

## **A Rapid Survey of Butterflies in the Atewa Range Forest Reserve, Ghana**

Authors: Aduse-Poku, Kwaku, and Doku-Marfo, Ernestina

Source: A Rapid Biological Assessment of the Atewa Range Forest Reserve, Eastern Ghana: 55

Published By: Conservation International

URL: <https://doi.org/10.1896/054.047.0110>

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

## Chapter 5

### A rapid survey of butterflies in the Atewa Range Forest Reserve, Ghana

*Kwaku Aduse-Poku and Ernestina Doku-Marfo*

---

#### SUMMARY

Butterflies were used as one of the target species in a Rapid Assessment Program (RAP) survey to obtain quick, reliable and cost-effective biodiversity data from Atewa Range Forest Reserve. Overall, 143 species belonging to 55 genera in five families were recorded during the entire RAP expedition. The composition of butterfly species is plainly indicative of a good forest. The presence of *Tetrarhanis baralingam*, *Neaveia lamborni* and *Bicyclus auricruda* in Atewa were confirmed during our survey. *N. lamborni* and *B. auricruda*, prior to this survey, had not been seen in any protected area in Ghana. Almost half of the 17 rare species recorded are known either exclusively from Atewa or from just one other protected area in Ghana. The conservation of and further studies on these species is of ultimate importance in the quest to use butterflies as biological indicators. More than 700 different species of butterfly are now expected to occur on the Atewa Range. This is more than in any other single locality in Ghana, and for that matter anywhere in Africa west of the Dahomey Gap (and more than twice as many butterflies as in the whole of Europe!). As many as 50 rare species in Atewa may be recorded nowhere else in Ghana. The RAP expedition recorded 16 endemic species of which two (*Euphaedra maria-christinae* and *Ceratrachia maesseni*) are endemic to the Ghana sub-region of West Africa. The remaining are endemic to the entire West Africa sub-region. The Atewa Range Forest Reserve provides a haven for many West African endemics. Ten of such endemic species are so far known only from the Range and might well in Ghana be limited to this reserve. Conservationists' understanding of the Afrotropical biological diversity has significant gaps and this hampers efforts to formulate sound biodiversity conservation measures. A few biologically rich, surviving forests like the Atewa forest remain the only hope for understanding some of the complexities and the functioning of ecosystem processes. The very high index of biodiversity, the presence of many endemic species, and several other species known from nowhere else in Ghana, and the pan-African rarity status of many of the species present in the Atewa Range Forest Reserve combine to indicate that its conservation importance is of the highest priority that the area should not be subject to development of any kind.

---

#### INTRODUCTION

Butterflies (Lepidoptera, Rhopalocera (Papilionoidea and Hesperioidea)) are a useful insect group in environmental monitoring and evaluation studies and have been used in several biodiversity monitoring programs around the globe with considerable success (Kremen 1992, 1994; Brown 1997; New 1997; Kerr et al. 2000; Larsen 2005a). They are by far the best known and most studied larger group of organisms apart from plants and vertebrates (Larsen 2006). Information such as habitat preference, habits, host plants, geographical distribution, endemism and/or rarity of most species is readily available for use in biodiversity data synthesis and interpretation. They can arguably be used as flagship taxa for terrestrial invertebrate biodiversity conservation.

The aesthetic beauty and charismatic nature of many butterflies have the ability to invoke

people's passion and interest, both of which are useful in butterfly conservation. Public interest in butterflies has grown enormously and has even become a political force in some countries. Major building developments have been rejected and proposed motorways have been relocated simply to protect scarce butterfly populations (New et al. 1995). By using butterflies as targets in biodiversity conservation, many co-existing and co-dependent organisms, like their food plants and natural enemies, may also be conserved.

Butterflies, by virtue of their high sensitivity, respond strongly to habitat disturbance (Brown, 1997) and most have special geographical distributions (Larsen 1994, 2006), reflecting past conditions, making them potentially useful biological indicator species. The use of butterflies as tools in rapid biodiversity assessment missions presents other advantages as well, such as their relatively stable and well known taxonomy, high sensitivity to changes in their habitats and microclimate heterogeneity and a high correlation with spatial, structural, and taxonomic diversity of vascular plants (Panzer and Schwartz 1998). Their high species richness (~20,000 in the world; ~4,000 in Afrotropics and ~925 species in Ghana), relative ease of capture, ubiquitous nature and explicit ecological preference, more or less, make them a useful taxon for use in a rapid biodiversity assessment.

Butterflies were therefore used as one of the target species in a RAP mission to obtain quick, reliable and cost-effective biodiversity data in the Atewa Range Forest Reserve (Atewa). The data resulting from this expedition are intended to inform conservationists and/or policy makers in formulating sound science-based conservation measures needed to conserve these charismatic species and the millions other species that co-exist with them or even depend on them.

## STUDY SITES AND METHODS

Atewa covers a total landmass of 232 km<sup>2</sup>. It is located within moist evergreen and semi-deciduous forest at lower levels and upland evergreen forest at higher levels (above 700 m). It is one of just two major areas of upland evergreen forest in Ghana, the other being at Tano Ofin. The RAP mission concentrated on three plateaux within the reserve that had been designated for bauxite exploration (and potential extraction) by ALCOA. The three plateaux were named Atiwiredu, Asiakwa South and Asiakwa North by the RAP team for consistency.

Atiwiredu was the first survey site for the research team. It is located at 06°12'22.7"N and 00°34'39.2"W with an altitude of 817 m a.s.l. There was evidence of very recent human disturbance of the vegetation. The plateau had numerous fresh (bauxite) exploratory transects constructed mainly with cutlasses and chainsaws. Investigation here was conducted over five field days from 7-11 June 2006.

Asiakwa South (06°15'44.3"N; 00°33'18.8"W; altitude 783 m a.s.l) was the second RAP camp. Again, the team stayed here for five field days (12-16 June 2006). The site generally had lots of old exploratory transects, indicating

that mineral exploration had been carried out here not more than two years ago.

Asiakwa North (06°16'16.1"N; 00°33'52.7"W; altitude 814 m a.s.l) was the least disturbed habitat with most of its vegetation still intact. The team spent six field days, from 17-22 June 2006, sampling this plateau.

On the last sampling day (22 June), the butterfly team collected specimens along the main access road passing through the reserve. Portions of the road sampled were at least 10 km from the nearest plateau or camp site. This was done to build up the species checklist for the expedition. As a result, only species that had not been recorded earlier in the three study plateaux were noted.

Typical fruit-baited traps (see DeVries 1987 for details) and standard butterfly nets were used for specimen collection. Traps were baited mainly with rotten banana fruits, though pineapple fruits were used occasionally. Traps were set in suitable butterfly habitats along main roads used by vehicles within the reserve, exploratory transects, hunter trails and in the forest interior. A few traps were also set in the tree canopy. The trapping protocol was intended to yield most of the species in the Nymphalidae family (Satyrinae, Charaxinae, Nymphalidae) that are difficult to catch with butterfly nets. In all, 20 fruit-baited traps per site were used for the study, except for Atiwiredu where 14 traps were set. Traps were re-baited every 24 hours during the sampling periods. This protocol was repeated for each study/camp site.

Using mainly pre-existing hunting trails passing through suitable butterfly habitats, a standard butterfly net was also used to collect specimens. Species seen (and easy to identify in flight) during transect/trail walks were also recorded. Available taxonomy treatises (e.g. Larsen 2005) were used for properly identifying confusing/difficult specimens. The distance walked at each site depended very much on the prevailing weather conditions. Longer distances were walked at sites with more favorable butterfly weather conditions (i.e. reasonable amount of sunshine) and vice versa. To allow for effective comparison of butterfly composition between sites, the time spent during trail walk survey was standardized into "effective sampling hours". For this RAP survey, one effective sampling hour denotes one hour of good butterfly weather. This may not necessarily be one uninterrupted hour of good butterfly weather. High quality specimens were kept in glassine envelopes and taken to a laboratory in Kwame Nkrumah University of Science and Technology (KNUST), Kumasi for further processing. Specimens that were confusing or difficult to identify were sent to Dr. Torben B. Larsen for clarification. KNUST has recently built a museum and a space for a butterfly specimens collection has been applied for. The specimens together with others collected by the lead author (Kwaku Aduse-Poku) from other localities will form the first batch of butterfly voucher specimens for the university museum. Species rarity and endemism status were adopted from Larsen (2006).

## RESULTS

Overall, 143 species belonging to 55 genera in five families were recorded during the RAP expedition (Appendix 4). This number represents about one-fourth of the species positively recorded from and accepted for the entire reserve. It is probable that more favorable butterfly weather (lots of sunshine) would have yielded many more species. It was raining on average almost every three out of four (75%) days throughout the expedition period. Overwhelmingly, two-thirds of the specimens collected belonged to the Nymphalidae family. This family contains species that are mostly fruit feeders and will normally come to fruit-baited traps. This indicates that the trapping protocol was a useful component of the RAP survey. The unfavorable weather (characterized by heavy mist and frequent rain showers) probably accounted for the conspicuous absence of Lycaenidae and Hesperidae (skippers) from the list.

As a comparison of the butterfly biodiversity between sites, at Asiakwa South we recorded the highest number of species (89) and at Asiakwa North we recorded the lowest number of species (57) (Table 5.1). Thirteen additional species were recorded along the main road (about 20 km from the study site) after 2.5 'effective sampling hours'. It is worth mentioning that many species were seen along the main road but only those not recorded in the three RAP survey sites were noted. Over 90 percent of the species collected during the expedition were typical forest species (Appendix 4).

Considering the species composition at the various sites, our results indicate that Asiakwa South was the most disturbed. Here, we recorded a high incidence of 'sun-loving' species like *Bicyclus sandace* and *B. vulgaris*. There were also many activities and individuals of *Junonia terea terea* and *Precis pelarga* on this plateau. These species prefer (patchily) disturbed habitats within forest zones and are often justifiably used as indicator species for anthropogenic disturbance within forest zones. The Asiakwa South site is believed to have been explored last year for bauxite deposits. The exploration has created significant openings in the vegetation, much more than in the two other study sites, hence giving way for many species not strictly limited to forest. It was not surprising, therefore, that this area recorded the highest number of species since butterflies, like most insect groups conform well to the mild (intermediate) disturbance principle (Fermon et al. 2000, DeVries and Walla 2001). It must

also be mentioned that the area still has a reasonable amount of good forest patches that are able to support viable population of forest butterfly species. In contrast, Asiakwa North held the lowest species richness, though this site was the best in terms of vegetation or habitat health conditions. There were generally low relative numbers of species collected on this plateau. Atiwiredu was intermediate to the two plateaux in terms of both species richness and habitat health.

## DISCUSSION

### Overall Biodiversity

More than 700 different species of butterfly are now estimated to occur on the Atewa Range, of which almost 600 are positively recorded. This is more than in any other single locality in Ghana, and for that matter anywhere in Africa west of the Dahomey Gap. The presence of *Tetrarhanis baralingam*, *Neaveia lamborni* and *Bicyclus auricruda* in Atewa was confirmed during the mission. *N. lamborni* and *B. auricruda* have so far not been recorded from any of the protected areas in Ghana. *T. baralingam* however has been recorded in three of the National Parks in Ghana; namely Kakum, Ankasa and Bia. Interestingly, each site recorded one of these confirmed species. *T. baralingam* was seen on the Atiwiredu plateau. *N. lamborni* and *B. auricruda* were collected on the north and south plateaux of Asiakwa respectively. The three confirmed species were among those suspected as possibly occurring on the Atewa Range (Larsen 2006). This will now raise the number of species that have been positively recorded and accepted in Atewa Forest Reserve to 575. This is nearly twice as many butterflies as in the whole of Europe.

### Endemicity

The RAP expedition recorded 16 endemic species of which two are endemic to the Ghana sub-region (*Euphaedra mari-aechristinae* and *Ceratrachia maesseni*). The remaining 14 species are endemic to the West Africa sub-region as a whole. Atewa provides a haven for at least 66 of the known 100 West African endemics. Ten of such endemic species are so far known in Ghana only from Atewa and might well be limited to this area. Some of these species are suspected to reside also in Tano Ofin, which is similar to Atewa in terms of both vegetation and topography. Unfortunately this reserve is highly degraded and earmarked for bauxite mining.

**Table 5.1.** Details of actual fields days and effective sampling hours spent per site during a RAP survey in the Atewa Range Forest Reserve in Ghana. The number of species observed per camp site is also presented.

Sites	Field days spent	Effective Sampling hours	No. of Species
Atiwiredu	5	12	74
Asiakwa South	5	9	89
Asiakwa North	5	8	57
Along main road	1	3	13 additional

*Astictopterus anomoeus*, recorded at Atiwiredu and Asiakwa South during the RAP survey, is one such species, recently known from nowhere else in Ghana but Atewa and just in Volta. Among other West African endemics (not seen during the RAP expedition but) known only from Atewa in Ghana are:

*Mylothris atewa*. Described from Atewa and almost certainly a narrow endemic to the Atewa Range, this species is found only above the 600 m contour. This distinctive species may be common, and is unlikely to have been overlooked elsewhere in West Africa. Larsen (2005b) comments that it has no obvious affinities to other members of the genus.

*Anthene helpsi*. Described from Atewa following its capture by Major T. Helps, this is the only white *Anthene* among almost a hundred others in Africa. Though a questionable record from near Abidjan in Côte d'Ivoire exists, Larsen (2005b) now discounts this record and considers the species to be an amazing Atewa endemic. What is fascinating is, at the very same spot where two individuals of this species were collected in 1993, two other species of conservation interest (*Mylothris atewa* and *Papilio antimachus*) were also seen. Unfortunately, bauxite exploratory transects have already been cut into this area.

*Acraea kibi*. Described from Atewa as a distinct species, Larsen (2005b) considers this to be a distinctive and valid subspecies of *A. kraka* which is otherwise known only from the mountains of the Nigeria/Cameroon border. The species is obviously a resident of the upland forest habitat and has also once been found in numbers at Tano Ofin.

The Atewa Range also supports most of the butterflies that are endemic to Africa west of the Dahomey Gap (for details see Larsen 2006).

### Biogeography

Some species found at Atewa have biogeographical affinities with the fauna of eastern Nigeria and Cameroon. Two examples are:

*Bicyclus sylvicolus*. Widely distributed in the equatorial rainforest of central Africa and occurring in eastern Nigeria, it also occurs in the forests of the Ghana/Togo Mountains, widely separated from the main population. The species is found also on Atewa, but nowhere else in Ghana. Although there are old records of this species from Father Masseni Atewa collection in Allyn Museum, USA, Larsen (2005b) suspected possible mislabeling and needed this claim substantiated. Not long after the RAP survey in August 2006, the lead author (Aduse-Poku) caught both female and male of this species in baited traps. On Atewa it co-habits with *Bicyclus abnormis* which is an endemic of Africa west of the Dahomey Gap that is widely distributed from Ghana to Sierra Leone. ONLY on the Atewa Range do these two species occur in the same locality. It is very rare to find such two geographical vicariants inhabiting the same locality.

*Acraea translucida* is similar in its range, being found only in western Cameroun, Nigeria, the Volta Region Mountains and on Atewa. However, this species has no proper West African vicariant; so that Atewa is the westernmost point of its range.

### Rare Species

The importance of Atewa is also underlined by the presence of a large numbers of very rare butterflies – species that are rare not just in Ghana but in Africa as a whole. Almost half (48%) of the 17 rare species recorded during the expedition (see Table 5.2) are positively recorded either exclusively from Atewa or from just one other protected area in Ghana. Some of the rare species recorded either are positively limited to the Atewa Range Forest Reserve or occur in just one of the protected areas in Ghana. *Vanessula milca* is one of the Atewa exclusives. *Bicyclus trilophus*, *Aslauga lamborni* and *Bebearia arcadius* occur in Atewa and just one of the protected areas in Ghana. The conservation and further studies on these species is of importance in the quest to use butterflies as biological indicators in overall biodiversity assessment. The host plant of *Vanessula milca* for instance, to date, remains unknown and finding it will provide an understanding of its irregular distribution in West Africa: though usually common on Atewa, it has not recently been found elsewhere in Ghana and its distribution in the rest of Africa is very patchy. Review of existing butterfly literature of the forest reserve shows that about as many as 50 rare species in Atewa are recorded nowhere else in Ghana (Larsen 2006). One good example of such species is the recently discovered *Charaxes furnierae jolybouyeri*, Vingerhoedt, 1998. This species is most unusual and some authors (Joly 2003) consider the presence of this species sufficient to justify conservation measures for Atewa. *C. furnierae jolybouyeri* is the western subspecies of an extremely rare butterfly from equatorial Africa; it was found on the Atewa Range and then – amazingly – also in the Guinea Mountains near Nzérékoré.

The extremely rich butterfly fauna of Atewa contains a number of rare species worthy of special mention, though they were not recorded during the RAP survey. First among these is the magnificent *Papilio antimachus* Drury, 1782 whose wing-span can be up to 25 cm, the widest of any butterfly in the world. The wings are very narrow and other butterflies surpass it in wing surface. The only other Ghana records traced are from Amedzofe in the Volta Region and most recently (2005) from Bobiri. The population in Volta now appears to be extinct and the rather extensive forests below Amedzofe have largely been destroyed. The species is, however, still present on Atewa and has been found on at least five occasions during the past five years – but it is rarely seen except when coming down to drink from the edge of streams since it stays in the canopy.

Other interesting and significant species include:

*Graphium rileyi* – a large species that is endemic to West Africa and in Ghana known only from Atewa; there are long series from Atewa in collections but no recent records from Ghana or Côte d'Ivoire.

*Pentila petreoides* – a very rare West African endemic species; the only Ghana records are from Atewa.

*Ornipholidotos issia* – is a West African endemic; its only known Ghana population is on the Atewa Range.

**Table 5.2.** Rare butterfly species recorded at each study/camp site during a RAP survey in the Atewa Range Forest Reserve, a forest fragment in Ghana. Rare species as adopted from Larsen (2006) are species usually found on less than 10-20% of visits to most suitable localities.

	Species	Atiwiredu	Asiakwa South	Asiakwa North
1	<i>Aslauga lamborni</i>		x	
2	<i>Ornipholidotos onitshae</i>		x	x
3	<i>Mimeresia cellularis</i>	x		x
4	<i>Iolaus aethria</i>	x		
5	<i>Hypolycaena clenchi</i>			x
6	<i>Bicyclus trilophus jacksoni</i>			x
7	<i>Bicyclus nobilis</i>		x	
8	<i>Heteropsis peitho</i>	x	x	x
9	<i>Vanessula milca milca</i>			x
10	<i>Precis sinuata</i>	x	x	
11	<i>Euriphene incerta incerta</i>		x	
12	<i>Bebearia arcadius</i>		x	x
13	<i>Euphaedra splendens</i>	x		
14	<i>Euphaedra eupalus</i>		x	
15	<i>Acraea orina</i>	x		
16	<i>Ceratrachia semilutea</i>	x	x	x
17	<i>Ceratrachia maesseni</i>	x		
	<b>TOTAL</b>	<b>8</b>	<b>9</b>	<b>8</b>

*Mimeresia moyambina* – a very rare West African endemic, originally described from Sierra Leone, where it has not since been re-found; a few were found in Côte d'Ivoire during the 1960s and a small series caught on Atewa a few years ago.

*Liptena griveaudi* – an almost unknown species described from Côte d'Ivoire; the only Ghana records are from Atewa. The status of Sierra Leone material is uncertain.

*Stempfferia staudingeri* – a rare butterfly found from Sierra Leone to western Nigeria, in Ghana only known from Atewa.

*Iolaus mane* – this species was recently described from the Fouta Djallon in Guinea; a specimen from Atewa was unexpectedly located in the Allyn Museum of Entomology in Florida and no other Ghana specimens are known

*Anthene atewa* – a recently described butterfly named after the Atewa Range that has been found also in other Ghana forests of good quality and rarely in Côte d'Ivoire; it seems a very scarce West African endemic.

*Bicyclus dekeyseri* – a rare endemic of the wettest forest in West Africa; very few are known from Ghana, mostly from Atewa.

*Euphaedra ignota* – a distinctive Ghana endemic that was described from Atewa but has been recorded also from Kakum and forests near Atewa.

*Euphaedra eusemoides* – a most distinctive and very rare butterfly, endemic to Africa west of the Dahomey Gap, only

known from the Atewa Range in Ghana; none has been found in Ghana since the 1960s.

*Celaenorrhinus sagamase* – a very rare butterfly recently described from Atewa (named after the Sagyemase track to Atiwiredu), but one has also been found in Kakum; a spectacular West African endemic.

*Celaenorrhinus ankasa* – a rare West African endemic; one of the types was from Atewa; it has since been found also in Sierra Leone.

Many other species that are rare on a pan-African basis are found in the Atewa forests. Dr. T.B. Larsen (pers. comm.) was consulted on this section and commented that the list of rare species could be continued for more pages than this report can contain.

## CONSERVATION RECOMMENDATIONS

The very high index of biodiversity, the presence of many endemic species and several other butterfly species known from nowhere else in Ghana, and the pan-African rarity status of many of those species present in Atewa combine to indicate that its conservation is of the highest priority – possibly the most important site in the country apart from the national parks (Ankasa, Bia, Kakum). It is therefore not surprising that the conservation status of this reserve has increased and elevated over the years from a Special Biological Protection Area (SBPA), to a Hill Sanctuary, and most recently a Globally Significant Biological Area (GSBA).

Conservationists' understanding of Afrotropical biological diversity has significant gaps and this paucity of information hampers their ability and efforts to formulate sound biodiversity conservation measures. The few biologically rich, surviving forests like the Atewa forest remain the only hopes for understanding some of these complexities and functioning in ecosystem processes. Forests in Ghana are fast disappearing and even considered one of the most imperiled ecosystems in the world (FAO 2006). Unfortunately what is unknown in this vulnerable ecosystem eclipses what is known, making it one of the least studied and ecologically understood forest zones in the world (Laurance 1997). We strongly recommend, based on the results of this survey and prior work in the Atewa area, that the Atewa Range Forest Reserve should be fully protected and not opened up for development activities that could harm this site of global conservation priority.

## REFERENCES

- Bakarr, M., B. Bailey, D. Byler, R. Ham, S. Olivieri and M. Omland (eds.). 2001. *From the Forest to the Sea: Biodiversity Connections from Guinea to Togo*. Conservation International. Washington, DC. 78 pp.
- Brown, K.S. 1997. Diversity, disturbance, and sustainable use of Neotropical forests: insects as indicators for conservation monitoring. *Journal of Insect Conservation* 1: 25-42.
- DeVries, P.J. 1987. *The Butterflies of Costa Rica and their Natural History*. Princeton University Press. 327 pp.
- DeVries, P.J. and T. Walla. 2001. Species diversity and community structure in Neotropical fruit-feeding butterflies. *Biological Journal of the Linnean Society* 74: 1-15.
- Food and Agriculture Organization (FAO). 2006. *Global Forest Resources Assessment 2005. Progress towards sustainable forest management*. FAO Forestry paper 147. Rome. 322 pp.
- Fermon, H., M. Waltert, T.B. Larsen, U. Dall'Asta and M. Muhlenberg. 2000. Effects of forest management on diversity and abundance of fruit-feeding nymphalid butterflies in south-eastern Côte d'Ivoire. *Journal of Insect Conservation* 4: 173-189.
- Joly, C. 2003. Contribution à l'étude des Charaxinae du Ghana (Lepidoptera: Nymphalidae). *Notes faunistiques de Gembloux* 50: 27-47.
- Kremen, C. 1992. Assessing the Indicator Properties of Species Assemblages for Natural Areas Monitoring. *Ecological Applications* 2(2): 203-217.
- Kremen, C. 1994. Biological inventory using Target taxa: A Case Study of the Butterflies of Madagascar. *Ecological Application* 4(3): 407-422.
- Kerr, J.T., S. Alissa and P. Laurence. 2000. Indicator Taxa, Rapid Biodiversity Assessment and Nestedness in an Endangered Ecosystem. *Conservation Biology* 14: 1726-1734.
- Larsen, T.B. 1994. *The Butterflies of Ghana and their Implications for Conservation and Sustainable Use*. Compiled for Ghana Wildlife Department and IUCN. 54 pp.
- Larsen, T.B. 2005a. Rapid Assessment of Butterflies of Draw River, Boi-Tano and Krokosua Hills. Pp 33-39. *In: McCullough, J., J. Decher and D.Guba Kpelle (eds.). A biological assessment of the terrestrial ecosystems of the Draw River, Bio-Tano, Tano Nimiri and Krokosua Hills forest reserves, Southwestern Ghana*. RAP Bulletin of Biological Assessment 36. Conservation International, Washington, DC.
- Larsen, T.B. 2005b. *The Butterflies of West Africa*. Apollo books: Stenstrup Denmark.
- Larsen, T.B. 2006. *The Ghana Butterfly Fauna and its contribution to the objectives of the protected Areas System*. A report submitted to Ghana Wildlife Division. WDSP Report No. 63. 200 pp.
- Laurance, W.F. 1997. Introduction. Pp. 1-2. *In: Laurance, W.F. and Bierregaard (eds). Tropical Forest Remnants Ecology. Management and Conservation of Fragmented Communities*. Univ. of Chicago Press, IL.
- New, T.R. 1997. Are Lepidoptera an effective 'Umbrella Group' for Biodiversity Conservation? *Journal of Insect Conservation* 1: 5-12.
- New, T.R., R.M. Pyle, J.A. Thomas, C.D. Thomas and P.C.Hammond. 1995. *Butterfly Conservation Management*. *Annu. Rev. Entomol.* 40: 57-83.
- Ntiamao-Baidu, Y., E.H. Owusu, D.T. Daramani and A.A. Nuoh. 2001. Important Bird Areas in Ghana. Pp. 367-389. *In: Fishpool, L.D.C. and M.I. Evans (eds.). Important Bird Areas in Africa and Associated Islands: Priority sites for conservation*. BirdLife International, Cambridge.
- Panzer, R. and M.W. Schwartz. 1998. Effectiveness of a vegetation-based approach to insect conservation. *Conservation Biology* 12: 693-702.