Skin-piercing blood-sucking moths. Part II, Studies on a further 3 adult "Calyptra (Calpe)" sp. (Lepid., Noctuidae)

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Skin-piercing blood-sucking moths II: Studies on a further 3 adult *Calyptra [Calpe]* sp. (Lepid., Noctuidae)

H. BÄNZIGER

Summary

1. Of the scarce *Calyptra minuticornis, C. orthograpta* and *C. labilis*, 51, 24, and 7 adults, respectively, were observed during some 600 night inspections at over 100 sites in 1965–1967 and 1971–1977.

2. Hitherto biologically completely unknown, and not recorded before in S.E. Asia, the latter two species flew in or near tropical monsoon forests in hilly regions (300–600 m) of N. Thailand (*C. orthograpta* also N. Laos). *C. minuticornis* was found in these and in tropical evergreen and semi-evergreen rain forests of S. Thailand and N.W. Malaysia.

3. In N. Thailand the three species were more common at the end of the cool season/start of the hot season and at the start of the rainy season. They were active mainly during the first half of the night.

4. Flight and piercing behaviour, alighting, resting, enemies, and the lack of females, were similar to virtually identical with the "classical" skin-piercing blood-sucking *C. eustrigata.*

5. *C. labilis* was seen attacking elephant, *C. orthograpta* also water buffalo and sambar, *C. minuticornis* also zebu and tapir but not sambar. *C. minuticornis* settled on man also but did not pierce.

6. Though no piercing of hosts' skin has actually been seen in nature, indirect evidence suggests that the 3 moths are likely to be occasional blood-suckers. They pierced and sucked blood from the author's skin in experiments.

7. Reasons for lack of direct evidence may be: less developed hematophagy, less favoured hosts, lack of easy-to-pierce injured skin (which may also trigger the piercing response), different climatic and phytoecological environment, fewer specimens than in the case of *C. eustrigata.*

8. Field observations and experiments indicate that the closely related, fruit-piercing *Oraesia emarginata* is not skin-piercing blood-sucking – a habit likely to be exhibited mainly in humid equatorial regions by a few *Calyptra* only.

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Key words: Calyptra; Calpe; Noctuidae; Lepidoptera; blood-sucking; flight activity; seasonal frequency; tropical monsoon forest; evergreen rain forest; Thailand; Laos; Malaysia; host; man; mammals.

Introduction

Ever since the finding in 1967 of the skin-piercing blood-sucking behaviour of the adult *Calyptra [Calpe] eustrigata* (Hmps.) there was a need to know whether this is an isolated development, or if other species of this or related genera evolved comparable feeding habits. During studies on the biology of this scarce moth, 3 further species were found to exhibit a similar behaviour: *C. minuticornis* (Guen.), *C. orthograpta* (Butl.) and *C. labilis* (Berio).

This appears to be the first published record of the presence of *C. orthograpta* and *C. labilis* in S.E. Asia, and first biological notes ever, the species having been described taxonomically from China (Butler, 1886; Berio, 1956) and Sikkim (Berio, 1970), respectively, without further details. *C. minuticornis* has been suspected as fruit-piercing in Indonesia (Kalshoven, 1951) and lachryphagous in Cambodia (Büttiker, 1962).

In nature it has not yet been possible to verify whether any of the three species successfully pierced mammal skin but specimens trying to do so were witnessed. Moreover, as will be discussed, there is strong indication – e.g. the moths' piercing and sucking blood from the author's finger in experiments – that the moths are likely to be at least occasional blood-suckers.

The "classical" skin-piercing blood-sucking *C. eustrigata,* on the other hand, is the most thoroughly studied adult of the genus, with published accounts on biotope, flight period and behaviour, hosts, feeding habits, mouth part morphology, possible evolution, etc. (Bänziger, 1968, 1971, 1972, 1975, 1976). The fruit-piercing *C. thalictri* (Bkh.) was used for an analysis of the piercing mechanism in *Calyptra* (Bänziger, 1970).

The present study includes observations on closely related, fruit-piercing *Oraesia emarginata* (Fab.). Neither this, nor members of the taxonomically more distant, but in their feeding physiology more similar, lachryphagous moths, nor the suckers of skin secretions, display a behaviour comparable to that of *C. eustrigata.*

The generic name *Calpe* Treitschke 1825 has once again been replaced by *Calyptra* Ochsenheimer 1816 (Nye, 1975). *C. labilis* is likely to be a junior synonym of *C. fasciata* (Moore) 1882.

The study presented here was realized during an expedition[1] to Thailand, Malaysia and Laos 1971–1973, and part time investigations, 1973–1977, but includes also some earlier observations (1965–1967).

[1] Supported with a grant by the Committee for the Travel Grant of the Swiss Society of Natural Sciences

Observation sites

In order to avoid repetitions, reference is made to earlier studies (Bänziger, 1972, 1975) where sites (f 4) = (1 d) and (c)–(g), respectively, have been described and mapped in detail. Additional sites with positive findings are:

N.W. Malaysia (N. Malaya) (1971–1972)

Taiping Zoo (c 17). Checked 14 sambar *(Cervus unicolor)*, hogdeer *(Hyelaphus porcinus)*, lesser mouse-deer *(Tragulus javanicus)*, Malayan tapir *(Tapirus indicus)*, 2 Indian elephant *(Elephas maximus)*, binturong *(Arctitis binturong)*, civet (*Viverra* sp.), mongoose (*Herpestes* sp.), leopard cat *(Felis bengalensis)*, porcupine *(Hystrix brachyura)*, gibbon (*Hylobates* sp.), cassowary (*Casuarius* sp.) in a park near the foot of Maxwell's Hill (~1100 m) with secondary and primary evergreen rain forest.

Near Padang Rengas (c 18), 10 km north of the town. First of 8 sites with over 90 water buffalo *(Bubalus bubalis)* and few zebu *(Bos indicus)*; situation similar to (c) (loc. cit.) though with less fruit trees and more rubber plantations.

N. Thailand (1972–1977)

Rifle Range (f 2), Chiengmai, situation similar to (f 4), though vegetation more disturbed, inspected 1 elephant.

Near Ban Mae Ha (f 3), ~20 km southwest of Chiengmai, checked 1 elephant, several water buffalo and zebu in similar situation as (h 1).

Elephant Camp 1 (h 1), 55 km north of Chiengmai, and Elephant Camp 2 (h 2), 2 hours on elephant's back east of (h 1), mountainous area with much monsoon forest, and semi-evergreen forest at (h 2); inspected 1–6 elephant.

Ban Co (Doi Saket) (f 5), 22 km east of Chiengmai, village in rice fields, with some fruit trees, 2–3 km from hills with very open, dry forest.

Negative findings

No adult of the three *Calyptra* species reported on in this paper was found at over 110 sites of 25 major areas (cf. loc. cit.).

Geographical distribution and biotope

Based on findings on or near mammals, the geographical distribution appears to be as follows: *C. minuticornis*, N. and S. Thailand and N.W. Malaysia; *C. orthograpta*, N. Thailand and N. Laos; *C. labilis*, N. Thailand.

The adults of the last two species appear to be limited, in the present study area, to the tropical monsoon climatic region, in hilly (up to at least 600 m) biotopes with deciduous (monsoon) forest on sun-exposed, sometimes rocky slopes, with spots of evergreen forest in sheltered pockets and evergreen gallery forest along streams (Küchler and Sawyer, 1967; Khomkrys, 1972; Ogawa et al., 1961). The places were not far down from evergreen hill forest on mountain tops and often at the border of the large intramontane plane (300 m) under cultivation. *C. minuticornis* also lives in the more or less constantly wet tropical lowland biotopes with evergreen dipterocarp rain forest and, higher up, evergreen hill dipterocarp rain forest (Wyatt-Smith, 1952), as well as semi-evergreen rain forest and moist deciduous forest (Whitmore, 1975).

The moths attacked mammals in forests with or without thick undergrowth (h 1, 2), but attacks in small clearings (h 1) or small open pastures (f 4) also occurred, though mainly by *C. minuticornis*.

At (f 5) one *C. minuticornis* entered through a window of the wooden stilt-house where the author was having dinner; it flew around restlessly probably because of the neon lights.

Annual flight period, frequency and time of activity

As shown in Figs. 1 and 2, in N. Thailand *C. minuticornis*, *C. orthograpta* and *C. labilis* had a peak in their annual flight frequency near mammals at the end of the cool season/start of the hot season (February–March) and another about the end of the hottest month/start of the first rains (May–June). In N.W. Malaya *C. minuticornis* had a peak in March (onset of more rains), but it could not be checked whether there is a second peak April–November. By comparison, *C. eustrigata* had a fairly even population throughout the year at site (a) in W. Central Malaya (Bänziger, 1975).

The three species, with 51, 24 and 7 specimens, respectively, found during 110 (the latter 2 during 66) night inspections, are rather scarce at the sites where they are proved to occur. This does not take into account some further 200 inspections at sites with likely but not proved occurrence of the moths; and an additional 300 inspections in 1965–1967 when the author studied lachryphagous Lepidoptera which live in similar ecological niches.

The 3 species were active mainly during the first half of the night (Fig. 3).

Flight patterns and alighting; feeding spots

These were as described for *C. eustrigata* (Bänziger, 1975) except for the following 4 differences: 1. *C. orthograpta* and *C. labilis* displayed a distinctly more vigorous flight. 2. The search for an alighting point generally took longer. 3. Successful landings were far more scarce in *the species treated here* (Tables 1–3). 4. On 3 nights at sites (c 1, 3, 18) *C. minuticornis* circled around the head of a zebu. One landed at the nostrils and seemed to lick fluids (Fig. 11), one landed on the lip and 4 (of which 3 may have been the same specimen) on the rope near where it was attached to the nostril, licking and sometimes performing what appeared to be piercing attempts. The nose, lips and the rope – which must have incised the nasal septum because the zebu vigorously drew on it to escape – must have been smeared with blood. While the moths may have been after saliva and nasal fluids since those nights were unusually dry, it seems more likely that blood and wound exudates attracted the moth.

The observation of one *C. minuticornis* at or near the eye of a water buffalo (Büttiker, 1962, and personal communication) may also be explained as above

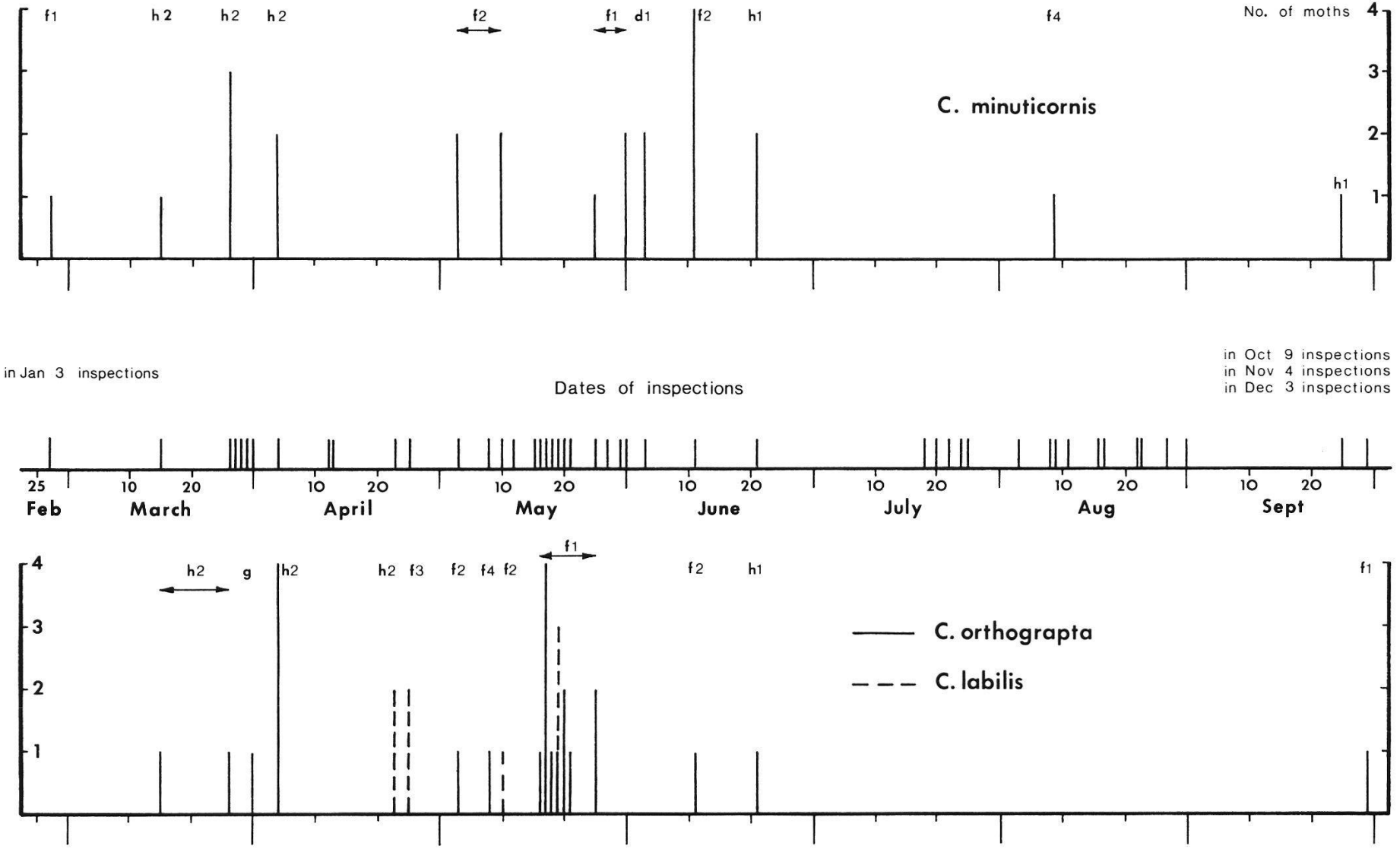


Fig. 1. Records of *C. minuticornis*, *C. orthograpta* and *C. labilis* on or near mammals in S. and N. Thailand, and N. Laos. Numbered letters refer to collecting sites; dates of inspections are on central line.

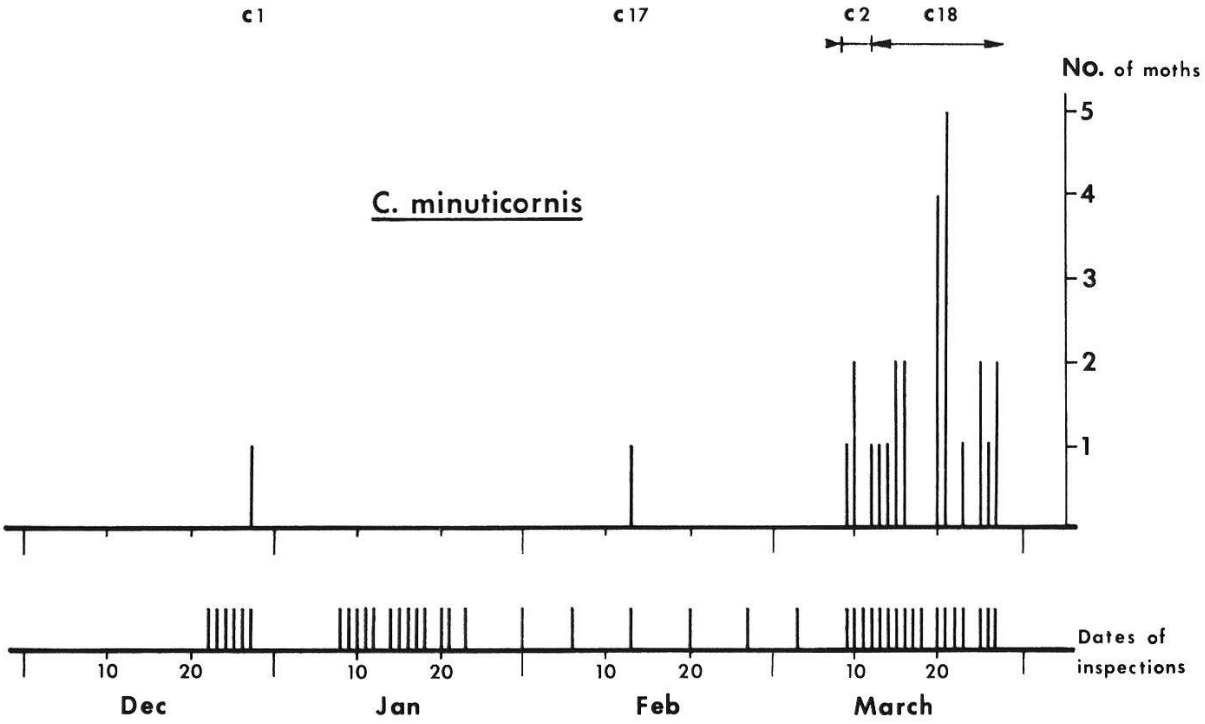


Fig. 2. Records of *C. minuticornis* on or near mammals in N.W. Malaysia, with places (numbered letters) and dates of inspections.

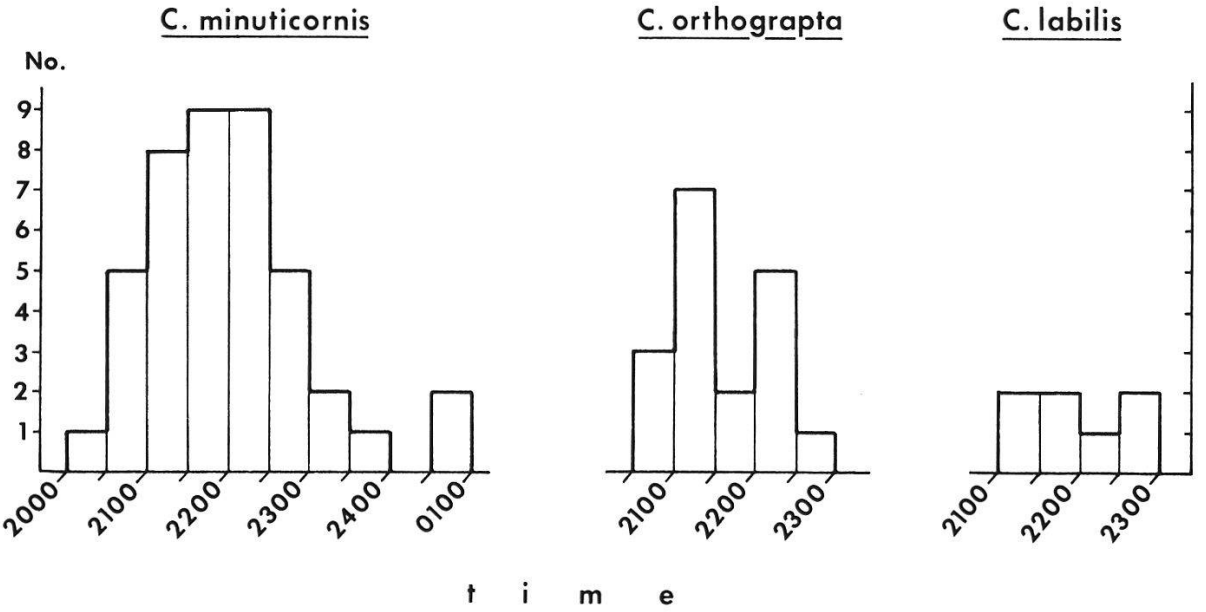
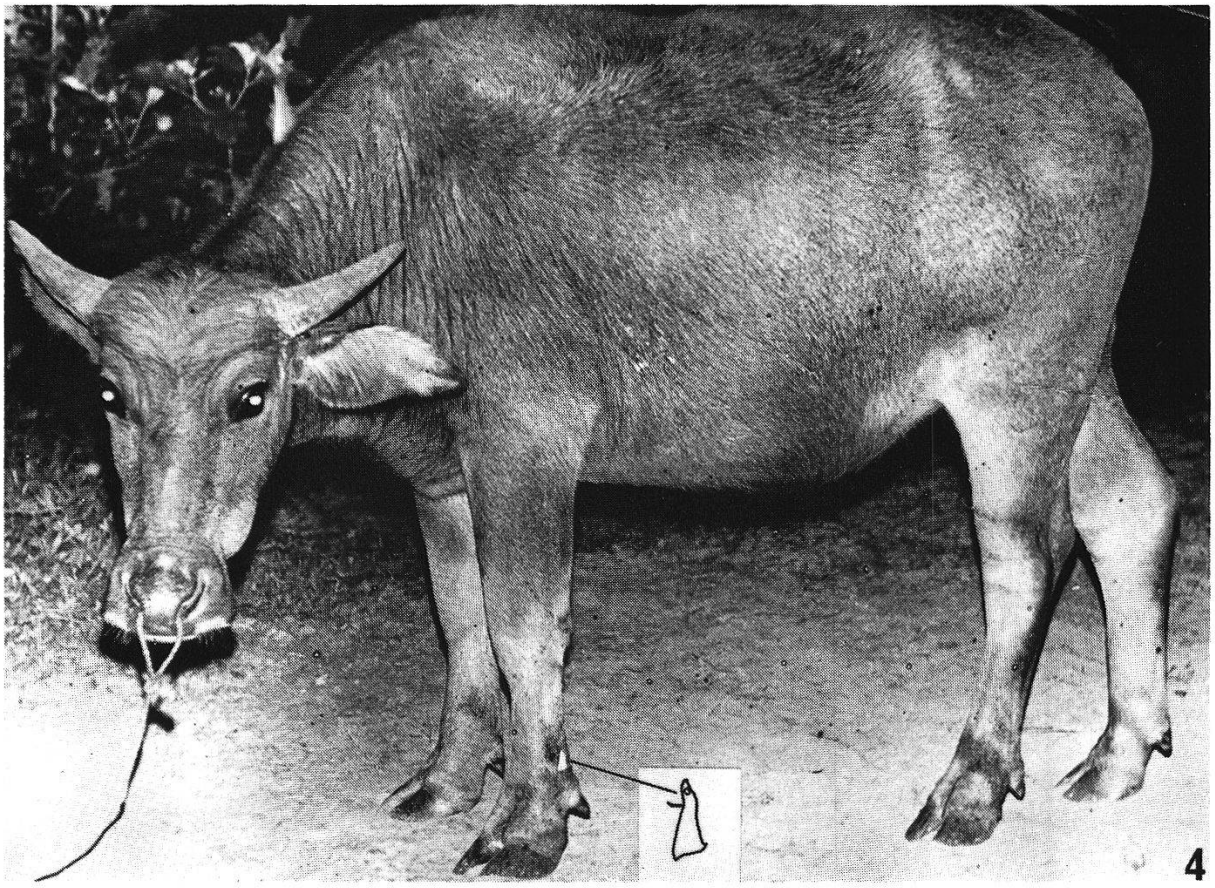


Fig. 3. Time of appearance of *C. minuticornis*, *C. orthograpta* and *C. labilis* on or near mammals. No. = number of specimens recorded.

Fig. 4. *C. minuticornis* attempting to pierce the skin of a water buffalo's leg (N.W. Malaysia).

Fig. 5. *C. minuticornis* in search of a suitable feeding spot just above the hoof of a water buffalo (N.W. Malaysia).



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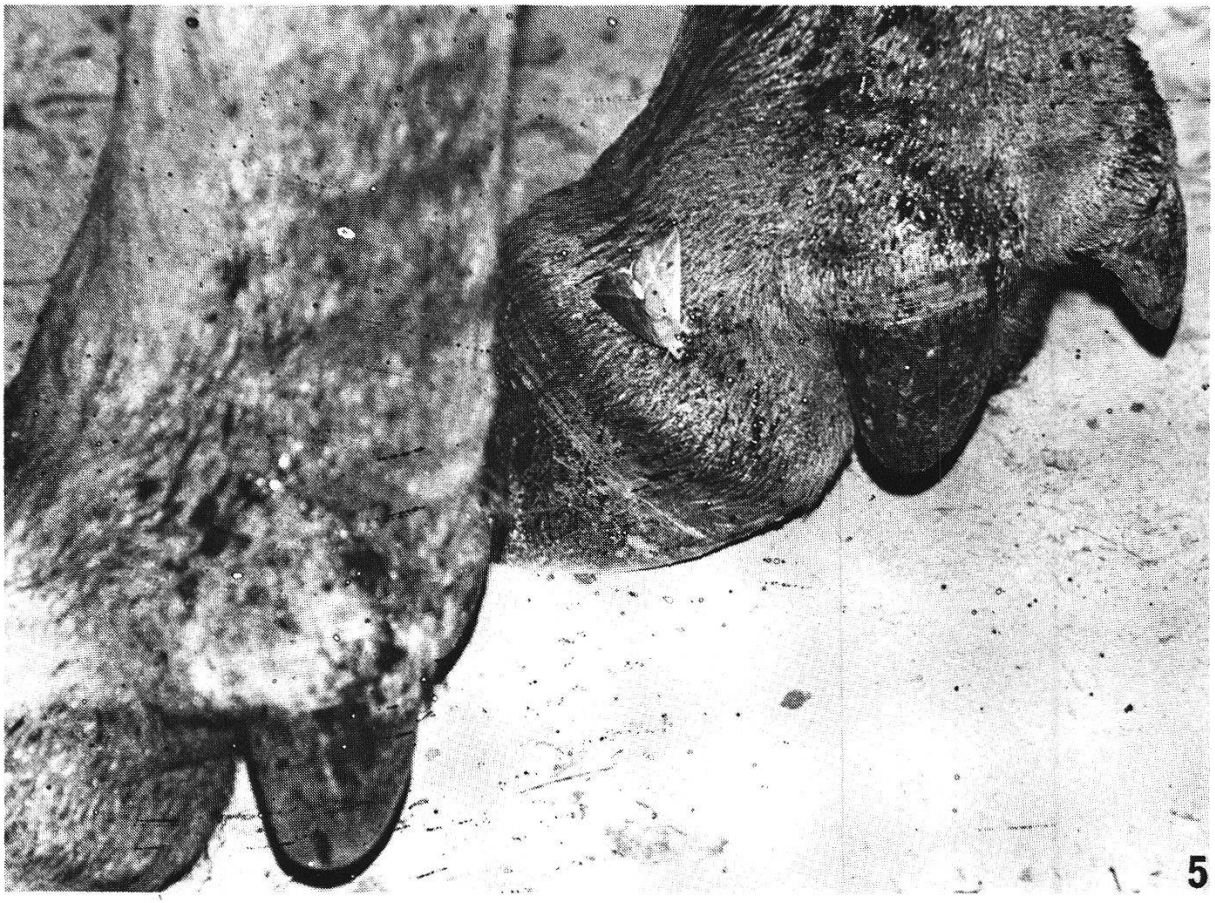

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or alternatively as a casual landing since overall behaviour and mouth part morphology of the moth is not that of a lachryphagous species.

It is interesting to note that previously mentioned (Bänziger, 1972) blood droplets excreted anally by mosquitoes – sometimes by the thousands as at (c 18) – were not imbibed by *C. minuticornis*, except accidentally in tiny amounts, though their presence (smell?) may well have attracted the moth. But they were eagerly imbibed by zoophilous Geometrids (*Scopula* sp., *Nobilia* sp.), Pyralids (*Sylepta* sp.) and sometimes even by the otherwise typical lachryphagous *Filodes fulvidorsalis* Hbn.

Hosts (Figs. 4, 5 and 11)

As shown in Tables 1–3, *C. minuticornis*, *C. orthograpta* and *C. labilis* were found to be attracted to 4, 3 and 1 animal species, respectively. Though the moths attempted to pierce, it has not yet been possible to see them actually sucking blood by piercing the skin of these animals in the wild – a feature discussed in more detail later.

Table 1. Observed frequencies of behavioural elements of *C. minuticornis* near or on mammals

Host	Flying nearby	Circling around	Landing attempts	Successful landing	Piercing attempts
Zebu (*Bos indicus*)	10	9	8	5	1
Water buffalo (*Bubalus bubalis*)	31	27	24	16	4
Malayan tapir (*Tapirus indicus*)	1	1	1	1	1
Indian elephant (*Elephas maximus*)	24	22	14	7	2
Man (author)	5	4	3	3	0

Table 2. Observed frequencies of behavioural elements of *C. orthograpta* near or on mammals

Host	Flying nearby	Circling around	Landing attempts	Successful landing	Piercing attempts
Sambar deer (*Cervus unicolor*)	1	1	0	0	0
Water buffalo	4	4	4	4	1
Indian elephant	23	20	12	7	0
Man (author)	1	1	0	0	0

Table 3. Observed frequencies of behavioural elements of *C. labilis* near or on mammals

Host	Flying nearby	Circling around	Landing attempts	Successful landing	Piercing attempts
Indian elephant	10	10	8	4	1

N.B. Figures represent total number of instances of a particular behavioural sequence, not the number of individuals.

The hosts belong to the Artiodactyla, Perissodactyla and Proboscidea, as do the 10 mammals to which *C. eustrigata* is attracted. The smaller number of mammal species attacked by the 3 moths under study here is probably due mainly to the smaller variety of mammals present at sites where the 3 moths occurred, as well as to the scarcity of these moths.

None of the other animal species listed in "Observation sites" were seen to attract the 3 moths.

The hosts' behaviour during attacks by and defensive reactions against the 3 moths were as those which *C. eustrigata* elicited (Bänziger, 1975).

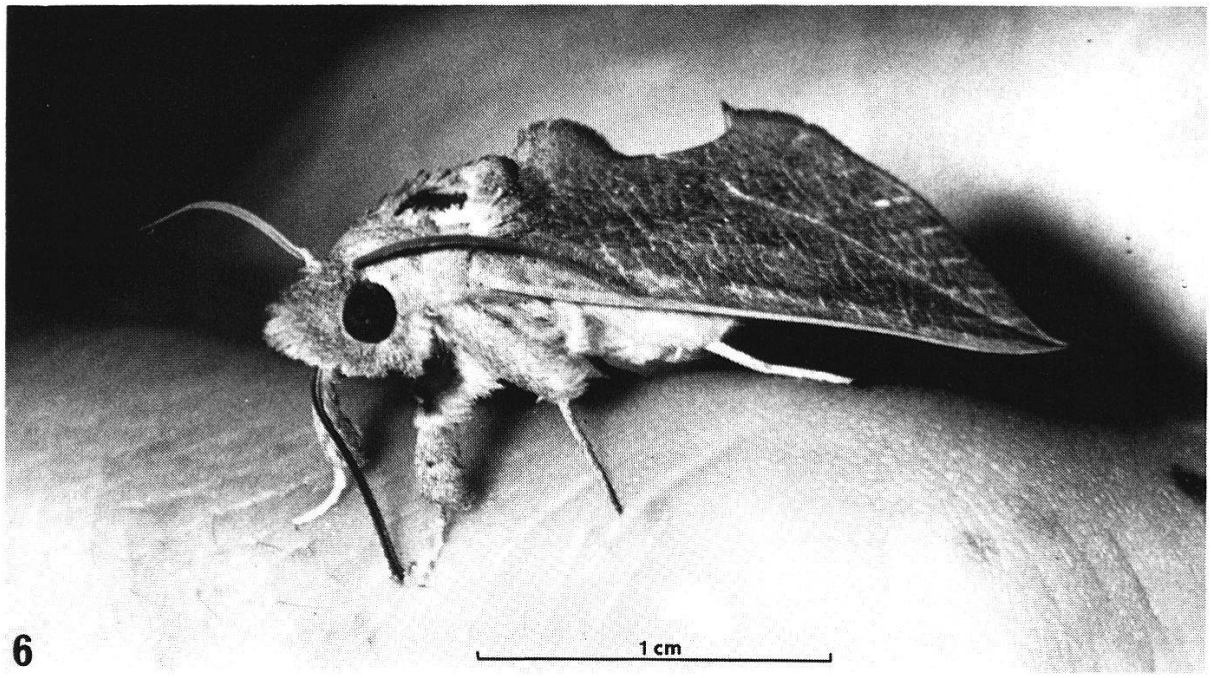
Attacks on man in nature and in experiments (Figs. 6 and 7)

C. minuticornis and *C. orthograpta* circled around the author in a few cases at (f 4) and (h 2). One *C. minuticornis* alighted 3 times at minute-long intervals on the author's leg, arm and hand where it crawled restlessly and palpated the skin with the proboscis as if in search of something; it did not attempt to pierce.

In an outdoor trial at midnight, a *C. labilis* captured an hour earlier from an elephant, climbed onto the author's finger as he introduced it into the portable cage, and after some palpating rapidly pierced 4 holes. It then sucked blood piercing unusually deep, causing considerable pain, for some 15 min.

In indoor experiments *C. minuticornis* pierced and sucked blood from the author's intact skin 3 times on its own initiative, 4 times only after stimulation, and did not pierce in 4 trials. In *C. orthograpta* the ratio was 1, 1, 4. In one case it was necessary to shake the hand vigorously to get rid of a particularly persistent *C. minuticornis.* Except for the more frequently repeated piercing attempts, the piercing behaviour corresponded closely to that of captive *C. eustrigata.*

Possible cases of 2 moths, and unlikely ones of *Catagramma* butterflies, sucking blood from man have been mentioned by Bänziger (1976) and Bourgogne (1970), respectively. So far, however, lachryphagous moths feeding at the human eye remain the only fully documented cases of lepidopterous ectoparasitism on man (Bänziger, 1966; Bänziger and Büttiker, 1969).



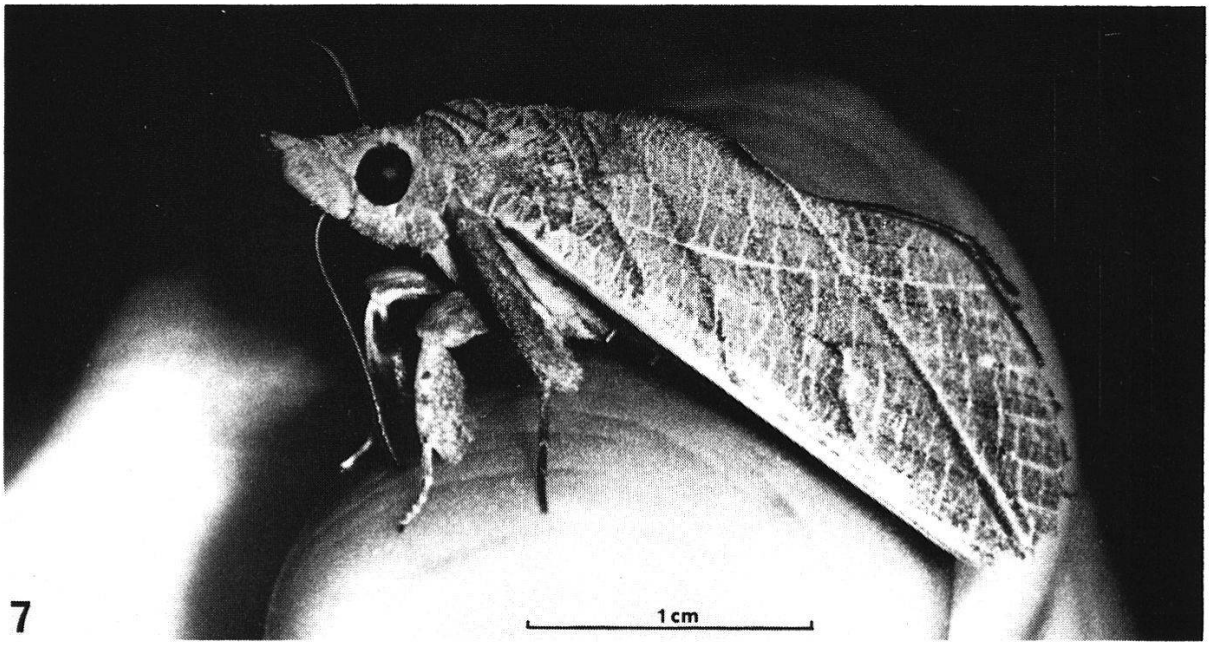


Fig. 6. *C. minuticornis* piercing the skin of the author's finger (experiment).

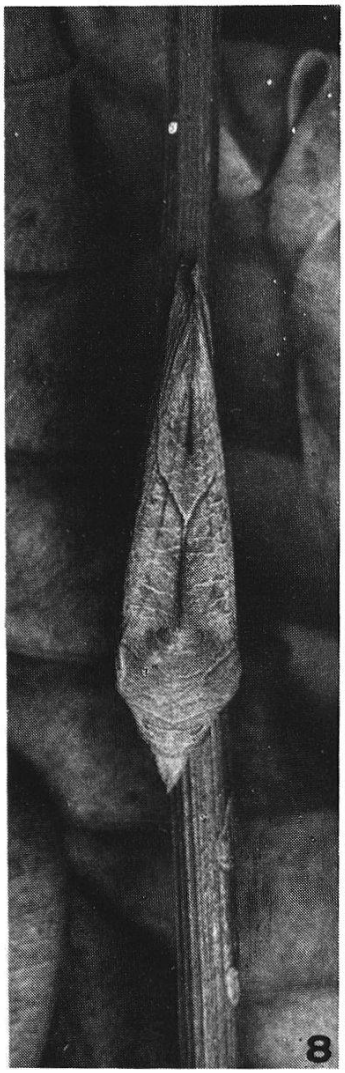
Fig. 7. *C. orthograpta* piercing the skin of the author's finger (experiment).

Fig. 8 and 9. When seen from above or from the side, resting *C. minuticornis* is reminiscent of a bud or a dry leaf.

Fig. 10. *C. orthograpta* at rest, with mimetic characteristics as above.

Fig. 11. Rather unusual behaviour of *C. minuticornis* palpating and possibly sucking fluids, with rounded proboscis (P) in "flamingo position", at the nostril of a zebu (N.W. Malaysia).

Fig. 12. Fruit-piercing *Oraesia emarginata*, close relative of *Calyptra*, in action on a guava fruit. (Inserts drawn from the original colour negatives.)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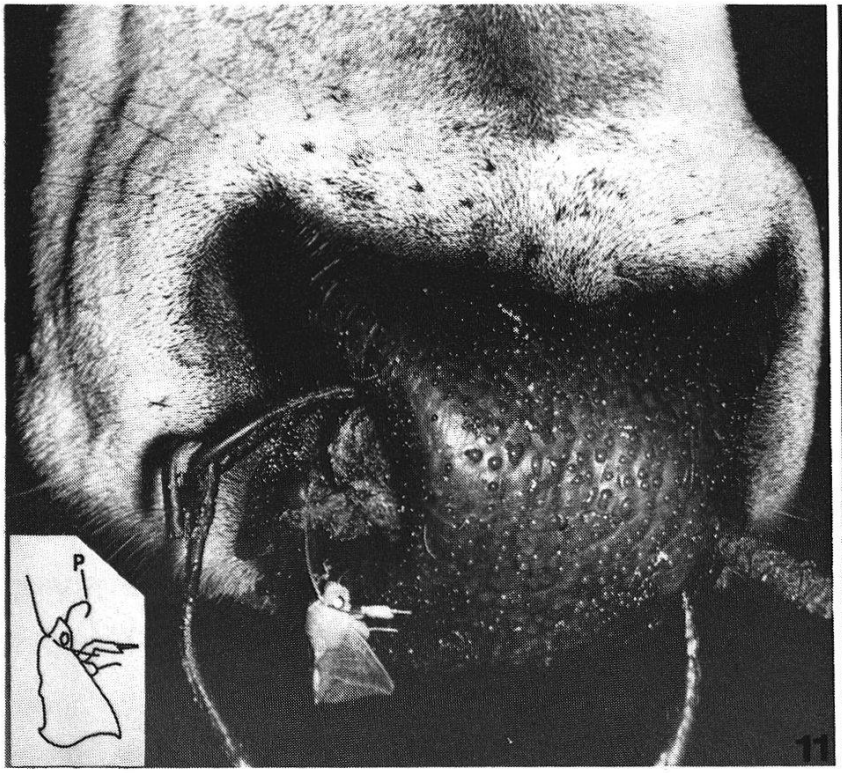
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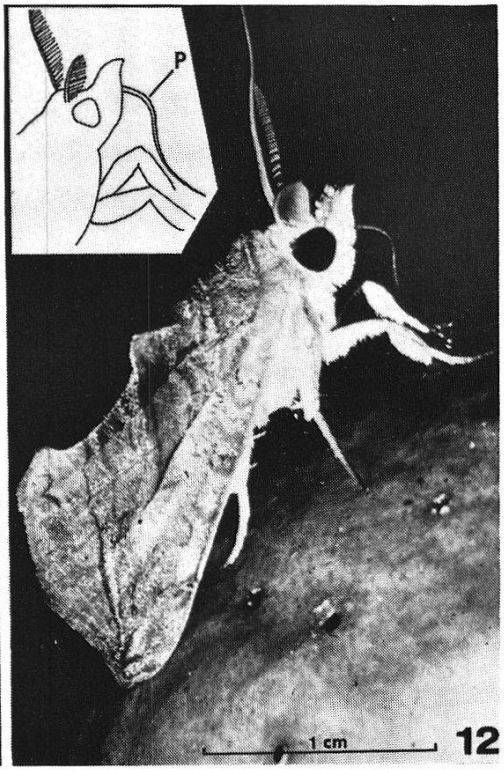
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Sex ratio and resting

Only male *C. minuticornis, C. orthograpta* and *C. labilis* were found on or circling around mammal hosts. As in *C. eustrigata* the females must have a different feeding habit – an intriguing feature which has been extensively discussed (Bänziger, 1975).

In nature none of these species – active or at rest – was found during the day. Caged specimens were at rest during the daylight hours in a characteristic position (Figs. 8–10).

Enemies

A bat swooped several times in quick succession at a *C. labilis* circling around an elephant at (f 1). The moth countered all attacks with a sudden flight deflexion and after a short zig-zag course soon returned to the elephant. Unsuccessful strikes by two other species of bats at *C. minuticornis* flying around a water buffalo were also witnessed on several occasions at (c 18). Like *C. eustrigata,* this species generally did not return to the host after such an attack. Sometimes bats were hunting so regularly that their harassment seriously handicapped observations.

Feeding habits in a closely related genus (Fig. 12)

Oraesia is the genus most closely related to *Calyptra;* some of its species are still wrongly placed in *Calyptra.* The piercing armature of the proboscis of *O. emarginata* does not appreciably differ from that of *C. eustrigata* or *C. minuticornis.* Despite this resemblance, *O. emarginata* is strictly a fruit-piercing moth. It occurred together with *C. minuticornis* at site (f 1) and (f 4), and elsewhere, but was never seen circling around, or trying to land on, mammals. Trials to induce it to pierce and imbibe blood from the author's finger failed.

Discussion

Although there is no strict evidence yet that *C. minuticornis, C. orthograpta* and *C. labilis* are skin-piercing blood-sucking moths like *C. eustrigata,* the following observations indicate that they are likely to occasionally exhibit such feeding habits: a) persistent circling around, alighting attempts and clinging on, a mammalian host despite its defensive reactions; b) landing indiscriminately on different parts of the body except eyes, ears, horns, claws and anal region (indication that the 3 moths are not looking for eye-secretions, urine or dung); c) little, if any, crawling around on the host's body without persistent palpating with the proboscis (indication that the 3 species' main search is not for skin secretions as moths imbibing these move around continuously with rapid pal-

pating of the proboscis); d) piercing attempts observed; e) experimental proof of the 3 moths' capability to pierce and eagerness to suck blood from the author's skin; f) piercing behaviour and proboscis morphology range from similar to virtually identical to those of the typical skin-piercing blood-sucking *C. eustrigata.*

Reasons for the lack of direct evidence that the 3 species exhibit skin-piercing blood-sucking habits may arise from one or a combination of the following factors: 1. hematophagy may be less developed than in *C. eustrigata;* 2. broken skin with excoriations, blood crusts, sores or fresh wounds was missing in the area where the 3 moths were studied (only exception: a chronic sore on a tapir at site [c 17]). *C. eustrigata* often pierced such spots to suck blood (Bänziger, 1975). Damaged skin may trigger or enhance the alighting and piercing response in the 3 species. Also, the 3 moths may be able to pierce only severed skin; 3. if *C. eustrigata* is taken as a reference, the two most attractive hosts, tapir and rhinoceros, were not present at the study sites of the 3 *Calyptra* (only exception as above); 4. the rarity of the 3 moths; 5. the area of the seasonal monsoons with its more differentiated climate may have a different impact on the 3 moths from the ever-wet tropical climate where the "classical" *C. eustrigata,* and to some extent also *C. minuticornis,* were mainly studied. Humidity and temperature may directly influence the moths' behaviour, as they do the flying and biting frequency in mosquitoes (Freyvogel, 1959; Provost, 1973). *C. minuticornis* appeared to be more "aggressive" in N.W. Malaysia (site c 18) than in N. Thailand (sites f). "Classical" *C. eustrigata* has not yet been seen in the act of successfully piercing hosts' skin in N. Thailand though it was recorded on mammals there; 6. In the latter two moths, mentioned feeding differences may be an expression of genetical differentiation in geographically distant populations. Autogeny in populations of *Culex pipiens* was found to decrease from north to south (Spielman, 1964, 1971), or vice versa in *Aedes taeniorhynchus* (O'Meara and Evans, 1973), and this difference is genetically fixed.

Climatic-phytoecological factors are likely to explain also the population fluctuation of the 3 moths on or around mammals as compared with the fairly even populations of *C. eustrigata* in ever-wet W. Central Malaya. More pronounced ripening seasonality and more agglomerated distribution patterns of fruits may offer, or cause lack of, alternate food sources. Also, cool-dry and hot-dry climates are likely to demand different food and water requirements than a hot ever-wet climate. Increased water loss through evaporation in dry-hot air may be compensated for by production of metabolic water through combustion of fat as in clothes-moths (Babcock, 1912), or possibly diminished by larger intake of salt. Blood offers both.

As to the presence of skin-piercing habits in other lepidopterous species and genera, *C. thalictri* did not pierce the author's skin, though experiments made were primarily not devised to check this. There is no report about *Calyptra* species sucking blood in the temperate and subtropical Oriental Region. It

has been shown that closely related, fruit-piercing *O. emarginata* does not suck blood. Other S.E. Asian fruit-piercing moths known to the author are either distant relatives of *Calyptra* (e.g. *Othreis, Eumaenas, Platyja*) and/or have no suitable piercing mouth parts (e.g. *Ophiusa, Plusiodonta*). The known zoophilous (lachryphagous, blood-licking, skin-secretion, dung and urine sucking) Noctuids, Geometrids, Pyralids and Notodontids have been discussed elsewhere as being non-piercing species (Bänziger, 1970, 1972). From the above it may be tentatively assumed that skin-piercing blood-sucking habits are exhibited, in S.E. Asia, mainly in the humid equatorial regions by a few species of *Calyptra* only.

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