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SURVEY OF HESPERIDS FOUND IN THREE AGE GROUPS OF *CALAMUS MANAN* PLANTED UNDER RUBBER TREES

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STEINER, H. & AMINUDDIN, M. 2001. Survey of hesperids found in three age groups of *Calamus manan* planted under rubber trees. In the face of dwindling natural resources, rattan is slowly becoming a plantation crop. This is especially true for *Calamus manan*, which has been successfully planted in between rubber trees. However, systematic surveys of the associated insect fauna are few. In a study of phytophagous insects in plots of three different age-groups of *C. manan* planted under rubber trees, hesperid larvae were found to be the most important herbivores. Four different species, *Gangara thyrsis, Erionota hiraca, Quedara monteithi* and *Salanoemia sala*, were observed regularly, with increasing abundance in the stated order. An additional species, *Zela* sp. was found on a few occasions only. Abundance of *G. thyrsis* and *E. hiraca* were quite similar, while those of *Q. monteithi* and *S. sala* were significantly different from the first two and from each other. Differences in abundance between the different aged plots were only significant for the two least abundant species. It was concluded that the hesperid fauna did not show any age-related differences between the plots of rattan. The dynamics of *G. thyrsis, E. hiraca* and *Q. monteithi* did not show any distinct pattern during the observation period, with only minor variation in their abundance. *Salanoemia sala*, while showing the same pattern in the first part of the survey, displayed a 10- to 20-fold abundance increase in one month during the second part of the survey. Possible relations with climatic data are discussed, as well as possible economic considerations. No adverse effects are expected at the current levels, but a close eye on the future development is recommended.

Key words: *Calamus manan* - cultivation - Hesperiidae - abundance

STEINER, H. & AMINUDDIN, M. 2001. Kajian terhadap kupu-kupu hesperid yang didapati dalam tiga kumpulan umur *Calamus manan* yang ditanam di bawah pokok getah. Akibat kekurangan sumber-sumber yang tumbuh secara semula jadi, rotan kini beransur-ansur menjadi tanaman ladang terutamanya *Calamus manan* yang ditanam dengan jayanya di antara pokok-pokok getah. Bagaimanapun, kaji selidik secara sistematik mengenai fauna serangga yang wujud pada pokok ini adalah kurang. Dalam kajian mengenai serangga fitofagus di dalam petak tiga kumpulan umur *C. manan* yang berbeza yang ditanam di bawah pokok getah, larva kupu-kupu hesperid didapati merupakan serangga herbivor yang paling penting. Empat spesies yang berbeza, *Gangara thyrsis, Erionota hiraca, Quedara monteithi* dan *Salanoemia sala* dicerap secara tetap, dengan kelimpahan yang bertambah dalam susunan yang dinyatakan. Satu spesies tambahan iaitu *Zela* sp. didapati beberapa kali sahaja. Kelimpahan

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G.thyrsis dan *E.hirata* hampir sama tetapi kelimpahan *Q. monteithi* dan *S. sala* berbeza dengan bererti daripada kedua-dua spesies ini dan juga antara satu sama lain. Perbezaan dalam kelimpahan antara petak yang berbeza umur hanya bererti bagi dua spesies yang paling kurang kelimpahan. Oleh itu dapatlah dirumuskan bahawa fauna kupu-kupu hesperid tidak mempamerkan perbezaan berkaitan umur antara petak-petak rotan. Dinamik bagi spesies *G.thyrsis, E.hiraca* dan *Q. monteithi* tidak menunjukkan corak yang jelas seperti semasa tempoh cerapan, dengan perubahan kelimpahannya kecil sahaja. Walaupun *Salanoemia sala* menunjukkan corak kelimpahan yang sama dalam bahagian pertama kajian, ia mempamerkan pertambahan kelimpahan sebanyak 10 hingga 20 kali ganda sebulan dalam bahagian kedua kajian. Kaitan dengan maklumat cuaca yang mungkin wujud dibincangkan, begitu juga dengan pertimbangan dari segi ekonomi. Walaupun tiada kesan buruk dijangkakan pada masa ini, disyorkan supaya perkembangan kupu-kupu hesperid ini diawasi dengan teliti.

Introduction

Rattans are a characteristic element of nearly all types of rain forests in Asia (Dransfield 1981). Of about 600 species found in the world, 107 species are recorded in Peninsular Malaysia. About 20 species of these are used commercially by the rattan industry (Aminuddin 1990). Rattan, although classified as a minor forest product, is the most valuable forest product next to timber.

The most sought-after rattan species of large diameter is *Calamus manan* (rotan manau), due to its unsurpassed quality as furniture cane (Dransfield 1979). As a result of the high demand, its natural resources are increasingly depleted, and mature plants are only found in areas where access is restricted or difficult.

To avoid shortages of rattan as raw material, the Forest Research Institute Malaysia (FRIM) has started trial plantations with *C. manan* as early as 1978 (Nur Supardi & Wan Razali 1989). Since 1980, FRIM's scientists have been involved in planting rattan under rubber trees (Aminuddin & Nur Supardi 1986). This has proven to be a viable alternative to planting in forested land and is economically sound (Aminuddin *et al.* 1991, Aminuddin & Salleh 1994).

Although rattan has been extracted from the forests for decades, little attention has been paid towards its pests. This is reflected in the lack of scientific literature in this area. The standard reference for insects on palms lists 25 species collected from rattan in contrast to 131 species from date palm, 315 species from oil palm and 750 species from coconut palm (Lepesme 1947). Dammerman (1929) and Kalshoven (1981) reported rattan as food plant for only two and four insect species respectively. Publications dedicated entirely to insects feeding on rattan are few and almost all of recent times (Norani *et al.* 1985, Maziah *et al.* 1992, Chung 1994, 1995, Steiner & Aminuddin 1997, 1999).

With the cultivation of rattan, however, pests will become an important issue, as any large scale planting is generally bound to increase pest problems. One insect group mentioned in all publications on herbivores of rattan is the lepidopteran family Hesperiidae. Dammerman (1929) and Kalshoven (1981) both mentioned the hesperid *Gangara thyrsis*, while Lepesme (1947) stated three additional species, namely, *Erionota thrax, Telicota palmarum* and *Hyarotis adrastus.* Recent additions are *E. torus, Quedara monteithi* (Maziah *et al.* 1992), *Lotongus calathus* and *Salanoemia sala* (Steiner & Aminuddin 1997, 1999). The Hesperiidae is a cosmopolitan family which has its maximum development in the tropics, and some 250 species are found in Peninsular

Malaysia. The majority of these, about 185 species, belong to the subfamily Hesperiinae, one of the three subfamilies occurring in Malaysia. The larvae of Hesperiinae feed almost exclusively on monocotyledons (Corbet & Pendlebury 1992).

Since the main habitat of hesperids is forested land, more hesperid species are expected to be associated with rattans. In addition to the six species reported in this paper, another 13 species of hesperids were found by us to feed on various rattan species in the forest.

The objective of our study was to monitor the insect fauna affecting *C. manan* in different plantations. Preliminary results have been published in Steiner and Aminuddin (1997). This paper presents final results of the monitoring of Hesperiidae larvae associated with three age groups of *C. manan* planted under rubber.

Materials and methods

The study was conducted at Ladang Kampung Bongsu of Syarikat Kurnia Setia in Pahang, Malaysia. The area has an undulating topography with swampy patches and an elevation of about 50 m asl. It is mainly planted with rubber trees, but some small areas of oil palms and fruit orchards are also present. *Calamus manan* has been planted between the rows of rubber trees, with the first areas being planted in 1986. To date, 300 ha of rubber plantation has been interplanted with *C. manan* of varying ages.

For the sake of accessibility to the growing parts, only the three youngest age groups were chosen for the survey. The names of the three plots are the names assigned to the respective rubber lots by the management of the plantation. In the first plot, Task 333, *C. manan* was planted in 1992 in single rows between the rubber trees (Kamarudin, pers. comm.). This plot is completely surrounded by other areas planted with rubber trees and rattan. The second plot, Task 46/47, was planted in 1991 with single rows of *C. manan* between the rows of rubber trees (Kamarudin, pers. comm.). It is located at the edge of the area planted with rubber trees and rattan, with one side bordering a housing area. In the third plot, Task 275, *C. manan* was planted in double rows between the rubber trees in 1990 (Kamarudin, pers. comm.). This plot is also completely surrounded by other areas either planted with rubber trees and rattan or rubber trees alone. A total of 100 plants were marked individually in Task 333, and 50 plants in each of the other two plots.

Previous rearing experiments with hesperids showed that development from egg to imago takes between six and eight weeks. Therefore, a monthly monitoring interval was chosen for this study. For each plant, numbers of all insects found, their location on the plant and all feeding marks were recorded during daytime. A second census was taken the following night to check for differences in species composition. Monitoring was carried out from October 1994 to June 1995, and with a different set of plants in the same plots, from March 1996 to January 1997.

Hesperid larvae found on marked plants were recorded, but not removed. For identification purposes, larvae were collected from unmarked plants, raised in containers at the University Field Studies Centre, Ulu Gombak and identified according to the keys provided by Corbet and Pendlebury (1992). Specimens were deposited at the Forest Research Institute Malaysia. Since all the hesperid species found built characteristic shelters out of the leaflets they feed on, empty shelters can be assigned to the different species with a high degree of certainty. In addition to the larvae, all empty shelters found on marked plants were also recorded. Empty shelters found on leaves on which no larvae were present or had been recorded the previous month, were regarded as being built by larvae that had not been detected. This is based on the assumption that larvae usually do not switch over to different leaves. In this way, a minimum number of unrecorded larvae was calculated.

For examination of possible climatic influences, data provided by the Malaysian Meteorological Service were used. The meteorological station is located in Temerloh, 20 km east of the plantation and at a similar altitude.

All statistic tests used followed the description given in Zar (1996).

Results

Hesperids in relation to other groups of herbivores

Within the plots, hesperid larvae accounted for 51.2% of all herbivores found, thus making them the most abundant group. Other important groups are Oecophoridae (Lepidoptera), represented by a single, yet unidentified species, with 26.6%, and Hispinae (Chrysomelidae, Coleoptera), with 15.7%. Table 1 lists the total numbers and percentages of the feeding stages of all groups of herbivores found. Feeding stages of Hispinae and Orthoptera are larva and adult, but only larva in the rest of the herbivores.

Table 1. Total numbers and percentages of herbivores found on *Calamus manan* (feeding stages only)

Group	N	%
Hesperiidae	1573	51.2
Nymphalidae	40	1.3
Oecophoridae	816	26.6
Notodontidae	23	0.7
Limacodidae	30	1.0
Other Lepidoptera	16	0.5
Hispinae	481	15.7
Orthoptera	91	3.0
Total	3070	100.0

Species composition and total numbers of hesperids found

Four different species of the family Hesperiidae were found quite regularly. These are *S. sala, Q. monteithi, E. hiraca* and *G. thyrsis*. A fifth species was present in the plots, but was only found in three censuses. It keys out to *Zela zeus*, but will be assigned to a new species due to strong differences in its life history and more subtle differences in morphology (Kirton, pers. comm.). It was found in Task 46/47 in March and August 1996, and in both Task 46/47 and Task 333 in January 1997, each time restricted to one or two plants. Despite its rare occurrence, total number of larvae was fairly high. Table 2 lists the total numbers and percentages of larvae for all hesperid species found.

The percentage of larvae not found, but accounted for by their empty leaflet-shelters was between 20% (*S. sala*) and 27% (*E. hiraca*) of the total. This indicates that a monthly interval is sufficient to detect about three quarter of the larvae.

Table 2. Total numbers and percentages of the different hesperid larvae found

Species	T333	T46/47	T275	All plots	
	N	N	N	N	%
Salanoemia sala	613	287	212	1112	70.7
Quedara monteithi	125	68	45	238	15.1
Erionota hiraca	37	37	9	83	5.3
Gangara thyrsis	21	28	2	51	3.2
Zela sp.	43	44	0	87	5.5
Undetermined	1	0	1	2	0.1
Total	840	464	269	1573	100.0

Observations on life history and abundance

Salanoemia sala is the most common hesperid in this survey. With a total of 1112 larvae, it comprises 70.7% of all hesperid larvae found (Table 2). Its larvae build semicircular shelters with openings, resembling a pavilion. The pupal case has a completely closed form. It is severed from the plant and dragged under the litter by the larva before pupation occurs.

The second commonest hesperid is *Q. monteithi*. Its larvae fold the leaflets longitudinally, building a channel along the middle, and feeding at the tip. They pupate in a different, undamaged leaflet which is folded as well. We also found *Q. monteithi* on *C. ornatus, C. scipionum* and *Daemonorops grandis.*

Of the four regularly occurring species, *E. hiraca* and *G. thyrsis* were the least common, with the former somewhat more abundant than the latter. *Erionota hiraca* larvae cut into the leaflets near the base and roll the distal end lengthwise. They feed and pupate inside the same type of roll. *Gangara thyrsis* larvae feed in the open and stay on the lower surface of the leaflets, which are sometimes slightly folded. Their presence is indicated by a white layer of wax on the leaflets. The pupal case is rolled spirally out of a narrow strip of a leaflet.

Comparison of the dynamics

Figures 1–4 show the dynamics in all three plots for each of the regularly occurring species. Numbers were converted to larvae per plant to compensate for the different numbers of plants. With the exception of *S. sala,* the species showed a rather even distribution over the monitoring period without major peaks.

While *S. sala* showed the same pattern for the first monitoring period, its abundance exhibited sharp peaks beginning July 1996 (Figure 1). The increases were about 10- to 20-fold above the first period levels. This trend was generally observed for all three plots. To quantify the amount of correspondence for the whole survey, the correlations of monthly abundance between the three plots were calculated. For *S. sala,* the correlation coefficients for the different plot pairings were between 0.78

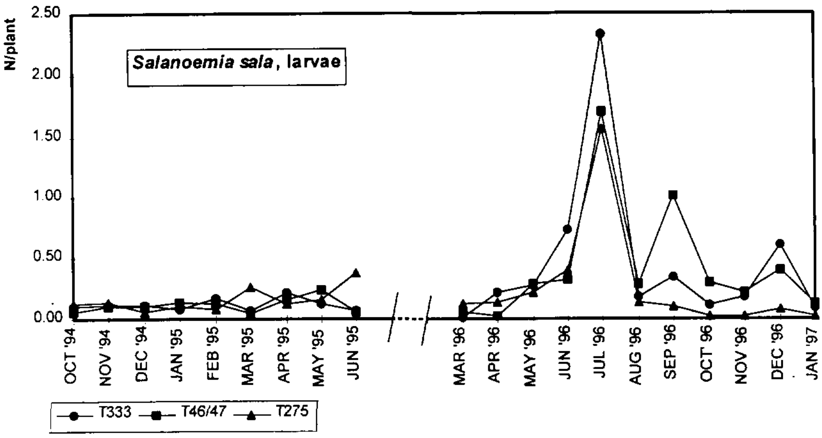

Figure 1. Monthly abundance of *Salanoemia sala* larvae in three age-groups of *Calamus manan* planted under rubber at Ladang Kampung Bongsu, Pahang

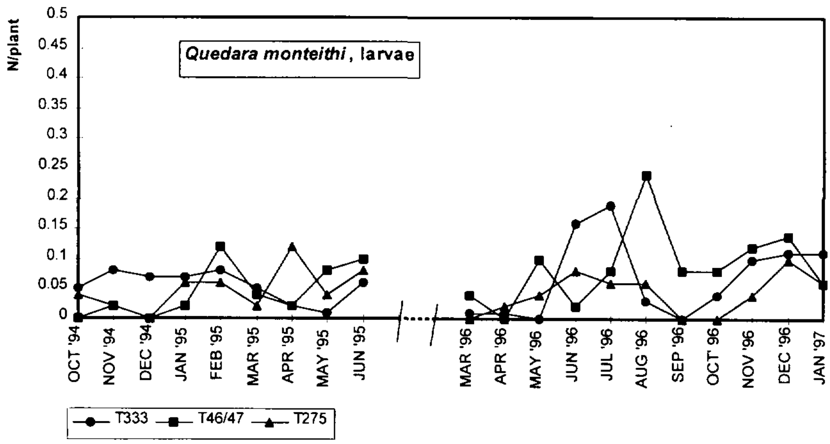

Figure 2. Monthly abundance of *Quedara monteithi* larvae in three age-groups of *Calamus manan* planted under rubber at Ladang Kampung Bongsu, Pahang

and 0.92. The coefficients of determination, r^2, as a measure for the amount of variability in one plot accounted for by the variability in the other plot, were accordingly between 0.60 and 0.85 for *S. sala*, while those for all other species ranged between 0.00 and 0.26.

The monthly distribution of total numbers differ significantly from a normal distribution ($p < 0.001$, D'Agostino-Pearson K^2 test for normality) for *S. sala* and *G. thyrsis*, the latter also from a Poisson-distribution ($p < 0.001$, chi-square test for goodness of fit), which is more adequate for small numbers. Non-parametric tests were therefore employed to compare the different plots.

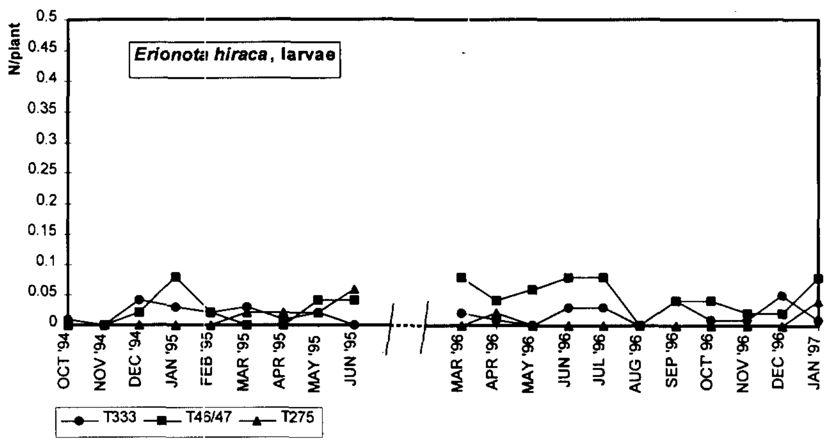

Figure 3. Monthly abundance of *Erionota hiraca* larvae in three age-groups of *Calamus manan* planted under rubber at Ladang Kampung Bongsu, Pahang

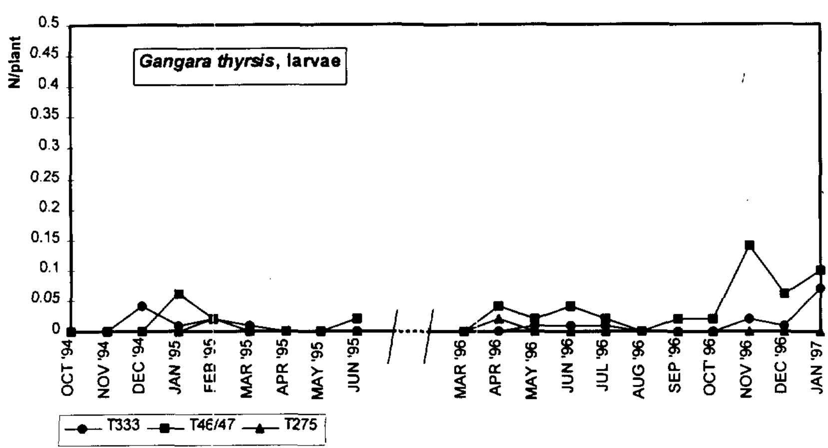

Figure 4. Monthly abundance of *Gangara thyrsis* larvae in three age-groups of *Calamus manan* planted under rubber at Ladang Kampung Bongsu, Pahang

For each species, the existence of differences between the three plots were tested using the Kruskal-Wallis Analysis of Variance. Differences were not significant for *Q. monteithi* ($0.50 < p < 0.25$) and for *S. sala* ($0.75 < p < 0.50$), while a significant difference was indicated for *G. thyrsis* and *E. hiraca* (both $0.001 < p < 0.01$). Further analysis of the different plot pairings, using the Nemenyi Test for a non-parametric multiple comparison showed significant differences between Task 46/47 and Task 275 in both *G. thyrsis* and *E. hiraca* (both $0.001 < p < 0.01$). Differences between Task 333 and either Task 275 or T46/47 were not significant for both species (T333-T275: $0.20 < p < 0.10$; T333-T46/47: $0.50 < p < 0.20$).

Figure 5 shows a comparison of the dynamics of all four species, using the mean of the three plots. Testing for the existence of differences between the four species, the Kruskal-Wallis Analysis of Variance indicated that significant differences do exist ($p < 0.001$). Non-parametric multiple comparison using the Nemenyi test did not show any significant difference between *G. thyrsis* and *E. hiraca* ($p > 0.50$). However, differences between all other pairings were significant ($0.05 > p > 0.01$ for *Q. monteithi-S. sala* and *Q. monteithi-E. hiraca*, $p < 0.001$ for the others).

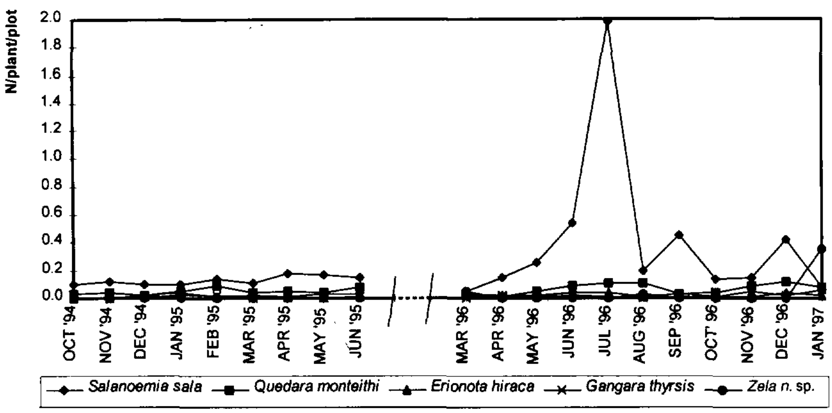

Figure 5. Comparison of the dynamics of all hesperid larvae found regularly on *Calamus manan* planted under rubber at Ladang Kampung Bongsu, Pahang (mean of all three plots)

Correlation with climatic data

A Spearman-Rank correlation of the monthly abundance of *S. sala* with monthly climatic data for the same period yielded correlation coefficients of $r_s = 0.594$ for mean minimum temperature and $r_s = 0.588$ for lowest minimum temperature. These correlations were significant ($0.01 < p < 0.001$). No significant correlation were obtained for the monthly amount of rainfall, number of days with rain, mean 24-h temperature, mean maximum temperature and highest maximum temperature. The monthly abundance of all other species gave no significant correlations with any of the climatic data.

Discussion

Gangara thyrsis occurs in Peninsular Malaysia as the nominal subspecies, *G. t. thyrsis* (Corbet & Pendlebury 1992). *Gangara thyrsis* has been associated with *C. manan, C. trachycoleus, C. caesius* (Norani *et al.* 1985, Maziah *et al.* 1992), *C. rotang* (Lepesme 1947), *C. subinermis* (Chey *et al.* 1993), and with a variety of other palms (Corbet &

Pendlebury 1992). Chey *et al.* (1993) concluded from the wide host range and distribution that *G. thyrsis* is a pest of unlimited potential, whose threat cannot be underestimated in the planting of rattans. In contrast to that, we found *G. thyrsis* in plantations of *C. manan* to be the hesperid of least importance. Its abundance was the lowest of all species, and damages seemed negligible.

Erionota hiraca occurs in Peninsular Malaysia in form of the subspecies *E. h. apicalis* (Corbet & Pendlebury 1992). *Erionota hiraca* has not been reported on rattans yet, but *E. thrax* was reported on *C. manan* (Norani *et al.* 1985), and *E. torus* was reported on *C. manan* as well (Maziah *et al.* 1992). All three species are rather similar and easily misidentified. The species feeding on palms, including rattans, was almost certainly *E. hiraca* (Kirton, pers. comm.).

Quedara monteithi occurs in Peninsular Malaysia as the nominal subspecies, *Q. m. monteithi* (Corbet & Pendlebury 1992). *Quedara monteithi* was recorded from *C. manan* for the first time by Maziah *et al.* (1992).

No subspecies of *S. sala* have been described. *Salanoemia sala* was first recorded from *C. manan* by the authors (Steiner & Aminuddin 1997, 1999). It is said to be a rare species (Corbet & Pendlebury 1992). In this survey, however, it comprises more than 70% of all hesperid larvae found. This apparent contradiction is certainly due to the fact that its food plant, previously found only in primary forest, is in cultivation now for the first time. The sharp rise in abundance for July 1996 matches closely for all three plots (Figure 1), indicating that it is at least a plantation-wide phenomena. The good correlation and high coefficient of determination for all three plots further strengthened the notion of a true population dynamics driven by internal or external forces. Nothing can be said yet about the regularity of such events, and possible causes can only be speculated.

The correlation between abundance and minimum temperature indicated that temperature might be involved in the dynamics, yet correlation coefficients were higher if the peak itself was excluded. Yearly data were nearly identical for 1994–1996. Comparing the climatic diagrams for 1996 (Figure 8) with those for 1994 and 1995 (Figures 6 & 7 respectively), the only striking difference observed was that the July minimum of the amount of rainfall was considerable higher in 1996 than either 1994 or 1995. However, long term surveys are necessary to establish any definite relationship between climate and abundance.

Between the three plots, overall abundance increased in the order Task 275 < Task 46/47 < Task 333 for all species, with the exception of *S. sala* (Table 2). The pattern for *S. sala* is mainly caused by its extremely high abundance in July 1996. If rank sums of the monthly abundance were regarded, as used in Kruskal-Wallis-Analysis of Variance and Nemenyi Test, *S. sala* showed the same general order. However, differences between the plots were only significant for the two least abundant species, *E. hiraca* and *G. thyrsis*, and even then, only between the two extremes, Task 275 and Task 46/47. It was therefore concluded that there were hardly any differences between the three plots, as far as hesperids were concerned, and, since the years of planting for the three plots are in the order T46/47 > T275 > T333, it is clear that there were no differences connected to the age of the plants.

From an economic point of view, the density of *S. sala*, the most common species, was regarded as very low, even at its peak. The highest recorded average value in our survey was 2.3 larvae of *S. sala* per plant at Task 333 in July 1996. With an average of

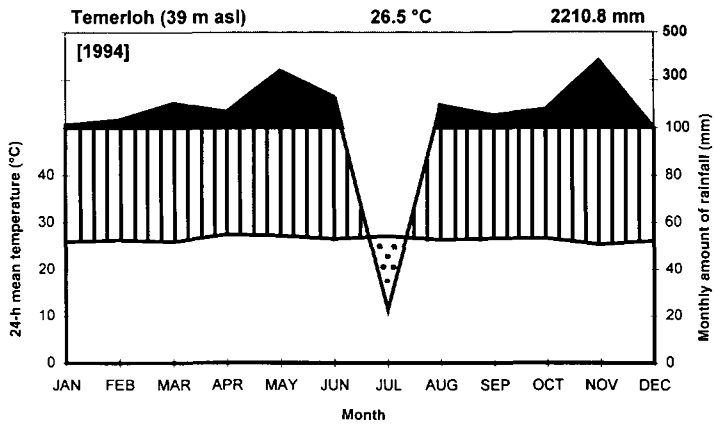

Figure 6. Climate diagram for 1994, meteorological station Temerloh, (standard format following Ehrendorfer (1978), data provided by the Malaysian Meteorological Service)

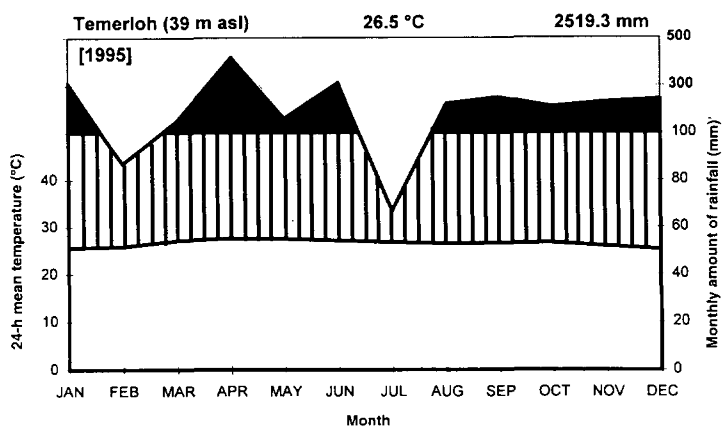

Figure 7. Climate diagram for 1995, meteorological station Temerloh, (standard format following Ehrendorfer (1978), data provided by the Malaysian Meteorological Service)

13.1 leaves per plant for *C. manan* in our plots, the maximum peak level for *S. sala* was equivalent to 0.18 larvae/leaf. Overall leaf damages of the monitored plants were estimated at 10%, and the damages done by the hesperids did not exceed the general level. Relationship between removed leaf area and stem growth in rattan is not known, but it seemed unlikely that a 10% removal would cause a significant reduction in stem growth. Thus the current level of defoliation by hesperids should not be of economic concern. Nevertheless a project to investigate the effects of defoliation on stem growth of rattans should be considered to establish economic threshold levels. Published data for other palm crops are hardly comparable, especially since the item of concern is fruit yield and not stem growth, but they can serve as a point of orientation for

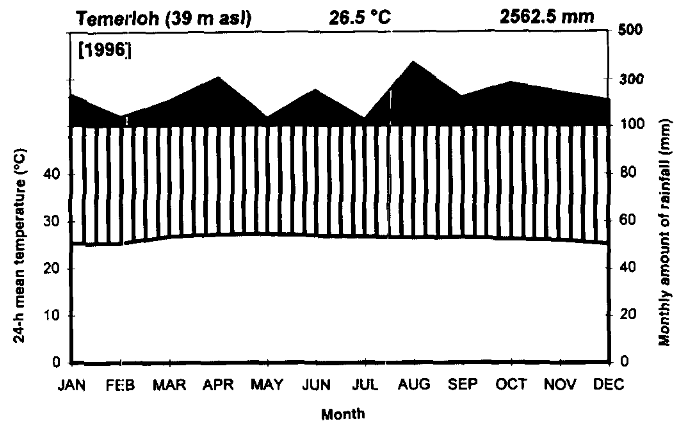

Figure 8. Climate diagram for 1996, meteorological station Temerloh, (standard format following Ehrendorfer (1978), data provided by the Malaysian Meteorological Service)

economic considerations, until more adequate data are available. The economic threshold level for Limacodidae on oil palm (*Elaeis guineensis*) is 10 to 20 large or 30 to 80 small larvae per leaf (Wood 1987). For oil palms in West Africa, Mariau (1976) recommends control action to be taken at 15 to 20 larvae/leaf for *Latoia* sp. (Limacodidae) and at 5 to 20 larvae/leaf for *Zophopetes dysmephila* (Hesperiidae).

Abundance for the other hesperid species was less than a quarter of *S. sala.* The variation of their numbers seemed to be due more to erratic or even random changes. This was indicated by the low coordination between the different plots, as judged by the coefficient of determination, and the failure to find a significant difference from a normal distribution for *Q. monteithi* and *E. hiraca.*

As the amount of available food was abundant for hesperids in the plantation, these species seemed to be still under natural control. However, little is known about the agents and mechanisms of possible natural control. During this survey, parasitoids were bred from all four hesperids: from *S. sala* a species belonging to the Chalcidoidea; from *Q. monteithi* a braconid and a tachinid; from *E. hiraca* a Chalcidoidea; from *G. thyrsis* a tachinid as well as an ichneumonid, which constituted a new species and genus (Gupta 1999).

Likely predators of hesperids are the occasionally found Gryllacrididae, which also make shelters out of the leaflets of *C. manan.* Of superior importance is certainly the ant fauna of *C. manan,* which has been shown to be highly abundant and diverse (Sandvoss 1997). The habit of hesperid larvae to build shelters out of the leaves or leaflets of their food plant has most probably evolved to reduce the risk of predation. Ants are a major part of this risk and significant differences in herbivore damage between ant-inhabited and -uninhabited plants in the same plots have been reported (Sandvoss 1997).

Another species of hesperid, *Lotongus calathus,* which was not present in the plantation, but was found by the authors on *C. manan* in a trial plot at the Sg. Buloh

Forest Reserve, has managed to turn this precarious relationship with ants to its advantage by evolving a symbiotic association with a common ant species. The ability of *L. calathus* to avoid predations by other ants in this way allowed it to reach far higher abundance than all other hesperid species present at the Sg. Buloh plot, which are the same four species reported in this study that occurred regularly at the Kampung Bongsu plantation. The abundance of these hesperids in both sites is in the same order of magnitude (Steiner & Aminuddin 1997). The high abundance of *L. calathus* is thus a hint on the limiting powers of the ant fauna for non-symbiotic herbivores.

Notwithstanding, *S. sala* demonstrates that it has the potential for a strong increase in abundance. With plantations of *C. manan* spreading, it is therefore advisable to watch any further development, especially of this hesperid, closely.

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References

AMINUDDIN, M. 1990. Ecology and Silviculture of *Calamus manan* in Peninsular Malaysia. Ph.D. thesis, University of Wales. 245 pp.

AMINUDDIN, M. 1992. Income from harvesting trial of manau cane in rubber plantation. *RIC Bulletin* 11(1): 2–3.

AMINUDDIN, M. & NUR SUPARDI, M. N. 1986. Intercropping of rotan manau (*Calamus manan*) with rubber (*Hevea brasiliensis*). *Pertanika* 9(2): 161–165.

AMINUDDIN, M., NUR SUPARDI, M. N. & ABD. GHANI, I. 1991. Rattan growing under rubber in Peninsular Malaysia – Status, problems and prospects. Pp. 79–86 in Appanah, S., Ng, F. S. P. & Roslan, I. (Eds.) *Proceedings of the Conference Malaysian Forestry and Forest Products Research*. 3–4 October 1990. Forest Research Institute Malaysia, Kepong.

AMINUDDIN, M., NUR SUPARDI, M. N. & WOON, W. C. 1992. Economics of cultivation of large-diameter rattan. Pp. 205–237 in Wan Razali, W. M., Dransfield, J. & Manokaran, N. (Eds.) *A Guide to the Cultivation of Rattans*. Malayan Forest Records No. 35, Forest Research Institute Malaysia, Kepong.

AMINUDDIN, M. & SALLEH M. N. 1994. Opportunities for commercial rattan planting in Malaysia. *The Planter, Kuala Lumpur* 70: 113–117.

CHEY, V. K., LEE Y. F. & CHIA, F. R. 1993. *Gangara thyrsis thyrsis* attacks *Calamus subinermis* in Sabah. *RIC Bulletin* 12(1/2): 13–14.

CHUNG, A. Y. C. 1994. *Insect Pests of Rattans in Sabah*. Entomology Section, Forest Research Centre, Sepilok, Sabah Forestry Department, Malaysia. 28 pp.

CHUNG, A. Y. C. 1995. Insect pests of rattans in Sabah. *The Planter, Kuala Lumpur* 71: 55–66.

CORBET, A. S. & PENDLEBURY, H. M. 1992. *The Butterflies of the Malay Peninsula*. 4th edition (rev. Eliot J. N.). Malayan Nature Society, Kuala Lumpur. 595 pp.

DAMMERMAN, K. W. 1929. *The Agricultural Zoology of the Malay Archipelago*. J. H. de Bussy Ltd., Amsterdam. 473 pp.

DRANSFIELD, J. 1979. *A Manual of the Rattans of the Malay Peninsula*. Malayan Forest Records No. 29, Forestry Department, Kuala Lumpur. 270 pp.

DRANSFIELD, J. 1981. The biology of Asiatic rattans in relation to the trade and conservation. Pp. 179–186 in Synge, H. (Ed.) *The Biological Aspects of Rare Plant Conservation.* John Wiley & Sons, Chichester.

EHRENDORFER, F. 1978. Geobotanik. Pp. 856–987 in *Lehrbuch der Botanik für Hochschulen.* Begr. E. Strasburger, F. Noll, H. Schenck & A. F. W. Schimper, 31.Aufl. neub. D. von Denffer, F. Ehrendorfer, K. Mägdefrau & H. Ziegler. Gustav Fischer Verlag, Stuttgart.

GUPTA, V. 1999. A new genus and species of Mesostenine Ichneumonidae from Malaysia (Parasitic Hymenoptera). *Oriental Insects* 33: 95–98.

KALSHOVEN, L. G. E. 1981. *Pests of Crops in Indonesia.* Translated and revised edition. Ichtiar Baru-van Hoeve, Jakarta. 701 pp.

LEPESME, D. 1947. *Les Insectes des Palmiers.* Paul Lechevalier, Editeur, Paris. 849 pp.

MARIAU, D. 1976. Insect pests in West Africa. Pp. 369–383 in Corley, R. H. V., Hardon, J. J. & Wood, B. J. (Eds.) *Oil Palm Research. Developments in Crop Science (1).* Elsevier Scientific Publishing Company, Amsterdam.

MAZIAH, Z., AZMI, M. & KIRTON, L. G. 1992. Pests and diseases of rattans. Pp. 127–141 in Wan Razali W. M., Dransfield, J. & Manokaran, N. (Eds.) *A Guide to the Cultivation of Rattans.* Malayan Forest Records No. 35, Forest Research Institute Malaysia, Kepong.

NORANI, A., THO, Y. P. & HONG, L. T. 1985. Pests and diseases of rattans and rattan products in Peninsular Malaysia. Pp. 131–135 in Wong, K. M. & Manokaran, N. (Eds.) *Proceedings of the Rattan Seminar.* 2–4 October 1984, Kuala Lumpur, Malaysia. Rattan Information Centre, FRIM, Kepong.

NUR SUPARDI, M. N. & WAN RAZALI, W. M. 1989. The growth and yield of a nine year old rattan plantation. Pp. 62–67 in Rao, A. N. & Vongkaluang, I. (Eds.) *Recent Research on Rattan. Proceedings of the International Rattan Seminar.* 12–14 November 1987. Chiangmai, Thailand. Kasetsart University & IDRC.

SANDVOSS, M. 1997. *Biologische Schädlingskontrolle bei einer neuen Kulturpflanze: Schützen Ameisen die Kletterpalme* Calamus manan *gegen Herbivore?* Diplomarbeit im Fachbereich Biologie der Johann Wolfgang Goethe-Universität, Frankfurt am Main. 121 pp.

STEINER, H. & AMINUDDIN, M. 1997. Survey of hesperids found on *Calamus manan* in a natural forest and three types of plantations. *Journal of Tropical Forest Science* 10(2): 256–261.

STEINER, H. & AMINUDDIN, M. 1999. A hesperid, *Salanoemia sala* (Hewitson) (Lepidoptera: Hesperiidae) associated with *Calamus manan* (Arecaceae). *Malayan Nature Journal* 53(3): 201–209.

WOOD, B. J. 1987. Economic aspects and chemical control. Pp. 223–235 in Cock, M. J. W., Godfray, H. C. J. & Holloway, J. D. (Eds.) *Slug and Nettle Caterpillars.* C.A.B. International, Wallingford, U.K.

ZAR, J. H. 1996. *Biostatistical Analysis.* 3rd edition. Prentice Hall, New Jersey. 662 + 256 pp.