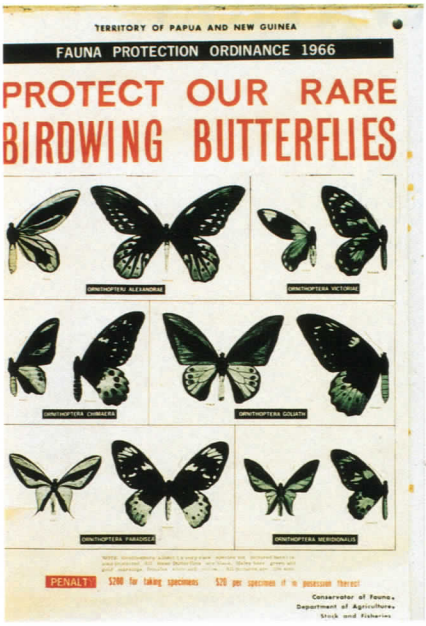
THE BUTTERFLY FARMING AND TRADING INDUSTRY IN THE INDO-AUSTRALIAN REGION AND ITS ROLE IN TROPICAL FOREST CONSERVATION


TERRITORY OF PAPUA AND NEW GUINEA
FAUNA PROTECTION ORDINANCE 1966
PROTECT OUR RARE
BIRDWING BUTTERFLIES
ORNITHOPTERA ALEXANDRAE
ORNITHOPTERA VICTORIAE
ORNITHOPTERA CHIMAERA
ORNITHOPTERA GOLIATH
ORNITHOPTERA PARADISEA
ORNITHOPTERA MERIDIONALIS
PENALTY
Conservator of Fauna,
Department of Agriculture,
Stock and Fisheries

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THE BUTTERFLY FARMING AND TRADING INDUSTRY IN THE INDO-AUSTRALIAN REGION AND ITS ROLE IN TROPICAL FOREST CONSERVATION

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ABSTRACT.– The events in the establishment of the concepts and principles of butterfly farming in the Indo-Australian Region are chronicled. The question is posed as to whether harnessing the wealth provided by the tropical butterfly trade in this way can be truely effective in tropical forest protection. Topics such as ill-conceived legislation affecting the international butterfly trade, and the controversy concerning overcollecting, are discussed. It is shown that by using certain now well-tested methods, and if properly implemented under government supervision, the system can indeed be very beneficial in conservation of tropical forests. Coupled with appropriate legislative restrictions to cut out middle-men, it can be very effective in utilising this highly sustainable resource and directing the valuable funds it provides back into habitat protection. It is argued that the butterfly farming system can provide rural economies with much needed income which reduces the financial need for peoples living in or adjacent to tropical forests to non-sustainably exploit them. Thus it directly promotes forest conservation, as well as indirectly through its associated educational attributes. Based on the author's extensive field experience, and a number of problems that have been experienced in project startup in various countries in the past, particularly through lack of funding, it is concluded that regional butterfly farming projects could be far more effectively achieved if established through a dedicated umbrella organisation. This would be best set up and coordinated within an already existing international conservation body.

KEY WORDS: *Argema*, Aristolochiaceae, *Atrophaneura*, Australia, *Bhutanitis*, birdwings, China, collecting controversy, *Coscinocera*, economics, government policies, *Graphium*, Hong Kong, *Idea*, India, Indonesia, Insect Farming and Trading Agency, Japan, Korea, Lasiocampidae, legislation, Malaysia, Nymphalidae, *Ornithoptera*, *Papilio*, Papilionidae, Papua New Guinea, *Parnassius*, Saturniidae, Solomons, Sri Lanka, Taiwan, Thailand, *Trogonoptera*, *Troides*, Vietnam, World Wide Fund for Nature.

The aesthetic appeal and positive appreciation of butterflies is almost universal amongst humans. Throughout the centuries, and especially in the present era, thousands of people have studied butterflies with a zeal that often approaches, perhaps sometimes even surpasses, a religious fervour. Who can fail to marvel at a cabinet display of the world's largest and arguably most impressive swallowtails, the *Ornithoptera* (Papilionidae)? For reasons of their beauty and benignity butterflies have developed great intrinsic value, with the result that a large and important industry has built up around them in order to supply the demands of thousands of collectors worldwide.

One of the better analogies of butterfly collecting by the amateur is that of stamp collecting. Like stamps, butterflies offer a combination of characteristics that are difficult to resist: beauty, variety, color, and a sense of the exotic. Certain unique specimens with aberrant color patterns, or those that are considered to be rare or hard to come by, like their stamp counterparts realize high individual prices and may be collected for this reason. Such collecting frequently leads to specialisation in groups that provide the greatest attractiveness, and this, in turn, may lead to true scientific appreciation and study of the particular group, perhaps the best example being the Papilionidae.

The world trade in butterflies alone has been estimated at as much as US$ 100 million per annum, much of which originates in the Indo-Australian Region. Most of this revenue continues to be channelled into the pockets of 'middle-men' and end dealers. However, if controlled at its various sources by specially set up government agencies, a great percentage of this wealth can be put back into rural economies. This can greatly benefit conservation of natural habitats, especially those areas that remain prone to pressures of population growth and development. Importantly, this therefore benefits the conservation of the very butterfly popula-

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Fig. 1-10.– 1. Waidoro Villager (Western Province, PNG) wearing a traditional headdress featuring adornments of *Ornithoptera priamus poseidon* wings. 2. Misima Island butterfly farmer inspecting *Ornithoptera priamus caelestis* and *Atrophaneura polydorus aignanus* pupae in an eclosion cage at Gulewa Village (June 1991). 3. Misima Island butterfly farmer inspecting an indigenous *Aristolochia* foodplant, supported by a simple pole, on his farm at Gulewa Village (June 1991). 4. Fauna Protection Ordinance protected *Ornithoptera* poster displayed during the Australian era of the Administration of PNG (circa 1968). 5. A crop of *Ornithoptera priamus urvillianus* pupae hung on a raised pole for protection at a butterfly farm near Buin, Bougainville, PNG (Mar. 1979). 6. Papered *Ornithoptera priamus urvillianus* awaiting shipment from a butterfly farm near Buin, Bougainville, PNG (Mar. 1979). 7. Member of the PNG IFTA staff sorting and repacking specimens mailed into the Agency headquarters by butterfly farmers/collectors. 8. *Ornithoptera priamus urvillianus* in cop. — an easily farmed Solomon Islands subspecies that has constantly good market demand and value. 9. Butterfly farmers/collectors frequently personally bring their stock into the PNG IFTA to sell (ensuring its safe arrival and their quick payment), and will occasionally assist staff to sort, count and repackage their merchandise. 10. Two huge larvae of one of the world's largest moths, *Coscinocera hercules* (Saturniidae) from PNG, a commercially valuable species that is extremly popular with collectors.


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tions that are the foundation of the trade, and through associated research can provide particular protection to rare or endangered species. For over a decade, this type of ecologically safe system of exploitation of tropical butterflies, mainly originating from forest habitats, has been carried out in Papua New Guinea (PNG) to meet the huge demand for many of its spectacular endemic species. Based on this experience, the coordinated techniques of this sustainable development style project have subsequently been introduced into other countries in the Indo-Australian Region (IAR), notably to assist in the protection of a complex of five major forest reserves in the tropical Xishuangbanna National Nature Reserve region of southern China.

Butterfly farming conforms very well to the World Conservation Strategy (WCS), a global plan which especially emphasises protection of the biodiversity of tropical forest ecosystems. The well-tested butterfly farming system has been carefully devised to balance aspects of both conservation and commerce: particularly to promote habitat conservation, whilst simultaneously providing people in rural areas with a beneficial income. It also provides valuable income and education through its strong associations with ecotourism. Based on my 13 years experience of work in this field, and with reference to the available literature on the subject, the following attempts to chronical (and of necessity summarize) the successes and past problems of the system, and its benefits in the protection of tropical forest and effective rural land-use.

EXOTIC EXPORTS

The casual visitor to a village or institutional butterfly farm in the tropics will often express some astonishment at the fact that butterflies are the primary subject of animal husbandry. Such people are doubtless more accustomed to the commonplace scene of domestic animals, such as cattle or chickens, under farming conditions. The novelty of insect livestock tends to be a great stimulus to the senses, especially when it is learned that, gram for gram, exotic butterflies are far more valuable than cattle or, some species, even gold. As Morris (1986) well stated "The notion of 'butterfly farming' has variously excited amazement, incredulity, amusement or even contempt, but has always intrigued outside observers." The term "farming" is used loosely here to include also ranching as, strictly speaking, farming applies to those animals wholly reared in captivity, whereas ranching more aptly applies to situations on butterfly farms where adults and larvae move freely about their uncaged foodplants, only the pupae being brought into captivity. Indeed the physical caging of the adults of some species together with their larval foodplants is often unnecessary to encourage females to oviposit, and can be counterproductive for large species such as *Ornithoptera* if the available space is limited (Parsons, 1980b).

As pointed out by Pyle and Hughes (1978) and Pyle (1981), the trade in butterfly deadstock consists of two basic components: 1. Low quantity/high value (the specialist trade); 2. High quantity/low value (the decorative trade). Over the last decade there has grown an important third category of export: livestock. All three trade categories have been discussed at length by Collins and Morris (1985) and Morris (1986). In the first category, which has been traditionally followed by PNG, the specimens marketed overseas (usually papered in triangular envelopes: Fig. 6) are mostly of the highest possibly quality, often being ex-pupa, a percentage of which are farmed. Every attempt is made to also include with each of them accurate data of their original collecting or breeding localities. Therefore, besides being of interest to dealers and amateurs, such specimens are also of great interest to scientists, often ending up in museums and other institutional collections.

The second export category typically originates in many Oriental countries, including Thailand and Malaysia, but most notably Taiwan. It comprises the greater majority of the world's butterfly exports and invariably includes the commonest species that can be obtained in large numbers with relative ease. Specimens are often of low quality in that the condition of their wings is not perfect. With the rapid rise in popularity of the "butterfly house" over the last decade, particularly in the United Kingdom where there were 45 such facilities by 1987 (Collins, 1987), but also in countries such as Australia (e.g., Rolfe, 1973) (Fig. 28) and Japan (Figs. 14, 16 and 17), there has been a reciprocal increase in demand for butterfly livestock.

A CHALLENGE

All physical resources are finite. Although biological resources fit this category they are also self-renewing. Nevertheless, they are threatened by continual human population increase and the attendant growth in industrialization. Unfortunately, the rate at which this is now proceeding usually precludes the integration of effective conservation with industrial development. Thus a major concern is how best to utilize such resources in a world where both human populations and people's aspirations are rapidly increasing (Morris, 1986). In 1980 the International Union for the Conservation of Nature and Natural Resources (IUCN) developed a World Conservation Strategy (WCS) which recognizes the people's right to develop, as well as the inevitability of this, but which promotes the concept of development projects that are environmentally well integrated, and which actually promote the conservation of these environments over the long-term (e.g., McNeely, *et al.*, 1990). The dilemma of conservation versus development in Papua New Guinea was aptly summed up by

Fig. 11-18.– 11. PNG IFTA staff member holding cocoons and newly eclosed male and female of farmed *Coscinocera hercules*. 12. Butterflies that come onto the international market from the Neotropics are predominantly wild collected from the field, often by children, as in the Buga region of Colombia (April 1983). 13. Range of tourist gift items for sale at the PNG IFTA. 14. Young visitors (entomologists and conservationists of the future) are enthralled to see the diversity of Lepidoptera displayed at Tama Zoo Insectarium, Tokyo, Japan. 15. The author and Provincial Wildlife Officer, Mr Eddie Malaisa, carrying out all-important educational extension work about butterfly farming and tropical forest conservation at a village near Afore, Northern Province, PNG (May 1991). 16. *Idea leuconoe* Erichson (Nymphalidae) imbibing sugar water from an artificial flower feeder at the Tama Zoo Insectarium, Tokyo, Japan. This large, slow-flying species, which just ranges into southernmost Japan, makes an impressive live display in the zoo's butterfly flight house. 17. View from inside the huge aluminium framed, moth-shaped flight house at Tama Zoo Insectarium, Tokyo, Japan through which many thousands of domestic and foreign visitors file each year. Because of restrictions on importing livestock from other countries, only Japanese Lepidoptera (mainly butterflies) are flown at the zoo. Nevertheless, the insectarium complex is consistently an extemely popular attraction. 18. The Sanchahe Butterfly Farm flight cage dome in southern China — steel framed and clad with fine-guage stainless steel mesh.


西双版纳自然保护区
野生蝴蝶饲养繁殖
试验场
SANCHAHE BUTTERFLY FARM

Peter Ellyard (in Webb, 1977) who stated "PNG is custodian of one of the world's greatest tropical lowland forest resources; it is also committed to the development of a significant proportion of that resource. In the country's constitution, the National Goals and Directive Principles clearly direct the country's development into an Ecodevelopment pathway. However, the translation of those goals into practice, when sources of overseas capital are not necessarily dedicated to those same National Goals, is not easy."

Butterflies and other insects provide a very good example of a utilizable, sustainable resource, even though they are of no use to man in his three main categories of needs: food, fuel and shelter. Since the majority of Papilionidae and other butterflies are tropical forest species, it is from these regions of the world that there is the greatest demand by the butterfly trade. Unfortunately, however, with the steep rise in human population in these 'developing' regions of the world, with great interest in the timber which the tropical forests contain, and similarly in the potential value of the land on which it stands for agriculture, the main source of the butterfly trade has come under increasingly serious threat and now faces its ultimate demise. On the positive side, however, it has already been shown that the butterfly farming system can play a vital role in locally halting, and even reversing, the incessant trend towards a complete global destruction of tropical forests. Morris (1983) concluded "Although butterfly farming can never contribute greatly to the national economy, it has a useful supportive role and can introduce an element of diversification and provision of a cash crop to village subsistence agriculture ... There is certainly a lesson to be learned from the buttefly farmers of PNG for the conservation of other resources, most notably tropical rain-forest." The National Research Council (NRC, 1983) stated that "The program ... could become a force in preventing clear-felling of the forest for timber exports or the wholesale conversion of rain forests to cash-crop monocultures ..." Simcox and Calvert (n. d.) stated the case aptly: "Recently, conservationists have begun to realize that it is immoral to expect poor people in developing countries to conserve rainforest just because it is attractive to look at. There are currently many projects in operation to help forest dwellers to earn a good income from the forest, without destroying it. This theory is called 'conservation by sustainable yield'. Butterfly farming is becoming recognized as an alternative income to clearing rainforests."

Thus, the challenge is obvious: Can the tropical butterfly trade, with its great potential as a renewable resource, be truely effectively used in preventing tropical forest destruction, in the face of the incessant depredation of tropical forests?

ORIGINS OF FARMING CONCEPTS

THE DEMAND BEGINS

The tropical butterfly trade has its origins in the earliest days of maritime exploratory expeditions from Europe to various parts of the world. As early as the seventeenth century impressive butterfly specimens had reached Europe from the Dutch trading colonies. The period marked the start of more concerted efforts at amassing natural history specimens from the Indo-Australian Region (IAR). Such collections invariably included the more spectacular butterfly species, especially swallowtails, already renowned for their size and beauty.

The first sizeable zoological collections from the IAR, were made by noted naturalist, Englishman Alfred Russel Wallace, who was particularly interested in Papilionidae (Wallace, 1865 and 1869). From such beginings there grew, in Europe, an ever-increasing interest in the butterflies of the region. This was to reach the height of its fervour in Victorian times and the early 1900s, and was greatly accelerated by the sponsorship of various collectors, notably Alfred Stanley Meek (e.g., Meek, 1913) by the wealthy British collector Lord Walter Rothschild.

The roots of the mail order butterfly trade can also be found in the latter phases of exploration in the IAR. With increasing improvements in communications by sea, including the advent of a basic postal service, a period began when various European churches took the opportunity to settle in countries like New Guinea in order to make converts. This was to the advantage of certain home-based Lepidopterists, not fortunate enough to be able visit the region for themselves, who were then able to recruit the services of sympathetic missionaries to provide them with material for study. For example, missionary, Rev. Diamond Jenness, based at Bwaidoga Mission on Goodenough Island, in Papua New Guinea (PNG), during the years 1911 and 1912, was asked to collect butterflies and other insects for Prof. E. B. Poulton of Oxford University, England, including the distinctive *Graphium weiskei goodenovii* Rothschild, still only known by two males.

In contrast to the Victorian zenith of butterfly collecting, the advent of the First World War turned minds to matters of more immediate concern, and the outbreak of the Second World War almost entirely halted the pastime. Yet collectors did still operate, even those actively engaged in battle preparations. For example, Wyatt (1955) pointed out that, during the WW II years, *Ornithoptera* came to be highly prized for their market value by Australian and American servicemen fighting in New Guinea. Because of the beautiful transluscent golden-yellow scaling on the wings of some

Fig. 19-28.– 19. Colombian girl collector with a wild-collected swallowtail (April 1983). 20. Loosely woven split bamboo *Aristolochia* trellises under construction in the foodplants nursery at Sanchahe Butterfly Farm, Mengyang Reserve, Xishuangbanna, southern China (Sept. 1990). 21. Like many visitors, Chinese photographers of the Yunnan press from the provincial capital, Kunming, show great interest in the spectacular butterflies of southern tropical China (part of the YFB DIFT collection). 22. Chinese girl at Sanchahe Butterfly Farm, Mengyang Reserve, Xishuangbanna, southern China admires a freshly eclosed ♀ *Argema maenas* — a beautiful and valuable long-tailed silkmoth that is easily farmed on chestnut or oak leaves. 23. The Yunnan Forestry Bureau Butterfly Farming Project staff and the author (WWF consultant) with the Sanchahe Butterfly Farm entrance sign. 24. Member of Yunnan Forestry Bureau Butterfly Farming Project killing farmed specimens of *Troides helena* and *T. aeacus* by thoracic injections of small amounts of near absolute alcohol. 25. Yunnan Forestry Bureau Butterfly Farming Project staff inspecting the previous night's catch by the project's Mercury Vapour moth trap, constructed entirely from locally available materials. Running such a trap can provide local villages with many dollars income per week, with little capital outlay. 26. *Troides (Trogonoptera) brookiana* ♂ feeds on the damp ashes of an old campfire in Brunei. An extremely popular primarily Malaysian species, it has been collected in the thousands over at least the last 100 years to supply the international butterfly trade, more recently mainly for the artwork part of the market. 27. Yunnan Forestry Bureau Butterfly Farming Project staff with an initial experimental cladding of the flight cage dome with fine-guage nylon mesh (see also figure 18). 28. Member of Kuranda Butterfly Sanctuary staff, in north Queensland, Australia, collecting eggs of *Papilio ulysses* as fast as the females lay them on the isolated *Euodia* (Rutaceae) bush inside the commercial farm's large flight house. All butterfly eggs are removed to complete development in the adjacent hygenically maintained rearing house.

males, and especially *Ornithoptera goliath* Oberthür, they were referred to at that time as "Guinea Golds".

Unno (1974) noted that the collecting of Taiwanese butterflies reportedly began in 1880, when the country was controlled by China, and a professor at Hokkaido University undertook studies of them there. In 1895 Taiwan came under Japanese rule for the next 50 years and so their influence began to increase. At the beginning of the twentieth century, the Meiwa Insect Research Institute in Japan established the Kisei Insect Collection Centre in the Taiwanese town of Puli, which marked the start of commercial interest in the production and sale of decorative handicrafts made from butterfly wings. By the late 1960s the Taiwanese butterfly industry had reached industrial proportions, with Puli remaining its centre. Jackman and Regan (1987) stated that the demand for Malaysian butterflies took off in the 1950s when British forces stationed in Malaysia used the Cameron Highlands as a base. This led to the establishment of a network of dealers there, predominantly Chinese, who purchased dead butterflies from the local aborigines and sold them to the British soldiers.

A MODEL EVOLVES

The concepts of modern-day butterfly farming (or ranching) in the tropics are best elucidated by discussing the advent of the model system in PNG. Prompted by the rapidly growing overseas demand for its insects, particularly butterflies, and especially endemic Papilionidae such as certain *Ornithoptera* and *Graphium weiskei* (Ribbe), it was in PNG that the fundamental methods were pioneered.

The basic farming technique of planting out butterfly larval foodplants within, or adjacent to, areas of forest (Fig. 3) commenced with the personal experiments of expatriate PNG Government employees, who were also avid butterfly collectors. These men, notably Ramon Straatman, Richard Carver, and Harold Borch, conducted plantings between the late 1960s and early 1970s, mainly of *Aristolochia* (Aristolochiaceae) vines in order to better study the early stages of *Ornithoptera*, but also to obtain perfect specimens of these papilionids for sale to overseas collectors. The method was adopted by the Australian Administration when it was decided to establish an official national system of butterfly farming in 1974.

By the early 1970s the Administration had become well aware that a small number of expatriates were profiteering from their dealings in PNG's butterfly trade, and indeed largely controlled it. They exploited the naivete of the local landowners who had little or no idea of the market value of the various specimens that they were asked to collect. Moreover, a number of these expatriates were also illegally engaged in smuggling of *Ornithoptera* protected in 1968 under PNG's Fauna Protection Ordinance (see below and Fig. 4). There have been many such examples of 'Europeans' who took advantage of Papua New Guinean collectors, giving them little recompense for butterfly specimens (mainly *Ornithoptera*) which were usually worth a great deal of money on the international market. One of the earlier accounts of this practice was recorded by Meek in his correspondence to Rothschild when he stated that "I felt more pleased when the male of this species [the first of that sex of *Ornithoptera chimaera* (Rothschild)] was brought in than if I had been left a fortune. I gave the boy two shillings, two tins of English bacon, and five sticks of tobacco. I have got what I came for, so I am satisfied." A. Hutton (in litt., 1977), D'Abrera (1979) Vietmeyer (1979b), Cherfas (1979), Pyle and Hughes (1978) and Pyle (1981) have all related similar recent examples. Thus, in the period prior to, and during the establishment of, butterfly farming as a fully fledged project in PNG, purges of expatriate collectors illegally trading in PNG butterflies, including fines (Anonymous, 1976; Waugh, 1976) and deportations (Anonymous, 1979c), were undertaken under the Fauna (Protection and Control) Act. Such prosecutions had the benefit of finally providing the PNG Government full control of its butterfly trade.

At the same time that expatriate entrepreneurs were operating in PNG, certain Nationals were being encouraged, through a growing number of postal requests, to mail specimens to overseas collectors, notably in Europe, U.S.A. and Japan. The applicants would offer various monetary incentives, but these were usually well below the real worth of the species requested. In order to establish a fair system of trade to benefit the people of the Garaina area, Morobe Province, they were assisted by tea plantation manager, Angus Hutton, to conduct business with dealers and overseas collectors through the mail. Not long after this, in 1974, the Australian Administration decided to consolidate the national system of butterfly farming under the Insect Farming, Trading, and Conservation Project of its Division of Wildlife (Pyle and Hughes, 1978). This was bolstered by legislation introduced at the time restricting the trade to PNG citizens (Hutton, 1985). Hutton was employed by the Division of Wildlife as the Project's National Coordinator, and from about 30 village collectors/farmers in 3 provinces, the system grew to about 500 in 10 provinces by 1978 (Vietmeyer, 1979a and 1979b). The latter figures have remained fairly stable since that time.

In August, 1977, Dr Robert Pyle and his wife Sarah Hughes were contracted by the Division of Wildlife of the recently independent PNG Government to assess the aims and acheivements of its Insect Project, and to make recommendations for its improvement where necessary (Pyle and Hughes, 1978). It had previously been agreed that, just prior to his retirement in February, 1978, Hutton should move the operations of the Project to Bulolo, Morobe Province, a town more centrally situated on the PNG mainland with better facilities and communications than rather isolated Garaina. The Project's title was also officially changed to the Insect Farming and Trading Agency (IFTA) (Figs. 7, 9 and 11). When Hutton left PNG, agricultural officer, Peter Clark, who since 1975 had been based at Maprik in the East Sepik Province assisting the Project by helping local villagers in the region to supply overseas postal orders for insects, took over the role of IFTA's business manager. The IFTA operation plan called for an entomologist/ecologist to be brought into the conservation programme to improve village farming techniques, and to implement some of Pyle and Hughes' recommendations (Parsons, 1979). This position was filled by the author in March, 1979, who established the research side of the IFTA (see below and Fig. 15).

The 1981 World Economic Recession had a severe effect on the IFTA (as well as on all other Wildlife Division projects: Kitchen, 1982), with financial repercussions that left the future of the Agency very much in doubt. Thus the following year saw its

transfer from the Wildlife Division to the Livestock Section of the Department of Primary Industry with the stipulation that the IFTA should quickly turn itself from a Government-supported non-profit making enterprise to become self-funding in order to survive. With the personal decision of Parsons to depart in 1983 the research and monitoring side of the IFTA ceased. Since that time the Agency has operated on a purely commercial basis, experiencing many financial problems. After yet another change, June, 1989, finally saw the IFTA transferred to the business development section of the Papua New Guinea University of Technology (UNITECH), and an expatriate was employed as an assistant manager.

According to the Wau Ecology Institute (WEI, 1989) the IFTA is one of the few PNG Government agencies that is now making money, and is growing at about 10-15 percent per annum (Fig. 31). The majority of its sales of papered specimens are made to dealers in the U.S.A., U.K., West Germany and France, individual collectors not being so preferred as they tend to place much smaller orders. However, Morris (1986) stated that this trade has not enabled the Agency to be self-supporting, and that self-sufficiency has only been achieved by tapping the local tourist trade (in reality mainly departing expatriates once they had finished work in PNG), thereby exploiting the high mark-up value of tourist items (Fig. 13).

At its inception, and in keeping with Government policy, it was intended that the IFTA was to become fully nationalized within the initial contract periods of its expatriate managers, with Papua New Guinean managers taking over from their expatriate conterparts in each of its business and research sections. This would have had the important result of making the overall agency operation more financially viable since the salaries of expatriates, compared to those of PNG nationals, are so much greater, and so use up a much greater proportion of the Agency's funding. However, due mainly to the problem of the dropping out of national understudies that were employed by the Agency, and with problems of finding further adequate national staff to understudy the positions, this was never implemented, and remains so to present. Thus, since 1983, the all important countrywide extension trips that promotion of the farming system requires, as well as the associated research and educational functions, have not been affordable by the IFTA. Now that it is part of UNITECH, the IFTA hopes, however, to find overseas funding to carry out extension (Mercer and Clark, 1989), and the WEI also intends to assist it in this work (Bloch, 1988; WEI, 1989).

GOVERNMENT RATIONALE AND GENERAL POLICIES

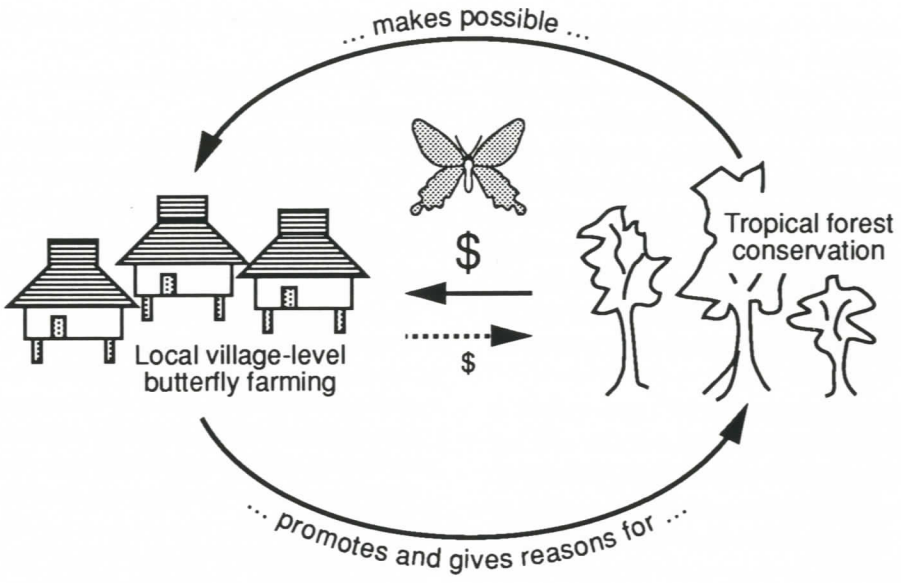
The main reasons for the establishment of the IFTA in PNG have been stated above. Others additionally served to strengthen the initial resolve of the PNG Government to fully financially support the scheme as a non-profit making conservation project. In no particular order of merit these reasons can be summarized as follows:

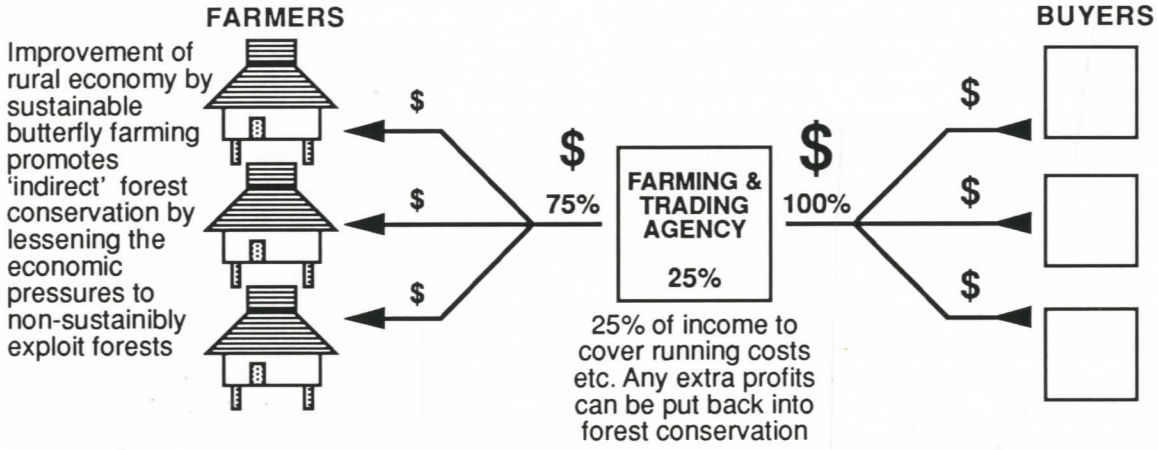
1. To promote, through extension trips, the production of butterflies and other insects in less advanced areas of PNG as an alternative source of income for a large number of subsistence farmers (in line with the Government's decentralization policy).
2. To restrict the insect trading business to citizens only.
3. To provide basic collecting and storage equipment to collectors/farmers.
4. To ensure that fixed and reasonable prices are paid to collectors/farmers.
5. To ensure that payments are made more expediently than they would be if the collectors/farmers had to wait for monies to be returned via overseas mail (losses of mailed cheques also being known).
6. To provide a centralized body within PNG with which both citizens and buyers can directly and more easily communicate than if they had to do so with each other.
7. To act as an official agent in business dealings with overseas buyers in order to better deter payment defaults by buyers.
8. To ensure the best quality of incoming (and outgoing) stock, including the addition of locality data to each specimen.
9. To pool stock in order to supply the larger orders of dealers.
10. To assume some control over demand by the manipulation of outgoing stock.
11. To act as an educational centre for the instruction of citizens in insect farming and trading methods.
12. To ensure that insects are treated as a renewable resource.
13. To promote conservation of butterflies and their habitats.

Regarding clause 1, Vietmeyer (1979b), Parsons (1981d), and Cody (1981) all pointed out that some Papua New Guineans had difficulty in understanding why foreigners attach so much importance to butterflies, and why they are prepared to pay money for them. However, reasons are soon grasped, especially when they are related in terms of a Papua New Guinean's own appreciation of butterflies (or other brightly colored insects) as decoration and ornamentation, of particular value in costumes and headdresses used on ceremonial occasions (Fig. 1).

Clauses 1 and 2 encompass a very important function of the butterfly farming method. Namely that, through careful government control, it spreads the financial rewards that it creates evenly throughout those communities which are most closely dependent on forest resources, rather than allowing profits to be entirely removed from the system to the benefit of only a relatively few entrepreneurs who are, more often than not, usually little concerned with maintaining forests as the source of their wealth. Thus, it is very effective at removing the profits from the middlemen and ploughing them back nearest their source. As Pyle and Hughes (1978) put it "Instead of small, concentrated capital businesses, the program seeks to provide a means of investment in the cash economy for numerous individuals in rural surroundings where there is little other chance of employment and where the insect resources present great potential."

The last two functions of butterfly farming ennumerated above embrace the overall rationale for the system (Figs. 29, 30 and 32), with obvious links through clauses 8 and 11 to its purely commercial aspects (summarized in Fig. 33). First-time collectors invariably bring, or send, in damaged specimens to the IFTA. Thus a policy has been to attempt to purchase at least a few of the best specimens of initial shipments containing damaged specimens, whilst returning the remainder with a concise explanation as to why they are reject, and why, therefore, farmed specimens are superior. In this way collectors are not entirely discouraged as they obtain some reward, whilst at the same time need for quality and farming is given impact. It is explained to potential farmers that, once well established, a farm can save the time and energy expended in finding and catching butterflies from





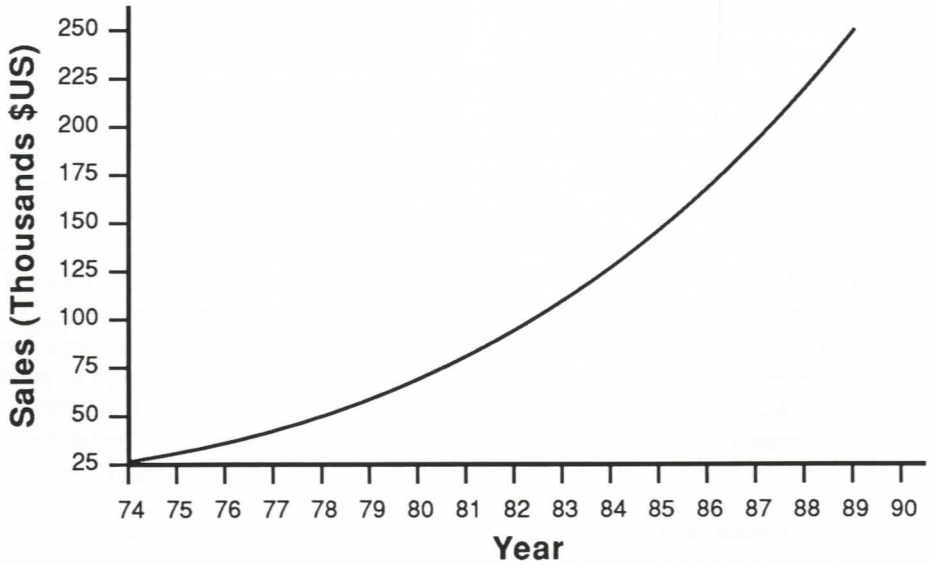


Fig. 29-31.– 29 (top). Diagrammatic representation of the main philosophy of butterfly farming. 30 (center). Diagrammatic representation of the basic cash-flow and economics of butterfly farming in relation to its conservation benefits. 31 (bottom). Graph showing overall yearly increase in sales of insects by the PNG IFTA.

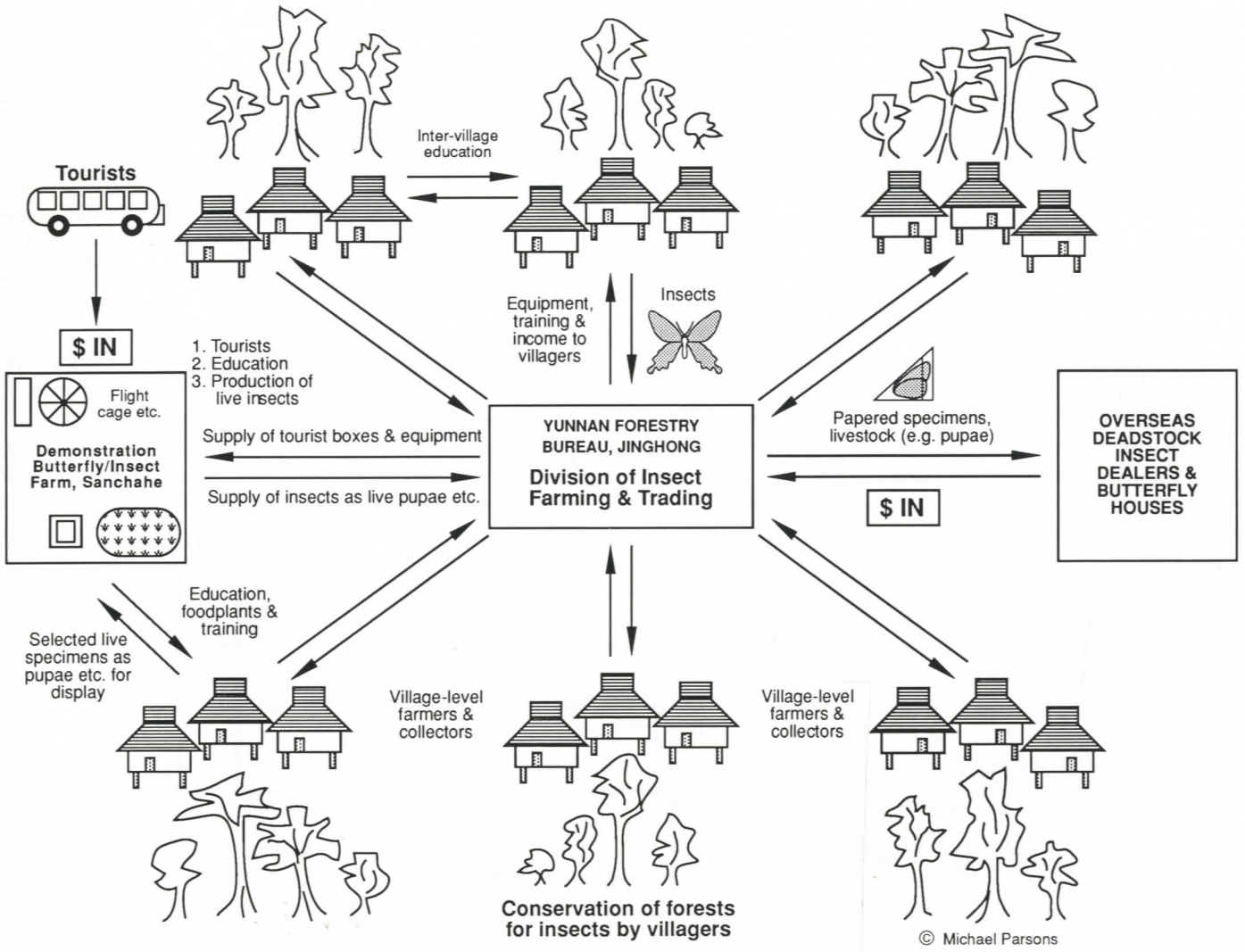


Fig. 32. Diagrammatic representation of the overall integration of butterfly farming with tropical forest conservation as demonstrated by the Xishuangbanna project in southern China.

wild populations. Wild specimens must often be rejected because many butterflies, especially those with powerful wings, damage themselves very quickly after emergence. Livestock within a defined farm area can be better tended, monitored, and so protected from predators, parasites and dieseases (Figs. 2 and 5). Farming can also serve to maintain a sustained yield of certain species, wild stocks of which are not depleted, so benefitting their conservation.

Pyle and Hughes (1978) and Breeden and Wright (1978) pointed out that PNG insect collectors soon grasped the concepts of fostering butterflies to enable continuous yields over the long term, and indeed had often already implemented, in their own way, some of the ideas promoted by the government system. Thus villagers soon actively practiced methods such as dispersed collecting activities (rotating collecting in a series of different localities to allow recovery of local populations), selective taking of pupae, and non-capture, or release, of damaged specimens.

Other major benefits of the farming system are that it is unnecessary to clear forest to start such a farm, and that little capital outlay is required to commence butterfly collecting (Hutton, 1975, estimated about US$ 12). Indeed the farming method actually encourages the creation of new habitat. In creating a butterfly farm ideal areas for planting of *Aristolochia* or *Adenia* vines, for example, are old food gardens past their prime for vegetable production. Such vines are plants of the regrowth community and so do not require soils rich in nutrients. Therefore, the concept of butterfly farming promotes the conservation of existing forests by providing a sound economic reason to do so. In this way actual reaforestation also becomes a more lucrative proposition.

In PNG, extension patrols (undertaken to explain butterfly farming and trading to people in remote villages) have been necessary for several important reasons, including the paramount need to maintain the interest of farmers in producing stock (see below and Fig. 15). Although often recruiting only a few new suppliers per visit, extension work is essential to initiate farming in areas which have the potential to provide new additions to the butterfly sales list, and hence the importance of extension in the PNG's many outlying islands. In line with the Government's decentralization policy, remote mainland missions and schools were also targeted. This was not only because of the benefits of such a valuable yet lightweight 'crop' that could easily be flown

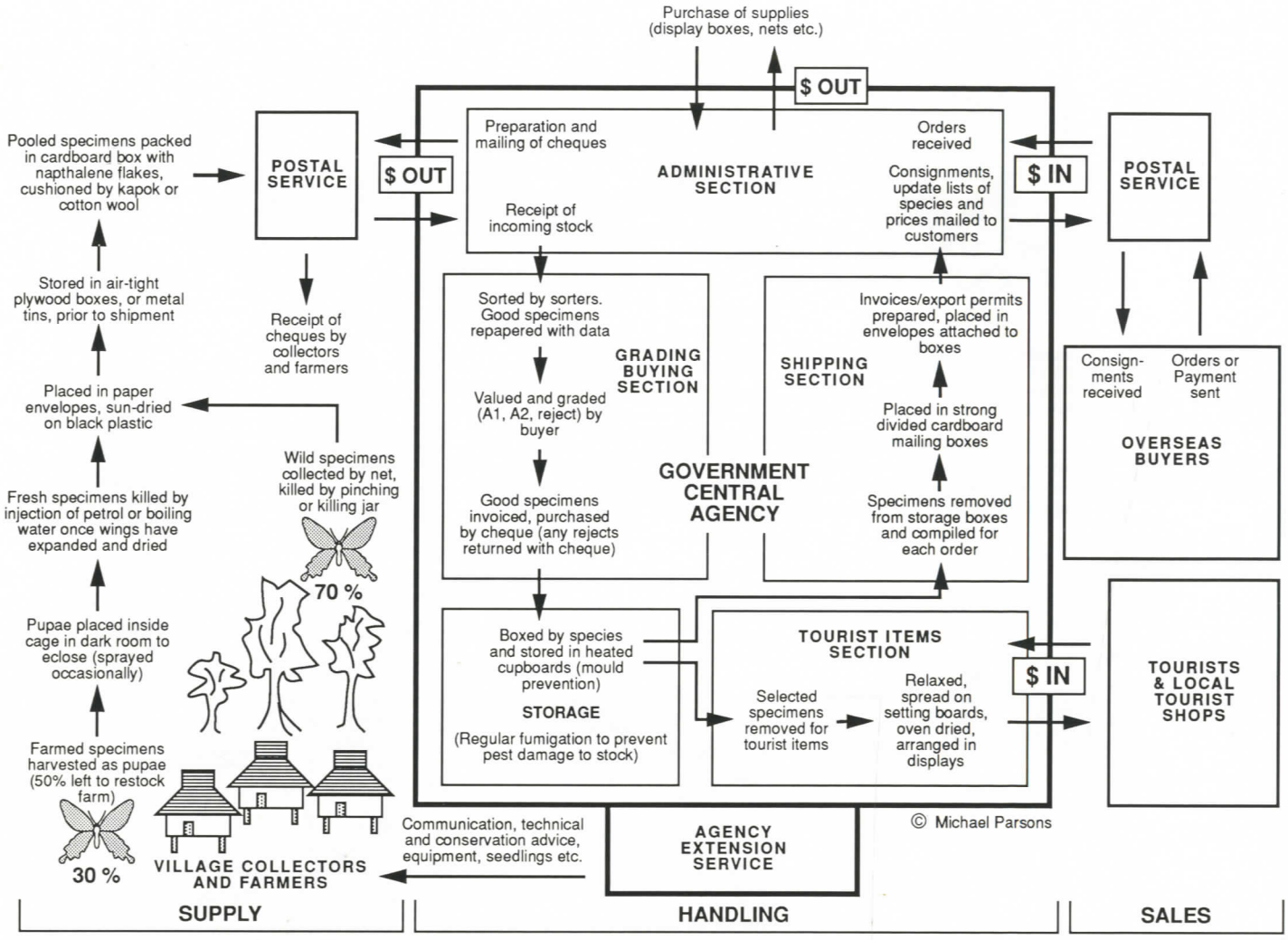


Fig. 33. Diagrammatic representation of the basic steps in the supply, handling and sales of butterfly stock in relation to the fundamental operations of a controlling central government agency.

out by mission planes and then put into the domestic postal system, but also because the missionaries could serve as permanent extension officers once they had the relevant information and basic equipment to hand.

The quality of incoming stock is also kept up by repeated extension visits. For example, the NRC, (1983) reported that, during 1981, out of the 500 IFTA collectors, fewer than 50 were sending in good material. Such trips also allow the collection of new data on butterfly life histories, as well as teaching of the known foodplants and farming techniques of others. The basic extension literature is the PNG insect farming manual by Parsons (1982a) which includes two local language versions of its English text. Another is in preparation in conjunction with the China project (see below), using English, Chinese, and Japanese (Parsons, 1990c). On extension trips in PNG it was often pointed out to potential butterfly farmers that, by comparison with production of coffee, for example, butterfly farming is far easier and more profitable. Coffee growers in remote missions must usually pay a large air freight fee to fly their produce out to marketing centres by light plane, thus reducing profits, whereas many hundreds of dollars worth of butterflies and other insects can be packed into one or two lightweight boxes and mailed for a fraction of the cost (Fig. 6).

ASSOCIATED RESEARCH AND MONITORING

As Morris (1986) noted, utilisation of the butterfly resource both depends on, and contributes to, its research base, the three strands of conservation, utilisation and scientific development being very closely woven together and interdependent. Every new piece of scientific information gained about a species during its economic utilisation adds to the pool of knowledge about it, and has obvious potential for use in its conservation if this eventually proves necessary. Therefore, it is important that a Research Section for the gathering of this data exists as part of an IFTA, otherwise it may never be recorded. Such a Section is also crucial in self-monitoring by an IFTA of its activities, particularly as they relate to conservation. Once such a facility is established, many of its results are effectively an extremely valuable 'byproduct' of the everyday operations of the overall Agency. The research and monitoring part of the butterfly farming system can ensure the implementation and promotion of educational aspects that a purely commercial enterprise might not have time to do. For

example, such a facility can compile and publish educational literature which can be sold to benefit the commercial side of the operation (e.g. Parsons, 1982a and 1983b). It aims to improve the knowledge of insect populations, and their distribution, as well as their life histories and foodplants in order to permit farming where it is economically worthwhile. Research findings are important in raising the scientific image of an IFTA, and all noteworthy results of such studies should be formally published in scientific journals (Parsons, 1990c).

Whilst in operation, benefits of PNG's IFTA Research Section included the identification and study of butterfly larval foodplants (e.g. Parsons, 1983c, and in prep., the *Ornithoptera Aristolochia* foodplants), research into butterfly ecologies and life histories (e.g. Parsons, 1983a, 1984a and 1984b), as well as later taxonomic studies in order to clear up problems with identification and nomenclature (Parsons, 1986a, 1986b, 1989a and 1989b) which have formed the foundations for books on the subject (Parsons in press and in prep.). As part of the IFTA Research Section operations, staff collected, identified, and named butterflies and other insects for the Agency's own reference collection. Unique or interesting specimens received from butterfly farmers/collectors were also added to this collection, or that of the National Insect Collection, thereby ensuring that scientifically important insects from incoming stock did not leave the country. Parsons also began research on *Ornithoptera alexandrae* (Rothschild), a species of priority conservation concern (Parsons, 1980a, 1980b, 1980c and 1981a), with follow-up articles (Parsons, 1981c, 1982b, 1984c, 1985, 1988a and 1988c), and three follow-up consultancies (Parsons, 1988b, 1990b, and 1991a). In the latter two reports Parsons strongly recommended that, as part of the re-establishment of a conservation project for *O. alexandrae*, butterfly farming should be started again in the Popondetta region to help provide landowners with an income alternative to that from oil palm.

Acting on the often overlooked logic that without details of the distribution and status of a species it is impossible accurately to assess its conservation requirements, and based on the recommendations of Pyle and Hughes (1978), Parsons (1979 and 1981b) also established a 10km grid distribution mapping scheme for all butterflies in PNG (and later birds and mammals). Parsons (1981d) pointed out that the data from many butterflies received from IFTA collectors were used to provide 10 km grid records for the mapping scheme where these were accurately known. In this way even those specimens too damaged to be of economic value, yet which were identifiable, had scientific value. Where protected *Ornithoptera* were collected in obvious ignorance of their identity the specimens were confiscated for the National Insect Collection and often provided important locality data which improved the distributional information for each species. The distribution maps compiled for the *Ornithoptera* from all sources provided data crucial to an assessment of their conservation requirements (Parsons, 1983c).

Despite the above mentioned benefits of an IFTA Research Section, it may still seem difficult to justify its existance as an integral part of a government-sponsored butterfly farming enterprise considering its additional financial requirements. However, in reality, the basic aspects of research and monitoring are relatively cheap to instigate and maintain. Special equipment, such as microscopes and maps, may be expensive in terms of capital outlay, but once purchased are indefinitely usable at no further cost. Research and monitioring must also be appraised in the light of its returns, which may be aesthetic, but which are often also in the form of much needed hard cash. It is obvious that research resulting in increased yields of farmed species, or which newly permits the efficient farming of others, can only benefit the financial well-being of an IFTA.

HARNESSING THE WEALTH

The exact value of the world's butterfly trade is impossible to accurately assess. Pyle (1981) first estimated that it amounts to between US$10-20 million per year, and this was quoted by the NRC (1983). However, Collins and Morris (1985) rightly pointed out that this must be a conservative estimate since there have been reports that the Taiwan trade alone is $20-30 million. They considered a figure of $100 million per annum not excessive. The number of commercial dealers has risen steeply since the end of the war years (Nagano, 1984). Jackman (1976) stated that, at the time, Taiwan earned about $24 million from butterfly exports, and noted that even the Daily Telegraph Newspaper's business columns (Campbell, 1976) were urging stock marketeers to buy rare butterflies as a hedge against inflation. Morris (1986) pointed out that, as some previously hard to come by species have become better available over the recent years, their prices have fallen to lower levels. For example, this has happened with many swallowtails, such as *Ornithoptera rothschildi* Kenrick, *Ornithoptera (priamus) croesus* Wallace, *Papilio chikae* Igarashi, *Papilio neumogeni* Honrath and *Papilio blumei* Boisduval.

SELECTED FINANCIAL FIGURES

The swallowtails are renowneed for their beauty, and often rarity. Therefore, they provide good examples of the high prices commanded by some species on the World Market. De Worms (1967), Ingram (1975), Jackman (1976), Macfarlane (1984), Cherfas (1979), Vietmeyer (1979b), Morris (1986), and many other authors, have all pointed out that the 'rarer' *Ornithoptera* often command prices in the hundreds, even thousands, of dollars per specimen. For example, Collins and Morris (1985) recorded that an imperfect *O. alexandrae* male was recently advertised for $2,850. Other birdwings are not so valuable, but remain a staple of the butterfly trade. For example, de Worms (1967) reported that, in a Paris auction, *Troides (Trogonoptera) brookiana* (Wallace) (Fig. 26) realized the equivalent of about $108 for 1 male, 2 females, whilst 3 males, 1 female of the Malayan race obtained about $72. Since that time prices for *T. brookiana* have declined steeply with the increase in its supply. Bökemeier and Soutiff (1987) noted that one collector in the Cameron Highlands stated that a decade had passed since he had sold the species at $80 each to an American client, the 1987 price being 50 cents apiece. Jackman and Regan (1987) reported that, despite its inclusion on a list of restricted species, thousands of pairs of *T. brookiana* are sold in Malaysia (e.g., in the tourist shops of Tanah Ratah in boxed displays) at about $20 per pair. They maintained that a bilateral gynandromorph of *T. brookiana* in the collection of David Goh of Penang, Malaysia, was worth about $38,000. Morton and Collins (1984) recorded that, in 1983, batches of 100 *T. brookiana* were offered by a West German dealer at about $20,

and that a U.S.A. dealer was selling 100 for $30.

Some examples of the market values of other IAR papilionids include a pair of *Bhutanitis thaidina* (Blanchard) advertised by a West German dealer in 1983 for the equivalent of about $225 (Collins and Morris, 1985). The species now appears on Hong Kong dealership lists at $30 each; *Bhutanitis mansfieldi* (Riley) at $50 (pers. obs., March, 1990). Many Chinese *Parnassius* are also advertised on such lists, ranging from species such as *Parnassius jacquemontii* Boisduval at $10 each, to *Parnassius preswalskii* Alpheraky at $100.

ASPECTS OF IFTA ECONOMICS

Pyle and Hughes (1978) recorded that, prior to the establishment of PNG's IFTA, the temporary Garaina headquarters marketed 14,915 insects in 1975-1976 for a total of about $6,215, all of which was returned to the collectors farmers, and that from July-August, 1977, 5,573 insects were sold overseas for about $4,155. Mercer and Clark (1989) reported that the IFTA received 4,000 shipments from its suppliers between 1978-1981, at a value to the collectors of about $225,000. Collins and Morris (1985) recorded that IFTA sales in 1983 amonted to $110,000 and increasing. IFTA sales for 1989 amounted to about $250,000 (WEI, 1989). The approximate increase in trade by the PNG IFTA, based on these rough figures, is graphically illustrated in Fig. 31.

The IFTA pays its suppliers about 75% of the price which it sells to dealers, thereby making about 25% markup (NRC, 1983) (Fig. 30). Thus the producers receive most of the value of their specimens, which contrasts markedly with the situation in Taiwan, Malaysia or Irian Jaya (Morris, 1986). Mercer and Clark stated that this modest markup is enough to cover running costs, plus making a slight profit. They estimated that the IFTA sales over the last decade of its operation and, therefore, mostly divided amongst its suppliers throughout PNG, have amounted to well over $1.25 million.

Using *Ornithoptera priamus* (Linnaeus) an example, Fenner (1976a) estimated the income that might be expected from casual small-scale butterfly collecting/farming in PNG if 5,000 pairs per annum were produced at about $5 per pair, thereby bringing in about $25,000 in foreign currency to the economy. At the individual level he conservatively considered that a person could easily produce 125 top quality pairs per annum, and earn about $625 (or perhaps about $582 after expenses) which, at that time, slightly exceeded the basic rural wage. Thus 40 villagers, or perhaps 200 people, might be supported by the sale of a single species. Pyle and Hughes (1978) recorded that P. Clark estimated that if a farmer could establish 1,500 *Aristolochia* plants per hectare, one fifth of one hectare could yield about $2,250 per year in *O. priamus* and *Troides oblongomaculatus* Goeze). Parsons (1980a) similarly used *O. priamus* in an analysis of the estimated profit that might be expected from a large scale 1 ha butterfly farm producing only that species, if run on an efficient and intensive basis using over 1,500 foodplant vines. If the estimated capital costs of set up and production (about $2,625) were deducted, then it was suggested that a profit of about $15,000 could be made from an annual production of about 4,500 pairs of *O. priamus*. Parsons (1983c) calculated that, if farming and marketing of protected *Ornithoptera victoriae* (Gray), *O. goliath*, and *O. chimaera* were permitted in PNG, then a total sale of only 600 specimens of each in the first year of carefully monitored farming would realize about $37,500, $22,500 and $56,250, repectively. WEI (1989) estimated that a yearly income of about $44,000 could be expected from a fully operational butterfly ranch once established on their grounds.

Parsons (1983c) illustrated, graphically, the total sales by IFTA of two birdwings, *O. priamus poseidon* and *T. oblongomaculatus*, over a 4 year period (1978-82) (Fig. 34). An indication of the slight decline in demand as supply increased is evident, but this is well concealed by the manipulation of the supply of specimens to buyers by the IFTA. A better indication of this are the prices realized by these two species over the same time period. For example, during the 1978-79 period perfect (ex-pupa) pairs of *T. oblongomaculatus* realized $3.50, being reduced to $2.50 per pair during 1980-81, and in 1982, to promote further sales, to $1.25 per pair. Eventually, farming of the species was so effective that it was overproduced and, as mentioned below for *Graphium weiskei*, moratoriums had to be imposed on its supply to the IFTA. The farmed blue subspecies, *O. p. caelestis* (Rothschild) of *O. priamus* has had a similar history (Fig. 2). Before the establishment of the IFTA, prices per pair were in the region of $87.50. They were then progressively lowered from $25 to $18.75, and then $12.50 in 1983 (to present). The green subspecies, *O. p. poseidon*, of *O. priamus* has maintained a stable price at about $5.00 per pair. The graph also shows a definite average level of demand for each species, that of *T. oblongomaculatus* generally being half that of poseidon because it is a less 'showy' papilionid. In 1983, on average, about 75 *T. oblongomaculatus* were sold per month compared to about 150 *O. priamus poseidon*. Parsons also pointed out that over the 4 year period 6,700 specimens of *T. oblongomaculatus* were sold, compared to nearly 9,200 specimens of *O. p. poseidon*, and that if other subspecies of *O. priamus* were considered — *O. p. caelestis* 4,400; *O. p. admiralitatis* (Rothschild) 1,800; and *O. p. urvillianus* (Guérin-Méneville) (Figs. 5, 6 and 8) 5,500 — then sales for the species between 1978 and 1982 totalled over 20,500, of which most were perfect ex-pupa specimens. It is obvious that, on the relatively small scale that the IFTA operates, there has not been any 'market saturation'.

Mercer and Clark pointed out that there has been a significant increase in the income of individual insect collectors and farmers in PNG since 1978, reflecting a rise in the world prices, but also improvement in the quality of the stock received by the IFTA. For example, when the NRC visited PNG in May, 1981, the average price per box of insects received had risen to $50 from $37 in 1979. However, the level of payment per shipment of insects varies greatly according to the skill and determination of the supplier, the number of specimens sent and, importantly, the particular geographical area from where they originate. For example, collectors in certain areas, particularly islands or high mountain ranges, are able to specialize in geographically restricted and, therefore, more sought-after and valuable endemic species or subspecies. Most PNG mainland collectors average about $25-100 per shipment, but some even obtain about $150-300, and one farmer regularly receives about $550 per shipment. A farmer in the Trobriand Islands alone earned about $15,000 between 1987-1988 (WEI, 1989). Mercer and Clark noted that a Manus

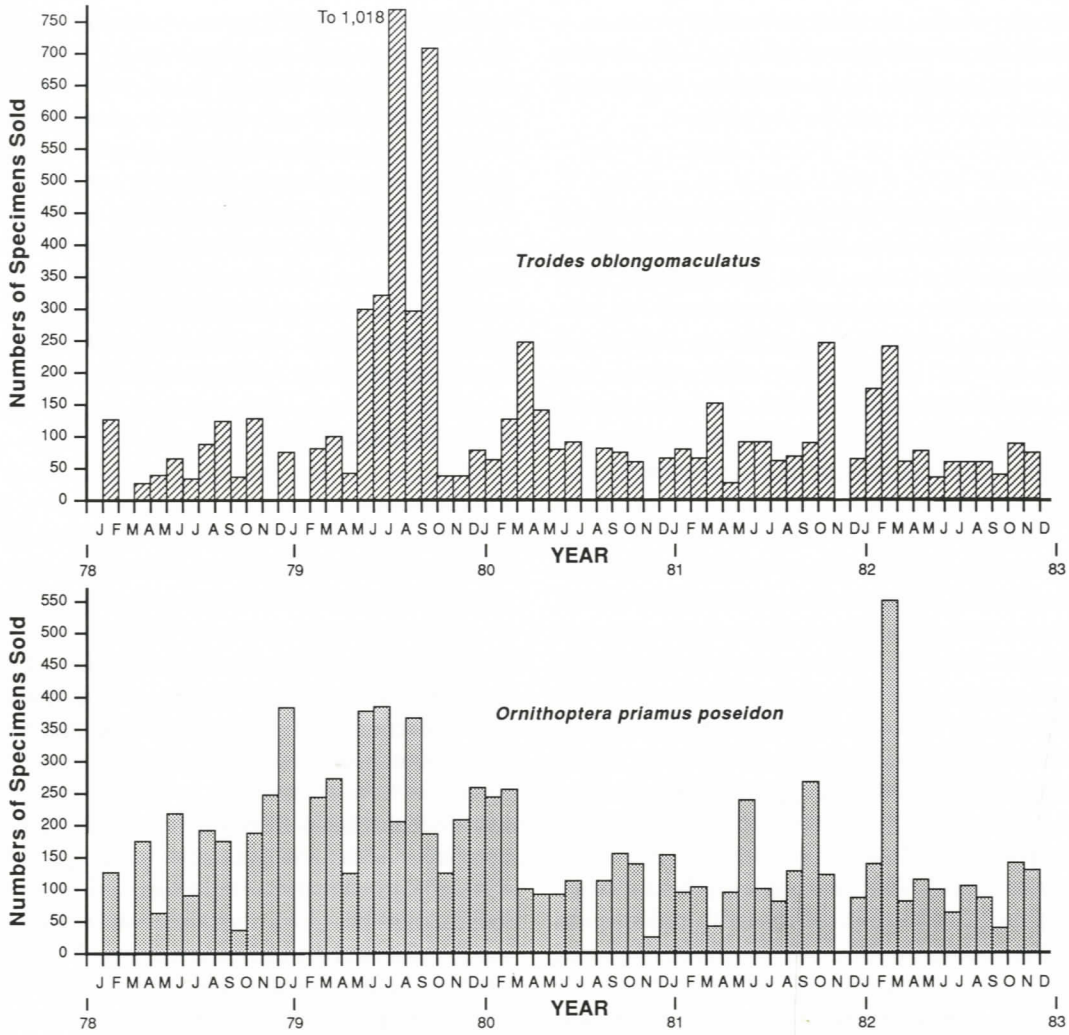


Fig. 34. 1978-82 sales of two birdwing swallowtail butterflies, *Troides oblongomaculatus* and *Ornithoptera priamus*, by the PNG IFTA — the primary farmed species in PNG which continue to provide good income. Note the drop and leveling off in demand for these species by buyers after the early peak sales by the IFTA.

Island farmer specialising in the endemic *Papilio weymeri* Niepelt and *Graphium codrus auratus* (Rothschild) sends the IFTA shipments about every three months receiving, on average, about $875 for an annual income of about $3,500, and so comparing favourably with the income of agricultural small-holders growing coffee, etc.

THE IDEA TAKES FLIGHT

Butterfly farming in its purest sense is still little practiced throughout the IAR, most of the existing enterprises being based on private entrepreneurships employing collectors, with little or no attempt at farming. Collins and Morris (1985) found that butterfly trading was extensive in India and Indochina, occuring at all levels, from personal collectors to substantial businesses. Approximations of the ideal farming concept have obviously been, or are presently being, implemented in some countries. For example, Pyle (1981) stated that smaller industries, similar to PNG's IFTA system, were established in Korea, Malaysia and Hong Kong. Collins (1987) calculated that about 0.5 million butterflies were used for live display in the 45 butterfly houses in Britain during the 1987 season. Of these he noted that the largest importer was using 40,000 specimens per year, 75% of them coming directly from breeding centres in the tropics, thus implying some true farming of livestock. For example, Collins stated that British expertise was advising on the development of butterfly houses in Sri Lanka, and that the small island of Marinduque in the Philippines had several family businesses supplying butterfly houses. Simcox and Calvert (n. d.) stated that some of the main suppliers to the London Butterfly House are in Australia, Malaysia, Philippines, Taiwan, Japan, and Sri Lanka. In conjunction with the Malaysian Government, the Washington, U.S.A.-based conservation organisation, Intergrated Conservation Research (ICR), has established a tourist butterfly demonstration farm at Poring Hot Springs near Sabah's Kinabalu National Park (I. Muul pers. comm. Feb 1990; Muul, 1989). Outlines of other known projects are discussed below under their country of origin.

Papua New Guinea

PNG's pioneering IFTA has already been detailed. However, the WEI, backed by about $100,000 in overseas grant funds, has very recently begun to establish a working butterfly ranch on its grounds at Wau in the Morobe Province (Bloch, 1988; WEI, 1989). It is hoped that the project, apart from being educational, will supply specimens to the IFTA, and so will augment the funding which WEI presently obtains from its own coffee estate. On the advice of Parsons (1990b) the commercial firm of Mainland Holdings Pty. Ltd., based just outside Lae in the Morobe Province, is also interested in commencing commercial

captive farming of *O. priamus* as an experimental precursor to attempting the same with presently protected *O. goliath* once the species is de-listed as predicted. The company is presently modifying some of its crocodile pens for the purpose.

Taiwan

Strictly speaking, farming is not a feature of Taiwan's butterfly industry. However, the country merits discussion for its historically prolific output of butterflies (Unno, 1974; Severinghaus, 1977; Marshall, 1982), and because some farming apparently has been implemented. Pyle (1981) reported that estimates of Taiwan's output of butterflies by 1981 varied from 15-500 million specimens per annum. Marshall stated that there were no captive breeding programmes in Taiwan, but that a few people reared rare papilionids for sale to collectors as high quality specimens.

Quoting the Chinese Information Service (CIS), Severinghaus reported that an estimated 20,000 people were involved in Taiwan's butterfly trade, including many factory workers, and 10,000 collectors, 2,000 of whom were termed "professional." According to CIS, about 20 million butterflies were caught each year and sold to more than 30 factories which processed the almost wholly wild-caught butterflies. Many males are urine-baited on the moist sandy banks of river courses, and patient collectors might catch 500 in one morning in this way. Single factories may process 2,000 butterflies a day. Severinghaus noted the CIS maintained that, in 1975, more than a dozen "butterfly farms" had been established in Taiwan "to preserve and cultivate rare and high quality species". They also reported that a "breeding ground" was to be established in Spring 1976, at Lishan by a high school biology teacher in Puli, and that 6,000 flowering plants "to attract the 100-odd species of butterflies frequently found in the vicinity ... and to support butterfly larvae and pupae" were to be shipped there. Severinghaus did not know whether the project had been carried out. Bökemeier and Soutiff (1987) observed that an insect farm existed near Taipei, which amongst other species, captively reared *Papilio demoleus* Linnaeus for supply as pupae to British butterfly houses. Since 1988 a breeding farm has operated near Puli (Emmel and Heppner, 1990), primarily for rearing *Papilio* species, and more recently a butterfly house was added; another butterfly house opened in Puli at the Mokusei Insect Museum (J. Heppner, pers. comm.).

Morris (1985) reported that the situation had changed markedly by the time of his visit to study the Taiwan butterfly trade. Its decline, coupled with a steady increase in conservation awareness, was mainly due to the fact that it was no longer economically necessary for as many Taiwanese to collect and sell butterflies under the current rise in their living standards (this despite World Recession at the time). Factories that had employed upto as many as 1,000 people, had only 2-5 employees. Morris suggested that, because Taiwanese rarities were so rare, and because of the advent of the valuable livestock supply market, it seemed likely that the establishment or increase of butterfly farming in the country would probably not greatly benefit the conservation of its native fauna.

Malaysia

Jackman and Regan (1987) stated that the Cameron Highlands of central Malaya are the world's richest hunting grounds for butterflies, and that the entire economy there depends on them. They reported that the largest dealer in the area, David Goh, based on offshore Penang Island, has one of the world's best private collections of Malaysian butterflies, worth at least $180,000. According to Jackman and Regan, Goh turned his predominantly deadstock dealership into one of supplying mainly live pupae from a rainforest butterfly farm/ranch, at the suggestion of Britain's London Butterfly House owner/operator Clive Farrell. Collins (1987) stated that this new enterprise was established at a cost of $350,000. Goh (in Bökemeier and Soutiff, 1987) stated that it was the only such enterprise in Southeast Asia, being the largest in the world, with its own forest reserve.

FAILED TAKEOFFS

The Solomons

Through an initial interest by a Solomon Islands Government employee, Robert Macfarlane, it was planned that IFTA entomologist/ecologist, Michael Parsons, was to visit the country in 1981 on brief 'loan' from PNG to advise on the establishment of a system in the Solomons similar to that of the IFTA model. However, due to lack of funding, the consultancy did not take place. Macfarlane (1984), emphasizing that he subscribed to the idea of conservation through utilization, stated that the enterprise continued to be delayed due to the difficulty of finding funds to carry out the basic research to define which insects would be involved, and the possible marketing systems. Macfarlane (1985) stated that the Solomons birdwings were an unexploited resource, only being endangered when their habitat is destroyed. He pointed out that the success of IFTA was well known and documented, and that he had initially hoped to set up a research project to provide information on the biology and conservation of endemic Solomons Papilionidae and other Lepidoptera, especially *O. priamus urvillianus* (Figs. 5, 6 and 8) and *O. victoriae*, at the same time establishing pilot farming on different islands. With knowledge of Macfarlane's attempts (gained during buying visits to the PNG IFTA) West German insect dealer, Volker Schneider visited the Solomons at various times after 1983. He was particularly interested in obtaining *O. victoriae* for sale in Europe and so actively lobbied the Solomons Government to establish a farming system. However, the country still lacks a cohesive system of sustainable utilization of its butterfly resources, although specimens of *O. victoriae* and other butterflies do reach the world markets from collectors there.

Indonesia

In 1980, World Wildlife Fund (WWF) regional coordinator for Irian Jaya (IJ), Dr. Ronald Petocz, visited the IFTA with a delegation of Indonesian Government representatives as part of an educational visit to study methods employed by the PNG Division of Wildlife. Somewhat later, this resulted in a proposal to fund and establish a similar butterfly farming project in IJ (Petocz, 1984). Based on his past experience of visiting the IFTA, and work on the NRC panel, Dr. Michael Morris of the Institute of Terrestrial Ecology (UK) was selected as WWF consultant to visit IJ and PNG in order to advise the Directorate General of Forest Protection and Nature Conservation (PHPA) and WWF on the instigation of the project.

Morris (1986) observed that a supply to the butterfly trade from IJ did exist, but that this was mainly centred on the competative monopolies of two private entrepreneurs who operated their own networks of collectors throughout the country. No butterfly farming was being carried out. He suggested that an IFTA-style agency be established at Sentani or Jayapura, but that, for a variety of reasons, it was not expected that Government, or its agencies, would administer an IFTA in a way similar to PNG. Morris suggested that the focus of farming and trading should be on the protected *Ornithoptera*, particularly *O. rothschildi* and *Ornithoptera tithonus* de Haan as these two species do not occur in PNG, or elsewhere, and so are solely utilisable by Indonesian citizens. Other species suggested as important candidates for farming included *Papilio lorquinianus* Felder & Felder, *Papilio fuscus* Goeze, *Papilio laglaizei* Depuiset, and *Graphium thule* (Wallace). Morris also believed that the IJ system should exploit its butterfly resources on a village-level corporate, collaborative or community basis. In this way it was proposed that any ill feelings of envy or jealousy, or any over-competative actions, engendered by the large sums of money that it was possible for individuals to earn, would be lessened. It was also suggested that by using a community approach the income would benefit village projects, rather than just individuals. Village-level extension work was considered a priority for the successful establishment of an IJ butterfly farming enterprise.

For various reasons, but primarily due to the lack of necessary funding, the IJ project proposed by Morris was never undertaken. Recent WWF activities in IJ are only weakly associated with the envisaged project, being very low-level. Under WWF guidence, and based on the above mentioned habitat enrichment technique, some *Aristolochia* vines have been planted under the forest canopy adjacent to areas cleared by local Hatam tribe villagers for food gardens. In this way it is hoped to provide the 14-20 village communities, residing inside the Arfak Mountains National Park near Manokwari, some income from the sale of *Ornithoptera*, and so reduce the pressure of their subsistence agriculture on the local forest (C. Hails, WWF Switzerland, pers. comm. December, 1990). Hartmann (1991) pointed out that the WWF International project in the Arfaks has suffered numerous setbacks due to resentments and various other problems that have arisen within local tribal groups. EEC mission member, Michael Morris (in litt., Feb 1992), was unable to evaluate a butterfly farming project in IJ, established using EEC funds, due to problems of the team obtaining travel permits on their arrival in Indonesia.

India

Morton and Collins (1984) reported that there were two large commercial "farms" in India at the time, but that it was thought that neither had a captive breeding programme. They noted that the Indian Government was interested in setting up a farming project for common species and that two trial farms were planned for north-western and eastern India. The basis for this was a UN/FAO consultancy report by ex-PNG IFTA manager, Angus Hutton, who assisted the Indian Government in April and May, 1985, to set up pilot butterfly farms in tribal areas (Hutton, 1985). However, as pointed out by Rao (1990) "in spite of the tremendous potential which butterfly farming has in enhancing rural economy in the forested regions in India no effort has so far been made in this direction mainly due to a lack of initiative on the part of both government and non-government agencies."

CHINA: THE LATEST TESTING GROUND

Collins and Morris (1985) noted that, being a very large country with a wide range of habitats, China has a huge swallowtail fauna (104 species/15 endemics) of international value and concern, providing a potential for development of seasonal butterfly ranches in western China. They observed that, in recent years, Japanese entomologists have forged links with Chinese in Sichuan and Yunnan, resulting in important collections of *Bhutanitis mansfieldi* and the slightly more common *B. thaidina*. They hoped that the accessibility of these important regions would improve, that opportunities for joint programmes of environmental assessment would be possible, and pointed out that it was important that commercial collecting in China should not be not encouraged in the absence of monitoring. Collins and Morris suggested that *B. thaidina* has important potential for ranching, and that research into the breeding biology and management of *Bhutanitis* would be an essential first step.

Interest in research on the Chinese butterfly fauna has continued to accelerate as is evidenced by the growing number of recent publications, especially by Chinese and Japanese Lepidopterists, on the distributions, biologies and early stages of Chinese butterflies (e.g., Koiwaya, 1989; Lee, 1986c; Li, 1989). On the basis of a visit to Beijing in May, 1988, at the invitation of Academia Sinica, Sibatani (1989) published a detailed memorandum outlining the problems and misunderstandings underlying the present attempts at Sino-Japanese cooperation in research on Chinese butterflies. Like various other entomologists and conservationists over the recent years he concluded that, to supply the demand for Chinese butterflies, commercial butterfly farming (and its associated activities), modeled on the example of the PNG IFTA system, should be established in China.

Since the late 1980s WWF has advised and assisted China's Yunnan Forestry Bureau (YFB), managers of the country's remaining tropical forests located in the extreme south of the southernmost Yunnan Province. Based on the above mentioned WCS, renewable resource methods have been implemented as part of this assistance (Mackinnon, 1987). The area, known as the Xishuangbanna Dai Autonomous Prefecture, is bounded to the south and southeast by Laos, and to the southwest by Burma. Its forests are particularly fragile because they lie at the absolute limits of the moist tropics, at the interface of the tropical and sub-tropical biogeographical belts. The Xishuangbanna region is economically one of the poorest in China due to its general remoteness and lack of industry, being primarily based on subsistence agriculture. It is hoped that the use of environmentally sound, sustainable, rural projects in the region, such as butterfly farming, agroforestry and wildlife tourism, will have two-fold benefits for forest conservation in the area. Firstly, that by providing the human population surrounding the reserves with alternative means of income, this will help to relieve the pressure on the reserves by drastically reducing activities such as tree cutting for firewood, or for agricultural use of the cleared land (Figs. 29-30), and secondly, to provide the YFB with an income that can be used to fund its conservation activities throughout the

reserves.

Mackinnon (1987) reported to WWF that Xishuangbanna abounds in tropical butterflies, and that a butterfly farming project in the area would be feasible. He noted that many specimens of the valuable *B. thaidina* exist in the collection of the Kunming Institute of Zoology (KIZ), indicating that it was not rare locally. He also pointed out that many other beautiful papilionids, such as *Troides* species, would also be valuable exports, either as dead specimens for the collector market, or live (as pupae) for show in the growing number of commercial butterfly houses around the world. Li (1989) stated that about 432 species of butterflies belonging to 188 genera from the Yunnan Province have been preliminarily determined in the collection of about 12,000 butterfly specimens housed in the KIZ Entomology collection.

At the invitation of WWF International, Parsons (1990a) was employed as a consultant to establish a butterfly farming system in Xishuangbanna. To ensure that the system be fully and successfully implemented, Parsons suggested 4-phase approach over a 2-year period, which was agreed upon by WWF and the YFB. The YFB's Division of Insect Farming and Trading (DIFT) is the first such enterprise in China. Phases 1 and 2 for the 1990 period saw the establishment of a model/demonstration butterfly farm (Fig. 21-25). This includes a large flight cage dome (Figs. 18 and 27) and foodplants nursery (Fig. 20) on an extensive site, entirely surrounded by impressive forested slopes, just inside the large Mengyang Forest Reserve. It will serve both as an educational facility, and as a money-making tourist attraction. Success in ranching *Troides helena* (Linnaeus) was achieved within only six months of planting out *Aristolochia tagala* cuttings on the site (Parsons, 1990c), and similar results with *Troides aeacus* (Felder & Felder) were achieved soon after that (Parsons, 1991b). Three other local *Aristolochia* species have been cultivated in order to farm the four *Atrophaneura* species in the area [*Atrophaneura aidoneus* (Doubleday), *Atrophaneura aristolochiae* Fabricius, *Atrophaneura polyeuctes* (Doubleday), and *Atrophaneura zaleucus* (Hewitson)], and many other foodplants are also under propagation in order to farm a wide range of butterflies, including *Papilio (Chilasa) clytia* Linnaeus and various other papilionids. Various impressive wild silkmoths are also under consideration for farming, such as *Argema maenas* Doubleday (Fig. 22; front and back covers), while a huge diversity of other moths (and many large beetles) can be collected using Mercury Vapor traps entirely constructed from locally available materials (Fig. 25).

Phases 3 and 4 during the 1991/92 period will see the development of the DIFT central marketing agency in the nearby prefectural capital of Jinghong on the Mekong River (Parsons, 1991b), the establishment of local village farmers through extension, and the subsequent intergration of the whole system as depicted in Fig. 32 and 33. Reference collections of butterflies and moths have been established. To date, Parsons and his trainees have compiled a checklist of 390 butterfly species from the Xishuangbanna reserves (Parsons, 1990c), several of which are new records for China. It is expected that the list will expand to at least 450 species as research progresses.

It is hoped that the DIFT will eventually reach a stage where it will be able to act as the main agency for the development of butterfly farming and collecting in other important localities throughout China, particularly the more mountainous northern Yunnan/southern Sichuan region. In this way its activities will extend to promote the farming and conservation of many sought-after butterflies, such as *B. mansfieldi*, *B. thaidina* and various *Parnassius*.

MYTHS AND MISUNDERSTANDINGS

COLLECTING CONTROVERSY

As the outright collecting of wild butterflies (as opposed to farming) has been, and will continue be, such an important part of the overall operation of an IFTA system, the topic warrants discussion. As Morris (1986) pointed out, provided the resource is wisely used, the distinction between farmed and wild-caught butterflies is not important in the context of conservation. The argument that overcollecting of butterflies can lead to their extinction has prompted serious discussion in the recent past (e.g., Gardiner, 1973 and 1976; Owen, 1974 and 1976). As Thomas (1984) noted, collectors in temperate climates have been blamed more often than any other factor for the decline in butterflies and, even today, committees spend as long debating whether certain species should be protected by law as on most other aspects of conservation. This attitude has been arbitrarily extrapolated by many in the developed world (but primarily in Europe) to include similar concerns for tropical species (e.g., Bökemeier and Soutiff, 1987). As has been shown above, this was the main reason for protecting various *Ornithoptera* under PNG's 1966 Fauna Protection Ordinance. There are, of course, circumstances where species limited by geography might be detrimentally affected if subjected to pressures of intense collecting, *O. alexandrae* being a prime example, and especially where endemic species are restricted to small low-lying islands or isolated montane localities. However, the concept of overcollecting has been seriously questioned by many entomologists in recent decades, some of whom have also clearly pointed out that habitat destruction is the main threat to the future of many butterfly species (e.g., Carvalho and Mielke, 1972; Pyle, 1976 and 1981; Fenner, 1976a; Gardiner, 1973; Severinghaus, 1977; Collins and Morris, 1985). There is no evidence that overcollecting has ever threatened the existance of a butterfly species anywhere in the world (e.g., Key, 1978; Pyle et al., 1981; Morris, 1986) (Figs. 12 and 19).

Although Pyle and Hughes (1978) expressed concern that at least some PNG butterflies might have been subject to overcollecting in the past, upon detailed investigation they found that this was not the case at the time of their consultancy visit to PNG. They also noted that it is unrealistic to expect that all collecting will be replaced by farming, as some species will resist easy breeding. Anyway, for many of the common and less valuable species the ease and economics of collecting often outweigh the initial investments of time and effort in farming. As Pyle (1976) pointed out, the enormous reproductive capacity of most insects, and the logistical problems of physically removing a large percentage of individuals from a population (especially formidable in very tall lowland tropical forests), mean that overcollecting seldom poses a genuine threat to butterflies.

Good examples of IAR papilionids that have been discussed in terms of concern for their possible overcollection include lowland *Troides (Trogonoptera) brookiana*, insular *Ornithoptera priamus caelestis* and montane *Graphium weiskei*. Yet in these cases the

evidence not only strongly demonstrates that collecting has had little, if any, adverse effects on these species, but actually furnishes proof of the benefits of collecting to satiate, and thereby beneficially suppress, their market demand. Morton and Collins (1984) recorded that possibly over 125,000 specimens of *T. brookiana* are exported each year from Malaysia and Indonesia. These comprise mainly wild-caught males, but the species can apparently sustain these levels of collecting and is not thought to be threatened (Collins and Morris, 1985). The transition over the last decade from its use in the specialist market to primarily now being part of the decorative trade indicates the high level of this supply. Pyle and Hughes (1978) registered their concerns with regard to pressure of collecting on *G. weiskei*, "... one staple of the Highlands butterfly trade", and for *O. p. caelestis* (Figs. 2 and 3). Nevertheless, for about the last 13 years *G. weiskei* has been supplied in many hundreds to the IFTA by numerous collectors operating throughout PNG's Central Cordillera. As with *T. brookiana* mostly males are collected when they come down to mineral water seepages and the damp sand of stream margins (Fig. 26). However, as Morris (1986) pointed out, a lengthy moratorium had to be imposed by the IFTA on collection of *G. weiskei* because of oversupply, and this had been the case several other times before 1986. These facts not only point to the continuing abundance of *G. weiskei*, but that the species had, anyway, ample periods of time in which to recover its numbers. Morris also noted that *O. p. caelestis* too had been overproduced in 1986. In this case the collecting was enhanced by farming. In PNG many hundreds of *Papilio* species, such as *Papilio ulysses* Linnaeus and *Papilio euchenor* Guérin-Méneville, are also collected, yet it is unlikely that these common and widespread papilionids will be affected by collecting, habitat destruction being the key factor in any concerns for their survival.

EXTENT OF FARMING

Another controversial subject has been the actual extent of butterfly farming. On the basis of a popular article by Vietmeyer (1979b) on butterfly farming in PNG, Cody (1981) visited the country in order to see what he understood to be at least 20 butterfly farms in the Maprik area alone, complete with well regimented rows of foodplants on which the early stages of many butterfly species could easily be studied. Cody's consternation at only being able to locate a single farm in the Maprik region was not a unique case amongst visitors to PNG, and Gagné and Gressitt (1982) pointed out that butterfly farming is actually little practiced there. Having read articles such as Vietmeyer's, and similar accounts that followed (e.g., Cherfas, 1979), many tourists who visited the IFTA had equally high expectations of seeing what they took to be the equivalent of minor butterfly zoos widely dispersed throughout PNG. The paucity of PNG butterfly farms, as is the case in reality, merits explanation as it highlights some of the problems of implementing butterfly farming in the tropics. Farming difficulties vary in different countries, and mainly result from the diverse attitudes and aptitudes of the people who adopt the techniques.

Cody concluded that a less casual attitude would be needed by Papua New Guineans if eventually all *Ornithoptera* species were to be successfully farmed in PNG. Collins and Morris (1985) suggested that less than 10% of the world's swallowtails are farmed. The NRC (1983) estimated that, of the butterflies exported by the IFTA, 30% were from village farms, whereas 70% were field collected. Mercer and Clark (1989) maintained that the proportions are presently about equal in PNG. However, it is likely that, despite the past history of promotion of farming techniques by IFTA, the greater majority of the approximately 500 people engaged in supplying the IFTA are still outright collectors. As Pyle and Hughes (1978) pointed out, only a limited number of butterfly species are actually farmed in PNG. Because of their foodplant specializations and ease of culture these are primarily *O. priamus* and *T. oblongomaculatus*, but various *Papilio* and *Graphium* species, and a very limited number of nymphalids, are also farmed, as well as the giant silkmoth, *Coscinocera hercules* Miskin (Figs. 10 and 11). The majority of IFTA suppliers are villagers of rural communities who operate on an extremely casual basis, collecting only when they wish to do so. In PNG it is also easy for certain village elders to set themselves up as 'collector barons'. They are able to send out large numbers of village children to collect and bring back specimens for which the youths are paid minor sums of money, the main profits going to the elder. In other areas of the IAR, collectors (as opposed to butterfly farmers) are also in the majority mainly because greater effort is required to establish and maintain a butterfly farm.

The supply to the IFTA from many farmers/collectors in PNG is often also notably sporadic on an idividual basis. This results partly from the fact that collectors often aspire to earn money in order to pay for specific 'luxury' items (e.g., cassette radios). Otherwise rurally-based collectors are usually self-sufficient and so do not need to collect in order to purchase food or other staples. The irregular nature of supply also stems from the fact that, because the prices paid by the IFTA are so fair, such collectors can often earn enough money in one shipment to last them several months, during which time they do not bother to send others. An attitude also exists that is more difficult for those versed in the ways of capitalism to comprehend: many PNG collectors just cease to collect, even though the financial rewards remain lucrative. This usually stems from a feeling of discouragement that can develop in the minds of village collectors (especially those in the remoter rural areas) if there is no apparent physical interest in their activities. It is also associated with the fact that villagers usually show the greatest interest in those projects where foreigners can be seen to be actively involved in them (Parsons, 1990b). For this (and other reasons noted above) extension visits have been essential to the project in PNG, because collectors, especially in certain areas, require constant encouragement to sustain their interest.

DEFINING THE FARM

Despite the 'idealized' or model farm outlined by Pyle and Hughes (1978) and further detailed and figured by Parsons (1982a) (Fig. 35), village butterfly farmers in PNG rarely embrace such a concept. Instead, they usually adapt the idea to suit more their own lifestyles. Butterfly foodplants (almost invariably *Aristolochia* vines, and primarily *A. tagala* for *O. priamus* and *T. oblongomaculatus*) are treated in a way similar to planting their normal food crops (such as yams: Fig. 2), and often in a rather randomized fashion. Small areas adjacent to village buildings are opportunistically utilized, vines being placed

wherever there are trees to provide the appropriate support. Village farmers do not usually concern themselves with the overall appearance of these butterfly gardens, and certainly do not see the necessity to maintain them in any form of neatness. The result is that so-called butterfly farms in PNG are usually almost indistinguishable from secondary vegetation, or areas of young secondary forest, and are certainly not what a tourist might expect: "... a loose form of butterfly gardening and habitat enrichment" as Pyle and Hughes called it, whilst they also predicted that "... the majority will continue to farm in this more dispersed and informal way."

The term "habitat enrichment" (i.e., enhancement), as used by Fenner (1976) and Pyle and Hughes, most accurately describes the technique developed in PNG whereby *Aristolochia* vines are planted out in secondary forest areas to increase local populations of *Ornithoptera*. For example, it was promoted by Parsons (1980a) as an important method in the conservaton of *O. alexandrae*, and by Parsons (1983c) for the farming of various other *Ornithoptera*. Mercer and Clark (1989) maintained that the IFTA now "prefers" habitat enrichment over the idealized concept of a butterfly farm, and so has "changed" to that technique because, as previously pointed out by Pyle and Hughes, the wider spacing of foodplants means that there will be less threat to butterfly early stages due to the lower concentration of their predators and parasitoids. However, each farming method has its benefits and drawbacks, and it is clear that both provide useful means of raising butterflies.

Even assuming higher mortality of early stages using the idealized model, the simple sleeving of larvae and pupae on their foodplants within micro-mesh sleeves (e.g., constructed from good muslin or cheesecloth) on such a farm will drastically reduce such losses, whilst providing other important benefits over the habitat enrichment plan. For example, sleeving also obviates the necessity to search widely, and on a hit or miss basis, for early stages as the farmer must do in a habitat enrichment situation. The idealized farm layout is also important for the fact that it is logistically far easier to more accurately assess the amount of stock present within the farm area. This is important if a farmer intends to adhere to the guidelines of butterfly farming and so leave about half of his pupal stock to repopulate the farm. That person will be more able to do this accurately on a well organized farm where vines are grown in orderly rows on low trellises or support trees, and various foodplant trees are kept pruned to acceptable heights. Conversely, it is extremely difficult to locate all butterfly early stages in a haphazardly organized farm, especially where larvae and pupae high in trees often go unnoticed. In such cases farmers very often assume that, merely by cropping the lowest pupae others remain higher up that will continue to repopulate the farm, but this is a very inexact approach to conservation.

Pyle and Hughes (1978) noted that insects are amongst the most habitat-limited organisms, and that "... successful and diverse long-term insect farming must be based upon a matrix of natural habitat reserves", concluding that "Habitat conservation, then, is a matter of keeping the options and opportunities open." Based on their comments Gagné and Gressitt (1982) stated that proximity of habitats containing healthy wild populations would continue to be necessary for butterfly farming operations to succeed, so that insect farming may require nearby habitat reserves. Mercer and Clark refuted this, maintaining that, once established, farms can be self sustaining, provided that not all farmed stock is killed. Nevertheless this has never been proven. Success indicative of self-sustainablity in town areas has, so far, only been achieved (attempted) with *O. priamus poseidon* and *T. oblongomaculatus*, the most ubiquitous of the birdwings, but it is unlikely that other truely economically valuable butterfly species, particularly the remaining *Ornithoptera* which have more specialized ecological requirements, could be farmed effectively in the absence of adjacent areas of prime habitat. In the case of the presently farmed birdwings, adults are known to range quite widely (Parsons, 1983a and 1983c), so that the turnover within a farm area is very likely to also include visiting wide-ranging wild individuals, as well as those that appear to remain mostly in its immediate vicinity (which undoubtedly many do, based on mark/recapture experiments).

A TANGLED WEB OF LEGISLATION

No discussion of IAR butterfly farming would be adequate without addressing the important topic of the legislation that is directly associated with it, or which has had important, but more indirect, repercussions on the industry in the region. PNG provides a particularly good example of the effects of such legislation. As Pyle (1981) pointed out, trade regulation or collecting laws very often tend to become smoke screens for serious habitat issues. He noted that this 'paper protection' by local governments does little to halt habitat destruction caused by projects approved by the very same governments, whilst in passing such laws officials feel that they have discharged their responsibilities for butterfly conservation. Morris (1986) noted that the legislation of most nations and states continues to assume that the main, or only, threat to species is from collecting or utilisation/exploitation. A good example was the passage by the Indian Government of an ammendment to its 1972 Wildlife Protection Act listing a large number of butterflies as fully protected (Collins and Morris, 1985). Morris suggested that, although such legislation has been effective in the protection of some vertebrates, there have, for various reasons, been serious reservations about the corresponding value of such in the protection of invertebrates, particularly insects. As Morton and Collins (1984) concluded, legislation against collecting and trade is unlikely to preserve a species unless parallel measures to protect its habitat are enforced.

THE BIRDWING GENERA

By the late 1960s the growing worldwide demand for the spectacular *Ornithoptera* brought them to the attention of certain expatriate Government officers working for the Australian Administration of the then Territory of Papua and New Guinea. If left unchecked it was believed that overcollecting could threaten the survival of various species, the majority of which were considered to be "rare" and/or "localized". This concern for overcollecting was strongly promoted by the Senior Entomologist to the Department of Agriculture Stock and Fisheries, Joseph Szent-Ivany, who recommended that most of the *Ornithoptera* should be declared protected insects (e.g., Szent-Ivany, 1967). This had the result that, as from November 1, 1968, seven *Or-*

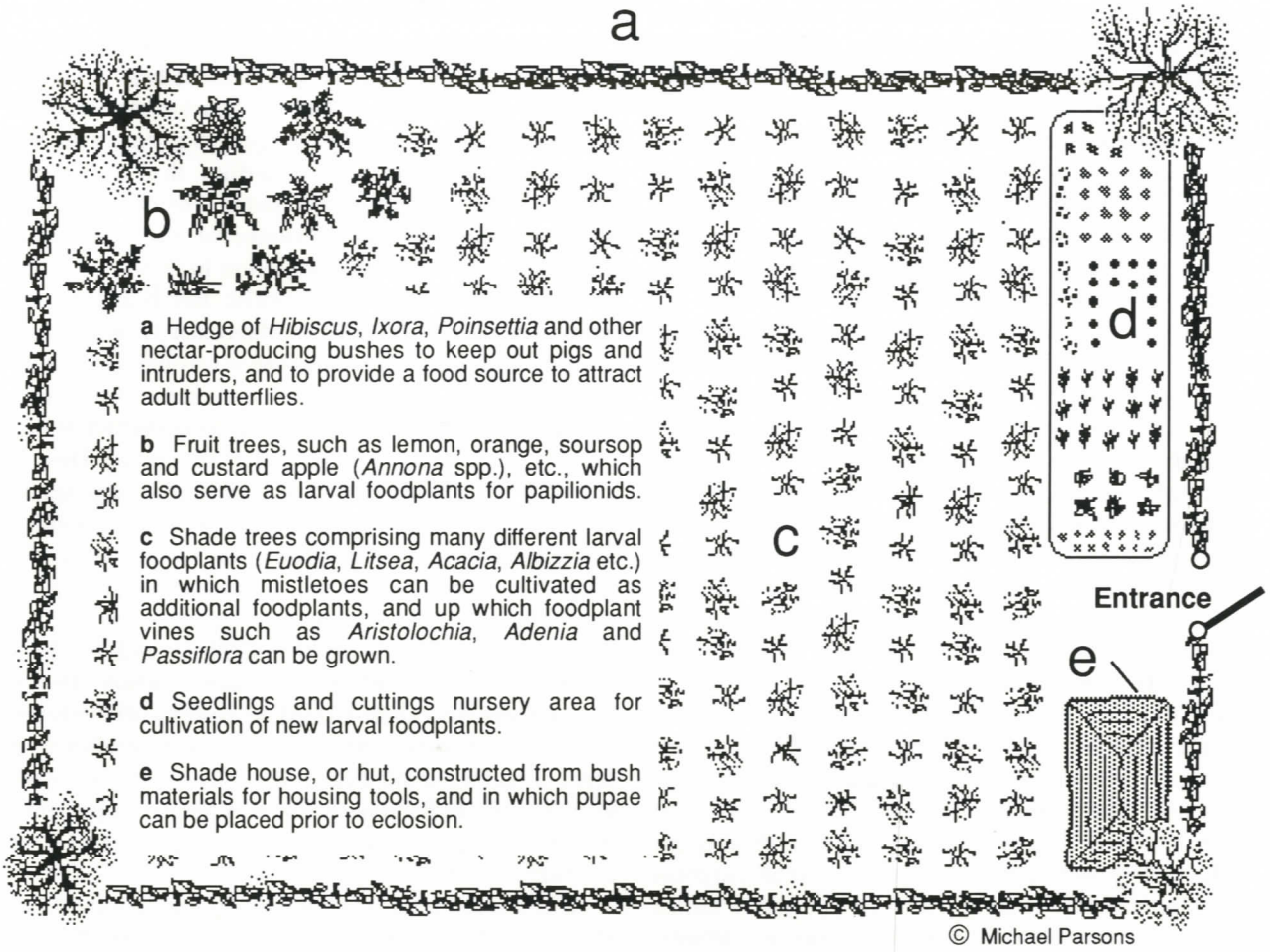


Fig. 35. Layout of an idealized small-scale butterfly farm.

nithoptera species [*O. alexandrae*, *O. chimaera*, *O. goliath*, *O. meridionalis* (Rothschild), *O. paradisea* Staudinger, *O. victoriae* and *O. allottei* (Rothschild) — the latter taxon almost universally now accepted as being of hybrid origin from *O. priamus urvillianus* x *O. victoriae regis* (Rothschild)] were completely protected by their listing in the Government Gazette under the 1966 Fauna Protection Ordinance by the Australian Administration (Shaw, 1969) (Fig. 4). Permits to anyone wishing work on PNG's National Insects are granted only for justified research purposes. By contrast, although Indonesian Government legislation for Irian Jaya 'protects' all birdwings, permits are usually granted to commercial operators to deal in dead specimens of even the rarest of these butterflies (Morris, 1986).

Even after the imposition of national laws governing the collection and export of *Ornithoptera*, some resident expatriates in PNG continued to search for their early stages in order to breed the butterflies for sale as perfect specimens. Warnings were published stating that a maximum fine of about $250 (now about $625) would be imposed on anyone who was caught in possession of protected *Ornithoptera* (e.g., Anon., 1973). Dried specimens of adult butterflies, even the large *Ornithoptera*, are extremely light, and are easily concealed for shipping, the rewards to smugglers being high. In the Indonesian (Irian Jaya) half of the island of New Guinea the trade in *Ornithoptera* increased even more rapidly as, although Indonesia also had laws governing trade in fauna, these were not effectively enforced. In fact, the listing of these butterflies under PNG's Fauna Protection Ordinance actually had the effect of making trade in them even more lucrative. By making them unavailable to the market, they became still more coveted by collectors, thereby increasing their value dramatically: a point made by various authors (e.g., Gressitt and Zeigler, 1973; Ingram, 1975; Fenner, 1976b; Jackman, 1976; Waugh, 1976). As late as 1989 collectors from overseas, posing as general tourists, have asked some local people in Popondetta to collect the species for them (Povincial Wildlife Officer, E. Malaisa, pers. comm. June, 1990). *O. alexandrae* is still advertised in American, German, British and Japanese insect dealer catalogues, and certainly not all of these are pre-Protection Ordinance specimens. For example, Jackman (1976) reported that Government officials estimated that about $140,000 worth of protected birdwing butterflies were on sale in Britain and Germany alone at that time.

By 1976 PNG's Fauna Protection legislation had led to the confiscation of about 140 illegally collected specimens of various *Ornithoptera* species, and the successful prosecution of several non-citizen expatriates who were illegally engaged in trafficking of protected *Ornithoptera* in PNG (Fenner, 1976b). Several other offenders were prosecuted soon after (e.g. Waugh, 1976; Anon., 1976; Grenard, 1979; Anon., 1979). Thus, with the realisation that, if the large demand for the protected *Ornithoptera* could not be satisfied in a controlled manner it would only continue to the detriment of their survival, Fenner proposed, in an internal PNG

Government memorandum, that experimental farming of these butterflies, and in particular of *O. alexandrae*, should be begun. He also promoted his ideas at a conservation symposium held at the WEI (Fenner, 1976a), but these proposals were never adopted.

In recognition of the international importance of the *Ornithoptera*, legislation was also introduced for them in other countries. In early 1973 PNG was one of many countries to agree, in principal, to an international convention governing the trade of wildlife (Kwapena, 1975). International agreement on wildlife trade control is contained in the July 1975, Convention on International Trade in Endangered Species (CITES), which establishes controls and monitors export of the species listed in Appendices I and II (Pyle, *et al.*, 1981). PNG is one of 95 signatories to this agreement. Appendix I, which presently contains no insects, is a list of species threatened with extinction in which their trade is subject to strict regulation, and commercial trade is virtually prohibited. Appendix II, which contains all of the birdwings (*Ornithoptera*, *Troides*, etc.), is a list of species which, it is considered, must be regulated in order to avoid the threat of extinction. Their commercial trade is permitted, but only with proper documentation (i.e. export permits) issued by the government of the exporting country.

In 1982 the European Economic Community (EEC), implementing CITES, included in its Regulation 3626/82 an annex of species listed on Appendix II of CITES that the Community treated as though they were on Appendix I. This prevented virtually all trade in those species by prohibiting their importation into the EEC, if they were primarily for commercial purposes (Collins and Morris, 1985; Collins, 1987). It effectively turned CITES Appendix II species, into Appendix I species (Morris, 1986).

Jackman (1976) reported that, in 1974, largely due to the efforts of then Britain's largest butterfly dealer, Robert Gooden, an Entomological Suppliers Association (ESA) was established which drew up its own "red list" of endangered species which members promised not to buy or sell. Since 1975 this has included all of the protected birdwings. However, Jackman noted that, since not all dealers were bound by the ESA code, protected species (i.e., *Ornithoptera*) from PNG were still being offered by some British dealers at up to about $400 per pair. Collins and Morris (1985) noted that the ESA banned trade in the rare Taiwan endemic *Troides aeacus kaguya* Nakahara & Esaki under the guidelines of its "Code of Conservation Responsibility", the only code adopted by commercial entomologists.

In 1989 the U.S. Department of the Interior, Fish and Wildlife Service, proposed to determine endangered status for *O. alexandrae* having received a petition from Ms. Marion Kelly Murphy requesting that the species be added to the list of Endangered and Threatened Wildlife (Dunlop, 1989). This proposal was found by the Service to be warranted. Like EEC Regulation 3626/82 this action turned *O. alexandrae* from a CITES Appendix II species, into an Appendix I species, as far as the U.S.A. is concerned. However, in this case the action, being specific and justified (Parsons, 1983c), is welcome, whereas the 'blanket protection' of the *Ornithoptera* under Regulation 3626/82 was a derimental move (see below).

EMOTIONAL VERSUS RATIONAL

The *Ornithoptera* were the subject of a wrap-up conservation report to the PNG National Government by Parsons (1983c) in which it was pointed out that the 'blanket' protection of all but *O. priamus* in PNG was based more on an emotional view of the conservation needs of these butterflies, than on a sound knowledge of their distribution and status. For example, most of the basic ecologies and life histories of the *Ornithoptera* were published well after their protection in 1968 (Straatman, 1969, 1970 and 1971; Szent-Ivany, 1970; Borch and Schmid, 1975; Straatman and Schmid, 1975). Malaysian *T. brookiana* provided a similar example: For a long time it was thought that its females were extremely rare, numbering only about one to every 1,000 males, until Wheeler (1940) more closely studied its behavioural ecology and found a normal 1:1 sex ratio. This emotional approach to birdwing protection is further emphasized by the fact that two smaller papilionids in PNG were not granted protected status at the time of the gazettal of the *Ornithoptera*. These were *Graphium meeki* (Rothschild & Jordan) and *Papilio moerneri* Aurivillius, long known to be extremely rare and far more localized than most of the *Ornithoptera*, and which, therefore, apparently also merited some protective action. The legislation was, anyway, very short-sighted because, by officially designating certain *Ornithoptera* species as rare, and prohibiting access to them, it had the immediate effect of enhancing their desirability to collectors. In addition it has also helped to perpetuate to the present day a general belief that all of the protected *Ornithoptera* are extremely rare.

As discussed above, the overriding fear that the *Ornithoptera* would be collected to extinction (e.g., Owen, 1974) was the main reason for their protection. However, other factors, such as the high cost of air fares to the region from Europe, and stories of the dangers facing collectors (even stressed by recent authors: Kobayashi and Koiwaya, 1978; D'Abrera, 1979; Regan, 1988), have also served to perpetuate a mystique which has surrounded the Ornithoptera since the period of their first discovery, and which still continues today. Therefore, it should be realized that much of the legislative judgements made on behalf of these papilionids, subsequent to their protection in PNG, were also founded more on fear than fact.

Parsons (1983c) summarized his findings on the PNG birdwings as shown in Table 1. He proposed a system of 20 nature reserves throughout PNG which, it was considered, would provide adequate baseline habitat protection for the *Ornithoptera*. Based on ecological and distributional data Parsons also strongly recommended that *O. goliath*, *O. chimaera* and *O. victoriae* should be immediately brought into the insect farming system in PNG. In the case of *O. chimaera* it was pointed out that the often precipitous topography in which the species occurs is likely to be its ultimate safeguard. This is because not only is *O. chimaera* difficult to collect in such areas, but its habitat is extremely difficult to exploit commercially (e.g., for timber). This naturally favours the continued existance of *O. chimaera* as its habitat is not as easily threatened as is that of other *Ornithoptera* species which mainly occur in lowland forest containing larger, more accessible (and, therefore, more commercially viable) timber. Similarly, Morris (1986) recommended that all the Irian Jayan

Table 1. Summary of Statuses and Justified CITES Appendix Ratings of PNG Birdwings (after Parsons, 1983c).

Species	Summarized Status	Justified CITES Appendix Rating
T. oblongomaculatus	Locally common to abundant, generally common, widespread	None
O. priamus	Locally common to abundant, generally common, very widespread	None
O. goliath	Locally common, generally rare, widespread	None
O. chimaera	Locally occasional to common, generally rare, fairly widespread	None
O. paradisea	Locally occasional to common, generally rare, restricted to localized geographical localities	App II
O. meridionalis	Locally occasional to common, generally rare, restricted to localized geographical localities	App II
O. alexandrae	Endangered, rare even in its habitat and extremely restricted geographically	App I
O. victoriae	Locally occasional to common, generally occasional, widespread in its overall geographical distribution	None

birdwings protected by Indonesian law (including *O. rothschildi* and *O. tithonus*), but excepting *O. meridionalis*, be 'de-listed' from that legislation, and be farmed as soon as possible.

Parsons found that *O. priamus*, the most biologically successful *Ornithoptera* species, is common and widespread, and exploits the widest foodplant spectrum of its genus. He noted, therefore, that it was correctly omitted from the PNG's list of protected species, and obviously did not require protective legislation, especially since *O. priamus* had been successfully farmed in PNG for several years for sale overseas as perfect ex-pupa adults. Parsons stated that to correctly emphasize the endangered status of *O. alexandrae* the species should be upgraded from CITES Appendix II to Appendix I, and that it should remain so until such time as all of its remaining habitat is safeguarded under PNG's Conservation Areas Act.

The fact that, to date, no insects are listed on CITES Appendix I, and that Appendix II includes all *Ornithoptera* and all *Troides* (i.e., plus *Trogonoptera*) stands as testament not only to the ineffectuality of the legislation as it applies to butterfly conservation, but also the inaccurate treatment of the butterflies which it lists. For example, there is no need for international trade regulation of the common and widespread *O. priamus* or *T. oblongomaculatus*, both of which have been very successfully farmed/ranched in PNG for over 13 years now. In fact, well over a decade ago Pyle and Hughes (1978) recorded that the 1974 position that *Ornithoptera sensu lato* be included on CITES Appendix II, adopted by the IUCN Lepidoptera (now Butterfly) Specialist Group (LSG), would almost certainly be reversed. This was because during their consultation with three members of the Group representing PNG (all Government entomologists) the recommendations of these members were unanimously against CITES action as it would "... vastly complicate both marketing and scientific export of two butterflies which make up an important segment of most trade parcels, as well as being important research subjects, yet are not endangered by these activities: *Ornithoptera priamus* (all ssp.) and *Troides oblongomaculatus*."

Eight years have elapsed since Parsons (1983c) demonstrated that at least *O. goliath*, *O. chimaera* and *O. victoriae* require no CITES protection, whilst *O. alexandrae* should be placed on Appendix I because of its truely endangered status. Yet still no action has been taken on this advice, even though these recommendations (albeit initiated in restricted unpublished Government reports) were later published by Morton and Collins (1984) and Collins and Morris (1985), and further promoted by Morris (1986). Collins and Morris similarly found that none of the IAR *Troides* were threatened, with the implication that most did not require legislative protection. Because of the CITES listings, the 95 countries presently party to the Convention are obliged to invoke national legislation in its implementation. Collins (1987) pointed out that, since IUCN believes that the rational and sustainable utilization of wildlife should be integrated into conservation programmes in the developing world, it has lobbied since 1984 for the relegation of birdwings from CITES Annex C (1) to Annex C (2). He pointed out that interventions have been sent out directly to the CITES Committee Secretary, and to the UK Department of the Environment.

The legislative problems concerning birdwing conservation were further highlighted in a letter to the editor of the Royal Entomological Society of London newsletter, *Antenna*, by Macfarlane (1984). He stated that his attempts to establish an IFTA-like butterfly farming project in the Solomons were seriously jeopardized by the unilateral decision of the EEC to prohibit trade of birdwings within Europe, except for ranched species. Macfarlane understood that this legislation was made without any effort to take advice from conservationists, the British Nature Conservancy Council, or the IUCN LSG, and stated that he would like to see a repeal of the measures. Collins and Morris (1985) confirmed that the EEC unexpectedly added the CITES Appendix II Papilionidae to the Regulation 3626/82 annex species list without consultation with the CITES Secretariat, or the IUCN LSG, and that the Regulation would seriously jeopardize the PNG birdwing ranching programme, and others, all of which rely heavily on European markets. As Morris (1986) pointed out "By prohibiting trade in birdwings, the EEC is helping to prevent their conservation in countries like PNG."

Only recently has the advice of Macfarlane, and other entomologists in the field (Parsons, various references; Morris, 1986), begun to be heeded to a degree. Notably that, in 1987, EEC Council Regulation 1422/87 was passed which finally ammended the earlier Regulation 3626/82. The 1987 emmendation recognized that ranching of birdwings is enjoying some success in developing countries, and so correctly downgraded the protected status of all species, but *O. alexandrae*. This permitted the other species to be imported into the EEC for trade purposes, "... whilst maintaining adequate safeguards for the prevention of imports of specimens of endangered species and populations of birdwing butterflies." (Smet, 1987). It is pertinent to add that one dealer in Irian Jaya, ignorant of the EEC rulings, had no trouble at all in 'breaking' Regulation 3626/82 for his European clients even whilst it did exist (Morris, 1986). Invariably it is customs officers who have to enforce such legislation and, unless given the appropriate training, it is easy for them to confuse species, and/or fail to recognize those that are protected. It is also pertinent to point out that it is extremely difficult (mostly impossible) to ascertain whether specimens have originated from a true farming set up, or have merely been collected as wild pupae, or as good quality wild adults.

A decade was to pass from the time that Pyle and Hughes (1978) urged the PNG Government some expediency in resolving the eventual marketing of its protected *Ornithoptera*, until the time when the first definite action was taken. Although *O. victoriae* still remains on PNG's list of Protected Fauna, on February 8, 1988, PNG's Conservator of Fauna finally granted the IFTA control of collecting and commercially marketing the species (dead or alive) under Section 29 of the Fauna (Protection and Control) Act (taking of protected animal for special use). Thus it is interesting to note that the economic utilization of the species was achieved by merely using a simple legal move, thereby obviating use of laborious burecratic measures to entirely revoke its protective legislation. The document (a straightforward permit) requires that only farmed specimens are to be sold, and that this is done only through the IFTA. It also stipulates that the IFTA monitors the activities of the specifically selected and registered farmers to ensure that a certain percentage of adults are released to maintain viable breeding populations. This action is in line with the recommendations for the utilization of *O. victoriae*, *O. chimaera* and *O. goliath* in PNG's butterfly trade as detailed by Parsons (1983c).

It remains to be seen whether similar permits will be granted for the utilization of *O. chimaera* and *O. goliath* as has frequently been lobbied for by the IFTA since Parsons' final report. Nevertheless, the WEI is going ahead with the planting of *O. chimaera* and *O. goliath* foodplants with the expectation that these will soon be similarly granted exemption from protection (Bloch, 1988; WEI, 1989). Mercer and Clark (1989) reported that 11 farmers have now been licenced by the Government to farm *O. victoriae*. It is a sad irony that, almost exactly as the species finally became legally utilizable by the butterfly farming system in PNG, a revolutionary war on Bougainville Island precluded its shipment from there to the IFTA, so maintaining its unavailability and continuing to deny the IFTA income from this valuable additional species.

THE CHINA SITUATION

There have been various parallels in China with the problems of legislation affecting PNG. China's continuing policy to expand its international export trade (Xu, 1990) bodes well for the establishment of a government-run butterfly farming enterprise there. Nevertheless, legislation is presently hindering the development of the YFB's DIFT (outlined above) as National Government business permits are required in order to sell butterflies and other insects, as well as butterfly-based products. Although it is expected that this problem will soon be resolved, it is, nevertheless, a very time-consuming process.

Table 2 lists China's protected insects, of which it will be noted that only 5 are butterfly species, all papilionids, none of which are known to occur within the Xishuangbanna area. Clearly it is arguable that, since China's 1988 Wildlife Conservation Laws (Yang, 1989) are rightfully intended to fully protect only those species that are endangered, then as there are no known rare or endangered insects in the Xishuangbanna region there should be no cause to withhold granting of the necessary export permits to the YFB DIFT.

Sibatani (1989) stated that every application for the collection and export of Chinese insects by foreigners is judged on its merits by the Department of Insect Classification at the Beijing Institute of Zoology. He noted that it was mainly the biologists in the country who condemned the initial inclination of the Government to use rare biological resources for economic gain through export, mainly through fear of 'loosing' scientifically valuable new taxa to overseas scientists. Sibatani maintained that there has been extensive poaching and smuggling of butterflies in China since about 1980, primarily by Japanese, but also by Europeans. Koiwaya (1990) criticized Sibatani, stating that, contrary to Sibatani's belief, about 99% of the Chinese specimens imported into Japan over about the last decade were legally exported from China (based on his estimation of 5,000 specimens smuggled into Japan from China, compared to the 600,000 specimens that he and another Japanese dealer legally imported during their dealings in Chinese butterflies). He pointed out that, prior to 1983, foreigners were not allowed to collect butterflies, and that the first smugglers were West Germans, Ekweiler and Goergner, in 1985. Later Beligians, Spanish, and many other Europeans were arrested in Beijing and other areas on butterfly smuggling charges. Koiwaya maintained that, in China, there are no laws prohibiting the export of insects by Chinese people, or that prohibit insect collecting by Chinese, or prohibiting the export of insects by Chinese export companies licensed by the Government. Therefore, since 1976 many insects have been sold through the Canton import/export market. However, he noted that, as it is illegal for foreigners to collect or export without the permission of the Chinese authorities, this is the most important legislation affecting foreign collectors.

From the information presented by Koiwaya, it appears that the decade between 1978 and 1988 was a period during which the Chinese have attempted to come to terms with the demand for their butterflies, with various experiments being tried before the introduction of clearly defined wildlife protection laws in 1988. It is clear that, as is the case elsewhere in the IAR, legislation is still being broken in China. Koiwaya pointed out that, on two occasions, specimens confiscated by Chinese authorities from

Table 2. List of Protected Insects in China (after Yang, 1989).

Note that the status ratings of I and II refer to the strict Chinese system of control (not CITES), meaning no collecting, etc., of category I species, unless with written permission from the relevant *state* authority, and likewise for category II species, unless with written permission from the relevant *provincial* authority.

Group	Status Rating
DIPLURA (Diplurans)	
Japygidae	
Atlasjapyx atlas	II
ODONATA (Dragonflies)	
Gomphidae	
Heliogomphus retroflexus	II
Ophiogomphus spinicorne	II
ZORAPTERA (Zorapterans)	
Zorotypidae	
Zorotypus medoensis	II
Zorotypus sinensis	II
ORTHOPTERA (Grasshoppers, Mantids, Cockroachs, etc.)	
Grylloblattidae	
Galloisiana sinensis	I
COLEOPTERA (Beetles)	
Carabidae	
Carabus (Apotopterus) davidi	II
Carabus (Cryptolabrus) lafossei	II
Euchiridae	
Cheirotonus spp.	II
Dynastidae	
Allomyrina davidis	II
LEPIDOPTERA (Butterflies and Moths)	
Papilionidae (Parnassiinae)	
Teinopalpus aureus	I
Papilionidae (Papilioninae)	
Bhutanitis mansfieldi	II
Bhutanitis thaidina donguchuanensis	II
Leuhdorfia chinensis huashanensis	II
Parnassius apollo	II

foreign collectors (including himself) ended up for sale in Hong Kong. Although protected by law since 1988 *Bhutanitis mansfieldi* and *B. thaidina* are still advertised on the lists of Hong Kong butterfly dealers (pers. obs. March, 1990).

CONCLUSIONS AND THE FUTURE

The 'testing' of butterfly farming for more than a decade in the IAR has established a set of fundamental principles by which future action plans can be enhanced. The overriding threat to populations of butterflies in the tropics is destruction of their habitats. These are primarily fragile forest ecosystems which rapidly succumb to the pressures of expanding human population through agricultural and industrial exploitation. Therefore, governments interested in the long-term benefits of butterfly farming must first address the need to establish forest reserves on which the system ultimately relies. D'Abrera (1979) expressed similar sentiments, pointing out the hypocrisy of some governments in fiercely policing their laws against collecting or breeding birdwings, whilst at the same time time permitting wanton destruction of their habitat.

Overcollecting has only ever been suspected of occasioning minor harm to butterfly populations, and then only where habitat destruction has been the primary cause for a species becoming vulnerable. Legislative actions promulgated for those butterflies known (or assumed) to be rare or endangered have proven ineffectual, and much worse counter beneficial, and anyway fail to strike at the root cause of species endangerment: habitat destruction. Legislation is laborious to instigate, tedious to change, easy to ignore and, in the face of the profits that can be made from the illegal traffiking of butterflies, imposable fines have served as little deterrant to offenders. No legislative action in the world has been shown to halt the extinction of a species where its very home is under steady elimination due to commercial development.

Clearly, the butterflies that most warrant attempts at actual farming are those endemic to particular regions within the scope of a butterfly farming project. Thus it follows that the system has the potential to work best in those areas where there is a high percentage of endemicity in the butterfly fauna. By definition these are usually species of restricted range, and/or of rarer occurance, which implies that such butterflies are of the highest value. Such countries can be assured of utilizing these higher-value species for the specialist trade, even where their condition may not be perfect. By supplying the demand for the 'rarer' species, a beneficial decrease in their desirability, at least to 'acceptable' levels, can be expected. Many wide-ranging species are migratory and so occur extensively throughout the IAR: for example, *Graphium sarpedon* (Linnaeus), *Graphium eurypylus* (Linnaeus), *Papilio demoleus*. They are, by definition, usually common, which implies such butterflies are of the lowest commercial value. Therefore, unless used for the livestock trade, they may not warrant the investment of time and effort in farming. Nevertheless, they do have the potential to provide income by being collected en mass as adults for use in the decorative trade. In countries which must rely mostly on the common species these are not really 'bread and butter' to the industry unless used in the decorative or livestock sections of the trade.

Despite the media attention given to the various attractive aspects of butterfly farming, in practice the vast majority of butterflies (except perhaps the growing number that form part of the livestock trade) are collected outright. It is also clear that the collecting of wild butterflies will remain a mainstay of the industry, meaning that, as it forms such an important part of the overall 'system', methods should be perfected to utilize it, but also to monitor and control it where necessary. With collecting being inevitable there is ample reason for government-run butterfly farming projects to establish extension and monitoring sections, not only to strongly promote farming concepts and to assist in their implementation, but also to keep a close scrutiny of the local effects of collecting. With growth of butterfly trading in any given area the need for extension also grows in order to provide advice on the most effective use of resources. It is time that much greater efforts were made in the field to teach the philosophies and techniques of farming and ranching butterflies (and other insects). Anyway, it is likely that the need for detailed advice on farming techniques will increase steadily as the demands of the livestock trade grow to supply butterfly houses, scientific and educational institutions, zoos, and those individuals who will want to fly exotic species at home for their own

personal enjoyment.

It is now recognized that tropical forest ecosystems cannot simply be preserved by being placed within reserve boundaries and left untouched. This is, anyway, wholly impractical. Management is required, preferably based on procedures which allow local landowners to benefit in controlled, environmentally safe ways from their forests. In this way they are given firm practical and economic reasons and means to act directly as custodians of their forest resources. Many people of the world's tropical subsistence economies are so poor that, unless they can make money from their resources, they cannot afford to conserve those resources, even if they have a clear understanding of the conservation problems facing tropical forests. Unless such people in the various countries of origin of rare or valuable tropical butterflies are permitted some reward for their custodial work, then the future of these species is bleak. However, by demonstrating to the subsistence farmers of the tropics that butterflies have real monetary worth, and that they can provide people with an important income, the reasons for treating butterflies as a renewable resource are made clear. This, in turn, will stimulate active participation in butterfly, and therefore forest, conservation.

Butterflies can be made to 'pay their way' if projects which promote them as a sustainable resource are well implemented. Harvesting of the wealth of insect resources present in tropical forests perhaps epitomizes a means of safely removing wealth from a natural system without causing it damage, whilst at the same time engendering a positive conservational attitude towards the resource and its source. Butterfly farming permits people to participate in a cash economy without causing disruptive changes in traditional village lifestyles, and without harming fragile tropical environments. It is infinitely adaptable to either high or low levels of effort on the part of the supplier, but can be quite lucrative, even when little effort is invested in it. Although the system clearly cannot alone be expected to provide the means for safeguarding tropical forests it is, nevertheless, one of the most effective and profitable of the small-scale WCS-type projects. It is one prime example that proves economic development need not necessarily be destructive. If orchestrated in concert with other such projects (e.g. agroforestry, ecotourism, highly selective log extraction by airships, rattan cane growing, medicinal plants, tribal artifacts for tourists, etc.) butterfly farming will be vital to the future existence of tropical forest reserves.

So can the challenge posed above be met? The answer is yes, circumstances permitting, and providing that such projects are given adequate time, initial funding, and expert guidence during their establishment. The philosophies and methods of butterfly farming have evolved to a point where their effective use by all IAR governments is possible. The recent rapid development of low cost, yet very powerful, personal computers, and the vast increase in, and constant improvement of, easy to use software programs specifically tailored to the operation of small businesses, has made the logistics of operating the business aspects of butterfly farming projects still easier. Accounting programs, for example, enable financial operations to be very effectively automated and controlled. Other programs, such as databases and word processors, permit the production of 'publication quality' documents, such as checklists and information booklets, to be made extremely rapidly and with relative ease.

It must be realized that although the combined butterfly resource is valuable, it is not so valuable as to be of real use in forest conservation unless, as outlined above, it is divided amongst those people most closely reliant on forests for their livelihood. It can greatly benefit individuals, but only where they are able to monopolize the resource, and where such individuals are able to exploit others in order to do this more effectively. Obviously, where such monopolies or middlemen exist, the imposition of a government-run system that eliminates their profits by dispersing them to others would be strongly resented. Therefore, as in the case of PNG which purged all non-citizen profiteers to permit its IFTA project to become fully effective, a government intending to implement effective butterfly farming must firstly gain full control of its insect trade in order to be able to apportion it out, and so achieve the desired conservation benefits of the system. This 'get tough' government action is essential in order for the right conditions to be created to allow successful butterfly farming. Government involvement is also essential for reasons of the need to control the level of the farming enterprise in any given area, as each region will vary in its 'carrying capacity' for butterfly farming.

Those governments wishing to implement the butterfly farming system should realize that, to be truely successful, a fine balance must exist between the business side of the venture and its conservation aims. This may be difficult to reconcile within the government structure since government departments are invariably divided strictly on the basis of their relevance to either conservation or commerce, rarely both. It is essential that, under government proprietorship, the business side of the system remains healthy in order to give the best possible support to its conservation aspirations (and vice versa). It follows too that the capabilities of a butterfly farming project leader are critical. Not many professional ecologists/entomologists are businessmen, or vice versa, yet it requires a good knowledge and understanding of both to establish and run a butterfly farming project to be complete and effective. Worries have been voiced that, because of their very nature, governments are not effective in the necessary business tasks. For example, Koiwaya (1990), noting that Parsons was engaged in establishing a Government-backed butterfly farming project in China, stated that he was concerned that, based on his experiences in doing business with the PNG IFTA, the project would face great difficulties. He related that he and other dealers had received specimens in bad condition from the IFTA, these specimens, if sent at all, being mostly pest-damaged. Koiwaya also pointed out that IFTA favoured a particular German dealer with its best specimens. He concluded that the main reason for the poor standard of business by the IFTA was due to the fact that its staff receive government salaries, so that there is little incentive to maintain a high standard for its exported specimens. Therefore, he considered that this effect would be even worse in China with its political system of communism and attendant high level of bureaucracy.

In tropical 'developing' countries the responsibility for the successful utilisation of ecologically sound development techniques, such as butterfly farming, sits squarely on the shoulders of the people of those countries, or perhaps, more accurately, those of their governments. No longer is it possible to plead ignorance over the mismanagement of natural resources, or the

consequences of this. Mistakes have been made worldwide and the lessons have been abundantly clear. Nevertheless, the 'global village' is now a reality and it is the responsibility of all nations to promote and assist in sustainable development techniques, especially those 'developed' nations who can afford to do so. There is also an onus on all of those organisations throughout the world that are involved with butterflies in one way or another to take an active role in conservation. With tropical forest preservation being the key to conservation of the insect fauna which inhabits it, it is clear that butterfly-based clubs and societies, for example, should do everything possible to promote the conservation of these forests. Some such institutions are already directly involved with this, others are beginning to take action, yet many remain uncommitted. Even at the level of the individual private collector concerned about the future of tropical butterflies a stand can be taken by lobbying government officials, or by financial sponsorhip of those organisations actively engaged in promoting tropical forest conservation or butterfly farming concepts.

Although buyers engaged in the business of butterflies (dead-stock dealerships, temperate butterfly houses, etc.) are primarily interested in the financial well-being of their own enterprises, many are also well aware of the need to promote habitat conservation (e.g. Collins, 1987, Simcox and Calvert, n. d.). After all it is in their own interest to be so concerned. It is obvious that, in the absence of constantly renewing wild populations of species, supplies of dead- and livestock to butterfly traders and collectors will eventually become seriously limited, or cease. Thus, there is good reason for insect buyers/dealers worldwide to adopt a policy of actively caring for the 'goose that lays the golden egg' (an argument also applicable to Lepidopterists in general).

Macfarlane (1984), Morris (1986) and Parsons (1990b) have all pointed out the difficulties in finding adequate external funding to initiate insect farming projects. Both Morris and Parsons mentioned the importance of pooling the resources of various conservation-based Non-Government Organisations (NGOs). Morris (1983) pointed out the great need for expertise, particularly using on the ground practical demonstration, to instruct would-be butterfly farmers in different countries, and to bridge the gap between government departments — understandably bemused by this novel form of agriculture — and these farmers. In China, Parsons (1989a) found it necessary to implement butterfly farming in a well-paced programme in order to establish the system on a suitably sound base, the concepts, although straightforward and logical, being numerous and requiring a sturdy underpinning of practical knowledge obtainable only through experience and close supervision. Morris (1986) noted that, as yet, faculties of agriculture and forestry in the world in general do not have any course or programme of research on the utilisation of the butterfly resource.

At time of writing, the economies of many countries have drastically 'slowed' and another World Economic Recession has developed. The previous Recession severely threatened the existence of PNG's IFTA not long after its inception. Once again, grant aid, external donor funds, bank loans, and other such sources of funding, are becoming more difficult to obtain for the develoment of WCS-type projects. Thus it is all the more essential to coordinate the spending of funding that is presently available in order for this to be used most effectively. It is clearly counterproductive for conservation-based NGO's operating in the same developing countries to duplicate efforts in forest conservation, when their cooperation should permit the effective doubling of imput.

A method is required to coordinate effort, and to pool butterfly conservation funds so that they can be better directed into butterfly farming projects. It would also ensure that such projects are well integrated with similar WCS-type programmes to better achieve tropical forest conservation. This could possibly be achieved through a specially formed international monitoring and advisory committee which would promote farming/ranching concepts. However, it might be better directed through an already existing 'umbrella' organisation. For example, Collins' (1987) report logically called for British butterfly houses to invest in tropical butterfly conservation through international organisations such as WWF, thereby assisting in the joint financing of conservation projects, and so putting a percentage of their profits back into butterflies throughout the world. Collins' suggestion that resources from the butterfly industry could be channelled into the WWF network, thus helping with a programme of butterfly habitat protection, is eminently sensible. Recognising this, Emmel and Garraway (1990), for example, have called for a butterfly farming programme, coupled with support through WWF funding, be instigated to assist in the conservation of the endangered Jamaican endemic swallowtail, *Papilio homerus* Fabricius. With its promotion of butterfly farming in China, WWF has clearly demonstrated its commitment to the system, and by so doing has set a world example amongst conservation organisations. Thus a logical extension of the idea is that WWF should adopt a lead role in establishing a section within its organisation to coordinate, implement, monitor, and improve butterfly farming and related matters.

Publications such as those of Parsons (1982a), NRC (1983), and Collins and Morris (1985) have done much to document the main principles of butterfly farming, but these are becoming outdated. It is apparent from the findings of Collins and Morris that a detailed and updated appraisal of the IAR butterfly trade at its various sources is required. In addition to this, concurrent field assessments should be made of the potential for the sustainable utilisation of most of the 78 papilionid taxa which they considered to be threatened, all of which obviously command the greatest market values. Other economically important butterflies, such as the nymphalids, should also be assessed in this way.

There is presently no documentation which conveniently pools and discusses the integration of all of the techniques utilized in all aspects of the butterfly trade and butterfly farming, or the development of butterfly-based ecotourism in tropical countries. For example, methods used in the growing trade in live butterfly pupae should be fully recorded. Such information, if eventually published in the form of a detailed handbook, would provide the basis for a much-needed unified approach to the establishment of butterfly farming projects. As one of several precursors to this, various computerized databases should be established. These would permit the preparation of documents such as a world list of insect dealers/buyers for distribution amongst interested governments. Names could be recruited and updated by placing advertisements in entomological journals, or by obtaining such information from the major existing suppliers. Other documenta-

tion should include specific databases of known butterfly larval foodplants for comparison with databases able to generate regional plant checklists. Such information-gathering would also usefully include translations into various major languages, especially English, of the fauna protection and collecting laws of various relevant countries. In this way people, such as tourists interested in personal butterfly collecting, or dealers wishing to import specimens, would find it easy to obtain the necessary information as to if, and how, this was possible. If sponsored by the international community, such a handbook would cost little and yet provide information on a range of extremely important interrelated topics.

Demonstration butterfly farms in the tropics, and their associated facilities, are an excellent means of educating the general public about issues of conservation and deforestation. They have great value as tourist attractions and bring in money directly by this means. Even if the butterfly farming system as a whole (i.e. including farming practiced by widespread village communities) is not seen by certain governments as being important or practical to adopt, at least model or demonstration-style butterfly farms could be set up under their existing wildlife departments. These would then provide an income for use in conservation, whilst at the same time serving as popular as educational centres. It would be beneficial if such establishments could be set up throughout the IAR.

Local agencies, such as the Wildlife Institute of India (Rao, 1990), and international organisations, such as the NRC (NRC, 1983) and WWF (Mackinnon, 1987), have hailed butterfly farming and its general principles as one of the most ecologically sound forms of rural development. Few other such projects so adequately combine development through conservation as set out in the WCS (Morris, 1983). Yet though the concepts are well-known and understood, their application in the field is not a simple matter. The sustainability of butterfly farming projects is open to question considering the bureaucratic nature of governments, the various attitudes and aptitudes of the people involved, problems with funding, and occasional steep downturns in the World Economy. Such factors have stalled, hindered, or completely halted the implementation of butterfly farming projects intended for countries such as the Solomons, Indonesia, and India. Nevertheless, with better coordination on a global scale, the concurrent promotion of a concert of similar sustainable rural development projects, and with greater commitment from the governments involved, butterfly farming will continue to play an important, and hopefully increasing, role in stemming the tide of tropical forest destruction. With the refinement of a Tropical Forestry Action Plan by the joint efforts of several major world conservation and commercial organisations (e.g., McNeely, *et al.*, 1990), the time is apparently right to integrate butterfly farming into many tropical forest conservation projects.

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