



Nepenthes thorelii, an emended description and novel ecological data resulting from its rediscovery in Tay Ninh, Vietnam

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Recent exploration has culminated in the rediscovery of *Nepenthes thorelii* Lecomte, a species that has not been knowingly encountered by botanists in the wild for over a century. The emended description and ecological data presented here are the result of field studies carried out on the only known extant population of this exceedingly rare taxon.

The original description of *Nepenthes thorelii* (Lecomte, 1909) was based on type materials that included three Indochinese *Nepenthes* taxa (Mey, 2010). Since the last authenticated collection of this taxon by Désiré Bois in 1903, no populations of *N. thorelii* have since been knowingly studied or collected from the field by botanists. *Nepenthes thorelii* was rediscovered by the authors near to its type locality within a military zone in Tay Ninh Province, Vietnam, in August 2011. Research carried out *in situ* and subsequent to collection of additional herbarium specimens has

Figure 85 (facing page). A large, striking, lower intermediate pitcher of *Nepenthes thorelii* nestled in leaf litter amongst low growing vegetation in Lò Gò-Xa Mát National Park, southern Vietnam. Note the small weevil on the lower part of the tendril.

allowed for the presentation of an emended description, validated local voucher specimens, and novel ecological observations for this hitherto poorly understood taxon and Vietnam endemic.

ETYMOLOGY: *Nepenthes thorelii* is named in honour of French medic and botanist, Dr. Clovis Thorel (1833-1911) (Figures 85 and 86). Between 1862 and 1866, Thorel worked in Cochinchina (now southern Vietnam) where he collected more than 1500 plant specimens (Garnier, 2009) including the types of *N. thorelii*.

TYPES: *Nepenthes thorelii* –*Thorel 1032* (lecto P!), Lo-Thieu, Vietnam. *Thorel 1032* (isolecto P!), Guia-Toan, Vietnam. *Thorel 1032* (isolecto P photo!) Ti-Tinh swamp, Vietnam. *Thorel 1032* (isolecto NY photo!), forest swamp, Cochinchine.

The specimens Luu *et al.* 577A, 578, 579, 580, 581, 582 (VNM!) are herein validated as representative of *Nepenthes thorelii*. The ICBN Code does not provide for the designation of type status to non-original materials where the original type materials contain all elements on which the original description is based. However, these voucher specimens are representative of the only extant populations of this taxon and are valuable as easily accessible specimens in the host country.

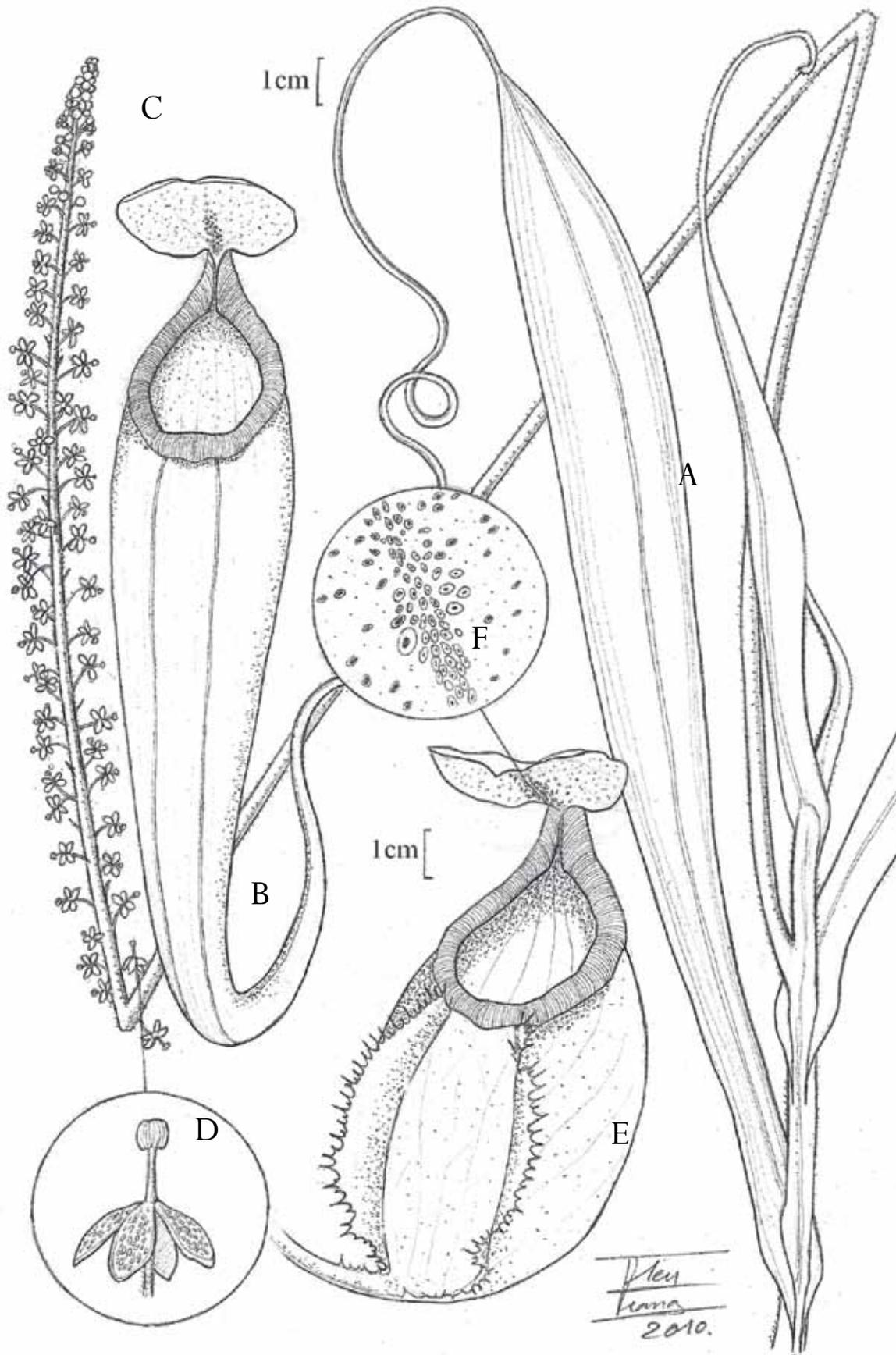
Additional material examined: *Bois 2228, 2229* (P!), Herbar du Prince Roland Bonaparte, Ong-iem swamp, Vietnam. *Thorel 903* (P!), Ti-Tinh, Vietnam.

The following description of *Nepenthes thorelii* supplants the previous description published by Mey (2010).

Nepenthes thorelii Lecomte emend. Mey, Luu & A.S.Rob.

Folia coriacea subpetiolata, lamina linearis-lanceolata vel anguste elliptica,

Figure 86 (facing page). A botanical illustration of *Nepenthes thorelii* showing climbing stem (A) with upper pitcher (B), male inflorescence (C), flower detail (D), lower pitcher (E) with detail of glands under the lid (F). Illustration based on *Thorel*



C

1cm [

A

F

1cm [

B

D

E

Kien
Hana
2010.



ascidia inferiora ovata vel subglobosa, peristomio cylindrico et tumido, ascidia superiora nunc obovata nunc parte inferiore infundibuliformia et parte superiore obovata, caulis rosularium 45 cm. altus, interdum scandens ad 2 m. altae.

DESCRIPTION: Terrestrial vine, with a perennial rootstock producing large, annual basal rosettes followed by climbing stems to ca. 2 m over course of wet season. During dry season, most vegetative parts lost to drought and fire. *Roots* consist predominantly of irregularly branched, swollen tubers.

Stems generally up to 45 cm tall, occasionally climbing to 2 m, cylindrical in cross section, up to 5 mm in diameter, internodes up to 1.5 cm on rosettes, 3.5 cm on climbing stems. The stem is green to red. *Leaves* of the rosettes and climbing stems are coriaceous, sub-petiolate, lamina linear-lanceolate to elliptic, rarely obovate, up to 30 cm long and 3.7 cm wide, longitudinally folded to form a V-shape (Figures 87 and 88). The apex of the lamina is acute to acuminate, and the base is amplexicaul and decurrent to the stem for 0.8 to 2.5 cm. Two to four longitudinal veins are present on each side of the midrib. Numerous inconspicuous pennate veins run obliquely towards the margin. Tendrils are 12 to 24 cm long, up to 3.5 mm in diameter and coiling rarely, and only in upper pitchers. The foliage is generally green with some red speckling in mature plants, with a reddish-bronze hue to newly opened leaves and an invariably red midrib.

Lower pitchers up to 18 cm long, 8 cm wide, ovoid to sub-globose, 60 to 80 % glandular within from the base upwards (Figures 89, 90, 91, 92, 93 and 94). Broad wings up to 1 cm wide extend down the front of the pitcher, fringed with filaments up to 6 mm long and ca. 2 mm apart. The pitcher opening is positioned at an oblique angle, slightly concave, orbiculate to cordate and up to 7 cm across. The peristome is cylindrical and bulbous in appearance, up to 0.8 cm wide at the front, and up to 1.5 cm wide towards the sides and rear of the pitcher, where it rises to form a column below the lid. The peristome is striate, with pronounced ribs

Figure 87 (facing page). Climbing plants of *Nepenthes thorelii* growing beneath trees in Lò Gò-Xa Mát National Park. Lower, intermediate and upper pitchers are apparent. The pitcher of a hybrid with *N. mirabilis* can also be seen.



Figure 88 (facing page). Multiple rosettes of *Nepenthes thorelii* growing in open scrub on sandy soil. Note the many inflorescences produced by these plants despite their rosetted form.



Figure 89 (above). A lower pitcher of *Nepenthes thorelii* growing amongst grass.



Figure 90 (above). An ovate lower pitcher of *Nepenthes thorelii*.



Figure 91 (above). A lower pitcher of *Nepenthes thorelii* bearing a swollen base.



Figure 92 (above). An especially robust lower pitcher of *Nepenthes thorelii*.



Figure 93 (above). A low growing rosette of *Nepenthes thorelii* on open ground.



Figure 94 (above). A lower pitcher of *Nepenthes thorelii*. Note the morphological variability of this species.



Figure 95 (above). An upper pitcher of *Nepenthes thorelii* exhibiting typical morphology and colour.

Figure 96 (facing page). An upper pitcher of *Nepenthes thorelii*, characteristically infundibular towards the base and obovate above.





Figure 97 (facing page). A flowering rosette of *Nepenthes thorelii* growing in open grassland. Note that this specimen is producing upper pitchers despite not yet having formed a climbing stem.

0.25 mm high, up to 0.4 mm apart, and teeth up to 2 mm long towards the column. The lid is planiform, orientated at approximately 40° from the horizontal, broadly ovate to orbiculate, with a cordate base, up to 4.8 cm long and 4.5 cm wide, lacking appendages, but with prominent, lipped, crateriform glands on the lower surface, 0.3-0.7 mm across and numerous about the midrib, 0.15 mm across and sparse towards the margins, nectar secretions are copious, with distinctly sweet taste. The spur is simple, covered in a fine, brown indumentums, and up to 5 mm long. The exterior of the lower pitchers is variable in colour, usually dark red, though a minority of plants produce pitchers that are entirely green, yellow, or green mottled with red blotches. The peristome usually takes on the colour of the pitchers, being thus dark red or green and rarely, if ever, striped.

Upper pitchers up to 20 cm long and 5 cm wide, obovate or infundibulate in the lower half and obovate above, rarely wholly infundibulate (Figures



Figure 98 (above). A male inflorescence of *Nepenthes thorelii*. The tepals, which open green, darken to red and eventually olive or black.



Figure 99 (above). The thickened rootstock of *Nepenthes thorelii* enables survival during periods of seasonal drought and wildfire activity.

95 and 96). The wings are reduced to prominent ribs that run down the ventral surface of the trap. The pitcher mouth, peristome and lid are consistent with the lower pitchers, although the peristome is of a slightly more uniform width, 3 to 8 mm across, and sometimes with a sinuate margin. The upper pitchers are of a similar colouration to the lower pitchers, but with a higher incidence of pitchers that are entirely greenish-yellow to yellow suffused red.

Inflorescence a racemose panicle; male inflorescence 80 to 120 cm long, 4-5 mm diameter, 120 to 160 flowers, peduncle 50 to 100 cm long, rachis 15 to 30 cm long; female inflorescence 60 to 80 cm long, to 5 mm diameter, 18 to 30 flowers, peduncle 50 to 70 cm long, rachis 5 to 12 cm long; 1-flowered pedicels 3-8 mm long, with or without a small bract (Figures 97 and 98). Tepals ovate to narrowly elliptic, up to 4 mm long and 2.5 mm wide, coloured green or red in young flowers, turning olive to black as flowers age, with a fine indumentum towards the rachis. Male flowers with a sweetish, murine scent.

Indumentum of sparse, fine white hairs often present on the stem and leaves, up to 1.5 mm long on the adaxial surface of the leaf and shorter, ca. 0.1 mm long, on the abaxial surface. A similarly short, but slightly coarser, tomentum of ferruginous hairs may be present on the pitchers and inflorescence, giving the former a slightly scabrous texture.

Material of other Indochinese species examined:

Nepenthes andamana - *Catalano 013395* (holo BCU), Takuapa, sea level, province of Phang-nga, Thailand.

Nepenthes bokorensis - *M. Martin 1231 bis* (holo P!), Bokor Hill, 800 m, province of Kampot Cambodia.

Nepenthes chang - *Catalano 013394* (holo BCU), Ko Chang, 300 m, province of Trat, Thailand.

Nepenthes geoffrayi - *Geoffray 84, 85, 87, 88, 91, 92, 93* (synt P!), Kampot, Cambodia.

Nepenthes holdenii - *Mey 1A* (holo RUPP!), western Cambodia, Cardamom Mountains, 653 m, Province of Pursat.

Nepenthes kerrii – Kerr 14127 (holo BK), Tarutao Marine Park, 500 m, province of Satun, Thailand.

Nepenthes kampotiana – Geoffray 89, 90, 191, 362 (synt P!), Kampot, Cambodia. Mey & Robinson 1 (RUPP!), near Koh Kong town, 491 m, Koh Kong province, Cambodia.

Nepenthes smilesii – Charenphol, Larsen & Warncke 4623 (P!), Phu Kradung, Loei, Thailand. Mey 2 (RUPP!), Kirirom National Park, 712 m, province of Kampong Speu, Cambodia. Luu et al. 569, 570 571, 572, 573, 574, 575, 576 (VNM!), Trang Tan Thanh, Lò Gò-Xa Mát National Park, Tay Ninh province, Vietnam.

Nepenthes smilesii x *mirabilis* – Mey 6 (RUPP!), near town of Kampot, 14 m, province of Kampot, Cambodia.

Nepenthes suratensis – Kerr 13136 (holo BK), Kanchadanit, sea level, province of Suratthani, Thailand.

Nepenthes thorelii x *mirabilis* – Luu et al. 583, 584, 585 (VNM!), Lò Gò-Xa Mát National Park, Tay Ninh province, Vietnam.

FIELD OBSERVATIONS: The authors examined several *in situ* populations of *Nepenthes bokorensis* at its *locus classicus*, populations of *N. holdenii* at its *locus classicus*, populations of *N. kampotiana* in Cambodia, populations of *N. smilesii* in Cambodia and in Vietnam, the population of *N. thorelii* in Vietnam herein documented, as well as isolated plants and populations of *N. smilesii* x *mirabilis* and *N. thorelii* x *mirabilis* in Cambodia and Vietnam respectively.

DISTRIBUTION: *Nepenthes thorelii* has a historic range that was reported to include



Figure 100 (above). The blue dot denotes the location of *Nepenthes thorelii* in Tay Ninh Province, Vietnam. The red dot denotes the Phan Thiet site from which putative *N. thorelii* were poached, wiping out the population.

Cambodia, Thailand and Vietnam, but those collections have proven to be mostly a mix of various, closely related taxa (Mey, 2010). The taxon was first collected by Clovis Thorel from the villages of Thi Tinh (also written *Ti-Tinh* on herbarium labels), Lo Thieu and Guia Toan between 1862 and 1866, and then by Désiré Bois from Ong-iem Village in 1903; each of those are old names for locations in Cochinchina, or modern day southern Vietnam. The name Ong-iem is a misspelling of Hung Yen, a village in Tan Hung Commune, Hon Quan District, Binh Phuoc Province. Though it is difficult to trace the exact location of Guia Toan, all of these villages are located near to each other in the former Song Be Province, which is now divided into Binh Duong and Binh Phuoc Provinces in south-eastern Vietnam, neighbours to Tay Ninh Province. The original vegetation of these locations was largely destroyed by the use of Agent Orange during the Vietnam War and has since been turned into rubber and other crop plantations (Brocheux and Hemery, 2004; Tertrais, 2004). Extensive research by various parties (Mey and Clarke, pers. observ., 2010) demonstrates that *N. thorelii* has been rendered extinct at all historic sites, including the areas surrounding Thi Tinh and Ong-iem (Figure 100). Although Ho (1999) noted its distribution in Da Lat (Lam Dong Province, in the Central Highlands), Dong Nai Province and Ha Tien (Kien Giang Province, in the Mekong Delta), these records have not been confirmed and our own experience in these areas does not support this. Additionally, all *Nepenthes* materials from Ha Tien and Da Lat deposited in Paris (P) have been studied by the authors and found to fall within the range of *N. smilesii*.

Nepenthes thorelii is currently known only from a small population of less than 1 km² located in Lò Gò-Xa Mát National Park, Tay Ninh Province, Vietnam – adjacent to its type locality.

In recent years, *Nepenthes* that seemed to fit the description of *N. thorelii* have been found near the town of Phan Thiet, on the south-west coast of Vietnam (Figure 100), but attempts to study these plants failed owing to the decimation of the entire population by poachers (Mey, pers. observ.). As such, *N. thorelii* has been effectively brought close to a programmed extinction in its remaining forest habitats only in recent

years, rather ironically, through the poaching of plants by local *Nepenthes* enthusiasts.

Following a recent survey by the authors in Vietnam and Cambodia (August 2011), the species is now assessed as being endemic to Vietnam; the authors were unable to locate the taxon elsewhere despite extensive searches, including the Cambodian provinces of Prey Venh and Kampong Cham adjacent to the Vietnam border.

As suggested in a previous paper (Mey, 2010), *Nepenthes thorelii* may survive elsewhere in the form of small, isolated and highly localised populations. Such populations, if present at all, are likely to be sparsely distributed in southern Vietnam, and possibly eastern Cambodia since the only known population lies very close to the Cambodian border.

ECOLOGY: At its only known locality, *Nepenthes thorelii* grows terrestrially on acidic, riverine silt at 10–20 m above sea level. Plants occur singly or in sparsely scattered groups across open and semi-open, seasonally wet land amongst *Melaleuca cajuputi* Powell (Myrtaceae) scrub, occupying wetter depressions in full sun to part-shade. During August, sampled day time temperatures as recorded in the shade (6th August, 2011) were up to 35 °C with afternoon showers. The majority of female specimens observed at this time bore fruit that was a number of weeks from maturity, whereas the male inflorescences had withered. In common with other pyrophytic *Nepenthes* taxa (Mey *et al.*, 2010), *N. thorelii* commonly flowers in the rosette stage, particularly when growing in full sun amongst grasses. The taxon does form strong climbing stems, but the majority of plants are stout and upright.

Associated species consist predominantly of trees that include *Dipterocarpus obtusifolius*, *D. intricatus*, *Parinari annamensis*, *Buchanania* sp. and *Callophylum* sp., as well as understory and grassland shrubs that include *Calamus* sp., *Livistona* sp., *Osbeckia*, *Phoenix loureiroi*, *Dillenia hookeri*, *Melastoma* sp., *Rhodamnia trinervia* and species of Apocynaceae. The grass layer mainly includes species of Cyperaceae, Poaceae, Xyridaceae, Fabaceae, Commelinaceae and Zingiberaceae. Sympatric



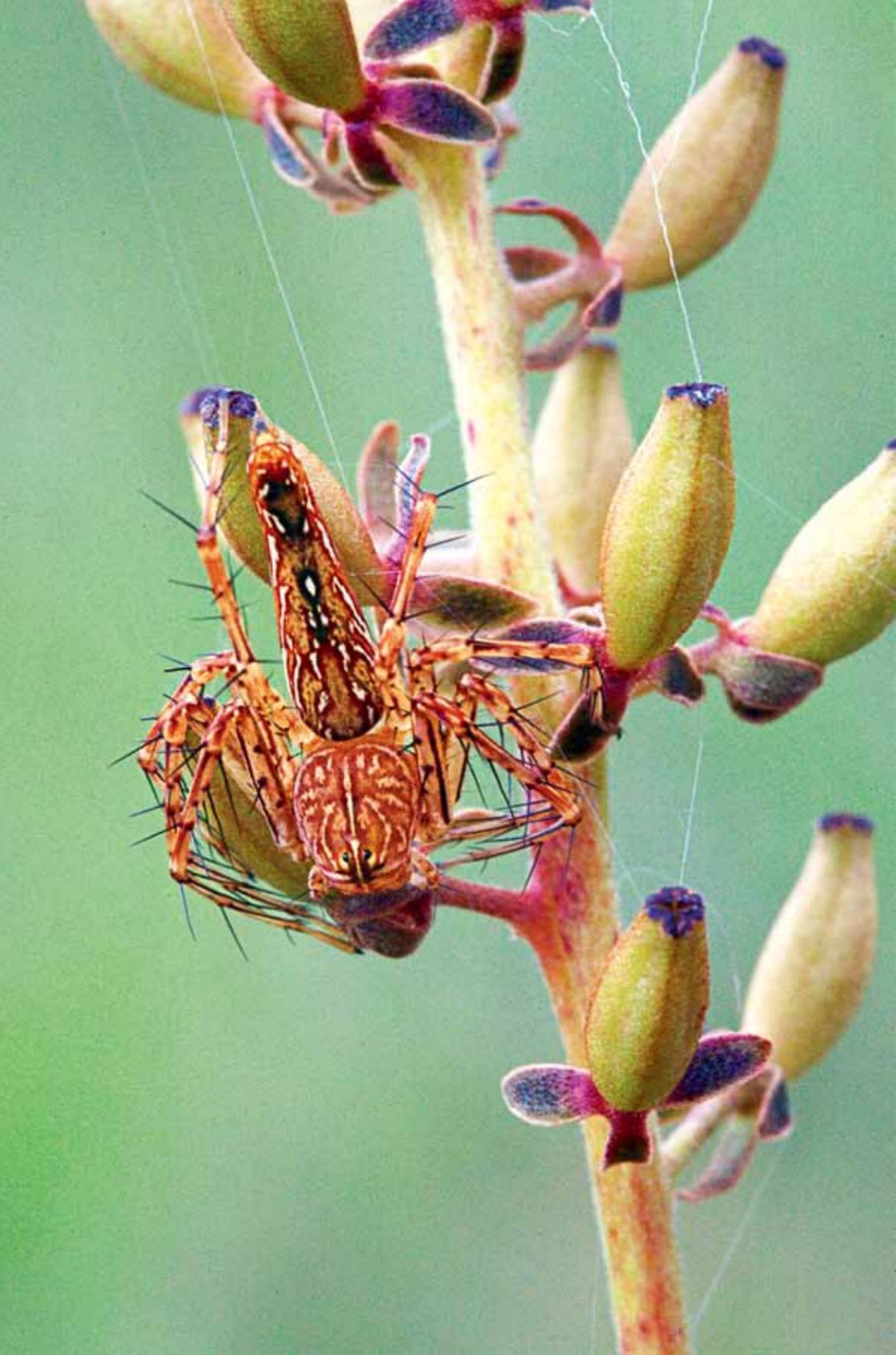
carnivorous plant taxa include *Nepenthes mirabilis*, *N. mirabilis* x *thorelii*, and *Drosera burmanii*.

The observed rainfall in Tay Ninh town, close to Lò Gò-Xa Mát National Park, is 1800 mm annually, with maximum of 2346 mm and a minimum 1387 mm. The wet season occurs from May to October, possibly continuing into mid-November. During these months, the flat areas from which the species is recorded are partially submerged. The dry season lasts from late November to April. The yearly average temperature is 26.7 °C.

Although *Nepenthes thorelii*, *N. kampotiana* and *N. smilesii* share broadly similar habitat preferences, in particular their preference for open, seasonally wet scrublands, *N. thorelii* can be partly distinguished by its ecology. Unlike other pyrophytic *Nepenthes*, *N. thorelii* seems to occupy a strict ecological niche; it is known only from swamps, and the observations made at Lò Gò-Xa Mát National Park suggest that it prefers the wetter soils of swamp margins.

Two populations of *N. smilesii* were also located in Lò Gò-Xa Mát National Park within a few kilometres of the location where *N. thorelii* was rediscovered. These populations of *N. smilesii* were observed growing in a fairly dry environment. *Nepenthes thorelii* was found in a marshy location and, according to herbarium sheets labels, Clovis Thorel and Désiré Bois also collected this taxon from marshes. It would be reasonable to assume that the materials were collected during the wet season and that the indication of swamp (*marais* in French) by both parties could apply to any flooded part of southern Vietnam. However, several fully developed specimens with bearing lower and upper pitchers were collected by Bois on 26 January 1903, at the peak of the dry season, indicating a true preference for perennially moist habitats. Observations by Mey and Clarke (February 2010) in Phan Thiet, on the eastern coast of southern Vietnam (see map), from where the putative

Figure 101 (facing page). A large, rosetted *Nepenthes* representing a vigorous hybrid between *Nepenthes thorelii* and *N. mirabilis*.



N. thorelii were identified and subsequently poached, found that this location, too, was a swamp, even during the dry season. Though no *N. thorelii* were found, the locality was otherwise filled with *N. mirabilis*, which favours swamp habitats.

Like *Nepenthes rowanae*, from Queensland, Australia, *N. thorelii* appears to occupy a strict niche and may grow exclusively in the margins of swamps (Clarke & Kruger, 2005), being therefore less tolerant of drought than *N. smilesii*. This feature could partly explain the relative success and wider distribution of the latter taxon across Indochina. However, more field research of verified *N. thorelii* populations would be required to validate this claim.

INFAUNA: The following animals were observed on various parts of *Nepenthes thorelii* plants (Table 7).

Insects on flowers and fruit:

Two species of insect were found on the flowers of *Nepenthes thorelii*; a praying mantis (*Creobroter* sp., Hymenopodidae), and a bug (*Zelus* sp., Reduviidae). Both of these taxa are insectivorous and assumedly take advantage of the plants' ability to attract prey.

Mantids of the genus *Creobroter* camouflage themselves through mimicry of the shape or colour of the flowers amongst which they live, thereby avoiding detection by their prey, and assumedly by higher order predators. Four individual mantids of different ages were found amongst the *Nepenthes* inflorescences in a range of colours from brown to violet (Figures 103 and 105). Consequently, the *Creobroter* were easily able to hide amongst the flowers and fruit of *Nepenthes* irrespective of their age since the various inflorescences were found to be maturing at slightly different rates. Since no mature individuals of this mantid were seen during the survey period, it is impossible to state whether or not the mature individuals maintain their preference of plant host to adulthood.

Figure 102 (facing page). A lynx spider (*Oxyopes* sp.) hunting on the inflorescence of a *Nepenthes* in Lò Gò-Xa Mát National Park, Vietnam.



Figure 103 (above). A young nymph of the flowering mantid, *Creobroter* sp. on *Nepenthes* fruit.



Figure 104 (above). An assassin bug (*Zelus* sp.), camouflaged amongst *Nepenthes* fruit.



Figure 105 (above). An older *Creobroter* sp. mantid nymph on the inflorescence of a *Nepenthes mirabilis* x *thorelii* hybrid. The fine colours of this flowering mantid are apparent.

Whilst the mantids appeared on flowers and fresh fruits, the one individual of *Zelus* that was observed was found on dried fruit, and of a corresponding shade of brown (Figure 104).

The observation period was not sufficient enough to reveal whether the presence of these species has a positive or a negative effect on the *Nepenthes*. Even so, the morphology and colour of these predator species effectively simulated the environments in which they were found, suggesting that these insects must more or less benefit from their association with *Nepenthes*.

Spiders on flowers:

A genus of lynx spider, *Oxyopes* (family Oxyopidae), was also found hunting amongst the *Nepenthes* flowers (Figure 102).

As free-living plant-dwellers, members of this genus may jump towards flying prey and catch it in midair, whereas some species spin small webs.

Their formidable, spiky appearance makes them readily recognisable as members of the Oxyopidae. They build no web-snares, but are active hunters, frequenting grass, small shrubs, bushes, and other low vegetation, where they use their acute eyesight and jumping ability to capture prey and avoid predators. They are rarely found on bare ground. *Oxyopes* usually hunt in bright sunlight, leaping from leaf to leaf towards prey. When at rest, they flatten themselves against broad leaves or stems where they are camouflaged by their pale green to dark green and brown colouration, which usually matches that of the leaves and twigs of the host plants.

Lynx spiders are most easily recognised by the sharp, usually black, spines on their legs, which presumably assist the spider in scrambling from leaf to leaf.

Spectrum of prey observed in pitchers:

14 pitchers were randomly collected, preserved with ethanol, and analysed in the laboratory. There were 53 species of insect and four

Table 7 (below). A checklist of the fauna found within the pitchers of *Nepenthes thorelii*.

No	Class	Order	Family	Species	No. of individuals
1	Insecta	Hymenoptera	Formicidae	<i>Aenictus</i> sp.	2
2	Insecta	Hymenoptera	Formicidae	<i>Anomalomyrma</i> sp.	36
3	Insecta	Hymenoptera	Formicidae	<i>Camponotus</i> sp.1	11
4	Insecta	Hymenoptera	Formicidae	<i>Camponotus</i> sp.2	15
5	Insecta	Hymenoptera	Formicidae	<i>Camponotus</i> sp.3	1
6	Insecta	Hymenoptera	Formicidae	<i>Cardiocondyla</i> sp.1	1
7	Insecta	Hymenoptera	Formicidae	<i>Cardiocondyla</i> sp.2	4
8	Insecta	Diptera	Coelopidae	Coelopidae sp.	4
9	Insecta	Hymenoptera	Formicidae	<i>Crematogaster</i> sp.1	237
10	Insecta	Hymenoptera	Formicidae	<i>Crematogaster</i> sp.2	3
11	Insecta	Diptera		Diptera sp.1	1
12	Insecta	Diptera		Diptera sp.2	10
13	Insecta	Hymenoptera	Formicidae	Dolichoderinae sp.	6
14	Insecta	Diptera	Ephyridae	Ephyridae sp.	1
15	Insecta	Hymenoptera	Formicidae	Formicidae sp.1	165
16	Insecta	Hymenoptera	Formicidae	Formicidae sp.10	1
17	Insecta	Hymenoptera	Formicidae	Formicidae sp.11	2
18	Insecta	Hymenoptera	Formicidae	Formicidae sp.12	1
19	Insecta	Hymenoptera	Formicidae	Formicidae sp.13	1
20	Insecta	Hymenoptera	Formicidae	Formicidae sp.14	1
21	Insecta	Hymenoptera	Formicidae	Formicidae sp.15	2
22	Insecta	Hymenoptera	Formicidae	Formicidae sp.16	2
23	Insecta	Hymenoptera	Formicidae	Formicidae sp.17	2
24	Insecta	Hymenoptera	Formicidae	Formicidae sp.18	21
25	Insecta	Hymenoptera	Formicidae	Formicidae sp.19	37
26	Insecta	Hymenoptera	Formicidae	Formicidae sp.2	184
27	Insecta	Hymenoptera	Formicidae	Formicidae sp.3	6

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28	Insecta	Hymenoptera	Formicidae	Formicidae sp.4	18
29	Insecta	Hymenoptera	Formicidae	Formicidae sp.5	1
30	Insecta	Hymenoptera	Formicidae	Formicidae sp.6	1
31	Insecta	Hymenoptera	Formicidae	Formicidae sp.7	13
32	Insecta	Hymenoptera	Formicidae	Formicidae sp.8	2
33	Insecta	Hymenoptera	Formicidae	Formicidae sp.9	4
34	Insecta	Hymenoptera	Formicidae	Formicinae sp.	1
35	Insecta	Hymenoptera	Formicidae	<i>Iridomyrmex</i> sp.1	1
36	Insecta	Hymenoptera	Formicidae	<i>Iridomyrmex</i> sp.2	14
37	Insecta	Hymenoptera	Formicidae	<i>Iridomyrmex</i> sp.3	1
38	Insecta	Hymenoptera	Formicidae	<i>Loweriella</i> sp.	2
39	Insecta	Hymenoptera	Formicidae	<i>Mayriella</i> sp.	32
40	Insecta	Diptera	Muscidae	Muscidae sp.	4
41	Insecta	Hymenoptera	Formicidae	Myrmicinae sp.1	11
42	Insecta	Hymenoptera	Formicidae	Myrmicinae sp.2	1
43	Insecta	Hymenoptera	Formicidae	Myrmicinae sp.3	1
44	Insecta	Hymenoptera	Formicidae	Myrmicinae sp.4	1
45	Insecta	Hymenoptera	Formicidae	Myrmicinae sp.5	7
46	Insecta	Hymenoptera	Formicidae	<i>Paratopula</i> sp.	1
47	Insecta	Hymenoptera	Formicidae	<i>Paratrechina</i> sp.	32
48	Insecta	Hymenoptera	Formicidae	<i>Plagiolepis</i> sp.	8
49	Insecta	Hymenoptera	Formicidae	<i>Polyrhachis</i> sp.	1
50	Insecta	Hymenoptera	Formicidae	<i>Rhopalomastix</i> sp.	1
51	Insecta	Diptera	Sarcophagidae	Sarcophagidae sp.	13
52	Insecta	Diptera	Trichocelidae	Trichocelidae sp.	1
53	Insecta	Diptera	Culicidae	<i>Wyeomyia</i> sp.	527
54	Arachnida	Araneae	Clubionidae	<i>Clubiona</i> sp.	1
55	Arachnida	Araneae	Salticidae	Cf. <i>Myrmarachne</i> sp.	1
56	Arachnida	Araneae	Salticidae	Cf. <i>Phintella</i> sp.	1
57	Arachnida	Opilion		Opilion sp.	1

species of spider trapped within the phytotelmata of *Nepenthes thorelii* (Table 8).

All Dipteran larvae were still alive when they were found. Even so, only Culicidae was found in the pupae stage. Larvae of the family Culicidae dominate, being found in 9/14 of the collected pitchers, with a total number of 527 individuals.

The majority of captured insect taxa in the pitchers belong to the family Formicidae, with 45 separate species identified and 895 individuals captured in total (based on the number of head capsules counted). However, most species were found at a relatively low frequency, whereas some, such as *Crematogaster* sp., numbered 237 trapped individuals. The dominance of these species as prey in pitchers may simply indicate relative numbers in this habitat, but might also suggest *Nepenthes thorelii* is particularly efficient at attracting specific insect taxa. Four spiders were also identified as prey within the pitchers. All four were non-web building, free living, cursorial or nocturnal hunting species.

Table 8 (below). A summary of the insect prey found within the pitchers of *Nepenthes thorelii*.

Order / Family	No. of species	No. of individuals
Araneae	3	3
Clubionidae	1	1
Salticidae	2	2
Diptera	8	561
Coelopidae	1	4
Culicidae	1	527
Ephyridae	1	1
Muscidae	1	4
Sarcophagidae	1	13
Trichocelidae	1	1
Unknown	2	11
Hymenoptera	45	895
Formicidae	45	895
Opilion	1	1
Unknown	1	1

TAXONOMIC AFFINITIES: *Nepenthes thorelii* falls within a group of closely related Indochinese species, namely *N. smilesii* (Cambodia, Thailand, Vietnam and Laos), *N. kampotiana* (Cambodia, Thailand), *N. chang*, *N. suratensis*, *N. kerrii*, *N. andamana* (Thailand), and *N. bokorensis* and *N. holdenii* (both from Cambodia). As a consequence of their similarities, these species are ascribed to a single group, the *Nepenthes thorelii* aggregate, a key to this aggregate having been proposed in Mey *et al.* (2010).

The species of this aggregate share the following features; 1- or 2-pedicellate, long thyrsoid panicles, flower production from the rosette stage, seeds with reduced filiform appendages, coriaceous, narrow leaves with variably decurrent attachment, and a pyrophytic habit with the associated production of a thickened rootstock.

The most obvious features that distinguish *N. thorelii* from all the other species of the aggregate are its ovoid to sub-globose lower pitchers. Although other species can, exceptionally and in isolated specimens, produce similar lower pitchers, it is a stable feature of *N. thorelii*.

Within the aggregate, the closest relatives of *N. thorelii* are; *N. kampotiana*, which is only known with certainty from south to south western Cambodia and from the bordering Thai province of Trat (Catalano, 2009), and *N. smilesii*, known from all four countries of the Indochinese peninsula. The three species share the production of decurrent, long linear to lanceolate leaves and the production of 1-pedicellate racemose inflorescences.

Nepenthes thorelii differs from *N. smilesii* in producing leaves that are linear lanceolate to elliptic, sometimes obovate, whilst the latter usually produces narrowly linear leaves. In addition to its lower pitchers being ovoid to sub-globose, versus cylindrical with an ovate and swollen lower half, *N. thorelii* pitchers differ from those of *N. smilesii* in having a broadly orbiculate lid, versus elliptic, and a bulbous, cylindrical peristome versus merely cylindrical in the majority of specimens. The upper pitchers of *N. thorelii* are commonly obovate, rarely wholly infundibular, whilst the upper pitchers of *N. smilesii* demonstrate

great plasticity and are often cylindrical with a swollen base, narrowly infundibular or rarely obovate.

Nepenthes thorelii differs from *N. kampoiana* in producing leaves that are linear lanceolate to elliptic, sometimes obovate, whilst the latter typically produces narrowly linear leaves. The lower pitchers of *N. thorelii* are ovoid to sub-globose, while the lower pitchers of *N. kampoiana* are cylindrical with a swollen base or, most commonly, ovate in the lower two thirds and narrower above, giving them a pyriform appearance. The peristome of *N. kampoiana*, though cylindrical, is narrower than that of *N. thorelii*, which is cylindrical and bulbous. Also, the foliage of *N. kampoiana* is typically glabrous whereas in *N. thorelii*, all parts of the plant are covered with short hairs.

In the last decade, extensive field research in Indochina has led to the descriptions of most of the aforementioned taxa, and of course the rediscovery of a very poorly known taxon, *N. thorelii*. This research has helped to highlight the fact that the *Nepenthes* flora of Indochina is far more complex than once believed. The clear affinities within the aggregate suggest that all of the species are derived from a common ancestor, though the timing and rates of speciation within the aggregate are entirely unknown. The very close features of certain of these taxa suggests that some are in the very earliest stages of speciation and, in some cases, the use of a sub-specific rank would perhaps be more desirable a means of illustrating their relationships (Mey & Robinson, in prep.).

CONSERVATION STATUS: Following years of research and concluding with the survey carried out during August 2011, it is believed that *Nepenthes thorelii* is endemic to Vietnam and extant at only a single, small site of less than 1 km² located in Lò Gò-Xa Mát National Park, Tay Ninh Province, Vietnam – adjacent to the type locality. The exact number of existing individuals is not known, but the population numbers fewer than 500 individuals. Whilst the natural habitat of this species has been reduced greatly due to agricultural expansion, its existence in the wild is threatened by poaching. We recommend strict protection of the taxon

and its habitat in Lò Gò-Xa Mát National Park. Human dispersal of seeds and seedlings should also be undertaken in similar habitats in the park to help bolster numbers. Vegetative propagation measures should also be applied in order to support *ex situ* conservation; furthermore, this may help produce seedlings for legal horticultural trade and so reduce the pressures of illegal poaching.

A recent assessment of the global threatenedness of Indochinese plants was held in Chiang Mai, Thailand, in November 2011 by a group of botanists led by the Missouri Botanical Garden in cooperation with the IUCN. Here, it was recommended that the species be raised to the rank of **Critically Endangered** (CR) as suggested in previous research (Mey, 2010). Before this update, which is based on the findings of the authors of this paper, the species was ranked as Data Deficient.

It is equally important that additional field research be undertaken to fully document the range and diversity of *N. thorelii* in southern Vietnam. Should this result in the discoveries of further populations, *in situ* and *ex situ* survival projects will need to be enacted so as to manage the careful and sustainable introduction of plants into cultivation from the controlled culture of wild-collected seed by authorised parties.

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