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A PERSISTENT TEAR DRINKER: NOTODONTID MOTH *PONCETIA LACRIMISADDICTA* SP. N., WITH NOTES ON ITS SIGNIFICANCE TO CONSERVATION

*Hans Bänziger**

ABSTRACT

Recently discovered *Poncetia lacrimisaddicta* sp. n. is described and illustrated together with related Notodontidae. Adult males of *P. lacrimisaddicta* imbibed lachrymation from eyes of zebu with unusual persistence. Ethological and ecological details, and photographs of feeding individuals, are included. The moth seems to be restricted to Doi Chiang Dao Wildlife Sanctuary. Doi Chiang Dao, Doi Suthep-Pui National Park, and a few other high mountains of N. Thailand appear to be the only homes of four further *Poncetia* spp. The region is considered to be a center of species diversity for *Poncetia*; possible explanations for the moths' habitat restriction are presented. The wider significance of protected areas as sanctuaries for specialized, endemic forms of life is stressed, especially since these tend to be interlinked with further, often not yet known biota.

INTRODUCTION

The present study resulted from what happened in the night of June 1, 1988. A zebu caravan stopped for the night in a forest clearing of Doi Chiang Dao Wildlife Sanctuary. Over the years I had passed many nights in that clearing, and I knew from traces left behind that caravans occasionally bivouacked there, but I had never actually met one. They walk for over a month on their long way from far beyond the Burmese borders, and are therefore in an exhausted condition; this enhances their entomological interest.

The clearing had been a good study site, though never outstanding, for zoophilous moths. However, that particular event will remain impressed in my mind as one of the most glorious ones I have ever experienced in terms of diverse, rare or previously unknown moth species tormenting 20 tired zebu.

During the misty, drizzly night, representatives of 5 lepidopterous families were engaged in visiting eyes: 15 species of Geometridae, 10 of Pyralidae, 2 each of Noctuidae and Notodontidae, and 1 of Sphingidae—an unprecedented orgy of different tear drinkers. This article deals with one of them only, the notodontid *Poncetia lacrimisaddicta* sp. n., because its discovery is of some actuality.

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Firstly, in a recent treatise of the ecology and systematics of lachryphagous Notodontidae (BÄNZIGER, 1988a), among else 5 new *Poncetia* were described, all but one from Doi Suthep-Pui National Park and some other mountains of N. Thailand. That study covered a research period of 17 years and thus there was reason to be confident that all *Poncetia* likely to be expected in N. Thailand had been treated. This assumption seemed all the more likely since until recently *Poncetia* was known as a widely distributed, species-poor genus consisting of only 3 taxa, further reduced to one single species in the mentioned study: *albistriga* Moore, 1888. This moth had been reported from such widely separated regions as N. E. India (MOORE, 1888), Taiwan (WILEMAN, 1914), W. Malaysia (HOLLOWAY & BENDER, 1985), Sumatra (VAN EECKE, 1929; BENDER & DIERL, 1977; BENDER, 1985), and apparently even Java (KIRIAKOFF, 1968).

Therefore, the finding of a fifth new species, *P. lacrimisaddicta*, in N. Thailand, so soon after completion of that study, and that during a single night about as many *P. lacrimisaddicta* were observed as of the other species together in 17 years indicate that Thailand's wildlife has indeed surprises in store even where it has been researched in some detail.

Secondly, before that article no photographic documentation of any *Poncetia* spp. taking lachrymation at eyes of mammals had yet been realized; the ones presented here are the first.

Thirdly, besides the ethological interest of the new species, this and the other *Poncetia* spp. are of biogeographic interest and have some bearing in the context of nature conservation in Thailand, as discussed further down.

SYSTEMATIC ACCOUNT

Poncetia lacrimisaddicta sp. n.

(Figures 13–22)

Holotype. ♂, THAILAND: Chiang Mai Prov., Chiang Dao Distr., Doi Chiang Dao, 1150 m, 1.vi.1988, Bänziger leg., genitalia slide 2729, to be deposited in the collection of the Department of Entomology, Faculty of Agriculture, Chiang Mai University.

Paratypes. 5 ♂, ibid. genitalia slides 2727 (to be deposited at the British Museum (Nat. Hist.), London), 2725, 2726, in coll. Bänziger.

Derivation of name. Alludes to the species's craving for tears as described in more detail in the ecological account.

Diagnosis. Closest to *P. siamica* Bänziger, 1988 (Fig. 10) and *P. bhutanica* Bänziger, 1988 (Figs. 3,4) but smaller than both, the markings on fore wing darker and more obvious. Darker also than *P. huaykaeoensis* Bänziger, 1988 (Figs. 7,8) especially the hind wings. Distinct from *P. bovoculosugens* Bänziger, 1988 (Fig. 9) and *P. doisuthepica* Bänziger, 1988 (Figs. 11,12) in the larger size, lack of light cross

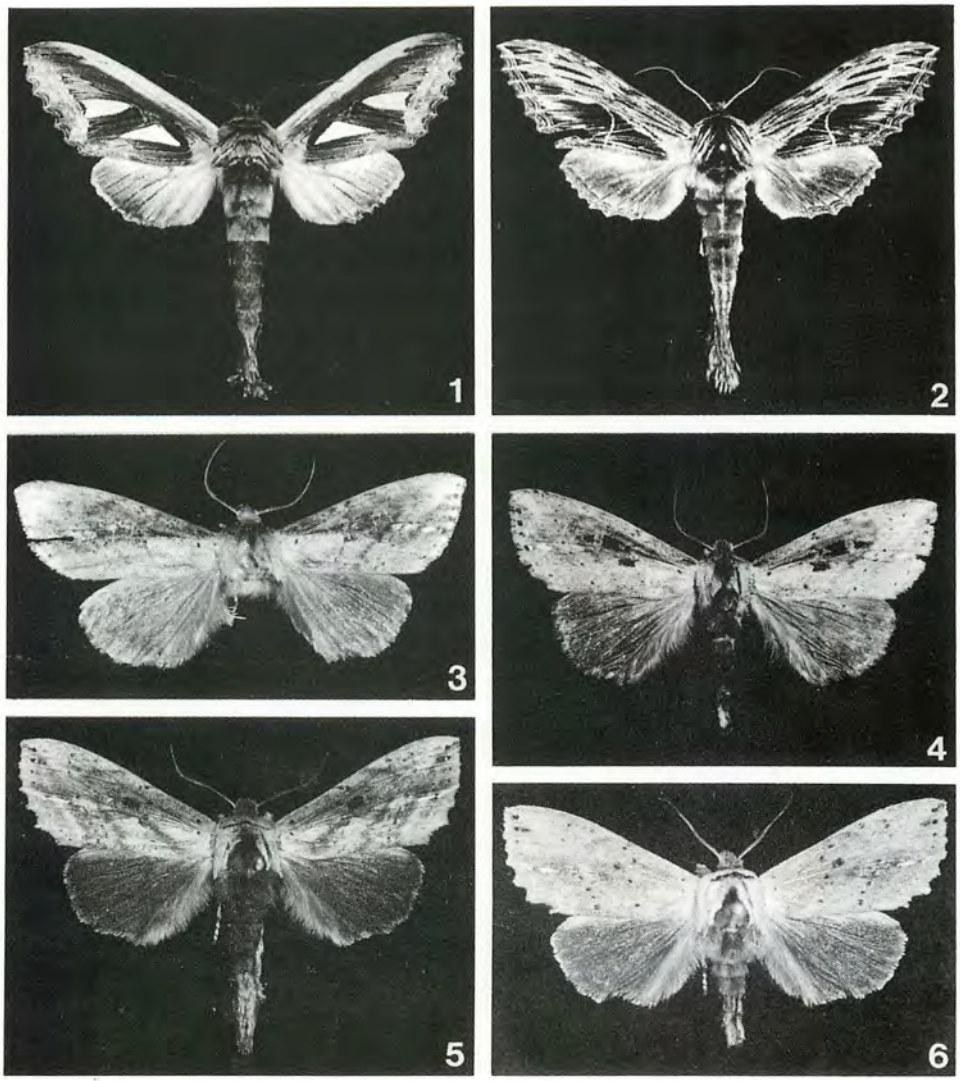
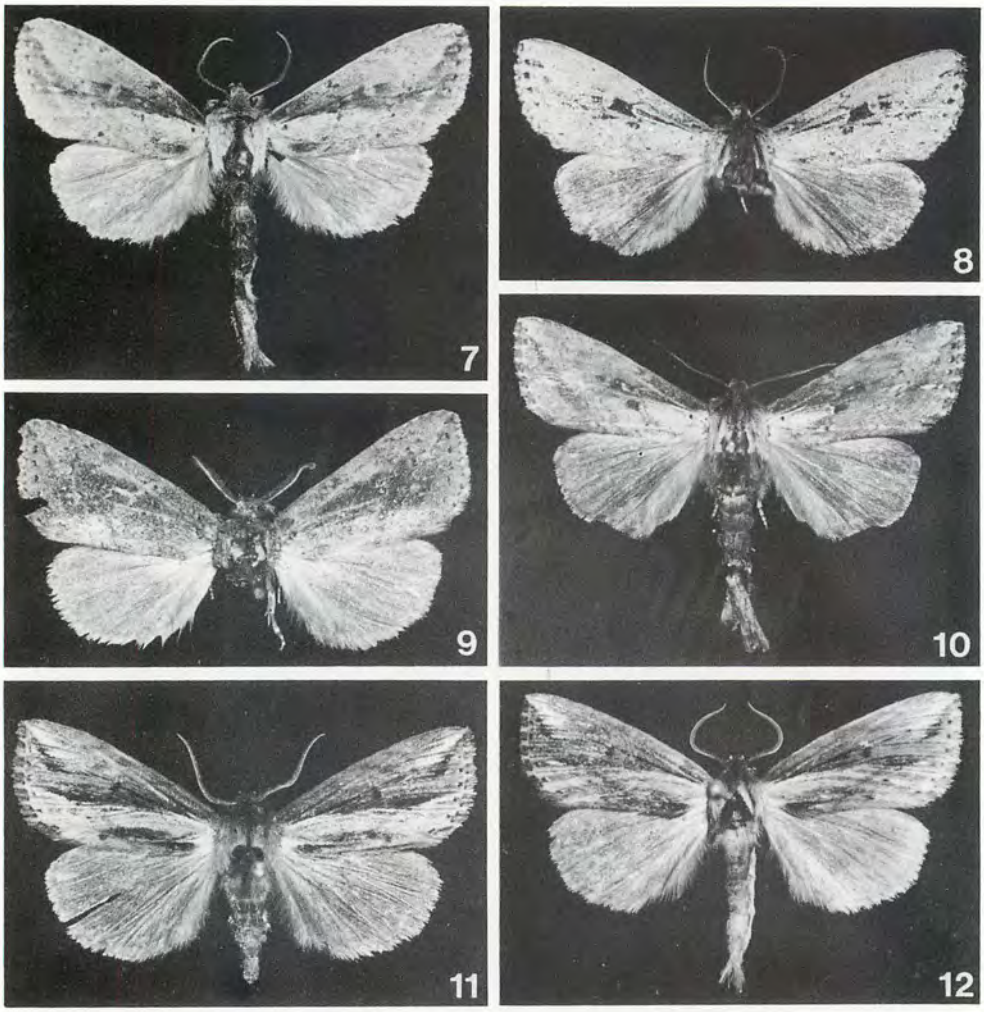
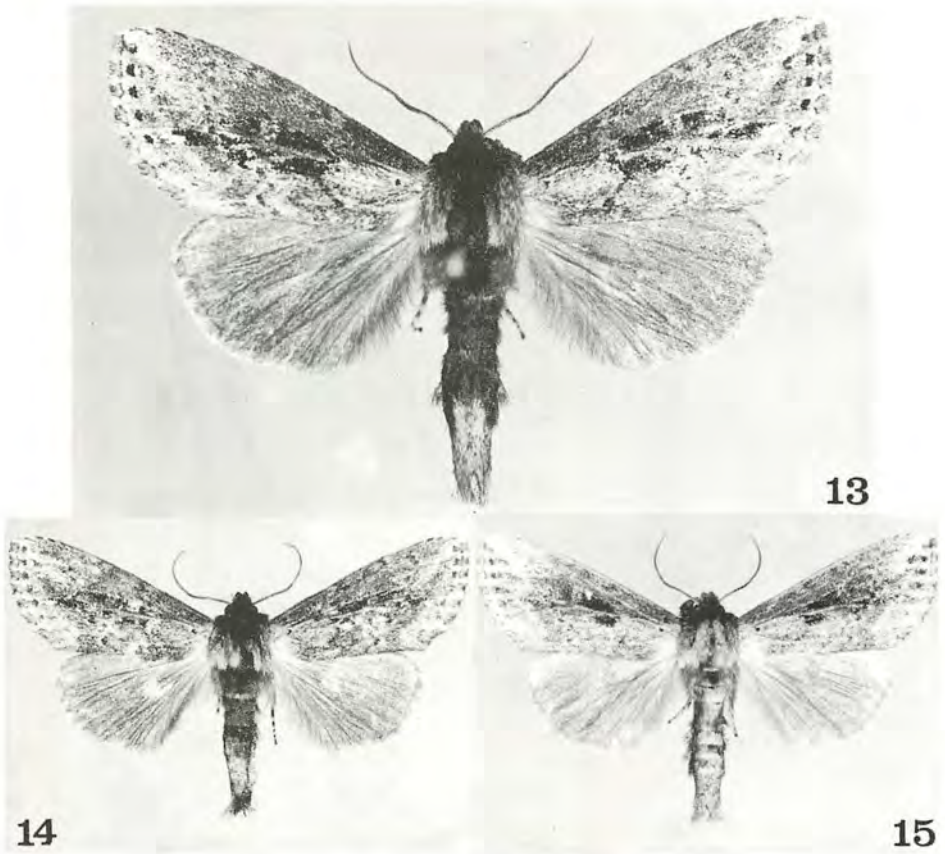


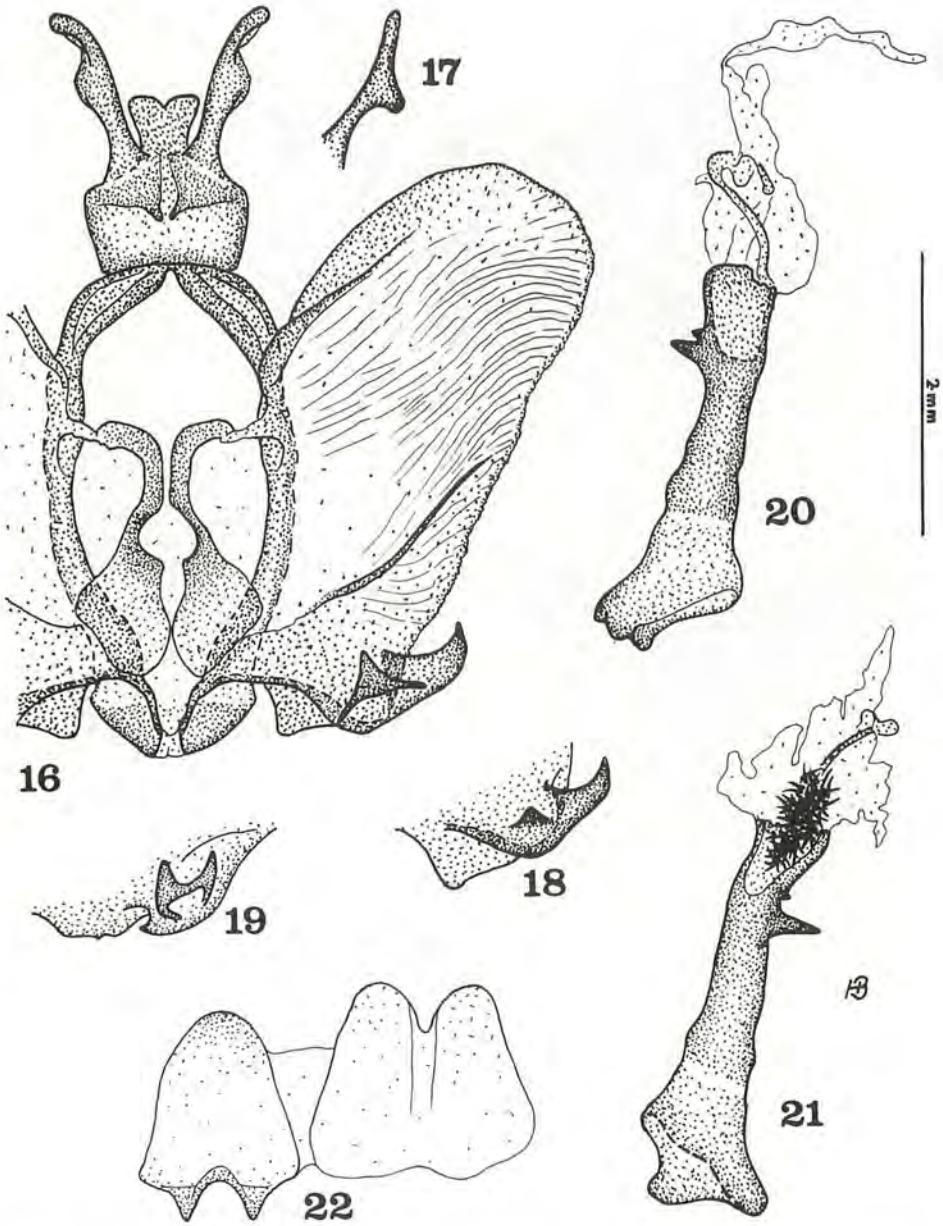
Figure 1. *Tarsolepis elephantorum,* paratype.
Figure 2. *Megashachia brunnea equidarum* stat. & comb. n.
Figure 3. *Poncetia bhutanica*, holotype.
Figure 4. *Poncetia bhutanica*, Nepal.
Figures 5, 6. *Poncetia albistriga.*



Figures 7,8. *Poncetia huaykaeoensis*, paratypes.
Figure 9. *Poncetia bovoculosugens*, holotype.
Figure 10. *Poncetia siamica*, paratype.
Figures 11, 12. *Poncetia doisuthepica*, holotype, paratype.



Figures 13 – 15. *Poncetia lacrimisaddicta* sp. n., paratype (enlarged) (13), holotype (14), paratype (15).



Figures 16–22. ♂ genitalia of *Poncetia lacrimisaddicta* sp. n., with the arm of the uncus seen laterally (17), variation of the basal lobe (18), a sketch of the basal lobe folded in (reduced)(19), aedeagus (20), variation of the aedeagus seen from the other side, with cornuti (21), and 8th sternite and tergite (reduced) (22).

band which is present in the latter species, while the former is remarkable in being the only *Poncetia* having a bipectinate antenna. *P. albistriga* (Moore) (Figs. 5, 6) can be separated by the dentate-serrate outer fore wing margin. Clearest differences are in the genitalia as mentioned below.

Description. Male (Figs. 13–15). Wingspan 39–41 mm. Head, palpus, antenna as in *albistriga* but much darker. Proboscis just over 5 mm long and hence shorter and thinner than in the above-mentioned species except *doisuthepica* and *bovoculosugens*; sclerotization and sensillae as mentioned for the other species (BÄNZIGER, 1988a). Thorax above distinctly darker than in all other *Poncetia* spp.; the 7th and 8th abdominal segments of otherwise dorsally dark abdomen are light brown.

The dark areas of the fore wing upperside are more greyish and darker than even *siamica*. When at all visible, the antemedial and postmedial lines are strongly undulating, generally better defined than in other *Poncetia* spp. The white streak is nearly as evident as in *siamica*. On the outer wing margin, and on the fringes, dark blotches alternate conspicuously with white ones. At the wing's apex a diffuse yellowish grey band may be more or less well developed, the tornus area may also be paler, and a pale wing base like that of *siamica* is mostly present.

Hind wing very dark grey, the fringes being alternately dark and pale, unlike *siamica* in which they are plain grey.

Wings underside yellowish grey to brownish grey, the fore wing darker than the hind wing, especially in the central area, the terminal line consisting of three to four black dots set between the veins near the apex. On the hind wing a strongly undulating postmedial line may be present.

Male genitalia (Figs. 16–22). Closest to *siamica, huaykaeoensis* and *bhutanica*. *P. lacrimisaddicta* is distinct from these in the rounded apical part of the valve (angulated or slightly lobed in others), as well as in the presence of a somewhat variable, triangular, strongly sclerotized extension on the basal lobe of the valve, this ending in a point or sharp ridge (extension missing in the others, and lobe not pointed). Distal arms of the juxta narrower than in the other 3 species. Uncus appendages narrower than in *siamica* and *bhutanica* but much less so than in *huaykaeoensis*. The aedeagus, which is more slender than in the other 3 spp., has a prominent tooth extending out laterally at some distance from the apex, with a smaller one distal to it; it is arranged differently than in the other species. Cornuti were present in 2 out of 4 aedeagi studied; in the other two they probably were lost during copulation.

Synonymic Note

Dr. A. Schintlmeister made me recently aware of the close alliance between *Tarsolepis equidarum* Bänziger, 1988 and *Megashachia brunnea* Cai, 1985 from China. Cai's work was not available to me, nor was the species present at the British Museum (Nat. Hist.), London, where I carried out my study. Compared with Cai's description and drawing, there are small but possibly important differences between the two taxa, especially in the shape of the uncus (extremity not claw-like in *T.*

equidarum), juxta, and valve, that may be of subspecific significance. Until larger collections of Thai and Chinese specimens can be compared, the following proposition would seem to be the most appropriate:

***Megashachia brunnea equidarum* Bänziger, stat. & comb. n.**
(Figure 2)

Megashachia brunnea Cai, 1985, Acta entomol. Sinica **28:** 314–316, Figs. 1, 2.
Tarsolepis equidarum Bänziger, 1988, Nat. Hist. Bull. Siam Soc. **36:** 25–26, Figs. 2, 20–22.

ECOLOGICAL NOTES

Biotope and Weather

The author carried out ecological research at the study site and nearby areas during 1980–1988. Thirty-five night investigations were made during all months of the year except December and January when few, if any, lachryphagous lepidopterans can be expected at such an elevation.

The site, at 1150 m, is a small clearing about 50 m across, surrounded by Mixed Deciduous and Hill Evergreen Forest, with much undergrowth. It is a limestone area and not far from the site are heavily eroded limestone cliffs. Fire rages through sections of the forest during every dry season. Illegal potato, maize, cabbage and, at least until very recently, poppy plantations have replaced much of the original vegetation in nearby areas.

The temperature at nightfall on 1 June 1988 was 21°C; it increased to 22°C near midnight. The moon, a few days past full, intermittedly illuminated the clearing when the clouds opened up. Light rain fell at times from 2230 h onwards, often just a drizzle. Mist drifted over the clearing after 2300 h.

Hosts

All 11 cases of *P. lacrimisaddicta* taking fluids—10 at eyes, 1 at mouth—occurred on zebu (*Bos taurus indicus* (L.)). On 2 June 1988 the author was again in the clearing, alone, the caravan having left early in the morning. Shortly after nightfall an unidentified *Poncetia* species, most likely *lacrimisaddicta*, alighted on the sleeve of the author's shirt, climbed up beating its wings but then flew off. The author did not attempt to capture it as he thought it might like a sip of his tears and so be the first species of the genus proved to have a liking for human tears. *P. albistriga* had once landed on the author's face but failed to suck lachrymation, and another specimen of the species, or possibly *siamica,* took perspiration from his hand.

It is worthwhile noting that other hosts, such as horse (*Equus caballus* L.),

mule (*E. caballus* × *E. asinus* L.) and pig (*Sus scrofa* L.) had been investigated during more than 30 nights since 1980 at a nearby place (less than 1 km away, behind two hills), including that particular night of 1 June 1988. But no *P. lacrimisaddicta* had been seen on or near them. Zebu had been checked only four times in the years before that night; they are irregularly kept by highlanders in the vicinity.

The area is also frequented by barking deer (*Muntiacus muntjak* (Zimmermann)) and wild boar (*S. s. jubatus* Miller) but because of their timidity and scarcity it has not been possible to look for lachryphagous Lepidoptera on them. Captive individuals in zoos had their eyes visited by *Filodes mirificalis* Lederer and *Lobocraspis griseifusa* Hampson, respectively (BÄNZIGER, 1973).

It seems certain that zebu exert a stronger attraction to lachryphagous moths in general than do horses which, moreover, tend to be rather more sensitive and restless to moths approaching them. Nevertheless, the conditions at the zebu caravan site appear to have been more favourable for zoophilous moths than those where the horses were. Body odours, visibility and approachability of a herd of 20 individuals in a forest clearing can be expected to offer a stronger attraction for host-seeking moths than one or two horses under a stilt barn, or thatched roof, in the 'unnatural' environment of a hamlet, where many other odours, and often also smoke, occur.

Behaviour

On 1 June 1988 the first zoophilous Noctuidae, Geometridae and Notodontidae arrived soon after nightfall (1930 h). About an hour later there was a lull lasting until 2200 h when many moth species reappeared in large numbers. After 0200 h a decrease set in though at 0300 h single moths were still very active. The first *P. lacrimisaddicta* sucking at a zebu's eye was caught shortly after 2000 h. Then none was seen until 0050 h. The remaining 10 individuals arrived and attacked the zebu singly until shortly before 0300 h; 5 were caught and 4 photographed. Unfortunately, after 0300 h the observations had to be terminated as the batteries, and the author, were exhausted. The attack on the author on 2 June 1988 occurred just after nightfall.

Because the species is so dark in coloration, it was difficult to see individuals in flight unless direct torchlight illumination was used. Whenever possible, however, this had to be avoided in order not to disrupt the moth's searching action during which time they are very sensitive to light. They were fairly quick in reaching the eye of the zebu , at least when compared with other notodontids.

Interesting was the moth's eagerness to drink tears—hence the name—by persisting to remain attached to the eye of the host despite its repelling reactions. Lying in the grass ruminating or dozing, most of the zebu seemed so exhausted from their long journey as to be unwilling to muster a reaction against the moths stronger than just pressing the eyelids tightly closed together. In a few cases, however, the discomfort must have been considerable; this was probably due to the closeness of sucking *P. lacrimisaddicta* to the sensitive eyelid and -ball (Figs. 23 – 25).

As mentioned in the description the proboscis of the moth is short and so it has to cling very near to the eye, generally on the lower eyelid just behind the cilia, or at the inner or outer eye corner. The fore legs' claws were often applied near or on the hairless, moist section of the lid (Fig. 24) where it is quite sensitive. Hence, in order to rid itself of the intruder, the host at times pressed the lids so forcefully together that the folds, especially that adjacent to the upper lid, bulged out and over the lid, briefly squeezing the moth's head and thorax between them (Figs. 25 – 28). Still, so 'addicted' to lachrymation the moth seemed to have become that it would not leave the eye. It would make extrication movements and then continue feeding while the author was busy taking close-up flash photographs. This did not seem to disturb the moth in the least, unlike when it is flying. It is interesting to compare the reaction of other lachryphagous Lepidoptera to flash light, viz. other notodontids such as *Tarsolepis remicauda* Butler and *T. elephantorum* Bänziger (Fig. 1). These generally fall off the eye, sometimes remaining entangled in the grass. The thyatirid *Chaeopsestis ludovicae* Le Cerf, while also often falling from the eye, recovers nearly instantly and may fly back and attack the same eye again (BÄNZIGER, 1988a, b).

DISCUSSION

There is now ample evidence that northern Thailand must be considered as a center of species diversity for the genus *Poncetia*. Six of its total of eight recognized species are found in this area; only the S. E. Himalayan *P. bhutanica* and the Burmese *P. fuscipennis* have never been reported from Thailand—so far. Even when considering *P. albistriga,* a species known to inhabit a wide region stretching from Sumatra (and apparently also Java) to N. E. India and across S.China to Taiwan, N. Thailand is centrally located in the distribution of the genus.

The remaining five species of *Poncetia* are endemic to N. Thailand—at least there is no evidence yet of their presence outside the kingdom. From present and previous findings, Doi Suthep is the only home of *P. bovoculosugens* and *P. doisuthepica,* Doi Chiang Dao of *P. lacrimisaddicta*. The two mountains share another endemic, *P. huaykaeoensis*, which was also found at the foot of another hill located between them. A fifth endemic, *P. siamica,* is found again both on Doi Suthep and Doi Chiang Dao as well as on the more northerly Doi Ang Khang, an area which unfortunately is not protected and where only the highest peak sections and most inaccessible limestone outcrops retain their original vegetation cover.

The above zoogeographic findings are of interest also in another respect. Namely, they stress the significance of two of the three most important protected areas of Thailand's Upper North: Doi Chiang Dao Wildlife Sanctuary and Doi Suthep-Pui National Park (the third being Doi Inthanon National Park). Their outstanding significance for Thailand stems from two main attributes, viz. their northerly location and the relatively high elevation of their mountains. Consequently they are among the very few areas in Thailand with mountain flora and fauna. They

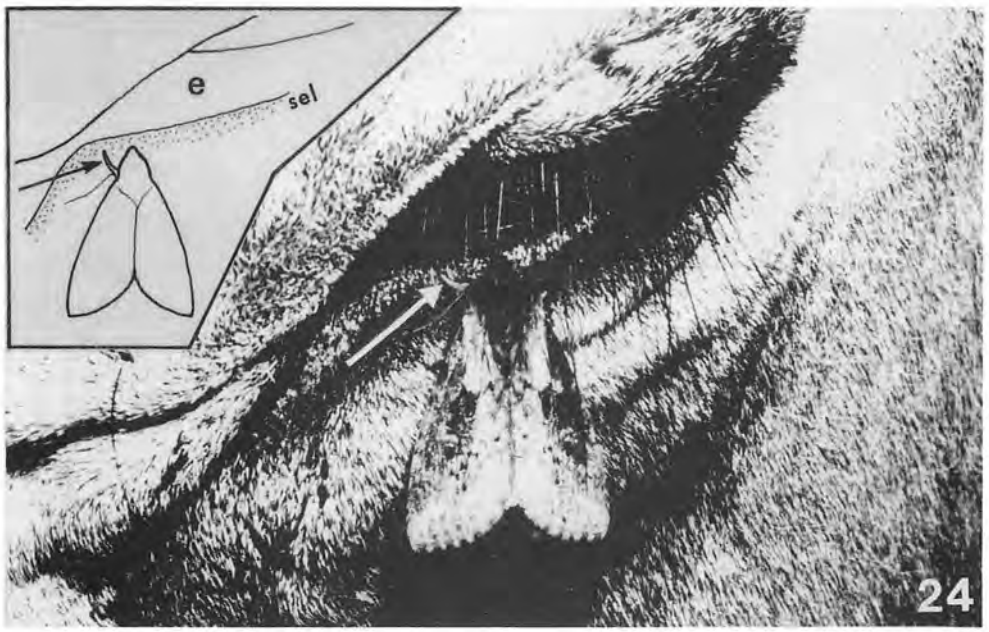
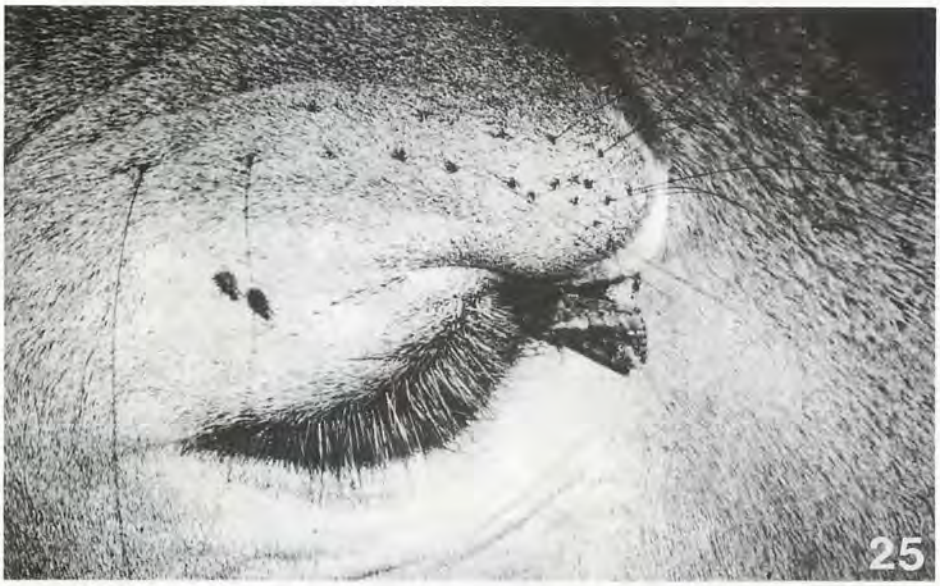


Figure 23. *P. lacrimisaddicta* drinking tears from the eye of a zebu.

Figure 24. *P. lacrimisaddicta* sucking very close to the eye of a zebu. Note the left fore leg (arrow) clinging to the sensitive, hairless part of the eyelid, causing discomfort to the host. Drawing on insert clarifies action (explanation on p. 39 – 40). Sel = sensitive eyelid; e = eye.



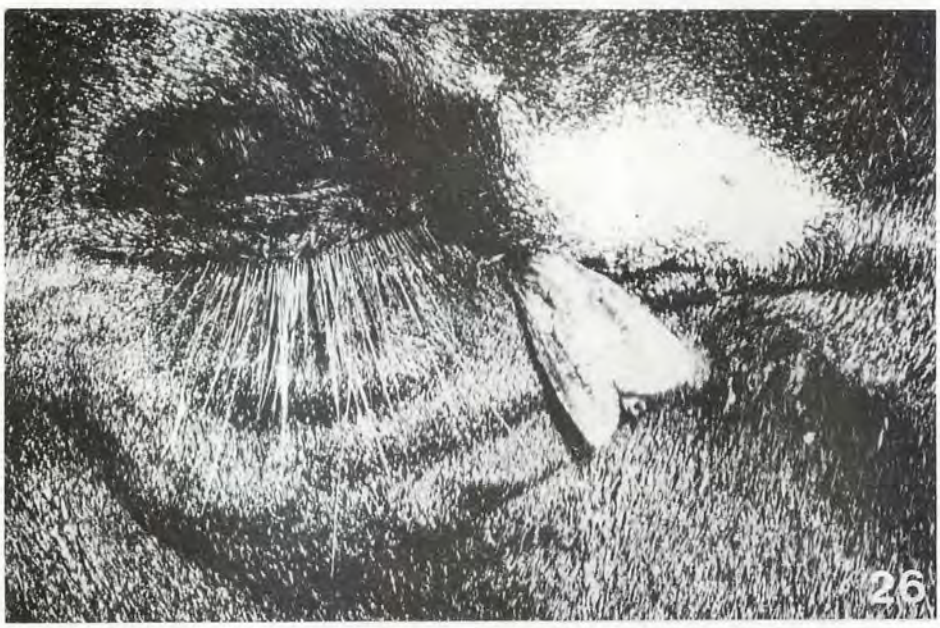
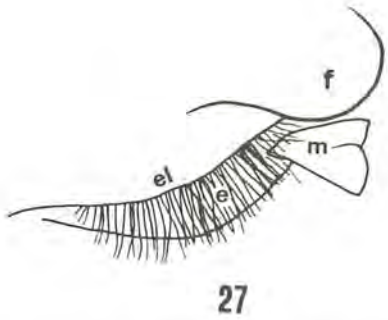


Figure 25. *P. lacrimisaddicta* at the nearly closed eye of a zebu. Due to the irritation caused by the moth's claw, the host tries to dislodge the intruder: note the fold bulging over the host's inner eyelid angle, just before squeezing the moth. Further clarification in Fig. 27.

Figure 26. *P. lacrimisaddicta* being squeezed by the fold which bulges over the eye. The moth tries to extricate itself. Even if successful, it will not fly off but persist in drinking tears when the fold returns to its normal position. Further clarification in Fig. 28.



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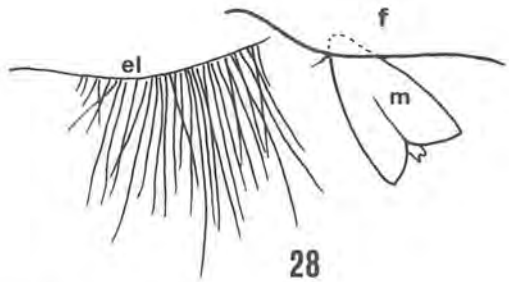

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Figure 27. Drawing clarifying the action shown in Fig. 25.
Figure 28. Drawing clarifying the action shown in Fig. 26. E = eye; el = eyelid; f = fold; m = moth.

are probably the only places in N. Thailand where Himalayan floristic and faunistic elements have remained established to any significant extent and, indeed, for some species they represent their southernmost distribution limits. Moreover, a substantial number of endemics seem to have evolved through adaptation to the particular environment prevalent there.

Doi Chiang Dao, the home of the new *P. lacrimisaddicta*, shelters some of the most striking endemic flora and fauna of all Thailand; possibly it is Thailand's most important refugium for relict species of past glaciations. The crest of the mountain, horse-shoe shaped and 10 km long, includes 17 peaks and ridges above 2000 m; in terms of altitude, 11 of them rank from the third (2220 m) to the thirteenth (2160 m) highest points in Thailand (if the next highest, an unnamed peak of 2150 m 65 km SW of Kamphaengphet, is correct). Coupled with this is the fact that Doi Chiang Dao is a limestone massif. These are known to have an unusual flora, both because of the chemical composition of their rocks and soils, and because of their fractured and deeply eroded configuration—sharp, often steep, cliffs with crevices, dolines, caves, narrow gullies, etc. Exposure to rain, sun, and wind makes the climate there particularly harsh, and the cold may be the most decisive factor, considering the tropical setting of Doi Chiang Dao. Some species have survived there, and only there, as so-called relicts on cold 'islands' when after the last ice age the climate became warmer again. In other species, only part of the population remained trapped there during their northbound retreat, while the bulk reached their present day, more northerly distribution in China and S. E. Himalaya.

Among plants a typical example for the latter is the vine *Stephania subpeltata* H. S. Lo (Menispermaceae) described from S. W. China; the only other place where the plant is known to occur is a very restricted area at 2050 m on Doi Chiang Dao where the present author found it in April 1980 (BÄNZIGER, unpubl.; FORMAN, 1988). An insect example is the ravishing Bhutan Glory butterfly (*Bhutanitis lidderdali* (Atkinson)) likewise known in Thailand only from the upper reaches of this mountain

where it was first collected as recently as 1976 by Mr. K. Tantivejasakhdi (PINRATANA, 1977). Its main distribution is S. E. Himalayan. Quite sadly, both species may now be extirpated as those habitats have been heavily encroached upon by opium poppy growing Ho Chinese, Hmong and Lisu highlanders.

Examples of species endemic exclusively to the mountain are 7 species of plants (BAIN & HUMPHREY, 1980). SMITINAND (1966) mentions an impressive 64 plant taxa known only from this mountain. That today, after more than 20 years of botanical research, 57 of them (SMITINAND, *in litt.*) are still accepted as endemic to Doi Chiang Dao is remarkable. Species slightly less restricted, i.e. present also on other regional limestone mountains, include the fruit-piercing moth *Anomis fructusterebrans* Bänziger, *Anomis* sp. n., and a number of geometrid moths which still await description (BÄNZIGER, 1986 and in prep.; HOLLOWAY, in press).

Doi Suthep-Pui National Park may harbour fewer strict endemics than Doi Chiang Dao, but its flora and fauna are otherwise exceptionally rich in species: No examples are mentioned here as a number of studies have been and will be highlighting this (e.g. DEIGNAN, 1945; ROUND, 1984; SEIDENFADEN & SMITINAND, 1959 – 1964; BÄNZIGER 1988c; ELLIOTT et al., 1989).

Although small to average size, *Poncetia* are good fliers and over the millennia they might have been expected to have spread much farther, as indeed one of them has done, viz. *P. albistriga*. The most likely explanation may be that they are just too rare to have been detected elsewhere. Nevertheless, research on lachryphagous Lepidoptera has been going on for over 20 years and the possibility that some species may indeed be restricted to one or a few mountains should not be dismissed out of hand. BENDER & DIERL (1977) have observed in Sumatra and Nepal that many mountain notodontids are apparently restricted to narrow habitats which they rarely leave. Similarly, HOLLOWAY (1987) mentions that the Sulawesi (Indonesia) Notodontidae have a far lower dispersive power than the Noctuidae of that island.

The reason for the philopatric tendency of many Notodontidae is not plain. But given Doi Chiang Dao's—and to some extent also Doi Suthep's—richness in endemics or plants which are rare elsewhere, the possibility that one or the other *Poncetia* may be dependent on some of these is real: Many lepidopterans have mono- or stenophagous larvae. Another explanation for the philopatric habits of some lepidopterans may lie in a possibly highly developed respect for so-called vegetational barriers. In birds, for example, different vegetational zones can be important isolating barriers in the tropics (MAYR, 1969). Indeed, the great diversity of birds in Amazonia is assumed to be in large part due to such vegetational barriers which fluctuated in the course of pluvial and arid maxima during past epochs (HAFFER, 1969). (Such climatic variations are thought to be the principal cause for Amazonian plant speciation in the first place (e.g. PRANCE, 1982), although GENTRY (1986) proposed edaphic specialization as the main factor behind it.)

Some *Poncetia* spp. may well be more widely distributed than assumed here. But from the viewpoint of these species' conservation—and that of other similarly

rare plants and animals—it would be unwise to dismiss their endemic status and rely for their continued existence on a hypothetical presence elsewhere. Given the fast disappearance of the natural forest cover in Thailand and neighbouring countries, in the end the assumption that such species are endemic will almost certainly turn out to be the sad *de facto* situation. To designate such species as endemics is prudent.

In view of the above findings, national parks, wildlife sanctuaries and whatever original vegetation remains in Thailand, gain even more in importance. The destruction of even relatively small forest areas can bring along with it the extinction not only of sedentary species but also of mobile, philopatric insects and other specialized wildlife forms dependent on such habitats. Only in protected areas do they stand some chance of survival. However, the continued existence or extirpation of such animals, like *Poncetia* spp., are generally considered to be of little, if any, practical consequence to man. While lack of usefulness of a particular form of life to man cannot be an ethically acceptable criterion to condone its extirpation, unfortunately it is only the anthropocentric value which will decide its fate. In one respect, though, such highly specialized species are significant. They indicate that the habitat they live in is likely to harbour more, possibly a whole network of rare organisms which may yet reveal unknown relationships between plants and animals and their abiotic environment. As integrating parts of a complete whole they cannot be ignored.

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REFERENCES

BAIN, J. R. and S. R. HUMPHREY, 1980. A profile of the endangered species of Thailand. *Rep. No. 4, Off. Ecol. Serv., Florida State Museum*, 367 pp.

BÄNZIGER, H. 1973(1972). Biologie der lacriphagen Lepidopteren in Thailand and Malaya. *Revue suisse Zool.* 79: 1381 – 1469.

BÄNZIGER, H. 1986. *Anomis fructusterebrans* sp. nov., a new fruit-piercing moth of Northern Thailand, with notes on agriculturally important *Anomis* spp. (Lepidoptera, Noctuidae). *Nat. Hist. Bull. Siam Soc.* 34: 59 – 64.

BÄNZIGER, H. 1988a. The heaviest tear drinkers: Ecology and systematics of new and unusual notodontid moths. *Nat. Hist. Bull. Siam Soc.* 36: 17 – 53.

BÄNZIGER, H. 1988b. Unsuspected tear drinking and anthropophily in thyatirid moths, with similar notes on sphingids. *Nat. Hist. Bull. Siam Soc.* 36: 117 – 133.

BÄNZIGER, H. 1988c. How wildlife is helping to save Doi Suthep: Buddhist Sanctuary and National Park of Thailand. *Symb. Bot. Ups.* 28: 255 – 267. *In* I. Hedberg (ed.), Systematic botany – a key science for tropical research and documentation. Almqvist 8 Wiksell International, Stockholm, 286 pp.

BENDER, R. 1985. Notodontidae of Sumatra. Heteroc. Sumatr. 5: 1 – 101.

BENDER, R. and W. DIERL, 1977 (1976). Kommentiertes Verzeichnis der Notodontidae Sumatras (Lepidoptera). *Z. Arbeitsgem. Österr. Entomologen* 28: 117 – 131.

CAI, R. Q. 1985. A new species of *Megashachia* Matsumura (Lepidoptera: Notodontidae). *Acta entomol. Sinica* 28: 314 – 316.

DEIGNAN, H. G. 1945. The birds of Northern Thailand. *U.S. Nat. Museum Bull.* 186. Smithsonian Inst., Washington D.C.

EECKE, R. van, 1929. De Heterocera van Sumatra VII. *Zool. Mededeel* 12: 137 – 175.

ELLIOTT, S., J. F. MAXWELL, and O. BEAVER. 1989. A transect survey of forest in Doi Suthep National Park. *Nat. Hist. Bull. Siam. Soc.* 37: (in press).

FORMAN, L. L. 1988. A synopsis of Thai Menispermaceae. *Kew Bull.* 43: 369 – 407.

GENTRY, A. H. 1986. Endemism in tropical versus temperate plant communities. Pages 153 – 181 *in* M.E. Soulé (ed.), *Conservation Biology: The Science of Scarcity and Diversity*. Sinauer Assoc., Mass. 584 pp.

HAFFER, J. 1969. Speciation in Amazonian forest birds. *Science* 165: 131 – 137.

HOLLOWAY, J. D. 1987. Lepidoptera patterns involving Sulawesi: What do they indicate of past geography? Pages 103 – 117 *in* T. C. Whitmore (ed.), *Biogeographical Evolution of the Malay Archipelago*. Clarendon Press, Oxford, 147 pp.

HOLLOWAY, J. D. A review of the subgenus *Rusicada* Walker of the genus *Anomis* Hübner (Lepidoptera: Noctuidae). (in press).

HOLLOWAY, J. D. and R. BENDER, 1985. Further notes on the Notodontidae of Sumatra, with descriptions of seven new species. *Heteroc. Sumatr.* 5: 102 – 112.

KIRIAKOFF, S. G. 1968. Lepidoptera, Familia Notodontidae, pars tertia, Genera Indo-Australica. *In* P. Wystman, *Genera Insectorum* 217c. (not seen in the original).

MAYR, E. 1969. Bird speciation in the tropics. Biol. J. Linn. Soc. 1: 1 – 17. *In* R. H. Lowe-McConnell (ed.), *Speciation in Tropical Environments*. Academic Press, 246 pp.

MOORE, F. 1888 (1879). *In* W. C. Hewitson and F. Moore, *Description of New Indian Lepidopterous Insects from the Collection of the Late M. W. S. Atkinson*. Asiatic Soc. of Bengal, Calcutta 299 pp.

PINRATANA, A. 1977. *Butterflies in Thailand*. Vol. 1, Viratham Press, Bangkok, 91 pp.

PRANCE, G. (ed.). 1982. *Biological Diversification in the Tropics*. Columbia University Press, New York, 714 pp.

ROUND, P. D. 1984. The status and conservation of the bird community in Doi Suthep-Pui National Park, North-West Thailand. *Nat. Hist. Bull. Siam Soc.* 32: 21 – 46.

SEIDENFADEN, G. and T. SMITINAND, 1959 – 1964. *The Orchids of Thailand. A Preliminary List*. The Siam Soc., Bangkok, 870 pp.

SMITINAND, T. 1966. The vegetation of Doi Chiengdao, a limestone massive in Chiengmai, North Thailand. *Nat. Hist. Bull. Siam. Soc.*, 21: 93 – 128.

WILEMAN, A. E. 1914. New species of Heterocera from Formosa. *Entomon*. 47: 318 – 323.