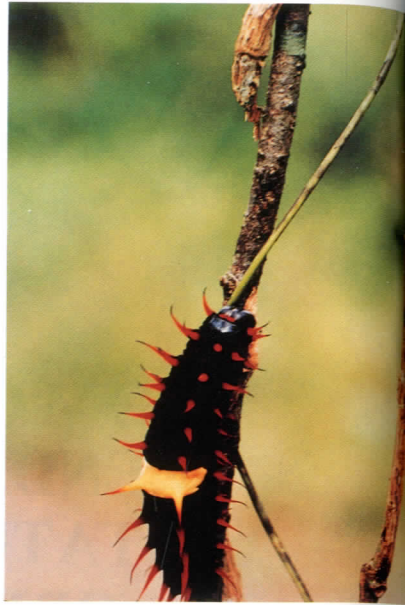


**THE WORLD'S LARGEST BUTTERFLY  
ENDANGERED: THE ECOLOGY,  
STATUS AND CONSERVATION OF  
*ORNITHOPTERA ALEXANDRAE*  
(LEPIDOPTERA: PAPILIONIDAE)**







# THE WORLD'S LARGEST BUTTERFLY ENDANGERED: THE ECOLOGY, STATUS AND CONSERVATION OF *ORNITHOPTERA ALEXANDRAE* (LEPIDOPTERA: PAPILIONIDAE)

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**ABSTRACT.**— The ecology and conservation of the world's largest butterfly, endangered *Ornithoptera alexandrae* Rothschild (Lepidoptera: Papilionidae), known only from the Popondetta and Afore regions of Papua New Guinea's Northern Province, are outlined and discussed. The continuing loss of habitat to the oil palm and timber industries in the Popondetta area is detailed, and the neglect of protection of the species over the past decade is stressed. The results of a recent two month (April-June 1991) field survey to update knowledge of the present-day distributional status of the species are outlined. An action plan is given which is aimed at greatly improving the survival prospects of the species. Among other factors, it emphasizes the need to continue surveys to provide an in-depth update of the present status of the species, to set aside reserves of remaining natural habitat, to recreate new areas of habitat, to carry out further ecological research and education, and to work towards the economic utilisation of the species for its own benefit.

**KEY WORDS:** Afore, Aristolochiaceae, *Atrophaneura*, birdwings, Encyrtidae, endangered, habitat, *Heliconius*, larva, logging, Nymphalidae, oil palm, Papua New Guinea, Popondetta, predators, pupa, Queen Alexandra's Birdwing, *Troides*.

Ever since the days of pioneering naturalists who brought back spectacular new discoveries to the amazement of people in Europe, the beauty and diversity of New Guinean insects, and the great size of many of them, have astounded scientists and collectors. Perhaps the epitome of such species is *Ornithoptera alexandrae* Rothschild, Queen Alexandra's birdwing butterfly. Because of its huge size and very high flight the first specimen, a large female, was brought down by a blast from a shotgun in January, 1906. Its collector, Alfred Stanley Meek, was employed by wealthy Lord Walter Rothschild, founder of his own natural history museum at Tring in England. With the publication of its description in his museum journal, *Novitates Zoologicae*, the following year, the butterfly was then named by Rothschild in honour of Queen Alexandra of Great Britain (Rothschild, 1907).

The collecting location of the first *O. alexandrae* female, and thus the type locality for the species, was stated by Meek (1913) to be "Biagi, about 5000 feet high, at the head of the Mambare River". Cheesman (1935) stated that the large gardens of the

Biagi tribe were on the upper slopes of the mountains, "plainly visible from Kokoda" and the frontispiece map to her book illustrated the Biagi Tribe on the Yodda River, between it and Mt. Scratchley. Despite the fact that Meek is known to have been somewhat erroneous in the exact positioning of at least some of his collecting localities (Heron, 1975), his account seems plausible. The veracity of this type locality has also been strengthened by other supposed sightings of *O. alexandrae* in the Kokoda area over the last decade, although none of these have been confirmed by qualified observers.

About a year after the initial discovery of the single female, Meek captured the first male of *O. alexandrae*, presumably in the region of the present town of Popondetta. However, he was again extremely vague about the locality: a "position under the Owen Stanley ranges" (Meek, 1913). He also collected further females and succeeded in finding the huge larvae and pupae of the species. Thus, by the end of 1908, perfect specimens became available, most of the previous ones, of necessity, having been

Fig. 1-10.— 1. Typical 'U-shaped' larval feeding damage to *Aristolochia dielsiana* leaves by *O. alexandrae* and *O. priamus*. Such behavior is possibly related to the foodplant's biochemistry. 2. Flower, fruit and leaf of unnamed *Aristolochia* larval foodplant of *O. alexandrae*. 3. Having completely eaten a thick, woody, circa 9 x 1 cm-long section of its young *Aristolochia dielsiana* foodplant, a mature *O. alexandrae* larva continues to consume the lower portion (behaviour more typically recorded for *Ornithoptera goliath*). 4. *O. alexandrae* prepupal larva (lateral profile). 5. Kapurakambo villagers and three 1991 Survey team members celebrate the finding of two mature *O. alexandrae* larvae in the Kapurakambo-Sananada area. 6. The preparation of thousands of cuttings of *Aristolochia dielsiana* for eventual planting *O. alexandrae* conservation areas (Nov. 1980). 7. Conservation stamp set designed and painted by the author for the World Wide Fund for Nature and PNG Philatelic Bureau *O. alexandrae* conservation issue. 8. *O. alexandrae* pupa (lateral profile). 9. *O. alexandrae* habitat destruction by Ambogo Sawmill logging operations within the Girua-Haijo Timber Area, just north of Bapuhi Village (May 1991). 10. Aerial view of 'Parahe North' during the 1991 Survey showing the Y-shaped kunai grass field system that, like other grassland areas on the Popondetta Plain, has remained relatively stable over at least the past 50 years. A recently planted smallholder oil palm block is visible in the foreground. The advanced secondary forest to the right of this is good *O. alexandrae* habitat.



damaged by shot holes.

Of the nine species of *Ornithoptera*, all but three are endemic to the huge and mountainous tropical island of New Guinea. They are much sought after by insect collectors because of their size, beauty and general unavailability. *O. alexandrae* is recognized as the world's largest butterfly, having a wingspan that, in larger females, can slightly exceed 25cm. For this reason, and because it is entirely restricted to Papua New Guinea's (PNG) Northern Province, it was chosen as the emblem for the Northern, or Oro, Provincial Government's flag (Anon., 1978a).

*O. alexandrae* is typical of its genus in that the male and female are very different in appearance and exhibit, therefore, extreme sexual dimorphism. However, unlike all other *Ornithoptera* (but resembling *O. victoriae*) *alexandrae* adults possess markedly narrow and elongate wings, especially in the male. In this way, and in the unique colours and pattern of the male, *alexandrae* is very distinctive.

*O. alexandrae* is probably an indicator species of an apparently unique tropical forest ecosystem in PNG's Northern Province; one that also includes a colourful rainbow fish known only from within an area of about 25 km from Popondetta (Darby, 1990), and several spectacular birds of paradise. The butterfly, which is a 'National Animal' of PNG, only occurs in the general region of Popondetta in the Northern Province of PNG. Parsons (1983a) summarized the status of *O. alexandrae* as "Endangered, rare even in its habitat, and extremely restricted geographically" and suggested that a CITES Appendix rating of I was justified for the species. This recommendation was later adopted in print by Collins and Morris (1985) but, to date, *O. alexandrae* remains on Appendix II.

The limited range and specialised ecology of the butterfly render it highly vulnerable to the pressure of human activities. Therefore, for over a decade *O. alexandrae* has been placed at the top of an international list of threatened butterflies, much of its habitat in the Popondetta region having been radically degraded or completely destroyed by the timber and agricultural industries, as well as by various other developmental activities. Unfortunately, this habitat destruction has continued, unabated, to the present day. Planting of oil palms has been ongoing since 1976. These extensive plantations have progressively claimed primary and secondary forest habitat known to be of importance to the survival of *O. alexandrae*. Between 1983 and 1989, exploitation of an extensive forested region, known as the Kumusi Timber Area (KTA), was undertaken by logging and extraction of its marketable timber. Other large areas have likewise since been logged. Both major industries are centred immediately on the Popondetta hinterlands and are, therefore, almost exactly superimposed on the distribution of *O. alexandrae* within the Popondetta Plain. The effect of this habitat destruction has been enhanced by the influx of people into the area because of the expansion of these industries, as well as by domestic population growth arising from better standards of medical care, etc. Although presently 'on hold', further expansion of the Oro Smallholder Oil Palm Development Project (OSOPDP) is stated to be imminent.

Since the termination of the PNG Government's *O. alexandrae* Conservation Project in 1983 (Fig. 6) little serious action has been taken to further protect the butterfly. Part of the reason for

the poor response to the conservation requirements of the species has been the severe shortage of government funding for this and other such conservation projects within PNG. Now, however, with an ever growing awareness by the world's public of the critical need to preserve areas of World Heritage status, and especially the huge and complex biodiversity represented by tropical forest ecosystems, the opportunities seem better than they have been in the recent past to finally implement the necessary action to safeguard *O. alexandrae* from extinction. In particular, recent actions taken by the PNG Government to radically remedy its almost complete failure in the past to utilize the 1978 *Environmental Planning Act* for the purpose of providing sound environmental plans for each proposed new developmental project within the country, has set the stage for the re-establishment of an *O. alexandrae* Conservation Project. This has been especially true in the relevant forestry sector where many logging permits have been revoked by the Minister for Environment and Conservation who has requisitioned certain major logging operations (including some outright closures) until environmental plans are provided by their relevant companies (various unpublished Department of Environment and Conservation [DEC] information sheets).

This platform for conservation in PNG has been further strengthened by the Government's now ongoing two year moratorium on logging in the country, its increasing trend towards the better integration of conservation with development in PNG through promoting the closer liaison of its various departments, and the guidelines set out in World Bank promoted Tropical Forestry Action Plan (TFAP) for PNG (Anon., 1990), as well as those jointly put forward by several world conservation organisations, working together with the World Bank (McNeely, *et al.*, 1990), and within PNG by a number of Non-Government Organisations (NGOs) groups working together with various government departments (Dart, *et al.*, 1989).

The following attempts to encompass (and of necessity to summarise) the work in which I have been involved, on both a personal and professional basis, in my ongoing endeavours over the last decade to re-establish a dedicated conservation project on behalf of this magnificent, and potentially extremely economically important, insect. Apart from the four year period from 1979-1983, during which time I coordinated the *O. alexandrae* Conservation Project for the National Government in PNG, it includes information gathered by myself during discussions made on behalf of the World Wide Fund for Nature (WWF) during a consultancy in 1988, that of a World Bank consultancy in 1990, as well as data gathered during a two-month Conservation International (CI) funded field survey by from 8 April-13 June, 1991 (respectively Parsons, 1988b, 1990, and 1991).

#### HABITAT AND GENERAL TOPOGRAPHY

The Popondetta 'Plain', a small, fairly flat coastal region of volcanic ash soils, is deeply dissected by the rivers radiating outwards from Mt. Lamington, which reaches a height of 1679m. Situated to the south-east of Popondetta the volcano blew out its northern slopes during an extremely violent eruption in 1951. This caused extensive destruction of forest in the inner blast zone (Fig. 12): namely that situated within a radius of about 10km from the summit (Haantjens, 1964; Taylor, 1957).



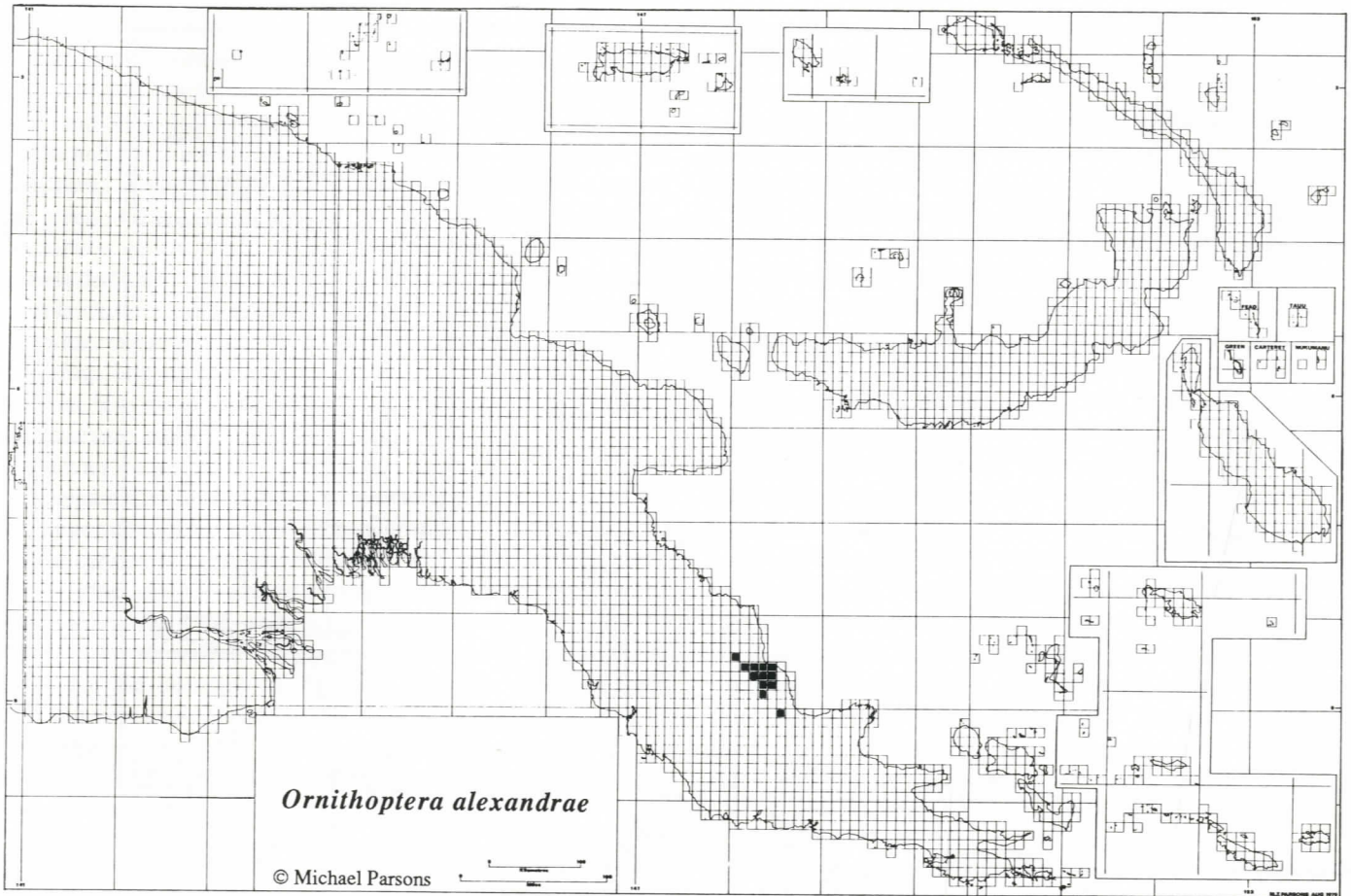


Fig. 11. 10km UTM grid distribution map of *O. alexandrae*.

Haantjens stated that the vegetation on the Popondetta Plain is, strikingly, very species-rich, especially on the lower north-western slopes of Mt. Lamington (W. Popondetta, circa 20km<sup>2</sup> in area) where he noted that the best development of rainforest occurred. There is much variation in both structure and floristic composition of the vegetation of the area, due notably to drainage, rainfall and temperature which provides for optimal growth, but partly the reasons for this variation are not fully understood. These lowland tropical rainforests are more than 40m tall, with three distinct layers, plentiful lianas, epiphytes and buttress roots, leaving only a very sparse ground layer. However, little remains of the original primary forest, much of which has now been logged out, and the areas of advanced secondary forest comprise mostly inner coastal swamp forests, or are otherwise heavily affected by food crop gardening.

In the Popondetta region the habitat in which *O. alexandrae* occurs comprises very small remaining areas of 40m tall primary, and larger tracts of 5-20m tall, secondary lowland rainforest. These are mostly the drier forests occurring on the sandy volcanic ash-based soils above the lower coastal flood plains, but some areas of habitat lie in the semi-swamp forest zone between these two regions. The forest tracts are often somewhat linear in shape and they form an overall mosaic spread across the Popondetta Plain. They are divided by large areas of hot, monotonous kunai grass (*Imperata* spp.) fields which are regularly burned by people from the various clans in the region to maintain them open for wallaby hunting (Fig. 10). These grasslands, which reach

their greatest extent on the very sandy soils of the north-eastern volcanic outwash fans, would otherwise gradually revert to woodland. They may have been anthropogenically maintained in this way for many hundreds of years, during which time constant leaching of their soils has occurred.

It is difficult to adequately categorise forest types on the Popondetta Plain (Figs. 9 and 10), as most woodland regions have been affected at one time or another by the actions of man. Intensive gardening, and subsistence (and obviously also commercial) logging have undoubtedly affected them ecologically, leaving forests that may be predominantly classified as secondary, although some of these are now at an advanced stage of 're-growth'. Nevertheless, it is also interesting to note that, from a comparison of the present Topographic Map of Popondetta with the 1:250,000 series Popondetta area wartime maps, produced by the Australian Army Survey Corps in the 1940s, the kunai grasslands throughout the region have changed very little in size and shape since that time. From the brief helicopter reconnaissance of the 1991 survey (see below) it also became clear that, during the approximately 20 years since the production of the current Topographic Map of Popondetta, the woodlands of the north-eastern half of the Popondetta Plain have continued to remain rather stable relative to the grasslands (Fig. 10). This illustrates that the core areas of the various lowland forest tracts in this region (i.e., outside the KTA) have at least remained as mostly intact woodland for 50 years, and obviously far longer in the majority of cases.



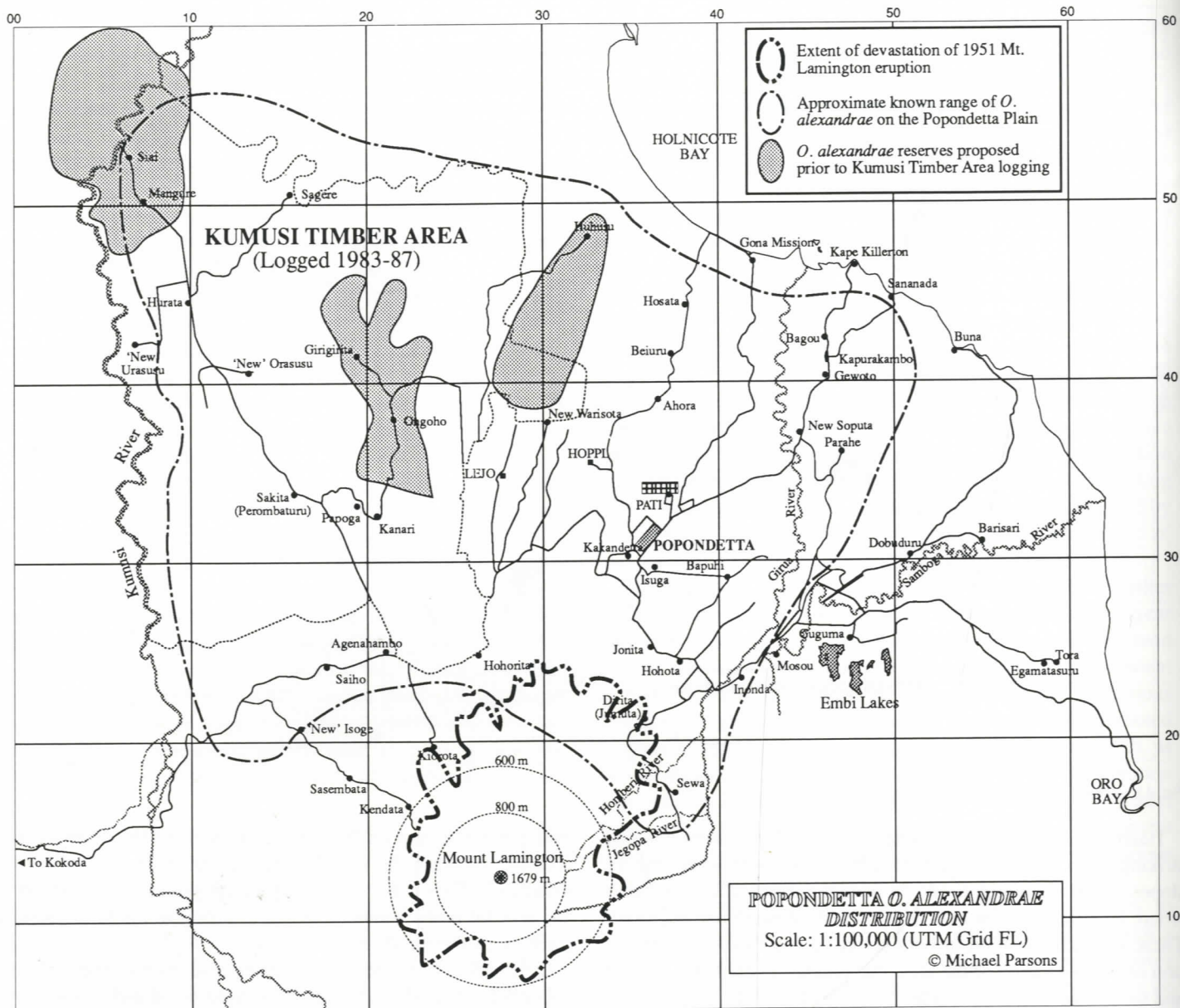


Fig. 12. Approximate range of *O. alexandrae* on the Popondetta Plain.

### *O. ALEXANDRAE* DISTRIBUTION

Only many years after its discovery was it finally confirmed that *O. alexandrae* occurs nowhere else in the world except in the hinterlands surrounding the town of Popondetta in the Northern Province of the north-eastern coastal region of south-eastern PNG, and in a separate area about 45km to the SSE, at Afore (Straatman, 1970, and 1971, Parsons, 1983a and 1984). However, as outlined above, the type locality for *O. alexandrae* at Biagi implies that the species may yet be found to be still extant in the Kokoda area.

The ecological specialisations of *O. alexandrae*, in part, explain its rarity. To date the species has only been recorded within a total of twelve 10km grid survey squares: eleven on the Popondetta Plain, and one at Afore (Fig. 11). The known extent of its range in the Popondetta area apparently covers only about 1,200 sq. km, being almost entirely bounded by the Kumusi River to the west, the Embi Lakes to the east, the 400m contour of Mt. Lamington to the south, and varying to within 1-10km of the

coast to the north (Fig. 12).

Yet even within its range *O. alexandrae* occurs sporadically. There are seemingly ideal areas of habitat where its *Aristolochia* larval foodplant vines grow abundantly, but where the butterfly cannot be located. The numbers of *O. alexandrae*, in comparison with those of the common and widespread related *Ornithoptera priamus* (Linnaeus) in the Popondetta region, show that its distribution can, at best, be described as fragmented. As *O. alexandrae* appears to restrict its flight to 'home range' areas, it may also be slow to colonise new areas. Both the butterfly and its foodplant are apparently absent from forests of more irregular structure, such as those present on the alluvial soils of the Lower Mambaré and Gira River floodplains to the north-east of the Popondetta Plain.

### FOODPLANT ECOLOGY AND DISTRIBUTION

As a larva *O. alexandrae* feeds on a group of two, possibly three, closely related *Aristolochia* species. These include an as



yet unnamed species on the Popondetta Plain, and *A. dielsiana* in this and the Afore area (Figs. 1 and 2) (Parsons, in prep.). These particular *Aristolochia* vines can grow to 40m tall in primary forest and their leaves sprawl throughout the canopy. Their flowers and fruits are borne on segmented stalks arising from the thick, corky lower mainstems. The beautiful maroon-red and/or lime green (*A. dielsiana*), three-perianth-lobed ('petaled') blooms, with tubular yellowish throats and a smooth or, if hirsute, sparse or dense felt-like covering of hairs, grow singly, or sometimes in multiple clusters, on segmented flower stalks. When mature, the somewhat cucumber-like, pendulous, six-ribbed, tough, green fruits (Fig. 2) hang from the segmented stalks at intervals along the basal few metres of the thick, corky stem, usually between 0.5-2m above ground.

In advanced secondary and primary forest these *Aristolochia* vines apparently grow together with (and appear to be as old as) their huge supporting trees, as their mainstems often head straight into the canopy without any twining around the host tree. Some of these vines are probably in excess of 50 years old. In this tall forest the leaves of the vines occur well out of sight. In the much lower secondary forest the vines sprawl in profusion throughout the canopies of saplings. Usually, each vine also sends out vegetative shoots which creep through dry leaf litter to climb other nearby trees, putting down rootlets as they go. It is only in the lower canopy of secondary forest that the large, tough, ovate leaves of the vines can be readily observed.

The larval foodplant choice of *O. alexandrae* is dictated by the adult female which will only lay her large, rounded yellow eggs on the above mentioned group of tough-leaved *Aristolochia* species. Although *O. alexandrae* has such a restricted distribution, one of its larval foodplants, *dielsiana*, is curiously far more widespread. The vine occurs throughout much of south-eastern lowland mainland PNG, on the island Goodenough just off the north coast (D. Sands pers. comm.), and apparently on Umboi Island (W. Gabara pers. comm.) (although on this more disjunct island the vine is likely to represent a closely related but undescribed species). Also unusual is that *O. alexandrae* larvae have been recorded to mature well, and notably faster, on *Aristolochia tagala* (Straatman, 1971) (although the late R. Straatman, pers. comm., used only three larvae for this experiment). The softer-leaved *A. tagala* occurs throughout the entire Indo-Australian Region. Its leaves are more easily chewed and provide greater nutrition per volume of foliage than *dielsiana* and its unnamed relatives. However, *tagala* is strongly competed for throughout New Guinea by the two commonest birdwings, *O. priamus* and *Troides oblongomaculatus* (Goeze).

#### LARVAL FEEDING BEHAVIOUR

At the larval stage it is assumed that, like other *Aristolochia*-feeding butterflies, *O. alexandrae* can store certain secondary compounds, such as toxins, from its foodplant. As in various other *Aristolochia*, *A. dielsiana* is known to contain bitter-tasting aristolochic acid-I (Parsons and Holdsworth, in prep.), which is presumably one of the active compounds sequestered by *O. alexandrae* larvae. The larvae exhibit characteristics typical of aposematic (or warning) colouration found in many animal groups (and especially insects), being mainly black which highlights the

bright red, fleshy spines, and an obvious yellow saddle-mark (Figs. 3 and 4). These markings appear to deter at least ordinary predators from attacking and eating larvae. The biochemical aspects of the relationship of *O. alexandrae* with its *Aristolochia* foodplants apparently have an important bearing on its mode of larval feeding behaviour.

After hatching from the egg the young larva first eats the eggshell. This provides it with sufficient food to last it for the next 24 hours. It then begins to feed on the young leaves and tender shoots of its foodplant. Later instars feed on older stems and leaves. Fifth (or sixth) instar larvae feed mainly on the tough stems, chewing through or past the leaf petioles so that the fresh green leaves fall to the ground. In this way, vines occupied by *O. alexandrae* (or *O. priamus*) larvae may be indicated by these leaves lying strewn beneath them. Older larvae also exhibit behaviour similar to those of *Ornithoptera meridionalis*, *O. chimaera* and *O. priamus* in that they will eat a large characteristic U-shaped section from the centre of the apex of old tough leaves (Fig. 1). Shortly before pupation *O. alexandrae* larvae may move to the lower parts of the vines and ring-bark them, or eat sections from them (Fig. 3), causing the upper parts of the vines to wither and die (e.g., as in *Ornithoptera goliath*). Straatman (1971) found that small vines were eaten down to the ground by *O. alexandrae* in this way.

#### ASPECTS OF MORTALITY, LONGEVITY AND FECUNDITY

In PNG, the eggs of swallowtail butterflies whose larvae feed on *A. tagala* (*Atrophaneura polydorus*, *T. oblongomaculatus* and *O. priamus*) are often subjected to between 50-90% mortality by a species of minute *Ooencyrtus* (Encyrtidae) parasitoid wasp (Parsons, 1983a and 1984). Other *Ornithoptera* are also known to suffer mortality at the egg stage from these parasitoid wasps, although none have yet been found to parasitize *O. alexandrae* eggs. It is possibly for this reason (and perhaps also because of past interspecific competition with *O. priamus*) that *O. alexandrae* utilises *A. dielsiana*, a plant which does not permit its optimum developmental rate, yet which possibly helps the species avoid such hazards. Apparently analogous findings have been made for the passion fruit vine-feeding butterflies, *Heliconius*, in South America. Such specialisations have been termed "ecologically induced monophagy" (Smiley, 1978).

The possibility of parasitization as a mortality factor at the egg stage may also explain why *O. alexandrae* females (like *O. priamus*, for example) lay their eggs singly, often on the bark of the supporting tree, or on other plants or debris immediately adjacent to the foodplant mainstem. In this way, although the young larvae must wander a short distance to locate the foodplant after hatching, the eggs may be harder for parasitoids to locate. In advanced secondary forest and primary forest, however, *O. alexandrae* oviposits high above the ground, usually directly on the underside of its foodplant vine leaves. Females may take 10-20 minutes carefully inspecting very tall vines, flying throughout the supporting tree canopy, then finally laying an egg below one of the vine's leaves. The long time and great care taken in egg placement implies that such behaviour is of great importance in reducing mortality at the egg stage.



Using adult marking experiments it has been shown that *O. alexandrae* adults can live for up to three months in the wild, and probably longer (Straatman, 1971). Similar results were obtained for another New Guinean birdwing, *T. oblongomaculatus* (Parsons, 1983b). *O. alexandrae* may sometimes be seen soaring high above the forest canopy, but the species very occasionally comes into the Popondetta town area to feed on flowers such as those of *Hibiscus*, *Ixora*, *Poinciana* and *Poincettia*. Other than this, little is known of adult movements. They appear to suffer little predation but some do become trapped in the huge webs of the very large, commonly-occurring orb-weaver, *Nephila maculata* (Fabricius), and so are eaten by this spider.

If they live to to enjoy an optimum life-span, *O. alexandrae* females are believed to be capable of laying at least 240 eggs (Parsons, 1980a). To sustain such egg production possibly requires organic nitrogen obtained from pollen, as has been documented in various South American heliconiines (Pianka, *et al.*, 1977), and possibly also in troidines from the region (DeVries, 1979). The total time from egg to adult is about 122 days: egg 12 days, larval development through 5, but sometimes 6, instars about 70 days, and pupa averaging 40 days. During this period eggs, larvae and pupae (Figs. 3, 4 and 8) may fall prey to ants, wasps, *N. maculata*, and small marsupials. They sometimes develop fatal viral or fungal diseases (Straatman, 1971). Some birds, such as kingfishers, and especially the Grey-breasted Brush Cuckoo (*Cacomantis variolosus*), are apparently specialist predators of *O. alexandrae* larvae (and those of other PNG troidines).

#### THREATS TO *O. ALEXANDRAE* SURVIVAL

International trade in dried specimens of *O. alexandrae* adults to collectors was believed to have been halted with its protection in 1968. However, there are known events of attempted smuggling after that date. For example, in the early 1970s Mr. Henry Rouber was fined for being in possession of 35 male and 62 female specimens of adult *O. alexandrae* which he had persuaded local people to collect for him at a fraction of their market value. Regrettably, it is still likely that today some specimens are illegally collected and sold on the 'black market', and even in 1989 collectors from overseas, posing as general tourists, had asked some local people in Popondetta to collect *O. alexandrae* for them (Mr. E. Malaisa pers. comm.). Dried specimens of adults are extremely light, and are easily concealed for shipping, the rewards to smugglers being high. Even now *O. alexandrae* is often advertised in American, German, British and Japanese insect dealer catalogues, and certainly not all of these are pre-Protection Ordinance specimens.

The main factor threatening the survival of *O. alexandrae* is, however, the constant depredation and degradation of its habitat. In the Popondetta region this is by the tree crop and logging industries, whilst in the Afore area population growth and the spread and intensification of subsistence agriculture is the main problem. Prior to its replacement by a more successful oil palm tree crop, large estates of cocoa and rubber were planted throughout the Popondetta Plain. This loss of habitat to agriculture is now also compounded by the steady expansion of the human

population in the Popondetta hinterlands, which is increasingly cutting down areas of forest to plant food gardens.

#### THE OIL PALM INDUSTRY

The history of the oil palm industry in the Popondetta region dates back over the last 15 years. C. Benton (in Parsons, 1980a) stated that, after the success of the Hoskins (East New Britain Province) Oil Palm Scheme, the Government of PNG requested the International Bank of Reconstruction and Development (World Bank I.B.R.D.) assistance in financing of smallholder oil palm development in Biialla (West New Britain Province) and Popondetta. The Bank submitted its proposals in 1973, and in February, 1976, a World Bank mission visited PNG to finalize the Popondetta sub-project (Anon., 1976a). The proposed eight-year project went ahead without provisions for conservation or management of *O. alexandrae*.

Parallel to this, in 1974, the Commonwealth Development Corporation (CDC), at the invitation of the Government of PNG, mounted a study to investigate the the feasibility of large-scale oil palm planting in the Northern Province on land previously occupied by an unsuccessful cocoa scheme. The proposal was for a nucleus estate and processing mill which would also handle the output of the accompanying smallholder scheme. The results were deemed favourable and development began, under CDC management, in 1976, with the first processing line coming into production in May 1980 (Higaturu Oil Palms Pty. Ltd. [HOPPL] fact sheet).

Where forest clearance was undertaken to permit the planting of oil palms there was serious loss of *O. alexandrae* habitat. This was reported on by Parsons (1980a and 1980b) who noted that 4,000 Ha of land, encompassing much forest habitat, were given over to 50% PNG Government- and 50% British-owned HOPPL, and that 5,600 Ha were utilized by the OSOPDP, the overall development affecting, therefore, 9,600 Ha of land. This resulted in the loss of at least 2,700 Ha of actual or potential *O. alexandrae* habitat.

#### RECENT OIL PALM DEVELOPMENTS

The development of oil palm plantations on the Popondetta Plain is now extensive (Fig. 13). According to Department of Agriculture and Livestock (DAL) officials in Port Moresby, in April 1991, expansion of the OSOPDP was placed on 'hold' due to the very low world market oil palm prices. However, DAL intends to resubmit the project for National Government funding once this is no longer a problem, and CDC-backed HOPPL is looking to extend its estates, lying just to the north of Popondetta (Fig. 13), by a further 2,000 Ha in order to bring its mill processing efficiency up to that required by its management. The mill was built to the specifications of 60 ton fresh fruit bunch (FFB) per hour capacity: an overly large handling capability considering the region, according to HOPPL operatives (in hindsight). This has proven correct, as for a long period of time the mill has processed only about 30-40 FFB tons/hr because of the failures and shortcomings of the system of actual input of oil palm nuts from the surrounding plantations. The further 2,000 Ha of oil palm plantings was to be developed in the Dobuduru area. However, due to a dispute with the landowners there, HOPPL is



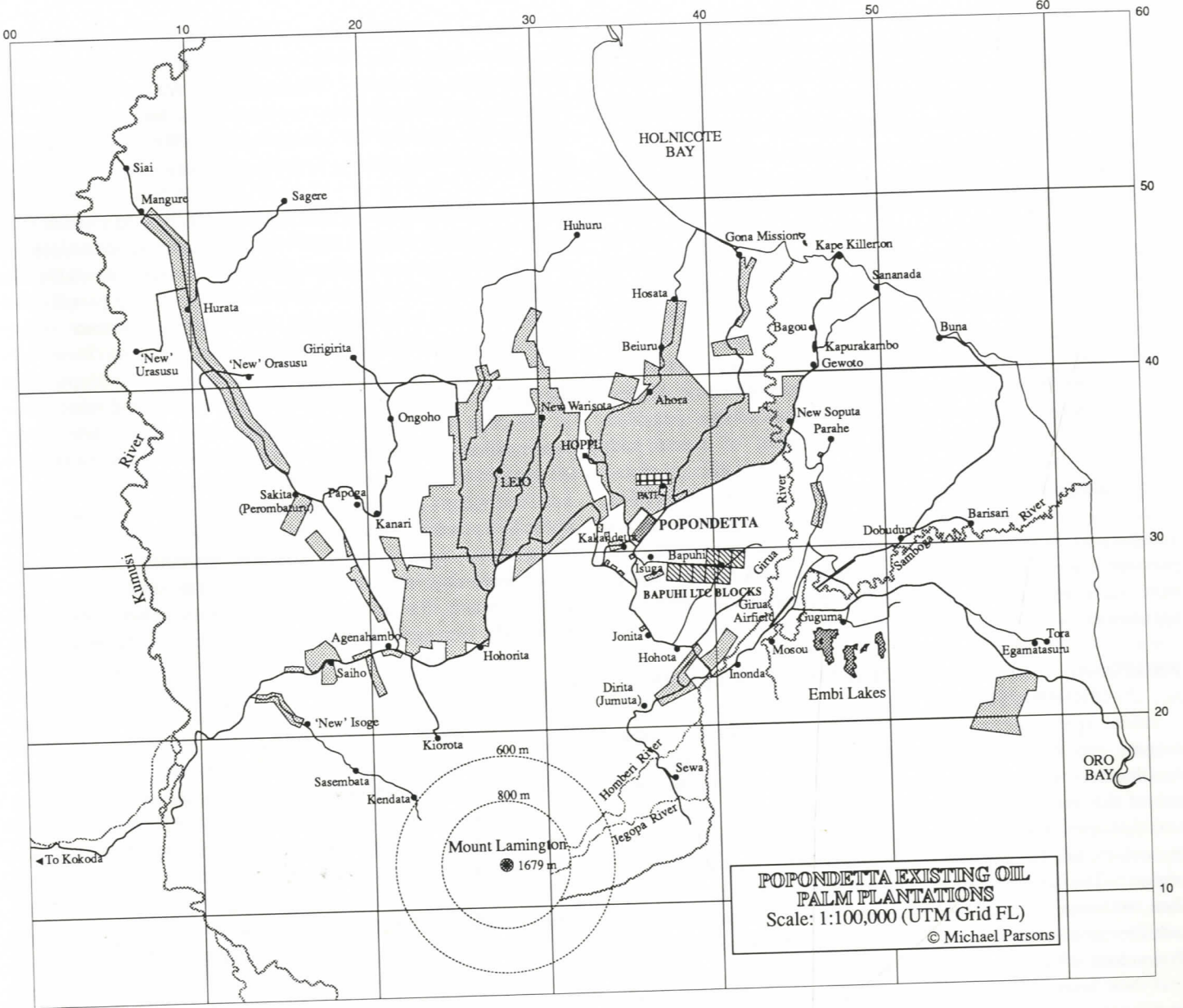


Fig. 13. Map of existing oil palm plantations on the Popondetta Plain.

looking to 'replace' this with development elsewhere.

The company has established 500 Ha of productive oil palm at Warisota, leaving, according to HOPPL Field Manager, Mr. R. Marshall (pers. comm.), another 1,500 Ha still outstanding. Consequently, HOPPL has focussed its attention on planting about 500 Ha for their estate expansion in the Bapuhi (Bapui) Village area, which is very close to Popondetta. The region has, therefore, now become a priority area for a detailed Environmental Plan to be drawn up as the villagers met with HOPPL in April 1991, with a view to HOPPL planting the eight Land Tenure Conversion (LTC) blocks in the area (Fig. 13) with oil palm. OSOPDP Manager, Mr R. Atkins (pers. comm.), noted that, as a 'last resort' (due to the transport distance involved, as well as the presence of squatters), HOPPL could develop the 1,500 Ha of its Mamba Estate lease, near Kokoda at the end of the valley there, which includes land already under plantation, and secondary vegetation, but also some forest.

Marshall and HOPPL Managing Director, Mr. C. Warn, both

stressed (pers. comm.) that the HOPPL management are well aware of the environmental concerns of loss of forest habitat in the Popondetta area, especially pertaining to *O. alexandrae* conservation. They also pointed out that the company is anxious to see that any areas of forest that come under the proposed estate expansion are first surveyed in order to assess their biological value and potential in line with the requirements of PNG's 1978 *Environmental Planning Act*.

Atkins stated that, to develop kunai grassland areas for oil palm costs PNG Kina 200 (1 Kina = circa US\$ 0.94) per 2 Ha block, as opposed to about K40 for its planting in areas where forest is cleared. The main financial outlay in grasslands is in planting a cover crop prior to the oil palms, requiring various machinery and fertilizer to do this. However, the Girua Airstrip-'New' Soputa road kunai grassland blocks (e.g. Fig. 10), and those near Gona Mission, provide good examples of non-cover crop oil palm planting. Nevertheless, it has been found that, although such plantings eventually require similar management to those on



cleared forest areas (the PNG Oil Palm Research Association [OPRA] now believes that yields are not suppressed over the long-term in kunai plantings), they are disadvantaged inasmuch as production only commences after about four years (as opposed to two). The OSOPDP was aiming at 60% forest (or secondary growth) plantings, and 40% kunai plantings. Atkins pointed out that, even if reversed to 40/60, the project would still essentially require plantings in forested areas and certainly could not be planted as 100% kunai, for example.

It is pertinent to point out here one of the perhaps less immediately obvious environmental problems created by the OSOPDP. This is that, by requiring smallholders to reside as small, or single, family units on blocks, the scheme has disseminated village communities throughout the large project area. For the blockholders, this has resulted in a breakdown of the 'extended family' system that the village otherwise provides. Therefore, besides the obvious replacement of forest with plantations, the oil palm blockholder scheme has also promoted more widespread people pressure on the forests (especially those adjacent to block areas) for food gardening. This has further accelerated the demise of the remaining natural woodlands. The pressure is also greater because smallholder block families aim to raise sufficient children to assist the parents in the necessary agricultural work of the block.

#### PROPOSAL TO IMPROVE SMALLHOLDER OIL PALM PRODUCTION

Atkins (pers. comm.) pointed out that a 'tribute' harvesting scheme has been proposed to improve the yields of those smallholders who are operating notably inefficiently. If the initial test of this scheme (now in progress) does work in Popondetta, and full-scale tribute harvesting implemented, then this would remove the need to expand smallholder oil palm plantations in the region. The potential success of such a scheme is obviously, then, extremely important, as it will serve the aims of both wildlife conservation and agricultural development in the Popondetta area.

It has been suggested that the present oil palm transport company (completely owned by the Provincial Government, but managed by HOPPL) be given a two year contract to first rehabilitate (fertilization, pruning, etc.) such blocks, then harvest them. The blockholders would be given K5.00 per ton royalty payments, plus any residual profits remaining after the company has recovered all of its costs. At present, the grower receives about K24.00 per FFB ton, and so can expect returns of about K1,000 per 4 Ha block in the second year of the scheme's operation, with about K500 for the initial rehabilitation year of low production. The average nett income was K970 per 4 Ha block in 1990, with only 50% of the existing smallholders earning over K1,000 per block in 1989.

Atkins stated that the success of the scheme would be dependent on actual yields, coupled with world palm oil prices. Therefore, as a test, the present scheme proposal has been limited to working just 100 Ha for only one year. If this works, then there would be scope to increase production over the entire smallholder scheme. Such a tribute harvesting scheme was attempted in New Britain. However, this failed as the blockhol-

ders demanded their blocks back after only six months had elapsed. Atkins also cautioned that the scheme would be dependent on the number of growers who would be prepared to sign the tribute harvesting contract. Marshall (pers. comm.) pointed out that, for the scheme to run efficiently, the tribute blocks would also have to be in large groups.

#### PROPOSAL TO PRIVATISE PNG'S OIL PALM INDUSTRY

DAL, together with the PNG National Government Cabinet and Asian Development Bank (ADB), is looking to revitalise its extension work in the tree crop sector through a privatisation scheme. This will commence with the establishment of the Coffee Industrial Corporation (CIP), and then, on January 1, 1992, the Oil Palm Industrial Corporation (OPIC), with plans for the same for the cocoa and/or coconut industries, and subsequently all other tree crops. It is hoped that, in this way, more accountability can be given to growers, who will also have more of a say in how the extension services are run.

It has not yet been decided whether OPIC will be a statutory body, or a private company. The industry hopes that the structure will give the regional Project Managers greater scope to manage the projects more effectively, none of the extension officers being public servants. (i.e. all of the DAL Smallholder Schemes will be effectively separate from the government). However, the government would provide a minimum 50% funding of the scheme for the first five years, with the balance to be provided from levees from both the smallholders and the company (dependent on world palm oil prices). A similar system has been implemented elsewhere, especially in Malaysia (as promoted by the ADB). It is also believed by those in the oil palm industry that the new company, as established under OPIC, would provide a better means for implementing the requirements of environment and conservation in the Northern Province.

#### THE TIMBER INDUSTRY

The timber industry has been important to PNG's economy, earning K114 million in 1988 when it represented the country's third major foreign exchange earner (Anon., 1988). The history of this industry in the Popondetta region dates back over at least the last decade. In consideration of PNG's 1978 *Environmental Planning Act*, and the endangered presence of the world's largest butterfly, it is remarkable that all logging within TRP areas in the Popondetta region appears to have been effectively illegal because no Environmental Plans (EPs) have ever been drawn up for any of the areas designated as timber reserves within the region.

In 1975, about 60,000 Ha to the north-west of Popondetta were loosely defined as the Kumusi Timber Area (KTA) (available for Timber Rights Purchase: TRP). Exploitation of this region was begun in 1983 by a large logging company, Fletcher Forests Pty. Ltd., of New Zealand, operating as the Kumusi Timber Company (KTC). However, due to immediate financial difficulties within the company, the accounting firm of Price Waterhouse was brought in to restructure the project's finances. Singapore-based Ambogo Sawmill Pty. Ltd. (ASPL) was then appointed as the subcontractor to the KTC and took over operations from Fletcher just one year later, in 1984. ASPL Co-Directors, Mr. T. P. Lai



and Mr. C. L. Tan own 60% of shares in the sawmill, 40% belonging to the Provincial Government (T. Lai pers. comm.). In the past, any logs that were rejected for export via shipping from Oro Bay to various countries (but mainly Japan) were processed by the sawmill for domestic use to reduce wastage. Now ASPL cuts timber that supplies only local markets, especially in Port Moresby, Lae, and Madang.

From 1983 until May 1989, logging operations proceeded virtually without concern for the future survival of *O. alexandrae*, despite the fact that three key *O. alexandrae* reserves within the area (Fig. 12) had been identified by Parsons (1980c) in a specific environmental plan for the butterfly within the KTA. This was enormously detrimental to its habitat within the KTA, and in the central region some areas of primary forest were even clear-felled as the density of merchantable timber logs was higher there. The proposed reserves have now been almost wholly affected by logging, despite the initial agreements (recorded in the Moi *et al.* in their 1984 reports) of all the landowners contacted by the DEC that the reserves should be processed and legally finalized. Mr. Z. Kwevekavubutu, OIC, Provincial Office of Forests, Popondetta, pointed out, with the aid of a large scale map, to Parsons (1988b), that the proposed reserves had been almost completely logged, especially centred on the villages of Girigirita and Sehoru. This was later confirmed by Boyer, *et al.* (1990a) in a World Bank mission to Popondetta.

Z. Kwevekavubutu (pers. comm.) stated that only one small area north of Siai Village (and bounded by the eastern banks of the Kumusi River), out of the entire TRP region, was left unlogged as an *O. alexandrae* reserve. Therefore, the much larger reserve boundaries proposed by Parsons (1980c) for the area in an attempt to maximise the value of the surrounding ecosystem for the butterfly, were violated. However, there apparently also remains a substantial region of unlogged forest belonging to Father Lucien Evehupa and other members of his clan. This area (possibly as much as 700 Ha) lies approximately midway between Sagere and Girigirita and was determinedly defended by Father Lucien, despite pressure from his peers to exploit it for its timber. In a meeting with him in May, 1991, he was adamant (pers. comm.) that he wanted to see the area given Wildlife Management Area (WMA), or Conservation Area, status.

In the Girigirita/Ongoho/Jaujau area the landowners refused to accept the *O. alexandrae* reserve proposed by Parsons (1980c) (see Land Tenure Problems below) so this was logged, leaving only all of those trees below 40cm still standing. During the 1991 survey, a study of the immediate area north of Girigirita and Sasovi Villages was carried out and it became clear that extensive logging in the area during the mid-1980s had effectively destroyed the *O. alexandrae* habitat reported by Parsons (1980c) (and obviously also the region south to Jaujau Village — all of which had been recorded as good *O. alexandrae* habitat by Parsons). The forest destruction has also been compounded by heavy gardening in the region due to the improved access along the now overgrown forestry roads. It is noteworthy that the villagers of the region have nothing lasting to show for the logging royalty payments they received, all of which was rapidly spent soon after it was obtained.

Another substantial area, the Inonda/Mosou TRP, was also

logged between 1986 and 1989. It comprised a large region of hill forest containing the headwaters of the Samboga River, and including ground owned by Mosou and Inonda villagers. This region of about 64km<sup>2</sup>, lies approximately between the present Sewa area logging operations, and (to the east) a line drawn from the main headwater of the Emboga River to the western shore of Big Embi Lake (Fig. 14). Its importance to the survival of *O. alexandrae* and other wildlife was never ascertained by environmental surveys.

The continuing financial problems of the logging operations within the KTA finally forced the closure of the KTC in May, 1989, when Price Waterhouse liquidated all of its operations. Nevertheless, the ASPL still operates (supposedly under Timber Authority guidelines, outside of TRP areas), but on a much smaller scale, for example, using logs that would otherwise be burned in garden clearance, or from clearing in tree crop plantation areas.

### PRESENT STATUS OF PROVINCIAL FORESTRY AND THE TIMBER INDUSTRY

Z. Kwevekavubutu (pers. comm.) noted that a two year logging moratorium in PNG began in July 1990, but those companies with permits in existence could continue if their operations were considered by the Minister of Forests to follow the environmental guidelines imposed on each project. Over the moratorium period no more new permits will be issued, and a review of the situation will be made at the end of the ban. Therefore, ASPL can continue to operate.

Besides Timber Purchase Rights (TRP) agreements, Native Timber Agreement (NTA) negotiations are another way by which Popondetta area landowners have been approached by timber companies to log their forests. According to Kwevekavubutu, such agreements by timber companies need only be made with individual land owners (but sometimes also the clan), and can be 'salvage' logging on a small scale, for example where the land owner will plant a food garden. However, NTA agreements invariably include much larger areas of forest, for example a maximum size of 500 Ha (= circa 5,000m<sup>3</sup>) of logs. The royalty payments on logs from NTA areas are double (about K6.00) as the logging company must pay in accordance with a sales agreement, as well as the standard per cubic metre royalty payment. Apparently such NTA logging areas, being based on personal decisions of landowners, do not require EPs to be drawn up, so the system is an obvious loophole to conservation and environmental planning in PNG, and is especially worrying in the Popondetta area because of concern over the future of *O. alexandrae*.

Kwevekavubutu stated that landowner royalties from such operations are 75% of the logging fee, or K5.41/m<sup>3</sup>, 25 percent going to the Provincial Government. The entire royalties are first paid over by the logging company to the Provincial Office of Forestry who then makes payments to landowners accordingly. There is also a grading system imposed, so that the royalties are usually in the region of K3.00-4.00/m<sup>3</sup>, and the average expected amount of royalties for a 50-100 Ha area (i.e. per clan group) is between K1,500-2,500. Obviously this level of income is not particularly high, and so prospects of bettering, and thus replac-



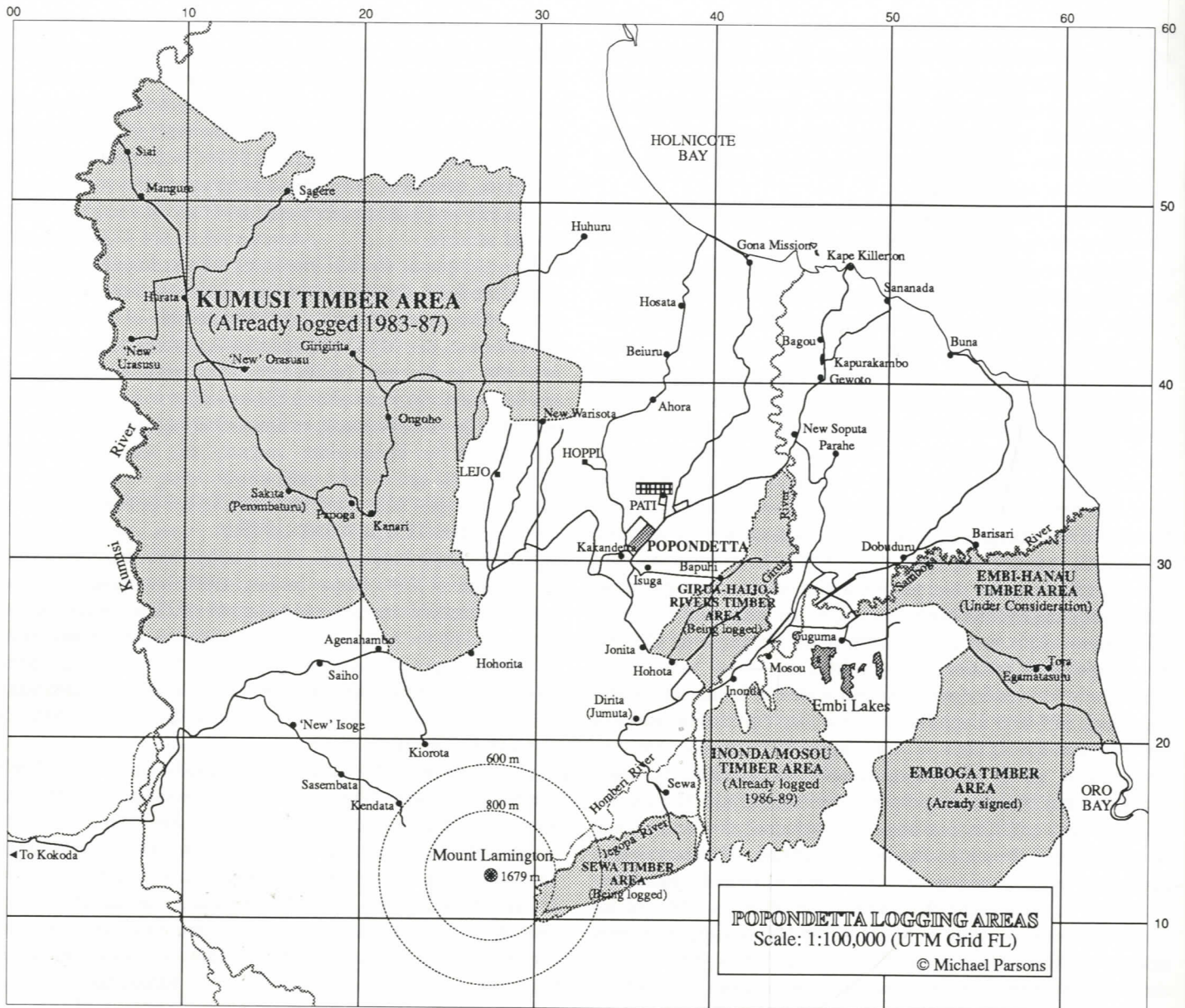


Fig. 14. Map of timber areas on the Popondetta Plain.

ing, logging with alternative, and more effective, environmentally benign and ecologically sustainable land-use methods are good.

The Sewa area TRP, sited directly below Mt. Lamington, and bounded to the south by the Girua River, and approximately as far north as Sewa Village (Fig. 14), represented, in 1989, primary forest under TRP negotiation with the Sewa area landowners. It was stated to include the "best" dipterocarp-rich forest in the district (Darby, 1990). In late 1990 the area became yet another focal point for logging in the Popondetta region. A permit had been issued to ASPL in mid 1989 to log in the Sewa area (Figs. 14). This was given to Price-Waterhouse, who, at the time, were operating KTC during its period of financial difficulties. However, when Price-Waterhouse finally shut down the operations of KTC, the permit was returned to the Provincial Office of Forestry. Nevertheless, in November, 1990, the permit to log in the area was reissued to KTC/ASPL, the Provincial Forestry Office instructing the sawmill to keep its operations within the boundaries of the Girua and Jegopa rivers.

The Sewa scheme had included a much larger proposed area, continuing northwards right up to the main road and the Samboga River, in the region of the Embi Lakes. However, the focus shifted to the Sewa region as the National Parks Section of the DEC instructed the Provincial Forestry Office to cease consideration of TRP status for the area around the Embi Lakes. At least since 1978 the Embi Lakes area has been considered for its potential value as a National Park (Gagné and Gressitt, 1982). Based on the three *O. alexandrae* larvae, and four adult females, located by the 1991 Survey in the Sewa region, and on the distribution of the remaining foodplant vines in the area (see 1991 Survey below), this was obviously very important *O. alexandrae* habitat prior to logging.

Another logging permit also granted KTC/ASPL unrestricted logging in the Girua-Haijo Rivers Timber area. Timber cutting by ASPL in this area (about 2km north-east of Bapuhi Village: Fig. 9) started in October, 1990 (Mr. I. Kojia, pers. comm. of Bapuhi Village). Another Bapuhi landowner, Mr. Humphrey



Apora from the Soputa Village area, like Koiija, also signed a logging agreement with ASPL, and timber in his area is scheduled to be felled as a continuation of the present operations on Koiija's land.

During the time that the 1991 Survey team studied the Girua-Haijo logging operations, it was noted that logging and logging 'tracks' had been taken right to the very edge of the Ijika Creek in several areas. According to PNG Law (Kwevekavubutu, pers. comm.), the minimum distance for such operations along watercourses is 50m. However, he added that he had no Provincial Government transport to check on the way in which logging was being carried out. When actually carried out, most visits by his officers were invariably on Public Motor Vehicles (PMVs). In this region, the logging operations have destroyed much prime *O. alexandrae* habitat. This comprised good advanced secondary forest, and some 12-16m tall pandanus swamp (fairly dry at the time of the visit), in which its larval foodplant vines were particularly abundant (observation of cut and destroyed, plus damaged but still standing *Aristolochia* vines), the butterfly having been recorded as several larvae in an adjacent unlogged forested area.

Kwevekavubutu pointed out that the next proposed logging area is the very large Embi-Hanau TRP area (Fig. 14), which lies to the left of the road on the way to Oro Bay. However, it is not yet known whether logging in the area will actually be "agreed" to. Although no *O. alexandrae* were found, numerous *Aristolochia* vines were located by the 1991 survey team within the one small section of this area near Tora Village (Fig. 12). Opposite the proposed Embi-Hanau logging area, on the other side of the road, and centred on the Emboga River, lies a somewhat larger proposed logging area for which the TRP has already been signed.

Lai and Kwevekavubutu (pers. comm.) both agreed that the operations of ASPL are presently only being sustained by NTA logging that the sawmill is carrying out. However, in light of Parsons' (1991) findings, Kwevekavubutu stated that he had formally written to inform ASPL that no further NTA logging was to be carried out once a volume of 5,000m<sup>3</sup> of timber had been reached in 1991. TRP negotiations require about 3-5 years to set up, so Lai has estimated that his sawmill would probably have to close its operations by about August, 1991, if logging was not permitted in any other areas in the Popondetta region. He stated that ASPL requires at least 18,000m<sup>3</sup> of timber per annum to run efficiently as a business.

Another sawmill very recently established in the Popondetta area is Thailand-based timber company, Kiatichai, which is a subsidiary of Pactim Timbers, a company already well established in Port Moresby, PNG. The company has informed the Office of Forests that they wish to log only previously planted teak in partnership with a local company, Aika Brothers Company. However, it is clear that many in the local timber industry think that such a resource, being only relatively new and very limited, has a maximum life of about 6 months before it is entirely cut. Thus many are doubtful as to the real intentions of Kiatichai, believing that the company must rapidly move to standard logging operations to make their capital investments in the start-up company (sawmill, etc.) worthwhile.

In a letter of May 1991, to the Provincial Wildlife Office, Kiatichai General Manager enclosed a 'proposal' which clearly states that "Expansions are allowed to process other species of logs after six months of commencing operations. The company is presently carrying out survey and discussion with Oro provincial Government, Forestry Department and landowners to secure timber areas." The proposal also states that the sawmill, when completed, will be "one of the largest in Oro Province." At an estimated K800,000 capital investment by Kiatichai (Project Summary section) the company would obviously want to rapidly expand to other species of timber trees in order to recoup this, and to permit the company to run at a profit. Under the Environmental Management Section of the Kiatichai project proposal (which numbers just 15 lines of general promises to run a clean operation) nothing is mentioned of the intended operations of the company as they would apply to felling of other timber, presumably in natural forests. In the face of competition from ASPL, and in the light of Lai's statement that Ambogo may have to close down due to lack of available logging rights, it seems extraordinary that Kiatichai are so optimistic as to set up operations in the Northern Province, unless they already have prior knowledge of, or consent for, other timber resources that would be made available to them.

## O. ALEXANDRAE CONSERVATION

### ATTEMPTS THROUGH ACTIONS

In 1970, the Australian Government's Administration in PNG employed Mr. Ramon Straatman to survey and map the distribution of *O. alexandrae*. This was carried out in a limited way, but nevertheless provided (in the form of a report submitted to the then Department of Agriculture Stock and Fisheries) the main information required to begin a logical programme of conservation for *O. alexandrae*. The report was duely filed and effectively forgotten. During that period Gressitt and Zeigler (1973) attempted to draw attention to the needs of the species, stating "Studies of *O. alexandrae* suggest that its entire range may become overrun by agriculture as it is entirely restricted on a coastal plain." During the early 1970s a large Wildlife Management Area (Hurapa-Jajiko), of about 10,000 Ha, north of Popondetta, was proposed at the request of traditional landowners. Certain areas within the region were known to be used by *O. alexandrae*, although it also included large tracts of open kunai grassland and other unsuitable habitats. Nevertheless, the proposed WMA was never surveyed for gazettal, and the area finally became badly affected by logging, oil palm plantations, and other developments (Parsons, 1988b; Boyer, *et al.*, 1990a).

In an insect farming consultancy report to the PNG Government, based on three months of field studies in PNG, Pyle and Hughes (1978) included a recommendation for an in-depth study of *O. alexandrae* to enable a management and conservation plan to be drawn up for the species. Following this, in March, 1979, the author was contracted by the Government of PNG to begin a research project, part of which included a conservation study of *O. alexandrae*: its distribution, ecological requirements, and the needs for its protection from extinction. This culminated in a number of survey and recommendation reports submitted to the



Wildlife Division (Parsons, 1980a, 1980b, 1980c, 1981c, and 1983a), and associated publications (Parsons, 1979, 1981a, 1981b, 1982, 1984, 1985, 1988a and 1988c). Discursive follow-up missions were also undertaken for the World Wildlife Fund (Parsons, 1988b), and World Bank (Parsons, 1990), whilst an actual field survey (see below) was funded by Conservation International (Parsons, 1991). Kiafuli (1979) assisted Parsons on one of the first extension visits, and Mr and Mrs Wasam Gabara (Oro Provincial Wildlife staff) also conducted surveys to complement the project between October 1980 and May 1981. Until January 1982, the Division of Wildlife funded the programme for the conservation of *O. alexandrae*. Due to financial repercussions of the World Economic Recession of the early 1980s, the project was then transferred, along with the Bulolo-based Insect Farming and Trading Agency, to come under the funding of the Department of Primary Industry (DPI: now DAL) Livestock Section.

Between April and July, 1984, three visits were made by DEC staff to the KTA as a follow-up to Parsons' (1980c) recommendations regarding the establishment of *O. alexandrae* reserve areas within the KTA. These visits resulted in three reports (Kwapena and Moi, 1984; Moi, 1984; Moi, *et al.*, 1984) and a general, undated, summary report (Anon., 1984). Basically, these reports discuss the various negotiations held with landowners, and point out the lack of Provincial and National Government funds and manpower to implement the necessary conservation proposals and decisions (such as surveying proposed reserve boundaries, and the monitoring of such tasks).

In March 1988, Parsons was contracted to re-visit PNG as consultant to the World Wide Fund for Nature (WWF) International to prepare a logistics report for re-establishment of an *O. alexandrae* Conservation Project. At the time, the project was pending funding by WWF as Project 3814. In the resultant report Parsons (1988b) drew various conclusions from this fact-finding mission to Popondetta, but mainly that re-establishment of an *O. alexandrae* project was then of crucial importance in the light of the unabated logging of timber throughout the KTA. The 1988 WWF mission was followed by a joint WWF/PNG Philatelic Bureau September, 1988, postage stamp issue in PNG, designed and painted by Parsons (Fig. 7). The four stamp set and its information sheet (Parsons, 1988a) were produced to highlight the conservation needs of *O. alexandrae*, and to raise some funding from sales of the stamps.

As a result of the WWF mission it was also verbally recommended by Parsons that WWF contact the World Bank at its Washington (U.S.A.) headquarters, as the Bank was preparing to assist the PNG Government with a loan to expand the smallholder oil palm industry in the Popondetta region. Consequently, a World Bank mission in March 1990, which included an environmental consultant (Darby, 1990), recommended that, not only should the *O. alexandrae* Project be funded as an integral part of the OSOPDP, but that the DEC should be strengthened with funding to enable the *O. alexandrae* Project (and other important conservation projects in PNG) to be more effectively supported by this branch of the government in perpetuity (Boyer, *et al.*, 1990a, and Darby, 1990).

In March, 1990, a World Bank review mission for the proposed OSOPDP visited PNG. Their Aide Memoire report (Boyer, *et al.*,

1990b) made general recommendations for the budgeting of the *O. alexandrae* Project, and also for a revitalisation of the DEC, as necessary safeguards to the long-term future of the *O. alexandrae* Project. Tentative costs for the butterfly project were estimated at US\$900,000 for the for the proposed 6 year project period (commencing in early 1991). In June 1990, a second World Bank review mission concentrated on drawing up an action plan for *O. alexandrae* conservation based on the intergration of this with the continued development of the oil palm industry in the region. In its ammended form this is outlined below.

Between 1983 and 1990, records of *O. alexandrae* were extremely intermittent and necessarily made on an oportunistic basis, there being no coordinated attempt to gather and map its present day distribution due to lack of funding. Nevertheless, some recent records were extremely important in establishing that the butterfly was still extant. For example, the District Wildlife Officer, Mr. E. Malaisa, reported that, in April 1990, two *O. alexandrae* adults (a male and female) were eclosed in his protective custody from pupae collected at an old butterfly farm at Kakendetta, near Popondetta town. Prior to this, in November 1989, a mature larva was observed in the same area, as well as at least two further adults in flight (one male, one female). Experienced butterfly farmer Mr. Roderick Orari (pers. comm. June 1990) noted that, although few in number, he had continued to observe *O. alexandrae* adults flying in the vicinity of his butterfly farm/proposed *O. alexandrae* reserve area at Ahora (approximately 7km north of Popondetta).

In 1989, the now Provincial Secretary, Mr. Arthur Jawodimbari (pers. comm.), had requested assistance for the Provincial Wildlife Officer from the Japan International Cooperation Agency (JICA). In answer to this request, Japan Overseas Cooperation Volunteers (JOCV) volunteer, Mr. Tomoyuki Suzuki, was then posted to Popondetta in July 1991, to spend two years in Popondetta on this mission.

#### ATTEMPTS THROUGH PROTECTIVE LEGISLATION

In the recent past most *Ornithoptera*, or birdwing butterflies, were considered by expatriate government officers, working in PNG, to be extremely rare and localized. If left unchecked it was believed that over-collecting could threaten the survival of certain 'rare' or local species. During the late 1960s this view was strongly promoted by the Curator of the National Insect Collection, 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 1 November 1968, seven *Ornithoptera* species (*O. alexandrae*, *chimaera*, *goliath*, *meridionalis*, *paradisea*, *victoriae* and *allotiei* — the latter taxon certainly of hybrid origin: *O. priamus urvillianus* x *O. victoriae regis* Rothschild) were completely protected by their listing under the 1966 *Fauna Protection Ordinance* by the then Australian Government of the Territory of Papua and New Guinea (the date when the Act was first gazetted: Shaw, 1969). As the rarest of these butterflies *O. alexandrae* certainly warrants its protected status. These seven (six) *Ornithoptera* species now represent PNG's National Insects in general because no other insects are of protected status in the country.

By 1976 this legislation had led to the confiscation of about



140 illegally collected specimens of various *Ornithoptera* species, and the successful prosecution of several persons for illegal possession of protected butterfly specimens (Fenner, 1976). Later, several other offenders were prosecuted, and some expatriates who were caught smuggling *Ornithoptera* were even deported (e.g. Waugh, 1976, Anon., 1976b, Anon., 1979). The Fauna Protection legislation also led to associated media coverage, such as a warning in the *Pacific Islands Monthly Magazine* (Anon., 1973) not to collect *O. alexandrae*, with a penalty of A\$200 for anyone caught doing so. (The fine is now K500).

Recognizing that the large demand for the protected species of *Ornithoptera* would only continue to be detrimental to their survival, if it could not be satisfied in a controlled manner, Fenner (1976) proposed, in an internal Government memorandum, that experimental farming of these butterflies, and in particular of *O. alexandrae*, should be begun. However, this proposal was never adopted.

During 1977 the National Parliament of PNG accepted the document "Environment and Conservation Policy — a statement of principles" as a description of the directive principles which were to be applied in the development of PNG (Anon., 1978b). PNG's constitution is the only national constitution in the world which specifically encompasses the rationale behind insect conservation: "We declare our forth goal to be for Papua New Guinea's natural resources to be conserved and used for the collective benefit of us all, and be replenished for future generations. We accordingly call for ... (3) all necessary steps to be taken to give adequate protection to all our valued birds, animals, fish, insects, plants and trees." Bearing this in mind it is obvious that there is a strong onus on the PNG Government to make every attempt to uphold its constitutional values. Legal methods were provided for the maintenance of these values by the introduction, in 1978, of three important acts: a) *Environmental Contaminants Act*, b) *Environmental Planning Act*, and c) *Conservation Areas Act*. The second Act establishes proper environmental considerations as a part of policy and project planning, and gives the Minister for Environment and Conservation authority to compel proponents of a project to include in the proposal the effects upon the environment, and the social and cultural systems of the people in the area where development may occur. Most importantly, the latter Act provides for the conservation of sites and areas having particular biological importance to the Heritage of PNG, and for the management of those sites and areas (Anon., 1978b). These Acts (in particular the *Conservation Areas Act*) have never been effectively used in PNG, and certainly not to benefit *O. alexandrae*. However, one of the main reasons for this is the problem of land tenure rights (see below).

Wildlife Management Areas (WMAs) are a national system of usually small reserves which have been implemented in the past by the DEC, the most recent being the gazettal of the Mt. Kaindi WMA, near Wau, Morobe Province, in March 1990. These are established at the request of, and with the collaboration of, their landowners in areas considered to be biologically important, usually with respect to the conservation of a particular species. The landowners are also asked to draw up a list of rules that they wish to apply to the reserves, together with those advised by the Wildlife Division. However, in reality, WMAs are of limited

conservation value as they remain open to exploitation at any time by outsiders, or the landowners themselves, and policing of WMAs is extremely difficult. Although they are, theoretically not subject to the problems of land tenure rights, landowners may reverse their decisions about WMAs.

With the recognition of the international importance of the *Ornithoptera*, legislation was also introduced on behalf of these butterflies in other countries. International agreement on wildlife trade control is contained in the July 1975, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which controls and monitors export of listed species. PNG is one of 87 signatories to this agreement. Appendix I, which presently contains no insects (although Parsons, 1983a, recommended that *O. alexandrae* should be placed on it), 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 various birdwings (*Ornithoptera*, *Troides*, etc.), is a list of species which must be regulated in order to avoid the threat of extinction. Their commercial trade is permitted, but an export permit from the country of origin is required.

The 1982 European Economic Community (EEC) Regulation No. 3626/82 implementing CITES included an annex of species listed on Appendix II of CITES that the Community treated as though they were on Appendix I (i.e. preventing virtually all trade in those species by prohibiting their importation into the EEC, if they are primarily for commercial purposes). Collins and Morris (1985) pointed out that the EEC unexpectedly added the CITES Appendix II Papilionidae to this list without consultation with the CITES Secretariat or the International Union for the Conservation of Nature and Natural Resources Species Survival Commission (IUCN/SSC) Butterfly Specialist Group, and that the Regulation would seriously jeopardize the PNG birdwing ranching programme, and others, all of which rely heavily on European markets. In a letter to the editor of the Royal Entomological Society of London newsletter, *Antenna*, Macfarlane (1984) also pointed out similar objections to the EEC regulation as, at that time, the Solomon Islands Government was intending to establish its own insect farming scheme. He stated that he would like to see a repeal of the measures.

Only recently has the advice of Macfarlane, and other entomologists in the field (Parsons, 1983a; Morris, 1986) been heeded. Notably, 1987 EEC Council Regulation No. 1422/87 was passed which finally amended the earlier Regulation No. 3626/82. The 1987 amendment 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* (Smet, 1987). 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".

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.



None of the above mentioned legislations have served to solve the root cause of the problems facing the survival of *O. alexandrae* (or its relatives): namely that of continuous habitat loss. In short, it would have been far better if the costs of implementing all such legislations had been spent on promoting actual conservation in the field.

## PROBLEMS FACING PROJECT RE-ESTABLISHMENT

### LAND TENURE

As Hoyle (1977) pointed out, there are very few totally protected areas of land in PNG due to the Government's reluctance to alienate Traditional Land from the people, most land belonging to someone on a customary basis. In fact, 97% of the country's land area is under customary tenure, and National Parks only occupy 3,349 Ha (Dart, *et al.*, 1989). Even prior to Independence from Australia in 1975 the Administration was reluctant to create National Parks for much the same reason, so only two were created. Historically, there have been persistent land disputes between clans in New Guinea, and this has continued to the present.

The Popondetta area is no different from elsewhere as evidenced by claims for compensation made by Orokaiva clanspeople for certain lands within the region that they maintained were illegally taken during the colonial era (e.g., Emboge, 1980). For these reasons, the purely conservational components of the *O. alexandrae* Project have, in the past, met with various levels of opposition from landowners who were unsympathetic to the idea that they should leave the forests on their land intact, and so could not exploit their timber resources, or the land on which it stood (e.g., see following paragraph). Such resentments, coupled with the rights of the landowners to make the ultimate decision about what course of action they would permit in development of their land, has made the use of legislation, such as the *Conservation Areas Act* (outlined above), practically unusable. The land on which *O. alexandrae* occurs is almost entirely privately tribally owned. WMAs and reserves can only be established with the consent of the relevant clans, and there have often been differences of opinion even between the various clan members regarding such matters.

It is apparent that certain landowners in the Popondetta region would presently prefer to obtain money from their land quickly and easily, regardless of the plight of *O. alexandrae* or other environmental concerns. This is partly because, although initially sympathetic to the plight of *O. alexandrae*, such landowners have often become highly disillusioned by the lack of progress in decision-making and action by the PNG Government on behalf of *O. alexandrae* over the last two decades. Such problems were encountered by Moi (1984) and similar disagreements were still ongoing in May 1986, as evidenced by various correspondence on DEC files. For example, Mr. Stoneweek of the Ethana Clan, Popondetta, objected to a proposed "Butterfly Zone" around New Kikinota, so Mr. T. Lai, ASPL Managing Director, advised the landowner to appeal to the relevant authorities to "waive this imposition to allow Ambogo to start logging."

## FUNDING

In an historical perspective it is clear that attempts to conserve *O. alexandrae* have been typically fraught with difficulties stemming from the lack of the funding needed to carry out even the most basic of operations. The overriding result has been that *O. alexandrae* habitat has been steadily lost to development over the last two decades, in spite of sensible recommendations for conservation of the species made at the very outset of this period (Straatman, 1970 and 1971). Since the World Economic Recession of the early 1980s, and the subsequent huge 1982 cut-backs in the PNG Government's funding of the DEC (e.g. Kitchen, 1982), many Government departments have lacked funds to fully carry out their work and/or to promote conservation by field extension education, etc. None of the departments or organisations approached by Parsons (1988b) were able, at the time, to volunteer funds to augment proposed WWF funding of the *O. alexandrae* Project.

The PNG economy suffered a further large set-back following the out-break of a virtual civil war in Bougainville. This completely halted all operations at the Bougainville copper mine, and rapidly cut off that major source of revenue to the National Government. As of 7 May 1990, the PNG Government imposed an economic blockade on Bougainville, and there appears no end in sight to this crisis. This has obviously added greatly to the major financial hurdle facing the re-establishment of an *O. alexandrae* Project.

The interests of IUCN and WWF in protecting *O. alexandrae* have often been stated and are well documented. For example, Pyle, *et al.* (1981) pointed out that the IUCN/SSC Lepidoptera Specialist Group developed an action programme of world priorities for the conservation of butterflies and moths, among them *O. alexandrae*, and Collins and Morris (1985) noted that, in 1984, the newly formed Butterfly Specialist Group of the IUCN/SSC inherited the "long-standing" priority to protect the species. These organisations have been involved for several years with negotiations aimed at re-establishing the project. Indeed the re-establishment and funding of an *O. alexandrae* Project was requested in an official application to WWF by Parsons in February 1982, whilst he was still employed by the PNG Government, and in an additional private application in February, 1987. This resulted in the project becoming a WWF project under proposal (Project No. 3814).

Nevertheless, attempts at re-establishing a project to safeguard *O. alexandrae* have been plagued by inertia, including the overall lack of response from the PNG Government in asking for outside aid, and its failure to commit itself to providing at least some complimentary funding. Another factor has been that, until recently, the IUCN/WWF guidelines for tropical forest conservation in the Indo-Australian Region, have placed PNG as subordinate in importance to Indonesia and Thailand, although there is now a full-scale project underway, headed by WWF International through WWF Australia, to rehabilitate PNG's protected areas (WWF, 1991). The country also lacks primates, the chosen prime fund-raising animals by WWF (Anon., 1981); and as Collins and Morris (1985) pointed out, attracting funds for conservation projects is more difficult for invertebrates than vertebrates. As tropical forest destruction has quickened in recent years, the



IUCN's concerns for conservation has also shifted from individual species to questions of habitat protection. Selection of priorities and concentration of available resources are, therefore, uppermost considerations for IUCN, and so WWF Asia/Pacific Region funds have been preferentially channelled to the Oriental Region, for example.

It is certainly ironic that the proposed expansion of the oil palm project in Popondetta has finally served to focus much-needed attention on the plight of *O. alexandrae*, and to provide serious motivation to those concerned to finalize proposals for the conservation of this species. In light of this, initial funding for *O. alexandrae* conservation by the PNG National Government has finally commenced through the DEC, K119,000 having been provided for the fiscal year 1991. In Popondetta, the Provincial Wildlife Officer has recently made a submission to the National Government, through his department (DAL), for K49,000 to enhance the capabilities of his office. On the advice of Parsons (1991), he also prepared a K15,000 submission to the Provincial Government for funding to specifically augment Provincial work on *O. alexandrae* conservation.

#### FUTURE SUSTAINABILITY AS AN ECONOMICALLY VIABLE SPECIES

It is perhaps ironic that, once the future of the world's largest butterfly is assured by a concerted conservation programme, the species could become a highly profitable export in its own right. The past lack of progress in this area has, in part, been due to the failure of the PNG Government to establish any effective means of conserving *O. alexandrae*, despite the fact that the species has often been promoted as a serious candidate for economic utilisation in its own right. Because *O. alexandrae* has remained a totally protected species, with no target date in sight for its economic utilization, the Popondetta area clanspeople, who naturally seek to raise their own incomes, have become disillusioned as to the actual 'worth' of the species. To eventually permit the controlled marketing of the butterfly would then more assuredly promote its sustainability, as has already been demonstrated with the common, non-protected PNG birdwings: *O. priamus* and *T. oblongomaculatus*. It is also likely that *O. alexandrae* could be promoted as a prime attraction for the tourist industry in PNG (which might be potentially very large if future air transportation costs to, and around, PNG can be sufficiently lowered, and the present Law and Order problems of the country can be successfully combated).

Fenner (1976) estimated that experimental farming of *O. alexandrae* alone could raise revenues of about US\$ 1,120, per butterfly farmer, per annum, based on a price of circa US\$ 56 per pair of specimens if 20 pairs were sold in a year (and assuming that the world trade would be as low as 200 specimens). These estimates are now clearly too low. The species is presently selling for a market price of about US\$ 1,000 per specimen (e.g., Sakulas, 1990). Fenner's estimate of the sale of 20 pairs of *O. alexandrae* per annum are also low. If the project eventually safeguards the species, and it is finally marketed, then, based on IFTA sales figures of *O. priamus* given by Parsons (1983a), levels of about 300 specimens per annum would not be high, if

they are produced by fully supervised ranching or captive breeding methods. This would provide an annual income to the Northern Province of US\$ 300,000 from *O. alexandrae* alone, and this would, anyway, be well augmented by the sale of other species.

#### THE 1991 SURVEY

Over a two month period, from 8 April-13 June 1991, the author was contracted to carry out a distributional survey of *O. alexandrae*. Requested by the World Bank Missions (Boyer, *et al.*, 1990b; Parsons, 1990), and funded by Washington-based Conservation International (CI), it was carried out by Parsons (1991) in advance of a proposed full-scale conservation project for the species in order to provide an important update of seriously aging data on its range. The survey was prompted by a World Bank-backed National Government proposal to expand the number of smallholder oil palm blocks in the Popondetta region under its OSOPDP.

The survey was focused on those forest areas where the likelihood of locating *O. alexandrae* was considered to be higher. Restricting the survey to areas proposed for oil palm development would likely have provided only relatively few (if any) records of the species, especially in the logged-out region of the old KTA where about 50% of the new smallholder blocks are proposed. It was considered, therefore, that an update of *O. alexandrae* population data from studies of relatively untouched areas of likely-looking forest habitat, would provide a better and more valuable baseline for the future conservation of the species. Priority was also given to areas whose landowners actually extended invitations to survey their land. Such requests were taken to indicate a definite interest in the future of *O. alexandrae* and its conservation, with the implication that the chances of securing these areas of land as *O. alexandrae* reserves in the future would be higher.

During the initial phase of the survey, priority was also given to visiting the Sewa and Bapuhi (Girua-Haijo Rivers Timber Area) areas in order to survey and assess the environmental impact of timber extraction in these regions, and loss of *O. alexandrae* habitat to logging operations (see Timber Industry above). Due to its critical nature, data gathered on this was immediately made available to the National and Provincial Governments in the form of a first draft of the section of the 1991 survey report that deals with logging, copies being sent to the Provincial Office of Forestry and DEC.

#### METHOD

The method employed in the field recording and mapping of *O. alexandrae* and its *Aristolochia* larval foodplant vines was, where logistically practical, 'strip lining': walking survey areas in straight lines with teams and team members spread out to maximise ground coverage. The 1:100,000 Series topographic maps (Kokoda 8480, Popondetta 8580, Sibium 8579) of the survey area were then used to map the species using the 1km<sup>2</sup> Universal Transverse Mercator Projection (UTM) grid. Where possible, ground surveying was carried out by dividing the main team into two or three subgroups. Woodland areas were also



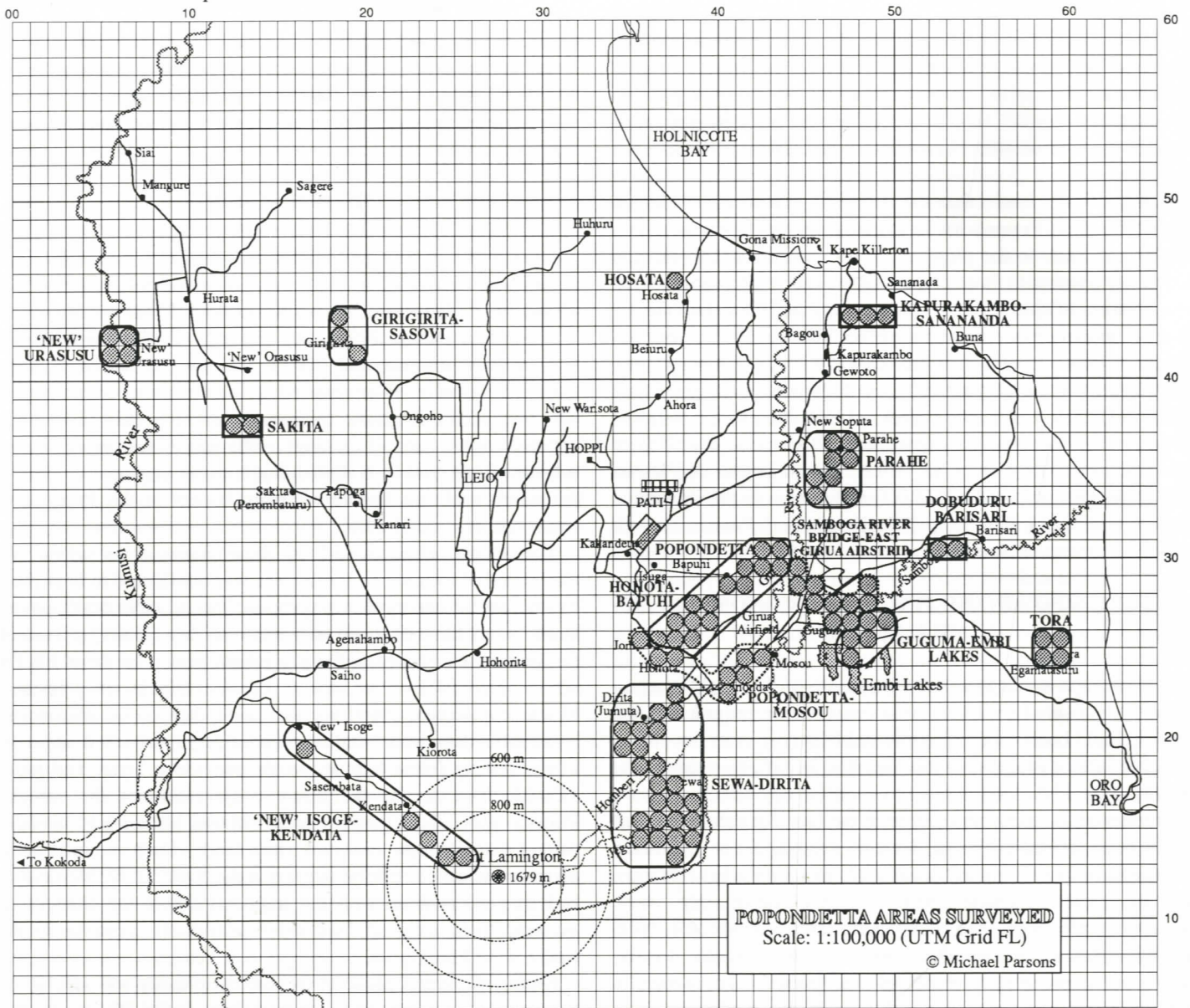


Fig. 15. Areas covered by the 1991 Survey.

entered from particular directions in order to increase coverage. In areas of denser vine distribution, surveying was carried out with greater concentration of manpower (i.e., closer survey lines). Whenever possible, all sightings of *O. alexandrae* early stages and/or adults were corroborated by a second survey team member in order to ensure accuracy. Where necessary, larvae high on vines were climbed to for confirmation.

Some areas could not be completely surveyed where they contained regions of swamp and/or dense stands of rattans or sago palms. However, these areas were anyway unlikely to be important habitat for *O. alexandrae*. On only a very few occasions (the survey period being mainly remarkably dry), rainy weather also hampered surveying. This was mainly due to the difficulty of checking vines in the gloomy conditions created by the dull overcast sky, which made it hard to sight larvae and pupae high in trees, apart from the rain which compounded the problem when looking upwards.

An Apple Macintosh SE30 computer and Imagewriter II printer

were used in the 'field' to map and print maps and survey results for immediate use. Software used included a postscript-capable (300 dpi laser printable) graphics program, and a database program, the latter used to compile and organise *O. alexandrae* records made during the survey period. Prior to arrival in PNG, the graphics program was used to draw a postscript quality base map of the Popondetta using the above mentioned Popondetta and Kokoda maps. Features on this were then amended as necessary, based on new field data and on-the-ground verification, and *O. alexandrae* and *Aristolochia* distributional data were added graphically as this was gathered (Fig. 16). The base map was also used to print out relevant sections from it, at conveniently enlarged scales, these being used as accurate sketch maps in the field for manual annotation illustrating survey details.

An opportunity afforded by HOPPL management included a brief (one half hour) aerial reconnaissance, by helicopter, of various of the areas surveyed to the north-east of Mt. Lamington. During this overflight, colour photographs were taken between



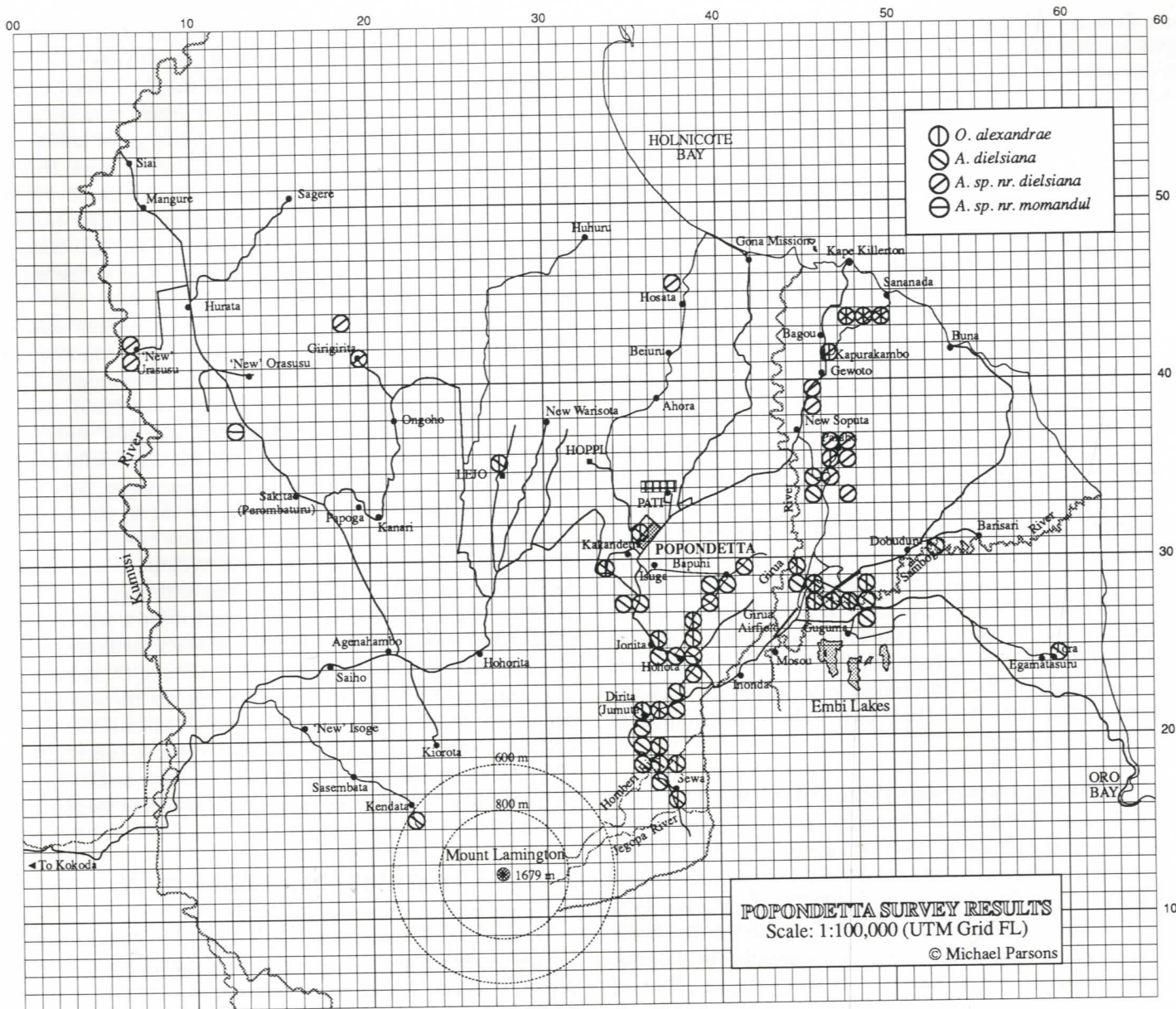


Fig. 16. Results of the 1991 Survey.

1,000-1,500 feet altitude (e.g., Fig. 10). These were later used to map certain details that were difficult to visualise on the ground, and to obtain another perspective of forest types and habitat maturity and structure.

**RESULTS**

Only a summary of the detailed results in Parsons (1991) are given here. A total of 17 main areas were surveyed (Table 1) inside 7 of which a total of 40 *O. alexandrae* were observed (23 larvae, 14 adult females, 3 adult males). Areas surveyed within the Popondetta region are shown in Fig. 15, and the survey cumulated results of the distributional records for *O. alexandrae* and its foodplants in this region are illustrated in Fig. 16.

Of all the survey areas listed above, that lying approximately midway between Kapurakambo and Sanananda is particularly noteworthy, being interesting and somewhat surprising for several reasons. Firstly, it was found to contain both species of *O. alexandrae* foodplants (*A. dielsiana* and the unnamed related hir-

Table 1. Areas covered by the 1991 survey: asterisks denote regions where *O. alexandrae* was found to be present (see also Fig. 15).

Popondetta	Kokoda	Afore
Dobuduru-Barisari	Kamondo-Kepara	Afore-Kawawoki*
Girigirita-Sasovi	Kovelo-Kokoda Trail	
Guguma-Embi Lakes		
Hohota-Bapuhi*		
Hosata		
Kapurakambo-Sanananda*		
'New' Isoge-Kendata		
'New' Urasusu		
Parahe*		
Popondetta-Mosou*		
Saktia		
Samboga River Bridge-East Girua Airstrip*		
Sewa-Dirita*		
Tora		



sute-flowered species: Fig. 2), as well as hybrids of these, all growing sympatrically. Secondly, a total of 11 *O. alexandrae* (7 larvae and 4 adult females) were located in the area (Fig. 5). This good number also reflects the ease with which those larvae which were low on the vines could be sighted, the vines anyway only being able to grow about 5-10m into the low secondary forest canopy. Thirdly, the habitat, being within only about 1km of the coast, contains typical subcoastal swamp vegetation. Therefore, the abundance of *A. dielsiana* vines (a plant not tolerant of permanently inundated soils), and presence of a good number of *O. alexandrae*, were somewhat unexpected. In fact, this represents the first record of the butterfly in a region so close to the coast. For these reasons the region, although containing rather poor habitat (in the general sense of categorising forest types), is obviously an area that is important to the overall distribution of *O. alexandrae*.

It is pertinent to mention here that a notable 'spinoff benefit' of the survey was that, for the first time in nearly a decade, extension work promoting wildlife conservation in the Province was carried out on a reasonably large scale over a very wide area. This was during the time required to discuss the project with each of the many different landowners in each survey area in order to gain their support for the project, and so gain permission to survey their land. It permitted the Provincial Wildlife Officer a level of access to four-wheel drive transport, and obviously therefore villages where educational extension work could be undertaken, that had hitherto been unavailable to him because of constant lack of funds.

#### SELECTED RECOMMENDATIONS OF SURVEY

Based on the CI funded 1991 survey, some key recommendations were made by Parsons (1991) to improve the circumstances for the conservation of *O. alexandrae*, and wildlife conservation in general. In view of the shortcomings of the present 1978 *Environmental Planning Act*, it was proposed that the Act should be improved to require *all* companies (potential or existing, Government-sponsored or private) that will have an effect on PNG ecosystems, to actually submit EPs in *advance of all such activities*. It was also proposed that the DEC Environmental Planning Section should prepare a basic information sheet that explains PNG's 1978 *Environmental Planning Act* in *simple English*. This would be distributed, *registered mail*, to the managers of all developmental projects (potential or existing) in the country. It would then hopefully improve on the ignorance of the Law pleaded by most such people, and would anyway document that development companies were actually provided with such information. It would explain clearly *who* is required to submit an EP, *what* a sufficient EP should contain (i.e. that ideally it should cover all main faunal groups, as well as flora), *how* it should be implemented, and by *whom*; and that the implementing company would be required fund such an EP (bearing in mind that the DEC and other organisations could assist in lowering the costs by supplying some of the relevant manpower and survey expertise).

Another recommendation was for the DEC to produce an educational poster, and a compact two-sided information card to promote accurate *O. alexandrae* identification and its conservation

in preparation for the proposed full-scale project. Like the poster, the information card would be well illustrated to show clearly the differences between the adults and early stages (5 larval instars and pupae) of *O. alexandrae* and two other more common birdwings in the Popondetta area: the mainly green and black, *Ornithoptera priamus*, and the mainly yellow and black *Troides oblongomaculatus*, both of which are often confused by the novice with *O. alexandrae*. The card would be fully weather-proofed for field use, using the same tough, heat-bonded, protective plastic covers that are used to laminate airline safety information cards, for example.

Parsons (1991) further suggested that arrangements should be made through the National Mapping Bureau, Port Moresby, for a new run of aerial photographs of the Popondetta region to be made. The Topographic Map of Popondetta (No. 8580), and the aerial photos from which it was drawn, are now about two decades old, and so are becoming less and less useful in this region of great biological and agricultural importance. New aerial photos would thus be highly important for use in planning any future conservation and development projects in the area.

It was also advised that the Provincial Wildlife Officer and his JICA volunteer assistant, once provided with their own 4WD vehicular transport, should begin to implement a well-planned programme of butterfly farming in areas where landowners have demonstrated a sympathy for the conservation of *O. alexandrae*, and particularly in those areas where the species has been located during the present survey. This would demonstrate to the landowners that there is actual monetary value in butterflies and other insects, and so encourage them to conserve insects such as *O. alexandrae*, whilst at the same time providing them with a wildlife-related income.

#### *O. ALEXANDRAE* ACTION PLAN

Parsons (1990) was commissioned by the World Bank to include in that report an action plan for the integration of oil palm development and *O. alexandrae* conservation. The following year the DEC requested that this should be abstracted by Parsons as a succinct and separate draft document so that it could be submitted by DEC for specific government funding through the Office of International Development Assistance (OIDA). Mr. Gerald Mwayubu (pers. comm.), of OIDA, stated that his office usually accepts the views of the implementing agencies (e.g., DEC), that OIDA supports the idea of an *O. alexandrae* Conservation Project, and that on receipt of the funding submission OIDA would commence its fund-raising procedures.

As pointed out in the introduction, re-establishment of an *O. alexandrae* Conservation Project would serve as an extremely valuable test case of the TFAP (and other) methods and logistics proposed for conservation in PNG (despite the many documented and acknowledged TFAP problems and shortcomings: Brunton, 1990). Thus experience gained from this would provide an even sounder base of experience for the establishment for similar projects to follow. It would represent the first discrete project actioned under the overall umbrella of the TFAP in PNG. As such it has been viewed by many as an ideal opportunity to set up a prime example of a joint agricultural development and



conservation project. The project would also provide a model for perfecting the methods by which the PNG Government would work together with NGOs at channelling funding to the project. Essentially it would execute activities similar to those requested of a PNG National Taskforce to study environmental planning in priority forest areas of PNG under the TFAP guidelines, but on a local and provincial scale.

The Project would have four main and mutually complementary subcomponents, as discussed below: i) a core conservation subcomponent, ii) a research subcomponent, iii) a sustainable development subcomponent, and iv) an education subcomponent. All subcomponents are considered to be equally important parts of the project and its development. However, the circumstances of present rapid agricultural development in the Popondetta area, and of the presently limited project funding, make it necessary that the identification and protection of the butterfly's habitat receives immediate attention, above all else.

### THE CORE CONSERVATION SUBCOMPONENT

*Objectives* To implement the surveying and conservation of *O. alexandrae*, its habitat, and associated supporting ecosystem, and to advise DAL, landowners, and others, on the ways of minimizing the adverse effects of development activities on the species.

This, the most critically important subcomponent, would be run by a 8-10 person team. It would address the need to focus on *O. alexandrae* habitat protection and enhancement. The Core Conservation Subcomponent would be based in Popondetta, and would be carried out for the duration of an approximately 4-6 year period. It would be aimed at mapping the present distribution of *O. alexandrae*, advising DAL on the necessary permanent conservation areas to secure the butterfly's long-term survival, as well as those areas of primary forest containing associated biodiversity. It would also pay particular attention to the socio-economic considerations affecting landowners. Further aspects of the Core Conservation Subcomponent are discussed under the following six subheadings.

#### 1. Coordination with DAL of Screening of Sites Proposed for Oil Palm

The screening of sites proposed for smallholder oil palm development which might be of particular importance to *O. alexandrae* can be achieved through four main strategies:

- i) Survey teams from the proposed *O. alexandrae* Conservation Project and OSOPDP would carry out initial field surveys together.
- ii) Based on the results of phase i), management representatives from each of the two component projects would, together, make contact with as many members of the relevant clanspeople/landowners as possible in order to discuss land usage for oil palm, or alternative methods in those areas deemed important for the protection of *O. alexandrae*.
- iii) Once an *O. alexandrae* area has been generally defined, then the conservation team would survey this in greater detail and advise the OSOPDP of possible alternative adjacent sites for the expansion of oil palm.
- iv) The *O. alexandrae* Conservation Project would provide *Aristolochia* cuttings and seedlings, and planting advice, to the OSOPDP team for the purpose of creating new habitat adjacent to those areas where the land owners choose oil palm as the main means of developing an income from their land.

#### 2. Habitat Surveys and Reserve Establishment

The Core Conservation Subcomponent requires that areas known to be important habitat for *O. alexandrae* in the past be re-surveyed, as well as the surveying of new areas. This would be carried out by the project team under the guidance of a Senior Entomologist. In line with the requirements of the 1978 *Environmental Planning Act*, priority will be given to surveying areas of primary or secondary forest within the Popondetta, Kokoda and Afore areas that are under consideration for development for oil palm, other tree crops, timber, or any other similar development projects. The survey team would subsequently extend its activities to those forested areas which are partly, or wholly undisturbed by development.

The legal establishment of a series of clearly mapped and signposted reserves would be carried out by the DEC surveyor based in its Surveys Section. The reserves would preferably be established using the 1978 *Conservation Areas Act* in order to better safeguard the selected areas. Negotiations would be held with landowners to decide new reserve areas, and discussions would be made with all villagers to enlist their help and support.

#### 3. Survey and Mapping Methods

Surveys would be carried out as outlined for the 1991 Survey above (Parsons, 1991), and as previously employed by Parsons (e.g., 1980a). Aerial photographs would be employed to ascertain forest types and to assist in planning their surveying. Those areas that are considered to be of importance to *O. alexandrae* and its foodplant will be discussed with landowners by the project, and the DEC. A questionnaire-style form would be used to conduct interviews and meetings with landowners. In this way no important questions and information would be omitted, and each completed questionnaire would stand as its own record of the meeting, especially if signed by village headmen in attendance. On the basis of these negotiations the future status of the areas would be decided (e.g., gazetted as Wildlife Management Area status, or Conservation Area status. etc.).

#### 4. *Aristolochia* Foodplants Propagation

The Core Conservation Subcomponent would gradually prepare several thousand cuttings and seedlings of *Aristolochia* foodplant vines to be planted out in *O. alexandrae* reserves. These would be produced in the project's own nursery, and that of HOPPL at its Lejo nursery (the latter assistance having already been given to the proposed project in advance by HOPPL). Some cuttings would be made from those vines known to be under threat for which there is absolutely no other option but to 'transplant' them. The making of potted cuttings, and the establishment of these in reserve areas etc., would also be implemented with the assistance and close co-operation of the Office of Forests in Popondetta, and with the assistance of the agricultural services of the OSOPDP.

It is pertinent to mention here that, in early 1991, the Lejo nursery manager noted several *O. alexandrae* larvae feeding on *Aristolochia dielsiana* vines planted in the reserve by Parsons' team in the early 1980s. The company protected area also contains several mature and very tall naturally-occurring *A. dielsiana* vines, and the Lejo reserve is obviously an important area for conservation of the butterfly. Therefore, it is heartening to record that the HOPPL management intends to extend this by



adding about 12 extra hectares of land to the northern boundary of the reserve. Further enhancement of the reserve to benefit *O. alexandrae* can be achieved through additional plantings of *A. dielsiana* cuttings, as well as a variety of rainforest tree species in open areas that will eventually provide shade and support for the foodplant vines, and eventually grow into new forest cover.

### 5. Habitat Enrichment and Creation

All areas established as reserves would be enhanced by plantings of additional vines from the cuttings and seedlings produced in the project's own nursery, that of HOPPL at Lejo, and possibly also the Provincial Office of Forestry nursery. The expansion of habitat by *Aristolochia* vine planting would also be carried out in adjacent areas, or those areas which are considered to be safe from forest clearance.

### 6. Assistance from Landowners

For those landowners owning known *O. alexandrae* habitat, and/or important areas of primary forest and biodiversity, it is obvious that extra attention in the form of extension visits must be given. Only truly effective and realistic alternative means of land use will be proposed to them. Therefore, a scheme to promote and actually enlist the help of landowners in locating *O. alexandrae*, and/or its habitat, would be implemented by an *O. alexandrae* Conservation Project. It would also financially benefit those who provide such assistance. This might be initiated on the lines of offering small monetary prizes, 'awards', or 'rewards', for landowners who provide the project with information on the presence of *O. alexandrae* and/or its *Aristolochia* foodplant vines on their land, so that this can be verified by project staff. A Reward Fund would initially be established to test this method of enhancing survey, which might greatly assist in Core Conservation Subcomponent. The rewards scheme would have the added advantage of greatly raising the awareness level of local landowners in the project.

## THE RESEARCH SUBCOMPONENT

**Objectives:** To further advance knowledge of *O. alexandrae* and its ecological requirements, in order to enhance the management procedures adopted for the conservation of the species.

The Research Subcomponent aims to enhance five main areas of understanding of the biology and ecology of *O. alexandrae*: 1. Adult vagility; 2. General mortality factors; 3. Adult usage of the primary forest canopy, and larval presence in it; 4. General foodplant relations; and 5. The possible benefits of captive populations. These areas of research are all considered to be of equal importance, but funding constraints, and the urgency of the Core Conservation Subcomponent, have obvious bearing on the relative priorities of each in relation to the overall implementation of the *O. alexandrae* Conservation Project as a whole (e.g., see section 5 below).

### 1. Adult Vagility

**Objectives:** To assess the overall movement and various activities of adult *O. alexandrae*, and to gain a better understanding of this critical dispersal phase of the butterfly's life cycle.

In order to assess the movements of *O. alexandrae* a method is required to track adults on a continuous basis from the time of eclosion from the pupa to the time of natural death. A solar-powered microchip transmitter (portable by insects as small as honey bees), which emits an infrared signal that can be detected up to a mile away, is now available. This or similar technology is proposed for use in this aspect of research.

### 2. Mortality Factors

**Objectives:** To gain a fuller understanding of the relative frequencies, and therefore the overall effects on *O. alexandrae* survival throughout its life cycle, of known, or presently unknown, predators and parasitoids, and also to ascertain the average expected life span of the species.

In order to implement this area of research the qualitative and quantitative sampling and monitoring of *O. alexandrae* under field conditions at selected study sites is required. This would permit an assessment to be made of those mortality factors (particularly, insect, arachnid, bird, reptile and mammal) which have the greatest impact on natural populations of the butterfly, as well as providing a better understanding of any critical phases of its life cycle when the butterfly would perhaps be most vulnerable to attack from specific predators or parasitoids. Such information is obviously important in considering management plans to be drawn up for the species. This area of research would also include the identification and analysis of those parasitoids and predators which have yet to be scientifically described and named (e.g., *Ooencyrtus* egg parasitoid wasps).

### 3. Primary Forest and Advanced Secondary Forest Canopy

**Objectives:** To study the interaction of adult and larval *O. alexandrae* with primary forest habitat at canopy level in order to determine the overall value of this section of its habitat to the survival of the species.

Primary or very advanced secondary forest containing large mature *Aristolochia dielsiana* vines is undoubtedly extremely important to the survival of *O. alexandrae*. The problem in the past has been in surveying this extremely high canopy, where the leaves of these vines occur, for *O. alexandrae* larvae. For this reason it is not possible to simply assume that the species will be safeguarded just because large tracts of primary forest containing *dielsiana* vines are left intact. Confirmation of this would require devising effective methods of canopy surveillance. It would include analyses of the spatial distribution of the early stages of the butterfly on the leaves of its foodplants where they sprawl throughout the canopy, and also the observation of adult behaviour in the topmost canopy, including courtship and feeding, etc.

The project would identify a suitable test plot within intact primary forest containing *A. dielsiana* species group vines in which to construct an aerial walkway complex, and associated observation platforms. These would be established immediately adjacent to the vines for the purpose of monitoring the interaction of *O. alexandrae* with its foodplants in the primary forest canopy. Furthermore, these naturally occurring vines could be augmented on site by potted *Aristolochia* foodplants hoisted into the canopy, or carried into positions alongside the platforms and walkways.



#### 4. *Aristolochia* Foodplants

*Objectives:* To study the various aspects of the intimate relationship between *O. alexandrae* and its *Aristolochia* larval foodplants.

Various topics of research would be studied under this part of the Research Subcomponent. For example, biochemical testing of the different *Aristolochia* foodplants for their different alkaloids and other secondary compounds, is needed as part of the investigation into the foodplant specificity of *O. alexandrae*. Seed germination tests would also be important to ascertain why this is usually so slow and what is main vector of their distribution (tree kangaroos, cassowaries, fruit bats etc). Vegetative propagation tests would ascertain whether cuttings could be more effectively grown than with currently used methods. The accurate 1km distribution mapping of the two or three different *Aristolochia* larval foodplant species of the butterfly would be necessary in order to determine their particular ecological preferences (soil type, forest type, etc.).

#### 5. Captive Populations

*Objectives:* To ascertain whether captive populations of *O. alexandrae* are sustainable, and whether any surplus individuals could be so produced in order to augment natural populations by their release back into the wild.

This Research Subcomponent topic would require the use of at least one very large flight cage, which would be an expensive investment. It would also require an unknown minimum of *O. alexandrae* to be taken into captivity from wild populations, which (with present knowledge) might place unwarranted stress on the overall gene pool of the species in the wild. Thus, it should be noted that, of the five research topics within the Research Subcomponent, the lowest priority would be given to that of captive population research, and this would only be implemented after successful results are obtained in the Core Conservation Subcomponent. Nevertheless, valuable data might be gained on adult hand-pairing techniques, the minimum internal volume required for such flight cages, and the best methods to obtain maximum growth rates and yields of *O. alexandrae* larvae, for example. The results of this study would also have an obvious bearing on the Sustainable Development Subcomponent outlined below, especially once the species has become sufficiently well protected to permit its economic utilization.

#### THE SUSTAINABLE DEVELOPMENT SUBCOMPONENT

*Objectives:* To develop environmentally safe, sustainable, small-scale rural income-generating (or enhancing) alternatives to plantation crops, logging activities, and other such developments, as an effective means of assisting landowners and, therefore, in promoting the long-term conservation of *O. alexandrae* and its associated ecosystem.

It is important that, besides the purely conservational aspects of an *O. alexandrae* Conservation Project, parallel projects should attempt to achieve the aspirations of the IUCN promoted World Conservation Strategy by assisting Popondetta area landowners in their socio-economic needs. The establishment of such small-scale sustainable development projects for Popondetta area landowners would require assistance from those NGOs who have

had most experience in their implementation in PNG in the past. The concept of Integrated Village Development is one of which all PNG Government departments are aware, and into which they have usually had an input in the past. For example, a Village Livestock Development Project, operating through DAL and its respective Provincial Divisions, has been planned to provide for a large increase in village livestock types and numbers between 1989-1993 (Malik, 1989).

In particular it is proposed that an excellent environmentally safe means by which landowners in the Popondetta area could develop their land, and yet still maintain areas of important forest habitat on it, is insect farming (ranching) as has been promoted by PNG's Insect Farming and Trading Agency at Bulolo for over 12 years (e.g., Morris, 1983; Vietmeyer, 1979a, 1979b, 1983). It should not be overlooked that *O. alexandrae*, once truly safeguarded, should be phased into the PNG insect trading industry so that its great economic viability will reciprocate its sustainability (see Future Sustainability As An Economically Viable Species above). To lose sight of this fact would likely mean that the future survival of *O. alexandrae* will continue to remain a matter of uncertainty.

#### THE EDUCATION SUBCOMPONENT

*Objectives:* To raise public awareness of *O. alexandrae* and its conservation needs, and the activities and objectives of the proposed *O. alexandrae* Conservation Project, in order to promote the Project, and to augment and improve its operations by obtaining help to raise project funding and/or logistical support.

The Education Subcomponent is initially aimed at teaching Popondetta area villagers at the local level that conservation is of great importance in the preservation of their heritage, and in emphasising that *O. alexandrae* is an important part of this. However, it is also intended to create a nationwide awareness in PNG of the uniqueness of *O. alexandrae* to their country, and at establishing a pride in the people's 'ownership' of the butterfly so that all concerned become committed to continue the programme of conservation on its behalf.

Educational activities would be implemented at three main levels: i) village and provincial level, ii) national level, and iii) the international level. Educational materials that have been well-trying, and which have been found to be effective in the past, would be used to assist in this, including posters, T-shirts, information leaflets and other printed media, video tapes, post cards, postage stamps, stickers, badges, souvenirs etc. These would be made use of at all levels, but particularly at the village level during extension visits. At the national level, the involvement of educational institutions in the proposed *O. alexandrae* Conservation Project would be sought and lectures and discussions would be held with students.

A priority concern of the project would be to hold educational seminars, in both the classroom and field, to teach officers of DAL, and the Department of Forests, plus also those of the logging and oil palm industries in the Popondetta area, how to identify the various early stages of *O. alexandrae* and its foodplants. This is important because these groups often send out their own surveyors and extension officers into the field. Therefore, the additional valuable man hours that might be spent



by these groups in also noting the presence or absence of the butterfly or its foodplants are presently lost to the cause of *O. alexandrae* protection merely through lack of simple and straight-forward education.

Where possible, educational extension visits to villages will be carried out during the usual habitat surveys as the help of local people is always enlisted during surveys for both diplomatic and logistical reasons. Video filming of educational videotapes introducing the *O. alexandrae* Conservation Project, and the concepts butterfly farming and general rainforest conservation, would be necessary to augment this, as would the production of T-Shirts (printed with an *O. alexandrae* Conservation Project motif) and posters to promote the project. Such items have proven extremely useful in other conservation projects in PNG (e.g., Turtle and Dugong), especially if used as incentives, or prizes, for information-gathering campaigns. Similarly, wall posters would be designed and printed for their direct use as educational items, but these could also be used as rewards to landowners (see Core Conservation Subcomponent, section 6, above).

## DISCUSSION

Study of Figs. 13 and 14 illustrating the broad extent of the existing oil palm plantations, and of the extensive logging areas within the Popondetta region, respectively, should leave the reader in no doubt that *O. alexandrae* habitat has been very seriously reduced in the region to a perhaps now critical level. Only the forests of the eastern half of the Popondetta Plain have remained relatively unaffected, yet much of these are now listed by the National Department of Forestry for timber extraction.

Despite the widely recognised World Heritage value of *O. alexandrae*, and its potential importance as an economically valuable species in its own right, not one dedicated Environmental Plan (EP) has ever been implemented on its behalf in the Popondetta region. Although an apparently good system exists to implement protection of this butterfly, it obviously suffers from inadequacies in the 'real world' of PNG today, and developers have found it entirely convenient to exploit these. The outright absence of any EPs in the Popondetta area has obviously benefitted Ambogo Sawmill, for example, as the company has enjoyed almost complete freedom to carry out logging in every area for which timber rights have been granted, with no restraints whatsoever in terms of environmental considerations (except for those laid down as general environmental rules). In actuality, therefore, Ambogo Sawmill has been able to capitalise on, and exploit, the weakness and complacency of the national and international environmental and conservation communities.

The failure to establish reserves for *O. alexandrae* within the KTA (because of the landowners ultimate decision in favour of short-term financial gain from extraction of their timber) only serves to highlight a now well known problem in PNG: that despite PNG's conservation laws (e.g., especially the *Conservation Areas Act*), the Provincial and National Governments are virtually powerless in the face of defiant landowners, many of whom may change their minds in favour of outright 'development' projects despite their apparent initial acceptance of conservation concepts.

Such a change in attitude is sometimes due to peer pressure from those clan members who are only interested in obtaining quick and easy cash returns from their forests. In particular, logging provides such cash, requiring no effort on the part of the landowners.

Apart from the biological results of the 1991 survey, demonstrating the continued existence of *O. alexandrae* over a large portion of at least the eastern half of the Popondetta Plain, a major finding of the fieldwork was to document the failure of the National and Provincial Governments (at all levels and in the various departments) to uphold the wildlife conservation laws of PNG. This is particularly lamentable considering that *O. alexandrae* represents both one of PNG's seven *National* Insects and the very *Provincial* emblem of the Oro Government.

It has been shown above that, despite the much-heralded two year moratorium on logging in PNG of 1990-1992, and despite the Barnett Commission of Inquiry Report into PNG's forestry industry (summary of report by Asia-Pacific Action Group [APAG] 1990) — nothing has changed in the logging practices in the Northern Province (which also appears to be true for PNG in general). The APAG Barnett Commission Report summary, and the World Bank report by Parsons (1990), both include summaries of the logging industry in the Popondetta area, including details of the operations of the KTC/ASPL. The APAG summary (p. 53) also specifically mentions *O. alexandrae*, noting that "The International Union for the Conservation of Nature gives the species an "E" rating (endangered taxon in danger of extinction, and whose survival is unlikely if causal factors continue operating). The main causal factor is the destruction and clearing of habitat. It is distressing that no attempt has been made to control this." The APAG summary also notes that "The original agreement for the Kumusi TRP area included butterfly protection areas but this condition was dropped along with all others as the company tried to recoup its losses. The only blessing is that the agricultural projects, that were, no doubt, equally ill-conceived and would have entailed permanent changes of habitat, also came to nothing."

As shown by the Barnett Report, commercial development companies in the forestry industry in PNG, have promoted immense corruption in PNG Government circles because of the large profits involved. Thus it is pertinent to point out that the Forestry Industries Council (FIC) Chairman, Mr. Diki Kari, noting that none of the Barnett Report recommendations have been implemented (since publication of the report in 1990) stated that it was *mandatory* for all timber operations to obtain approval of their environmental plans (EPs) by the Ministry of Environment and Conservation *before* starting up logging operations (Rea, 1991). In fact, as has been shown above, no EPs have ever been drawn up for the Northern Province, despite the focus of *world* attention on the plight of *O. alexandrae* there.

The Barnett Report also raised another very important issue, namely that of the past lack of cooperation and coordination between the Department of Forestry and the DEC in PNG. The need for this interdepartmental exchange of information was also raised on PNG National Radio during the 1991 Survey in a discussion broadcast through the programme "Talking Point", which covered the environmental aspects of the Barnett Commis-



sion Report. Like the Barnett Report, the radio panel also concluded that there is a great need for the DEC and the Department of Forestry to work more closely together in future. It was pointed out that this was to form the subject of a National Government Cabinet meeting in July 1990, in an attempt to resolve the problem.

As emphasised above, notable shortcomings of PNG's Laws, as they pertain to the conservation of *O. alexandrae*, have become particularly apparent. In particular, the 1978 *Conservation Areas Act* and *Environmental Planning Act* have failed to protect the butterfly, although they were obviously intended for such purposes. In the case of the 1978 *Conservation Areas Act*, which was established to provide for the protection of sites, lands, landforms, etc., which may be considered as part PNG's National Heritage, there has long been good cause to use this Act to benefit the conservation of *O. alexandrae*. However, according to DEC First Assistant Secretary, Mr. Guy Kula (pers. comm.), the Act has never been utilised because, under its Section 4, para. (2) (b) A National Conservation Council is required to "include at least one member nominated by the Local Government Association of Papua New Guinea". According to Kula, this prohibits the use of the Act because the Local Government Association does not exist, so that a National Conservation Council cannot be established.

Kula stated that, in order to permit the DEC to be able to utilise the *Conservation Areas Act*, the DEC must apply through the Public Solicitor's Office to change clause (2) (b) to read "Premier's Council" instead of "Local Government Association". He pointed out that the Act could then be used to declare the entire range of *O. alexandrae* as a Conservation Area, which would require that any development projects within the area would have to be fully justified and planned, compliant with the *Conservation Areas Act*, and also, therefore, the *Environmental Planning Act*. Nevertheless, it has long been realised that the land tenure system in PNG is an important impediment to the good intentions of the *Conservation Areas Act*, because, as with the *Wildlife Management Act*, it fundamentally relies on the goodwill of the relevant landowners to leave forest, or other habitats, within their land boundaries intact.

In the 1978 *Environmental Planning Act*, Section 4, para. (1), headed Submission of Environmental Plan, states that "... the Minister may, if in his opinion the [development] proposal may have significant environmental implications, serve a requisition in the prescribed form on the proponent requiring him [or her] to submit an environmental plan." Obviously, if the Minister is unaware of such a development project, or indeed is ignorant of a particular value of habitat affected, then he or she will not serve such a requisition. In other words, the DEC is obliged to 'police' the developer, rather than the onus being on the development company (or organisation, etc.) to inform the DEC of its intentions, or to prove that its actions would be environmentally benign. As pointed out by head of the DEC Environmental Planning Section, Mr. Kembi Watoka (pers. comm.), his office is under-staffed and under-funded and can, therefore, exercise little control over development companies who are determined to ignore the environmental requirements of PNG's National Constitution.

It is clear that an *O. alexandrae* Conservation Project must, of

necessity, be founded on a series of compromises arising from the fact that it is primarily the Popondetta area landowners who will dictate its ultimate success or failure. Past experience has demonstrated that the lure of short-term profits from timber or agricultural crops has proven a stronger attraction than to explore or implement the more restrained avenues of sustainable development advocated by conservation-minded organisations. The attractiveness of such economic propositions has gained particular momentum over the last few years in the Popondetta area. However, greater focus of attention in the region by NGOs representing sustainable development, by working through an *O. alexandrae* Conservation Project, would hopefully provide a much needed counterbalance to this.

Since the budget cuts necessitated by the World Economic Recession of the early 1980s, which particularly affected the PNG Government's conservation sector, there has been no entomological contingent actually working within the Wildlife Division/DEC, as there was prior to that time. This is extremely worrying since PNG's tropical fauna comprises mostly insects, and contains a large percentage of the insects which constitute the world's largest animal group (about three quarters of its total animal species). Additional concern stems from the fact that insects also provide a very important industry for the country. Therefore, an *O. alexandrae* Conservation Project would eventually serve to rectify this deficit in DEC expertise by providing valuable entomological training that would then be brought directly into the department at the termination of the project. One legacy of such a project would presumably then be a DEC team able to cope authoritatively with all such future matters of entomological conservation.

The most urgent and primary component of the project must be to reactivate detailed surveys for *O. alexandrae* and its habitat to accurately renew data on its present-day status and distribution. It must be emphasised that it is most important to ensure that all forested areas within the Popondetta area, no matter how large or small, or seemingly poorly structured, should at least be surveyed, and the results of these surveys should then be incorporated into an overall environmental plan. Even small pockets of secondary forest have been shown to support the species, so it follows that seemingly poor secondary forest areas, if planted with the larval foodplant vines of *O. alexandrae*, have the potential to mature into important areas of new habitat. This field action should be augmented by the creation of legally valid reserve areas with properly surveyed boundaries.

It is generally recognized that there is often little room for compromise between conservation and commercial development. Inevitably one side or the other must give at least some ground, and this is more often than not on the side of conservation. Peter Ellyard, Director of Environment and Conservation in PNG in 1977 wrote (in Webb, 1977) "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." An *O. alexandrae* Conservation Project may provide a means of, once again, putting the National Goals into practice.



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