THE BUTTERFLIES OF GHANA AND THEIR IMPLICATIONS FOR CONSERVATION AND SUSTAINABLE USE

Compiled for Ghana Wildlife Department and IUCN

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Introduction

This report gives a faunistic, ecological, and biogeographical overview of the butterflies of Ghana, seen in perspective of the butterfly fauna of western West Africa. It also attempts to evaluate the adequacy of the proposed system of protected areas in Ghana in relation to butterfly distributions and the presence of endemic and/or rare and biogeographically important species. Butterflies are the best studied insect group and most species have now been described. They constitute about one percent of all named insects, but most insects are still undescribed, and the 860 Ghanaian species of butterflies can be viewed as a very rough proxy for 200,000 - 400,000 other insects.

The data were been gathered during almost an entire years' research on West African butterflies as part of a wider project in the form of a comprehensive book: *Butterflies of West Africa - origins, natural history, diversity, and conservation*.

Appended to the report is the first ever *Provisional checklist of the butterflies of western West Africa and Ghana*, classified in relation to their main ecological and biogeographical categories (appendix 2). No such up-to-date list exists for any other West African country.

Most of the research and all of the figures and tables in this report are new, specifically for this study. Field research continued till 31st, January 1994. Since the table were compiled at various times during January, there are slight discrepancies in the totals.

Overview of the Ghana butterfly fauna

i) Overall biodiversity

The Ghana butterfly fauna, with 860 species, is the richest in western West Africa - i.e. the area from the Togo/Ghana border mountains to Senegal, and including the Sahel countries. This means that no less than 85 % of all species from western West Africa have been recorded from Ghana, and another 5 % will eventually be found. Only three categories are missing: i) species endemic to the wet forests of the Nimba area; ii) some interesting endemics from the drier forests west of Côte d'Ivoire; and iii) a number of species restricted to the driest parts of the open formation in Burkina Faso, Mali, and Niger.

The wet evergreen and the moist evergreen forests of Ghana are an important repository of butterfly biodiversity in West Africa, and by implication also of the biodiversity of other insects.

The following table highlights the biodiversity of Ghana butterflies in comparison with other areas around the world. Though Ghana is situated at a less complex biogeographical junction

than Kenya, the number of butterfly species is about the same as that of Kenya. The number is also about the same as for the vast territory south of the Zambesi River in southern Africa.

Butterfly numbers in Africa compared to other parts of the world

Region	Number of species
Afrotropical Region	3,600
West Africa (Nigeria to Senegal)	1,300
Western West Africa (Senegal to Togo)	1,001
Ghana (40-60 will be added) *	858
Endemic to western West Africa and Ghana	116
Of which endemic or near-endemic to Ghana	23
Zaïre	1,600
Cameroun	1,500
Kenya	880
Lake Tanganyika area, Tanzania	780
Africa South of Zambesi	870
Madagascar	360
Brazil	3,121
Costa Rica	1,543
Oriental Region	2,611
Indian Peninsula (excluding the Himalaya)	350
Malaysia	1,007
Europe	380
Denmark	60
World	18,000

ii) Ecological composition

A first attempt was made to allocate all species of the butterflies in Ghana to their primary habitat. Most of the species are also able to survive in their neighbouring habitats. The Ghana butterflies are overwhelmingly forest species as shown in table 3 in the main report; the following table is summary.

Ecological categories of butterflies in western West Africa (WWA) and Ghana.

Species that are centered on	Number	Percent
Wet evergreen forest	203	
Moist evergreen forest	242	
All forest types	219	
Dry forests	43	
FOREST CENTERED SPECIES	707	83 %
Guinea savannah	77	
Sudan savannah	37	
SAVANNAH CENTERED SPECIES	114	13 %
Ubiquitous	29	
Only special habitats	2	
UBIQITOUS OR SPECIAL HABITATS	31	4 %
TOTAL	852	100 %

Thus, more than three-quarters of all the butterflies are forest-centered, more than half on the wetter forest types. Those special to the drier forests are relatively few, while a large group seems at ease in most types of forest. However, our knowledge of which forest species are definitely absent from the wettest forests is not good, for which reason further studies at Ankasa will be made.

Only 13 % of Ghana's butterflies are savannah (open habitats) species. The Guinea savannah is not rich in butterflies, and many of the dry savannah species of the Sahel division are wholly absent from Ghana.

Only 29 of Ghana's butterflies can be said to be ubiquitous, found in most habitats all over Africa, and often beyond to Asia and the Mediterranean. Two species are associated with swampy habitats throughout the continent. This group comprises only 4 % of the total butterfly fauna, a clear-cut demonstration of how fine-tuned insects are to their specific niches. However, the 29 ubiquitous species are those most frequently seen in disturbed habitats. Virtually all can be found in the garden suburbs of Accra.

The different habitat types in Ghana have very different levels of biodiversity. A good wet evergreen forest has more than 600 butterfly species, well developed Sudan savannah only about 100. Butterfly biodiversity is closely correlated with annual rainfall as shown in the table below.

The estimated number of butterfly species present in different habitats in Ghana and the average annual rainfall.

Vegetation type	Rainfall mm	Butterfly species
Wet evergreen forest	1900-2100	630
Upland evergreen	1700-1800	600
Moist evergreen forest	1600-1700	550
Dry forest types	1300-1600	450
Guinea savannah	1000-1300	170
Sudan savannah	800-1000	100

iii) Biogeographical composition

It is difficult to summarize the complex biogeography of the Ghana butterflies, but the present composition and distribution of the forest elements in Ghana reveal a complex biogeographical history. Over time - most recently during the Quaternary glaciations - the forested area has increased and retreated on many occasions. A major key to the biogeographical history lies in the extent to which the width of the Dahomey Gap - a tongue of savannah reaching the coast in what is now Togo and Benin - interrupted gene-flow between the main equatorial forests and the wet forests of western West Africa.

The picture that emerges is, that in dry periods during the Miocene and the Quaternary the mountainous areas of the Volta Region, the Atewa Range at Kibi, and probably Tano Ofin, retained elements of the forest fauna when wholly surrounded by savannah, stretching almost from the Niger to the level of Takoradi. Thus, Ghana lies at an important junction in the dynamics of biogeography in the region, the Volta Region being exceptionally complex.

The forests of western West Africa contain at least 800 butterfly species, of which some 120 are endemic to western Africa - that is, not found west of the Dahomey Gap. More than 20 of these are strictly endemic to Ghana and, in some cases, the adjoining forests of Abengourou in Côte d'Ivoire. The present system of protected areas in Ghana is a major safeguard for a unique and interesting forest butterfly fauna in West Africa, and by extension of tens or hundreds of thousands other insects. Ghana is not only the guardian of its own precious fauna, but of that of West Africa as a whole.

iv) Endemicity

In this paper 23 species are identified as endemic to Ghana (in a few cases in combination with the extreme eastern forests of Côte d'Ivoire). This is about 2.5 percent of the total butterfly fauna, a figure that is larger than in plants, with only about 1.2 percent endemic (43 out of 3,600). I have a number of candidates for species new to science which would become further Ghana endemics, but some apparent endemics may 'dissolve' when more collecting of obscure groups has been done in western Côte d'Ivoire and Sierra Leone.

What is clear, however, is that the endemic species fall in three groups, that are genuine: 1) endemics of the Volta Region; 2) endemics of the Atewa Range at Kibi (and probably also the upland evergreen forest at Tano Ofin), and 3) the moist and wet evergreen forests of western Ghana and eastern Côte d'Ivoire. Each of these areas also have other interesting species that do not extend west of Abidjan.
By extension, if there are several narrowly endemic butterflies, there will be hundreds of other endemic insects in these three areas. These areas are, therefore, clearly deserving of special conservation interest.

Butterflies and the proposed system of protected areas

It is a pleasure to able to report that in general the existing and proposed system of protected areas in Ghana general fulfills its purpose of conserving the unique biodiversity of the region. The protected areas in the key ecological zones are sufficient in number and size to cover the main needs, always provided that their future integrity is fully assured. From my own investigations in Ghana, it would appear that a size of 200 km² is sufficient for the conservation of most insect biodiversity. At present, the Department of Game & Wildlife is doing a commendable job in preserving their domain, though selective improvements are possible.
Nonetheless, it is cause of concern that the possibility of gene-flow from reserve to reserve is fast diminishing through the eradication of forest, or even secondary forest, in the areas between the reserves. For instance, the Kakum National Park is now really isolated from similar habitats.
This concern brings into focus the network of sacred groves that exists throughout Ghana, where little pockets of original habitat have been conserved for traditional, religious, sentimental, historical, or aesthetic reasons. My own preliminary researches into sacred groves (Boabeng-Fiema, Aburi Botanical Gardens, and incidental stops elsewhere) indicate that they may retain a remarkable amount of the original biodiversity within a very small area. While this is important in its own right, the value of sacred groves as 'stepping-stones' in continued gene-flow between unspoilt forests may be high. The maintenance of sacred groves should be a real conservation concern in Ghana, though this is not within the formal brief of the Department of Game & Wildlife. Study of the biodiversity of sacred groves and their role a stepping-stones seems a must.
The analysis revealed what appear to be two major gaps and one minor gap in the protected areas' system.

Conservation gaps

The first major gap is the *Atewa Range* near Kibi. The remaining forests here are of minimum size for conservation purposes and of especial interest. They are one of the two areas of upland evergreen forest in Ghana, the other being Tano Ofin. The Atewa range has an exceptionally high degree of endemicity, a number of semi-montane species not known elsewhere from West Africa, and a very high level of biodiversity. The conservation of this habitat is of the highest importance - its tourist potential is significant, the rolling hills having exceptional beauty, and the climate being clement by West African standards.
The second major gap is the *Volta Region*. This is an area of significant endemicity and of great biogeographical complexity. It is a potential laboratory for the study of historical biogeography. But all forests in this area are fast disappearing. Protection of what remains should be a high priority.

The third gap is the *Sudan Savannah Zone*, epitomized by the Nakpanduri area and the Gambaga Escarpment. This ecological type is well conserved in national parks in Benin, Togo, Niger, Mali, and Burkina Faso, but in Ghana it is unique, and would therefore seem worthy of conservation attention.

PART TWO - INITIAL CONSIDERATIONS ON THE ECONOMIC POTENTIAL OF BUTTERFLIES IN GHANA

National conservation policies need broad political support. The establishment and maintenance of national parks demand the understanding and the cooperation of the people living in proximity of or in the parks. This implies that the national parks' system must be perceived as at least as good a use of the land as alternative uses. Increasingly, it is accepted that - up to point - conservation must pay its way, and that the people living near or in the parks must benefit directly.

Butterflies, as a renewable resource, have the potential to provide income for a number local communities. The potential must not be exaggerated, but nor should it be discounted. It has not, as part of this exercise, been possible to undertake the necessary market research and production costings for such activities. It is probable that a well-managed butterfly project could turn over $ 150,000 or more, most of which would go towards producing an income for the collectors. While this is not much seen in terms of the GNP, it would be a very large sum for a number of rural communities.

Though estimates are difficult to make, a sober 1983 assessment by the National Research Council in USA reached a figure of US $ 10 - 20 million for the worldwide butterfly trade; it would probably be higher to-day.

Sustainable collecting of butterflies

Butterfly collecting on the scale demanded by potential butterfly projects in Ghana does not pose a risk to the butterfly populations - with the possible exception of one or two very rare species that can be trapped.

First, most of the butterflies collected will be males, since this is the active sex. Many come to damp patches where they are most readily collected, but where females are never seen. Males of all species can mate several times, while females only need to mate once to fertilize all their eggs. Even if a large proportion of males were removed from the population, it is still unlikely that many females remain unmated.

Second, most of the butterflies have very large populations, though they fluctuate seasonally. Some of the more common species exist at an average density of a minimum of one per 100 m^2; in a forest such as Kakum-Attandanso this means that the population is of at least 1.7 million individuals.

Third, large parts of most of the forests are trackless and virtually impenetrable and would no be visited by collectors.

It is important that any forest products - including butterflies - are provided with labels explaining that the are products of sustainable use, designed to assist in the protection of natural habitats.

Potential types of butterfly projects

The butterflies of Ghana could potentially provide the basis for income and employment in a number of ways:

Ecological tourism is a growth sector in the low-volume high-cost tourist industry. Butterfly collecting tours are organized to many parts of the world, not least to Costa Rica and Ecuador. The fauna makes such tours to Ghana of great potential interest and I have been approached by two tour operators with a view to organizing such a tour. I would seem worthwhile to test-run a tour in collaboration between a travel agency in Ghana and one abroad. The market in birdwatching is probably larger than that of butterfly collecting.

Research activities in butterflies are an important component in biology, entomology, population biology, evolution, and other studies, not least at North American universities. Many of these are conducted at ecological field stations in Latin America. Forests in Ghana are very suitable for such studies. It is probable that one or more small ecological field stations, meeting basic criteria (electricity for computers and catering possibilities are important), could be operated at a profit. Such field stations would obviously not be limited to butterfly research. The type of structure that has been built at Boabeng-Fiema could be used partly as a field station.

Butterfly marketing can take several different guises:

1) There is a market in Europe, Japan, North America, and South Africa for good quality specimens of all species. The butterflies are stored in small paper triangles. About a thousand would fit in a container the size of a shoe-box. Certain groups of large and showy butterflies are in demand by specialist collectors and on average fetch higher prices. There would need to be technical assistance with training and with setting up the network of dealers abroad, as well as financing for the initial shipment charges.

2) The production of display boxes with large, showy, or interesting butterflies for sale to visitors to the parks, and in souvenir shops in major cities, would be relatively easy to set up. Test-marketing would quickly produce an impression of the size of the total market and the desirable price levels to maximize income to the local communities.

3) Pictures made from butterfly wings are sold throughout Africa from sources in the Central African Republic and obviously produce sufficient income to permit a sophisticated distribution system. Possibly some group of craftsmen in Ghana might be interested in the concept, initially for the local market. They are not to everyone's taste, but they would not constitute a danger to butterfly populations.

4) Butterfly houses, where large tropical butterflies are displayed live under 'natural' conditions, are becoming increasingly popular. They began in the UK, spread to continental Europe and North America, and are now flourishing also in the Far East. They have a continued need for butterfly pupae, which need to be shipped by airfreight, since the pupal stage lasts only 14 days. Butterfly houses are very competitive and take pride in displaying species that have not been 'shown' before. A steady supply source of African butterfly pupae would have an assured market.

<u>General prerequisites for success</u>:

1) There needs to be a firm management structure with adequate supervision and technical assistance.

2) There has to be a *proper marketing structure* and a balance of supply and demand, an area which many such small-scale projects have failed adequately to provide for.

3) There has to be a *stability of supply*, or the wholesalers and retailers will lose interest.

4) There has to be an *adequate level of quality control*, so that the products do not deteriorate when the level of technical assistance needed is scaled down.

PART THREE - FUTURE POSSIBILITIES

1) Pretesting of the potential of ecological tourism in Ghana through collaboration between a Ghana tour operator and a travel agency abroad specializing in such tours.

2) Building up comparative inventories of selected groups of organisms in all the national parks of Ghana, possibly partly through the use of volunteers from abroad.

3) Multidisciplinary investigations into conservation needs and opportunities in the Volta Region are urgently needed, both in the form of desk-research and field-work.

4) The extent to which sacred groves conserves biodiversity, and their actual and potential value as stepping-stones for continued gene-flow between intact ecosystems seems a very important issue deserving of study.

5) The background study for this report and its contents could form the basis for a booklet on the butterflies of Ghana as a general illustration of evolution, biogeography, and biodiversity.

6) The quality of post-cards in Ghana is generally poor, both technically and photographically. A good series of animal and plant postcards - including butterflies - might well provide a reasonable profit while at the same time emphasizing the Department's work.

PART ONE - GHANA'S BUTTERFLY FAUNA IN RELATION TO ITS PROTECTED AREAS

Introduction

No attempt has ever been made to do a complete survey of the butterflies of Ghana or to relate them to the prevailing ecological conditions. The most detailed single list dates back almost exactly 100 years and records only 150 species (KARSCH 1895). The main sources on African butterflies (AURIVILLIUS *in* SEITZ 1925, D'ABRERA 1980, CARCASSON 1981) usually only give broad ranges without definite statements as to whether or not a species has been recorded in Ghana, and with no ecological details at all. The attached *Provisional checklist of the butterflies of western West Africa and Ghana* (appendix 2) is thus the first of its kind, and it classifies each species according to its main habitat and its general distribution in Africa.

A somewhat outdated list - to which I contributed 25 years ago - does exist of Nigerian butterflies (CORNES 1969, 1971, CORNES, RILEY, & ST. LEGER 1973). FOX *et al*. (1965) list the butterflies of Liberia, but their material was surprisingly limited, with only 420 confirmed species (300 'probable species' were also listed); thus, I have personally collected 525 of the 860 species in Ghana while working on this report. No complete list exists for any other West African country, though certain groups of Sierra Leone butterflies are relatively well studied (OWEN & OWEN 1972, 1973, BELCASTRO 1986, 1990).

During the past 35 years the African butterfly fauna has been the subject of extensive revisionary work with the result that published information from earlier in the century is often be difficult to interpret. A large number of type specimens were inspected in order to ascertain the correct allocations.

In order to develop the attached *Provisional checklist of the butterflies of western West Africa and Ghana* a considerable amount of background research was therefore required. Virtually all published information and taxonomic revisions dealing with West Africa were screened, yielding an initial list of about 650 species. In addition about 75 full days were spent collecting in various parts of Ghana on three separate visits. About 40 days were spent in a number of institutions studying significant collections from Ghana. The most important of these was the *Allyn Museum of Entomology* in Florida which has a collection of 16,000 Ghana butterflies, collected over 32 years by Father Theodor Maessen. *The Natural History Museum*, my base in London, also houses a significant amount of material Ghana, mainly from the colonial period. Visits were also paid to the *Carnegie Museum* in Pittsburgh which houses important collections from Liberia, and to the *National Museums of Kenya* in Nairobi which has an extensive holding of butterflies from Côte d'Ivoire and Nigeria. The collection at University of Ghana, Legon was also scrutinized. Also screened were a number of private collections as well as my own Ghana field notes from a visit in 1971.

The result of the field and museum research was the addition of 200 species to the known fauna of Ghana, bringing the total to about 860. A number of erroneous records were also eliminated through this process. Another 50 - 70 species are to be expected (and are marked as such in the check-list), while a modest number of new species remain to be discovered (about ten are being processed as part of my main research project).

It would have been preferable to write this report two years from now, based on additional study and more field-work in different parts of the country. The deadline did not permit this. However, the results are based on almost an entire year's work on the butterflies of West Africa with a special focus on Ghana, including more than 75 days' of field-work in the main ecological zones of the country, the Sudan savannahs of the northeast excepted. However,

further field research will refine the conclusions of this paper and conclusions will be published in appropriate journals as my West African butterflies research project progresses.
The checklist of Ghana butterflies was continually updated till January 31st, 1994, while the various tables were compiled at various points during January. There are very slight discrepancies in totals from table to table because of this. The total list of Ghana butterflies stood at 858 species on January, 31st, 1994.

Butterflies and insects in general

The number of butterflies in the world is about 18,000 (LARSEN 1991), representing perhaps 1 % of all known and described insects. We have no definite information on whether the proportion of butterflies to all insects is the same throughout the world, nor on whether their biogeographical and ecological patterns are parallel.
We do know that most butterfly species have been described (probably more than 95 % of the total in West Africa), while only a fraction of other insects have (estimates range from be from 15 to 45 % of the total - I would tend to support the lower levels). It is therefore not unreasonable to believe that the 860 butterfly species in Ghana serve as a rough proxy for more than 200,000 - 400,000 other insects.
Though each insect order has its own evolutionary history, there is every reason to believe that any area with butterflies of special interest will also have hundreds of other interesting insects, mostly undescribed. Thus, areas with endemic butterflies almost invariably have endemics in other insect orders and areas with high butterfly biodiversity will also have high biodiversity in other orders.

Numbers of butterflies

Africa as a whole has about 3,600 species of butterflies (Lepidoptera, Rhopalocera). Very few of these are truly ubiquitous. The distribution of most is limited, geographically as well as ecologically. Thus, only just over 1,000 are found in western West Africa (WWA), i. e. west of the Dahomey Gap, a salient of savannah country which divides the forest zone of WWA from the Nigerian forest zone. An additional 300 species, not found west of the Dahomey Gap occur in Nigeria, chiefly in the forests and mountains east of the Niger River. The fauna of West Africa as a whole is about 1,300 species. Nigeria, west of the Cross River contains a mixed fauna of both western and central elements. Cameroun, Congo, Gabon and the western parts of Zaïre forms a distinct biogeographical region.

Table 1. Butterfly numbers in Africa compared to other parts of the world

Region	Number of species
Afrotropical Region	3,600
West Africa (Nigeria to Senegal)	1,300
Western West Africa (Senegal to Togo)	1,001
Ghana (40-60 will be added) *	858
Endemic to western West Africa and Ghana	116

Of which endemic or near-endemic to Ghana 23

Zaïre	1,600
Cameroun	1,500
Kenya	880
Lake Tanganyika area, Tanzania	780
Africa South of Zambesi	870
Madagascar	360
Brazil	3,121
Costa Rica	1,543
Oriental Region	2,611
Indian Peninsula (excluding the Himalaya)	350
Malaysia	1,007
Europe	380
Denmark	60
World	18,000

Sources: Afrotropical (ACKERY *et al*. 1994); West Africa, WWA, Ghana (this paper); Kenya, Zaïre, World, Brazil, Costa Rica, Oriental Region, Malaysia (LARSEN 1991); Cameroun (LIBERT 1992); Lake Tanganyika (KIELLAND 1978);

Of the thousand species found in western West Africa (WWA), no less than 860 are known from Ghana, and another 50-60 may be expected once the wetter forests of western Ghana have been studied in more detail. As will be seen, those missing from Ghana are chiefly endemics of the Nimba mountains subregion and species of the driest savannah zones.

The composition of the Ghana butterfly fauna

Table 2 below compares the Ghana butterfly fauna with the fauna of the Afrotropical Region. Though containing only a quarter of all the species, the structure of the Ghana fauna is not markedly different from Africa as a whole.

Table 2 The composition of the butterflies of western West Africa (WWA) and Ghana by families and major subfamilies, compared to the Afrotropical Region as a whole.

Family	Afrotropical region		western West Africa		Ghana		Ghana in % of Aftrop.
Papilionidae	87	2%	27	3%	27	3%	31%
Pieridae	173	5%	57	6%	46	5%	26%
Lycaeninae	1473	42%	359	36%	282	33%	19%
Riodininae	14	0%	2	0%	2	0%	14%
Libytheinae	3	0%	1	0%	1	0%	33%
Danainae	19	1%	6	1%	6	1%	31%

Satyrinae	298	9%	50	5%	47	5%	16%
Charaxinae	187	5%	53	5%	49	6%	26%
Apaturinae	2	0%	1	0%	1	0%	50%
Nymphalinae	562	16%	192	19%	166	19%	30%
Acraeinae	199	6%	39	4%	39	5%	20%
Hesperiidae	478	14%	213	21%	189	22%	40%
TOTAL	**3493**	**100%**	1000	100%	855	100%	24%

SOURCES AND NOTES: Afrotropical region after LARSEN (1991) (based on ACKERY, et al., in prep.); WWA and Ghana from present paper.

The Lycaenidae are somewhat under-represented, but they are proportionally under-represented everywhere, since there are numerous species with very limited ranges, as well as a significant amount of endemicity in South Africa, especially the subtropical zone. The Satyrinae are similarly under-represented, especially because of many endemic species in South Africa and on Madagascar. The Hesperiidae are genuinely over-represented and this is because the Hesperiidae are very strongly developed in the West African forest zone and in Cameroun.

Ecological composition

Insufficient study has taken place in western West Africa to allow for precise details of the ecological composition of the butterfly fauna. CARCASSON (1964) analyzed the total African butterfly fauna using as the main ecological - as opposed to biogeographical - divisions: *forest species* and *open habitat species*. Many forest species show distinct preferences for different forest types and their associated climatic conditions, deserving of a more detailed study. However, for the purposes of this study, it is necessary to adopt a relatively simple approach. Each species in the checklist has been allocated to one of the following categories:

WEF - species linked to wet evergreen forest habitats limited to southwestern Ghana, many of which also penetrate the moist evergreen forests.
MEF - species which are linked to evergreen forests in general and which also penetrate the wet evergreen and the wetter semi-deciduous forests.
ALF - species which survive in most types of forest habitats and often penetrate the Guinea savannah and agricultural lands.
DRF - species which are linked to the drier forest types and which may penetrate into the Guinea savannah.
GUI - species which are linked to Guinea savannah and other open woodland.
SUD - species which are linked to the dry savannah habitats.
UBQ - ubiquitous species, found under nearly all conditions, and often in disturbed habitats.
SPE - species with special habitat requirements such as swamps.

It will be seen in table 3 that the butterfly fauna of WWA is strongly centered on the forest zones (85 %). Though biodiversity in general is at its highest in the wet forests, butterflies may well be relatively overrepresented compared to other groups of insects, though the necessary comparative data are not available. However, there are 6 - 7 forest butterflies for every savannah species; the ratio in total numbers of plants is certainly less than this, being closer to

2 - 3 forest plants for each savannah plant (judging from various figures given by SCHMITT (1993)).

Notable is also the low representation of the Sudan savannah species, many of which are found only in the Sahel division and do not extend as far south as the 1000 mm rainfall of northern Ghana.

The relatively low representation of the species centered in dry forests is mainly due to a certain amount of endemicity in such formations in Guinea and Senegal, where dry forest conditions have led to the evolution of new species, since they could not retreat to wetter forests further south. Without these, nearly all the dry forest species of this group are in Ghana.

Table 3 Ecological categories of butterflies in western West Africa (WWA) and Ghana.

Ecological category	WWA		Ghana	
	number	%	number	% of WWA
WEF - wet evergreen for.	251	25	203	81
MEF - moist evergreen for.	291	29	242	83
ALF - all forest types	221	22	218	99
DRF - dry forests	58	6	43	74
GUI - Guinea savannah	87	9	77	86
SUD - Sudan savannah	55	6	37	67
UBQ - ubiquitous	29	3	29	100
SPE - special habitats	4	-	3	75
TOTAL	996	100	852	85

Source: Provisional checklist as appendix 2

The table above is based on primary habitats. Most of the forest species are found also in the neighbouring zones, relatively few being linked strictly to a single zone (see also table 3 below). Nonetheless, it is possible to develop a list of indicator species for undisturbed primary habitats. Some selected examples are given in the next section.

Ecological indicator species

Butterflies are relatively mobile organisms and partly therefore often have wider distributional ranges than less mobile insects. They all have their ecological preferences, however. Some are tolerant of even relatively severe habitat disturbance, others are not. The lists below include a limited number of conspicuous species that are indicator species for each of the main habitats in good condition. If two-thirds of these are present in a given locality, it can be taken as a good, relatively undisturbed example of the habitat in question, especially if the indicator species of severely disturbed habitats are missing, or largely so. Thus, I recently examined four large samples of randomly collected butterflies from four successional stages in a Cameroun forest without finding a single indicator species of disturbed habitats.

Some indicator species for the wet evergreen forests
Papilio antimachus
Papilio zalmoxis
Graphium tyndaraeus
Pseudopontia paradoxa
Ornipholidotes larseni
Ornipholidotos onitshae
Ornipholidotos perfragilis
Charaxes hadrianus
Charaxes nobilis
Bebearia arcadius
Katreus holocausta

Some indicator species for the moist evergreen forests
Papilio sosia
Graphium latreiilanus
Nepheronia pharis
Pentila petreia
Ornipholidotos kirbyi
Hewitsonia boisduvalii
Euphaedra francina
Euphaedra zampa
Katrus hollandi

Some indicator species for the dry forest formations
Graphium almansor
Graphium adamastor
Graphium agamedes
Nepheronia thalassina
Belenois hedyle
Pentila pauli
Liptena septistrigata
Bicyclus funebris
Pardaleodes incerta

Some indicator species for the all forests category
Papilio dardanus
Papilio menestheus
Nepheronia argia
Leptosia alcesta
Euphaedra medon
Euphaedra ceres
Celaenorrhinus galenus
Andronymus caesar

Some indicator species for the Guinea savannah
Charaxes lactetinctus

Charaxes northcotti
Bicyclus angulosus
Neptis morosa
Caprona adelica
Astictopterus abjecta
Parosmodes morantii

Some indicator species for the Sudan savannah
Pinacopteryx eriphia
Colotis vesta
Colotis ione
Colotis eucharis
Colotis danae
Dixeia doxo
Junonia orithyia
Sarangesa phidyle

Indicator species of severe disturbance in the forest zone
Papilio demodocus
Catopsilia florella
Eurema hecabe
Colotis euippe
Belenois creona
Appias epaphia
Mylothris chloris
Iolaus ismenias
Lampides boeticus
Euchrysops malathana
Danaus chrysippus
Charaxes epijasius
Hamanumida daedalus
Hypolimnas misippus
Junonia oenone
Junonia terea
Acraea eponina
Acraea pseudegina

Butterfly diversity in Ghana

With nearly 860 species of butterflies confirmed, and a probable total of just over 900, Ghana has the richest butterfly fauna known from western West Africa, though probably closely followed by Côte d'Ivoire. Kenya, with its much more complex biogeographical positioning, has 870 (LARSEN 1991). The vast expanse of Zaïre has 1,600 (BERGER 1981, LARSEN 1991). However, Cameroun on its own has 1,500 species (LIBERT 1992), mainly because of its biogeographical positioning. The region of Cameroun/Congo/Gabon constitutes an evolutionary centre in its own right, and in addition has a significant penetration of species from both West Africa and the main equatorial zone (see also table 1).

The richest area of the Oriental tropics is Malaysia with a butterfly fauna of about 1,100 species, but most of the Oriental Region has fewer butterflies than Ghana. Thus, the entire Indian Peninsula (south of the Ganges), with habitats ranging from semi-desert to rainforest and montane grasslands has only about 350 (LARSEN 1987/1988).

The number of butterfly species present in different habitat types varies strongly. Data from Ankasa, Kibi, Kakum, Volta, Kogyae Nature Reserve, and Boabeng-Fiema in Ghana, and various localities in Nigeria permit an estimation of total species richness in various habitat types.

Table 4 The estimated number of butterfly species present in different habitats in Ghana.

Habitat	Number of species	Percent of Ghana total
Wet evergreen forest	630	73 %
Upland evergreen forest	600	70 %
Moist evergreen forest	550	64 %
Dry forest types	450	52 %
Mildly logged wetter forests	600	70 %
Secondary growth/cocoa/clearings	400	47 %
Wholly cleared forest land	80	9 %
Guinea savannah	170	20 %
Sudan savannah	100	12 %
Wholly cleared savannah	70	8 %
Ghana Total fauna	858	100 %

Source: Extrapolations from studies by the author in Ghana (LARSEN 1993 and unpublished) and Nigeria (CORNES & RILEY 1971, LARSEN *et. al*. 1980) as well as general information.

The figures for each vegetation type is much higher than in table 2, which related the fauna to *main* habitats of the species involved. Many species cover several vegetation types, and species from the dry forests and the all forests type spill over into the more wooded parts of the Guinea savannah. One gap in our knowledge is which species are genuine absent from the wettest forests, absence being more difficult to establish than presence. I plan continued work in Ankasa on this issue.

The figures in the table above are estimates. No forest type in West Africa has been comprehensively surveyed over a long period of time. The highest actual figures on record are about 460 for Kibi in Ghana (unpublished), 381 for a secondary bush locality near Lagos (Agege) (LARSEN *et al*. 1980), 376 for the Gambari Forest Reserve near Ibadan in Nigeria (RILEY & CORNES 1971), and so far just over 400 for Kakum, Ghana (the latter through my, singlehanded, collecting activities over 30 days of field work (unpublished)). One small hill near Yaoundé in Cameroun has yielded 700 species over a long period of study by several collectors (LIBERT, pers. comm.), but the Cameroun fauna is exceptionally rich.

A number of forest butterflies are very sensitive to any changes in their environment and seem to disappear as soon as there is logging or other interference. However, the presence of roads and artificial clearings, are beneficial to some species, especially the ubiquitous species for which virgin forest is the most difficult habitat. Open spaces also support more grasses with the result that certain groups of Hesperiidae and Sytyridae become more abundant. The impression is that slight interference, provided that virgin forest is also present, may actually enhance biodiversity, but there is no experimental evidence. What is clear, however, is that the presence of roads and artificial clearings make the study of biodiversity of most orders easier.

Table 5 Numbers of butterflies in relation to rainfall, the chief determinant of vegetation types.

Vegetation type	Rainfall mm	Butterfly species
Wet evergreen forest	1900-2100	630
Upland evergreen	1700-1800	600
Moist evergreen forest	1600-1700	550
Dry forest types	1300-1600	450
Guinea savannah	1000-1300	170
Sudan savannah	800-1000	100

Sources: Numbers of butterflies from table 3; rainfall data from Survey of Ghana (1968) isohyets.

In table 5 the data from table 4 are correlated with the average rainfall of the areas in question. As shown in figure 2a, butterfly numbers decline rapidly with the amount of rainfall, in what appears to be a an almost linear manner. The very low numbers for the sudan savannahs, however, compared to the East and South African savannahs, are also a reflection that the savannah butterfly fauna of West Africa is not rich. I have found up to 120 species in a single locality in Botswana at 700 mm rainfall, and the total comes to 250 in all of Botswana (200 - 800 mm) (LARSEN 1992).

Rarity of Ghanaian butterfly species

It is not easy to assess the absolute rarity of butterflies. They are often both seasonal and local. Even rare species have occasional population explosions in a single locality. To give a single example, I saw more specimens in the field of the rare *Abantis leucogaster* during one month in a secondary forest/agricultural area at Agege, north of Lagos than are present in all museums that I have visited during the past 25 years; I never personally met with the species in the field before or after this experience.

In the checklist, I have nonetheless coded each species according to rarity, based on the numbers available in museum collections and my own field experience. The values given are for the status in West Africa. Some species are more common in West Africa than in the equatorial unit; in other cases the converse is true.

I am somewhat surprised at the symmetry with which this classification came out. The number of species that are very common or very rare is small - less than 10 % of the combined total. The species that are rather rare or relatively common comprise almost half of the species. The group classified as 'not rare' contains a mix of species, some of which are rather poorly known. The very rare and rare species may be underestimated. Many are very distinctive and would have been preferentially collected by the - often - very discerning amateurs who were responsible for most of the material now in public collections.

Table 6. The relative rarity of the butterflies of Ghana.

Rarity category	Species	Percent
RR - very rare in collections, few or none even in major collections	28	3%
RA - rare, possibly few or at most a dozen in most major collections	187	22%
NR - not rare, but unpredictable, local, may be common, often absent	362	42%
CO - common, usually present in any collection from appropriate habitat	209	25%
VC - very common, always present in the appropriate habitat	54	6%
XX - uncertain status, mainly complexes recently revised	13	2%
TOTAL	853	100%

A quick check was done on this classification in relation to the species that I have personally found in Ghana.

Table 7. Proportion of species personally collected in Ghana by rarity category.

Rarity category	Ghana total	Found by me	Percent found by me
RR - very rare	28	6	21 %
RA - rare	187	55	29 %
NR - not rare	362	219	60 %
CO - common	209	192	92 %
VC - very common	54	50	93 %
XX - uncertain status	13	2	15 %
TOTAL	853	524	61 %

There is a slight circularity in the table above, since the definition of rarity is partly based on Ghana data, including my own collecting experience, but the table does validate the broad categories of rarity given in table 5. It should be mentioned that three of the very common species that I have not personally collected are restricted to the Sudan savannah zone, which I have not yet visited.

Butterfly biogeography in Ghana

a. The forest zone

The southern half of Ghana lies in the tropical forest zone which stretches from Sierra Leone to western Kenya, being most extensive in the main equatorial zone covering the Congo basin. West of eastern Sierra Leone and east of Zaïre, the forest zone begins to fragment into savannah/forest mosaic. The westernmost tropical forests are those of the Basse Casamance in Senegal, the easternmost those of Kakamega and the Mau Escarpment in western Kenya. The forests of western West Africa (WWA) are currently isolated from the central forests by a band of savannah reaching the coast in western Togo and Benin, the Dahomey Gap.
The flora and fauna of the forest zone have a common ancestry, but is it possible to identify a number of distinct geographical evolutionary units:

Western West Africa - stretches from Sierra Leone to the Volta River. Of the 1,000 butterflies in WWA, about 120 are endemic, only a few crossing the Volta River. It is possible to identify two subunits within WWA. One is centered on western Ghana and eastern Côte d'Ivoire (Ghana division), the other on the Nimba mountains of Guinea, Côte d'Ivoire, and Liberia (Nimba division). There is also some endemicity in the drier forests west of Sierra Leone, presumably in response to dry climatic conditions, hostile for the forest fauna. It is notable that there is virtually no endemicity at the level of genus, and none at tribe or subfamily level. Some species that evolved in WWA have crossed the Niger to reach Nigeria and Cameroun, but they are difficult to separate from those that reached WWA from Cameroun.

Volta region - the area between the Volta River and the unbroken savannah belt of the Dahomey Gap has apparently always retained some forest, even during periods of maximum desiccation. It has a peculiar species-composition which will be discussed in more detail later in the report.

Western Nigeria - mostly west of the Niger, but also to some degree east of the Niger, seems to be an area where considerable shuffling and reshuffling of faunal elements have taken place with climatic change. It has a modest endemicity as well as an unpredictable mixture of western and equatorial elements.

The Cameroun/Congo/Gabon unit - forms the richest evolutionary unit as far as butterflies are concerned, with at least 1,500 species in Cameroun alone. Species from this zone have reached WWA during periods when the Dahomey Gap was not a biogeographical barrier. This unit includes the Mayumbe and parts of northwestern Zaïre. It also includes a small montane fauna in the Cameroun mountains, allied to the East African montane zones.

The equatorial unit - covers the main Congo basin, the classical rainforest, and has about 1,600 species of butterflies. To the east it is bordered by the Kivu and Ruwenzori Mountains, which

have acted as a filter and barriers for the relatively depauperate lowland forest fauna of Kenya and Uganda.

The eastern unit - covers Uganda and western Kenya in a forest/savannah mosaic well differentiated from the main equatorial unit. The species number is not as large, but the levels of endemicity are higher than in to other zones, because of the Ruwenzori filter.

The montane sub-units - are found on the Cameroun Mountains, in Angola, central Africa, Ethiopia, and East Africa, but this formation does not occur in West Africa. Traces of montane fauna and flora can be found in the upland evergreen forests of Ghana and in the Nimba Hills.

b. The open habitats

The northern parts of Ghana lie in the zone of the open habitats, comprising two types of savannah. Various savannah habitats occupy the entire area of Africa between the forests and the desert (rainfall of less than 250 mm annually). There are two types in Ghana:

The Guinea savannnah - stretches in a broad belt between the forest and the drier savannah formations of the north, and occupies most of northern Ghana. On rocky soils and along river patches of, impoverished, occur; many hardy forest butterflies penetrate quite far into the Guinea savannah. A limited number of butterflies are peculiar to the Guinea savannah, and they usually range all the way from Senegal to northern Kenya, sometimes being found in Guinea savannah homologues also south of the main equatorial forest (e.g. the Miombo woodlands of Angola and Shaba.

The Sudan savannah - stretches in a wide band from Senegal to Ethiopia and northern Kenya, with the homologous, but more diverse Somali savannah on the Horn of Africa. The northern part of the dry savannahs comprises the Sahel division. Only the northeastern corner of Ghana belongs to this zone, and the Sahel division is absent.

Compared to the woodlands and savannahs of the Somali zone and eastern and southern Africa, the butterfly fauna of the West African open habitats is poorly developed and with very low endemicity, and that mainly in Sahel species.
The main biogeographical regions of West Africa are shown on figure 3.

c) Analysis

Table 8. below assigns all Ghana butterflies to a distributional category based on the broad divisions given above.

Table 8. The rough distributional categories of Ghana butterflies

Biogeographical category	WWA number	Ghana	Ghana % fauna	% in
AAF - all Africa in suitable habitats	123	119	14.0	96.7

SAA - Sudan savannah species throughout Africa	28	22	2.6	78.6
SAE - Sudan savannah species only to Ethiopia/Kenya	24	13	1.5	54.2
WWT - all tropical forests, including the EA coast	48	44	5.2	91.7
WWU - all forests to Uganda and western Kenya	318	289	33.9	90.9
WWZ - all forests, excluding Uganda and Kenya	96	83	9.7	87.4
WWC - all forests to Cameroun/Congo/Gabon	131	106	12.4	81.5
WWN - West Africa to the Nigeria/Cameroun border	77	68	8.0	89.5
WWE - endemic to western West Africa	94	47	5.5	50.5
GEQ - Ghana subregion to the equatorial unit	15	15	1.7	100.0
GCA - Ghana subregion to Cameroun/Congo/Gabon	10	10	1.2	100.0
VEQ - Volta to the equatorial unit	5	5	0.6	100.0
VCA - Volta to Cameroun/Congo/Gabon	8	8	0.9	100.0
END - Endemic and near endemic*	23	23	2.7	100.0
TOTAL	1000	852	100	85.5

* a list of endemic species is given later; they fall in three groups: 1) wet forests of Ghana and eastern Côte d'Ivoire, 2) Atewa Range, and 3) Volta Region.

It will be seen from table 5 that the bulk of the Ghana butterfly fauna has a wide forest distribution in West Africa and beyond. About 20 % are found in suitable habitats throughout Africa, and more than 30 % are found throughout the main forest zone from Sierra Leone to Uganda or western Kenya. A further 10 % are found from Sierra Leone to Zaïre. Figures of this magnitude clearly show that the Afrotropical forest zone, despite its subdivisions, constitutes a readily recognizable entity.

About 12 % of the forest butterflies are found from Sierra Leone to the Cameroun/Congo/Gabon unit, mostly representing species from this zone which have crossed when the Dahomey Gap did not constitute a barrier. However, 8 % of Ghana's butterflies are West African species that are also found in Nigeria, having crossed the Dahomey Gap, but not reaching the Cameroun/Congo/Gabon unit.

However, no less than 93 species are endemic to WWA and a further 23 endemic to Ghana, a total of 12 % of the entire WWA fauna. It is notable that the WWA endemics fall into two groups - the Nimba and the Ghana subregions each have about half of the WWA endemics.

The division between the two subregions of WWA is also demonstrated by the 25 species found only in the Ghana subregion and in the Cameroun/Congo/Gabon unit or beyond, and not extending into the Nimba subregion at all.
Though small in numbers (13 in all), the groups of species extending from the equatorial or the Cameroun/Congo/Gabon units only to the Volta Region and not beyond are significant, showing the biogeographical complexities of the Volta area.
In many cases West African endemics are vicariants of similar species occurring from Nigeria to Cameroun or to equatorial Africa. Since the ranges of vicariants by definition do not overlap, it may be quite difficult to decide whether such vicariants should be considered two species or well-differentiated subspecies. A good example is *Bicyclus sangmelinae*, found from Guinea to the Togo/Ghana mountains, being replaced by *Bicyclus mesogena* from eastern Nigeria to western Kenya.
In a few cases, the ranges of what must once have been vicariant species overlap in Ghana. One example is the pair *Bicyclus zinebi* - *Bicyclus iccius*. Such cases could provide the basis for interesting research on their specific requirements and isolation mechanisms.

Butterfly endemicity in Ghana

Endemic species are those that occur only in a given, defined geographical area. The term can be used at all levels, ranging from *macroendemicity* (only in the Afrotropical Region), to *regional endemicity* (only western West Africa (WWA)), or *microendemicty* (only found in a single spot or small area. The levels of endemicity of a country within political borders, which from an evolutionary viewpoint are wholly artificial, are thus somewhat artificial, though they still say something about the uniqueness or otherwise of the fauna and flora.
In defining the endemic butterflies of Ghana, I have included 'near' endemics, such as species also occurring both in the Togo and Volta mountains, or species found only in Ghana and the eastern forests of Côte d'Ivoire (east of roughly Abidjan). The list below comes to 23 species, about 2.5 % of the total fauna, compared to the 12 % that are endemic to WWA as an evolutionary unit.
While the number of butterfly endemics in absolute terms is not large, it must be remembered that for each endemic butterfly, there must be hundreds of endemics in other insect orders.

<u>Butterflies endemic to Ghana</u>

Papilio maesseni is a large Swallowtail, closely related to the widespread *P. zenobia*. It is limited to the Volta Mountains in Togo and Ghana. I would have considered it a modification of *P. zenobia*, were the genitalia not different (Hancock 1988). Hecq (Lambillionea, 1975) says it is sympatric with *P. zenobia*, but I do not think this is the case.

Mylothris atewa belongs to a large, taxonomically complex, genus of tropical forest butterflies. It is one of the few species where both sexes can be recognized at a glance. It is known only from the Atewa Range at Kibi and almost certainly is found nowhere else.

Telipna maesseni is a very distinct species known only from the Ghana side of the Volta Mountains, though it doubtless occurs in Togo as well. It is sympatric with two of the three other Ghanaian members of the genus and is not closely related to the third, *T. rothi.*

Tetrarhanis sp. nov. is a small species that I caught at Kakum. The species-group is taxonomically difficult and identification depends on the examination of the male genitalia. It is probably endemic to the wetter forests of Ghana and eastern Côte d'Ivoire.

Micropentila mamfe was collected by me in 1971 near Mamfe, in a Cocoa plantation with strong tree cover. It has not been seen since. The group to which it belongs consists of very scarce species, and it is most closely related to one known only from Sierra Leone. It is probably endemic to the wetter forests of Ghana and eastern Côte d'Ivoire.

Micropentila sp. nov. a pair collected by father T. Maessen near Likpe in Volta is related to the Nigeria *M. fuscula*, but appears to be a valid species, almost certainly limited to the Volta area.

Spindasis lutosa was described after a single specimen in poor condition collected at Aburi more than 100 years ago. None has been seen since, and it may have been an aberrations of another species, though the descriptions does not really match anything else.

Iolaus theodori is very similar to *I. lukabas* which is found west of the Volta and in western Nigeria, but which has not been recorded from Volta. Several characters make it quite certain that *I. theodori* is specifically distinct, and it is almost certainly a Volta endemic.

Iolaus sp. nov. is very similar to *I. menas* from the savannah zone and is known only from the Volta Region, where the two species are sympatric. It is almost certainly a Volta endemic.

Deudorix sp. nov. is known from a single male collected by father Maessen on the Atewa Range at Kibi. It is probably closest to *D. lorisona*, but the underside is dark brown. No-one with the slightest knowledge of West African butterflies would be in doubt that it was something of the utmost interest and it cannot have been overlooked elsewhere. It would appear to be endemic to the Atewa Range (I caught a male of what might be this species at Kakum in January, 1994).

Cupidesthes sp. nov. is known from a single male from Kibi collected by father Maessen. All species in the genus are rare or very rare, and it may occur elsewhere. However, it is certainly an endemic of WWA, and it may well be an endemic of the Atewa Range.

Anthene aurea is known in one specimen from Begoro, collected last century, and seems allied to the equatorial *A. pyroptera*. It belongs to a group of rare and local species, and may be found elsewhere. However, it is certainly an endemic of WWA, and it may well be an endemic of the Atewa Range.

Anthene helpsi was collected on the Atewa Range at Kibi by Major T. G. P. Helps on three occasions in late 1992 and early 1993. A single specimen would have been held to be an albino of *A. scintillula*, a rare but widespread forest butterfly, also occurring at Kibi. All members of the genus are bright orange, but *A. helpsi* is a light cream, with no gloss. Examination of the genitalia shows it to be quite distinct from *A. scintillula*. The species is so distinctive that it cannot have been overlooked elsewhere. It is probably a genuine endemic of the Atewa Range.

Bicyclus maesseni is a genuine endemic of the Volta Region. It replaces the fairly common *B. ignobilis* which is found in the rest of Ghana and from western Nigeria to the equatorial zone. It was described as recently as 1973. The structural characters (genitalia and androconia) make

its specific status quite certain, and the case is exactly parallel to that of *Papilio maesseni*, already discussed. This kind of encapsulation of and allopatric species, with the parent species both to the east and to the west is most unusual.

Cymothoe aubergeri is a very distinctive butterfly, described as recently as 1977, from Abengourou in Côte d'Ivoire, near the Ghana border. I found it also at Kakum. It is certainly an endemic to wetter forests of western Ghana and eastern Côte d'Ivoire.

Junonia hadrope is a very distinctive butterfly only known from Ghana. The type locality in the original description was 'Ashanti', but in 1847 that could have meant anywhere roughly near the present Ghana. All material that I have seen (thirty specimens from six or seven collectors) with adequate data are from Volta Region, except for one from near Tafo in the collections at Legon. The closest relative is *J. westermanni*, also found in Volta. I strongly suspect it should be considered a Volta endemic, despite the Tafo record.

Acraea kibi was described as recently as 1986 after series from the Atewa Range at Kibi. The foremost specialist of the large genus *Acraea* belives it to be only a subspecies of the rare *A. kraka* (Cameroun and Kivu). It is, however, almost certainly endemic to the Atewa Range in WWA, and is almost a montane element.

Celaenorrhinus sp. nov. exists in only two males, one from the Atewa Range, the other from a forest near Takoradi. The species keys in with *C. homeyeri* in the main review of the African Hesperiidae, a species Carcasson (1981) reports it from West Africa; I have not been able to pin down on which authority, but I am sure it must have been the present species which has nothing to do with *C. homeyeri*. It is certainly an endemic to wetter forests of western Ghana and eastern Côte d'Ivoire.

Ceratrichia maesseni appears to be yet another species that is special to the Ghana subregion on the WWA forest zone. It has been found in several localities, sometimes sympatrically with its closest West African relative *C. argyrosticta*. However, the species is more closely related to *C. mabirensis* from Uganda and western Kenya.

Osmodes maesseni has been caught both in the Kibi area and the Volta Region. It is difficult to tell from the rare, but widespread *O. adon* and may eventually be found not to be a Ghana endemic.

Paracleros maesseni is one of four members of a difficult complex. It has been found only in the Volta Region, but since its discovery is recent (1975) and examination of the genitalia is necessary to be certain of the identity, it may have been overlooked elsewhere. However, Berger (1978) emphasized it was the largest member of the genus and he would systematically have examined all large specimens from Ghana. I have taken none that appear to be this species.

Caenides stoehri is an extremely scarce butterfly known only from the Volta Region, the holotype being collected about 1892 in the German colony of *Deutschwestafrika* and further specimen in the 1960s from Likpe, Volta by father Maessen. It is possible that *Caenides volta* is the same species; it has been found in Volta and near Kumasi. However, the species is on present evidence endemic to Ghana.

Fresna maesseni has only been found in Volta Region by father Maessen, where it is sympatric with its close relative, *F. netopha*. It is most distinctive and almost certainly a genuine Volta endemic.

A few additional species are under review which may turn out to be Ghana endemics, but they belong to complex genera where it may take some time to determine their exact status. Two species that I found at Kakum, and one from Ankasa, appear to be new to science.
Collecting in western West Africa has not been as intensive as might be desired, and this report, *par force*, had to be written before I could examine several large, unpublished collections and undertake more personal field work. In evaluating the endemic species, it must be remembered that 'absence of evidence is not always evidence of absence'.

Centres of endemicity

Nonetheless, it is clear that three groups of endemic species emerge - those of: 1) the Volta Region, 2) the Atewa Range, and 3) the wetter forests shared with eastern Côte d'Ivoire. Several species in each group are so distinctive that I have no doubt that the endemicity is genuine. This will be discussed in more detail later in the report from a conservation standpoint. The importance of these three areas is further confirmed by the presence of several other very rare species, with at most a patchy distribution in WWA.
The proportion of endemic butterflies, 2.5 %, is somewhat higher than that of endemic plants, of which 43 species are accepted by Schmitt (1993), out of a total flora of 3,600 species (1.2 %).

Butterfly biodiversity and size of conserved areas

A very important issue in conservation is: How small is small? What is the minimum size of protected areas to give some guarantee that biodiversity is conserved? The answer will almost certainly differ from group to group. The necessary studies have not been made as far as butterflies are concerned, but some inferences may be drawn.
Extinction of individual breeding populations of butterflies and subsequent re-colonization is a well-known fact. However, re-colonization is only possible if there are other populations within colonizing distance. The colonizing power varies from species to species, but even in apparently feeble species, it is probably stronger than usually assumed. Nonetheless, the increasing fragmentation of the forest habitat in West Africa, and the increasing degradation and deforestation of intervening areas raises questions.
As far as butterflies - and probably other insects - are concerned, indications are that areas of 200 km² are more than adequate. The forests of the Atewa Range (less than 200 km²) show no sign of having lost butterfly biodiversity. My own investigations of Kakum (207 km²) indicate that the full butterfly fauna is still intact. The Ankasa/Nini-Suhien complex is thus probably more than adequate with an area of 500 km² in good condition.
However, a very interesting aspect of conservation in Ghana is the existence of various types of 'sacred groves'. These are small areas of natural vegetation, protected by local communities, for historical, religious, or sentimental reasons. They deserve conservation attention for two reasons:

1) as biodiversity repositories in their own right; and 2) as stepping-stones assisting the maintaining gene-flow between populations in major reserves that are now otherwise isolated.

I have had the opportunity of studying briefly two such sacred groves, the Boabeng-Fiema Wildlife Sanctuary and the Aburi Botanical Gardens. The extent of residual forest in both is very small, but the number of butterfly species remarkably high. I noted 135 species during two days at Boabeng-Fiema (twice the entire butterfly fauna of my native Denmark), indicating a total of at least 300, and possibly more (LARSEN 1993). The fauna when this area was part of an extensive forest would have been a maximum of 450. Four days at the Aburi Botanical Gardens yielded 165 species, though the little remaining forest is even more degraded than at Boabeng-Fiema. I would not be surprised if the total at Aburi came to 400 species. In both cases it means that 60-70 % of total biodiversity in butterflies (and probably other insects) has been conserved in a tiny, rather degraded area.

The sacred groves are clearly deserving of conservation attention, especially as traditional beliefs and taboos weaken, and as pressures for agricultural land increase. Though never an easy process, the type of collaboration between the Department of Game & Wildlife and the local communities in Boabeng and Fiema provides a model for the future.

Structured research into the value of sacred groves as a repository of biodiversity is a must, both in assessing their value as 'stepping-stones', and as part of the answer to question: How small is small?

Butterflies and proposed nature protection areas in Ghana

The major conclusion that can be drawn from this detailed study of the butterflies of Ghana is that the proposed system of protected areas adequately cover the main needs demonstrated by butterflies on grounds of their ecology, biodiversity, endemicity, and biogeographical origins. This probably means that most other insect orders are also well covered, though it must again be emphasized that we know little about how well butterflies function as indicator species of the entire invertebrate fauna. The pattern may not be the same for all orders, especially arid-adapted groups such as certain Orthoptera, Coleoptera, and Diptera.

The Ankasa/Nini-Suhien protected areas are not very large, but they are in good condition, and given the very small area of Ghana covered by the *wet evergreen forest* zone, they form a good proportion of the total. With a joint total of about 500 km², they are almost certainly sufficiently large to avoid more than a marginal amount of biodiversity loss. There are essentially similar ecosystems in Côte d'Ivoire under protected status. The Ankasa/Nini-Suhien areas are the only ones under protection by the Game & Wildlife Department. It is essential that every effort is made to afford maximum protection; the EEC appears interested in collaborating with Ghana on this, which would be most welcome. I believe that the Forestry Department also has some forests in this zone that are in relatively good condition; it would be useful if the best of these could be conserved without excessive logging.

The *moist evergreen forest* is mainly catered for by the Kakum/Assin-Attandanso and Bia protected areas, and the Kakum National Park. All appear large enough to avoid any major loss of biodiversity in butterflies and in insects in general. During a total of about 50 collecting days, I have - on my own - collected more than 400 species of butterflies at Kakum. The protected areas are rather small compared to the total area, but there is also an appreciable amount of forest under management by the Forestry Department.

The *drier forests* of the belt that forms the transition between the wet forest zone and the Guinea savannah are not well represented within the protected areas system. While it does not have many special butterflies, it is potentially a very important area for ecological studies on the transition between the forest and savannah zone. Kogyae Nature Reserve and the Digya National Park do contain this type of forest, but more as a forest/savannah mosaic than as a true transition belt. There are also many forests in this zone under management of the Forestry

Department; I am not certain of their conservation status. Within this zone lies some small isolated forests; the Boabeng-Fiema Wildlife Sanctuary is one of the foremost examples. This tiny forest (0.15 km² of true forest, though the gazetted area is larger) seems to have maintained a significant amount of its former biodiversity. Small, intact, isolated forests in the transition zone are natural laboratories for the studies of biodiversity and conservation. They need maximum protection.

The *Guinea savannah* (tall grasslands in some terminologies) is very well catered for by the Kogyae Nature Reserve, the Digya National Park, the Mole National Park, as well as the Bui National Park. The main role of the Guinea savannah in butterfly ecology is effectively to cut off the forest zone from the Sudan savannahs through the paucity of larval food plants for the true Sudan savannah butterflies (the relevant Capparaceae and the Mimosaceae are poorly represented or absent). Much of the Guinea savannah is now heavily transformed by agriculture. The main effect of this is to allow for the southwards spread of Sudan savannah elements to areas where they were previously absent. At least in butterflies, this seems to be happening with few negative effects on the original fauna - the most evident being lesser penetration of the forest fauna into the savannah zone than would previously have been the case.

The extreme northeast of Ghana, and pockets elsewhere in the north, fall into the true *Sudan savannah zone*. About 30 Ghanaian butterflies are effectively limited to this zone, and more may be found. They are mainly Pieridae feeding on Capparaceae and Lycaenidae feeding on Mimosaceae, but with a smattering of members of other families. Most are common elsewhere in West Africa and have adequate protected areas in northern Togo and Benin, as well as in Burkina Faso and Niger. The forestry Department has areas of Sudan savannah apparently in good condition (most of the butterflies I have seen come from Nakpanduri and Gambaga). Though not important on a regional scale, the Sudan savannahs of the northeast are unique for Ghana, and may merit protected status on those grounds.

There are two unique plant zones in Ghana, in the form of the *southern marginal forest* and the *coastal plain* with short grasslands. Both are very small of area, but remarkably rich in endemic plants. The areas are largely too small to have supported the evolution of special butterflies, but the large skipper, *Pyrrhiades lucagus* is mainly found in and around the southern marginal forest. It is found from Guinea to Ghana, but only occcasionally inland. It may be significant that *Pyrrhiades* is the only genus endemic to West African coastal areas. In the Shai Hills, the population of the Sudan savannah Pierid, *Belenois gidica*, has a female that seems monomorphic in a rather unusual form; elsewhere it is very variable. It may have evolved into a distinct subspecies since the nearest record to the Shai Hills is from Nakpanduri in the Sudan savannah. Apart from a population in the Volta Region, I know of *Leptosia wigginsi* in Ghana only from the Shai Hills forests; there are so few records of the species from WWA that the significance of this is uncertain. These species are well protected in the Shai Hills Resource Reserve.

The general conclusion, therefore, is that the present and proposed system of protected areas in Ghana is adequate for fulfilling the purpose of maintaining the important habitats of Ghana and their biodiversity, as demonstrated by butterflies. Most of the protected areas were defined and/or gazetted before independence, but they have been maintained and added to during the 35 years of independent Ghana - though there were real threats to their continued conservation at various times.

Analysis of the butterfly fauna does indicate two major gaps, and a minor one, in the system of protected areas, which need to be addressed. They are two areas of great biodiversity and significant endemicity: 1) the Atewa range at Kibi, and 2) the forests of the Volta mountain region on the Ghana/Togo border; 3) additionally, consideration may be given to having an

area of Sudan savannah in the northwest under formal conservation. These will be the topics of the three following sections:

Conservation gaps - the Atewa Range, Kibi

The Atewa Range at Kibi consists of a rolling set of forested hills with bauxitic soils. Their altitude of just over 700 metres allows them to get more precipitation than the surrounding moist semi-deciduous forests (1750 mm compared with 1550) and the bauxitic soils may be more water retentive. The forest is of the upland evergreen type of Hall & Swaine (1981) which even contains a few montane elements such as brambles (*Rubus*). The Tano Ofin area appears to have the same vegetation and, probably, butterfly fauna. The area covered by these two forests is only 292 km². Its continued conservation is of the highest priority.
The butterfly fauna is extremely rich. During a few days of personal collecting I recorded 200 species (I once noted 155 species in 20 hours. In all I have seen or found references to 460 species, even though several common and widespread species are not on the list. This is certainly the largest number of species yet recorded from a single small forest anywhere in West Africa. The eventual total will be around 600 species.
The endemic species, already listed, are potential objects for the study of evolutionary processes and time-frames. *Acraea kibi*, for instance, has its closest relative in the Cameroun highlands. *Anthene helpsi* is the only white species in a complex of orange species. In addition to the endemic species, Kibi is also home to other extremely rare species, often those with montane tendencies (*Acraea althoffi, Abantis ja*). It also has many of the high-value species sought after by collectors, including the largest African butterfly, *Papilio antimachus*.
Its scientific value apart, the rolling forested hills are of exceptional natural beauty, and in places there is access through abandoned logging roads (which should be kept open since they allow canopy species to be found lower down). The area has a considerable tourist potential, not least because the altitude makes the climate more pleasant.
I understand that the Forestry Department has decided to place the remaining Atewa forests under some level of protection. They may deserve upgrading to an upland forest national park, but the important thing is their complete protection.
A multidisciplinary investigation of the forest at Tano Ofin would appear to be a priority, since this is the only other major area of remaining upland evergreen forest.

Conservation Gaps - the Volta Mountains.

The Volta Mountains, now forming the border between Ghana and Togo, have a significant degree of endemicity in butterflies, a very rich fauna, and an extremely complex biogeographical history. We are fortunate in having very good data from the Volta area since about 12,000 butterflies from there, systematically collected by father Theodor Maessen between 1940 and 1970 are avilable at the Allyn Museum of entomologically in Sarasota, Florida.
However, entomological work in the area goes back more than a hundred years with the publication of numerous new species from the *Bismarcksburg*, *Adelihöhe*, and *Misahöhe* during the shortlived German establishment of *Deutschwestafrika*. As a result the type species of many African butterflies, and other insects, are from this area.
The butterflies of the Volta Region have the following interesting and special characteristics:

1) The number of known species is larger than for any other area of similar size in Africa, except for the Cameroun rainforests. Almost 600 species have already been recorded, despite

the fact that true wet evergreen forest is not present. The species richness is in part due to nature of the vegetation which is a forest/savannah mosaic, allowing the savannah elements to penetrate further south than elsewhere in Ghana. However, much of the richness is also due to the biogeographical complexity of the region.

2) The Volta region has a number of forest species that are otherwise only found east of the Dahomey Gap and which do not cross the Volta River.

3) As already mentioned, the Volta Region has a number of endemic species which must have evolved when the Dahomey Gap was wider than it is today, and when the mountains managed to retain forest cover while wholly surrounded by savannah. Among the most interesting endemics are *Papilio maesseni* and *Bicyclus maesseni*; they evolved into distinct species and their 'parent' species have not been able to reinvade the area.

4) The Volta Region of a number of species which are indicators of wetter conditions than the present. Africa's largest butterfly, *Papilio antimachus*, is the best example. These are species that were marooned in the Volta Region at the time of the latest dessiccation, possibly Holocene, and which have managed to survive by adapting to habitats considerably drier than their normal ones.

5) Nonetheless, most of the species limited to the wet evergreen and upland forests have not crossed the Volta, and there is a near absence of endemics to WWA - except, of course, of those that are endemic to the Volta Region.

6) Finally, the Volta Region has the westernmost outliers of some species of the savannah formations, previously thought to be wholly East African (*Anthene wilsoni* and *Neurellipes gemmifera* are the most outstanding examples).

The Volta butterflies appear more biogeographically complex than plants (Hall & Swaine 1981) and mammals (Booth 1958), but the mammals are few and the flora possibly more complex than previously thought. At any rate, the butterflies are clearly in part relics of one or more complete linkages between the western forests and those of Nigeria, while speciation has taken place in periods when forests were maintained within a much wider Dahomey Gap.

There is a long tradition (e.g. MOREAU 1952) that the most important events in the history of the West African fauna are very recent, and linked to climatic variations during the Pleistocene. I suspect the WWA forest zone has been a separate evolutionary unit for much longer than that. Recombinant mitochondrial DNA analysis of the Volta Region endemics would shed light on this issue. It is my intention to prepare a more detailed paper on the biogeographical complexity of the Volta butterfly fauna in the near future, with more precise comparisons with neighbouring areas.

The forested areas of the Volta Region are apparently fast disappearing and steps should be taken to conserve some of those that remain. At least until the 1970s, *Papilio antimachus* was present on the mountain near Amedzofe, and some of the most interesting species were found along riverine forests and near the small waterfalls of the region. However, I have only briefly visited the Volta Region and cannot make any precise recommendations beyond the fact that the butterfly fauna is of exceptional interest.

The mountain ranges, the highest in Ghana and among the highest in West Africa, are of great scenic beauty. There are many small sites of special beauty, such as waterfalls and isolated hills. Because of the altitude, the climate is more pleasant than in the surrounding lowlands.

The potential for developing a tourist industry is present. This potential will be much enhanced by the conservation of remaining forests.

Conservation gaps - the Sudan savannah

The Sudan Savannah habitats of the extreme northeast do not seem to have major areas under strict protection, though some areas are under the Forestry Department. From a West African perspective their conservation in Ghana is not very important since most of the national parks in northern Nigeria, Niger, Mali, and Burkina Faso covers this vegetation type. Butterfly numbers are low, and there is virtually no species with restricted distributions. But, from a specific Ghanaian perspective this does mean that one interesting biogeographical zone, of limited extent in the country, is not under the present protected areas system. I have not been able personally to visit the northern parts of Ghana, but I understand that there are well-conserved Forestry lands in the Nakpanduri area and on the Gambaga escarpment. It should be mentioned that some authorities (particularly Rose Innes 1967. 1977) consider the northeastern corner of Ghana to be derived Sudan savannah rather than original vegetation; however, both the flora and the butterfly fauna are quite distinctive.

The three areas of special conservation interest are shown in figure 4.

PART TWO - INITIAL CONSIDERATIONS ON THE ECONOMIC POTENTIAL OF BUTTERFLIES IN GHANA

Introduction

It is becoming increasingly accepted - some would say fashionable - that wildlife and wilderness must pay its way if long-term conservation efforts are to succeed in the face of population growth and alternative needs for land (see the excellent review by ADAMS & MCSHANE 1992). If the local population benefits from the protected areas' system, they will take a hand in protecting it. If not, a state of confrontation between the local population and conservation efforts may ensue.
Most such activities will have the additional advantage that more people will regularly visit the various protected areas, leading to a greater degree of supervision.
I have not been able to do in-depth research into these aspects as part of the present contract, so what follows are some general considerations placed in the context of the Ghana situation. More detailed feasibility studies are necessary before action can be taken.

Butterflies and ecological tourism

Ghana is trying to develop a tourist industry without having major tourist attractions on the scale of the historical sites of the Mediterranean, Egypt, India, or Mexico. Though interesting, and with potential for development, the coastal forts are relatively minor attractions on a global scale. The beaches of the area are often very good, and prices could be held relatively low, especially compared with Côte d'Ivoire. The friendly people of Ghana and the taste of the 'real Africa' in a region which few people have visited is the main selling point to tourists from abroad, but the local tourist market should not be underestimated.
Ecological tourism is becoming an increasingly important sector of the high-value tourist trade and should be encouraged. Among the main target groups for ecological tourism are people who wish to see the various ecological zones of Africa, birdwatchers, collectors/photographers of insects (butterflies, moths, and beetles being the most popular), and perhaps amateur botanists. It is interesting to see that M & J Travels in Accra already have a (short) specific ecological tour on their programme. In Ecuador, Brazil, and Belize this kind of tourism has resulted in the establishment of hotels at or in forests; in some cases hotel owners in the Amazon have actually purchased and are protecting their own patches of forest, now sometimes standing as islands as the clearfelling of the forest has proceeded apace. There are at least 50 travel agencies in the UK alone organizing birding tours - at prices between UKL 2000- to 4000- for two to three weeks.
There should be no objections on ecological grounds to allowing butterfly collecting. The numbers of visitors involved would be relatively small, and only a small area of any of the forests is readily accessible. The *Kenya Wildlife Service* have a policy of issuing collecting permits, except to commercial collectors (Leakey, pers. comm.). Only the large-scale trapping of *Charaxes*-species may need monitoring, especially in the case of one or two rare and local species (*C. hadrianus* and *C. nobilis*), but even these possibly considered rare because they are shy of the usual traps.
As far as butterflies are concerned, I have already had two offers to conduct butterfly collecting tours to somewhere in West Africa (one from Florida, one from the UK), especially to an English-speaking country with a rich fauna. Ghana meets these criteria excellently, except that the tourist infrastructure outside of Accra, Cape Coast, and Kumasi is still inadequate. The fact

that West Africa is a difficult place for the single tourist without much time, makes the tour option particularly attractive.
Such tours would normally be based on a total of three weeks out from the point of departure for 12-20 participants, with visits to three or four different localities, and a few days of general sightseeing. A Ghana programme might take in Kakum, Owabi, and Mole, but Ankasa can be reached from Takoradi. If hotels were available in or immediately at forests, longer-term single visitors with special interests might also be attracted.
Both bird-watchers and entomologists need good access to the forests and some areas of open view, which implies that old logging and access roads should be kept open. Byskov (1993) emphasizes that the old logging road at Kruwa Camp was one of the best observation areas he worked in when compiling his list of birds. The road going north from the southern edge of Ankasa is ideal, as are some of the logging and prospecting roads on the Atewa Range. Access to many other parts of a forest like Kakum is otherwise difficult in the extreme.
Consideration should be given to testing a butterfly-collecting and a bird-watching tour in collaboration between foreign tour operators and a local travel agency (perhaps taking in Kakum, Owabi, Kibi, and Mole).

Butterfly research potential

Butterflies are much valued as study objects in biological, ecological, population dynamics, evolution, co-evolution, and other research. A glance at the Royal Entomological Society Symposium Proceedings on (VANE-WRIGHT & ACKERY 1984) is a graphic illustration of the scope of such research. With the growing conservation movement and the increasing emphasis on biodiversity and its determinants, research interest in tropical areas is stronger than ever - and it is, of course, not limited to butterflies.
Field research stations in suitable tropical forests can attract researchers from both abroad and from Ghana, and provide for the protected areas' system with income, research findings, and the added protection of the permanent or semi-permanent presence of concerned observers. It can also assist in securing additional funds for the management of the protected areas' system by demonstrating its importance as a research base.
The ecological research stations at Lamto and the Taï National Park in Côte d'Ivoire are two examples from West Africa. A small hostel in Kenya's Kakamega Forest is almost permanently booked by researchers, despite very limited facilities. There are well appointed field stations in Panama, Costa Rica, and the Wau Institute of Ecology in Papua New Guinea has been used by hundreds of researchers over more than 25 years under the aegis of the Bishop Museum in Honolulu.
The establishment of such centres in conjunction with donor funding of developments (such as CEDECOM at Kakum and potentially the European Union at Ankasa/Nini-Suhien) might be explored. Provided a reasonable minimum of comfort is available, such a centre might well eventually function under private sector management as a going commercial concern. Minimum comfort would include working space, basic accommodation, electricity for light and computers, storage space for equipment between visits, basic cooking and cooking facilities, and reliable transport to and from convenient access points in the respective forests. The emphasis should be on adequacy and reliability, rather than on luxury.

Butterfly marketing potential

There are a number of ways in which butterflies can be turned into small-scale income-generating activities. They all share a number of characteristics which will be discussed before the various potential activities are briefly outlined.

The basic attraction of such projects is that they would use wildlife as a renewable income-generating activity that could benefit the people living in close proximity of, or within, the protected areas system. The need for tangible economic benefits to the local population from protected areas has been forcefully advanced as a key to long-term conservation efforts by ADAMS & MCSHANE (1992).

There is no risk at all to the butterfly populations, with the possible exception of very rare and local species of *Charaxes* which can be trapped, and even that is not certain. Generally the butterflies that be involved are males collected when they come to visit damp patches, which means that almost all are males (some species of *Graphium* in museum collections have a ratio of 100 males per female, though in nature the sex-ratio must be 1:1) Most females are mated very soon after hatching and can complete their entire egg-lying process with the stored sperm from a single mating. The males of virtually all species, not least the showy swallowtails that are in most demand, will mate several times, and the chance that any females remain unmated, even when a significant proportion of the males are taken out of the population is slight (New 1991). A project in Ghana would involve, perhaps, 50,000 - 100,000 specimens a year - to put this figure in perspective, I have seen a single butterfly migration in Botswana involving at least 1.5 billion individuals (LARSEN 1992).

A number of estimates have been made as to the global extent and value of the 'butterfly trade'. CARVALHO & MIELKE (1971) though that more than 50 million butterflies were used every year in Brazil, mainly the huge, brilliant *Morpho* (my estimate of sales value based on recent observation in Brazilian markets, if this were true, is $ 100 million). COLLINS & MORRIS (1985) thought the global butterfly trade reached a level of $ 100 million. These figures seem impossibly high, and an estimate by the National Research Council (1983) of $ 10-20 million seems more realistic, though it might be higher today.

It would be wrong to exaggerate the potential for the 'butterfly trade' in Ghana, but it should also not be dismissed. A well-managed enterprise might well be able to turn over $ 150,000 or more, involving the use of about 50,000 - 100,000 butterflies a year, depending on the type of use. While this is not a large sum by the standards of the GNP, it would be a very substantial sum for a group of communities in rural Ghana.

Such projects would have the additional advantage of producing flexible employment and some income for local people in rural areas. I have already mentioned that some of these activities might take place at the Boabeng-Fiema Wildlife Sanctuary (LARSEN 1993), but the communities at the fringes of Kakum National Park would also be suitable, and the provision of technical assistance simpler.

Setting up such projects, however, would not be easy, and in the initial phases a high degree of technical assistance and supervision would be needed. Some obvious prerequisites are given in the next paragraph.

Before embarking on any such projects it will be necessary to additional research on the demand, dealers, practicalities, and local capacity for the production of appropriate boxes.

<u>General prerequisites for success</u>:

1) There needs to be a firm management structure with adequate supervision and technical assistance. The most likely framework would be within an existing organization with

experience and skills in community-based income-generating activities. It may also be run as a commercial business after being established.

2) There has to be a *proper marketing structure* and a balance of supply and demand, an area which many such small-scale projects have failed adequately to provide for.

3) There has to be a *stability of supply*, or the wholesalers and retailers will lose interest.

4) There has to be an *adequate level of quality control*, so that the products do not deteriorate when the level of technical assistance needed is scaled down.

i) Collecting and breeding for sale of specimens

There is a market for specimens in good condition of all West African butterflies. The specimens need to be caught, killed, placed in simple paper triangles, dried, and then conserved in tightly closing boxes with some naphtaline or paradichlorbenzol (mothballs) as protection against ants and other insects.
Sales prices to wholesalers abroad are probably in the range of $ 0.50 - $ 0.75 a piece for consistently high quality samples, consisting not only of very common species. Costs, apart from the airmail packages are negligible, apart from time spent.
Many of the desirable species come to artificial baits, patches of urine, or to wet sand on the banks of streams, and are therefore easily collected. Other need to be netted by walking along streams.
Training local people in collecting, killing, and storing butterflies is not difficult. The necessary materials can be procured for $ 5.00 - $ 10.00 per participant to start them off.
The major issue is setting up equitable contacts between the local collectors and wholesalers in the main markets in the USA, Japan, and Europe. In the type of societies where such a project would operate, it would also be necessary provide finance for shipping the first shipments and assistance with the banking connection needed for receipt of money from abroad.
Dealers I have personally visited in Singapore and Kuala Lumpur estimated that at any given time they had 850 of the 1,100 or so Malaysia/Singapore butterflies actually in stock, and a number of 'difficult' requests made by me were immediately met. The species had in general been correctly determined according to Fleming (++++). Such sophistication would not yet be possible in West Africa, if only for the reason that, in the absence of any determination books, only specialists can determine most of the butterflies. The same seems to be true in Taiwan, which I have not visited.
Nonetheless, there is clearly a very real possibility for providing employment for a few communities adjoining the national parks.

ii) Sale of display cases, etc

A further possibility is the sale of display cases of butterflies caught locally, in glass covered display cases. Species suitable for use in display cases need to be species that are especially large, beautiful, colourful, or interesting. Since the potential buyers will usually have no special interests, there is no point in using rare species for display cases. A large number of common butterflies in Ghana, some of which may be trapped or collected when assembling at damp patches, are available for this purpose. The aim must be to include in each box a varied cross-section of butterflies.

The specimens should be labelled with the correct popular and scientific names, and each box should have a statement that they: *This display case is the result of sustainable use of the Ghana National Parks, collected and presented with the approval of the Department of Game & Wildlife, in the interest of showing the diversity and beauty of Ghana's natural heritage.*

I would envisage two or three box sizes, with different types of displays, ranging from:

1) small boxes with a single spectacular butterfly,
2) larger boxes with a selection of showy butterflies,
3) larger boxes with a deliberate representation of all the butterfly families in Ghana,
4) larger boxes with special interest, such as mimicry and camouflage.
5) boxes including other spectacular and interesting insects.

It should be possible to find a manufacturer in Ghana who could produce the necessary boxes locally, but the climate does demand that they be of high quality and have adequate protection against moulds and pests.

iii) Butterflies in decorative art

Butterflies are used for 'decorative' mosaic pictures sold in major cities throughout Africa. Among the motifs are women carrying baskets on their heads or babies on their backs, and I have seen a very skillfully designed parrot. Though they are not to my own taste, they have an appeal to some people, and I have frequently seen these pictures both in African and expatriate homes in various parts of the continent.

Irrespective of where they are sold, they all seem to come from the same group of manufacturers in the Central African Republic. Their representatives actually travel as far as Botswana to peddle them to the souvenir shops. Each involves the dismemberment of not more than six or eight butterflies, mainly the green *Graphium*, *Belenois*, *Appias* and other Pierinae, *Eurema*, black *Charaxes*, and a sprinkling of other common species. The species-composition clearly shows that they have been collected or trapped at damp patches in disturbed areas and not from intact forest, and that each specimen is used judiciously and not profligately.

Nothing is known about the scale of this industry (the three major hotels in Gaborone sell no more than one or two a week each), but 20,000-30,000 sales a year seems an outside maximum; there are probably 100 sales outlets in all of Africa, selling 2 or 4 a week). Thus, at the very most, a quarter of a million common butterflies are involved per year, though it would be interesting to study the matter more closely. I have discussed this issue in more detail elsewhere (LARSEN, *in* PULLIN 1994).

It seems doubtful that Ghana could compete with the established industry in the Central African Republic. The market in Ghana would probably be relatively small, though a group of artisans might well find it sufficient.

iv) Sale of livestock to butterfly houses

During the past 15 years there has been an explosive growth in butterfly houses in Europe, North America, and Asia, where large, showy tropical butterflies are allowed to fly free in specially constructed volieres for the benefit of paying visitors, typically paying an admission fee of $ 10- to 15-. There are now hundreds of such establishments in Europe and the United States. More recently, some of the largest and most sophisticated butterfly houses were established in Malaysia and Singapore as tourist attractions. The annual number of visitors runs into millions.

I have been pleasantly surprised at how naturally butterflies do behave in large, well-managed butterfly houses, though it can slightly be disconcerting to see Neotropical butterflies mingle with the Oriental species and a few European. Full courtship displays are frequently seen and many species breed freely in captivity; displaying larvae and pupae are considered an extra plus by the butterfly houses and make them less dependent on imports.

Butterfly houses are strongly competitive and feel a strong need to display live butterflies that have not been 'shown' before. A steady and reliable supply is available from Sri Lanka, Malaysia, and Taiwan. Material from the Neotropics has generally been more erratic, but Costa Rica and Belize are setting up more organized supplies. African material has at best been erratic in supply, and usually difficult to get. Pupae of interesting and showy species would have a ready market (LAMB 1993). A list of some of the species which are readily handled and sufficiently showy is given in appendix 1. If it were possible to breed the two largest African butterflies (*Papilio antimachus* and *Papilio zalmoxis*) in captivity, a steady market at high prices would be assured - the life history of neither species is known, they are very elusive, but with some effort it should be possible to pin them down.

Butterfly houses are often particularly interested in importing butterflies that will breed in captivity. Supplying such butterflies might seem to be a way reducing the market, but in fact they fetch better prices, and most butterfly houses in Europe close in the winter months so that new stocks need to be imported each year. The prices per pupa would vary with the desirability of the species, but would typically be cedis 2,000 - 4,000. The normal shipment size might be 100 pupa of 10-15 species at a time.

In addition to the general prerequisites for butterfly projects, the supply of livestock to butterfly houses demands a fast, safe, and assured access to airfreight. Pupae will only last for about 14 days before hatching. However, their bulk is small enough to allow for despatch by courier services such as TNT, DHL, or FederalExpress.

In general, butterfly breeding projects are more difficult to set up than collecting projects, since the caterpillars demand constant attention to ensure that they do not run out of food.

PART THREE - FUTURE POSSIBILITIES

Butterflies show Ghana's protected areas' system to be a valuable natural resource. Its role in preserving biodiversity is important not only for Ghana, but for West Africa in general, and for the world at large.
As a result of this study, and the four months I have spent in Ghana over the past year, the following activities, additional to those already mentioned in the previous section, suggest themselves for the future. There is no particular order of priority:

1) Pretesting of the potential of ecological tourism in Ghana through collaboration between a Ghana tour operator and a travel agency abroad specializing in such tours. A lead time of about a year will be needed before the trip can be conducted. Butterfly collecting and bird-watching would both be suitable.

2) Building up comparative inventories of selected groups of organisms in all the national parks of Ghana. Apart from trees, the ecological limits of various species in West Africa is almost unknown. For certain groups - especially butterflies and birds - it should be possible to tap the great interest of amateurs that exist in Europe, North Africa, and Japan. For other groups, various universities may be co-opted. It might even be possible to find societies and universities that could 'adopt' a forest for in-depth study. In all cases students from Ghana should also participate. If properly managed, this would achieve: a) a much better understanding of the ecology of the various habitats than we have at present; b) a higher profile for the protected areas' system within Ghana, and for Ghana internationally; c) an excellent training opportunity for Ghana students of biology and related topics; d) increased financial and material support for the protected areas' system; and 5) an operational profit for the Department of Game & Wildlife.

3) Multidisciplinary investigations into conservation needs and opportunities in the Volta Region are urgently needed, including both a review of existing literature and field-work. The butterflies - and biogeographical considerations in general - indicate that the area is of much greater importance and interest than it was accorded by HALL & SWAINE (1976, 1981) or by BOOTH (1958). Again, if well presented, this is the type of topic which might attract the long-term support of a university in the rich countries, thereby providing training opportunities for Ghana, as well as bringing resources to Ghana.

4) The extent to which sacred groves conserves biodiversity, and their actual and potential value as stepping-stones for continued gene-flow between intact ecosystems seems a very important issue deserving of study. I am actually seeking funds for in-depth studies of butterflies in Boabeng-Fiema, Aburi Botanical Gardens, and two or three other sacred groves. While the study of sacred groves falls outside the formal limits of the Department of Game & Wildlife, their role as stepping-stones for gene-flow is of vital interest, also to the Department.

5) The background study for this report and its contents could form the basis for a booklet on the butterflies of Ghana as a general illustration of evolution, biogeography, and biodiversity in West Africa.

6) The quality of post-cards in Ghana is generally poor, both technically and photographically. A good series of animal and plant postcards - including butterflies - might well provide a reasonable profit while at the same time emphasizing the Department's work.

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Appendix 1

Ghana butterflies of special interest and high value to the specialist commercial market (resale value more than cedis 3,000 per specimen, cedis 1,500 net for the Ghana producer).

PAPILIONIDAE
Most other Papilionidae have some commercial value

Papilio antimachus
Papilio zalmoxis
Papilio hesperus
Papilio horribilis
Papilio maesseni
Graphium tyndaraeus
Graphium illyris

NYMPHALINAE
Charaxinae
Most other Charaxinae have some commercial value

Charaxes lactetinctus
Charaxes hadrianus
Charaxes nobilis
Charaxes hildebrandti
Charaxes northcotti
Charaxes doubledayi

Nymphalinae
Many larger Nymphalinae have some commercial value

Euryphurana nobilis
Bebearia arcadius
Euphaedra rare species, but difficult genus
Cymothoe aubergeri

HESPERIIDAE

Pyrrhochalcia iphis - one of the world's largest Hesperiidae
