, some blend fabrics, such as raw silk with wool, or with linen, or with cotton, or some pure silk knit-wear and silk upholsteries are also manufactured. In 1989 China turned out 1.7 billion meters of pure silk fabrics, 0.3 billion meters of blend fabrics and 0.3 billion meters of synthetic blend fabrics.

IV. STRENGTHENING OF INTERNATIONAL CO-OPERATION

1. 'Silk makes friendship', this is one of the sayings in ancient China. As early as 2 B.C., the famous 'Silk Road' promoted the exchanges in economy, trades, sciences and technology between China and different countries in the world. Hence, silk technology was also spread through many

countries in the world. Today, various sericultural countries in the world have their own developing history and experiences. Sericultural science and technology have made great progress already, so it is quite important to strengthen international technical co-operation today. The various countries concerned can see their strong points as well as their weak points, and learn from each other, and make progress all together.

2. Since the opening policy of China in 1979, there has been a continuous progress of the sericultural technical co-operation between China and different countries. Decades of students and scholars have been to Japan to study and do some research work with their counterparts ; experts and professors have been sent to Japan, India, D.P.R.K., Bangladesh, Nepal, Pakistan, Sri Lanka, The Philippines, Thailand, etc. to have study tours, and to exchange information, personnel have also been sent to Turkey, Madagascar, Sri Lanka, Pakistan, the Philippines to undertake the counsellors' services. Experts are also sent to participate in the International Sericulture Congress for several occasions.

3. In order to promote the development of silk producing industry of sericultural developing countries in Asia/Pacific Region, a Regional Sericulture Training Center was co-sponsored in South China Agricultural University by the Chinese Government, UNDP, UNFAO. Since the opening of the first session, 119 trainees coming from 18 countries respectively have been trained. They come not only from the Asian and Pacific Region, but also from the Middle-East, Africa and Latin America. They take the experience of sericulture in China as reference, and also exchange their own experiences with each other. After returning to their various countries, they have played an active role in production, education, research work in this field.

4. Basing upon the facts mentioned above, we acknowledge, we should from now on, strengthen the international co-operation, set up the regional sericulture network between the countries concerned, and make connection at interval ; relevant information should be exchanged with each other ; international training should be carried on ; resources of silkworm and mulberry should be exchanged with each other ; co-operative research should be conducted ; scale of international trade among various countries should be enlarged, in this way, various sericultural countries will get benefit from each other. Hence, the world sericulture will be further developed, the friendship and co-operation between the people, and the scientists among the various countries concerned will be strengthened. I would like to make every endeavour together with ISC to take the great task in the future.

DEFENSE REACTIONS OF THE SILKWORM, *BOMBYX MORI* AGAINST THE NUCLEAR POLYHEDROSIS

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In the silkworm, *Bombyx mori*, fungus diseases can be controlled effectively by surface disinfection of the insect body with formaldehyde. In some experimental bacterial infections, the therapeutic effect of antibiotics and the experimental defense reaction by antigenic stimulation have been observed. However, in the virus diseases in insects, the therapeutic effect is not easily recognized and the occurrence of defense reactions, particularly by antigenic stimulation, is difficult to be demonstrated. This difficulty has caused only a limited study or neglect in the defense reactions in virus infections in insects.

The analyses of the mechanisms of the defense reactions in insects are fundamentally required not only for the control of the diseases in beneficial insects such as the silkworm and the honeybee, *Apis mellifera* but also for the microbial control of insect pests.

The defense reactions in the silkworm and wild insects against the virus diseases cover the following phenomena.

- 1) Resistance of the silkworm strains to the virus diseases (Aizawa, 1970 ; Furuta, 1974 ; Watanabe and Maeda, 1981 ; Eguchi *et al.*, 1986).
- 2) Antiviral substances in the silkworm gut juice (Aizawa, 1962 ; Hayashiya *et al.*, 1968).
- 3) Chemical therapy (Aizawa, 1970).
- 4) Immunologic-like defense reactions (defense reactions caused by antigenic stimulation and serum therapy) (Aizawa, 1970).
- 5) Viral inhibitory factor (VIF) which is produced in the silkworm hemolymph by virus infection (Aizawa, 1970).
- 6) Suppression of the multiplication of viruses at higher temperature (Tanada, 1967 ; Inoue and Tanada, 1977).
- 7) Cure of the cytoplasmic polyhedrosis in wild insects by feeding of silkworm cytoplasmic polyhedra (Noguchi and Yamaguchi, 1979, 1982).

This paper describes our recent investigations on the defense reactions in the silkworm against the nuclear polyhedrosis.

1. VIRAL INHIBITORY FACTORS (VIF) PRODUCED IN THE SILKWORM HEMOLYMPH INFECTED WITH A NUCLEAR POLYHEDROSIS VIRUS

When silkworm pupae were immunized with a vaccine prepared from hemolymph infected with a nuclear polyhedrosis virus of the silkworm (BmNPV), the effectiveness of vaccination was recognized in some cases although it was weak. However, the immunized hemolymph did not neutralize the virus (nonoccluded BmNPV in infected hemolymph) and the increase of agglutinin titer against polyhedra was not demonstrated. On the contrary, the serum therapy by antinonoccluded BmNPV rabbit serum was successful (Aizawa, 1970). During the attempts to find an interferon-like substance from the silkworm hemolymph infected with BmNPV, a viral inhibitory factor (VIF) was found (Aizawa, 1970).

Although VIF inactivated nonoccluded BmNPV strongly at 27°C *in vitro*, preventive and therapeutic effects by the injection of VIF into silkworm pupae were not shown. Silkworm larval hemolymph and phospholipids (phosphatidylcholine and phosphatidylserine) showed inhibitory effect on the antiviral activity of VIF. VIF was resistant against the treatments with trypsin and periodic acid but more than 90 % of the antiviral activity was lost by heating at 60°C for 10 min. A therapeutic effect of VIF by using phospholipase C was demonstrated (Funakoshi and Aizawa, 1989 b).

Ether extracts from VIF (VIF-E) inactivated nonoccluded BmNPV more strongly than VIF. VIF-E was not deteriorated by boiling for 30 min. VIF-E did not show the preventive and therapeutic effects by the injection into silkworm pupae and the antiviral activity of VIF-E was inhibited by the addition of silkworm hemolymph and phospholipids. The infrared spectrum of VIF-E was similar to that of oleic acid and C 18 unsaturated fatty acids, especially oleic acid showed the strong antiviral activity against nonoccluded BmNPV.

These results suggest that VIF-E is a fatty acid or a mixture of fatty acids (Funakoshi and Aizawa, 1989b).

2. ANTIVIRAL SUBSTANCES IN THE SILKWORM GUT JUICE

Nonoccluded BmNPV in infected silkworm hemolymph and alkali-liberated occluded BmNPV from polyhedra are inactivated *in vitro* by the gut juice of silkworm larvae (Aizawa, 1962 ; Hayashiya *et al.*, 1968).

It was found that an alkaline protease in the silkworm gut juice showed the strong antiviral activity against nonoccluded BmNPV and the antiviral activity was inhibited by a soybean trypsin inhibitor. Based on this result, the effects of proteolytic enzymes against BmNPV were tested. Nagarse, pronase E, pronase P, protease IV, and achromopeptidase inactivated nonoccluded BmNPV at the concentration of 1 mg/ml. Moreover, achromopeptidase inactivated alkali-liberated occluded BmNPV by the treatment at 27°C for 6 hrs. (Funakoshi and Aizawa, 1989a).

3. ANTIVIRAL ACTIVITY OF TUNICAMYCIN, PHOSPHONOACETIC ACID, AND TRISODIUM PHOSPHONOFORMATE

The effects of tunicamycin, phosphonoacetic acid (PAA), and trisodium phosphonoformate (PFA) were examined by using insect cell lines, BM-N and S.P.C. Bm36.

Although the replication of extracellular virus was markedly inhibited by tunicamycin in S.P.C. Bm36 cells, the formation of polyhedra was not affected at the concentration of 10 µg/ml.

The inhibitory effect of PAA and PFA for the replication of virus was clearly shown in S.P.C. Bm36 cells but not in BM-N cells. The formation of polyhedra was remarkably inhibited by PAA and PFA in BM-N cells (Funakoshi and Aizawa, 1988).

The aspects of defense reactions against microbial infections in insects are entirely different from those in invertebrates. Since defense reactions by antigenic stimulation have not been clearly demonstrated in insect microbial infections exclusive of bacterial septicemia, it is necessary to get new findings on defense reactions in insects. However, for the control of the virus diseases in the silkworm, approaches to find effective antiviral substances should be emphasized and developed.

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PROBLEMS AND PROSPECT OF TASAR CULTURE IN INDIA

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India produces 463 metric tons of tasar silk and stands next to China so far as global production of tasar silk is concerned. China produces entirely temperate (oak) tasar silk while India produces two varieties of tasar silk viz. tropical and oak. More than 1.32 lakh families are engaged in tasar culture and an equal number of families are involved in tasar cocoon processing and fabrics production. Out of 44.5 million hectares of forest, tasar food plants are available in 11.16 million hect.

Tasar culture is a forest-based industry traditionally practiced from time immemorial by the tribes inhabiting the central plateau of the country. Tasar, today, is an indispensable and growing part of the tribal culture. The prospects and potentials for tasar silk productions are high with vast natural food plants and manpower.

PROBLEMS

The tasar culture has several inherent problems due to its wild nature and dependency as natural environment. The problems are listed below :

i) Socio-economic condition

Tasar culture is practiced mainly by the tribals, many dogmas and superstition exist among them about tasar culture. As such the introduction of any new techniques amidst their age-old practices becomes a formidable task.

ii) Deforestation

Depletion of the forest area in general and merciless felling of the tasar food plants in particular have resulted in an overall shrinkage of the area of tasar food plant. It has eventually rendered the silkworm rearing difficult because of the wide scattered nature of the food plants.

iii) Seed organisation

Inadequate supply of tasar silkworm seed is another important constraints of the industry. Till date, hardly 30 % of the seed is prepared by the Government sector and some co-operative societies. The rest is prepared by the rearers themselves without adhering to the necessary norms of moth examination, disinfection and proper incubation of eggs.

iv) Lower profitability

The majority of the tasar cocoons are produced on forest plantation. The rearing capacity of a farmer is about 100-150 dfls. On forest plantation which provides a meagre income from tasar silkworm rearing. Due to low profitability, the educated person does not stick to this evocation. Tasar culture is restricted to the old generations only while young people are migrating to the urban areas in search of more remunerative employment.

Table I. Catalogue of important parasites and predators of *Antheraea mylitta*.Tableau I. Liste des parasites et des prédateurs importants d'*Antheraea mylitta*.

Parasites name <i>Nom des parasites</i>	Family <i>Famille</i>	Percentage damage <i>Pertes en %</i>	Stage of attack <i>Stade d'infestation</i>	Season <i>Saison</i>	Endemic area <i>Zone endémique</i>	Control measures <i>methode de lutte</i>
1 <i>Blepharipa zebina</i>	Tachinidae	20-25 %	3rd - 4th stage	Oct.-Nov.	M.P. Orissa, Bihar	Mechanical control
2 <i>Pimpla punctator</i>	Ichneumonidae	10-15 %	Spinning stage	Oct. - Nov.	Bihar, M.P., Orissa	- do -
3 Predators / <i>Prédateurs</i>						
1 <i>Canthecona furcellata</i>	Pentatomidae	10-15 %	1st, 2nd, & early 3rd stage	July-Nov.	M.P., Orissa U.P., Bihar	-do-
2 <i>Sycanus Callaris</i>	Reduviidae	7-10 %	1st stage to late 4th stage	July-Nov.	Bihar U.P. M.P., Orissa	-do-
3 <i>Hierodulla bipapilla</i>	Mantidae	5-7 %	3rd & 4th stage	September	Bihar & M. P.	-do-
4 <i>Vespa orientalis</i>	Vespidae	10-15 %	2nd & early 3rd stage	July-Nov.	Orissa, M. P. & U.P.	-do-
5 <i>Polistes hebracus</i>	Vespidae	10-15 %	2nd & early 3rd stage	July-Nov.	Orissa, M.P. & U.P.	-do-
6 <i>Oecophylla smaragdina</i>	Formicidae	5-7 %	1st & 2nd stage	July-Nov.	Bihar & U.P.	-do-
7 <i>Rattus</i>						
8 Snakes						
9 Birds						

v) Diseases and pests

The majority of the crop loss in tasar silkworm rearing is due to viral disease. Since rearing is conducted completely outside in the forest, there is no control over the climatic conditions (temperature and humidity) and rearing is subjected to great fluctuations in the climate conditions which result into virosis. In some part of the country the uzifly has become a big menace where loss has been recorded to the tune of 30 %. Since rearing is conducted on the trees in the natural habitat any control measures against uzifly is not effective. Besides uzifly parasite and diseases, there are several predators (Table I). Tasar silkworm is polyphagous and feeds on several food plants (Table II) and the food plants are severely infested by gall insects, particularly *Trioza flacheri* minor.

Table II. Lists of primary and secondary tasar food plants.

Tableau II. Liste des plantes nourricières primaires et secondaires du tasar.

Lists of primary tasar food plants
Liste des plantes nourricières primaires du tasar

- 1 *Terminalia tomentosa*
- 2 *Terminalia arjuna*
- 3 *Shorea robusta*

Lists of secondary tasar food plants
Liste des plantes nourricières secondaires du tasar

- 1 *Terminalia catappa*
 - 2 *Lagerstroemia parviflora*
 - 3 *Careya arborea*
 - 4 *Zizyphus mauritiana*
 - 5 *Syzygium cumini*
-

vi) Silkworm races

Tasar culture is practiced traditionally in the seven states of India, which represent widely varied agro-climatic conditions. But only two races of tasar silkworm are commercially exploited till now, they are Daba and Sukinda. It is imperative to have more silkworm races suitable to different seasons and agro-climatic conditions of the country. In order to make this culture more economically viable high yielding races of tasar silkworms are required.

vii) Poor reeling industry

The majority of the reeling and spinning work is done by the crude conventional method where the quality of yarn and rate of production is a great constraint. Further, tasar yarn is naturally coloured and hence requires bleaching. Further high denier yarn is produced from tasar cocoons, which are not suitable for production of soft and finer fabrics.

viii) Marketing

Though several Government. agencies are operating in the country to provide marketing support to the cocoons growers and silk reelers, still a proper marketing system is lacking in tasar sector as such, rearers and reelers are being exploited by the Mahajans and traders.

PROSPECTS

Tasar culture has several positive advantages when compared with other agricultural crops :

1. For tasar culture fallow land is utilized
2. One hectare of waste land can generate revenue worth rs.10,597/year and employment in term of 1072 manday.
3. Tasar culture can provide employment at home to the tribes inhabiting forest and migration from rural to urban area restricted.
4. Being a forest-based industry, it can reduce the increasing load of the eco-system with the increased production of synthetic fabrics through big industrial establishment. Since afforestation is a essential complement of tasar culture, the much dreaded air polution can be reduced the better the maintenance of the ecosystem will be ensured.

From the foregoing it is obvious that by and large the constraints of tasar culture in India is acute. If the basic constraints of the industry are first attended and solved, the tasar culture has good prospects in India.

CONSERVATION OF GODAMODAL ECORACE OF INDIAN WILD TASAR SILK INSECT, *ANTHERAEA PAPHIA* LINN. (LEPIDOPTERA : SATURNIIDAE)

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The Indian tasar fauna consists of eight *Antheraea* species in 40 ecoraces, of which only two tasar species, *Antheraea mylitta* Drury and *Antheraea paphia* Linn. (Arora and Gupta, 1979), confined to Orissa are famous for tasar silk production. Both these species belong to family Saturniidae and are polyphagous insects having three primary food plants Sal (*Shorea-robusta*), Asan (*Terminalia tomentosa*) and Arjun (*Terminalia arjuna*) and nearly two dozen secondary food plants (Jolly, 1966, Jolly *et al.*, 1976).

A. mylitta has two ecoraces Daba and Sukinda. These are semidomesticated and are commercially reared all over Orissa including Mayurbhanj district of Orissa. The added importance of this district is the presence of two important ecoraces of *A. paphia* called Godamodal and Bogei. Godamodal ecorace is the wild form which multiplies in nature in high altitude Sal forests and the Bogei is reared in lower altitude by the tribal tasar rearers on *Terminalia* food plants.

The quality of the cocoons produced by the Bogei ecorace is inferior to that of the cocoons produced by the Godamodal ecorace but is far superior to the cocoons produced by Daba and Sukinda ecoraces. Hence the tasar rearers of this district have greater fascination for rearing of Bogei ecorace as, unlike Daba and Sukinda ecoraces, it brings a very stable crop under all sorts of climatic stress and strain.

The Godamodal ecorace in Orissa is confined to Similipal Sal Forest range (2750 sq. km. area) situated at an altitude of about 500 - 1000 MSL. It is India's highest silk yielding ecorace (Nayak *et al.*, 1988) and probably in the world also. But regrettably this ecorace of *A. paphia* is at present threatened with extinction due to its rapidly decreasing natural population. In view of the above facts, this report was prepared with a hope that it would activate all concerned to save such a precious ecorace from the danger of extinction.

SUPERIOR CHARACTERS OF GODAMODAL ECORACE

Analysis of bionomics and commercial characters reveals that Godamodal is the best ecorace of all the ecoraces of tasar silk insects in India. The important commercial characters, such as cocoon weight, shell weight, shell percentage, silk filament length etc., give highest value in the case of cocoons of Godamodal (Table I). The cocoons of Bogei ecorace also show all the above characters on a higher side than the other semidomesticated races such as Daba and Sukinda (Table I). The study of bionomics also states that Godamodal is more highly evolved than other ecoraces as it is well adapted to its ecoclimate. The superior and highly evolved adaptive characters in the Godamodal ecorace are as follows :

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Table 1. Mean values of important commercial characters of cocoon of some tasar ecoraces of India.

Tableau 1. Valeurs moyennes des principaux caractères commerciaux des cocons de certaines variétés tasar d'Inde.

Name of ecorace <i>Nom de la variété</i>	Species <i>Espèces</i>	States where seen <i>Localisation</i>	Food plants <i>Plantes nourricières</i>	Cocoon weight (g) <i>Poids du cocon</i>	Shell weight (g) <i>Poids de la coque</i>	Silk (%) <i>Richesse soyeuse</i>	Filament length (mt) <i>Longueur de la bave</i>
Godamodal	<i>A. paphia</i>	Orissa	<i>shorea</i> Sps.	14.20	4.00	28.2	1383
Modia	<i>A. paphia</i>	Bihar	-do-	13.85	2.76	19.9	1234
Raily	<i>A. paphia</i>	M. P.	-do-	12.77	2.66	20.8	1232
Bogei	<i>A. paphia</i>	Orissa	<i>Terminalia</i> Sps.	12.50	2.05	16.4	895
Sukinda	<i>A. mylitta</i>	-do-	-do-	11.95	1.41	11.8	750
Daba	<i>A. mylitta</i>	Orissa & Bihar	-do-	12.40	1.62	13.1	750
Laria	<i>A. mylitta</i>	Bihar	-do-	7.21	1.37	19.0	785
Bhandara	<i>A. mylitta</i>	Maharastra	-do-	7.02	0.73	10.4	613
Tira	<i>A. mylitta</i>	W. B.	-do-	7.86	1.21	15.4	728
Andhra Local	<i>A. mylitta</i>	A. P.	-do-	7.83	1.32	16.9	746

The moltinism (tetramoulters) and voltinism (univoltine) in Godamodal are best suited to its forest mode of life. The fecundity is very high, i.e., 350-500 eggs, which helps the insect for effective perpetuation of the race. The polyphagous nature helps the worms to survive during adverse conditions of shortage of primary food plant leaves. Immunity to diseases in Godamodal and Bogei is very high as the dreadful diseases such as virosis, bacteriosis, sporozoosis and mycosis are very rarely seen in those races. The thick shell of the cocoon protects the diapausing pupa from external agents. The silk gums and pigments over the cocoon are strongly resistant to temperature, humidity, radiation and to other ecoclimatic factors which can not penetrate deep into the cocoon. Strong and stout peduncle protects the diapausing (Sept.- June) pupae from strong wind. The insect is fully adapted to exploit its ecological niche successfully at all levels through uniform distribution of its population. Mimicry (colour change) in larva, pupa and cocoon is an important adaptative character in its macroenvironment which protects the insect from the predators. Two most important commercial parameters such as silk yield and fecundity are highest in Godamodal throughout India and probably in the world. It is of particular interest that Godamodal produces 3.50 to 4.00 g of silk per cocoon against 2.05 g in Bogei, 1.41 g in Sukinda and 1.62 g in Daba etc. (Table II). Fecundity in Godamodal is 350-500 as against 230 in Bogei, 180 in Sukinda and 175 in Daba etc.

Table II. Population trend of Godamodal and Bogei ecoraces as per a survey by the authors.

Tableau II. Tendence des populations des variétés de Godamodal et Bogei d'après une étude réalisée par les auteurs.

Year <i>Année</i>	Godamodal lakh* cocoons <i>Cocons de Godamodal (lakh)</i>	Bogei (lakh cocoons) <i>Cocons de Bogei (lakh)</i>
1937-38	32	160
1985	8	96
1987	3	16

* 1 lakh = 100 000.

ALARMING TRENDS IN GODAMODAL POPULATION

Godamodal, the wild ecorace of *A. paphia* tasar silkworm, is only restricted to Mayurbhanj dist. of Orissa. Before independence Godamodal existed throughout the district in different forest patches. At that time the population was only regulated by nature. A report from Maharaja's administration (Anonymus 1937-38) showed that the Godamodal cocoon collection was more than 32 lakh cocoon per annum i.e., (2000 kahans, 1 Kahan = 1600 Nos.) plus a considerable amount was being smuggled out by smugglers. Unfortunately, Godamodal population in Mayurbhanj has been sharply declining over the past years i.e., from 32 lakh cocoons in 1937-38 to less than 8 lakh cocoons in 1985. In 1987 the population of Godamodal was further reduced to about 3 lakh cocoons (Table II).

The declining trend is certainly due to mass denudation of forest areas on one hand and mass plucking of diapausing cocoons by pluckers on the other hand for its high silk content. Simultaneously, the Bogei cocoon collection has also decreased from 160 lakh cocoons during 1937-38 to about 96 lakh cocoons during 1985 and only 16 lakh cocoons during 1987 (Table II). In addition the number of Bogei rearers in the district has increased much more from 1835 in 1937-38 to about 15 000 in present days. If immediate steps for preservation and multiplication of Godamodal ecorace are not taken, it will face extinction very soon.

STEPS FOR CONSERVATION

Now the situation is very much alarming as the Godamodal ecorace is only restricted to Similipal forest areas unlike in past years when it was distributed throughout the Orissa. So it is high time to take immediate steps for preservation of this precious ecorace of tasar fauna of Orissa failing which, this race will very soon be extinct in the present deteriorating conditions. In this regard, the following steps may be taken at an early date.

1. Effective measures should be made to prevent mass plucking of Godamodal cocoons.
2. As similipal is now the natural home of tasar, the conservation programme should be carried out there.
3. Similipal should be declared as Biosphere Reserve as it is adorned with rare plants and animals and should be included in the world list of Human Heritage.
4. One research and monitoring unit should be established at Similipal to carry out research on Godamodal and Bogei ecoraces of *A. paphia*.
5. Similipal should be made into three zones such as core, buffer and peripheral for conservation of Godamodal.
6. A total ban for at least ten years should be imposed on cocoon plucking, collection and transportation from Similipal forest in order to save this species from extinction.

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RESOURCE MANAGEMENT - A WAY FOR INCREASED PRODUCTIVITY

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Sericulture is an unique enterprise encompassing different types of activities and management practices. Because of its diversified nature of activities, resources and input utility is also equally heterogenous. The economics mainly depends on how these various resources and inputs are efficiently managed to get the best out of the resources. This is more so in an Indian context where resources are always a limiting factor. Sericulture is by and large practised by small/marginal farmers who seldom have a higher initial investment capacity and also cannot invest large sum for the follow up. Hence small scale enterprises are likely to be more handicapped in high initial investment activities. Therefore the objective of any developmental agency involved in this should concentrate more on the ways and means of reducing initial investment ; increasing the utility and efficiency of inputs ; and enhancing/intensifying the by-product utility. These exercises will make sericulture more remunerative, cost effective and finally acceptable to a large number of farming communities.

Unlike many other agro-based activities, sericulture needs diversified resources and inputs of specific nature and these inputs can be classified as resources inputs and purchase inputs. Of these inputs, some are nonrecurring and some are recurring having different utility span and value. Land and building are the long-term inputs. Rearing appliances, namely, stands, trays, chandrikes, sprayers and other supporting articles are medium-span inputs and farm inputs, labour irrigation etc., are the regular recurring components. In the present practices, farmers are taking on an average 5 crops in a year with an active span of 30-35 days for each crop and the total number of work/utility days are 150 to 175 which is about 50 %. Based on their frequency of utility and total utility hours, about 50 % of the time most of the inputs remain idle. For example : rearing trays, chandrikes etc., which are costly purchase inputs, are used only for 50-60 days of the year. Hence, inputs must be used quite frequently for their better utility and effectiveness.

As a part of the resource management exercise, split crop management appears to be more promising in resource utility, low initial cost for all type of inputs and for longer utility hours. The major component of this exercise is dividing available land into two pieces and taking 10 crops a year. This system require half of the purchase inputs and facilitates the maximum utility of all the resources by increasing their utility hours.

Rearing house required to rear 1000-1200 Dfls from one acre is about 450 sq. ft. costing about 40-45 thousand rupees and this space is kept engaged only for 150-175 days of the year. In the split crop method, only 60 % of the area is required to conduct 10 rearings and the space is put to use for 300-320 days of the year (80-85 %).

Similarly, rearing equipments like trays, chandrikes, rearing nets, foam pads etc., are required in maximum quantity only for a short period of 8-10 days in each crop. This means their maximum utility hours are only 20 % in the whole of the year. During the remaining period they remain idle. By way of split crop method, the utility is increased to 40 %. This holds good for trays (70 % are

required only in last 10 days) and chandrike which are used only for 5-6 days in each crop, means 30-35 days in the whole of the year.

Likewise, farm inputs, implements and labour. The utility value of these material will also be increased to double in split crop system. On the mulberry cultivation side, farm activities have to be continued regularly. Implement and other purchase input utility is increased. Irrigation water - one of the costly and scarce input, many a time poses problems. In the summer months, most of the irrigation resources get depleted and efficiency is reduced and as a result large area could not be covered at a stretch in few days. As the garden required irrigation on specific days, due to shortage, all plants may not receive irrigation as per schedule. Hence if the irrigation hours are extended, the possibility of up-keeping to the schedule is better and leaf quality is maintained. This is possible only in split crop system where irrigation days are extended. Drip and sprinkler methods could also be thought of for the effective utilization of water and reducing the waste. This also facilitates the better utility of irrigation machinery and energy. Another important consideration is intensive cultivation methods which are proved more efficient than extensive. Small units are better managed. Family labour is effectively utilized around the year and if it is hired labour, there is an assumed work and every time searching for the labour is avoided. Secondly in existing system, large number of labours are required only for last 10-12 days and if sufficient labourers are not available during this specified period (what is happening now), the efforts are going to be wasted and labours will be in a position to dictate terms leading to unhealthy atmosphere and hence the work suffers. Because of all these managerial problems, large-scale rearing in few crops becomes problematic.

Another important consideration is the storage place. As most of the material are bulky and occupy large space, proper storage becomes difficult. Since space is a limiting factor and involves more expenditure stacking of the material is rather not possible. If proper storage is not provided, most of the appliances become unserviceable and increase overhead expenditure.

The final and most important consideration is the initial investment and management efficiency. As stated earlier, the investing capacity of the farmer is limited. If the cost structure and investment on rearing space, appliances, labour etc., are compared it is cut down to only 60 % and 40 % is saved in split crop system. This itself is a big saving for the farmer. Storage space is also reduces to only 15-20 % as most of the appliances are put to maximum utility. Since the holdings or units become small, their efficiency is increased ; risk is minimised and labour dependency is reduced. Because of the above advantages, the split crop system is more efficient and cost effective. This is more so in large holdings (garden more than two acres). Above all, this system ensures monthly return and cash inflow unlike the traditional system where only bimonthly income is expected. This is an added attraction for the farmer whose requirements are met frequently and keep him away from becoming wilful defaulter and going for loans.

Though the system is more efficient and cost-effective, this has some pre-requisites too.

Split crop system keeps the farmer busy throughout the year and he cannot direct his attention to any of the other agricultural activities. Hence it is possible for only those who wish to become full-time sericulturists. The second presupposition is the assured supply of chawki reared worms. Since the main rearing space is kept constantly engaged he must get regularly chawki reared worms then only the method is more effective.

This system necessitates a thorough disinfection of the rearing place and appliance and maintain hygiene up to date. This is not possible in the present situation because of the rearing system. The above problems can be solved by good service facilities like assured chawki reared worm supply, disinfection support etc.

By practicing the above system of split rearing, the farmer can manage his crops more efficiently with less cost and productivity will go up per unit area which is the need of the day. But the services

of the developemnt agencies must assure him all the support for the successful implementation. To sum up, this method has the following advantages :

- 1. low initial investment (60 %),**
- 2. better utility value of all inputs (100 %),**
- 3. assured and continuous labour employment (85 %),**
- 4. less dependancy on labour,**
- 5. frequent returns (10 times a year),**
- 6. low crop risk,**
- 7. better and efficient management,**
- 8. improvement in yield and quality.**

Hence, all the development agencies should promote this system of crop management for better prosperity and progress.

SERICULTURAL RESEARCH IN INDIA AND ITS IMPACT ON SERICULTURE DEVELOPMENT

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Although silk industry in India is very ancient and several centuries old, it has had only a marginal existence for a very long time, because of the fact that it falls under tropical zone. Both productivity and quality of silk suffered due to adverse climatic conditions. Realising the need for harnessing Science and Technology for the improvement of Indian sericulture, technical development of sericulture received due attention in post-independent India. Early attempts consisted in trying to transplant alien technology developed for temperate regions into tropical India through technical co-operation with sericulturally advanced countries. This having not produced the desired results emphasis shifted to the development of indigenous technology suited to local tropical conditions. Thus serious sericulture research in tropical sericulture started in India only since 1961-62, and therefore, it is of recent origin only. During a short span of two to three decades, great strides were made in improving the productivity of Indian sericulture and today sericulture is a booming industry enjoying the status of a highly commercial cash crop.

With a view to improving productivity of tropical sericulture research thrusts were made in three major areas, namely :

- i) Mulberry productivity,
- ii) Silkworm cocoon crop yield,
- iii) Cocoon quality improvement.

As a result it became possible to achieve doubling of the performance levels in each of the above areas. These, in other words, meant an eight-fold improvement in productivity over the levels obtained prior to 1970-71. The impact of the sericultural technology developed began to be felt during the last decade and half (since 1976-77). Today Indian production of mulberry raw silk has gone up to almost nine fold during the last 15 years, being accounted for by a 3.5 fold increase in area and 2.5 fold increase in productivity.

Recently, sericulture in India has emerged as an important agro-industry with immense potential for rural income generation. This is specially significant in the context of rural poverty alleviation programmes of the country. The economic potential of sericulture having been realised, massive investments have been made since 1977-78 to develop the requisite infrastructure facilities. Initially a programme of Intensive Sericulture Development (ISDP) was taken up as a pilot project for implementation and proving of the improved technologies developed through scientific research. This was followed by the World Bank assisted Karnataka (State) Sericulture Development Programme during 1980-86.

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Currently a massive development programme has been launched for implementation during 1989-94, more or less coinciding with the VIII Plan of the country at a cost of Rs. 5553 million with financial assistance from the World Bank and the Swiss Development Co-operation. The mulberry raw silk production which stood at 1053 tons during 1956-57 is currently at 10800 (1989-90) tons. Presently the country is poised to achieve a target of 15000 tons by 1994-95.

Such phenomenal growth became possible as a result of intensive and productive research carried out in sericulture in India since 1961-62 aimed at evolving technologies suited to local (tropical) conditions. The research resulted in considerably improving productivity and thereby profitability. Sericulture, which was practiced in the past as a part-time subsidiary crop with just marginal profits, generally to augment the agriculture income of the farm households, assumed the status of an intensively cultivated cash crop with significantly increased returns, comparable to any of the highly remunerative cash crops like cotton, tobacco, sugar cane etc. The higher productivity achieved through scientific research resulting in higher profitability, combined with massive financial investment on development, saw an unprecedented growth in sericulture which is unique for any tropical country. New areas held to be not suitable for sericulture because of adverse conditions, emerged as sufficiently productive sericultural tracts and the industry spread far and wide, breaking all climatic barriers.

ORIGINS OF SERICULTURAL RESEARCH

Although sericulture industry in India is centuries old, the productivity remained one of the lowest in the world for a very long time. Hence, it was thought fit to harness Science and Technology for the improvement of Indian Sericulture. It was at the instance of the second All-India Sericultural Experts' Conference held in Lucknow in the year 1940 and later, the Silk Conference held in Delhi in 1942 that it was decided to establish a sericultural research station. Thus the first ever research centre for sericulture was established in the year 1943 at Berhampore (West Bengal) by the Government of India much prior to the constitution of the Central Silk Board in 1948-49. This was followed by the founding of another research centre in Channapatna in 1955 by the State Government of Mysore which was later transferred to the Central Silk Board in 1961. The Centre ultimately moved to Mysore city in 1963. In addition, some special schemes of research were sponsored by the Central Silk Board at the Indian Institute of Science in Bangalore and at some Universities during the 1950's and '60s. Despite the fact some research work was being carried out in the above centres, the research efforts were meagre and not on the scale required to make any impact on the sericulture industry of the country. Systematic research on an adequate scale and on a co-ordinated basis was yet to be organised. It was in the year 1960, that the Central Silk Board took a policy decision to centralise sericulture research in the country and to set up Central and Regional Research Centres according to the needs of the country. In that connection, a Central Research Co-ordination Committee comprising some eminent agriculture scientists was set up to draw up a blue print as to the lines on which sericultural research in the country was to be organised. This marks a significant event in the history of Sericultural Research and Development in India.

Thus, it can be truly stated that serious research in sericulture in India started only since 1961-62. Prior to that the efforts at improving Indian sericulture were mostly based on attempts at transplanting foreign technology into India or obtaining the services of foreign experts to advise the country on sericulture development. These, however, did not produce the desired results. The fact that the developmental activities in India are handicapped for want of much needed technical knowledge and experience built on indigenous scientific research suited to local tropical conditions came to be realised rather late, only around 1960.

RESEARCH STRATEGY

When serious research in sericulture was initiated around 1961-62, the area under mulberry cultivation was hardly 85-90 thousand hectares, most of which was under poor rainfall conditions with very poor leaf yields, averaging about 3 tons per hectare. In the case of irrigated mulberry or in areas with higher rainfall and partially supplemented irrigation, the yields ranged between 10-12 tons.

The average yields of cocoon crops from silkworm rearing were of the order of 15-20 kgs only per 100 disease-free layings. As regards quality of cocoons, the raw silk recovery was hardly 6-7 % (Renditta 15-16). The overall average productivity of raw silk was hardly 15-16 kgs per hectare of mulberry. The quality of silk did not measure up to even the lowest quality grade of the international standard of specifications. Hence, sericulture research in India had to address itself in tackling the twin maladies of the industry, namely :

- i) low productivity and hence the high cost of production and
- ii) poor quality of silk.

With a view to improving productivity and, thereby, making Indian sericulture economically viable, both long and short term strategies had to be devised and adopted. It should be recognised in this connection, that unlike in sericulturally advanced countries of temperate regions where climatic factors generally favour sericulture, with copious rainfall, more salubrious weather during seasons and so on, Indian sericulture falling under the tropics has to contend against several adverse factors such as low rainfall, hot weather throughout the year, etc.

Mulberry leaf productivity

Despite these handicaps and in full appreciation of the limitations, suitable research strategies were adopted to improve productivity. Taking advantage of the tropical climate where continuous mulberry growth is possible and also the fact that mulberry cultivation is for its vegetative growth (leaf yield) systematic agronomic research was undertaken to improve leaf productivity besides breeding studies to improve the mulberry varieties. From intensive research relating to mulberry agronomy and varietal improvements, it became possible to evolve a package of mulberry cultivation practices under irrigated conditions, whereby the leaf productivity per hectare could be stepped up to 30 tons under tropical conditions, almost double the leaf yield of temperate regions.

Silkworm cocoon crop yield

This is the most vulnerable area in tropical sericulture. Through intensive studies on rearing practices, a package of practices known as new technology of rearing was evolved whereby it became possible to step up the cocoon yields from 20-23 kg, to as much as 45-50 kg per 100 disease free layings. What is significant here is the fact that the leaf cocoon ratio which was very high in the past had been brought down to 20-25:1 - almost to the same level of efficiency of leaf conversion to cocoons as obtained in sericulturally advanced countries. This was indeed a great breakthrough in tropical sericulture and is a major contributing factor for improved productivity. Evolution of the improved technique of rearing also paved the way to breed highly productive silkworm races.

Cocoon quality improvement

With the advent of 'New technology' of silkworm rearing, it became possible to evolve more productive and stable silkworm races of both multivoltine and bivoltine varieties. For the first time, highly productive silkworm races with silk content of 16-17 % in the case of multivoltine varieties and 21-23 % in the case of bivoltine varieties suited to tropical zones were evolved and successfully introduced into the field. These races have helped immensely to improve the quality of commercial hybrid cocoons with the silk recovery going up from 6-7 % to as much as 11-12 %. When bivoltine silkworm race hybrids are reared on a large scale the silk recovery can be expected to improve still further.

Potential established through research

From the foregoing brief account of the research progress achieved in Indian sericulture it will be evident that doubling of performance levels in three major thrust areas was achieved namely :

- i) Mulberry leaf productivity from 12-15 tons to 30 tons
- ii) Cocoon yields from 20-23 kg to 45-50 kgs per 100 dfls.
- iii) Silk recovery from 6-7 % to 11-12 %

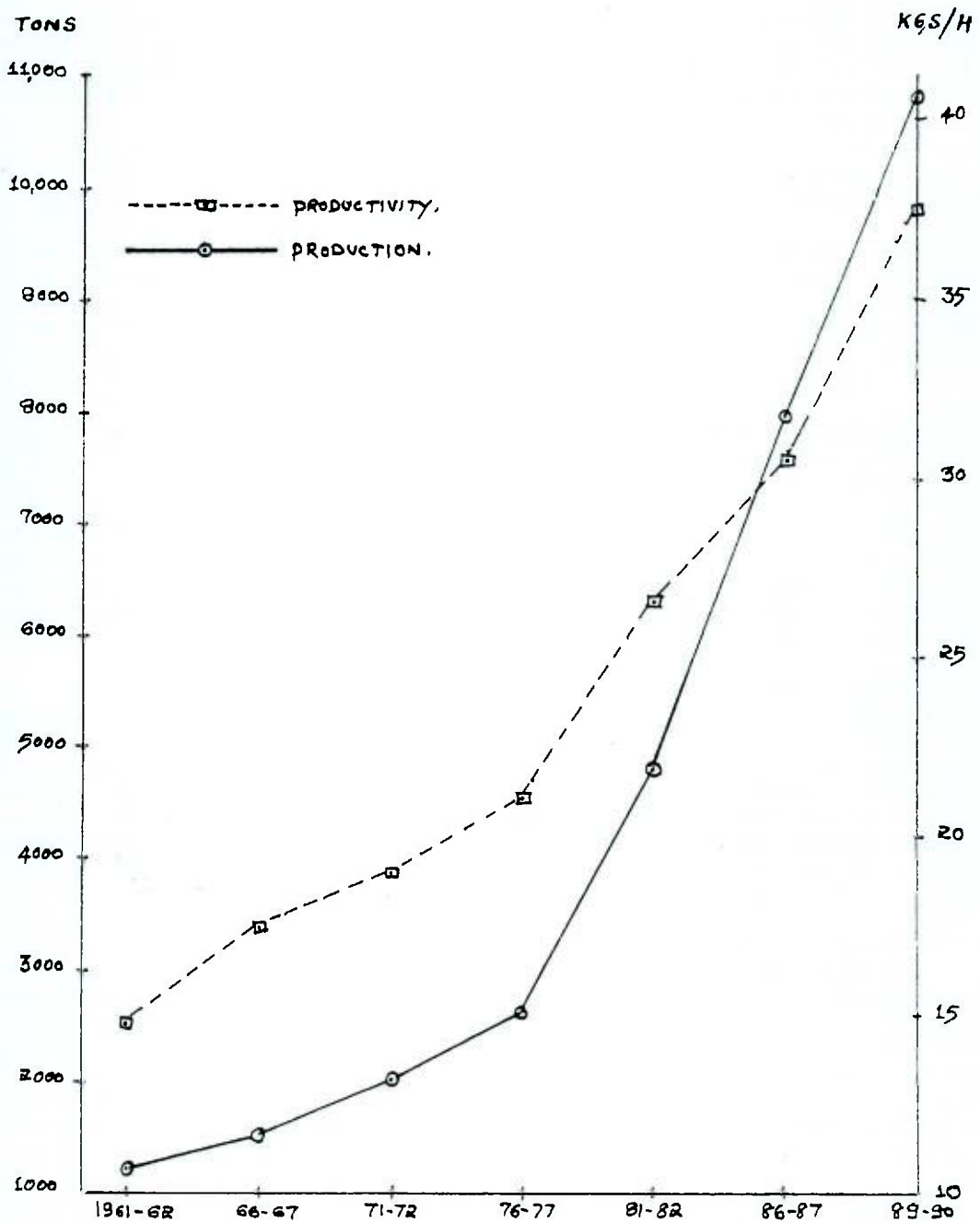


Fig. 1 : Graph showing productivity and production.

Fig. 1 : Graphique montrant la productivité et la production.

The above add up to an eight fold improvement in productivity over the last quarter century or so. In other words, it is possible to achieve an average productivity of 25 tons of mulberry leaf yield per hectare under irrigation, which should enable production of 1000-1200 kgs of cocoons which in turn should result in the production of over 100 kgs of raw silk per hectare.

Field impact

The impact of the technologies developed for tropical sericulture on the progress of the industry in India are shown in Table I and Fig. 1 for every five-year periods starting from 1961-62.

Table I. Progress of productivity and production in Indian sericulture.

Tableau I. Progrès de la productivité et de la production de la sériciculture en Inde.

Year <i>Année</i>	Area under mulberry (ha) <i>Surfaces de mûriers</i>	Raw silk production (tons) <i>Production de soie grège</i>	Productivity of raw silk hectare (kgs) <i>Productivité de soie grège (kg/ha)</i>
1961-62	82,247	1210	14.8
1966-67	84,732	1492	17.6
1971-72	104,885	1995	19.0
1976-77	125,046	2615	20.9
1981-82	179,949	4801	26.7
1986-87	229,758	7905	30.5
1989-90	281,049	10813	37.4
Growth in % <i>Croissance (%)</i>	354	894	253

It may be observed from the above figures that productivity growth was slower for the early fifteen years (from 1961-1975) which has gone up from 14.8 to 20.9 kg i.e. by 6.15 kg. Since 1975-76 as the impact of improved technology was being felt, the productivity has grown at a faster rate from 20.9 kg to 37.4 kg i.e. by 16.5 kg during the subsequent fifteen years. Almost a 9 fold increase in production during the last 30 years is accounted for by 3.5 times growth in area and a 2.5 times growth in productivity. With more intensification of extension efforts it is expected to achieve a productivity level of 50-70 kg of raw silk per hectare in different states under the National Sericulture Project currently under implementation.

Among other improved benefits accruing from the development of appropriate technology for Indian Sericulture are :

- (i) the breaking of climatic barriers,
- (ii) significant reduction in seed (silkworm egg) requirement and
- (iii) elimination of cocoon crop risk factor to a large extent.

POST COCOON HARVEST TECHNOLOGY IN INDIA

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A brief account of Indian sericulture industry is discussed in the paper. However, the paper is mainly on post cocoon harvest technology in India. The major research studies with reference to the existing practice done so far in post cocoon technology in India have been discussed. Central Silk Technological Research Institute (CSRTI) is the first of its kind in India devoted solely to the research in (natural silk) post cocoon technology. CSRTI was established in the recent past and there was a whole ocean of subjects to be dealt with. Stress was first laid on cocoon and reeling technology, since reeling forms the backbone of silk industry. After doing a good amount of work in reeling, emphasis is now being given to post reeling aspects like weaving and wet processing. There is vast scope to improve the level of technology in the country as improvement in silk technology is in itself a desirable objective without reference to the question of the markets where silk is sold. As a result of progress achieved, particularly in the field of research and planning, the silk industry is changing in its character and composition. A new vista has opened up with far greater opportunities both at home and abroad.

Sericulture is an ancient industry in India, dating back to at least the 2nd century B.C. Sericulture flourished in the states of the then Bengal, Mysore and Kashmir, and suffered a series of set backs but briefly made a come back. Thanks to the devotion of the Government of India, and the measures it took to encourage sericulture in the country after 1945, this industry once again entered a period of prosperity. Sericulture took a rapid stride towards progress, especially during the last two decades. Since 15 years, it has really come of age, and is now poised for a great leap forward.

Indian sericulture industry today presents the picture of a well-knit agro-based cottage industry firmly rooted in antiquity and traditions, with its muscles flexed to achieve continued progress through modernity and improved technology. This has been achieved through systematic planning, progressive government policies and hard work put in by millions of sericulturists, silk reelers, weavers and exporters all over the country during the last 4 decades. India stands next to China in the world, in the production of mulberry and tasar silk. In addition, she also produces muga and eri.

At present, about 2.55 lakh hectares are available under mulberry cultivation producing 91,300 tonnes of mulberry cocoons and 9,130 tonnes of raw silk. Out of the 5,76,000 villages in India, sericulture is practised in about 50,000 villages providing employment to about 6 million persons, most of them belonging to the weaker sections of the society i.e. silkworm seed producer, farmer and rearer, reeler/spinner, twister, weaver, trader etc. Sericulture industry has expanded very fast for the last 15 years at an average growth rate of about 10 % per year.

CENTRAL SILK BOARD ROLE AND ESTABLISHMENT OF CENTRAL SILK TECHNOLOGICAL RESEARCH INSTITUTE

Planned development of sericulture industry in India was taken up after the establishment of Central Silk Board in 1949. CSB played a significant role in shaping the different sectors of the industry from a scattered, unorganised condition into an integrate export oriented rural industry. The research Institutes established earlier under Central Silk Board were mainly engaged with research

in biological aspects of sericulture, namely mulberry cultivation and silkworm rearing. Only in 1983, a full fledged Central Silk Technological Research Institute entirely devoted to research in post cocoon harvest technology was established. The activities of CSTRI mainly aim at improving the overall quality of silk yarn, fabric and its finishing.

The technological innovation revolves around producing good quality cocoons, raw silk and fabrics. Economic processing of silk along with maintaining quality is very important to meet the local demand. Further, it is of practical importance to produce the yarn and fabrics of superior grade, in order to compete in the international market.

FACTORS INFLUENCING THE QUALITY OF YARN/FABRIC AND ACHIEVEMENTS OF CSTRI

The various factors and stages of processing which influence the ultimate quality of yarn and fabric are :

1. Cocoon properties.
2. Reeling/process technique.
3. Reeling device.
4. Weaving.
5. Wet processing/finishing.
6. Quality control steps.
7. Human skill.

SILK REELING

Reeling forms the backbone of silk industry. The quality of finished fabric greatly depends on the quality of the yarn and thus uniform quality of raw silk thread has to be ensured. Yarn quality mainly depends on the quality of cocoons and also processing technique combined with reeling device.

1) Cocoon :

Although, India is a sericultural country with a tradition dating back to several centuries, the quality of silk cocoons had been poor. A number of attempts have been made to improve the quality of cocoons.

Though the Indian multivoltine cocoons are very well adapted, they are strikingly low in productivity and quality. Normally multivoltine cocoons are soft, flossy and contain short filament length as compared to bivoltine cocoons produced in other temperate sericultural countries. There is a high degree of variation in terms of cocoon size, cocoon weight, cocoon shell structure etc. It is preferable to sort the cocoons according to at least size, shape and colour, in order to produce quality raw silk. Depending on the classification of cocoons, process technique will be applied accordingly. The comparative characteristics of ordinary multivoltine, improved multivoltine hybrid and bivoltine hybrid cocoons are given in Table I.

2) Process technique :

Silk reeling in India suffers due to diversity in quality of the cocoons available. However, efforts have been made to evolve an appropriate reeling technique.

Reeling technique consists of cocoon stifling/drying, sorting, storing, cooking, reeling and re-reeling.

a) Stifling/drying : After the cocoons are purchased, they are subjected to stifling, in order to avoid moth emergence and for storage before reeling. From the experiments conducted in the Institute it has been found that steam stifling (chamber type) is preferred for multivoltine hybrid cocoons. Multivoltine hybrid cocoons may also be hot air dried at a very low level of about 16 % in case of long storage.

Table I. Typical characters of mulberry cocoons.

Tableau I. Principaux caractères des cocoons de Bombyx.

Sl. no. No. série	Cocoon characters Caractères du cocon	Bivoltine Bivoltin	Improved multivoltine hybrids Hybrides polyvoltins améliorés	Ordinary multivoltine hybrids Hybrides polyvoltins ordinaires
1	Single cocoon weight (g) <i>Poids d'un cocon (g)</i>	1.580	1.419	1.150
2	Single shell weight (g) <i>Poids d'une coque</i>	0.335	0.237	0.150
3	Shell % <i>Richesse soyeuse</i>	21.12	16.80	13.14
4	Filament length (m) <i>Longueur du filament</i>	1030	579	350
5	Non-breakable filament length (m) <i>longueur filament sans casse</i>	913	506	200
6	Filament denier (d) <i>denier</i>	2.30	2.46	2.40
7	Defective cocoon % <i>% cocons défectueux</i>	5.6	5.6	6.0
8	Renditta <i>Rendement à la bassine</i>	6.9	10.0	15.0
9	Raw silk percentage <i>% de soie grège</i>	14.5	10.0	6.7
10	Degumming loss (%) <i>% perte au décreusage</i>	26	28	30

Normally cocoons are spread in thin layers in a tray, a number of such trays are arranged inside the steam chamber and steam is passed through, so that the cocoons are stifled uniformly in about half an hour.

b) Sorting : Cocoon sorting is done to separate out the defective cocoons from the good ones. Some of the defective cocoons are :

- 1) Urinated cocoons.
- 2) Flimsy cocoons.
- 3) Double cocoons.
- 4) Malformed cocoons.
- 5) Pierced cocoons.
- 6) Mould attacked cocoons.
- 7) Uzi affected cocoons.

c) Storing : After sorting, the cocoons are stored in thin layers in trays kept in wire meshed racks. The position of the cocoons is changed in order to allow aeration for the cocoons, which helps in avoiding fungus attack and diriage also takes place to a certain extent. In this way steam stifled cocoons

can be stored for about 15 days without any deterioration before reeling. However, hot air dried cocoons can be stored for quite a long period.

d) Cooking : The object of cocoon cooking or boiling is to soften the sericin in order to unwind the filament smoothly during reeling.

The research studies have shown that open pan cooking is quite suitable for steam stifled multivoltine cocoons. It is preferred to use steam as the source of heating during cooking, since steam will give some agitation which will help in loosening the cocoon layers.

The cocoon should neither be overcooked, nor undercooked, since otherwise the quality and productivity of silk will be affected. Cooking is a very vital process in reeling, well-trained operatives should be engaged for cooking.

e) Water quality : Water plays an important role in cocoon cooking and reeling. It has been found from the consistent experimental results, that water softened to the extent of 85-90 ppm and a pH in the range of 6.8 to 7.4 improves the reeling performance as well as the quality of the raw silk. Therefore cocoons should be cooked/reeled in treated water. In order to maintain the optimum hardness, water should be treated with softening agents. CSTRI has developed a simple water softening agent which is being used by reelers to improve reeling performance and quality of yarn (Table II.)

Table II. Reeling performance and quality of raw silk before and after using CSTRI water softening agent

Tableau II. Performances du dévidage et qualité de la soie grège après utilisation d'un agent adoucissant de l'eau provenant du CSTRI.

Sl. No.	Particulars Points particuliers	Before treatment Avant traitement	After treatment Après traitement
1	Total hardness (PPM)/Dureté totale	234	86
2	Water pH / pH contenu de l'eau	7	7
3	Cooking efficiency / efficacité cuisson (%)	95.5	96.26
4	Rendita/rendement à la bassine	10.1	9.9
5	Raw silk recovery / soie obtenue (%)	59.5	60.6
6	Winding breaks / hr / skein cassures au bobinage / hr / écheveau	3	1
7	Tenacity / tenacité (g/d)	3.8	3.8
8	Elongation / élongation (%)	21.1	20.7

3) Machine/Reeling device :

The reeling device has a great influence on productivity and quality of raw silk. Even if there are good cocoons, processed with proper technique, quality of raw silk will be spoiled if they are not reeled on standard machines.

In India there are 3 distinct reeling devices namely charkha crude system of reeling, cottage basin system - improved over charkha and Multiend basin (filature) which is the modern version in India. There are about 4-5 small automatic reeling units imported from Japan. It has been experienced that automatic reeling technique has not been suitable for multivoltine cocoon commercially available in the country. Whereas the automatic silk reeling technique has been found suitable for bivoltine cocoons only, for gaining production rate/saving labour force and quality of uniform denier raw silk. But investment cost is the factor to be considered in India, since an automatic reeling machine is a very costly unit as compared to the multiend reeling unit.

At present, more than 50 % of the total raw silk is produced on crude charkha, about 40 % of raw silk is produced on cottage basin and hardly 5-8 % of the raw silk is produced on multiend/automatic reeling machines. About 2 % of the raw silk is of dupion quality mainly produced on charkha system. There are about 21,850 charkha units, 7,250 cottage basins, 5,660 multiend basins and about 350 automatic reeling basins.

The main reason why charkha is still dominating in Indian silk reeling industry is that bulk of raw silk produced is used in the handloom industry, wherein the cost factor of the raw material has to be kept as low as possible for the rate of the finished product saleable. Secondly the establishment of charkha unit does not need any big investment or special skill and this enables charkha silk to be sold at minimum price which is very much wanted by the handloom industry. Thirdly, the inferior quality multivoltine cocoons and defective cocoons available at lower price can be reeled more economically on charkha than on cottage basin/multiend reeling machines.

However working conditions in existing crude charkha are unhygienic and the silk produced is of low quality, not suitable for weaving of fine fabrics. Therefore CSTRI innovated an improved charkha incorporated with smokeless oven which provides healthy working conditions to the reeler and also quality of raw silk is improved.

In principle the multiend basin is supposed to be a modern device in India and it is possible to use superior quality cocoons like bivoltines on these machines with better performance to produce quality raw silk.

So far the standard multiend reeling machine with perfect alignment, proper tension and simplicity in designing was not available. With the result, silk reeled from multivoltine cocoons on existing multiend reeling machines in the country was not coming to standard quality, particularly winding breaks and size deviation used to be abnormally high.

In view of the importance of machine factor in the reeling of quality raw silk, Central Silk Technological Research Institute (CSTRI) has innovated an improved multiend reeling machine with improved mechanisms on tension control principle. As a result it is possible to reel raw silk of International 'C' grade from multivoltine hybrid cocoons and 'A' grade from bivoltine cocoons (Table III).

The CSTRI multiend reeling basin is an ideal reeling machine under Indian conditions for reeling both multivoltine hybrid and bivoltine cocoons to produce quality silk comparable to international standard, besides high production capacity, to the extent of 1-1.5 kg. per 8 hrs for finer and medium denier silk.

BY-PRODUCT UTILISATION (SILK WASTE SPINNING)

On an average about 30 per cent of silk waste (on the weight of raw silk reeled) is being produced in the reeling sector, in both mulberry and non-mulberry fields in India. Besides this reeling waste, considerable quantity of pierced, cut and defective cocoons in silk reeling is available as waste cocoons in the sericulture industry. Utilisation of these silk wastes for spinning is a factor of vital importance. Inferior cocoons which are unsuitable for economic reeling process is also available. The quantity of silk waste may grow larger in the wake of modernisation in the process of reeling. All these varieties of silk waste may be processed for the production of spun silk yarn, which is nothing but pure silk thread, of course with less evenness as compared to reeled silk thread. There are 3 spun silk mills under public sector and about 5 small spun silk mills in private sector. These mills consume all the good waste produced in cottage basin/multiend reeling machines. However quite a bit of inferior quality silk waste such as charkha waste, basin refuse etc., is available unused. So CSTRI has taken up a programme of utilising such inferior silk waste on semi-mechanised spinning system such as Amber Charkha. CSTRI has designed and fabricated an improved pedal spinning wheel for effective spinning of quality yarn from cocoon waste.

SILK WEAVING

Silk weaving in India is totally traditional and is carried out to a large extent on handlooms and powerlooms taking a small portion of the total production. There are about 2,00,000 silk handlooms

Table III. Reeling performance and quality particulars of silk reeled on CSTR multiend reeling machine from multivoltine and bivoltine cocoons

Tableau III. Performance de la filature et qualité des paramètres de la soie des cocons polyvoltins et bivoltins dévidés à l'aide d'une machine multi-bouts du CSTR.

A	Reeling performances	Multivoltine	Bivoltine		
Sl. no.					
No.	Performances de dévidage	Polyvoltins	Bivoltins		
série					
I	Cocoon characteristics / <i>Caractéristiques des cocons</i>				
	1. Single cocoon weight / <i>Poids d'un seul cocon</i> (g)	1.63	1.591		
	2. Single shell weight / <i>Poids de la coque</i> (g)	0.27	0.318		
	3. Shell percentage/ <i>% de coque</i>	16.6	19.8		
	4. Ave. Filament length / <i>Longueur moyenne du fil</i> (m)	696	822		
	5. Ave. Non-breakable filament length (m)	497	673		
	<i>Longueur moyenne d'un filament sans casse</i>				
	6. Single cocoon filament denier / <i>Denier d'une balle</i> (d)	2.43	2.5		
II	Reeling characteristics / <i>Caractéristiques du dévidage</i>				
	1. Rendita / <i>Rendement à la bassine</i>	9.3	8.4		
	2. Waste percentage on silk weight	31.00	26.7		
	<i>pourcentage de perte du poids de la soie</i>				
B	Quality characteristics	M/V Silk	Grade	B/V Silk	Grade
Sl. no.					
No.	Critères de qualité	Soie univoltin	Grade	Soie bivoltin	
série					
1	Average size / <i>Taille moyenne</i> (d)	21.62		20.67	
2	Size deviation / <i>Déviaton du titre</i>	1.4	3A	1.57	2A
3	Maximum deviation / <i>Déviaton maximum</i>	2.64	6A	3.03	5A
4	Ave. Evenness / <i>Régularité</i> (%)	84	A	84	A
5	Ave. Cleanness / <i>Propreté moyenne</i> (%)	85	A	91	A
6	Ave. Neatness / <i>Netteté moyenne</i> (%)	84	C	90	2A
7	Winding breaks / 40 skeins/hour	8	3A	9	3A
	<i>Casses à l'enroulement/40 écheveaux/hr</i>				
8	Tenacity / <i>Ténacité</i> (g/d)	3.8	6A	4.1	6A
9	Elongation / <i>Elongation</i> (%)	24.5	6A	19.4	6A
10	Cohesion (strokes)	69	6A	60	6A
	<i>Cohésion</i>				

The overall grade of multivoltine and bivoltine raw silk reeled on CSTR Multiend Machine is 'C' and 'A' respectively. *Le grade de la soie grège provenant de vers polyvoltins et bivoltins dévidés sur la machine multi-bouts du CSTR est respectivement 'C' et 'A'.*

and about 40,000 powerlooms in India exclusively for silk weaving mostly in decentralised sector, comprising with small units. Most of the handlooms are fly-shuttle type and each place has its own traditional looms. Some improvements have been made in the primary and secondary motions of the loom. The use of improved handlooms enables weaving of much superior quality fabrics. However, these improved versions of handlooms are yet to reach the common weaver to the full extent.

Saree is the biggest item of production on handlooms as well as powerlooms in India. The handlooms weave sarees with all types of designs including complex motifs with the help of Dobby and Jacquard and also some designs that can be performed better only manually.

Fabric constructions such as Chiffon, georgette, crêpe, crêpe-de-chine etc. need highly twisted silk yarn. Twisting of silk requires a sequence of processes. This includes winding, doubling, twisting and steam setting.

The steam setting is done to set the twists in the yarn. This will avoid snarl formation, thereby allowing easier working of silk yarn. Twisting/throwing has also developed as an industry. There are many independent silk throwing factories in the country. There are about two lakh twisting spindles in the organised sector. There are also some composite units where the reeler takes up twisting.

The type of yarn preparation mainly depends on the type of fabric that is being woven. Chiffon, georgette and crepe need extensive yarn preparation.

In order to manufacture a quality fabric and with widths that are acceptable on the international markets, it is desirable that looms specially powerlooms for silk weaving are standardised.

A standard silk power loom should be of under pick type with box mechanism with metallic reed, dobby or jacquard, highly polished (chromium plated) rotating type back rest with warp and weft stop motions, with provision for weaving wide cloths. Superior quality yarns should be used as warp, while slightly inferior grade may be used as weft.

Generally cottage basin/multiend raw silk is used for warp and charkha silk is used for weft in the country. Twisted or thrown silk locally known as "Kathan" is used popularly for production of sarees and other silk fabrics on powerloom.

In southern India sarees are heavy in construction such as Kanjivaram, whereas in northern India the sarees are light and medium weight in construction. CSTRI has taken up a programme on improving the handlooms and powerlooms for silk weaving.

WET PROCESSING

One of the main characteristics of the Indian silk industry is an almost total lack of modern wet processing method. The term wet processing with reference to silk fabrics includes degumming, bleaching, dyeing, printing and finishing. This degumming and dyeing can be done either in yarn stage or fabric stage.

Soap and soda method of degumming is the conventional method of degumming. Modern methods like enzymatic degumming are also being practised in very few places in India. Studies on enzymatic degumming and acid degumming at low temperature are under progress in Central Silk Technological Research Institute laboratory.

Silk has affinity for various classes of dye stuffs. The dye stuffs recommended for silk include direct dyes, acid dyes, metal complex dyes, milling dyes and some of the reactive dyes. Though basic dyes, vats, solubilised vats, azoic dye and mordent dyes can be used for dyeing silk, their use is restricted because silk may not have ready affinity for some of these dye stuffs except basic dyes. Care should be taken while dyeing as some chemicals used in the dyeing bath may also tender the silk fibre. The dyeing method is extensively followed in India. Nowadays circular hank dyeing winch dyeing for silk fabrics is preferred.

In India, silk fabrics are generally printed by the manual printing methods, using either a block or a screen. Mostly acid dyes or metal complex dyes are used in printing. Recently some reactive dyes have also been found suitable. For getting decorative effects, pigments, khadi and gold printing can be carried out using synthetic polymer based binders and film forming compounds. Certain auxiliary chemicals which act as solvents, acid liberating agents and wetting agents can be added to enhance the yield of colours and quality of prints. Various types of thickening agents are used to increase the viscosity of printing paste to get sharp prints. Prints are fixed generally by steaming. Fixation of

pigments is done by curing in an electrically heated oven or oil heated chamber. Washing of the printed goods is done manually and drying is usually air drying.

Both dyed and printed silk fabrics have to undergo certain mechanical and chemical finishes to have certain desired effects. These treatments are generally known as finishing treatments. The conventional finishing treatment on silk includes calendering, weighting, scrooping, starch and glue finish etc. The purpose of finishing is basically to impart or improve certain desirable qualities like drape, fall, handle, feel, stiffness, weight etc., thereby enhancing both aesthetic value and utility. This also enables the fabric to fetch a better price in the market. Latest developments are also being made with regard to imparting certain special finishing such as antcrease and flame retardent finishes. CSTRI has undertaken a systematic research programme on finishing of silk fabrics.

The domestic market has settled down to accept the low quality of Indian silks, but the poor processing and lack of finishing has been pointed out in foreign markets. The Government of India, realising the importance of an alround study to expedite the process of improvement in the quality of Indian silk, appointed a committee to examine the various types of processing followed in various parts of the country and also to prepare a detailed project for the setting up of processing plants in different locations. This committee made a detailed study and came out with certain recommendations which are presently being materialised.

Pre-loom processing is conducted in almost all the States following the traditional level of technology i.e., manual processing in iron and copper vats on direct source of heat. Yarn and fabric processing with modern machines, under qualified dye masters take place only in a few integrated processing houses in Bombay, Bangalore, Delhi and Surat. The committee suggested different types of projects for various states taking into consideration, the type of weaving that is predominant in the state (yarn dyed and piece dyed), areas of concentration of handlooms/powerlooms, the market for the fabrics and the processing presently followed there.

One main disadvantage of Indian silk processing sector is that the industry is decentralised. Hence there is a great need to standardise the process parameters. The textile auxiliaries used during the process need to be tested before use. A centralised testing unit has to be established to facilitate this testing.

CSTRI has also a research programme under progress regarding reeling spinning, weaving and wet processing for tasar, eri and muga silk

REGULAR QUALITY CONTROL SYSTEM

CSTRI has already done useful work in standardising certain process technique and quality control.

Proper quality control steps have to be followed during the manufacturing process, right from silk reeling up to fabric finishing.

The quality control steps during silk yarn manufacturing includes appropriate cocoon drying, cocoon cooking, reeling, maintaining proper tension, speed, etc. The water used in reeling is of primary importance both in regard to the productivity and to the effect it has on the quality of silk thread. Properties of water used in reeling must be determined and suitable corrections should be made for hardness and soluble alkalinity. Hardness in water affects colour, lustre, softness etc., of the raw silk. Temperature of water in the reeling bath is another factor to be regulated.

Suitable reeling technique should be adopted depending on the cocoon quality. For example steam stifling, open pan cooking and reeling on cottage basin or on multiend reeling basin would be suitable for improved multivoltine hybrid cocoons whereas hot air drying, three pan or pressurised cooking, reeling on multiend or automatic machine would be suitable for bivoltine cocoons. Reeling of ordinary cross multivoltine cocoons may be done on charkhas. Therefore at least if systematic simple testing and classification of cocoons is followed, there will be considerable improvement in reeling performance as well as quality of raw silk reeled. CSTRI has evolved a simple method of cocoon testing and price fixing. The renditta of the cocoon lot can be assessed with the help of some constants derived from the actual reeling on the basis of raw silk percentage and the shell percentage of the cocoon lot in coordination with percentage of defective cocoons. Once the renditta and kakame cost is known the cocoon price can be calculated.

Raw silk should be subjected to various tests for assessing its quality. Testing and grading of raw silk is almost absent in Indian silk industry.

Some of the quality control steps during weaving and wet processing includes :

Proper yarn preparation, use of standard silk loom and maintaining right temperature and humidity conditions in weaving shed.

The dyeing process should be properly followed. The dyes and chemicals should be tested before use. The standard temperature and duration of dyeing should be properly followed. The mechanical and chemical finishing process should be standardised according to the end use of the fabric.

HUMAN SKILL/TRAINING

Adequate operative training is necessary in order to develop skill of the workers. As such CSTRI has made provision to impart practical training in post cocoon technology aspects. The Institute has established Demonstration cum training centres in several states with the prime objective of imparting practical training in reeling and spinning to the local candidates.

Along with maintaining proper process technology, the operatives should be properly trained before they are entrusted with the responsibility of production. CSTRI has been imparting practical training in silk reeling and other processes. This has resulted in good dividends in the silk industry.

Improvement in silk technology is in itself a desirable objective without reference to the question of the markets where the silk is sold. The Indian silk consumer today, is not aware of the characteristics of a good silk and consequently identifies good silk only with good and acceptable colour fastness and dimensional stability. The producers as well as the consumers have got used to, not only the inefficiently reeled and imperfectly woven better also imperfectly processed silk. This has created problems for Indian silk in international markets. Though presently only about 10 % of the country's production is exported, there will be a greater necessity and opportunity to push up the rate growth of exports in future. The necessity will arise from a vastly increased production envisaged in the 8th five year plan and opportunity will arise because of the diminishing role of Japan as a silk exporter and the change in China's export policy. A faster growing export in future will have to come partly from a shift in the export mix. It is well known that about 60 % of Indian exports today consist of the export of heavier varieties used for furnishings, upholstery and dress fabrics. While maintaining our importance in the international market in heavier fabrics of mulberry and tasar, we should try and produce more quality fabrics of better reeled, better woven and better processed silk.

CSTRI has formulated economically viable modern projects taking into consideration the socio-economic conditions of the country in silk reeling, twisting, weaving and wet processing.

SCREENING OF MULBERRY VARIETIES FOR RAINFED CONDITIONS

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About 52 % of the total sericultural area in Tamilnadu State, India, is under rainfed condition. Therefore, experimental studies were carried out during March-June 1990, with 6-month old six different varieties of mulberry (Local, M₅, MR₂, Roso, Kosen and C₁) to select the most suitable variety for rainfed conditions with good economic characters of silkworm, *Bombyx mori* L.).

To study the relative drought tolerance of different mulberry varieties, the level of free proline, relative water content (RWC), chlorophyll stability index (CSI), leaf fall percentage and average water loss by leaf, nutrient analyses, leaf yield component characters associated with leaf productivity and economic characters of silkworm were studied.

From the preliminary investigation taking into account all the above parameters, most particularly relative water content, chlorophyll stability index, relative water loss, leaf yield characters and economic characters of the silkworm, it may be mentioned that C₁ and Kosen could be recommended for rainfed conditions.

Keywords : Chlorophyll stability index, relative water content, nutrient analysis, effective rate of rearing.

INTRODUCTION

In developing countries like India, the mulberry (*Morus alba* L.) is being exploited in several ways to improve the quality of the leaf as well as its yield for commercial production of silk, as the mulberry is the chief food of the silkworm, *Bombyx mori*. The wide range of climatic conditions interlaced with varied constraints in management practices is characteristic of Indian Sericulture. Although attempts are made to solve the problem of irrigation in India, mulberry is still cultivated as a rainfed crop in about 50 % of the land in the southern parts of India. About one third of world's potentially arable land suffers from inadequate supply of water and on most of remainder crop yields are periodically reduced by drought (Kramer, 1980). Differences between species and cultivars with respect to their relative drought resistance have been observed and currently attempts are being made to improve the water use efficiency of crop plants (Morgan, 1980). Limited irrigation potential, depleting ground water source and prolonged dry and hot summer are the major limiting factors for further spread of sericulture in most parts of Tamilnadu, India, where sericulture has been extensively introduced in recent years. Summer extends from March to June with little (25 mm) or no rainfall high temperatures (21 °C to 34 °C) and low humidity (55-65 %).

Of the various factors attributed to the lower yield of silk per unit area, the poor quality of the leaf draws utmost attention. In Tamilnadu, Local and M₅ varieties are widely cultivated which do not meet the regional requirements because of production of low quality leaves. Success in sericulture industry and its ultimate profitability thus depends on the production of good quality leaves at an economical cost. This necessitates the introduction of a number of mulberry varieties to suit the local conditions along with good yield both in quality and quantity. Therefore, necessary steps of screening

and evaluation of new varieties will have to be systematically followed so as to ensure its successful propagation and sustenance (Bongale, 1990). Although work has been done on application of N-fertilizers and the effects of intercropping on mulberry in dry land farming (Kasiviswanathan *et al.*, 1977), evaluation of mulberry varieties has not been considered seriously hitherto correlating leaf yield and quality with silk production (Sikdar *et al.*, 1983 ; Venugopala Pillai and Krishnaswami, 1989 ; Mathur *et al.*, 1989).

Steps have been taken in the present study to evaluate a better mulberry variety suited for rainfed conditions of Tamilnadu from among the seemingly promising varieties and it is hoped that it might lead to further improvements of sericulture in Tamilnadu.

MATERIALS AND METHODS

In the present study to exploit a more suitable rainfed mulberry crop for Tamilnadu conditions, the seemingly promising varieties (Local, M₅, MR₂, C₁, Kosen and Roso) were collected from the Mulberry Germplasm Bank (Government Mulberry Farm, Conoor, Tamilnadu, India and planted in the mulberry garden, Botany Department, Bharathidasan University, Tiruchirappalli-620 024) during September 1990.

For mulberry plantation pits of 14" length, 14" width and 14" depth were prepared with optimum spacing of 3' × 3' and the cuttings of six different mulberry varieties were planted according to the procedure of Krishnaswamy (1978).

Experimental studies were carried out during March to June 1990 with six-month-old mulberry plants. The sprouting percentage of each mulberry variety was calculated by counting the rooted saplings. About 10 plants were randomly selected for recording data on the leaf yield component characters, namely plant height, average branch height, branch number per plant, leaf number per branch, leaf number per plant, leaf size, single leaf weight, internodal distance, stem weight per plant and leaf yield per unit area.

And all the six varieties medium (8th node) leaves were taken for biochemical studies. Chronoplast pigments (Arnon, 1949 ; Goodwin, 1954), total soluble proteins (Lowry *et al.*, 1951), total soluble sugars (Dubois *et al.*, 1956), total nitrogen (Umbriet *et al.*, 1972), total free amino acids (Troll and Canan, 1953), total sucrose (Van Haxdel, 1968), total phenols (Swain and Hillies, 1959) and total free proline (Bates *et al.*, 1973) were quantified to find out the superiority of leaf nutrients of different mulberry varieties under stress.

Relative drought tolerance parameters like chlorophyll stability index (Murphy and Majumder, 1962), relative water content (RWC), moisture content, average water loss per day and leaf fall percentage were also studied.

In order to select successfully crop for rainfed conditions, feeding trial experiments were conducted and the common economic characters of silkworm were studied and recorded. The data collected were expressed in mean ± S.D.

RESULTS AND DISCUSSION

The soil data of the mulberry garden of the Botany Department (Bharathidasan University, Tiruchirappalli-620 024, Tamilnadu, India) revealed that the soil was alkaline with pH and EC values of 8.1 and 0.6 μ mhos respectively. The available N and P (70.0 and 4.41 kg respectively per acre) was low in the soil whereas the K was 250 kg/acre). According to Basavanna and Bose (1989) the soil with above pH and EC values also well suited for the cultivation of mulberry with minor fertilizer inputs.

The sprouting percentage of rooted saplings of Local, M₅, MR₂, C₁, Kosen and Roso varieties was 80 to 92 % (Table I). The above observation is further supported by the finding of Nakagawa and Naoi (1982).

The data on the leaf yield contributing characters of six different mulberry varieties are presented in Table I. The results obtained indicated that the total leaf yield and its component characters are positively correlated, most particularly with branch height, leaf number per branch, leaf size, single leaf weight and stem weight. Leaf yield is a very complex trait directly or indirectly controlled by a

Table I. Leaf yield component characters associated with productivity in different mulberry varieties.

Tableau I. Composants du rendement en feuilles associés à la productivité chez différentes variétés de mûriers.

Mulberry varieties Variétés de mûriers	Sprouting percentage Pourcentage de bourgeonnement	Plant height (cm) Hauteur du plant (cm)	Average branch height (cm) Hauteur moyenne des branches (cm)	Number of branches/plant Nombre de branches/plant	Leaf number /branch Nombre de feuilles/branche	Leaf number /plant Nombre de feuilles/plant
Local	91.00 ± 1.41	141.60 ± 10.20	124.00 ± 13.50	4.80 ± 0.66	31.80 ± 6.20	140.00 ± 15.00
M ₅	90.40 ± 9.70	129.00 ± 9.40	102.00 ± 2.80	4.50 ± 0.50	35.40 ± 6.43	152.00 ± 4.00
MR ₂	82.20 ± 12.40	134.00 ± 4.00	101.00 ± 15.60	9.00 ± 1.00	46.00 ± 8.55	162.50 ± 5.50
C ₁	83.52 ± 14.70	145.00 ± 18.70	112.00 ± 2.60	6.00 ± 2.00	41.40 ± 4.88	158.50 ± 8.50
Kosen	81.65 ± 18.40	144.00 ± 12.00	109.00 ± 17.30	5.00 ± 1.70	42.40 ± 9.10	172.50 ± 2.50
Roso	86.85 ± 1.80	142.00 ± 7.5	123.00 ± 12.50	3.50 ± 0.50	37.40 ± 3.80	87.40 ± 12.30

Table I. Continued / Tableau I. Suite

Mulberry varieties Variétés de mûriers	Leaf area (cm ²) Surface foliaire (cm ²)	Single leaf weight (g) Poids d'une feuille (g)	Internodal distance Distance internodale	Stem fresh weight/plant (g) Poids frais de tiges/plant (g)	Total leaf productivity (g/plant) Productivité totale en feuilles (g/plant)
Local	97.66 ± 8.50	1.572 ± 0.060	4.40 ± 0.20	266 ± 4	228.67 ± 13.60
M ₅	123.40 ± 4.60	2.109 ± 0.170	3.40 ± 0.20	235 ± 15	312.67 ± 7.90
MR ₂	129.90 ± 12.80	2.174 ± 0.230	3.20 ± 0.40	230 ± 20	348.67 ± 10.90
C ₁	177.90 ± 6.80	3.172 ± 0.30	5.59 ± 0.60	425 ± 20	376.00 ± 9.00
Kosen	162.80 ± 5.5	3.084 ± 0.260	2.58 ± 0.20	281 ± 1	373.00 ± 8.60
Roso	110.00 ± 16.90	1.642 ± 0.170	4.00 ± 0.20	251 ± 9	178.33 ± 9.5

Table II. Chlorophyll pigment composition of different mulberry varieties.

Tableau II. Composition en pigments chorophylliens chez différentes variétés de mûriers.

Mulberry varieties <i>Variétés de mûriers</i>	Total chlorophyll <i>Chlorophylle totale</i>	Chlorophyll a <i>Chlorophylle a</i>	Chlorophyll b <i>Chlorophylle b</i>	Chlorophyll a/b ratio <i>Rapport chlorophylle a/b</i>	Total carotenoides <i>Caroténoïdes totaux</i>
Local	1.46 ± 0.01	0.88 ± 0.07	0.58 ± 0.30	1.51 ± 0.23	0.50 ± 0.06
M ₅	1.39 ± 0.20	0.85 ± 0.10	0.54 ± 0.15	1.57 ± 0.66	0.45 ± 0.16
MR ₂	1.62 ± 0.09	0.96 ± 0.23	0.65 ± 0.06	1.46 ± 0.34	0.61 ± 0.11
C ₁	1.76 ± 0.09	1.04 ± 0.05	0.72 ± 0.07	1.44 ± 0.71	0.68 ± 0.12
Kosen	1.92 ± 0.13	1.06 ± 0.01	0.86 ± 0.02	1.23 ± 0.5	0.70 ± 0.32
Roso	1.17 ± 0.05	0.71 ± 0.16	0.46 ± 0.06	1.54 ± 2.66	0.36 ± 0.25

The values are expressed in mg/gfw.

Les valeurs sont exprimées en mg/g de poids frais.

Table III. Nutrients analyses in different mulberry varieties.**Tableau III. Composition en éléments nutritifs chez différentes variétés de mûriers.**

Mulberry varieties <i>Variétés de mûriers</i>	Total soluble proteins <i>Protéines solubles totales</i>	Total nitrogen <i>Total azote</i>	Total soluble sugars <i>Total sucres solubles</i>	Total sucrose <i>Sucrose totale</i>	Total free amino acids <i>Acides aminés libres totaux</i>	Total free proline <i>Proline libre totale</i>	Total phenols <i>Phénols totaux</i>
Local	193.0 ± 1.0	145.6 ± 0.24	56.4 ± 0.24	52.8 ± 1.00	33.5 ± 0.50	0.18 ± 0.30	47.6 ± 0.20
M5	204.1 ± 0.5	134.4 ± 0.44	78.2 ± 0.40	56.0 ± 0.80	21.3 ± 0.50	0.23 ± 0.06	31.2 ± 0.50
MR2	259.0 ± 1.0	212.8 ± 0.50	104.7 ± 0.88	70.4 ± 0.60	50.0 ± 0.20	0.37 ± 0.01	47.0 ± 0.60
C1	231.1 ± 0.9	164.4 ± 0.50	95.0 ± 10.0	56.4 ± 10.0	21.3 ± 0.52	0.25 ± 0.20	25.2 ± 0.65
Kosen	220.0 ± 1.0	179.2 ± 0.50	74.5 ± 0.50	56.8 ± 0.20	47.5 ± 0.24	0.25 ± 0.10	28.8 ± 0.50
Roso	151.0 ± 1.0	140.8 ± 0.40	40.7 ± 0.77	48.6 ± 0.77	29.3 ± 1.0	0.23 ± 0.10	42.0 ± 10.0

The values are expressed in g/gfw.

Les valeurs sont exprimées en g/g de poids frais.

Table IV. Relative drought tolerant parameters in different mulberry varieties.

Tableau IV. Paramètres de tolérance à la sécheresse relative chez différentes variétés de mûriers.

Mulberry varieties <i>Variétés de mûriers</i>	Chlorophyll stability index <i>Indice de stabilité de la chlorophylle</i>	Relative water content <i>Contenu relatif en eau</i>	Moisture content (%) <i>Contenu en humidité</i>	Average water loss (%) <i>Perte moyenne en eau</i>	Leaf fall percentage <i>Pourcentage de chute de feuilles</i>
Local	17.0 ± 3.7	1.44 ± 0.03	62.0 ± 1.0	46.0 ± 0.5	24.5 ± 0.5
M5	20.7 ± 3.3	1.39 ± 0.03	63.0 ± 0.5	40.0 ± 0.8	26.5 ± 0.5
MR2	13.0 ± 3.7	1.52 ± 0.04	67.0 ± 1.0	45.2 ± 0.2	11.0 ± 1.0
C1	12.3 ± 2.1	1.58 ± 0.04	69.0 ± 0.8	31.5 ± 0.5	27.9 ± 0.07
Kosen	8.0 ± 1.6	1.62 ± 0.05	72.0 ± 1.0	32.5 ± 0.5	6.13 ± 0.12
Roso	13.3 ± 1.9	1.49 ± 0.04	56.0 ± 2.0	41.0 ± 1.0	27.5 ± 0.5

Table V. Effect of different mulberry varieties on cocoon and silk characters of the silkworm, *Bombyx mori* L.

Tableau V. Effets des différentes variétés de mûriers sur les caractères du cocon et de la soie chez le ver à soie *Bombyx mori* L.

Mulberry varieties Variétés de mûriers	Coefficient of digestibility (%) Coefficient de digestibilité (%)	Cocoon length (cm) Longueur du cocon (cm)	Cocoon width (cm) Largeur du cocon (cm)	Cocoon weight (g) Poids du cocon (g)	Shell weight (mg) Poids de la coque	Pupal weight (g) Poids de la chrysalide (g)
Local	45	3.28 ± 0.06	1.43 ± 0.03	1.130 ± 0.04	161.5 ± 0.5	0.789 ± 0.5
M5	41	3.09 ± 0.05	1.52 ± 0.01	1.171 ± 0.06	178.0 ± 1.0	1.033 ± 0.01
MR2	49	3.55 ± 0.08	1.66 ± 0.03	1.279 ± 0.04	192.5 ± 2.5	1.032 ± 1.5
C1	49	3.57 ± 0.03	1.64 ± 0.03	1.226 ± 0.04	192.0 ± 1.0	0.958 ± 1.5
Kosen	54	3.61 ± 0.06	1.79 ± 0.07	1.320 ± 0.02	223.0 ± 3.0	1.078 ± 0.03
Roso	45	3.10 ± 0.05	1.43 ± 0.04	0.959 ± 0.02	150.0 ± 0.5	0.790 ± 0.01

Table V. Continued / Tableau V. Suite

Mulberry varieties Variétés de mûriers	Floss weight (mg) Poids de la blaze	Shell ratio Richesse soyeuse	ERR (%) Taux effectif d'élevage (%)	Filament length (m) Longueur du filament (m)	Silk weight (mg) Poids de la soie (mg)	Denier of silk Denier de la soie
Local	25.2 ± 2.0	14.0	85.5 ± 0.5	710 ± 8.2	166 ± 6.6	2.1
M5	22.0 ± 3.0	15.0	81.0 ± 1.0	690 ± 10.8	175 ± 1.1	2.3
MR2	8.5 ± 1.5	15.0	70.5 ± 4.5	814 ± 10.2	204 ± 3.3	2.2
C1	12.0 ± 1.0	15.7	77.0 ± 1.0	778 ± 2.1	186 ± 9.4	2.2
Kosen	22.0 ± 1.0	17.0	61.0 ± 1.0	978 ± 12.5	254 ± 4.1	2.4
Roso	16.0 ± 3.0	15.5	72.0 ± 2.0	610 ± 10.7	157.5 ± 7.5	2.2

number of component characters. Hence, a comprehensive knowledge on the component characters is of great importance for adopting proper selection indices (Bari *et al.*, 1989).

Among the six mulberry varieties studied, MR₂, C₁ and Kosen showed good leaf component characters which lead to increased leaf productivity. In Kosen (2.58 cm) and MR₂ (3.2 cm) internodal distance was shorter, number of branches per plant was higher in MR₂ (9) and C₁ (6), compared to the Local and M₅ (4). Leaf size and single leaf weight were most significant in C₁ and Kosen as large and weighty leaves with short internodes are generally desirable genotypic characters (Rangaswami *et al.*, 1976 ; Ogieri, 1977). From this point of view, C₁ and Kosen may be considered to be best suited for rainfed conditions, besides, MR₂ with its maximum number of branches and leaves with less stem weight per plant also suited for drought conditions.

As far as nutrient analyses are concerned, the levels of nutrients were higher and significant in MR₂ (Tables II and III) and this is in agreement with the investigation of Thangamani and Vivekanandan (1984). Noticeably low levels of nutrients were observed in Roso. Total soluble proteins and total sucrose were moderately significant in C₁. The total nitrogen content was higher in Kosen (18 %) and C₁ (16 %). The data obtained on both Local and M₅ revealed a similar quantity of nutrients. This observation is strongly supported by Sen and Benchamin (1990) in that both Local and Kanva-2 (M₅) were nutritionally of the same quality. The total free proline which is generally considered as one of the drought tolerance parameters showed higher levels in MR₂ (0.37 mg/gdw), C₁, and Kosen (0.25 mg/gdw).

The chlorophyll stability index, relative water and moisture contents and leaf fall percentage were positively correlated in Kosen and thereby the variety could be considered to be more drought tolerant. The average water loss per day was minimum in C₁ variety but the leaf fall percentage was higher (28 %) (Table IV).

Silkworm rearing was done at 20 to 21 °C with 80 % relative humidity (RH) using the silkworm breed L×NB₄D₂. In the economic characters of the silkworm (*Bombyx mori*) the order of performance was Kosen, C₁, MR₂, M₅, Local and Roso (Table V) With respect to silk character, Kosen was superior especially with filament length (978 m) and silk weight (254 mg) and this could be compared with the results of Venugopala Pillai (1989). The coefficient of digestibility of mulberry leaves was optimum (50 %) effective rate of rearing (ERR). C₁, MR₂ and Kosen exhibited about 60 % of ERR.

Among the cocoon characters, significantly maximum cocoon weight was observed in Kosen (1.320 g) followed by MR₂. The highest shell weight of 223 mg was also noted in Kosen variety.

In conclusion, the preliminary investigation in finding out a suitable mulberry variety for rainfed conditions among a few varieties tested revealed that C₁ and Kosen could be recommended based on drought tolerance, leaf yield component characters and levels of available nutrients and rearing experiments. MR₂ variety was superior in nutrient contents but in the cocoon characters its performance was only second to C₁ and Kosen. Roso variety was inferior in all evaluation parameters employed. The performance of Local and M₅ varieties was intermediary with minimum leaf yield.

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