

THE HEAVIEST TEAR DRINKERS: ECOLOGY AND SYSTEMATICS OF NEW AND UNUSUAL NOTODONTID MOTHS

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ABSTRACT

Seven new moths are described; *Tarsolepis elephantorum* sp. nov., *Poncetia bovoculosugens* sp. nov., *Po. doisuthepica* sp. nov., *Po. huaykaeoensis* sp. nov., all from Doi Suthep; *T. equidarum* sp. nov., *Po. siamica* sp. nov. from elsewhere in N. Thailand; *Po. bhutanica* from Bhutan and N. E. India. The ssp. *sphingoides* (van Eecke) and *kanshireiensis* (Wileman) are new synonyms of *Po. albistriga albistriga* (Moore), *Po. fuscipennis* (Hampson) a new combination transferred from *Ramesa*. Nocturnal field research during 17 years in Thailand, W. Malaysia and other countries has shown *T. elephantorum*, *T. equidarum*, *T. remicauda* Butler, *Po. albistriga*, *Po. bovoculosugens*, *Po. huaykaeoensis*, and *Pydnella rosacea* (Hampson) to be lachryphagous: male moths suck lachrymal secretions from eyes, and/or other fluids from the body, of elephant, tapir, rhinoceros, 4 deer and 2 antelope species, and 5 species of domestic ungulates. *Py. rosacea* drank tears from the author's eye 8 times, *T. elephantorum* 3 times, and many more unsuccessful attacks were experienced. This is the first report of Notodontidae feeding on human tears. Details are given of the moths' distribution, biotope, type of foods, feeding behaviour, host preference and reaction, and seasonal frequency. Reasons for the sucking of tears by, and its restriction to, nocturnal Lepidoptera are offered.

INTRODUCTION

It was SHANNON (1928) in Argentina, S. America, who mentioned for the first time a notodontid moth, *Crinodes beskei* Hübner, among a number of moth adults of other families, as being attracted to horses. From his short note we also learn that in 1904 a friend of a certain Mr. Bruch in nearby Paraguay had observed moths 'with a perversion of taste' settling at the eyes of horses to suck lachrymation. As far as the author is aware, this is the earliest record – although not published until 1928 – of a lachryphagous habit in Lepidoptera. DE JOANNIS has actually already published in 1911 similar observations, made by his nephew in 1909 on the noctuid moths *Arcyophora longivalvis* Guenée and *A. zanderi* Felder taking lachrymation from the eyes of horses in Guinea, W. Africa.

Since then a number of moth species have been found to be attracted to eye and body fluids of many of the larger mammals in several tropical regions around the

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world (e.g. MARSHALL et al., 1915; GUILBRIDE et al., 1959; BÜTTIKER & WHELLAN, 1966; BÄNZIGER & BÜTTIKER, 1969; BÜTTIKER & BEZUIDENHOUT, 1974; BÄNZIGER, 1973, 1988a). The hosts include such ungulates as bovids, deer, tapir, horse, pig, and also elephants (REID, 1954; BÜTTIKER & WHELLAN, 1966; BÄNZIGER, 1973). Hence the moths' 'perversion of taste', however unorthodox, is functional, as treated in the discussion.

Unfortunately, however, Shannon gave no details about which of the species he listed actually settled at the eyes and imbibed tears, which only attempted to do so, and which sucked other body fluids such as saliva, perspiration, etc. Nor did he indicate if any drank secretions or excreta smeared by the host onto the surrounding vegetation or dropped onto the ground. These are important specifications, as some moth species apparently take only tears, others only skin secretions or urine, while still others exhibit several or all these feeding habits. Since lachryphagous moths are suspected of being potential carriers of disease pathogens, it is fundamental to know their exact behaviour. It is also of scientific and evolutionary interest, because the sucking of lachrymation represents the more advanced or specialized feeding of those mentioned.

The first detailed observations on lachryphagous behaviour of adult notodontid moths were not made until some two decades ago in Malaysia, followed by further reports from Laos and China (BÄNZIGER, 1973, 1983). These remained until today the only published information on lachryphagy in this moth family which contains the heaviest tear drinkers.

The object of the present article is to report on new ecological and systematic research on the subject, carried out in Thailand and to a lesser extent in Malaysia and other South and Southeast Asian countries. These observations were made on nearly 700 nights spent in or near forests to investigate moths associated with mammals during 17 years from May 1971 to April 1988.

The systematics around *Tarsolepis* Butler, 1872, has undergone some changes, especially following Holloway and BENDER's (1985) reappraisal of the identity of *T. sommeri* (Hübner), as mentioned in the systematic section below. It can be expected that an eventual taxonomic revision of the whole genus will provide more species and subspecies besides the two new ones described in this study: *T. elephantorum* sp. nov. and *T. equidarum* sp. nov., discovered to attack elephants, deer, other ungulates, and occasionally also man.

In the genus *Poncetia* Kiriakoff, 1962, three species were named. Later they were considered to be only subspecies of a single species. In the present study they are synonymized and reduced to one taxon, *Po. albistriga* (Moore), recorded here for the first time from Thailand. Of the four new *Poncetia* species from Thailand described below, three were discovered in the park encompassing the famous mountain, Doi Suthep, further adding to the extremely diverse fauna of Doi Suthep-Pui National Park (e.g., BÄNZIGER, 1988c). A fifth new *Poncetia*, from Bhutan and N. E. India, was an unnamed species present in the collection of the British Museum (Natural

History), London (BMNH).

No systematic innovation is made for the third notodontid genus treated, *Pydnella* Roepke, 1943. Its species *rosacea* (Hampson), apparently unknown before in Thailand, is remarkable because of a certain weakness it has for human tears.

The systematic part of the present report is partly based on the author's two latest of several studies at the BMNH.

SYSTEMATIC PART

Tarsolepis Butler, 1972

Following a reconsideration of the identity of *T. sommeri* (Hübner, 1821) – the type of which is lost – HOLLOWAY & BENDER (1985) designated as neotype of *T. sommeri* the holotype male of *T. javana* Swinhoe, 1907, type locality Java. This follows the older arrangement of *T. sommeri*, *T. javana* and *T. remicauda* Butler, 1872, as originally suggested by ROEPKE (1943), a reversal of BENDER & DIERL (1977) and HOLLOWAY (1983). The latter three authors were unaware of Roepke's work and had synonymized *T. sommeri* with *T. remicauda*. As a consequence the large species of *Tarsolepis* mentioned as *sommeri* from W. Malaysia and S. W. China in BÄNZIGER (1973, 1983), now refers to *remicauda*. The name for the smaller *T. sommeri* reported from N. Thailand and N. Laos (BÄNZIGER, 1983, as 'ssp. aff. *dinawensis* Bethune-Baker') would have remained unchanged. However, some minor differences have been noted between Sundaic and Mainland S. E. Asian specimens (HOLLOWAY & BENDER, 1985; BÄNZIGER, 1988a). Very recently additional characters have been found which now make taxonomic distinction unavoidable. In the author's view the two taxa differ at least as much as do *sommeri* and *remicauda*, so that specific distinction seems appropriate. Consequently, what had been mentioned as *T. sommeri* 'ssp. aff. *dinawensis*' in BÄNZIGER (1983) now refers to *T. elephantorum* sp. nov., described below.

The moths *T. sommeri* and *T. remicauda* and/or their genitalia have been illustrated in ROEPKE (1943), HOLLOWAY (1983) and BENDER (1985). Live specimens of the latter in the act of taking mammalian tears and body fluids are shown in Figs. 43 – 48 of this report.

Tarsolepis elephantorum sp. nov.

Holotype. ♂, THAILAND: Chiang Mai Prov., Huay Kaeo, Zoo, foot of Doi Suthep, 350 m, 16.v.1973, Bänziger leg., to be deposited in the collection of the Department of Entomology, Faculty of Agriculture, Chiang Mai University (DEFACU).

Paratypes. ♂, ibid. but 20.v.1973, genitalia slide 2670, in coll. Bänziger. 10♂, various forest places at 380, 400, 600 m altitude, up to 2 h walking distance

off Chiang Mai to Chiang Dao road, approx. km 55, 20.v.1973, 15.iii.1976, 27.iii. 1977, 14.iii.1981, 20.iii.1982, 7., 16., 22.iii.88, genitalia slides 593, 1205 (BMNH), 1206, 2670, 2671, 2680, 2685. 2 , LAOS: Luang Phrabang, Ban Kok Ngiew, 300 m, 30.iii.1973, genitalia slide 522, all Bänziger leg., in coll. Bänziger.

Derivation of name. The species was most frequently seen in association with elephants.

Diagnosis. Males can be readily distinguished from the very similar Sundaic *T. sommeri* by the presence of two red hair tufts ventrally near the base of the abdomen (no red tufts in *sommeri*), the proximal silver triangle being slightly longer than the distal one (reverse in *sommeri*), rami of bipectinate antenna numbering over 50 pairs, and their maximal length measuring over 0.8 mm (less than 40, and maximal length about 0.6 mm in *sommeri*), among other differences, especially also in the genitalia. *T. remicauda* is much larger.

Description. Male (Fig. 1): Wingspan 56–62 mm, ϕ =58 mm, n=12 (*T. sommeri* 65 mm, *T. remicauda* 79 mm). Head, thorax, abdomen generally are distinctly lighter than in *sommeri*. Antenna bipectinate on basal 52–54 segments, filiform on distal 24–27 (one Sumatran *sommeri* analyzed: pectinate 39, filiform 27; *remicauda*: pectinate 43–47, filiform 34–36). Longest rami on antenna: 0.85 mm (Sumatran *sommeri*: 0.61 mm; *remicauda*: 0.85 mm). Proboscis about 13 mm long, fairly sclerotized, progressively tapering towards the tip which is fine, with only very few minute sensillae. The red tuft mentioned by various authors actually consists of two clusters of very long hairs, one each attached to the utmost latero-ventral tip of the 3rd abdominal tergite. They are more or less well concealed and held in place ventrally on the abdomen, diagonally inwards, by great numbers of other hairs, some modified into long scales, many of which originate from a longitudinal sclerotized flap, an unusual modification of the 4th sternite. No tufts of red hairs are present in *sommeri* (but long greyish hairs), while in *remicauda*, and even more so in *rufobrunnea* Rothschild, 1917, and *japonica* Wileman & South ssp., they are a brighter red than in *elephantorum*. The flap is present in all 5 above-mentioned species. Wings, upperside patterned as in Fig. 1, not unlike *sommeri* but costal band very light. Distal silver triangle shorter than proximal one and also shorter than in *sommeri* (in this the proximal is shorter than, or at most equal to, the distal one, and is also rather narrower than in *elephantorum*; the triangles are about of the same length in *remicauda*). Hind wing, and wings underside similar to *sommeri*.

Female. As male except for the filiform antenna, the absence of the tuft and of the flap on 4th sternite.

Male genitalia (Figs. 13–19). Closest to *sommeri* and *remicauda* but quite distinct in the following characters. Twofold uncus of constant width (or in some specimens first slightly narrowing and then widening again distally), only near the tip rapidly narrowing in rostrated fashion into a sharp, slightly curved point (progressively tapering from base to tip in the other two species). Valve oval shaped

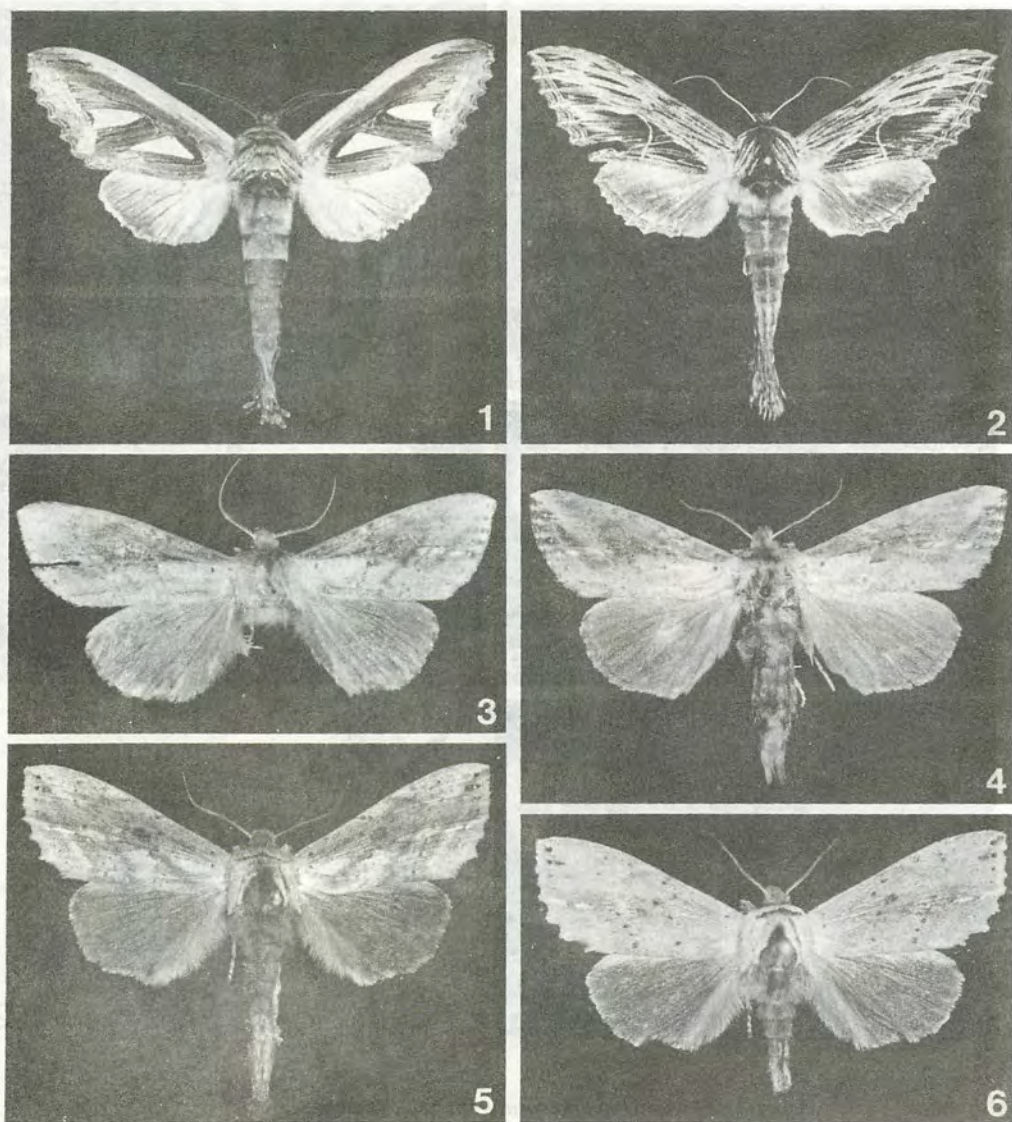


Figure 1. *Tarsolepis elephantorum* sp. nov., paratype.

Figure 2. *Tarsolepis equidarum* sp. nov., holotype.

Figure 3,4. *Poncetia bhutanica* sp. nov., holotype, paratype.

Figure 5,6. *Poncetia albistrigata* (Moore).

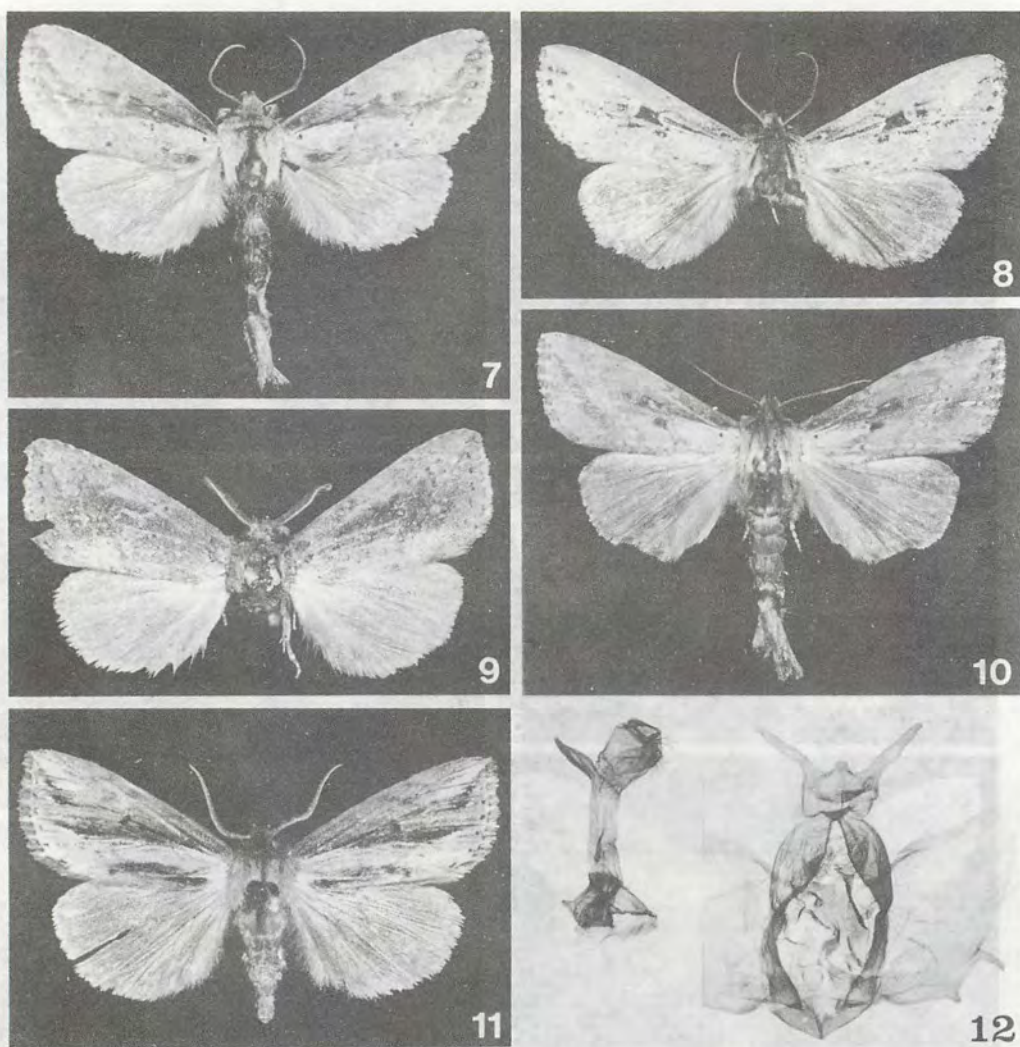


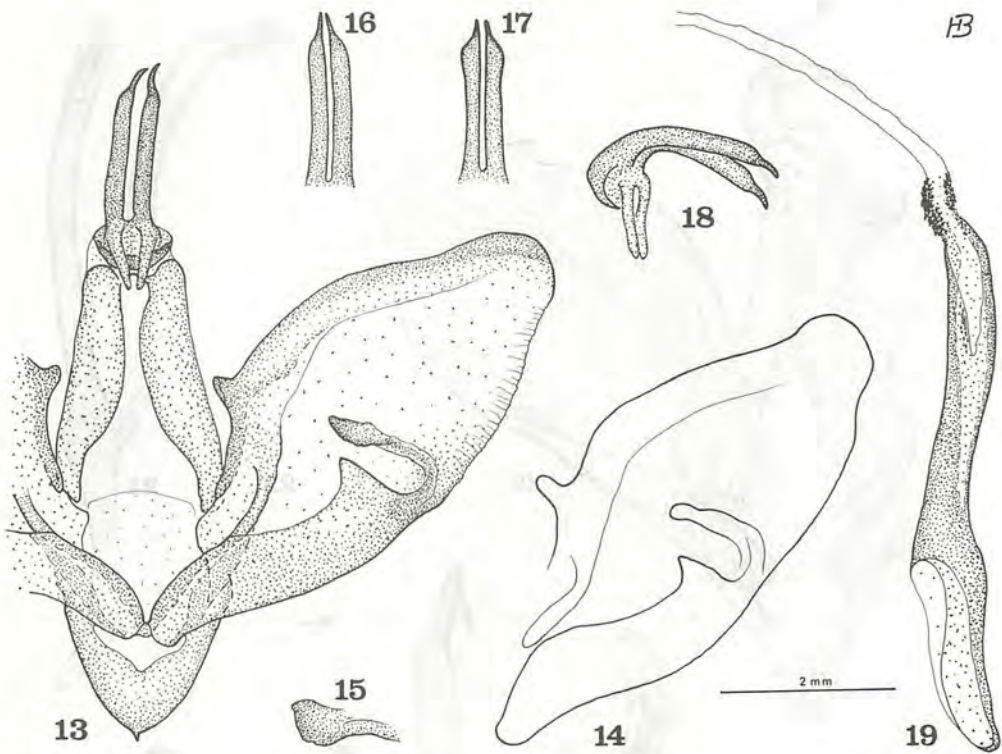
Figure 7,8. *Poncetia huaykaeoensis* sp. nov., paratypes.

Figure 9. *Poncetia bovoculosugens* sp. nov., holotype.

Figure 10. *Poncetia siamica* sp. nov., paratype.

Figure 11. *Poncetia doisuthepica* sp. nov., holotype.

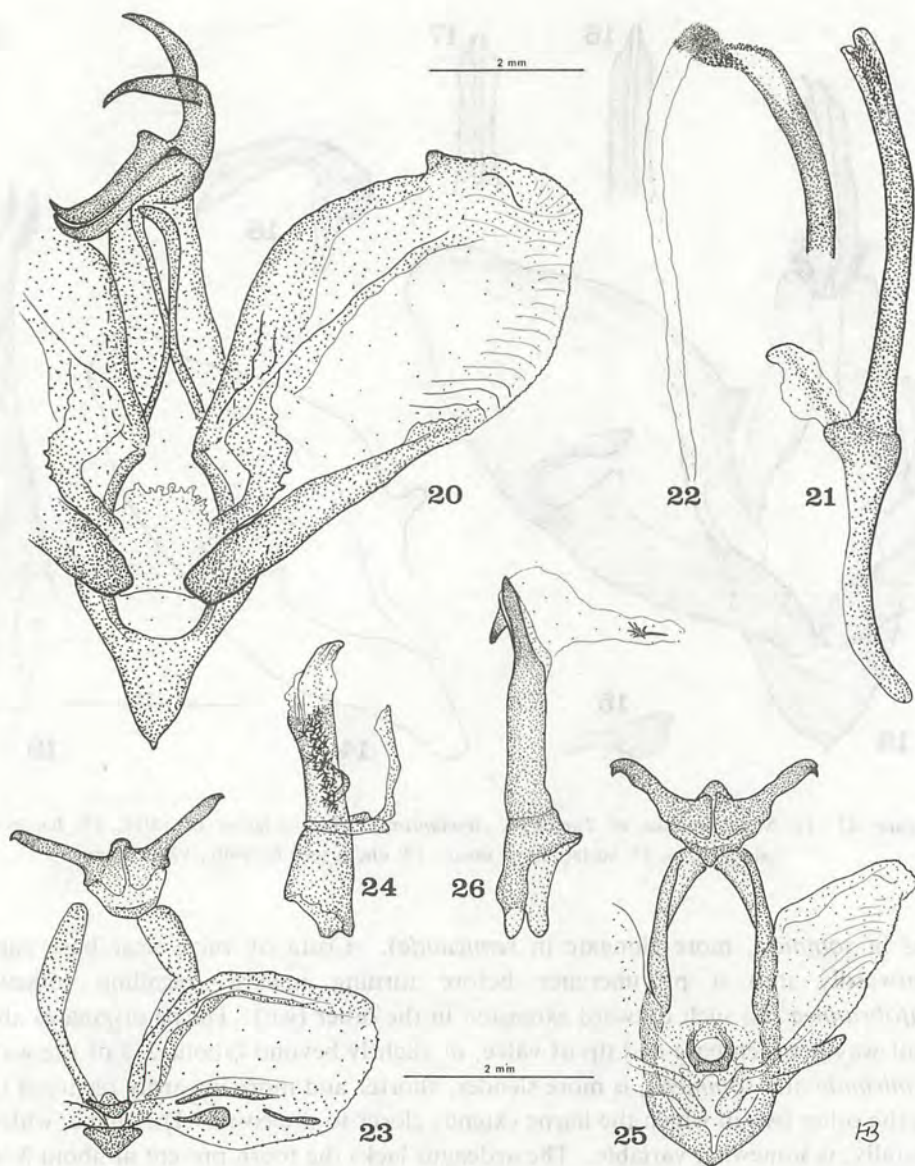
Figure 12. *Poncetia fuscipennis* (Hampson), holotype male genitalia.



Figures 13–19. Male genitalia of *Tarsolepis elephantorum*. 14: variation of valve, 15: harpe seen laterally, 16, 17: variations of uncus, 18: uncus seen laterally, 19: aedeagus.

(as in *sommeri*, more elongate in *remicauda*). Costa of valve near base curved outwardly into a protuberance before turning inward, recalling somewhat *rufobrunnea* (no such outward extension in the other two). Harpe originates about half-way between base and tip of valve, or slightly beyond (about 2/3 of the way in *remicauda* and *sommeri*), is more slender, shorter and more inwardly recurved than in the other two in which the harpe extends closer to the costa. The shape, widened distally, is somewhat variable. The aedeagus lacks the tooth present at about 3/4 of the distance from base to tip of the aedeagus in *sommeri* (4/5 in *remicauda*). *T. elephantorum* is closer to *sommeri* in the size of the genitalia (both rather smaller than in *remicauda*) but this should be no surprise since the former two moths are smaller than the latter.

Remarks. The female *T. elephantorum* is a worn specimen from the type locality, not included in the type series. Although the red tufts are the most obvious external character to distinguish *elephantorum* from *sommeri* males, they are sometimes completely concealed under the mentioned hairs of and around the flap;



Figures 20–26. Male genitalia. 20–21: *Tarsulepis equidarum*. 21: aedeagus. 22: same with extruded vesica. 23–24: *Poncetia bovuculosugens*. 24: aedeagus. 25–26: *Poncetia doisuthepica*. 26: aedeagus.

by introducing the tip of a forceps under the hairs it is possible to spread them out. *T. rufobrunnea* is more readily distinguished from the above. It is about the same size as *remicauda* but darker (especially the hind wings), with larger silver triangles, the distal one merging with the submarginal band which is narrower and less recurved. Further diagnoses and/or illustrations of the species, and its allied taxon *malayana* Nakamura, 1976, are given in BARLOW (1982), HOLLOWAY (1982, 1983), and BENDER (1985). The fifth species of the complex mentioned in this study, *T. japonica* ssp., so far has not been reported from Thailand. There is little doubt that it differs at least on a subspecies level from the typical form from Japan but more research is necessary before its proper status can be assessed. It is similar to *rufobrunnea* but not so dark and its silver triangles are even larger than those of *rufobrunnea*, especially the proximal one, and the discal dark dots on the hind wings are very conspicuous. Among other genitalic features, both species are distinct from the three first mentioned *Tarsolepis* in lacking the harpe.

Tarsolepis equidarum sp. nov.

Figs. 2, 20 – 22

Holotype. ♂, THAILAND: Chiang Mai Prov., Fang Distr., Doi Ang Khang, 1450 m, 15.iv.1986, genitalia slide 2125, Bänziger leg., to be deposited in DEFACU.

Paratype. ♂, Loei Prov., Phu Rúa, 17.iv.1968, A. Wattanapongsiri leg., genitalia slide of lot 3305.21, in coll. Dept. Agric., Bangkok. (Phu Rúa is both a small district town as well as a mountain of 1024 m, 35 km W of Loei town.)

Derivation of name. The moth was found while attempting to settle on Equidae (horses and mules).

Diagnosis. Lacks the conspicuous silver triangles of other *Tarsolepis* such as the *remicauda* complex. It has a very thin white streak instead, recalling that of the much larger *fulgurifera* (Walker, 1858) though in this it is more evident, and to some extent silvery.

Description. Male (Fig. 2): Wingspan 73 – 78 mm. Head, thorax, abdomen, legs as in *fulgurifera* but more greyish and the lines more sharply defined. The hair tufts mentioned for the other *Tarsolepis* are dark yellow, somewhat darker than in *fulgurifera*; the longitudinal flap of the 4th sternite is present in both. Antenna white above and weakly dentate as in *fulgurifera*, hence in contrast to the *remicauda* complex in which they are bipectinate. Proboscis 16 mm long, fairly sclerotized, tapering progressively towards the tip which is fine, with only a very few, minute sensillae distally. Wings upperside dark greyish brown or brown, patterned as in Fig. 2. The shiny silver triangles of the fore wing, most remarkable in the *remicauda* complex and reduced to a long and rather narrow, somewhat shiny streak in *fulgurifera*, is just an exceedingly thin, white line. Near the apex are white zigzag lines. The costal area also has many dark and light striae, unlike *fulgurifera* and the *remicauda* complex. Lines

along the outer margin, and the border, are undulating as in *remicauda* though more evident, and in contrast to *fulgurifera* in which they are straight. Hind wing similar to that of *remicauda*, without the dark discal fleck, and somewhat lighter in the middle. Wings underside greyish with dark markings.

Male genitalia (Figs. 20–22). General shape of valve as in other *Tarsolepis*. No sclerotized process except for a small protuberance on costa before the apex. Uncus bifid on distal 2/3, gnathos very strongly developed, comparable to that of *fulgurifera*. Aedeagus long and slender, without tooth but with a dorsal flat extension not quite half-way between base and tip; vesica with 2 patches of spicules near base, otherwise narrow and long.

Female unknown.

Remarks. Externally *T. equidarum* is similar to *Dudusa sphingiformis* Moore, 1873. *T. equidarum* shares with *Dudusa* spp. (e.g. *sphingiformis*, *nobilis* Walker, 1865, *vethi* Snellen, 1892, *synopla* Swinhoe, 1907) the lack of the silver triangles and the presence in the genitalia of a dorsal process on the aedeagus. It differs, however, in many other important characters: filiform antenna (bipectinate in *Dudusa*), much longer proboscis (only 5–9 mm in *Dudusa*, possibly no more fully functional), presence of a long hair tuft on 3rd tergite tip (missing or much shorter in *Dudusa*), longitudinal flap on 4th sternite (missing or less well developed in *Dudusa*), in the genitalia the uncus is 2/3 bifid (twofold in *Dudusa*), gnathos long and strongly sclerotized (thin and not sclerotized in *Dudusa*), and above all in the one single character which seems to differentiate consistently the *Tarsolepis* and *Dudusa* spp. analyzed here, i.e. the dorsal, more or less pronounced extension on the uncus found in the latter and missing in the former. Many other characters are present or missing in species of both genera.

T. equidarum is also reminiscent of *Stigmatophorina sericea* (Rothschild, 1917) and *S. hammamelis* Mell, 1922. However, in *Stigmatophorina* the antenna is bipectinate up to its tip, in male and female; no hair tufts nor longitudinal flaps are evident on the abdomen. The proboscis is much reduced (5 mm). Hence the genus would seem to be closer to *Dudusa* than to *Tarsolepis* though the reverse would apply for the genitalia in a number of aspects.

***Poncetia* Kiriakoff, 1962**

Poncetia albistriga (Moore)

Figs. 5, 6, 27, 28, 38

Niganda albistriga Moore, 1879, Descr. Indian lep. Ins. coll. Atkins.: 64.

Pydna kanshireiensis Wileman, 1914, Entom. 14: 322. *New synonym*

Stauropus sphingoides van Eecke, 1929, Zool. Mededeel. 12: 167–168, Pl. 14, f9. *New synonym*

Poncetia albistriga (Moore): Kiriakoff, 1962, Bull. Ann. Soc. ent. Bel. 98: 177.

Material examined. *Po. albistriga* holotype ♂, INDIA: Darjeeling, 1870, W.S. Atkinson leg., genitalia slide MB 2579, in Museum Berlin.

♂, Khasis, April 1896, native coll., genitalia slide 1742, in BMNH. ♂, CHINA: Kwantung, genitalia slide 1744, in BMNH. ♂, THAILAND: Chiang Mai Prov., Fang Distr., Doi Ang Khang, 1450 m, 30. viii. 83, genitalia slide 1582. ♂, ibid. but 400 m, Chiang Dao Distr., forest place off road Chiang Mai to Chiang Dao, approx. km 55, 24.ix.83, genitalia slide 1607. ♂, ibid. but Mae Taeng Distr., Huay Nam Dang, 1690 m, 3.ix.86, genitalia slide 2296, to be deposited at DEFACU. ♂, ibid. but Doi Chang, 1930 m, 9.iv.87, genitalia slide 2406, all Bänziger leg.

Po. kanshireiensis syntype ♂, herewith designated as lectotype, CHINA: Formosa, 18.v.1908, A.E. Wileman leg., genitalia slide 1741, in BMNH. ♂, Kwantung Prov., Lienping, genitalia slide 1744, in BMNH.

Po. sphingoides syntype ♂, herewith designated as lectotype, INDONESIA: Sumatra, Fort de Kock, 920 m, April 1921, E. Jacobson leg., genitalia slide and 2580, in Museum Leiden, Netherlands. ♂, MALAYSIA: Selangor State, Bukit Kutu, April 1915, genitalia slide 1743, in BMNH.

Remarks. The facies of *Po. albistriga* is fairly variable, even within a region like N. Thailand, or Formosa. The genitalia of *albistriga*, *kanshireiensis*, and *sphingoides* match well, especially when compared with the other 5 *Poncetia* species, so that there is no reason to consider them as separate taxa.

Poncetia fuscipennis (Hampson)

Figs. 12,40,41

Ramesa fuscipennis Hampson, 1893 (1892), *Fauna of British India, Moths* 1 : 143.

New combination

Type material studied. Holotype ♂, BURMA: labelled "Burmah, Moore Coll. 94-106, *Ramesa fuscipennis* Hampson type", Notodontidae genitalia slide 68, in BMNH.

Remarks. *P. fuscipennis* is quite close to *Po. bovuculosugens* sp. nov. but rather larger, the genitalia differing from the latter in the much larger size and in a long apical extension of the aedeagus. *Ramesa* Walker has quite different genitalia from *Poncetia*, especially the uncus.

Poncetia siamica sp. nov.

Figs. 10,31,32,36

Holotype. ♂, THAILAND: Chiang Mai Prov., Chiang Dao Distr., Doi Chiang Dao, NW Pass, 1150 m, 25.vi.86, Bänziger leg., genitalia slide 2202, to be deposited at DEFACU.

Paratype. ♂, ibid. but Fang Distr., Doi Ang Khang, 1450 m, 30.viii.83, Bänziger leg., genitalia slide 1581, to be deposited at BMNH.

Derivation of name. From an old name of the country where the moth was first found: Siam.

Diagnosis. Externally very similar to *Po. albistriga* and *Po. bhutanica* sp. nov. but darker than both, larger than the first, smaller than the second. Other *Poncetia* spp. are less uniformly coloured and/or smaller. Main differences are in the genitalia.

Description. *Male* (Fig. 10): Wingspan 44–45 mm (*albistriga* 37–42 mm, *bhutanica* 48–49 mm). Head, thorax, abdomen, palpus, and legs as in *P. albistriga* but darker. Antenna monodentate as in *albistriga*. Proboscis about 6 mm long, little sclerotized, with only 10–12 comparatively large sensillae per galea; the linking processi are well developed. Overall colour of wings upperside brown but more greyish and darker than *albistriga*, patterned as in Fig. 10. The white streak near the middle of the outer margin is slightly more conspicuous than in *albistriga*. A row of white-centered, black dots is along the margin, the fringes alternately brown and yellow, while the border is entire (undulate-dentate in *albistriga*). The pale wing base area more distinct, the inner margin area being only slightly lighter, if at all, while in *albistriga* this is ochraceous (though in one specimen the whole wing is light brown-grey). Hind wing uniformly dark grey. Wings underside shadowed with brownish grey as in *albistriga*.

Female unknown.

Male genitalia (Figs. 31,32,36). Differ clearly from *albistriga* as well as from *fuscipennis* and *doisuthepica* sp. nov. in the juxta, more complex uncus, the presence of teeth on the aedeagus, and in the 8th sternite, among other characters. Closest to *bhutanica* from which it can be distinguished in the more narrow and recurved juxta and lack of its basal lobe, the somewhat differently shaped appendages of the uncus and of the basal lobes of the valve, and especially in the more slender and differently shaped aedeagus and its teeth. Differs from *huaykaeoensis* sp. nov. in the more elongate and thicker appendages of the uncus, longer extensions on the 8th sternite, and more obvious characters of the juxta, valve and aedeagus.

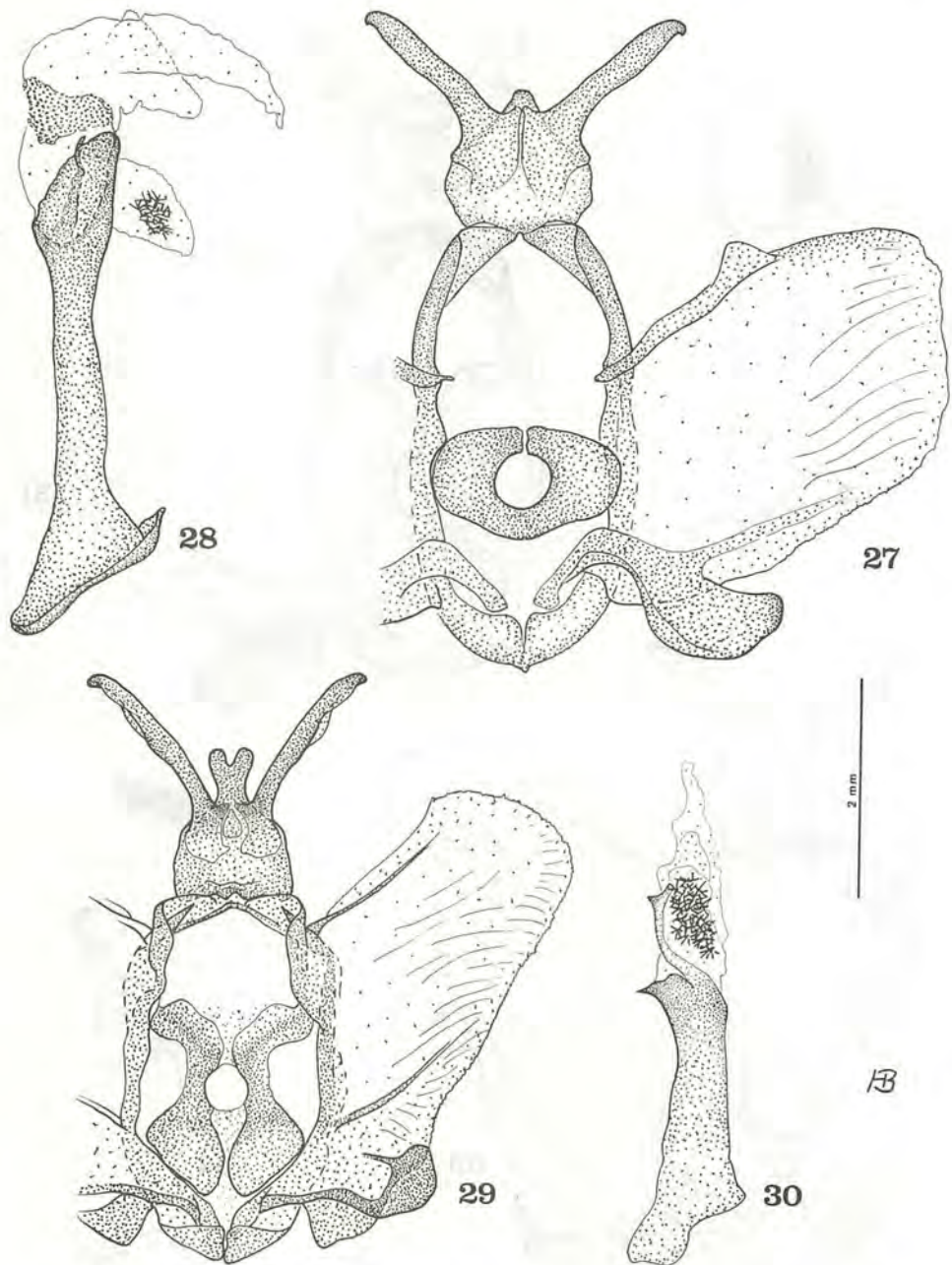
Note added in proof. An additional specimen of *Poncetia siamica* sp. nov. has just been caught at MVL and is designated herewith as second paratype: ♂, Chiang Mai Prov., Doi Suthep-Pui National Park, 1150 m, 14.viii.1988, genitalia slide 2798, Bänziger leg.

***Poncetia huaykaeoensis* sp. nov.**

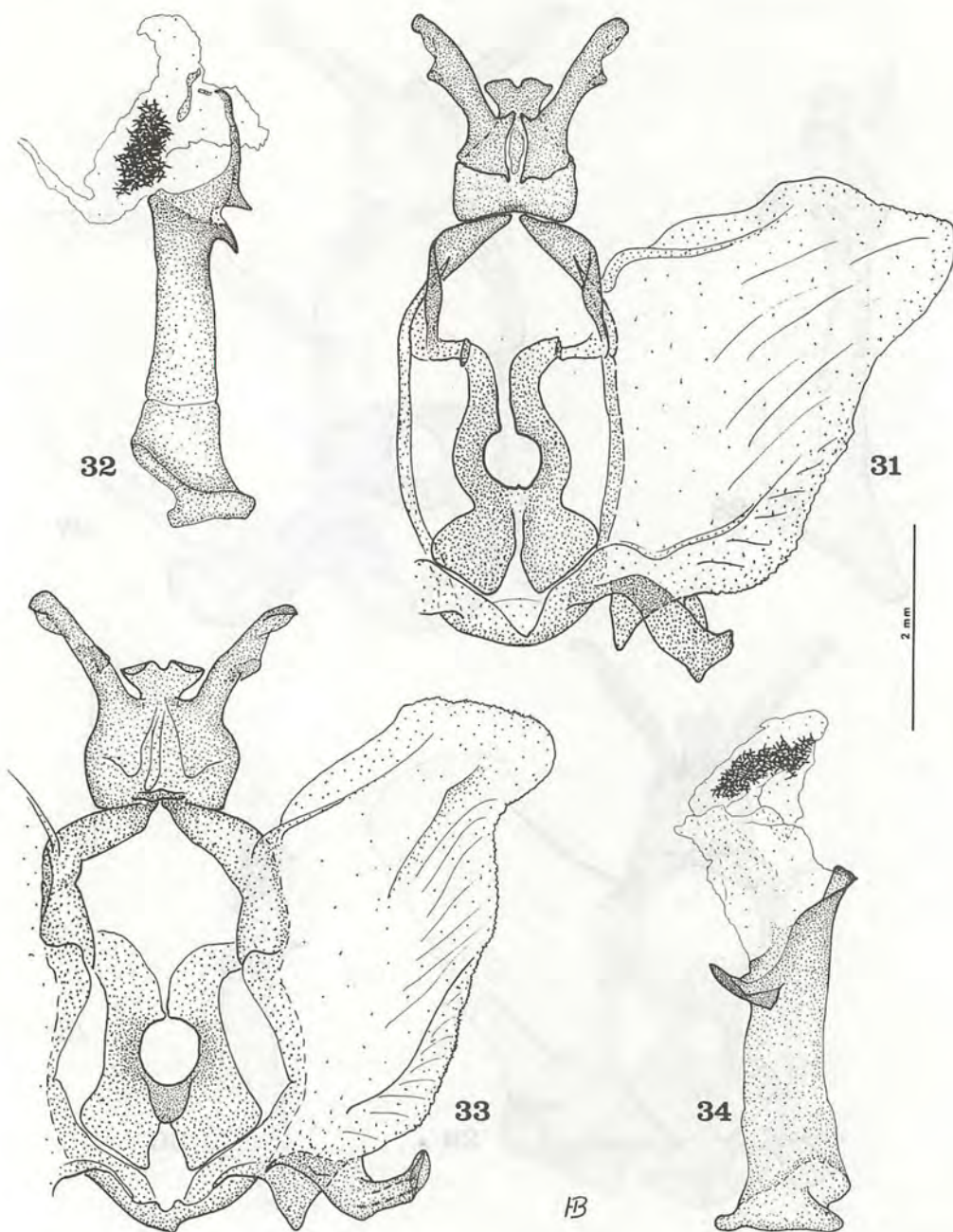
Figs. 7,8,29,30,35

Holotype. ♂, THAILAND: Chiang Mai Prov., Chiang Mai Distr., Doi Suthep-Pui National Park, Huay Kaeo, 350 m, 11.x.73, Bänziger leg., genitalia slide 546, to be deposited at DEFACU.

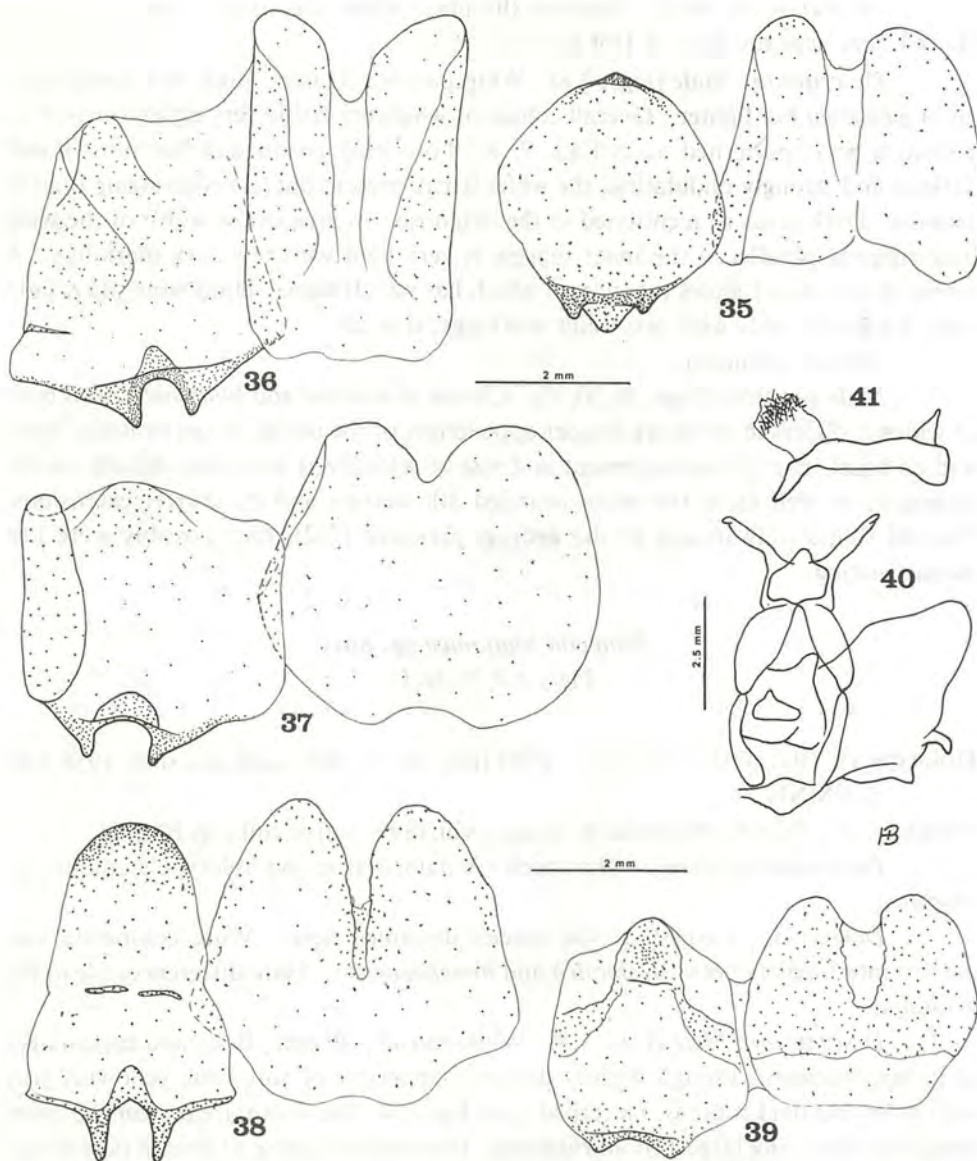
Paratypes. ♂, ibid. but 26.x.66 (abdomen lost). 1 ♂, ibid. but 1150 m, 1.viii.88, genitalia slide 2770. 2 ♂, ibid. but 380 and 400 m, Chiang Dao Distr., forest place off road Chiang Mai to Chiang Dao, approx. km 55, 28.xi.80 and 13.v.81, all Bänziger leg., genitalia slides 2607 (to be deposited at BMNH), 762 in Bänziger coll.



Figures 27–30. Male genitalia. 27–28: *Poncetia albistriga*. 28: aedeagus. 29–30: *Poncetia huaykaeoensis*. 30: aedeagus.



Figures 31–34. Male genitalia. 31–32: *Poncetia siamica*. 32: aedeagus. 33–34: *Poncetia bhutanica*. 34: aedeagus.



Figures 35 – 39. 8th sternite and tergite of male *Poncetia* spp. 35: *huaykazoensis*, 36: *siamica*, 37: *bhutanica*, 38: *albistriga*, 39: *doisuthepica*.

Figure 40-41. Sketch of male genitalia of *Poncetia fuscipennis*. 41: 318 – 323.

Derivation of name. Denotes the place where the species was discovered, Huay Kaeo, near the foot of Doi Suthep.

Description. Male (Figs. 7,8). Wingspan 38 – 41 mm. Body and appendages as in *albistriga* but lighter. Overall colour of wings upperside very light brownish or yellowish grey, patterned as in Figs. 7, 8. Fore wing postmedial line mostly well defined and strongly undulating, the white streak present but less contrasting than in *siamica*. Dark areas as mentioned in the diagnosis; an area of the width of the wing base running parallel to the inner margin is very light with few dark markings. A string of tiny dots follows the margin which has pale fringes. Hind wing plain light grey. Underside pale with very faint markings, if at all.

Female unknown.

Male genitalia (Figs. 29,30,35). Closest to *siamica* and *bhutanica* from both of which it differs in the more slender appendages of the uncus, shape of juxta, valve and its basal lobe, the arrangement and size of sclerotized structures distally on the aedeagus, as well as in the more rounded 8th sternite and its shorter extensions. Cornuti found only in one of the aedeagi prepared (762); they possibly were lost during mating.

***Poncetia bhutanica* sp. nov.**

Figs. 3,4,33,34,37

Holotype. ♂, BHUTAN: Dudgeon, 2500 feet, 14.vii.1895, genitalia slide 1958.320, in BMNH.

Paratype. ♂, INDIA: Meghalaya, Khasis, viii.1895, native coll., in BMNH.

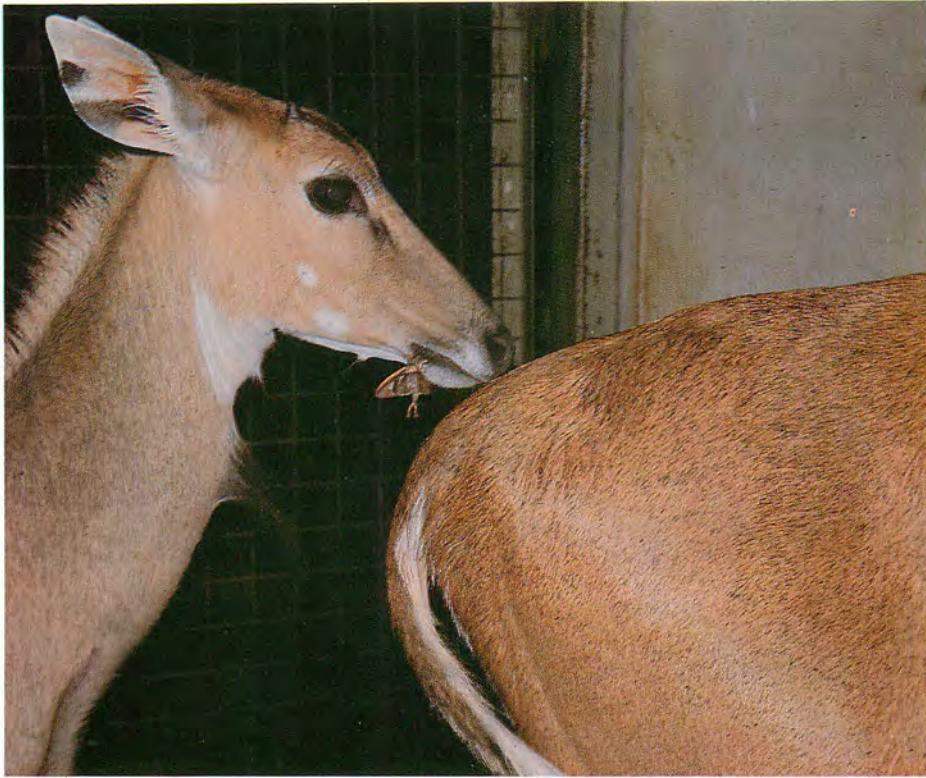
Derivation of name. The species is named after the holotype's country of origin.

Diagnosis. Largest of the species described here. Wing coloration and pattern intermediate between *siamica* and *huaykaeoensis*. Main differences are in the genitalia.

Description. Male (Figs. 3,4). Wingspan 48 – 49 mm. Body and appendages as in *huaykaeoensis* though slightly darker. Upperside of fore wing yellowish grey with paler and darker areas, patterned as in Fig. 3,4. The white streak near the outer margin of fore wing largest of all *Poncetia*. Postmedial a string of dots in part fused, forming an undulating line. Area near wing base pale except for a small portion near the costal margin. Hind wing uniformly dark grey. Fore wing underside dark brown-grey except near the outer and inner margin, hind wing yellowish and grey with a circular undulating line which is darker.

Female unknown.

Male genitalia (Figs. 33,34,37). Related to *siamica* and *huaykaeoensis*. Appendages of uncus rather broader than in *huaykaeoensis*, similar to *siamica*. Juxta broader than in *siamica*, longer and less recurved than in *huaykaeoensis*. Appendages



Figures 44–46. Zoo Kuala Lumpur. 44: *Tarsolepis remicauda* imbibing saliva from the mouth of a nilgai antelope. 45: *T. remicauda* just landed on the cheek of a sambar deer, before moving higher up to the eye. 46: The moth sucks tears from the eye, closed due to the irritation; note that only the fore legs are attached to the host.



Figure 42. *Tarsolepis elephantorum* sucking lachrymation from the eye of an elephant. Note the vigorous beating of the wings: these are moved while the moth's body and the host are sharp. Forest in N. Thailand.

Figure 43. *Tarsolepis remicauda* sucking tears from the edge of the eye of a water buffalo. W. Malaysia.



Figures 47, 48. Zoo Kuala Lumpur. 47: *Tarsolepis remicauda* sucking wound exudates from a chronic sore on the fore leg of a sleeping rhinoceros. 48: same, on a tapir.

Figure 49. *Pydnella rosacea* sucking lachrymation from the eye of a zebu. Forest in N. Thailand.



Figures 50, 51. Moths drinking tears from the eye of the author who photographed himself. 50: *Pydnella rosacea*; attack occurred in the night of 19.11.87 while he was studying zebu in a hill forest in N. Thailand. 51: *Tarsolepis elephantorum*; attack occurred in the night of 7.3.88 while he was studying elephants in a forest in N. Thailand. The moth's proboscis sucks from the outer part of the lid where is an overflow of tears due to the irritation; afterwards it is again applied on to the sensitive inner part of the lid and eye bulb.

of 8th sternite similar to but further apart than in *siamica*, longer than in *huaykaeoensis*. Aedeagus much thicker than in the other two species, with only one but much stronger 'tooth' in form of a curved lamina.

Remark. The paratype's abdomen seems to be glued on.

***Poncetia bovocolosugens* sp. nov.**

Figs. 9,23,24

Holotype. ♂, THAILAND: Chiang Mai Prov., Doi Suthep-Pui National Park, Huay Kaeo, 350 m, 22.ix.1973, Bänziger leg., genitalia slide 545, to be deposited in DEFACU.

Additional material. A second specimen escaped after it flew off the eye of a cow where the author had closely observed it, same date and place as holotype.

Derivation of name. Denotes the moth's behaviour, sucking from bovine eye.

Diagnosis. Smallest and dullest *Poncetia*, lacking the white streak and having a bipectinate antenna.

Description. *Male* (Fig. 9): Wingspan 33 mm. Head and thorax uniformly dark. Antenna bipectinate. Wings least elongate of species described here except *doisuthepica*. Upperside of fore wing brown, patterned as in Fig. 9. No white streak near the outer margin half way between apex and tornus of fore wing. Dark markings diffuse, postmedial nearly imperceptible, only a string of tiny dots near the outer margin which is somewhat wavy. Hind wing plain greyish yellow with broad band of pale fringes. Undersides of wings as in *huaykaeoensis* but slightly darker.

Female unknown.

Male genitalia (Figs. 23,24). Uncus closest to *albistriga*, juxta and ventral lobe of valve small, aedeagus without tooth. Differs from *fuscipennis* in the lack of the long apical extension of the aedeagus.

***Poncetia doisuthepica* sp. nov.**

Figs. 11,25,26,39

Holotype. ♂, THAILAND: Chiang Mai Prov., Doi Suthep-Pui National Park, 1150 m, 12.xi.1987, Bänziger leg., genitalia slide 2645, to be deposited in DEFACU.

Paratypes. 2 ♂, *ibid.* but 1.viii. 1988, Bänziger leg., genitalia slides 2769 (to be deposited at BMNH), 2771 in Bänziger coll.

Derivation of name. Denotes the place where the moth was discovered.

Diagnosis. Small, with least elongate wings of all *Poncetia* spp., and a conspicuous pale band running along the inner margin.

Description. *Male* (Fig. 11): Wingspan 35 mm. Head and underside of thorax very dark brown, upperside greyish though dark brown distally, abdomen

dark grey. Antenna unidentate. Proboscis as in *albistriga* though smaller. Upperside of wings patterned as in Fig. 11. Fore wing with a pale yellow-grey band parallel to the inner margin, about as wide as the wing base, sharply separated from the dark upper wing section. The white streak touches the pale band and is therefore not so obvious. Near the apex is a pale wedge shaded by dark (found also in many other *Poncetia* though less apparent and less well-defined); rest very dark brown. Fringes alternatively dark and pale. Hind wing plain dark grey with somewhat paler fringes. Wings underside dark greyish.

Female unknown.

Male genitalia (Figs. 25,26,39). Tip to the appendages of the uncus with a strong hook. Aedeagus very distinct, with a strong backwardly recurved flat hook near the apex; this has a long flattish extension terminating in a rounded tip; both are sclerotized. The 8th sternite also differs from known ones. Otherwise recalling *bovuculosugens*.

Remarks. The two paratypes were found after the original conclusion of the study. They are somewhat smaller (32–33 mm), the pale band on the fore wing is overshadowed in part by dark areas, and there are a number of black streaks and dots.

ECOLOGICAL PART

The Species Surveyed

The study treats all adult Notodontidae so far found to be associated with mammals in Thailand and W. Malaysia. It also includes some observations made elsewhere in S. and S. E. Asia, as well as notes on close relatives or other so far only suspected zoophilous notodontids. Seven species with confirmed or virtually certain lachryphagy are involved:

<i>Tarsolepis elephantorum</i>	<i>Pydnella rosacea</i>	<i>Poncetia albistriga</i>
<i>Tarsolepis equidarum</i>		<i>Poncetia bovuculosugens</i>
<i>Tarsolepis remicauda</i>		<i>Poncetia huaykahoensis</i>

Of the seven species only *T. remicauda* and *T. elephantorum* (then known as *T. sommeri*) had previously been established as tear suckers (BÄNZIGER, 1973, 1983); the remaining five species are recorded here for the first time as lachryphagous. However, two of these, namely *T. equidarum* and *Po. albistriga*, have not yet been seen with uncoiled proboscis to actually imbibe lachrymation from the host's eye. But their behaviour leaves little doubt that failure to have spotted them in this action was due to circumstantial factors. The records of the seven species are summarized in Tables 1–5.

It is probable that the other four known species of *Poncetia*, namely *bhutanica*, *doisuthetica*, *siamica*, and *fuscipennis* also take lachrymation. Only a few specimens have so far been caught – at mercury vapour lamps (MVL), where known – and lack of

information on their feeding habits may just be incidental. The same probably applies to the Sundanian *T. sommeri*, though possibly not to the taxon *dinawensis* from New Guinea, where no autochthonous ungulates and proboscidsians ever lived. Also such *Tarsolepis* as *fulgurifera*, *japonica* ssp., and *rufobrunnea* may not be tear drinkers. In relation to their size, the latter two have a less sclerotized and shorter (11 or 16 mm, respectively) proboscis than their lachryphagous congeners *elephantorum*, *equidarum* and *remicauda* (13, 16, 21 mm, respectively). It could be difficult for moths of their bulky size to obtain lachrymation. *T. fulgurifera* may have never succeeded in evolving lachryphagy because its dimensions, 10 cm wingspan, are such that it might just be too disturbing for hosts to tolerate, although its proboscis, 25 mm, is longest among *Tarsolepis*. Furthermore, considering the ratio between the number of specimens of *elephantorum* and *remicauda* caught at MVL and that found associated with mammals, one would expect *fulgurifera*, *japonica* ssp. and *rufobrunnea* to be frequently encountered on mammals if these moths were lachryphagous to the same extent as their congeners are. Investigations are being continued and it is hoped that this interesting point can be solved before long.

There are a few additional notodontids which are suspected of being tear suckers, viz. *Chadisra* (*Stenoshachia*) sp. aff. *bipartita* (Matsumura) in N. Thailand, *Anthena* sp., *Curuzza atrivittata* Hampson and *Innisca* sp. aff. *eupatagia* (Hampson) in C. Nepal. The way they were seen flying allows the inference that their aim probably was the head of prospective hosts, zebu and horse. In addition, one specimen of *C.* sp. aff. *bipartita* alighted on the author's arm and clothes. Such observations, however, are not sufficient evidence to include them in the list above, especially since they lack close relatives that are lachryphagous which could add strength to the inferred feeding habits.

Distribution

The records in this chapter are presumably all based on mercury vapour (MVL) or other light collections whenever authors other than BÄNZIGER are involved; unless otherwise stated, records by the latter resulted from observations of the moths on or near their mammalian hosts.

T. elephantorum, described from Doi Suthep, is also found elsewhere in N. Thailand, and N. Laos (BÄNZIGER, 1983, pres. rep). It is likely that the species is present also in S. China and N. E. India from where *T. sommeri* is reported (HOLLOWAY, 1985) since specimens under this name from such areas are probably the new *elephantorum*. *T. equidarum* so far is known only from N. Thailand and the adjoining northwesternmost part of N. E. Thailand. But since the border of Burma's Shan States is only a couple of km from Doi Ang Khang, the type locality, it is virtually certain that it flies also in Burma. Similarly, the proximity of Phu Rua to Laos (20 km) makes the moth's presence likely also in Laos.

T. remicauda, described from Java (BUTLER, 1872), has been reported from Sumatra (ROEPKE, 1943; BENDER & DIERL, 1977; BENDER, 1985), W. Malaysia, S. Thailand and S. W. China (BÄNZIGER, 1973, 1983, pres. rep.), Borneo (HOLLOWAY, 1983), and in 1987 also from N. E. Thailand (Mr. M. Allen leg.).

Of the so far non-lachryphagous *Tarsolepis*, the typical *sommeri* flies in Sumatra and Java (HOLLOWAY & BENDER, 1985). Interestingly, it is not reported from Borneo (HOLLOWAY, 1976, 1983) nor from W. Malaysia (BARLOW, 1982). In New Guinea there is what at present is regarded as a subspecies of the above, *dinawensis*; other forms are present also in the Philippines and Sulawesi (HOLLOWAY & BENDER, 1985). As already mentioned, N. E. Indian and S. Chinese records of *sommeri* probably pertain to *elephantorum*. *T. rufobrunnea* was described from S. India (ROTHSCHILD, 1917), is found also in N. E. India, Sumatra (ROEPKE, 1943; BENDER & DIERL, 1977), W. Malaysia (BARLOW, 1982), N. E. Thailand (Mr. M. Allen leg.) and most recently was also collected at MVL by the author in N. Thailand, again on Doi Suthep. *T. japonica* ssp. has been collected in Nepal by Mr. Allen and by the author who caught it also in N. W. India, both at MVL. *T. fulgurifera* was found in fair numbers at MVL in Nepal by the author, and two specimens were recently caught in N. Thailand by his colleagues, Mr. P. Sukumalanan and Mr. C. Siwasin.

Py. rosacea, reported for the first time in Thailand in the present report, is known also from Java, Sumatra, India (BENDER & DIERL, 1977; HOLLOWAY, 1983; BENDER, 1985). It is not listed in the fauna of Borneo (HOLLOWAY, 1975, 1983), nor in that of W. Malaysia (BARLOW, 1982) although it should be expected in the latter. *Py. galbana* (Swinhoe) is a species which has not yet been reported from Thailand though it should occur there as it is present in N. E. India and Sumatra (HOLLOWAY, 1983; BENDER, 1985).

In the genus *Poncetia*, *albistriga* shows the widest distribution: N. E. India (MOORE, 1879), Formosa (WILEMAN, 1914), Sumatra (VAN EECHE, 1929). HOLLOWAY (1985) mentions it from W. Malaysia but, again not from Borneo. The present study reports it from S. China (Kwantung Prov.) and for the first time in Thailand. *Po. fuscipennis* is from Burma (HAMPSON, 1893). Of the 5 new species, *bhutanica* flies in Bhutan and N. E. India while *siamica*, *doisuthepica* (both at MVL), *bovocolosugens* and *huaykaeoensis* so far are known only from N. Thailand; *bovocolosugens* and *doisuthepica* must be considered as endemic to the Doi Suthep-Pui National Park.

Biotopes

T. elephantorum and *Po. bovocolosugens* fly essentially in Tropical Lowland Deciduous Forests; *T. remicauda* occurs there also, but mainly in Tropical Evergreen Rain Forests (forest terminology for Thailand by SMITINAND, 1966). *T. equidarum* and *Po. siamica* have been found in highlands from 1000 to at least 1450 m, in or near limestone outcrops and mountains, both covered by dense vegetation. *Po. albistriga*, *Py. rosacea*, *Po. huaykaeoensis* live in a wider range of habitats, from lowlands to at

least 1700 m (the last to 1150 m), evergreen as well as deciduous forest, including limestone vegetation, and also in open shrubland.

Po. doisuthepica, *T. rufobrunnea* and *T. fulgurifera* are known from Tropical Hill Evergreen Forests, the last and *Po. bhutanica* and *T. japonica* ssp. were found in Lower Temperate Mixed Broadleaved Forests, near the limit with the Subtropical Semi-evergreen Hill Forests (forest terminology for Nepal by STAINTON, 1972).

Host Animals

Before the present study, 9 host species were known to be sought after by Notodontidae (BÄNZIGER, 1973). Five new hosts have since been found: The Asian elephant (*Elephas maximus* L.), Malayan tapir (*Tapirus indicus* Desmarest), black rhinoceros (*Diceros bicornis* L.), horse (*Equus caballus* L.) and mule (*E. caballus* X *E. asinus* L.). The black buck (*Antelope cervicapra* L.), hog deer (*Hyelaphus porcinus* Zimm.) and donkey (*E. asinus*), all previously confirmed hosts (*loc. cit.*), were not available at the observation sites of the present study. The 6 hosts in common with the previous study are: water buffalo (*Bubalus bubalis* (L.)), zebu and cattle (*Bos taurus indicus* L., *B. t. taurus* L., here considered as one entity because the studied animals were often crosses between the two), nilgai antelope (*Boselaphus tragocamelus* (Pallas)), sambar deer (*Cervus unicolor* Kerr), fallow deer (*C. dama* L.), red deer (*C. elaphus* L.).

All these hosts are shared with lachryphagous moths of families other than the Notodontidae, like the Geometridae, Noctuidae, etc., which however, frequent also several additional host species.

The most attractive host proved to be the elephant, with an estimated total of some 70 moth specimens seen approaching it, of which more than 20 *T. elephantorum* and 2 *Py. rosacea* visited the eyes. That is followed by zebu and cattle with 5 *Py. rosacea*, 2 *Po. huaykahoensis* and 1 *Po. bovoculosgens* at their eyes; sambar deer with 6, tapir with 4 and water buffalo with 2 *T. remicauda* at eyes, the bovid also with 1 *Py. rosacea*. Of course plenty more cases of notodontids sucking at mouth and other body parts, or attempting to settle on head, or just circling around the hosts, were noted as shown in Tables 1–5.

During the present research no notodontid was seen actually sucking at the eyes of nilgai, fallow deer, red deer, horse, and mule. But *T. remicauda* settled at the mouth of the nilgai and tried to alight on the head of the two deer, while *T. equidarum* attempted to do so on horse and mule. The eyes of nilgai, fallow deer and red deer were visited by *T. remicauda* during the earlier survey, and horse and mule are confirmed hosts of other lachryphagous Lepidoptera (*loc. cit.*).

A special position is held by the rhinoceros. His eyes are so far still inviolate by tear sucking moths as far as the author's investigations go, in spite of attempts by

T. remicauda to get at them; yet this and other confirmed lachryphagous moths, such as the geometrid *Zythos turbata* (Walker), have time and again settled on his body to imbibe body fluids. Against the massive body with several attractive chronic wounds, his small eyes may have been particularly difficult to locate. To some extent this would apply also to the elephant. However, one of the reasons why the elephant appeared to be sought after and have frequent visitors at his eyes, may be that it was mostly studied in forests or clearings with particularly rich insect fauna, while the rhinoceros was investigated in the Kuala Lumpur Zoo only.

The total number of hosts of Notodontidae therefore now amounts to 14 (not including man), although horse, mule and rhinoceros so far were not successfully visited at eyes.

The hosts' reaction to the moths approaching them, trying to alight near eyes, or being settled there with the proboscis probing or rubbing on lid and cornea, has been outlined in some detail (loc. cit.); reactions are generally mild. Of course such massive moths as *Tarsolepis* can disquiet a sensitive host by just circling around it, but when the insects persisted the host often ended up tolerating the intruder. This seems to indicate that they have at least got used to this nuisance. Also, it has been noted that a host such as sambar or elephant which in time may have become fairly trusting to the author's frequent visits, would alter its perception of, and behaviour towards, him when a *Tarsolepis* was circling around the animal; the host showed distrust and occasionally attacked the author. This complicated the studies significantly. On the other hand, the smallest of the lachryphagous notodontids, *Py. rosacea*, elicited scarcely any reaction and was able to suck undisturbed.

Man as a Host

Man is an unusual host for Lepidoptera. He is at least as distantly related to the classical hosts, found among the Ungulata and Proboscidea, as other mammals so far studied in this respect, such as the Carnivora which up to now have not been seen to have their eyes approached by lachryphagous moths. Nevertheless attacks on the author's eyes by moths of various families occurred repeatedly. Notodontidae, however, are recorded here for the first time to successfully drink human tears (Table 1 - 5). Of course, the author never scared moths away but let them settle freely and suck whatever they liked - in a sense a somewhat 'unnatural' situation as humans can be expected to flip intruders away, at least when they are obnoxious. However, there are moths which suck gently and at night man can be unaware of them when busy with his occupation, drowsy or asleep. Most importantly, for the purpose of study, it was necessary to investigate which species actually attack man and what their behaviour is. Except for temporary inflammation, the author's eyes never developed any complication following attacks by lachryphagous moths.

The only attack by *Po. albistriga* experienced by the author was not successful. It landed on his face but to his sorrow it did not drink his tears. An

unidentified *poncetia* – most likely *albistriga* or *siamica* – restlessly crawled on his hand and that of his colleague, Mr. P. Schwendinger, sucking perspiration; it escaped capture.

Attacks by *T. elephantorum* on the author (and one night also on his Karen assistants) occurred on 7 occasions when not less than 14 specimens attempted to reach his eyes. Three specimens actually drank his tears (Table 1).

The author's tears seemed to exert a more powerful attraction for the delicate little moth *Py. rosacea*. Although being less common than the latter, on 8 occasions a total of 12 attempts occurred during which the moths drank his tears in 8 instances. This is an unusually high incidence when compared with observed cases of the moth's lachryphagy on animals, numbering 10. Some Pyralidae, such as *Pionea aureolalis* (Lederer) and *Filodes mirificalis* (Lederer), fed more frequently from human eyes (loc. cit., and in prep.) but their ratio of human : animal lachryphagy is lower. If the relatively small number of *Thliptoceras anthropophilum*, *Th. shafferi*, *Th. umoremsugente* and *Toxobotys boveyi* observed is taken into account, they have been collected from man more often than other lepidopterans (BÄNZIGER, 1987); but these species took perspiration, not tears from man.

A comprehensive article on lepidopterous lachryphagy on man involving all families of moths known to exhibit this feeding habit is in preparation. However, one memorable case may be worth recalling here.

On the partly cloudy, relatively warm (20°C) night of 19.xi.87, the author had been observing moths in a clearing of a forest on Doi Suthep for several hours. When he heard a very subdued flutter near his ears he knew this was one of the moths seeking his fluids. By a fortunate coincidence he had his photographic equipment with the special self-made device to photograph himself ready. The moth's actual attack came fast and unusually direct. In what seemed less than half a minute it had reached the right eye and started to suck. It felt somewhat like a sand particle was in the eye. Presently the eye felt awash with tears. The first photograph had barely been taken when the moth unexpectedly flew off. It disappeared into the darkness and the author was unable to capture it. Disappointed at this setback, the only clue concerning the moth's identity which remained was the photograph. Upon development, the surprise was as great as winning in a lottery: the photograph revealed *Py. rosacea*, the first notodontid to be photographed at the human eye (Fig. 50).

Table 1. Observations of *Tarsolepis elephantorum* on or near mammalian hosts.

Date	Locality	Host	Details of behaviour
16.v.73	Zoo Ch. M.	sambar	tried to settle at eye, 10 min later again (same individual?)
19.v.73	Zoo Ch. M.	elephant	flew near host
20.v.73	Zoo Ch. M.	elephant	flew near host
12.iv.74	Zoo Ch. M.	sambar	flew near host
15.iii.76	forest place	elephant	flew around host
27.iii.77	forest place	elephant	several times groups of 5 – 10 individuals tried to settle at eyes (an estimated 8 successfully) of 4 hosts before total darkness; other body parts also alighted on
		man	sucked at author's eye; several more individuals attempted to do so on him and assistants
10.iii.79	forest place	elephant	many individuals attempted to settle at eyes some 30 times (an estimated 10 successfully), up to 3 individuals witnessed at one single eye
		man	several attempts to reach the author's eye
14.iii.81	forest place	elephant	approached host
20.iii.82	forest place	elephant	4 – 6 individuals attempted to settle on host
26.iii.84	forest place	elephant	settled on host's body
6.iv.84	forest place	man	settled 5 times on author's hand sucking perspiration for up to 2 min, also flew around head but did not settle
1.iii.88	forest place	man	flew around author for over 1 min, settled several times to suck perspiration on hand and arm
7.iii.88	forest place	elephant	some 15 attempts to alight by an estimated 4 individuals, none sucked successfully though 2 reached eyes briefly; hosts restless
		man	settled on clothes, hand, arm and face of author, sucked at eye for 2 min
16.iii.88	forest place	elephant	some 8 attempts to settle at eyes by presumably 3 – 4 individuals, none successful; hosts restless
		man	settled twice on hand, arm, face of author, sucked from mouth and nose, then at eye for 2 – 3 min, very unpleasant feeling

Table 1 (continued).

Date	Locality	Host	Details of behaviour
22.iii.88	forest place	elephant	some 10 attempts by an estimated 5 or more individuals, sometimes 2 simultaneously, 3 sucked at eye, in one case for over 2 min
		man	flew around author for 5 min, settled on trousers, arm, hand, throat; eye not reached

Explanations: Zoo Ch. M.: Zoo Chiang Mai; forest place: various sites in forest up to 2 h walking distance off road Chiang Mai to Chiang Dao, approx. km 55, where work elephants were released in semi-wild state at night

Table 2. Observations of *Tarsolepis equidarum* on or near mammalian hosts.

Date	Locality	Host	Details of behaviour
15.iv.86	Doi Ang Khang	horses, mules	flew within host group, trying several times to settle on head; presence of neon light of nearby probably disturbed searching action of moth

Table 3. Observations of *Tarsolepis remicauda* on or near mammalian hosts.

Date	Locality	Host	Details of behaviour
MALAYSIA			
14.v.71	Zoo K.L.	rhinoceros	settled on cheek for short time
15.v.71	Zoo K.L.	tapir	2 individuals sucked exudates for a few min
17.v.71	Sungei-t.	water buffalo	flew briefly around place where host had lain just before moth arrived
20.v.71	Zoo K.L.	rhinoceros	flew briefly in host's enclosure
22.v.71	Zoo K.L.	rhinoceros	flew around and fed on wound exudates for a total of 10 min; attempts to reach the eye also witnessed

Table 3 (continued).

Date	Locality	Host	Details of behaviour
5.vi.71	Zoo K.L.	tapir	sucked for several min at wound
8.x.71	Zoo K.L.	horse	flew around host for several min, landed briefly on leg
10.x.71	Zoo K.L.	nilgai	sucked saliva from mouth
18.x.71	Zoo K.L.	rhinoceros	flew around host
22.x.71	Zoo K.L.	nilgai	attempted to settle on head of sleeping host but author's torch light scared moth away
7.i.72	Zoo K.L.	nilgai	flew around host
4.ii.72	Zoo K.L.	sambar	2 individuals sucked simultaneously on host
		tapir	flew for several min around host and finally sucked lachrymation from eye
6.ii.72	Zoo K.L.	rhinoceros	sucked fresh blood from wound
25.ii.72	Sungei-t.	water buffalo	flew near host
4.iii.72	Zoo K.L.	sambar	4 individuals settled at eyes and mouth
		red & fallow deer, nilai	at least 2 individuals tried to settle on host
		rhinoceros	attempted to settle at eyes, nose, mouth but then sucked on host's body
		tapir	sucked 3 times (or more than 1 individual less often) lachrymation from eye
5.iii.72	Sungei-t.	water buffalo	3 individuals flew around body and eyes, 1 additional individual sucked lachrymation at eye, 3 further individuals tried simultaneously to settle on head and body
11.iii.72	Zoo Taip.	sambar	sucked at eyes and mouth of 2 hosts in close succession
12.iii.72	Kpg. Cheh	zebu	approached host
13.iii.72	Zoo Taip.	sambar	flew near host
26.iii.72	Pdg. Ren.	water buffalo	settled briefly at eyes, mouth and body
S. THAILAND			
4.iv.72	Bann. Sa.	elephant	tried to settle at eye for several min
5.vi.72	Tha Yai	elephant	flew around host

Explanations: Zoo K.L.: Zoological Gardens, Kuala Lumpur; Sungei-t.: Sungei-tua, 15 km NW of Kuala Lumpur; Zoo Taip.: Zoological Gardens, Taiping, Perak State; Pdg. Ren.: Padang Rengas, Perak State; Kpg. Cheh: Kampong Cheh, Perak State, all W. Malaysia. Bann. Sa.: Bannang Sata, 35 km S. of Yala, Yala Prov.; Tha Yai, 20 km N of Chumphorn, Chumphorn Prov., all S. Thailand.

Table 4. Observations of *Pydnella rosacea* on or near mammalian hosts.

Date	Locality	Host	Details of observations
24.iv.74	Doi Suthep ¹	zebu	caught as flying off eye of host
21.xi.80	forest place	elephant	sucked at eye
28.xi.80	forest place	man	sucked at author's eye
13.v.81	forest place	elephant	tried to alight on host
10.vii.82	forest place	elephant	approached host
28.x.82	Ban Mae Tho	water buffalo	sucked at eye
22.x.83	forest place	elephant	sucked at eye
9.viii.85	Doi Suthep ²	zebu	sucked at eye
22.x.85	forest place	man	sucked 3 times at author's eye
28.x.85	Doi Ch. D.	man	individual woke the author (2 a.m.) who was sleeping openly in forest, by circling near nose, mouth, eyes; did not settle at eyes, at least while the author was awake; insect repellent had been used a few hours before
21.viii.86	Doi Ch. D.	man	settled 3 times on author's hand, then on shirt, throat, mouth where it sucked saliva briefly, then moved to eye where it sucked until caught
16.xi.86	Doi Suthep ²	man	settled twice on author's face, then sucked at eye until caught
		zebu	sucked at eye for a long time until caught
5.xi.87	Doi Suthep ²	man	alighted on face of author and colleague but did not suck at eye; other individual sucked perspiration and then lachrymation at eye of author
6.xi.87	Doi Suthep ²	man	sucked at author's mouth and eye; other individual sucked at eye
19.xi.87	Doi Suthep ²	man	sucked at author's eye
23.xi.87	Doi Suthep ²	zebu	sucked twice at eye

Explanations: Doi Suthep¹: near Ban Meo, SW slope, approx. 1300 m; forest place: various sites in forest up to 2 h walking distance off road Chiang Mai to Chiang Dao, approx. km 55, where work elephants were released in semi-wild state at night; Ban Mae Tho: Hod/Mae Jaem Distr., Chiang Mai Prov.; Doi Suthep²: NW slope of Doi Pui, 1150 m; Doi Ch. D.: Doi Chiang Dao, NW Pass, 1150 m; Doi Suthep⁵: near Khonthatharn Waterfall, 660 m.

Table 5. Observations of *Poncetia* spp. on or near mammalian hosts.

Date	Locality	Host	Details of observations
<i>Poncetia albistriga</i>			
13.v.81	forest place	elephant	attempted to settle on host
24.ix.83	forest place	elephant	attempted to settle on host
9.iv.87	Doi Chang	man	alighted 4 times on face, briefly stopping at nose and mouth, evidently trying to find the eyes but without success
<i>Poncetia bovocolosugens</i>			
22.xi.73	Doi Suthep ³	zebu	sucked at eye before escaping; other individual caught while attempting to reach the eye
<i>Poncetia huaykaeoensis</i>			
26.x.66	Zoo Ch.M.	sambar	approached eye but was disturbed by author's torch light
11.x.73	Doi Suthep ³	zebu	sucked 3 min at eye; other individual flew around host
28.xi.80	forest place	elephant	flew near host
13.v.81	forest place	elephant	circled around host
12.xi.87	Doi Suthep ²	zebu	sucked at eye
Unidentified <i>Poncetia</i> (probably <i>albistriga</i> or <i>siamica</i>)			
29.iv.86	Doi Suthep ⁴	man	settled on author's and colleague's hand but escaped hence identification not certain

Explanations: Forest place: various sites in forest up to 2 h walking distance off road Chiang Mai to Chiang Dao, approx. km 55, where work elephants were released in semi-wild state at night; Doi Chang: Chiang Mai/Mae Hongson Prov., 1965 m; Zoo Ch. M.: Zoo Chiang Mai; Doi Suthep² : NW slope of Doi Pui, 1150 m; Doi Suthep³ : near Huay Kaeko; Doi Suthep⁴ : near summit, 1610 m.

Feeding Habits and Seasonal Flight

Two types of behavioural patterns exhibited in connection with the feeding of the 7 Notodontidae can be distinguished, namely that of the 3 *Tarsolepis* spp. as against that of the 4 species of *Poncetia* and *Py. rosacea*.

While alighted and feeding on a host, *Tarsolepis* spp. do not stop beating the wings and often cling to the host by one or two fore leg pairs only (Fig. 42,46). They

are frequently shaken off by the host and can suck for short periods only but attempts to land are constantly repeated. Species of the other two genera do not beat the wings once they are firmly settled with all 6 legs at the eye. They suck for longer periods, up to several minutes or so, seemingly without causing undue disturbance, after which they fly off without returning. If chased away, they may attempt to resume visiting the host.

When hit by the light of a photographic flash or strong torch *Tarsolepis* fall, sometimes remaining entangled in the grass, although the light's effect is often much reduced when *Tarsolepis* are eagerly sucking from an eye, making repeated photographs possible. *Py. rosacea* seems to be much less disturbed by such lights.

Tarsolepis spp. tend to arrive in groups, especially *elephantorum*, and appear early at night, sometimes before actual nightfall, though *remicauda* showed up late (22–23 h) in W. Malaysia, as occasionally would *elephantorum*. They can be encountered on or near mammals from March with a peak in the second half of March. This is remarkable for *T. elephantorum* because deciduous forests in N. Thailand are at that time driest and hottest. In W. Malaysia *T. remicauda* was observed attacking mammals also in January, February, June (also in S. Thailand and S. W. China), and October. Species of the other genera can be present very early on hosts but may just as often be encountered very late; *Py. rosacea* may turn up long after midnight. They do not seem to fly in groups. They appear in very low populations in April, increase thereafter to a maximum late in the rainy season (October-early November) (includes MVL captures).

Tarsolepis spp., besides taking lachrymation, very often suck fluids from the mouth and nose (Fig. 44), and perspiration from the skin, of the host. *T. remicauda* has also been observed to suck wound exudates from rhinoceros and tapir (Figs. 47,48). Thia has rarely been noted to occur in species of the other two genera, although one, *Py. rosacea*, sucked saliva from the author's lips and licked perspiration from his skin, as did one *Po. albistriga* and an unidentified *Poncetia*.

It is interesting to note that none of the 7 notodontid species have yet been seen to take the sodden mixture of earth, rainwater, urine, and dung so frequently observed in many Geometridae and Pyralidae. However, one specimen of the notodontid *Blennena griseodivisa* Bryk was noted to imbibe such a mixture near a pigs' sty.

Sucking at eyes involves no piercing of, or other macroscopic damage to, tissues; this has been extensively treated (BÄNZIGER, 1973).

Only male adults were found in association with mammals, as is the case with other zoophilous Lepidoptera with the notable exception of *Lobocraspis* and *Arcyophora* species (Noctuidae).

DISCUSSION

Tear drinking and zoophily, which to the earliest observer in S. America

appeared as puzzling eccentricities, appear to be normal behaviour for at least 3 of the 7 lachryphagous notodontids studied here. Knowledge of the other 4 species is too scanty so far to decide whether the scarcity of records on their lachryphagy is due to a less developed zoophily or rather just because they are rarely met with. The 3 common species, *Tarsolepis elephantorum*, *T. remicauda* and *Pydnella rosacea*, were seen more often in close association with mammals than at mercury vapour lamps. Yet the Notodontidae are poor achievers in most aspects of lachryphagy.

The family can muster only 7 species with the feeding habit so far, while the Geometridae and Pyralidae have some 30 species each, and the Noctuidae at least a dozen confirmed lachryphagous species (REID, 1954; BÄNZIGER, 1973, and in prep.; BÜTTIKER, 1973). Also, the family Notodontidae is more poorly represented in number of individuals involved, both in peak season and throughout the year. The highest count ever made amounted to about 2 dozen *T. elephantorum* on 26.3.77, in a group of 4 elephants. This was exceptional; generally only a few specimens, if any, were seen. Most notodontids are met sporadically, tend to fly only during part of the year, and mainly at nightfall and a few hours afterwards. In almost 700 night inspections during 17 years, fewer than 150 specimens were seen in association with mammals (just over 50 cases of lachryphagy).

By contrast, geometrids like *Hypochrosis hyadaria* Guenée, *H. flavifusata* Moore, *H. iris* Butler, and pyralids such as *Filodes mirificalis*, may fly by the dozens at the same time around their hosts throughout much of the night, in the early hot season and late rainy season; lower numbers are present also during other periods. But the noctuid *Lobocraspis griseifusa* Hampson beats them all: the record is 13 specimens at one eye of a banteng (*Bos javanicus* d'Alt.) and 12 on the other in dense ring-like clusters with their wings overlapping each other. Somewhat lower counts were more common. Also, the species' feeding behaviour and physiology are the most evolved for lachryphagy.

Notodontidae excel in two respects, however. *Py. rosacea* exhibits the most pronounced predilection for human tears of all Lepidoptera. *Tarsolepis* species, if not the most beautiful, are probably the most flashy lachryphagous moths with their silver triangles, red hair tufts and caudal remigants; with their large wingspan and bulky body size, they are the heaviest tear drinkers so far known.

Why this craving for tears? SHANNON (1928) was probably correct in hypothesizing that one of the substances the moths were probably after was the salt contained in the lachrymation and perspiration. Butterflies of certain regions have long been known to assemble at wet soil contaminated with animal effluvia. The earliest observations the author has come across go back to the middle of the last century: WALLACE's (1869) classic *The Malay Archipelago*. Butterflies also visit salt licks (ALLEN, 1923) and occasionally take human perspiration (VAN SOMERAN, 1927).

As the experiments by ARMS et al. (1974) have shown, the evidence suggests that butterflies are looking for salt (NaCl), though moisture may also play a role during hot dry weather. Not only butterflies, but also birds (finches) and mammals

(ungulates, rodents) have been seen drinking at puddles contaminated with salt (FRASER, 1985), besides of course moths (ADLER, 1982). It is also common knowledge that ungulates like to visit natural salt licks.

It is thought that scarcity of environmental sodium (Na) in the soil of certain regions (SHANNON, 1928; FRASER, 1985) and low sodium content in plants (ARMS et al., 1974) may induce herbivores (in this context certain moths) to increase their intake by utilizing other sources as mentioned above. It has even been suggested that low sodium content in plants may be a strategy to deter or control herbivory (BOTKIN et al., 1973; ARMS et al., 1974) though this is contested by SEASTEDT & CROSSLEY (1981).

There remain two questions: why only moths and no butterflies take lachrymation, and why is it that some moth species take all the trouble and risk to drink tears from mammals' eyes instead of simply sucking at contaminated puddles or salt licks as their more orthodox relatives do?

BÄNZIGER (1973) suggested that nocturnal lachryphagy represented an unoccupied ecological niche. Night-active Lepidoptera have successfully conquered it for themselves. Diurnal lachryphagy is the domain of Diptera, flies (Muscidae) and eye-gnats (Chloropidae), small, drab coloured, hardy, persistent intruders. Most butterflies would seem to be too large and brightly coloured, conspicuously fluttering, and delicate to successfully outwit the hosts. In order to snatch secretions under the nose and eyes of their victims, Lepidoptera must rely on stealth and darkness, when they are less visible and the host asleep or drowsy. This is the role for which moths were preadapted to a wide extent; through subsequent evolution they were able to fully dominate the niche.

As to the second question, it is often not realized that besides water and salt, tears also contain proteins. The proteins albumin and globulin are dissolved in human tears in amounts comparable to salt (similar concentrations can be expected in ungulates). Therefore it has been suggested (loc. cit.) that lachrymation may represent a high quality source of nourishment – available in reliable amounts and concentration throughout the year, if one can obtain it – and thus be more valuable than salt licks and puddles.

The physiology of digestion and nutrition in these moths is not yet fully understood and still under investigation; hence it is not elaborated here. However, the above discussion offers clues for the eccentric evolution of a taste for tears in moths of several different families.

ACKNOWLEDGEMENTS

The author is most indebted to Dr. J. Holloway, Commonw. Inst. Entomol., for offering important comments and the photograph of genitalia of *Po.fuscipennis*. Mr. A. Watson, Dr. M. Scoble, Mr. M. R. Honey, all of the BMNH, found time despite their other duties to assist him with characteristic efficiency throughout

several studies at the BMNH. Dr. A. Lewvånich, Bangkok, Dr. R. de Jong, Leiden, and Dr. H. J. Hannemann, Berlin, sent crucial type or other material. Dr. W. Dierl, Munich, and Mr. G. Linder, Zürich, found pertinent references. Mr. M. Allen, British Embassy, Bangkok gave information on his notodontid collection while the author's Department colleagues, especially Mr. P. Sukumalanon, Dr. S. Budharugsa, Dr. S. Ratanabhumma, helped in many ways. Dr. W. Brockelman, Mahidol University, and Mr. A. Bamford, Srinakharinwirote University, criticized and improved the manuscript. Prince Bhisadej Rachanee and Mr. N. Pipattanawongs, of the royal Project, extended official facilities, as did the authorities of the University of Malaya and Zoo Negara, Kuala Lumpur, and Taiping Zoo, Taiping, in W. Malaysia, and the Chiang Mai Zoo, Thailand. Mr. P. Schwendinger assisted with MVL trapping. Last but not least, Mr. R. Köchle, formerly of the University of Malaya, offered constructive discussions and long term accommodation during the author's 11 months' stay in Malaysia.

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