

LARDIZABALACEAE: NEW PLANT FAMILY FOR THAILAND 'PREDICTED' BY RARE MOTH ON DOI SUTHEP

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ABSTRACT

The natural host plant of the larvae of the fruit-piercing moth *Adris okurai* Okano is shown to be *Parvattia brunoniana* Decaisne of the Lardizabalaceae. This family, previously unrecorded in Thailand, was predicted to be there by the presence of the moth and the stenophagy of its larvae. *P. brunoniana*, rarely collected even in its main home, N.E. India to S. W. China, has been found in all northermost provinces of Thailand. Notes on its morphology and ecology are presented. A large liana, it was discovered to have strikingly prominent corky ridges on stems. Persistent search revealed that not less than 11 plant families in the area have liana species with corky ridges. The Lardizabalaceae can now be predicted to occur also in the Malesian phytogeographical region (e.g. W. Malaysia). The distribution of Berberidaceae, Lardizabalaceae, Menispermaceae and Schisandraceae in S. E. Asia is reviewed in the light of the possibility of their being host plants of the related moth *A. sikhimensis* Butler. Rare species such as these can thus lead to a 'cascade' of discoveries in various fields, and highlight the great importance of sanctuaries for their preservation.

INTRODUCTION

The present research investigates aspects of two very different but closely connected subjects, one entomological, the other botanical. Although originally only a sideline, the latter turned out to be the most rewarding aspect.

Adris okurai Okano is a large, elegantly shaped noctuid moth with bright yellow-orange hind wings (cf. Fig. 6 in BÄNZIGER, 1987); these are concealed below leaf-like fore wings when at rest (Figs. 1, 2). In Thailand it is very rare and was discovered only in 1980 in the upper reaches of Doi Suthep – Pui National Park. Its range includes the Lesser Himalayas: Nepal, Sikkim, Bhutan, N. E. India. The species' easternmost occurrence is in Taiwan, from where it was described (OKANO, 1964), although the oldest specimen still extant (British Museum (Nat. Hist.), London (BMNH)) is from Assam.

Recent research in Nepal confirmed a previous suspicion that the adults live upon fruit juices (BÄNZIGER, 1987) which they obtain by piercing holes into fruit with a formidable drilling apparatus which neither the thick rind of oranges (*Citrus* spp.) nor the leathery skin of longan (*Dimocarpus longan* Lour.) can resist. Study of the

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previously unknown immature stages also revealed a brightly coloured caterpillar. However, the most interesting aspect of the moth is the larval feeding habits which turned out to be something of a paradox.

Nepalese larvae ate only plants of the Lardizabalaceae, e. g. *Holboellia latifolia* Wallich. They died rather than accept plants of other but closely related families such as the Berberidaceae and Menispermaceae, the only logical alternative host plants. Many of these are eaten by the insect's near relatives, such as *Adris tyrannus* (Guenée), *Othreis fullonia* (Clerck) etc. Since many lepidopterans are stenophagous, *A. okurai*'s host restriction is not surprising. It is intriguing, however, that the Lardizabalaceae had never been reported from Thailand. They are a family with a disjunct distribution: mainly E. Asian to S. E. Himalayan, and S. American.

BÄNZIGER (1987) proposed two explanations: (1) Nepalese and Thai populations differ in their larval host plant preference. Thai caterpillars might feed on Berberidaceae rather than the Lardizabalaceae, but this could not be checked as Thai caterpillars were then unknown. Due to its rarity it had not yet been possible to breed the species in Thailand. A precedent for such a variable feeding habit is found in the related *O. fullonia*. (2) Rather less likely, the Lardizabalaceae actually do occur in Thailand but had been overlooked by botanists.

The more improbable explanation eventually proved to be correct when Mr. J. Maxwell came across the flowers of a male *Parvatia brunoniana* Decne. on Doi Suthep early 1988. The finding of this first species of Lardizabalaceae in Thailand, however, was not the only surprise. Mr. Maxwell had been aware of the absence of the family in Thailand because I had asked him to confirm this in connection with my studies of *A. okurai* caterpillars. Thus, he was astonished when, upon inquiry at the Leiden Rijksherbarium to insure his finding was the first, he was told the plant had in fact been collected once before by van Beusekom and Phengklai on Doi Suthep in 1969. But their finding had never been published and so remained unknown. When Mr. Maxwell showed me the plant it was my turn to be surprised. One year before him, but after completion of my 1987 study of *A. okurai*, I had myself found *P. brunoniana* in Chiang Rai Province (BÄNZIGER coll. No. 276). At that time I did not recognize the plant, as I had only sterile parts and no reference material for identification. Still, it tantalizingly had reminded me of the only other Lardizabalaceae I knew, viz. *H. latifolia*, but I could not believe I had found a new plant family, so soon after having cautiously suggested its possible presence in Thailand. With its trifoliate leaves it seemed more likely to be a Leguminosae. Without Maxwell's finding the family might still remain unrecorded for the country, 20 years after it was discovered by van Beusekom and Phengklai.

P. brunoniana has infrequently been collected even in its main area of distribution (N. E. India, S. W. China) and Bänziger 292 is the first specimen to reach Kew Gardens Herbarium in this century. Moreover, the remarkable structure of mature stems, aerial adventitious rootlets, fruits and seeds were unknown or incompletely known, and the ecology a blank.

In order to find the caterpillars of rare *A. okurai*, study their morphology and prove that they indeed live on *P. brunoniana*, I searched for as many individuals of this plant as I could find, mapped their location, and frequently checked for the presence of the moth's eggs and larvae. This also offered an opportunity to obtain further information on the plant's morphology and ecology.

The discovery of the Lardizabalaceae and also of *A. okurai* in Thailand on Doi Suthep, and the possibility of studying their interesting ecological relationships, highlight both Doi Suthep's suitability as a center for field research (e.g. ELLIOTT et al., 1989) and also its underestimated species richness (e.g. SEIDENFADEN & SMITINAND, 1959 – 1964; ROUND, 1984; BÄNZIGER, 1988).

THE MOTH

Morphological Notes

The taxonomy of the adult presents no difficulty as mentioned in BÄNZIGER (1987). The immatures from Thailand do not differ in any major aspect from those of Nepal's. There is, however, a small but important specification to be made valid for both Nepalese and Thai *A. okurai* larvae. The antero-dorsal, crescent-like section of the first 'eye-ring' (on 3rd abdominal segment) appears too white in the photograph of Figs. 13 – 15 of BÄNZIGER (1987); in reality it is light yellow (very light yellow in stages III and IV). In real life, from a barely perceptible yellowish discoloration, especially in freshly moulted III instars, the 'eye-ring' section gains in intensity of yellow in every subsequent instar. This yellow is the best indicator with which to distinguish III-V instar *A. okurai* from *O. fullonia* of the same stages in which the antero-dorsal crescent is white or only rarely very faintly yellow. This yellow is also the most obvious character to separate the last instar of *A. tyrannus* (Fig. 16, l.c.) from *O. fullonia*, the dark forms of which are otherwise very similar to *A. tyrannus*.

Ecological Notes

The population of *P. brunoniana* host plants on Doi Suthep was inspected 41 times during all months of the year between January 1988 and October 1989. It proved impractical to check all the 61 plants of 18 clusters during a single day. Moreover, some large lianas had leaves only high up in the crowns of trees. These were not surveyed. The more accessible clusters were inspected during every visit. Despite this effort, immature moths were found only on 6 occasions:

- 23.6.88: 9 eggs, 1 first instar, 1 third/fourth instar larvae
- 9.7.88: 1 third instar larva
- 14.8.88: 2 first instar larvae
- 15.6.89: 1 first instar larva shortly before moulting
- 11.7.89: 2 third/fourth instar larvae

4.9.89: 1 fourth instar larva

It is interesting to note that with one exception all 9 eggs and 9 caterpillars found were from a single cluster of two plants at 1370 m, both in 1988 and 1989; the larva of 4.9.89 was from a cluster of three plants at 1020 m of the same narrow valley.

P. brunoniana populations at other places in N. Thailand were inspected only occasionally; no immatures were found on these.

The finding of *A. okurai* caterpillars on *P. brunoniana* proves that the plant is indeed a natural host of the larvae – the first and so far the only one known. Nepalese caterpillars which in captivity developed normally on another Lardizabalaceae, *H. latifolia*, have never been found in the field in Nepal despite intensive searches in 1985 and 1988. This is ironic, as both moth and host plant are much more common at the study site in Nepal than in N. Thailand. Nevertheless, there is little doubt that *H. latifolia* must be the main host in that region.

Rearing experiments show that Thai caterpillars can develop normally on *H. latifolia*. In addition, feeding trials with Thai larvae show that, just like the Nepalese larvae, they are unable to survive on *Mahonia siamensis* Takeda (Berberidaceae), originally the most suspected host (BÄNZIGER, 1987). Although the Thai caterpillars ate more of this plant than Nepalese larvae, they soon died. Other potential hosts tested and rejected include:

Menispermaceae. *Cissampelos pareira* L., *Ci. hispida* Forman, *Cyclea atjehensis* Forman, *Cy. barbata* Miers, *Diploclisia glaucescens* (Bl.) Diels, *Fibraurea tinctoria* Lour., *Pachygone dasycarpa* Kurz, *Parabaena sagittata* Miers, *Pericampylus glaucus* (Lamk.) Merr., *Stephania elegans* Hook. f. & Thoms., *S. glabra* (Roxb.) Miers, *S. japonica* (Thunb.) Miers, *Tinomiscium petiolare* Hook. f. & Thoms., *Tinospora siamensis* Forman (= *Tinospora* sp. aff. *glabra* (Burm. f.) Merr. in BÄNZIGER, 1982, 1987), *Tinos. baenzigeri* Forman, including two genera and species new to Thailand, discovered during this study, viz. *Aspidocarya uvifera* Hook. f. & Thoms. and *Sinomenium acutum* Rehd. & Wils.

Ranunculaceae. *Thalictrum foliolosum* DC.

Due to the rarity of the moth, it is not yet possible to outline reliable yearly flight periods for *A. okurai*. However, a preliminary assessment based on findings of caterpillars and moths indicate that adults should be encountered from late May to early September, with a possible flight peak in June and one in August. Another peak should be expected in October/early November and April/May, but this is not yet substantiated by any adult or immature captures, either in Thailand or Nepal.

THE HOST PLANT

Parvatia brunoniana Decaisne, Arch. Mus. Hist. Nat. Paris I, 190-191, t. 12A, 1839; Hooker, f., Fl. Brit. India I, 108, 1872; Gagnepain, Fl. Indo-Chine, Suppl. 147-148, 1939; Nayar & Paul, Fasc. Fl. India 19, 36, 1988. *Stauntonia brunoniana* [Wallich, Cat. 4952, 1831 or 1832, *nom. nud.* ex] (Decne.) Hemsley in Hooker, Ic.

Pl. t. 2843, 1907. *Stauntonia trifoliata* Griffith, Notulae IV, 330, 1854 & Icon. Plant. Asiat. t. 495, 1854.

The generic name *Parvatia* is derived from Parvati (in Sanscrit meaning 'pertaining to the mountains'), Shiva's consort and deity of the mountains. The species name is the Latinized form of R. Brown, the British botanist who discovered the 'Brownian movement'.

Parvatia is closely allied to *Stauntonia* and *Holboellia*; some authors, e.g. HEMSLEY (1907), merged them into *Stauntonia*. However, no modern overall revision of this relatively small family is available and I therefore follow the classification at present used at Kew, which recognizes three species of *Parvatia*, viz. *P. brunoniana*, *P. decora* Dunn. and *P. elliptica* (Hemsl.) Nayar & Paul.

The nearest relatives of the Lardizabalaceae are the Menispermaceae and Berberidaceae.

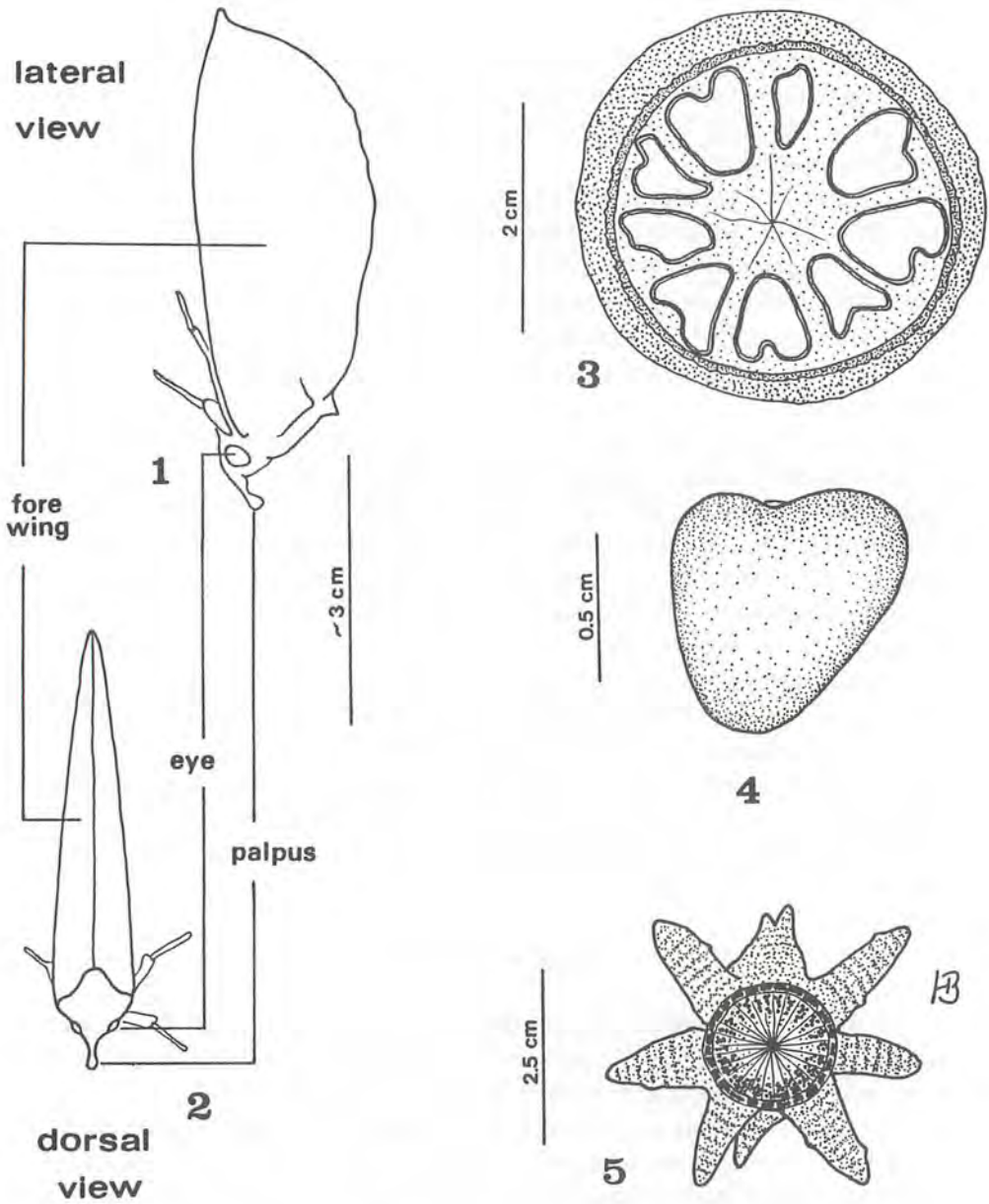
Collections of Thai material. Male inflorescence: Doi Suthep (van Beusekom & Phengklai 2597), Rijksherbarium Leiden & Bangkok (not seen), (Maxwell 88-30) Pharmacy Herbarium, and (Bänziger 282, 293, 294, 306, 520-522). Female inflorescence: Doi Suthep (Bänziger 281, 581). Fruits: Doi Suthep (Bänziger 291, 292) and Doi Chiang Dao Distr. (Bänziger 482, 512). Sterile: N. Thailand (for exact localities see Distribution) (Bänziger 276, 283-285, 295, 296, 307, 311-313, 315-322, 329, 330, 332, 333, 350, 351, 397, 410, 425-427, 466-468, 506).

Bänziger material has been or will be deposited at Kew Gardens, Bangkok, Pharmacy Herbarium of Chiang Mai University, and at the author's department. In order not to damage live plants, most of the sterile collections consist only of a few leaves and an occasional stem. They serve as vouchers and for variability studies. Identification based on the combined characters of stem and leaf of sterile *P. brunoniana* against all other non-lardizabalaceous plants of the area presents no difficulty for the trained eye.

Morphological Notes

The plant has been described several times, though never in detail, as mentioned above. HEMSLEY's (1907) and NAYAR & PAUL's (1988) accounts are illustrated. Only new or previously inadequately treated characters are added here.

Large, woody liana with stem up to at least 39 cm girth. Young stems less than 0.5–0.7 cm diameter are green, larger ones have brownish-grey flecks, those around 1 cm and more develop a suberous bark which in time grows into steep corky ridges. Although DECAISNE (1839), HEMSLEY (1907), NAYAR & PAUL (1988) noted the presence of a suberous bark, the most important feature, i. e. its remarkable formation of unusually prominent ridges, has not been pointed out. The ridges (Figs. 5, 8), light greyish to greyish brown in colour, run longitudinally along the stem, are generally interrupted every 0.5 to 3 cm, the sections sometimes being laterally displaced, or slightly oblique, occasionally anastomizing with nearby ridges.



Figures 1, 2. Explanation of the moth's position in Figs. 6, 7.

Figure 3. Cross section through fruit and seeds of *Parvatia brunoniana*.

Figure 4. Seed of *P. brunoniana*.

Figure 5. Cross section through a mature stem with particularly prominent corky ridges.



Figures 6, 7. *Adris okurai* in typical resting position — upside down — an example of dead-leaf camouflage. Should a predator call the bluff, sudden exposure of the brightly coloured hind wings is thought to startle the aggressor.

Figure 8. Old stem of *P. brunoniana* with corky ridges. Cf. size with sunglasses beneath trifoliate leaves.



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10



11

Figure 9. Female flowers of *P. brunoniana*. Note violet-red young leaves near top edge.

Figure 10. Male flowers of *P. brunoniana*.

Figure 11. Mature, greyish brown fruits of *P. brunoniana*.



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14



15

Figure 12. Male inflorescence and leaves of *Aspidocarya uvifera* (Menispermaceae), new for Thailand.
 Figure 13. Flowers, leaves and stem with corky ridges of *Heterostemma ?gracile* (Asclepiadaceae).
 Figure 14. Flowers, leaves and stem with corky ridges of *Dittoceras* sp. (Asclepiadaceae).
 Figure 15. Flower, leaves and stem with corky ridges of rarely collected *Kadsura heteroclita* (Schisandraceae).



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Figure 16. Flowers, fruitlets and stems with corky ridges of *Aristolochia* sp., probably a new species of Aristolochiaceae.

Figure 17. Flowers, leaves and stem with corky ridges of *Amalocalyx microlobus* (Apocynaceae).

Maximum ridge height measured 3.5 cm though mostly it was less than 2 cm, the width at base being much less, sometimes less than a third of the height. Stems of 1 cm diameter (bark not included) may have 6 ridges which may be as high as 1.2 cm, but the largest stems may have some 30 ridges around the full girth.

Aerial adventitious rootlets (Figs. 18, 19) are sometimes produced near the lowest part of the plant. New adventitious rootlets are 2–3 mm thick. The longest was 2 m long and 2–3 cm thick, with well developed corky ridges. Anatomically they are distinct from stems in the lack of the pith, and in the primary xylem of the center which is triarch and exarch (analysis by Dr. D. Cutler). The growth pattern is also different, as mentioned in the ecological section.

The dimensions of the largest leaves in Thai specimens are up to twice as big as those given by other authors for more northerly plants. The foliole can be up to 25 cm long and 12 cm wide; the middle petiolule up to 9 cm long, the lateral ones always shorter, sometimes as short as 1 cm; the common petiole can reach 23 cm. The most rounded folioles measured 9.5 by 7.5 cm, the most narrow 17 by 6 cm. They are dark green, shiny above, dull and lighter below, leathery-papyraceous, and entirely glabrous.

The inflorescences are shown in Figs. 9, 10.

The largest fruits (Fig. 11) attain 7.5 cm length and 3.5 cm width, but they are generally shorter. The surface is smooth, green when not yet ripe, rough, yellow to brown when ripe. A cross section through the middle of one fruit (Fig. 3) revealed a fleshy, green outer rind of about 1.5 mm thickness, followed by a grainy, somewhat woody, yellowish brown layer of 0.5 mm, and then by a fleshy pulp of light yellowish colour in which the seeds are embedded. They are arranged with the flat side in the plane of the cross section. There are 8–11 layers with 5–9 seeds each (rather fewer towards the base and apex) with a total of 50–60 seeds. They are variably asymmetric cordiform in shape (Fig. 4), up to 10 mm long and 4 mm thick, shiny, plain green or with yellowish and brownish patches when unripe, black when ripe. They collapse on drying.

Distribution

In Thailand, 9 widely separated (50–150 km) populations were located in all six of Thailand's northernmost provinces, with a total of well over 100 individuals, from January 1988 till September 1989, as follows.

Chiang Mai. Doi Suthep-Pui National Park: 18 clusters with 61 plants, 660 to 1635 m (No. 281, 282, 291-296, 306, 315-319, 329, 330, 350, 351, 410).

Chiang Dao Distr.: Ban Pang Hang, 2 clusters with 22 plants, 850 to 1030 m (No. 307, 466, 467, 482, 512).

Fang Distr.: Royal Agric. Res. Station, Doi Ang Khang: 1 cluster with 2 plants, 1500 and 1585 m (No. 331); E of road, approx. 3 km before Res. Sta., 1 cluster of 3 plants, 1720 and 1730 m (No. 332, 333); Ban Luang, 2 clusters with 7 plants, 1640 to 1670 m (No. 397, 468, 506).

- Mae Jaem Distr.: Ban Huay Khamin, 1 plant, approx. 1200 m.
- Chiang Rai. Mae Sruay Distr.: Ban Huay Ya Sai, 1 cluster with 10 plants near stream, 730 to 750 m (No. 276, 283-285, 311-313), and another plant 2.3 km from first cluster, 755 m.
- Lampang. Wang Nua Distr.: Valley at km 36.3 off road from Mae Khajan to Phrao, 1 plant, 830 m (No. 320).
- Phayao. Pha Chang Wildlife Sanctuary: 2 km W of Ban Santisuk, 2 plants, 600 m (No. 321).
- Nan. Tha Wang Pha Distr.: Near Ban Sop Khun, 1 plant at 450 m (No. 322).
- Mae Hongson. Pai Distr.: near road to Pai, approx. 30 km from Pai, 1 cluster with 4 plants at 1230 to 1250 m (No. 425-427).

P. brunoniana also occurs in S. W. China, N. E. India, Bangladesh, Burma, northernmost tip of Vietnam (HEMSLEY, 1907; GAGNEPAIN, 1939; NAYAR & PAUL, 1988).

The only other two species of *Parvattia*, *P. decora* and *P. elliptica* are known from China (FORMAN, in litt.) and N. E. India (NAYAR & PAUL, 1988), respectively.

Other Lardizabalaceae in Asia include *Decaisnea*, 2 spp. in China (E. Himalaya); *Akebia*, 5 spp. in China, Japan; *Stauntonia*, 12 spp. in Bhutan, N. E. India, N. Burma, China, Korea, Japan, Vietnam, Laos; *Holboellia*, 4 spp. in Pakistan to China and northernmost tip of Vietnam; *Sinofranchetia*, 1 sp. in W. China (FORMAN, in litt.; WILLIS, 1973).

Outside Asia the family is known only from S. America, viz. 2 spp. of *Lardizabala* and 1 of *Boquila* in Chile (l. c.).

Ecological Account

Habitat

P. brunoniana was found from 450 m up to at least 1735 m altitude. This range is broader than that so far known, viz. 1200 m (HEMSLEY, 1907) to 1600 m (GAGNEPAIN, 1939). The biotope is very shaded forest with abundant tall trees (Tropical Evergreen Hill Forest), often on steep slopes, mostly not far from streams. At elevations below 900-1000 m, where it is less frequent, it is found only in the dense vegetation along streams in deep gullies (Evergreen Gallery Forest). So far it has not been found on limestone soil (the collections from Chiang Dao and Doi Ang Khang are all near but just outside the limestone area). The liana was encountered mainly on eastern flanks of mountains, but this may be only circumstantial.

Phenology

P. brunoniana is evergreen. New shoot and leaf formation occurs throughout the year but is most profuse in late December to early February, and June-July. New shoots and leaflets are violet-red, later turning light yellow-green; mature leaves are dark green. New flushes, especially in smaller lianas, occur also on



Figure 18. *P. brunoniana*. Old adventitious aerial root with corky ridges (horizontal line), and some younger ones (oblique lines), growing into the ground.

Figure 19. Young adventitious aerial rootlets, mostly desiccated (oblique lines), of *P. brunoniana*.

Figure 20. Corky ridges on old stem of *Aspidocarya uvifera*.

stems growing over small bushes or even just following the ground. This is important for *A. okurai* caterpillars which seem to prefer the lower reaches of the host plant.

Flowering may start already during the latter part of the rainy season (e.g. 4.9.89) but occurs mainly during the cold season (November – January). The latest flowers seen were on 23.1.88.

Fruit growth is very slow. Fruits can still be present when the subsequent year's flowering starts. On 6.12.88 a few fruits from the previous year's flowering were still hanging on one plant, many had fallen, and most had been eaten while on the liana, the rind of the empty fruits still attached. However, in late August some fruits were almost full size though still green and very hard. The rind of some emptied fruits remained attached 16 months after formation.

Growth patterns

P. brunoniana twines clockwise. Mature plants do not emerge from the ground straight upwards but tangentially, sometimes following the ground for up to many meters, often partly embedded in the soil. This may be due in part to the falling of bushes and trees used as supports, or the breaking of parts of them, which may bring the lianas down to some extent. In other cases the prostrate basal part may have begun as a lateral runner of a mature liana. The runner following the ground — a common feature in *P. brunoniana* — produces rootlets and eventually grows into a large stem emerging tangentially from the ground, which may be the only part visible after the original old stem dies. Plants of a single cluster may well have originated from one or a few seeds only and become separated with the passing of time.

Apparently when in very humid habitats aerial adventitious roots are produced. Most of the ones found were in a desiccated state but some had reached the ground and developed further (Figs. 18, 19). Although old adventitious roots are morphologically indistinguishable from corky stems, they can be recognized by their different growth patterns. Stems tend to grow upwards or at most follow the ground, while adventitious roots grow straight down into the ground, and of course produce no leaves.

The aerial adventitious roots of *P. brunoniana* thus differ considerably from those of *Tinospora* spp. such as *T. crispa* (L.) Hook. f. & Thoms. In this plant they can grow down 15 m from the liana in a tree crown, lengthen up to 30 cm in 24 h, and be produced in numbers from any part of the stem except the young shoot (BÄNZIGER, 1982). Most importantly, if *Tinospora* stems are torn or cut, the distal part of the plant will not die but send down a new aerial adventitious root and become a new separate individual. When the stem of a *P. brunoniana* is severed, the distal part of the plant dies (unless it already has root connection with the ground) and only the basal section survives.

The stem of *P. brunoniana* may raise from the ground in a wide curve; a few meters above ground it may branch, one branch climbing up high on one tree while the other perhaps descends again in a wide curve stretching over several bushes before ascending another tree, 10–20 m from the first. *P. brunoniana* were seen to reach

tree crowns up to about 20–30 m from the ground in or near the upper storey of the forest. On Doi Suthep, at an elevation of 1300–1600 m, 40 m is probably the highest level attained by the tallest emergents.

Large *P. brunoniana* more commonly do not wind around the trunk of a tree or cling closely to it. From the tangential section they often extend directly into the supporting tree crown or high branches, away from the trunk. There are probably several factors acting singly, or more likely in combination, that cause this. New shoots can, due to a certain degree of stiffness, grow fairly straight up without much winding around a support for quite a few meters by leaning against the trunk and branches of small tree. More often, though, new shoots grow sideways making it possible for the liana to extend from one bush to the next higher, slowly but constantly upwards. In the course of time some of the smaller bushes or trees will die and the liana will remain hanging from the crown of the tallest trees.

Thick-stemmed *P. brunoniana* are probably quite old plants. The largest stems in some places are covered by a thick growth of mosses and other epiphytes.

Corky bark ridges

The most striking feature of *P. brunoniana* is its corky ridges, a character it shares with several other unrelated lianas in the study area. They range in appearance from faintly similar to *P. brunoniana* to virtually indistinguishable. This may help explain why *P. brunoniana* has remained undetected in Thailand for so long. Some of the lianas have not yet been identified due to a lack of reproductive material. Below is a preliminary list of those so far encountered.

APOCYNACEAE

Amalocalyx microlobus Pierre ex Spire (No. 418–420, 479) (Fig. 17).

ARISTOLOCHIACEAE

Aristolochia grandis Craib (No. 327, 373, 514, 558, 562, 563; probably also 452, 456, 469, sterile). According to PHUPHATHANAPHONG (1987) the species is known only from the type locality, Doi Suthep, and besides the types it had been collected only once before.

Aristolochia sp. (No. 433, 434) (Fig. 16). Although the collection No. 433 is complete with inflorescence, infructescence, leaves and stems, the taxon could not be matched with any species at Kew Gardens; it seems to represent a new species. Phuphathanaphong (1987) mentions *A. sp. cf. saccata* Wall. which may well belong to the same taxon; unfortunately the only specimen available is without flowers.

ASCLEPIADACEAE

Dittoceras sp. (No. 362, 381, 388, 446, 447, 507, 508, 538, 539, 541) (Fig. 14).

?*Gymnema latifolium* Wall. ex Wight (No. 383, 462, 453, all sterile).

Heterostemma ?gracile Kerr (No. 305, 364, 365, 379, 444, 445, 448, 542) (Fig. 13).

MENISPERMACEAE

Aspidocarya uvifera Hook. f. & Thoms. (No. 334–339, 358, 390–393, 458; new genus, new species for Thailand) (Figs. 12, 20).

Parabaena sagittata Miers ex Hook. f. & Thoms. (No. 440, 441, 442).

MORACEAE

Maclura amboinensis Bl. (No. 323, sterile).

RANUNCULACEAE

Clematis sp. (No. 347, sterile).

RUBIACEAE

Rubia siamensis Craib (No. 361, 443, 471).

SCHISANDRACEAE

Kadsura heteroclita (Roxb.) Craib (Fig. 15) (No. 348, 349, 366, 367, 417, 437, 438, 453, 470, 477, 481, 511, 515–518, 524). From KENG (1972) it seems the species was not known from Doi Suthep. However, Craib (Fl. Siam. En. 1: 27, 1925) mentions two specimens (Kerr 3296 & 6678) as coming from Doi Suthep while according to Keng (l.c., p 112) the same specimens are from Doi Inthanon. Rarely collected elsewhere in Thailand.

VERBENACEAE

Gen. 3 sp. 1 (No. 299, 359, 360, 368, 407, 421–423, 465). Possibly another new record for Thailand, no appropriate genus having been found for No. 299 bearing fruits).

VITACEAE

Cissus adnata Roxb. (No. 353, 430).

Family uncertain:

?ASCLEPIADACEAE

Gen. 2 sp. 1 (No. 298, 363, 378, 455, 473, all sterile).

Gen. 12 sp. 1 (No. 428, sterile).

Gen. 13 sp. 1 (No. 474, 485).

Family unknown:

Gen. 5 sp. 1 (No. 375, 491, sterile).

Gen. 6 sp. 1 (No. 308, 328, 352, 372, 409, 460, 461, all sterile).

Gen. 10 sp. 1 (No. 384, 389, 451, all sterile). The leaves remind *Aristolochia pothieri* Pierre ex Lec. and *Aristolochia* sp. (No. 433).

Gen. 14 sp. 1 (No. 486, sterile).

Not mentioned because they are quite different from *P. brunoniana* are *Tetra stigma* spp., as their ridge-like formations are on stems with elliptic or flattish cross section, and *Tinomiscium petiolare* Miers, in which the ridges, when present, are very hard. Least similar to *P. brunoniana* are *Clematis* sp., *Maclura amboinensis*, *Parabaena sagittata*, Gen. 5 sp. 1, all with poorly developed ridges.

The lianas corresponding most closely to *P. brunoniana* in ridge shape are *Amalocalyx microlobus*, *Aristolochia* sp. (No. 433), *Dittoceras* sp., Gen. 2 sp. 1, Gen. 3 sp. 1 and *Kadsura heteroclita*. Very often their stems are externally indistinguishable from those of *P. brunoniana* although in the latter the ridges tend to be the most split. However, the apocynaceous and asclepiadaceous lianas have a sticky latex, while *K. heteroclita* has a strong scent and taste when chewed.

Interestingly, the presence of corky ridges on old stems of *Aspidocarya uvifera* and *Parabaena sagittata* were unknown.

Research on these lianas are being continued and an analysis on the possible function of corky ridges is in preparation.

DISCUSSION

In view of the fact that botanical exploration in Thailand, particularly on Doi Suthep, has been going on for nearly a century, it is surprising that the Lardizabalaceae have defied detection by scientists for so long, as *P. brunoniana* is neither very rare nor localized, and its violet-red new leaves and corky ridges are quite conspicuous. The reason for the plant to remain overlooked may be twofold. Firstly, the inflorescence of *P. brunoniana* is difficult to detect as it develops near the end of the stems, generally high up and concealed in the crowns of trees. Secondly, the reddish shoots, while in stark contrast to the green background of the vegetation, are found in many other plants, e. g. *Arcangelisia flava* (L.) Merr., *Diploclisia glaucescens* (BL.) Diels, *Smilax* spp., and the corky ridges are present in liana species of at least 11 other families. *P. brunoniana* may have been taken for one of them. The fact, moreover, that a non-botanist found well over 100 specimens of a plant until recently thought to be absent from Thailand by using vegetative characters, shows how the reliance on reproductive parts causes collectors to overlook species. For field studies identification from vegetative parts is more useful and actually feasible to a wide extent.

The fact that *P. brunoniana* extends so widely into Thai territory while remaining unnoticed for so long suggests that two further Lardizabalaceae could well occur in Thailand. One is *Stauntonia cavaleriana* Gagnep., known from China, Vietnam and Laos (GAGNEPAIN, 1908, 1939); the other is *Holboellia chapaensis* Gagnep., from northernmost Vietnam (GAGNEPAIN, 1939). The latter may be a localized species and hence unlikely to be present in Thailand, but the first stands a good chance of being detected sooner or later in the country.

The ranges of moths and their host plants do not usually cover each other fully.

Striking incongruities exist in distributions which appear paradoxical, especially when considering that some species (at present under investigation) are related to *A. okurai* and *P. brunoniana*. However, in other cases a close dependence between host plant and herbivore is to be expected, or is at least worthwhile to discuss. For instance, the most interesting consequence of *A. okurai*'s discovery on Doi Suthep and of the larval stenophagy on Lardizabalaceae, is that the plant family—most likely *P. brunoniana*—can now be safely prognosticated also for peninsular Malaysia. Since this lies in a different phytogeographic province—Malesia—it is all the more exciting.

During a revisionary study of *Adris* and related genera at the BMNH, I found an adult *A. okurai* labelled as coming from Gunung Hijau (Ijau), W. Malaysia (no date mentioned, but from the faded discoloration it presumably was collected many decades ago). Therefore, the Lardizabalaceae should be present there and, barring a disjunct distribution, also on other mountains in the intermediate region between Doi Inthanon and G. Hijau, in Thailand and W. Malaysia, and probably further south in the peninsula. The same can be expected for *A. okurai*.

A related, even rarer and more beautiful moth, *A. sikhimensis* Butler, was recorded for the first time on Doi Suthep only five years ago (BÄNZIGER, 1985), four years after *A. okurai* had been discovered there. One would thus be tempted to suggest that its caterpillar, so far unknown, may feed on Lardizabalaceae and/or the related Berberidaceae, the hosts of the closely allied moth *A. tyrannus* (Guenée).

There is a problem, however. From study of the genitalia, I judged the Indonesian *Othreis abathyglypta* Prout to be a junior synonym of *A. sikhimensis*. This considerably complicates the situation as *A. sikhimensis*'s range is thus extended to Sumatra, Java, Bali, and across the Wallace's line to Lombok and Flores but, strangely, not beyond to other nearby islands of the Lesser Sunda. Lombok and Flores lie in yet another biogeographic province, the Lesser Sunda subregion.

From this information several possible scenarios concerning the larval food plants and their potential geographic distribution follow, none entirely satisfying:

(1) The larvae are stenophagous on Lardizabalaceae. This would imply the family's extension not only to the islands of the Sunda shelf, but to the western group of the Lesser Sunda Islands. Against this assumption is also the observation that *A. sikhimensis* appears to be more common in Sumatra and Java than in the Himalayas. This can be safely assumed to be the opposite for the Lardizabalaceae, in the unlikely case that they should be discovered in the Sunda Islands.

(2) The caterpillars are stenophagous on Berberidaceae. The taxonomy of this family in S. E. Asia has not yet been completely clarified. But it is certain that there are a few species also in Malesia, viz. *Mahonia sumatrensis* Merrill and *Berberis xanthoxylon* Hassk. ex Schneid. in Sumatra, the latter also in Java; *M. philippinensis* Takeda and *B. barandana* Vidal are in the Philippines (AHRENDT, 1961). According to VAN STEENIS (1972), on the other hand, in Sumatra and the Philippines occur *M. napaulensis* DC. and *B. wallichiana* DC., the latter also in Java and, significantly, also on Lombok. Although the Berberidaceae have not yet been recorded from

Flores (overlooked?), and are also present in the Philippines where *A. sikhimensis* is unknown, the family otherwise neatly covers the moth's range (except, of course, the holarctic region). The presence of *B. wallichiana* on Lombok, furthermore, would make it particularly tempting to propose the Berberidaceae as hosts for *A. sikhimensis*.

However, as mentioned above, *A. sikhimensis* seems to be more common in Sumatra and Java than it is in the Himalayas, the opposite of the Berberidaceae. Unless the distribution of this family in the archipelago has been greatly underestimated by botanists, one would tend to predict hosts other than the Berberidaceae for the moth's caterpillar. Yet foreign Berberidaceae, e.g. *B. thunbergii* DC. and *M. fortunei* (Lindl.) Fedde, have been introduced to Java as ornamentals (BAKER & VAN DEN BRINK, 1963), and local species have been spread for the same purpose, e.g. *M. siamensis* on Doi Suthep (MAXWELL, pers. comm., and pers. observation). Moths are often collected in places close to human habitation, i. e. where ornamentals tend to be planted. It would be interesting to know if the explanation to the problem lies in human interference in the natural vegetation, which led to a population increase of the moth. A somewhat similar case in point is that of *O. fullonia* which is thought to have become a locally serious pest of fruit orchards due to an increase in indigenous secondary vegetation which contained the caterpillar's host plants, following destruction of primary forests (BÄNZIGER, 1982, 1987).

(3) The caterpillars feed upon the Menispermaceae. From FORMAN's work (1986, 1988), some 22 genera live in the region covered by *A. sikhimensis*. To these must be added two genera previously not thought to reach into Thailand but now discovered in the course of this study: *Aspidocarya* and *Sinomenium*. (*Menispermum* is not considered here as it seems to occur far north of the moth's area.) Of these, 11 genera are missing in all or in parts of the Lesser Sunda Islands, seven in parts of Sundaland, three are absent from N. E. India, while six are present throughout but also beyond the moth's home. However, of the 11 genera lacking in the Lesser Sundas, seven are otherwise present throughout the area of the moth. For example, *Cocculus* is unreported only in the Lesser Sunda Islands. Of the six genera ranging throughout the moth's region, only *Tinospora*, *Pachygone*, *Pericampylus* and *Stephania* are present on Doi Suthep. Some species are, however, very common, unlike *A. sikhimensis*, and have a much wider distribution, reaching Australia. Possibly the caterpillars feed on several genera of the family, each with less wide a distribution than the moth, but covering as a complex the whole area of the insect. This may be the most likely explanation.

(4) The caterpillars live on a slightly less closely related family than the three ones mentioned and the Schisandraceae would be the most promising candidates. They have only very rarely been collected in Thailand; *Kadsura heteroclita* (Fig. 15), apparently new for Doi Suthep, is another liana found because of its corky ridges. *Kadsura* spp. have been more commonly reported from W. Malesia (RIDLEY, 1922), just like *A. sikhimensis*. Except for E. Asia, where the moth does not occur, it closely follows the range of *Kadsura* spp. from S. E. Himalaya to Java (BAKER & VAN DEN

BRINK, 1963; KENG, 1972; LI, 1976). The Schisandraceae, then, should be present also in the Lesser Sundas but I found no reference about this.

(5) Caterpillars of the Indian and Mainland S.E. Asian region live on different plant families from those of the Malay Archipelago, for example, on the Lardizabalaceae and/or Berberidaceae in the first, and on some genera of Menispermaceae in the second. As mentioned, a comparable feeding 'inconsistency' is known in *O. fullonia*.

(6) The synonymy of *A. sikhimensis* with *O. abathyglypta* is wrong. This would be a blow to the pride of the author, who established the synonymy. More crucially, it would also throw into question the importance of genitalia on which modern Lepidoptera taxonomy places so much emphasis. This is the least likely proposition but would offer a neat solution: *A. sikhimensis* would feed upon Lardizabalaceae and/or Berberidaceae, *O. abathyglypta* on one or several genera of Menispermaceae.

Whichever hypothesis will turn out to be correct in the end, the quest for larval food plants of *A. okurai* and *A. sikhimensis* promises to bring to light valuable information in the field of biogeography, ecology, and systematics.

Yet possibly the most important outcome of the present study is the recognition that rare species are not of mere curiosity or rarity value to collectors, but that they can play key roles in ecological communities, and lead to unsuspected findings across disciplines, as discussed above. The case of the remarkable corky ridges led to the discovery of plant species and genera new to, or rarely collected in, Thailand. In some lianas the occurrence of ridges appears not to have been noted before. That corky ridges are present in lianas of several wholly unrelated families has never been fully appreciated.

Rare species, like the moth *A. okurai*, are often linked to species which are themselves rare, unusual, and just as poorly known, so that detection and research on one can lead to a 'cascade' of discoveries. Wildlife sanctuaries and other areas protecting scarce plants and animals are thus given increased significance.

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