Seasonality and Abundance Of Sphingids in a Garden on the Lower Slopes of the Uluguru Mountains in Morogoro Township in Tanzania

Authors: Kingston, A. J., and Nummelin, M.

Source: Journal of East African Natural History, 87(1) : 213-220

Published By: Nature Kenya/East African Natural History Society

URL: https://doi.org/10.2982/0012-8317(1998)87[213:SAAOSI]2.0.CO;2

Journal of East African Natural History **87**: 213–220 (1998)

SEASONALITY AND ABUNDANCE OF SPHINGIDS IN A GARDEN ON THE LOWER SLOPES OF THE ULUGURU MOUNTAINS IN MOROGORO TOWNSHIP IN TANZANIA

A.J. Kingston
P.O. Box 299, Morogoro, Tanzania
e-mail: kingston@intafrica.com

M. Nummelin[1]
FORST Project
P.O. Box 292, Morogoro, Tanzania

ABSTRACT

For the past 14 years hawk moths (Lepidoptera: Sphingidae) have been collected in a garden (580 m a.s.l.) in the 'Forest Hills' area of Morogoro, on the lower slopes of the Uluguru Mountains, Tanzania. Moths were attracted using two 160-watt mercury-vapour bulbs and a 15-watt ultraviolet tube-light. They were collected and counted on a white cotton sheet affixed to the wall of a house with the lights suspended in front of it, facing towards the western slopes of the lower Uluguru Mountains. Different species on the wing have been recorded on a nightly basis from June 1996 to December 1997. Altogether, during the whole study period, a total of 56 sphingid species have been encountered. Hawk moths are most abundantly on the wing from March to June peaking in May (late rainy season). The most common species are *Agrius convolvuli, Daphnis nerii, Nephele aequivalens, Nephele comma, Euchloron megaera, Hippotion celerio* and *Hippotion eson.* These can be caught throughout the year. The common species in Morogoro are almost identical to those in similar habitat in Freetown, Sierra Leone (West Africa).

INTRODUCTION

Since Owen's (1969) classical study on seasonality of sphingids in a garden on the slope of Mount Aureol in Free Town, Sierra Leone, the seasonality of tropical hawk moths has been little studied. We are not aware of any published study made in East Africa. However, some studies have been made in the Neotropics, mainly Brazil (Abreu, 1974; Abreu *et al.*, 1979; Ferreira *et al.*, 1986).

In Sierra Leone, West Africa, the peak numbers of hawk moths occur at the onset of the rains, when the species diversity is also lowest (Owen, 1969). Moonlight is known to affect the occurrence of East African moths including the hawk moths *Agrius convolvuli, Basiothia*

[1] Present address : Division of Environmental Biology, Department of Ecology and Systematics, P.O. Box 7, FIN-00014 University of Helsinki, Finland, E-mail: Matti.Nummelin@Formin.FI

medea and *Hippotion celerio* (Taylor, 1986) as well as the neotropical hawk moth *Erinnyis ello* (Abreu, 1974). Haber & Frankie (1982) report that sphingids pollinating trees are more abundant during rainy than dry season in Costa Rica. Moreover sphingid larvae are reported to have their peak occurrence during the early rainy season in Costa Rica (Janzen & Waterman, 1984). Minimum night temperature and rainfall had no influence to the catches of *E. ello* (Abreu, 1974; Abreu *et al.*, 1979), its population peaks occurred when the mean monthly temperature was higher than 24° C (Abreu *et al.*, 1979). However, Ferreira *et al.* (1986) reported that the flight activity of sphingids was related to the temperature in Brazil.

This paper reports the seasonal occurrence of sphingids on the lower slopes of the Uluguru Mountains in Eastern Tanzania (part of Eastern Arc range of mountains) and relates their occurrence to the rainfall and moonlight as well as temperature. This is the first published report on hawk moth seasonality in East Africa.

MATERIAL AND METHODS

Hawk moths have been collected over the past 14 years in a garden (580 m a.s.l.) in the 'Forest Hills' area above the Morogoro town, on the lower slopes of the Uluguru Mountains (7°S 38°E) using two 160-watt mercury-vapour bulbs and a 15-watt ultraviolet tube-light. The hawk moths were collected and counted on a white cotton sheet affixed to the wall of a house with the lights suspended in front of it facing the western slope of the Uluguru Mountains. Different species on the wing have been recorded on a nightly basis between June 1996 and December 1997.

The possible effect of moonlight was checked by counting the number of hawk moth individuals caught during moonlight periods (from growing half moon to diminishing half moon) and during dark moon periods (from diminishing half moon to growing half moon); by using a two by two table chi-square-test (Statistix 4.0 analytical PC-software).

Rainfall data were obtained from the meteorological station of the Sokoine University of Agriculture situated about three kilometres east of the sampling site. Species numbers were correlated with rainfall and abundance (correlation function, Microsoft Excel 5.0, PC-software).

For testing possible effects of short term rains, the number of hawk moth individuals caught within five days dry period and the number caught during the following five-day period with >5 mm total precipitation were compared (Sign-test).

RESULTS

Over 14 years a total of 56 sphingid species have been detected in Morogoro. During the daily recording period from June 1996 to December 1998, altogether 42 species have been encountered. The most common species were *Agrius convolvuli, Daphnis nerii, Nephele aequivalens, Nephele comma, Euchloron megaera, Hippotion celerio* and *Hippotion eson.* These species made up more than half of all hawk moths recorded during 1996–97 (table 1). Peak numbers of hawk moths were recorded during the late rainy season (figure 1). All common species follow the same seasonal occurrence pattern (figure 2). The number of hawk moths observed each month correlates strongly with the rainfall in the previous month ($r = 0.85$, $n = 19$, $p < 0.001$, figure 3). During the peak month (May, 1997) almost 300 hawk moths were recorded, belonging to 18 species. The lowest record was in October 1997, with 12 individuals belonging to five species. There is a significant correlation between the log

Table 1. Total catches and monthly presence/absence occurrence of Sphingidae species between June 96–December 1997 in Morogoro (+ in total catch column indicates an observation of the species before the intensive study period).

Species	Tot	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Agrius convolvuli (Linnaeus, 1758)	141	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Acherontia atropos (Linnaeus, 1758)	22	-	-	+	+	+	+	+	-	+	+	-	+	+	+	-	+	-	-	-
Coelonia mauritii (Butler, 1877)	17	+	-	-	-	-	+	+	+	-	-	+	+	+	-	-	-	-	+	+
Xanthopan morgani (Walker, 1856)	4	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-
Macropoliana scheveni (Carcasson, 1972)	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Pemba favillacea (Walker, 1866)	9	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	+	-
Pseudoclanis kenyae (Clark, 1928)	10	-	-	-	-	-	-	+	+	+	+	+	-	+	-	-	-	-	-	-
Platysphinx piabilis (Distant, 1897)	2	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-
Neoclanis basalis (Walker, 1866)	1	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Neopolyptychus compar (R. & J., 1903)	1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polyptychoides grayi (Walker, 1856)	6	+	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	-
Falcatula falcatus (R. & J., 1903)	8	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	+	+
Rufoclanis fulgurans (R. & J., 1903)	15	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+
R. numosae (Wallengren, 1860)	3	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+
Afroclanis calcarea (R. & J., 1907)	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Afroclanis neavi (Hampson, 1910)	2	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-
Lophostethus demolini (Angas, 1849)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cephonodes hylas (Linnaeus, 1771)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Daphnis nerii (Linnaeus, 1758)	29	+	-	-	-	-	-	-	-	+	+	+	+	+	-	+	+	+	-	-
Nephele aequivalens (Walker, 1856)	113	+	+	+	+	-	-	-	+	-	-	+	+	+	+	+	+	-	+	+
N. comma (Hopffer, 1857)	194	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	-
N. funebris (Fabricius, 1793)	1	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
N. monostigma (Clark, 1925)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. bipartita (Butler, 1878)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. peneus (Cramer, 1776)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. accentifera (Beauvois, 1805)	3	-	-	-	-	-	-	-	-	-	-	+	+	-	+	-	-	-	-	-
N. argentifera (Walker, 1856)	11	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-
N. oenopion (Hubner, 1806)	5	-	+	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
N. rosae (Butler, 1875)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Tot	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Temnora fumosa (Walker, 1856)	5	-	-	-	-	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-
T. marginata (Walker, 1856)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. funebris (Holland, 1893)	3	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+
T. elegans (Rothschild, 1894)	7	-	-	-	+	+	-	+	-	-	-	+	-	-	-	-	-	-	-	-
T. sardanus (Walker, 1856)	1	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
T. crenulata (Holland, 1893)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. natalis (Walker, 1856)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. zantus (Herrich-Schaffer, 1854)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. pseudopylas (Rothschild, 1894)	30	+	+	+	+	+	+	-	+	-	-	+	-	+	+	-	+	-	-	-
Sphingonaepiopsis nanum (Boisduval, 1847)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atemnora westermanni (Boisduval, 1875)	4	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	+
Macroglossum trochilus (Hubner, 1824)	1	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Leucostrophus hirundo (Gerstaecker, 1871)	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Celerio lineata (Fabricius, 1775)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Euchloron megaera (Linnaeus, 1758)	90	+	+	-	+	+	-	-	-	-	-	+	+	+	+	+	-	-	+	+
Basiothia medea (Fabricius, 1781)	5	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+
Hippotion osiris (Dalman, 1823)	5	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
H. celerio (Linnaeus, 1758)	87	+	+	-	-	+	-	+	-	+	+	+	+	+	-	-	+	+	-	-
H. eson (Cramer, 1779)	73	+	+	+	-	-	+	-	-	+	-	+	+	+	-	-	-	+	-	+
H. balsaminae (Walker, 1856)	3	-	-	-	-	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-
H. roseipennis (Butler, 1882)	1	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
H. rebeli (R. & J., 1903)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H. irregularis (Walker, 1856)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
H. rosae (Butler, 1882)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Theretra capensis (Linnaeus, 1764)	1	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. monteironis (Butler, 1882)	8	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	+	+
Centroctena imitans (Butler, 1882)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

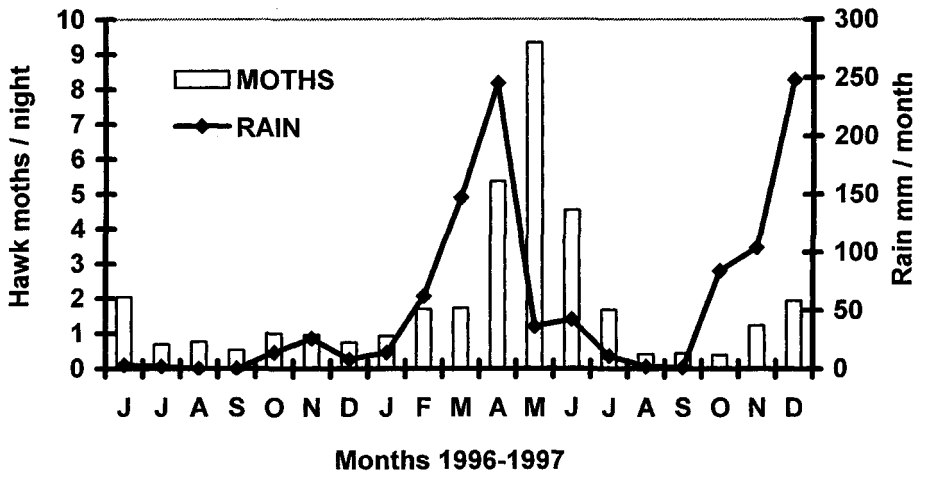


Figure 1. Monthly average catches per night of hawk moths, and monthly rainfall in Morogoro, 1996–1997.

number of individuals recorded per night and the number of species encountered ($r = 0.87$, $n = 19$, $p < 0.001$, figure 4). The numbers of nightly records were not at their highest during the warmest period of the year (November–January).

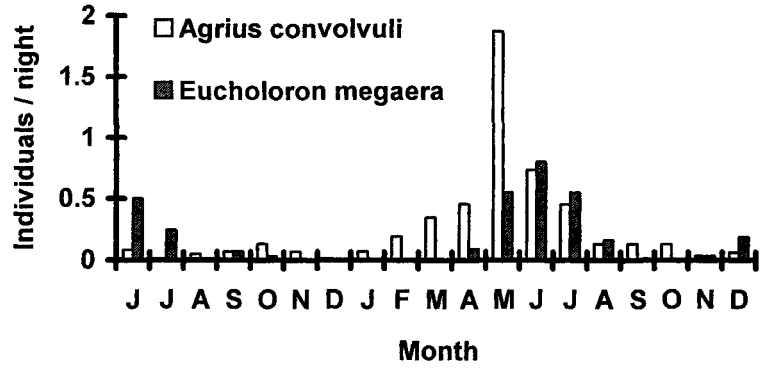
The phase of moon apparently affects the occurrence. During moonlight periods (from growing half moon to diminishing half moon) less than half of the number of individuals were caught compared to the dark moon periods (from diminishing half moon to growing half moon) (258 vs 603 individuals when corrected for equal observation period). The difference in catches between light and dark moon phases is significant ($\chi^2 = 71.14$, $p < 0.001$, $df = 1$).

No short-term effect of rain was detected when 14 different dry/rainy five-day pairs were analysed during the 1996–97 period. There were more hawk moths in eight dry and four rainy pairs and twice the catches were equal. The difference is not significant (Sign test).

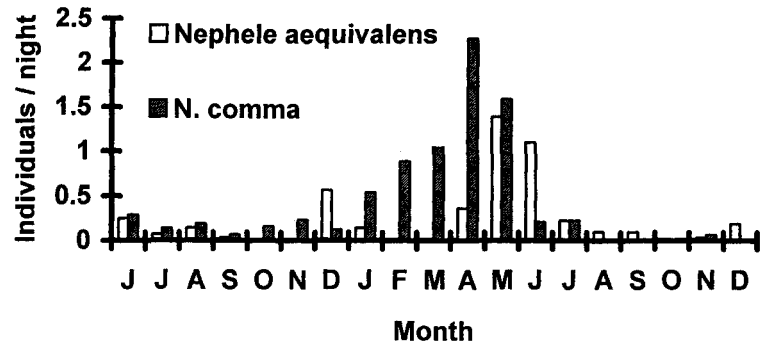
DISCUSSION

On the lower slopes of the Uluguru Mountains in Morogoro about one half of all hawk moth species known from Tanzania have been recorded (Bjørnstad, 1994, see also Carcasson, 1976). Only one species (*Macropoliana scheveni*) seems to be endemic to Tanzania. None of the species caught is an Eastern Arc endemic, although it is known that *e.g.* an Uluguru endemic grasshopper occurs commonly in the sampling site (A. Hochkirch, pers. comm.). Most of the species seem to have wide distributions in Africa being mostly migratory savannah hawk moths. This is probably due their good flying ability. The only Eastern Arc endemic hawk moth known so far is a weak flier found in the Udzungwa and Ukaguru Mountains (Kingston, pers. obs.). However, this species is still undescribed (subfamily *Smerinthidae*, Aarvik, in prep.). It seems that the hawk moths in this study represent a secondary fauna of generalists and good dispersers, which will invade original forest areas after their destruction. It is likely that sampling in the closed forest in the upper slopes of Uluguru

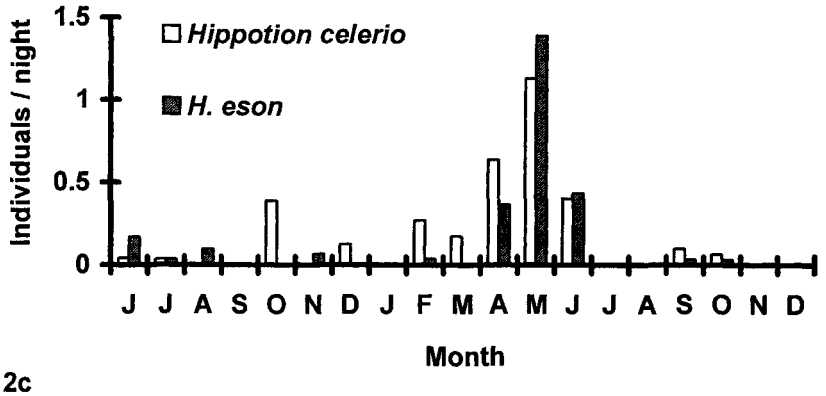
would change the picture of the Eastern Arc sphingid fauna, especially to include such forest species that are weak fliers.



2a



2b



2c

Figure 2. Monthly average catches per night of six most common hawk moth species in Morogoro, 1996–1997: a) Agrius convolvulli *and* Echoloron megaera, *b)* Nephele aequivalens *and* N. comma, *c)* Hippotion celerio *and* H. eson.

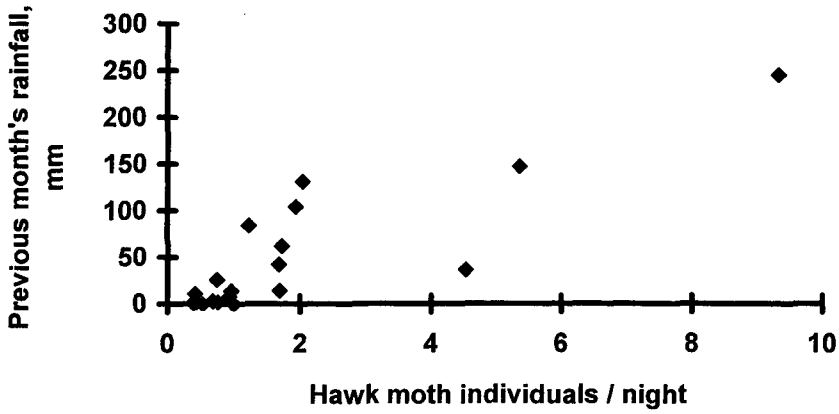


Figure 3. The effect of previous month's rainfall on hawk moth catches in Morogoro.

The species number in a Morogoro garden is roughly the same as in a garden in Freetown, Sierra Leone, West Africa (Owen, 1969), being 56 and 52 species, respectively. All the most common species in Morogoro are also common in Freetown (Owen, 1969). Only one common Freetown species, *Nephele funebris*, has only been caught rarely in Morogoro, suggesting that there is a great similarity in hawk moth assemblages in sub-Saharan gardens established in former forest sites on mountain slopes.

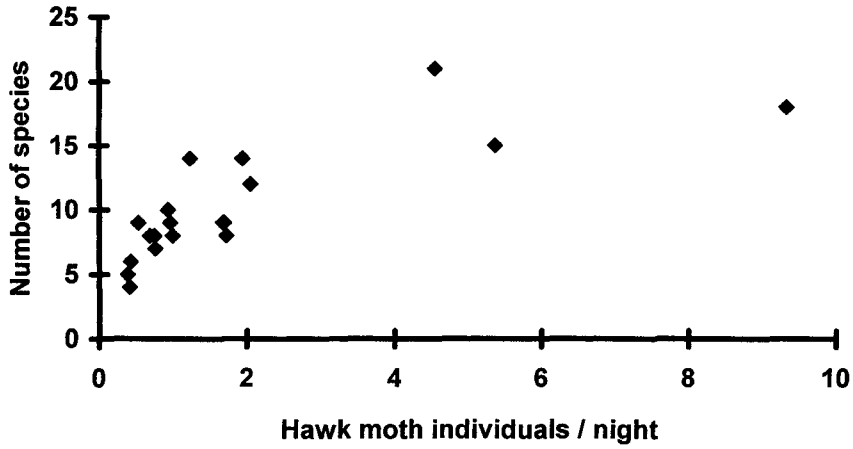


Figure 4. Hawk moths' monthly abundance and number of species in Morogoro.

The species number in Morogoro is highest during the period of peak abundances, differing from that in Freetown (Owen, 1969). In Morogoro the monthly species numbers were also lower than in Freetown: during peak months 18 species were found and during months of low diversity only five species were observed in Morogoro. In Freetown the species number observed per month was between 18 and 35 (Owen, 1969).

In Morogoro, there is a clear correlation between rainfall and hawk moth abundance with a one-month time lag (figure 1). A one-month time lag is shorter than the time lag observed between general insect abundance and rainfall on the Uluguru slopes (Nummelin &

Nshubemuki, this volume—see also Nummelin, 1996). Both in Freetown and Morogoro the hawk moth abundance peaks in May. However, May is in the late rainy season in Morogoro, but early rainy season in Sierra Leone. If the rainfall and hawk moth abundance correlation is calculated from Freetown data (Owen, 1969), the highest correlation is found between hawk moth abundance and the rainfall two months ahead of the month of capture, not with a one-month time lag as in Morogoro. This may indicate some kind of a continent-wide synchrony in hawk moth occurrence, and not a direct dependence on local rains.

Higher catches were obtained when there was least moonlight. This concurs with the results of hawk moth catches in Kenya (Taylor, 1986) and Brazil (Abreu, 1974; Abreu *et al.*, 1979). The result may be explained by higher attractivity of lamps during dark nights rather than differences in flight activity. However, the nightly flight activity requires further studies using other methodology than light traps, *e.g.* a Malaise trap (Owen, 1969).

ACKNOWLEDGEMENTS

We thank N. Burgess, J. Fjeldså and M. Nieminen for helpful comments on the manuscript.

REFERENCES

Abreu, J.M. (1974). Factors that influence the catches of *Erinnyis ello* L. (Lepidoptera: Sphingidae) in light-traps. *Revista Theobroma* **4**: 32–43.

Abreu, J.M., P.F.N. Cruz & F.G.E. Smith (1979). Seasonal abundance of the rubber hawk moth *Erinnyis ello* (Lepidoptera: Sphingidae) in Bahia. *Revista Theobroma* **9**: 39–44.

Bjørnstad, A. (1994). *A preliminary check-list of Tanzanian Sphingidae with a record of specimens in Norway*. Anders Bjørnstad, Drangedal, Norway.

Carcasson, R.H. (1976). *Revised catalogue of the African Sphingidae with description of the East African species*. 2nd ed., E. W. Classey, Oxon, England.

Ferreira, P.S.F., D.S. Martins, N. Hubner & A. Fiuza-Ferreira (1986). Survey, fluctuation and analysis of the entomological fauna in a relict forest of the Zona da Mata region, Vicosa, Minas Gerais. I. Sphingidae: Lepidoptera. *Revista-Ceres* **33**: 516–527.

Haber, W.A. & G.W. Frankie (1982). Pollination of *Luehea* (Tiliaceae) in Costa Rican deciduous forest. *Ecology* **63**: 1740–1750.

Janzen, D.H. & P.G. Waterman (1984). A seasonal census of phenolics, fibre and alkaloids in foliage of forest trees in Costa Rica: some factors influencing their distribution and relation to host selection by Sphingidae and Saturniidae. *Biological Journal of the Linnean Society* **21**: 439–454.

Nummelin, M. (1996). The community structure of arthropods in virgin and managed sites in the Kibale Forest, Western Uganda. *Tropical Ecology* **37**: 201–213.

Nummelin M. & L. Nshubemuki (this volume). Seasonality and structure of the arthropod community in a forested valley in the Uluguru Mountains, Eastern Tanzania. *Journal of East African Natural History* **87**: 205–212.

Owen, D.F. (1969). Species diversity and seasonal abundance in tropical Sphingidae (Lepidoptera). *Proceedings of the Royal Entomological Society London* A **44**: 162–168.

Taylor, R.A.J. (1986). Time series analysis of numbers of Lepidoptera caught at light traps in East Africa, and the effect of moonlight on trap efficiency. *Bulletin of Entomological Research* **76**: 539–606.