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Insights into The Diversity of *Nepenthes* L. (Nepenthaceae) Across Peninsular Malaysia, Including The First Sighting of an Undescribed Taxon with Flared Peristomes and Quadruple-Row Ventral Wings

Amin-Asyraf Tamizi[1*], Salasiah Mohamad[2], Mohamad-Alias Shakri[3], Nurshahidah Mohd-Rusli[4], Noriha Mat-Amin[1], Muhamad-Arif Mohamad-Jamali[5]

[1]Biotechnology and Nanotechnology Research Centre,
Malaysian Agricultural Research and Development Institute (MARDI) Headquarters, Serdang, 43400, Selangor, MALAYSIA

[2]Department of Technology and Natural Resources, Faculty of Applied Science and Technology,
Universiti Tun Hussein Onn Malaysia (Pagoh Campus), Pagoh Education Hub KM 1, Pagoh, 84500, Johor, MALAYSIA

[3]Fox Extreme Photography, Kuala Terengganu, 21200, Terengganu, MALAYSIA

[4]Natural Products Division,
Forest Research Institute Malaysia (FRIM), Kepong, 52109, Selangor, MALAYSIA

[5]Food Biotechnology Programme, Faculty of Science and Technology,
Universiti Sains Islam Malaysia, Nilai, 71800, Negeri Sembilan, MALAYSIA

*Corresponding author

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Abstract: The discoveries of six taxa between 2019 and 2022 have brought the total number of *Nepenthes* species occurring in Peninsular Malaysia to 18. This article serves as a comprehensive overview, incorporating the latest information and taxonomic insights concerning all species native to the peninsula. The information is derived from published taxonomic records and cumulative field observations conducted since 2013. Notably, it further reports heretofore undocumented discoveries, making it a significant contribution to the current knowledge of tropical pitcher plants. These include a sighting of a population of *Nepenthes* with unusual traits in the upper montane forest of Banjaran Titiwangsa, which may represent the 19th taxon in Peninsular Malaysia. The plants exhibit conspicuously expanded peristomes and an unusual wing morphology, which altogether provide compelling evidence supporting the recognition of these individuals as a distinct and previously unknown species. Therefore, a provisional taxonomic name—*Nepenthes* sp. Titiwangsa (pesonawangsa_223) A. Amin—is assigned. The species is inferred to belong to the *N. macfarlanei* group based on its toothed peristome and the presence of fine hairs below the lid. The partial description, species note, photographs, and a dichotomous key of the proposed new species are provided. In addition, a velvety *N. sanguinea* population has been observed in northern Banjaran Titiwangsa and treated as a new natural variation (var. *velutina*) in this article.

Keywords: Insectivores, monkey cup, *periuk kera*, plant systematics, taxonomy, tropical, pitcher plant

**Corresponding author: aminasyraf@mardi.gov.my*
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1. Introduction

The species members of the genus *Nepenthes* L. belong to the monotypic family Nepenthaceae Dumort, and there are an estimated 160-180 extant species, the majority of which are found in Southeast Asia, particularly in the Malesia floristic region [1] [2] [3] [4]. Part of this, the Thai-Malay Peninsula is considered a unique and rich ecoregion for biodiversity studies. It is one of the longest peninsulas in the world (approximately 1660 km long)—stretching from Samut Songkhram, Thailand, to Singapore in the south—and contains a series of discontinued mountain ranges that run practically its entire length [5]. According to the authors, the peninsula is home to four major mountain range systems, referred to as 'banjaran' in Malay. These mountain range systems are identified as the mountains of Tenasserim, Nakhon Si Thammarat, Sankalahiri, and Titiwangsa. Banjaran Titiwangsa, also known as the central mountain range of Peninsular Malaysia, is flanked to the east by Banjaran Timur and to the west by Banjaran Bintang. Collectively, the whole stretch of the Thai-Malay Peninsula acts like a biodiversity corridor that harbors at least 25 species of *Nepenthes* of which the highland taxa are endemic to their respective upland systems [6] [7] [8] [9] [10]. The Banjaran Titiwangsa is not to be confused with Mount Titiwangsa, located on the northern part of the Bintang mountain range.

Peninsular Malaysia comprises the Thai-Malay Peninsula's southern half and is home to many endemic flora and fauna species. Prior to the year 2020, only 12 species of *Nepenthes* from Peninsular Malaysia were recognised [7] [8]. In 2020, *Nepenthes domei* and *N. latiffiana* were published [9], followed by *N. malayensis* in the same year [8], bringing the total to 15 species. Two years later, the study of taxa within the *N. macfarlanei* group resulted in the circumscriptions of three additional species (*N. berbulu*, *N. sericea*, and *N. ulukaliana*) originating from the central part of the Banjaran Titiwangsa [10] [11]. These works on resolving '*Nepenthes* with hairy lids' within the *N. macfarlanei* aggregate has truly brought an improved understanding on the diversity of the Malayan montane species and served as critical references in our study with the pitcher plants. *Nepenthes berbulu* is remarkably distinct due to its aggregated needle-like bristles and the describing authors have produced an excellent taxonomic account by providing ample photographs depicting this species. Surprisingly, this group of plants went unnoticed until recently, despite growing in mountains frequented by local and foreign botanists. *Nepenthes sericea* has lower pitchers that are optically similar to several colour varieties of *N. gracillima*; however, its upper pitchers are distinct for being whitish and broadly infundibular. For the third species, *N. ulukaliana* is treated by the authors as a different taxon from *N. macfarlanei*—which we do agree—mainly on the gross shape of the pitcher and the shorter hairs of the lids.

In a recently published monograph on *Nepenthes* of Peninsular Malaysia, Ghazalli et al. [12] exclude *N. berbulu*, *N. kerrii*, *N. sericea*, and *N. ulukaliana* from the list, discussing only 14 *Nepenthes* species. In this paper, we present the most comprehensive and updated taxonomic notes on all 18 known species of *Nepenthes* in Peninsular Malaysia as of 2023. These notes are based on a compilation of various published materials and field observations, and we emphasise on the characteristics of the pitchers in distinguishing different taxa as these are highly reliable for the diagnosis purpose. The sightings of velvety *N. sanguinea* and a large population of *N. gracillima* outside its *locus classicus* (Mount Tahan, Banjaran Timur) are also highlighted as part of the novel findings that are worth to be mentioned. In the final segment, we present the discovery of a captivating unknown species based on several individuals sporting toothed pitchers with flared peristomes. These plants were initially considered as an extreme variant of *N. gracillima*. However, upon careful examination, we reckon these belong to an aberrant taxon since they exhibit strong diagnostic features that diverge from all the reported members of the *N. macfarlanei* group.

2. Methodology

Our interpretations of all discussed species in this paper are a cumulative work based on literature reviews and field observations that had been made since 2013. The habitats visited included forest reserves, marshlands, low-lying hills, mountains, and disturbed areas (road verges and abandoned mines). Entries into some of the protected areas were made through permits granted by relevant authorities, and the travel expenses and permit fees were mostly self-funded. The *in situ* images provided by the contributors were all taken using personal mobile phone and digital cameras. In addition, protologue, associated taxonomic accounts, and herbarium specimens were also thoroughly analysed. The local *Nepenthes* herbarium collections at the Kepong Herbarium (KEP), Forest Research Institute of Malaysia (FRIM), and digital herbarium specimens from The Kew Herbarium Catalogue (http://apps.kew.org/herbcat/gotoHomePage.do) were examined to discern ambiguous species and taxa of interest. The conservation status of all taxa covered in this article is accessed based on the IUCN Red List Categories and Criteria [13].

Nepenthes species occurring in highland habitats are given priority in this article. For this purpose, we treat the contiguous Banjaran Titiwangsa roughly into three areas: northern (A-1), central (A-2), and southern (A-3) regions (Fig. 1) in defining the distributions of intermediate and highland taxa. The relief map of Peninsular Malaysia was obtained from the NASA/NGA Shuttle Radar Topography Mission (SRTM) data sets from the U.S. Geological Survey's EROS Data Center (https://www.usgs.gov/centers/eros) and was further edited using PhotoScape v3.7 (http://www.photoscape.org/).

The taxonomic unit determined to represent an undescribed species that has not been fully characterised is given a provisional taxonomic name (interim nomenclature) in this article. It follows an interim naming system outlined by Schindel and Miller [14]—in order to establish priority for the discoverers of the species—and adheres to the Council of

the Heads of Australian Herbariums (CHAH) format: *Genus* sp. Locality (specimen identifier) Name of proposer. Since voucher specimens were recently deposited at the University of Malaya Herbarium (KLU) and are still in the process of obtaining accession numbers, a unique code is assigned as the specimen identifier. The exact locations of the proposed new taxon and some species of interest recorded in this paper are withheld for conservation priorities; only the general area, such as the name of the mountain range, is stated.

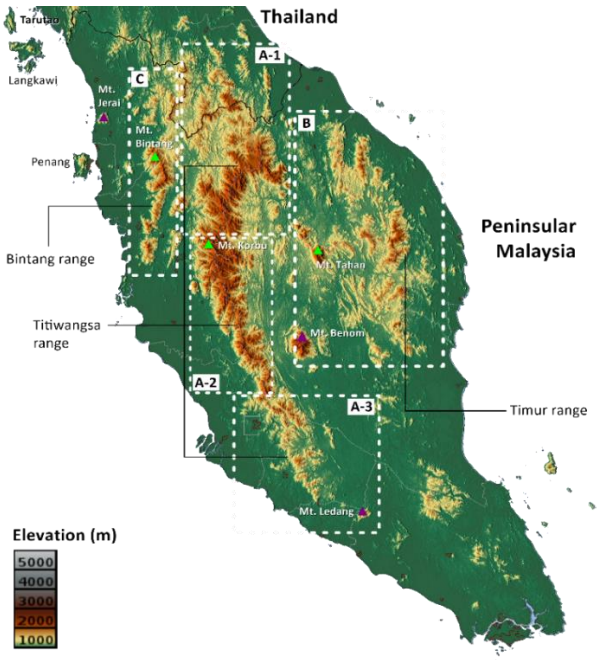

Fig. 1 - Relief map of Peninsular Malaysia. Banjaran Titiwangsa is treated as three areas; northern (A-1), central (A-2), and southern (A-3) regions. The A-1 region composed of elevated habitats that cover a swath area across two nations which may harbour understudied flora. The Banjaran Titiwangsa is flanked by Timur (B) and Bintang (C) mountain ranges, and the highest peak for each range is indicated by the green triangles. Prominent and isolated mountains are indicated by purple triangles.

3. Results and Discussion

The outcome of the survey presents the relevant information on all species of *Nepenthes* throughout Peninsular Malaysia with an emphasis on the taxa native to the highland ecosystem. The mountains of the peninsula are essentially grouped into three main ranges: Titiwangsa, Timur, and Bintang, each of which is home to several endemic highland *Nepenthes* taxa. Banjaran Titiwangsa is approximately 480 km long, stretching from southern Thailand and ending near Mount Ledang (formerly known as Mount Ophir) in Johor [15] [16]. Due to its extensive structure, we hypothetically divide this range into three regions (Fig. 1) in defining the distribution of highland *Nepenthes*. This main mountain range harbours 25% of known Malaysian plant diversity [17] and it is home to at least 12 species of Peninsular Malaysian *Nepenthes* [8] [9] [10] [11]. East of this main range lies the Banjaran Timur, from which a number of unique flora have recently been described [18] [19], including three endemic taxa of *Nepenthes* (*N. domei*, *N. latiffiana*, and *N. malayensis*) published in 2020 [8] [9]. The Tahan mountain range, here considered a part of the expansive Banjaran Timur, contains Mount Tahan—the highest peak of the whole Thai-Malay Peninsula, and is the *locus typicus* of *N. alba* and *N. gracillima*. Banjaran Bintang, which flanks Banjaran Titiwangsa on its left, is the only mountain range that none of the co-authors have physically visited. According to Tan et al. [10] and Lim et al. [11], the true *N. macfarlanei* is confined to this range.

It is known that highland *Nepenthes* are strictly restricted to their respective mountain systems, in some cases being found only on a handful of mountain peaks. On the contrary, lowland and intermediate species have a much wider distribution and occupy a broader elevation range from zero to 1000 meters (m) above sea level (asl). In this section, we provide taxonomical notes and *in situ* images of all known taxa based on taxonomic accounts and field observations. In addition, a description and diagnosis of a candidate new species [*N.* sp. Titiwangsa (pesonawangsa_223) A.Amin] sighted at elevations above 1800 m asl in Banjaran Titiwangsa are provided.

3.1 List of *Nepenthes* Species in Peninsular Malaysia

The total number of formally described *Nepenthes* in Peninsular Malaysia stands at 18, and the partial description of *N.* Pesonawangsa223 in this article secures its spot as the 19th species. *Nepenthes* are loosely grouped into three classes according to their habitat elevations: lowland, intermediate, and highland. The taxa that are bound to cool and humid

temporal zones ≥ 1000 m asl are considered true highland species and will not survive outside their natural elevations (Table 1). Meanwhile, the lowland and intermediate species can adapt well to a broader elevation range such as observed in *N. albomarginata*, *N. benstonei*, and *N. rafflesiana*.

Table 1 - An overview of the identified taxa in Peninsular Malaysia. *Nepenthes* species that grow only at elevations ≥ 1000 m asl are classified as restrictively highland. The conservation status is denoted as Critically Endangered (CR), Endangered (EN), Vulnerable (V), Near Threatened (NT), and Least Concern (LC)

	Species	Distribution	Elevations (m asl)	Conserv. status	Species Authorship
1.	*N. alba*	Peninsular Malaysia	1400-2187	LC	Ridl. (1924)
2.	*N. albomarginata*	Borneo, Sumatra, and Peninsular Malaysia	0-1100	LC	T. Lobb *ex* Lindl. (1849)
3.	*N. ampullaria*	Borneo, Sumatra, and Peninsular Malaysia	0-800	LC	Jack (1835)
4.	*N. benstonei*	Peninsular Malaysia	600-1000	VU	C.Clarke (1999)
5.	*N. berbulu*	Peninsular Malaysia	1400- 2100	EN	H.L.Tan, G.Lim, Mey, Golos, Wistuba, S.McPherson & A.S.Rob. (2023)
6.	*N. domei*	Peninsular Malaysia	400-1000	EN	M.N.Faizal, A.Amin & Latiff (2020)
7.	*N. gracilis*	Borneo, Singapore, Sulawesi, Sumatra, Thai-Malay Peninsula	0-1000	LC	Korth. (1839)
8.	*N. gracillima*	Peninsular Malaysia	1400-2100	LC	Ridl. (1908)
9.	*N. kerrii*	Thai-Malay Peninsula (Langkawi and Tarutao)	100-700	LC	M.Catal. & Kruetr. (2010)
10.	*N. latiffiana*	Peninsular Malaysia	1000-1100	CR	M.N.Faizal, A.Amin & Dome (2020)
11.	*N. macfarlanei*	Peninsular Malaysia	1460-1635	EN	Hemsl. (1905)
12.	*N. malayensis*	Peninsular Malaysia	900-1100	EN	A.Amin, M.N.Faizal & Dome (2020)
13.	*N. mirabilis*	Borneo, Cambodia, Java, Laos, Maluku, New Guinea, Northern Australia, Peninsular Malaysia, Southern China, Sulawesi, Sumatra, and the Philippines.	0-500	LC	(Lour.) Druce (1916)
14.	*N.* Pesonawangsa223*	Peninsular Malaysia	1800-2100	CR	A.Amin, Alias, Salasiah & Nurshahidah (2023)
15.	*N. rafflesiana*	Borneo, Peninsular Malaysia, Singapore, and Sumatra	0-1200	LC	Jack (1835)
16.	*N. ramispina*	Peninsular Malaysia	900-2000	LC	Ridl. (1909)
17.	*N. sanguinea*	Thai-Malay Peninsula	300-1800	LC	Lindl. (1849)
18.	*N. sericea*	Peninsular Malaysia	1300-2183	LC	Golos, Wistuba, G.Lim, Mey, S.McPherson & A.S.Rob. (2023)
19.	*N. ulukaliana*	Peninsular Malaysia	1200-1772	NT	A.S.Rob., Wistuba, Mey, Golos, G.Lim & S.McPherson (2023)

*****This taxon label is the simplified version of *N.* sp. Titiwangsa (pesonawangsa_223) A.Amin.

3.1.1 *Nepenthes alba* Ridl. (Fl. Mal. Pen. 1924:22) (Fig. 2)

Lectotype: *Wray & Robinson 5411* (SING), Peninsular Malaysia, Pahang, G. Tahan, 1500 m, 3 June 1905.

Distribution: Endemic to Peninsular Malaysia, Banjaran Timur, Mount Tahan complex, Pahang; 1400-2187 m asl.

Description: See McPherson [20], Clarke and Lee [21], Lim et al. [11].

Notes: The species epithet *alba* (white) refers to the whitish-ivory upper pitchers of the species. *Nepenthes alba* is currently accepted to be endemic to Mount Tahan and surrounding peaks. There were a series of bewildering interpretations of this taxon during the 20th century following its discovery, with some considering it as a synonym to another species native to the same area, *N. gracillima*. These two species were later revised and reinstated as distinct after the populations of the type locality were later thoroughly examined [20] [21] [22], resolving the century-old confusion in regards to the *Nepenthes* of Tahan. We consider *N. alba* to be limited to the upper montane forest of the Mount Tahan complex, as we have never come across this species in any other mountains. Previous accounts related to *N. alba* enlisted the Cameron Highlands (85 km west of Mount Tahan) and Mount Tapis in Pahang (100 km south-east of Mount Tahan) as some of its possible natural range; nevertheless, these need to be treated cautiously [20] [23]. We did encounter a species with white upper pitchers in the Cameron Highlands, but the lower pitchers were starkly different from those of *N. alba*. It has now been determined that this species is newly named *N. sericea*. (Fig. 18). Typically, *N. alba* produces upper pitchers that are around 10-12 cm tall and whitish in color, while its lower pitchers are dark purplish and rarely exceed 7 cm in height. The abaxial surface of the lids is covered with tiny hairs, and the inner margin of the peristomes is lined with short teeth, which classifies this species as a member of the *N. macfarlanei* species aggregate.

3.1.2 *Nepenthes albomarginata* T. Lobb *Ex* Lindl. (Gard. Chron. 1849:580) (Fig. 3)

Lectotype (Jebb & Cheek): Gard. Chron. 1849, p. 580. t. 3.

Distribution: Native to Borneo, Sumatra, and Peninsular Malaysia (Western side of the Titiwangsa range); 0-1100 m asl.

Description: See Clarke [24].

Notes: The species epithet *albomarginata* (*albo* = white, *marginata* = having a border) refers to the whitish band immediately below the peristome (Fig. 3c). It is the only *Nepenthes* with this feature, which makes it easy to be identified. In Peninsular Malaysia, this species is considered an intermediate highland taxon as it occupies lower montane forests on the western side of Banjaran Titiwangsa and can adapt to lowland conditions. Through our observations, *N. albomarginata* has been sighted in Penang, Kedah, inland of Perak, Pahang, and Johor. Interestingly, *N. albomarginata* is reported in Sumatra and Borneo, but it is absent from the area between the eastern side Banjaran Titiwangsa to Banjaran Timur. A study by Moran et al. [25] on the prey preference of *N. albomarginata* establishes that the creamy-coloured band below the peristome is composed of specialised trichomes that may act as a lure for termites (Isoptera). However, our inspection of the pitcher fluid of individuals growing *in situ* found that this species is unnecessarily an exclusive feeder of the isopteran insect as other insect remains, mostly those of ants, were also found. Due to its velvety pitchers paired with striking coloration, *N. albomarginata* is traded as an ornamental plant.

3.1.3 *Nepenthes ampullaria* Jack (Comp. Bot. Mag. 1835:271) (Fig. 4)

Lectotype (Jebb & Cheek): *Jack s.n.* (SING).

Distribution: Non-endemic to Peninsular Malaysia; Throughout the peninsular; 0-800 m asl.

Description: See Clarke [24].

Notes: The species epithet *ampullaria* means “flask-like” shape. This lowland species has a wide distribution in Southeast Asia and occupies different habitats, including disturbed areas such as road verges and abandoned mines, as well as forested regions including the secondary, reserve, and lower montane forests. Colour variants of *N. ampullaria* have been recorded in the wild, ranging from greenish to dark reddish, and they can be heavily mottled or plainly unpatterned (Fig. 4). The basal pitchers are usually borne on rosette stems, allowing the pitchers to be positioned in dense clutters on the ground with the mouth facing upwards. The lids flip away enable the pitchers to collect rainwater and organic debris that falls from above, such as leaves or bark chips. The species is not considered a true carnivore due to its partly detritivorous (feeding on decaying organic matter) behaviour. During the dry season, *Nepenthes* plants can draw water from their pitchers to some extent, and the flask-shaped pitchers of *N. ampullaria* might act as an emergency water reservoir when the soil is dry. We made an interesting observation on *N. ampullaria* plants grown in our greenhouse. When the soil was left dry for a few days, the pitcher fluid became depleted, and surprisingly, the plants remained turgid. The traps of *N. ampullaria* are also an important ecosystem for the least anticipated animal, the crab. Previously, Ng and Lim [26] reported the association of *Geosesarma malayanum* (a semiterrestrial fresh water crab) with the pitchers of *N. ampullaria* in Endau-Rompin Forest Reserve. In 2016, we observed a probable similar crab species with pinkish exoskeleton hiding inside a pitcher of *N. ampullaria* in Mount Benom complex, Pahang.

3.1.4 *Nepenthes benstonei* C.Clarke (Sandakania 1999:79) (Fig. 5)

Type: *Clarke s.n.* (KEP), Peninsular Malaysia, Kelantan, Bukit Bakar, 450-550 m, 24 July 1998.

Distribution: Endemic to Peninsular Malaysia, Banjaran Timur (Bukit Bakar, Mount Tahan complex and the Pasir Raja forest reserve); 600-1000 m asl.

Description: See Clarke [27], Clarke and Lee [21].

Notes: The species epithet commemorates Benjamin Clemens Stone, who was a British-American botanist and professor of botany at the University of Malaya in Kuala Lumpur (1965-1984). It was firstly identified as *N. sanguinea* until Charles Clarke published the description in 1999. Compared to *N. sanguinea*, *N. benstonei* has terete upper stems with a decurrent leaf base (as opposed to angular upper stems with a non-decurrent leaf base) and a bluntly toothed peristome (as opposed to peristome absent of teeth). *Nepenthes benstonei* is closely allied to other endemics of the Thai-Malay Peninsula species such as *N. domei*, *N. kerrii*, and *N. thai*. Tan et al. [10] consider *N. benstonei*, *N. domei*, and *N. thai* to be conspecific, though diagnostic features have been highlighted by the descriptors. The species is currently accepted to be endemic to Peninsular Malaysia and its populations have been confirmed in three locations within the Banjaran Timur. *Nepenthes benstonei* has also been observed growing in the Cameron Highlands, but not on the western side of the Banjaran Titiwangsa.

3.1.5 *Nepenthes berbulu* H.L. Tan, G.Lim, Mey, Golos, Wistuba, S.Mcpherson & A.S.Rob. (Carniv. Plant Newsl. 2023:15) (Fig. 6)

Type: *Lim 4* (KEP), Perak, Titiwangsa Range (exact location withheld for conservation reasons), above 1900 m, 23 August 2022.

Distribution: Endemic to Peninsular Malaysia, Banjaran Titiwangsa (Region A-2); 1400- 2100 m asl.

Description: See Tan et al. [10], Lim et al. [11].

Notes: *Nepenthes berbulu* is one of the three species discovered in 2022 and circumscribed by Tan et al. [10]. The species epithet *berbulu* is an adjective in Malay that simply means “hairy” or “with hairs”. The finding of this taxon was based on a photograph posted online in 2019 and one of the describing authors was quick to discern the peculiarity of it. The authors provide detailed information, characteristics, and *in situ* images, which serve as an excellent reference for the field identification. *Nepenthes macfarlanei* is considered the closest taxon to *N. berbulu* as these two are the only species in Peninsular Malaysia with fleshy bristles below their lids (up to 10-12 mm long). *Nepenthes berbulu* can be distinguished from *N. macfarlanei* based on its unevenly distributed bristles that concentrate towards the apex of the lid (vs. bristles being spread evenly). In addition, the upper pitchers of *N. berbulu* are much narrower and slender compared to the wholly infundibular *N. macfarlanei*‘s upper pitcher whose hips are positioned immediately below peristomes. *Nepenthes berbulu* occurs in several mountains and steep slopes in protected areas of the central (A-2) region of the Banjaran Titiwangsa, thus the describing authors classify it under EN (Endangered) criteria.

3.1.6 *Nepenthes domei* M.N.Faizal, A.Amin & Latiff (Webbia 2020:10) (Fig. 7)

Type: *Mohd. Norfaizal, Amin Asyraf, Dome Nikong, Muhamad Ikhwan, Edward Entalai & Anuar Rasyidi MDI12423* (MDI!), Peninsular Malaysia, Terengganu, Setiu, 30 April 2019.

Distribution: Endemic to Peninsular Malaysia, Banjaran Timur and Titiwangsa range (Region A-2); 400-1000 m asl.

Description: See Ghazalli et al. [9].

Notes: *Nepenthes domei* is an intermediate-highland species and the species epithet honours Dome Nikong, a nature photographer and the person who first discovered the population. Tan et al. [10] suggests that *N. domei* may be identical with *N. benstonei* (and *N. thai*), though Ghazalli et al. [9] have indicated that *N. domei* exhibits diverging features based on the lid morphology and its burrowing behaviour (Fig. 7a, 7c). In fact, the describing authors further provide the anatomical and molecular evidence needed to establish *N. domei* as a separate species. Based on our field examinations of the type localities of both *N. benstonei* and *N. domei*, they show very similar upper stem and upper pitcher characteristics. However; the lower and rosette pitchers of *N. domei* are stouter and more coriaceous than those of *N. benstonei*, which enables the species to produce subterranean traps. This adaptation may have played a role in the divergence of the two closely related species, marking an early stage of speciation. The plants of the type population grow in montane soil rich in humus and are confined to a highland habitat in Terengganu. A second locality has been confirmed in the eastern side of the central (A-2) region (400-500 m asl) of the Banjaran Titiwangsa, and the plants have stouter lower pitchers that exhibit the burrowing tendency despite growing in a sandy soil on river banks.

Fig. 2 - Pitcher forms of *N. alba* in Mount Tahan complex (a) lower; (b) intermediate, and; (c) upper pitchers; (d) habits of lower stem bearing multiple lower pitchers and; (e) upper stems with ivory upper pitchers and split seed pods. Photographs by A. A. Tamizi

Fig. 3 - *Nepenthes albomarginata* in Mount Jerai (a) lower and; (b) upper pitchers; (c) the white band below peristome showing white-matte reticulated surface that resembles lichen; (d) habits of lower stem with multiple lower pitchers. Photographs by A. A. Tamizi

Fig. 4 - *Nepenthes ampullaria* in its natural habitat (a) green lower pitchers; (b) red-blotched pitchers; (c) an upper stem with inflorescence; (d) green-blotched pitchers. Photographs by A. A. Tamizi

Fig. 5 - *Nepenthes benstonei* in Banjaran Timur (a) a lower pitcher from the type locality; (b) an upper pitcher with reddish colouration; (c) a single upper stem with four upper pitchers. Photographs by A. A. Tamizi

Fig. 6 - *Nepenthes berbulu* spotted in the central region (A-2) of Banjaran Titiwangsa (a) an intermediate-lower pitcher with unevenly distributed long bristles under the lid; (b) upper pitcher with long bristles under the lid; (c) upper pitchers exhibiting slender gross shape. Photographs by Hari Shanmugam (a), Yong Kwok Yew (b), and Sufian Rofiee (c)

Fig. 7 - Pitchers of *N. domei* in the type locality (a) unearthed rosette pitchers exhibiting the unique burrowing behaviour; (b) an upper pitcher with a keel below the lid; (c) subterranean lower pitchers with mouth parts visible above the substrate. Photographs by A. A. Tamizi

3.1.7 *Nepenthes gracilis* Korth (in C.J. Temminck, Verh. Nat. Gesch. 1839:22, t.l &4) (Fig. 8)

Lectotype (Jebb & Cheek): *Korthals s.n.* (L *n.v.*), Borneo, Gunung Pamatton, 325 m.

Distribution: Native to Borneo, Peninsular Malaysia (widespread in lowland habitats and surrounding islands) Singapore, Sulawesi, and Sumatra; 0-1000 m asl.

Description: See Clarke [24].

Notes: The epithet *gracilis* refers to the generally gracile (slender) and elongated pitchers of this species. *Nepenthes gracilis* is considered the most ubiquitous species in Peninsular Malaysia and probably the second most widespread tropical pitcher plants after *N. mirabilis*. As a result, this hardy species readily interbreeds with other sympatric taxa, producing various nothospecies (interspecific natural hybrids), some of which are not properly documented or have yet to be described, such as *N. benstonei* × *gracilis*—a novel nothospecies that we discovered in an eastern mountain of Peninsular Malaysia. In addition, *N. gracilis* grows well in both open and partially shaded areas of lowland and highland habitats with the highest elevation ever recorded is close to 1000 m asl. Given its ability to grow in highly degraded soils of abandoned mines and terraced slopes of road verges, it can be categorised as an important pioneer species. *Nepenthes gracilis* is easy to grow and can be readily propagated from stem cuttings.

3.1.8 *Nepenthes gracillima* Ridl. (J. Linn. Soc., Bot 1908:320) (Fig. 9)

Lectotype: *Wray & Robinson 5309* (SING), Peninsular Malaysia, Pahang, Gunung Tahan, 990 m, 29 May 1905.

Distribution: Endemic to Peninsular Malaysia, Banjaran Titiwangsa and Banjaran Timur (Mount Tahan complex); 1400-2100 m asl.

Description: See McPherson [20], Clarke and Lee [21], Lim et al. [11].

Notes: Due to a lack of comprehensive studies, *Nepenthes gracillima*—named for its slender upper pitchers (*gracillima* = gracile)—was believed to be restricted to the Mount Tahan complex (*locus typicus*) and the surrounding peaks. Lim et al. [11] documented a sighting of *N. gracillima* with "brown-speckled lower pitchers" in the Mount Tahan complex and instated that this species was limited to Banjaran Timur (Mount Tahan is part of this mountain range). However, our finding provides evidence to the contrary. After visiting the type locality, we went to northern Banjaran Titiwangsa and discovered a substantial population of *N. gracillima* here. Despite having colour variations (greenish and brownish) and occurring on different mountain ranges, all of the plants consistently exhibit the *N. gracillima*'s typical characteristics: pitchers (upper and lower) heavily mottled with speckles; hip positioned near (or slightly above) the midsection of the pitcher; broadly ovate to elliptical lids with abaxial fine hairs; toothed peristomes; terete to broadly angular lower stems with briefly decurrent leaf attachment; and narrow-infundibular to notably gracile upper pitchers. We have noted that *N. gracillima* in Banjaran Titiwangsa grows impressively tall upper pitchers, reaching up to 44 cm (Fig. 9f). Species treatment of this montane taxon must be cautiously made since it can be confused with *N. sericea* especially when the upper pitcher is absent.

3.1.9 *Nepenthes kerrii* M.Catal. & Kruetr. (*Nepenthes* Della Thailandia: Diario Di Viaggio 2010:32) (Fig. 10)

Type: *Kerr 14127* (BK!), Thailand, province of Satun, Tarutao Marine Park, 500 m, 1928.

Distribution: Native to Langkawi Island (Peninsular Malaysia) and Tarutao Island (Thailand); 100-700 m asl.

Description: See Catalano [28].

Notes: Formally described in 2010, *N. kerrii* was first discovered in Tarutao Island, Thailand (10 km north of Langkawi Island, Malaysia) and the species epithet commemorates an Irish medical doctor, Arthur Francis George Kerr, the species collector. A similar taxon has been sighted in Langkawi Island and there is an attempt to designate this population as a new species, thus being provisionally labelled as *N.* sp. Langkawi. Our examinations on the plants growing on Langkawi's rocky slopes (Fig. 10) and the herbarium sheet (online) of the *N. kerrii*'s type specimen [Kerr 14127 (BK)] deduce their climbing stems share very similar features: terete cross section; leaf base briefly decurrent; sessile leaves, which sometimes may appear subpetiolate. The original description of *N. kerrii* [28] states the lid as being round. However, the lids of the lower and upper pitchers of the Langkawi population can be rounded or slightly elliptical and the abaxial surface is usually reddish (Figs. 10c, 10d). Considering the close proximity and location within the same island cluster, it is highly probable that these two populations are indeed natural variations. Therefore, we treat the Langkawi plants as *N. kerrii*, consistent with Clarke [7] and Tan et al. [10]. Chua et al. [29] have reported the occurrence of *N. sanguinea* in Langkawi (five years prior to the publication of *N. kerrii*), but the deposited herbarium specimen [*Chua LSL* FRI 41736 (KEP)] could not be found and it might actually belong to *N. kerrii*. Latiff et al. [30] observed "*tiny immature aerial or upper pitchers of N. sanguinea with rounded red lids*" growing on the rocky slopes in Langkawi. Based on the photographs (Plate 2) provided by Latiff et al. [30] and the images we include here (Fig. 10c, 10d), the upper traps appear visually similar to the of *N. kerrii* in Tarutao reported by McPherson and Robinson [22].

3.1.10 *Nepenthes latiffiana* M.N.Faizal, A.Amin & Dome (Webbia 2020:7) (Fig. 11)

Type: *Mohd. Norfaizal, Amin Asyraf, Dome Nikong, Muhamad Ikhwan, Edward Entalai & Anuar Rasyidi MDI12424* (MDI!), Peninsular Malaysia, Terengganu, Setiu, 30 April 2019.

Distribution: Endemic to Peninsular Malaysia, Banjaran Timur; 1000-1100 m asl.

Description: See Ghazalli et al. [9].

Notes: The species epithet honours Emeritus Professor Dato' Dr. Abdul Latiff Mohamad, a prominent plant taxonomist in Malaysia. The species was published together with *N. domei* in 2020, the same year *N. malayensis* was published. Only a few plantlets and one mature plant of *N. latiffiana* were discovered at that time; thus, we propose here that it should be classified as Critically Endangered (CR) under the IUCB (2001) criterion, and immediate intervention is required to conserve the already scarce individuals. This species is related to *N. sanguinea*, *N. malayensis*, and *N. ramispina*; hence, they are grouped under the *N. sanguinea* aggregate based on their toothless peristomes, hairless lids, and non-decurrent leaf attachment. Compared to the three congeners, *N. latiffiana* has the most unique peristome structure, which is flattened and broadened on the lateral sides of the mouth, and slightly planar at the front. This characteristic is persistent in both lower and upper pitchers in the observed individuals (Fig. 11).

3.1.11 *Nepenthes macfarlanei* Hemsl. (Proc. Linn. Soc. 1905:12) (Fig. 12)

Lectotype (Jebb & Cheek): *King's Collector 7421* (K [#651560]), Perak, Gunung Bubu, 4800-5300 ft (≈1460-1620 m), March 1885.

Distribution: Endemic to Peninsular Malaysia, Banjaran Bintang; 1460-1635 m asl.

Description: See Tan et al. [10], Lim et al. [11].

Notes: The species epithet commemorates John Muirhead Macfarlane, a prominent Scottish botanist who lived at the turn of the 20th century. The plant was officially described by William Botting Hemsley in 1905 as having "*the underside of the lid* [corrected from *'lip'*] *being thickly beset with stiff bristles*" [31]. Tan et al. [10] and Lim et al. [11] provide detailed discussions on the morphology of the original *N. macfarlanei* in circumscribing closely related taxa. Of the many mountain systems in Peninsular Malaysia, Banjaran Bintang is the only one that has not been visited by any of the authors of this paper. Fortunately, we have received several photographs of pitcher plants depicting traps that exhibit features characteristic of *N. macfarlanei* (Figs. 12a, 12b) from hikers who had visited Mount Bubu. In addition, we carefully examined the herbarium specimens of *N. macfarlanei* [FRI 52358 (KEP!) and K000651563 (K!)] and confirmed the presence of bristles on the abaxial surface of the lids which are significantly coarser compared to those of *N. gracillima*, *N. sericea*, *N. ulukaliana*, *N. alba*, and *N.* sp. Titiwangsa (pesonawangsa_223) A.Amin. Another species with coarse bristles is *N. berbulu*, a closely related congener to *N. macfarlanei*, but the former taxon has notably slender upper pitchers with the hip positioned at midsection (vs. wholly infundibular, hip located just below the peristome), and does not share the same mountain system. Although Lim et al. [11] establish that *N. macfarlanei* is restricted to the summit area of Mount Bubu, we found evidence to the contrary: The K specimen (K000651563) clearly states that this species was also collected from Mount Larut (noted as G. B. Larut), a mountain located 20 km north of Mount Bubu on Banjaran Bintang.

3.1.12 *Nepenthes malayensis* A.Amin, M.N.Faizal And Dome (Kew Bull. 2020:3) (Fig. 13)

Type: *Amin Asyraf T, Mohd Norfaizal G, Dome N, Edward E.B. & Muhamad Ikhwanuddin M.E. MDI 12422* (MDI!), Semenanjung Malaysia, Terengganu.

Distribution: Endemic to Peninsular Malaysia, Banjaran Timur; 900-1100 m asl.

Description: See Tamizi et al. [8].

Notes: The species epithet *malayensis* is a Latin geographical adjectival word consisting of "Malaya" (historical name for Peninsular Malaysia) and the suffix "*ensis*", which essentially means 'belonging to Malaya'. This is the first instance of a *Nepenthes* species from this region being named after its geographical origin. *Nepenthes malayensis*' formal description was not published jointly with *N. domei* and *N. latiffiana*, though they were all discovered by the same team within the same time window. The reason for this is due to the lack of information on the lower pitchers and inflorescence during the early stage of discovery, therefore the authors decided to submit *N. malayensis* separately. Our subsequent visits to the type locality have yielded some new information concerning *N. malayensis* that was not included in the original paper. As observed, the leaf arrangement in mature lower stems of *N. malayensis* can take the form of an alternate-monopodial arrangement that resembles *Vanda* orchids. This phyllotaxy (leaf arrangement) has not been documented in other Peninsular Malaysian *Nepenthes* and could be a unique growth behavior of this taxon. The peristomes of the upper and lower pitchers are typically loosely cylindrical; however, *N. malayensis* sometimes develops flattened peristomes with a slightly scalloped outer margin (Fig 13a, 13e). The tendril insertion to the lamina (leaf blade) of mature individuals can also be briefly peltate. In terms of colouration, it was believed *N. malayensis* only produced green pitchers, but this is not always the case since individuals with reddish traps now have been confirmed (Fig. 13).

Fig. 8 - The pitchers of *N. gracilis* are distinguishable based on its very narrow peristomes and rounded lids (a) The lower and; (b) intermediate pitchers are usually reddish while; (c, d) the upper pitchers are consistently green; (d) the nectaries are large and sparsely scattered on the abaxial surface of the lid. Photographs by A. A. Tamizi

Fig. 9 - (a, b, c) *Nepenthes gracillima* observed in the type locality of the Mount Tahan complex and (d, e, f) a second locality in the Titiwangsa range; the colouration of the (a, b, d) lower and (c, e, f) upper pitchers of this species can be strikingly variable from greenish to purplish. Photographs by A. A. Tamizi

Fig. 10 - *Nepenthes kerrii* in Langkawi Island (a) lower; (b) intermediate-lower, and; (c, d, e) upper pitchers of the species can be observed along the trail to the peak and some grow on the hard-to-reach rocky slopes; (d, e) the leaf attachment to the upper stems is sometimes briefly decurrent or decurrent angling. Photographs by Shahidah Deman

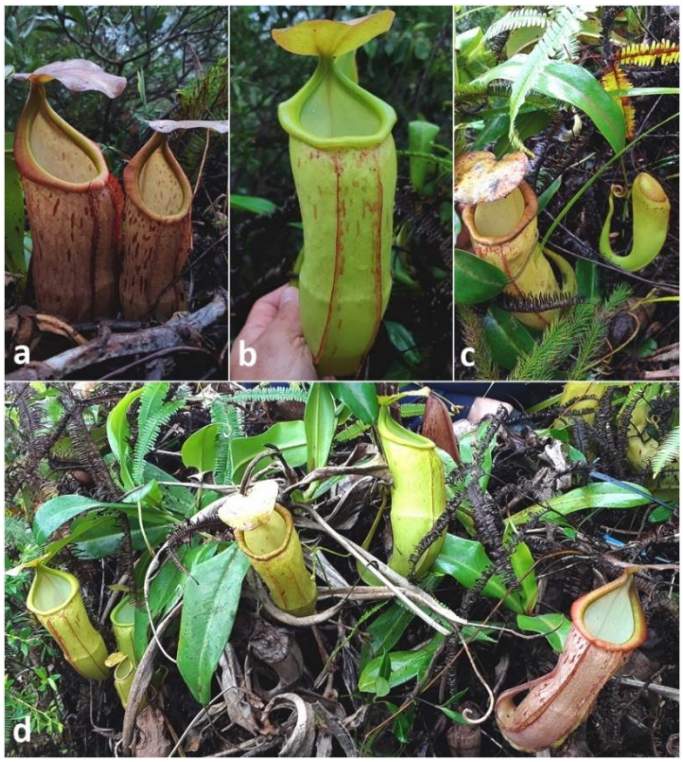

Fig. 11 - *Nepenthes latiffiana* in its type location (a) two lower pitchers nestled together; (b) a bright green upper pitcher showing peristome with planar frontal and flattened lateral parts; (c) seasoned and unopened upper pitchers; (d) habit showing green upper and pinkish intermediate pitchers. Photographs by A. A. Tamizi

Fig. 12 - Traps and herbarium specimen of *N. macfarlanei* (a) lower and; (b) upper pitchers exhibit coarse bristles under the lid; (c) the KEP specimen (FRI 52835) sampled from Mount Bubu; (d) bristle remains and nectaries under the lid. Photographs by Azuan Omar (a), Dewi Juwariyah (b), and N. Mohd-Rusli (c, d)

Fig. 13 - The pitchers of *N. malayensis* in the type locality. Colour variations (a) green and; (b) red, of lower pitchers borne on different plants from the same habitat; (c) a greenish upper pitcher; (d) habit, showing two mature lower pitchers; (e) a large reddish upper pitcher with scalloped peristome and keeled lid. Photographs by A. A. Tamizi (a, b) and M. A. Shakri (c, d, e)

3.1.13 *Nepenthes mirabilis* (Lour.) Druce (Rep. Exch, Cl. Br. Isl. 1916:637) (Fig. 14)

Type: *Loureiro s.n.*, (P. *n.v.*), Vietnam, near Huế.

Distribution: Not Endemic to Peninsular Malaysia, widespread in lowland habitats and surrounding islands; 0-500 m asl.

Description: See Clarke [24].

Notes: The species epithet *mirabilis* is a Latin word for "wonderful", and it was first described by João de Loureiro in 1790 as *Phyllamphora mirabilis*, which was later properly transferred to the genus *Nepenthes* by George Claridge Druce in 1916. *Nepenthes mirabilis* is a common swamp pitcher plant and has a very extensive distribution that covers most of the Southeast Asian countries and adjacent regions (Table 1). Clarke [24] states that the highest elevation of *N. mirabilis* is 1100 m asl, but we have never encountered any population higher than 600 m asl in Peninsular Malaysia. Despite having a range of pitcher colours (from green to reddish), this species can be easily distinguished from other lowland species based on its petiolated and soft leaves, leaves of lower stems with fimbriate margin, and tubular pitchers with indistinct teeth and flattened peristomes. Due to its extensive geographical range, some natural hybrids (nothospecies) have been reported and seen in Peninsular Malaysia, including *N.* × *kuchingensis* (*mirabilis* × *ampullaria*), *N.* × *neglecta* (*mirabilis* × *gracilis*), *N. mirabilis* × *benstonei*, *N. mirabilis* × *kerrii*, and *N. mirabilis* × *rafflesiana*. *Nepenthes mirabilis* is one of the most cultivated species by the hobbyists and it can be easily propagated through stem cuttings. Recently, we had succeeded in propagating some colour variants and a rare nothospecies, *N. mirabilis* × *rafflesiana*, from Johor using an optimised *ex vitro* propagation protocol.

3.1.14 *Nepenthes rafflesiana* Jack (Comp. Bot. Mag. 1835:270) (Fig. 15)

Lectotype (Jebb & Cheek): *Jack s.n.* (SING), Singapore.

Distribution: Native to Borneo, Sumatra, Peninsular Malaysia, and Singapore; 0-1300 m asl.

Description: See Burbidge [32], Clarke [24].

Notes: The species epithet *rafflesiana* is named after Sir Thomas Stamford Bingley Raffles, a British colonial official sent to the Malay Archipelago in 1805-1824. *Nepenthes rafflesiana* is known for its large and toothy lower pitchers, which can reach up to approximately 30 cm tall and are often colored in shades of green, red, and purple (Fig. 15). The leaves are leathery and conspicuously petiolated. This species can be found in both forest reserves and disturbed areas such as abandoned mines and road verges. Most of the populations are often sympatric with *N. ampullaria*, *N. mirabilis*, and *N. gracilis*, which gives rise to several described and undescribed nothospecies (natural hybrids) such as *N.* × *hookeriana* (*ampullaria* × *rafflesiana*), *N. mirabilis* × *rafflesiana*, *N. benstonei* × *rafflesiana*, and several others. Due to its highly variable pitcher morphology and wide distribution, there are several natural varieties (var.) of *N. rafflesiana* mentioned in some taxonomic accounts including var. *alata*, var. *minor*, var. *nigropurpurea*, and var. *nivea*. *Nepenthes hemsleyana* (endemic to Borneo) was initially treated as a natural variety of *N. rafflesiana* until Scharmann and Grafe [33] revised this taxon as a species of its own. Recently, a natural variety of *N. rafflesiana* discovered in Johor and Terengganu was launched as var. *zabawiana* [34]. This variety is identifiable by the presence of "truncated" ventral wings on its upper pitchers, which resemble ear flaps. According to the describing authors, the variety had not been published before. However, *N. rafflesiana* variants exhibiting the odd wing morphology have been reported by Latiff and Bahari [35] in Endau-Rompin State Park, by Lam and Tan [36] in Singapore, and by Schwallier et al. [37].

3.1.15 *Nepenthes ramispina* Ridl. (J. Fed. Mal. St. Mus. 1909:59) (Fig. 16)

Lectotype (Jebb & Cheek, 1997): *Ridley 12064* (SING), Peninsular Malaysia, Selangor, Ulu Semangkuk, August 1904.

Distribution: Endemic to Peninsular Malaysia; Banjaran Titiwangsa; 900-2000 m asl

Description: See Ridley [38], Clarke [24].

Notes: The species epithet *ramispina* is derived from Latin and translates to "branching spines", referring to the highly branched spur on the backside of the mouth. The lower pitchers of this species are predominantly black with some faded speckles, while the upper pitchers can be similarly black or entirely green with some dark speckles. The inner wall of the pitchers is waxy green, and the peristomes are usually cylindrical, sometimes briefly flattened. The species lacks teeth, its lids are absent of any hairs, and only occurs in upper montane forests. This species can be easily distinguished from other highland Peninsular Malaysian *Nepenthes* based on its dark colouration and slender pitchers. While we treat *N. ramispina* as a close ally to *N. sanguinea*, the latter species often produces larger pitchers and much-developed peristomes, making them easily distinguishable from each other. *Nepenthes ramispina* can hybridise with sympatric taxa, particularly *N. sanguinea* and *N. ulukaliana*, as observed in Genting Highlands and Mount Rajah.

3.1.16 *Nepenthes sanguinea* Lindl. (Gard. Chron. 1849:580) (Fig. 17)

Type: *Griffith 4411* (K), Peninsular Malaysia, Mount Ledang.

Distribution: Native to Peninsular Malaysia (Banjaran Titiwangsa), southernmost Thailand (the Sankalakhiri range); 300-1800 m asl.

Description: See Lindley [39], Jebb & Cheek [40], Clarke [24].

Notes: The species epithet *sanguinea* is a Latin word for "blood red", referring to the reddish lower pitchers of this taxon. Nevertheless, other color variations, such as green, yellowish-green, and orange, also occur. *Nepenthes sanguinea* is considered the most ubiquitous highland *Nepenthes* in Peninsular Malaysia, and our observations have verified its distribution in all three regions (A-1, A-2, and A-3) of Banjaran Titiwangsa, including the isolated Mount Ledang and Mount Benom (Fig. 1). Various taxonomic accounts establish that *N. sanguinea* as glabrescent (lacking hairs) and has sharply angular upper stems; however; the northern (A-1) population is notably velvety, and its upper stems are not sharply angular. The short hairs are brownish and present on the outer surface of the lower pitchers, adaxial surface of lids, tendrils, abaxial surface of the lamina midveins, and even internodes—features that are persistent in all mature individuals (Fig. 17e). We find the possibility of introgression as the cause for this characteristic to be unconvincing, as none of the other sympatric taxa exhibited this extensively hairy trait. Although the A-1 population is notably pubescent and has terete to slightly angular stems, it shares a very similar lower pitcher gross shape with the A-2 and A-3 populations. Therefore, we consider it to be a new natural variety, designated as *N. sanguinea* var. *velutina* (*velutina* = velvety). Currently, this A-1 population is being studied to further characterise its unique morphological features.

3.1.17 *Nepenthes sericea* Golos, Wistuba, G.Lim, Mey, S.Mcpherson & A.S.Rob. (*Nepenthes* - The Tropical Pitcher Plants 2023:2143) (Fig. 18)

Type: *Lim 3* (KEP), Kelantan, Gunung Warpu, 1745 m, 19 August 2022.

Distribution: Endemic to Peninsular Malaysia, central (A-2) Banjaran Titiwangsa; 1300-2183 m asl.

Description: See Lim et al. [11], Tan et al. [10].

Notes: The species epithet *sericea* is a Latin adjective that means "silken" or "silky", referring to the fine, silky hairs covering the abaxial surface of the lids. This species had long been mistakenly identified as a variety or nothospecies of *N. macfarlanei*. During our previous encounters with this species in the Cameron Highlands (in the years 2015 and 2017) (Fig. 18), and then in the easternmost part of Banjaran Timur (in the years 2018 and 2020), we carelessly lumped it as a variant of *N. macfarlanei* with fine lid hairs. Tan et al. [10] and Lim et al. [11] establish the taxonomic position of *N. sericea* in their effort to resolve confusing taxa within the *N. macfarlanei* group. As observed in the wild, the lower pitchers of *N. sericea* bear a striking resemblance to those of *N. gracillima*, while the upper pitchers are often mistaken for those of *N. macfarlanei*, *N. ulukaliana*, or *N. alba* due to their ivory-white coloration. Therefore, it is necessary to examine both the lower and upper pitchers in distinguishing *N. sericea*. The lower pitchers of *N. sericea* have a flattened peristome with teeth, ovate lids with fine abaxial hairs (up to 2 mm long), hips mostly positioned at the midsection (sometimes close to the mouth), and a heavily mottled outer surface. The upper pitchers are predominantly white with pinkish spots, yellowish green towards the tendrils, and may have hips positioned at the midsection or close to the mouth. While this species is reported to be limited to the central region of Banjaran Titiwangsa [11], the population in Banjaran Timur may potentially indicate a new locality or even represent an entirely different species.

3.1.18 *Nepenthes ulukaliana* A.S.Rob., Wistuba, Mey, Golos, G.Lim & S.Mcpherson. (*Nepenthes* - The Tropical Pitcher Plants 2023:2163) (Fig. 19)

Lectotype (Rob. et al. 2023): *Julius FRI 54894* (KEP! [#144426]) Pahang, Gunung Ulu Kali, 1707 m, 16 February 2007.

Distribution: Endemic to Peninsular Malaysia; Timur range; 1200-1772 m asl.

Description: See Lim et al. [11], Tan et al. [10].

Notes: The species epithet *ulukaliana* is derived from its type locality, Mount Ulu Kali, in the central region (A-2) of Banjaran Titiwangsa and its actual natural distribution may include the mountains in the southern region (A-3) of the range. *Nepenthes ulukaliana* had been mistreated as *N. macfarlanei* for decades as these two taxa share extremely similar upper pitcher morphology. According to the describing authors, *N. ulukaliana* can be diagnosed based on its amphora-shaped lower pitchers (due to hips positioned close to peristomes), short (≤1 mm long) and dense lid hairs, and the front portion of the peristomes being planar. *Nepenthes ulukaliana* is closely related to *N. sericea*, but the shape and hip position of the lower pitchers serve as distinguishing characteristics between the two taxa. It has been reported *N. ulukaliana* readily hybridises with other sympatric species [11]. To the southwest of the type locality, we sighted numerous individuals showing traits indicative of *N. sanguinea* × *ulukaliana* hybridisation. These plants displayed sharply angular stems, while their pitchers exhibited intermediate features derived from both parental species.

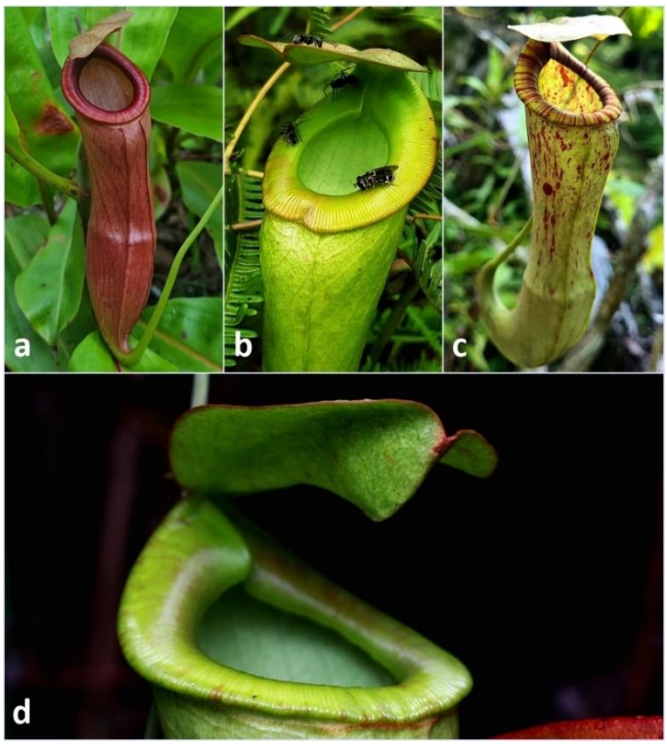

Fig. 14 - The traps of *N. mirabilis* (a) Reddish lower pitchers; (b) insects feeding on the nectar produced on the peristome and lid of an upper pitcher; (c) an upper pitcher with speckles and striped peristome; (d) keel formation towards the apex of the lid. Photographs by A. A. Tamizi (a, b, c) and M. Zulhusni Zakaria (d)

Fig. 15 - Pitchers of *N. rafflesiana* (a) a tubby lower pitcher; (b) prominent teeth lining the inner margin of the peristome; colour variations of the upper pitchers from the; (c) Johor and; (d) Terengganu populations. Photographs by A. A. Tamizi

Fig. 16 - *Nepenthes ramispina* is recognisable based on its black pitchers (a) a black lower pitcher; (b) lower stem with multiple lower pitchers; (c) climbing stem with multiple upper pitchers. Photographs by A. A. Tamizi

Fig. 17 - *Nepenthes sanguinea* populations occurring along Banjaran Titiwangsa (and nearby mountains) may possess notable variations (a, b) The population in Mount Benom, Pahang, produces extremely huge lower pitchers; (c) intermediate-lower and; (d) upper pitchers observed in Genting Highlands, Pahang; (e) the population sighted in the northern part of Banjaran Titiwangsa has velvety appearance due to the presence of short hairs on the pitcher surface, tendrils, and leaf midveins. Photographs by A. A. Tamizi

Fig. 18 - Pitchers of *N. sericea* observed in the natural habitats (a) A mature lower pitcher relative to the size of the hand; (b) fine hairs present below the lid; (c) a whitish upper pitcher with rosy speckles; (d) the hip on the upper pitcher is positioned at the midsection. Photographs by A. A. Tamizi (a, c, d) and M. A. Shakri (b)

Fig. 19 - Traps of *N. ulukaliana* (a) a lower pitcher from type locality. Note the hip close to peristome and fine hairs below the lid; (b) two nestled lower pitchers from Mount Rajah; (c) an upper pitcher with an ivory-white colouration. Photographs by A. A. Tamizi

3.2 Undescribed Taxon Exhibiting Peculiar Pitcher Morphology

The *Nepenthes macfarlanei* group concept was first introduced by Tan et al. [10] and Lim et al. [11] in referring to the different species that show high resemblance to *N. macfarlanei.* Prior to this, the montane *Nepenthes* with toothed peristomes, mottled pitchers, and hairs under the lid were erroneously lumped as *N. macfarlanei*, despite occurring on different mountain systems and having 'overlooked' diagnostic pitcher characteristics. Tan et al. [10] and Lim et al. [11] define six species in this group, including *N. alba*, *N. gracillima*, *N. macfarlanei*, and additional three new members (*N. berbulu*, *N. sericea*, and *N. ulukaliana*) demarcated from the previously broad concept of *N. macfarlanei*. These works, including the report by Clarke and Lee [21], have solved the long-standing confusion regarding *Nepenthes* with hairy lids and improved the understanding on the diversity of the pitcher plants in Peninsular Malaysia's mountains. Stemming from these findings, we report here the first sighting of an undescribed pitcher plant species with captivating characteristics, strongly affiliated to the *N. macfarlanei* species aggregate. Despite the lack of information on the flowers, the extremely unusual lower traps observed in several individuals are significant enough to warrant the establishment of a separate taxon. For this reason, the species is designated with the interim name *N.* sp. Titiwangsa (pesonawangsa_223) A.Amin, which is used interchangeably in this article with its simplified version, *N.* Pesonawangsa223, for ease of reference and clarity. The two taxonomic labels are synonymous and refer to the same species throughout this article and in other taxonomic materials. A detailed description, line drawing, and information on the type specimen of this provisional new species will be available in an upcoming publication.

3.2.1 *Nepenthes* sp. Titiwangsa (pesonawangsa_223) A.Amin, Alias, Salasiah & Nurshahidah (Fig. 20)

Diagnosis: This exquisite taxon differs from *N. gracillima* in having (differences in parentheses) lower pitchers with highly expanded or semi-flared peristomes up to 4.5 cm wide (vs. moderately expanded up to 2.5 cm wide), reniform or sub-orbicular lids with cordate base (vs. ovate to elliptical lids, base not or barely cordate), slightly raised basal appendage close to the lid attachment (vs. appendage absent), fine lid hairs shortest towards margin and longest at the basal appendage (vs. fine lid hairs shortest at the centre but longest at the lateral veins towards the margin), spurs highly branched (vs. spurs mostly simple or briefly branched), and ventral wings arise in four rows close to the peristome (vs. ventral wings arise in two rows for the entire length). The unique ventral wing formation is indeed a novel morphological feature that has not been reported in other species of this genus.

Description: ***Upper stems*** terrestrial climber, terete (cylindrical) to broadly angular; leaves base clasping ¾ of the stem and margin briefly decurrent for ca. 10 mm at 45° angle, blade green, midvein green or reddish. ***Lower stems*** terete, internodes glabrescent, reddish; leaves coriaceous, sessile, base clasping ¾ of the stem and margin decurrent 1-4 cm, apex acute, leaf abaxial and adaxial surfaces glabrescent, blade green, midvein reddish. Tendrils sparsely covered with short brown trichomes that dissipate towards leaf blade. ***Lower pitchers*** 22-27 cm high × 7-9.5 cm wide, reddish to burgundy and faintly blotched, arising abruptly from tendril, tendril 34-37 cm long (up to 67 cm in one individual), tendril always attached from side, broadly infundibular below hip, hip less pronounced and positioned close to peristome (one individual hip positioned slightly above midsection), pitcher body sparsely covered with short brown hairs. Ventral wings present, starting as two rows of fringed wings from the bottom of the pitcher, progressing into four rows of wings above the hip line and close to the peristome, each pair merging at the top to form spathulate structures (Figs. 20a, 20b, 20c). Peristome highly developed, ridged, flattened and expanded (or semi-flared), 1.5-2 cm wide at front, 2-2.5 cm wide at lateral sides, 3.5-4.5 cm wide towards rear, ribs 0.8-2 mm apart, teeth present and conspicuous towards posterior part of peristome. Lid sub-orbiculate or reniform, flattened or curved upward (convex), 8.5-9 cm wide × 7.5-8 cm long, base cordate, keel (medial ridge) absent, abaxial surface with raised basal appendage present close to the lid attachment; white lid abaxial hairs fine, evenly distributed, concentrated mostly at the centre (1 mm long), longest at the basal appendage (2 mm long) and shortest towards the margin (0.5 mm long); nectar glands (⌀ 0.3-0.8 mm) on the abaxial surface, crateriform, concentrated mostly at the lateral veins, appear as small black dots (punctate) on the basal appendage. Spur velvety, 1.3 cm long, branched into two of which each may further split into two tines at the tip. ***Upper pitcher's*** information withheld. ***Inflorescences, infructescence,*** and ***seeds*** all unknown. ***Indumentum*** short-brownish hairs present on mature pitcher surface, adaxial surface of lids, tendrils and young parts, other mature plant parts appear glabrous or lacking data.

Distribution: Currently known to be endemic to Peninsular Malaysia, Banjaran Titiwangsa; 1800-2100 m asl.

Notes: A pitcher plant with an expanded (or flared) peristome were first photographed by M. A. Shakri (Fig. 21b). Later, the first author (A. A. Tamizi) discovered more plants exhibiting a similar peristome characteristic in other different locations, which are assumed here to be closely affiliated. A single plant is known to produce a maximum of two opened pitchers per stem at a time (*N. gracillima* has been observed to produce up to four opened pitchers at a time), and the colour of the peristome can be entirely red or deep purple without stripes. During the field observations, it was noted that the species fed on ants (Hymenoptera), beetles (Coleoptera), and other arthropods, and the digestive fluid was viscoelastic. At first glance, these plants were thought to be a variant of *N. gracillima.* After a thorough inspection, they have been confirmed to be starkly atypical even to other members of the *N. macfarlanei* group. Broad peristome (≥3 cm) trait is known to a handful of the Sumatran, Bornean, and Mindanaoan *Nepenthes* but not for Peninsular Malaysian

species. In addition, the morphology of the ventral wings (four rows that develop into spathulate shapes) is unlike those of any other taxa—fitting to be classified as a very distinct type of *Nepenthes*—and it may serve as the main diagnostic feature. In total, 11 plants (nine observed *in situ* and two identified from photographs) representing the rare species have been recorded from two different locations. Some individuals exhibited reduced inner rows of the wings and do not clearly form the spathulate formation (Fig. 21a). The upper pitchers of this species were recently sighted, and they bear no resemblance to those of other species within the *N. macfarlanei* group. A detailed description of the upper traps of *N.* Pesonawangsa223 will be made available in an upcoming article. The holotype and isotype specimens—consisting of stems with lower and upper pitchers—were submitted to KLU, while a few more duplicates are being prepared to be distributed to other local herbariums.

Nepenthes varieties with irregular wing formations have been reported for *N. rafflesiana* by Lam and Tan [36]. According to the article, a natural variety (var. *alata*) appears to be having wings that persistently grow along its tendril while another unnamed variety produces truncated wings that resemble ear-shaped flaps on its upper pitcher. One may consider this as a unique characteristic but both of these *N. rafflesiana* varieties have wing arise from only two rows, not four as observed in *N.* Pesonawangsa223. Within the *N. macfarlanei* species aggregate, *N. gracillima*, *N. sericea*, and *N. ulukaliana* are regarded as the taxa with the closest affinity to *N.* Pesonawangsa223. The hairs on the lid abaxial surface of these four species are fine and less than 3 mm long. We examined the herbarium specimens (KEP and K) of closely related species and have confirmed the characteristics on the odd wing formation, lid abaxial hair distribution, and expansive peristome width are unique to this newly found montane taxon. The morphology comparison is presented in Table 2 to differentiate the newly proposed species from the three congeners. The specific locations of *N.* Pesonawangsa223 are withheld for conservation purposes, and the proposed conservation status of this taxon is Critically Endangered (CR) under criterion D of the IUCN Red List Categories and Criteria [13]. The taxon is currently known to have an area of occupancy less than 10 km^2, with a population comprising fewer than 50 individuals.

We intend to use the species name *Nepenthes pesonawangsa* to replace the provisional label *N.* sp. Titiwangsa (pesonawangsa_223) A.Amin in an upcoming species treatment; however, it has yet to be definitively finalised. The epithet is derived from the Malay words *pesona*, meaning "the charm", and *wangsa*, meaning "noble lineage" or "dynasty". Together, it represents the idea of charming and overly unique traits of this taxon that are not observed in other Peninsular Malaysian species. Furthermore, the name rhymes with 'Titiwangsa', the mountain system the species is limited to.

Additional specimens examined:

Nepenthes berbulu—MALAYSIA. **Pahang:** Banjaran Titiwangsa, summit plateau, 2011 m, 22 September 1994, *Chua et al. FRI 39045* (KEP!) (stem with two pitchers and infructescence, originally labelled as *N. macfarlanei*)

Nepenthes macfarlanei—MALAYSIA. **Perak:** Gunung Bubu, 1635 m, 20 December 2006, *Lim, C. L. FRI 52835* (KEP!) (stem with two lower pitchers); Gunung Larut, 1463 m, March 1885, *King K000651563* (K!) (one upper pitcher and two lower pitchers)

Nepenthes sericea—MALAYSIA. **Pahang:** Cameron Highlands, 2034 m, 18 November 2009, *Imin, K. FRI 68465* (KEP!) (stem with an upper pitcher and a female infructescence, originally labelled as *N. macfarlanei*)

Nepenthes ulukaliana—MALAYSIA. **Pahang:** Gunung Ulu Kali, 1770 m, 3 February 2010, *Imin, K. FRI 66469* (KEP!) (stem with an upper pitcher and two male inflorescences, originally labelled as *N. macfarlanei*); Pahang, Gunung Ulu Kali, 1707 m, 16 February 2007, *Julius, A. FRI 54894* (KEP!) (stem with three upper pitchers and two male inflorescences, originally labelled as *N. macfarlanei*)

Fig. 20 - Mature pitchers of *N.* sp. Titiwangsa (pesonawangsa_223) A.Amin, or *N.* Pesonawangsa223, displaying reddish colouration suffused with light-coloured blotches. (a, b) The pitchers of different plants display visible double pairs of fringed wings above the hip line, which merge to form spathulate (spatula-shaped) wing structures close to the peristome; (c) a close-up ventral view of a partially dried pitcher with arrows indicating the four rows of fringed wings; (d) the hairs under the lids are fine, longest on the basal appendages, and shortest towards the margin, while the nectaries are crateriform or can appear as glandular dots on the basal appendage. Photographs by A. A. Tamizi

Fig. 21 - Other individuals affiliated to *N.* Pesonawangsa223 that might represent natural variants or introgressed individuals. These pitchers are leaned against the ground and tree branch, which may trigger them to develop noticeably flared peristomes (a) Lower pitcher with a subdued extra wing that is hardly seen (white arrow); (b) lower pitcher with the hip positioned close to the midsection. Photographs by A. A. Tamizi (a) and M. A. Shakri (b)

Table 2 - A comparison of *N.* Pesonawangsa223 and three other members of the *N. macfarlanei* group.

	***N.* Pesonawangsa223**	***N. gracillima***	***N. sericea***	***N. ulukaliana***
Geographical distribution	Banjaran Titiwangsa	Banjaran Timur and Titiwangsa	Banjaran Titiwangsa	Banjaran Titiwangsa
Elevation (m asl)	1800-2100	1400-2100	1300-2183	1200-1700
Stems	Terete, glabrescent	Terete, glabrescent	Terete to slightly angular, pubescent	Terete to slightly angular, glabrescent
Leaves of lower stems	Coriaceous, sessile, base clasping ¾ of the stem, margin decurrent (10-40 mm long)	Coriaceous, sessile, base clasping ¾ of the stem, margin sometimes sub-decurrent angling (3-4 mm long)	Coriaceous, sessile, base clasping ¾ of the stem, margin not decurrent	Coriaceous, sessile, base clasping up to ¾ of the stem, margin not decurrent
Leaves of upper stems	Base clasping ¾ of the stem, mostly sub-decurrent angling (up to 10 mm long)	Base cuneate, clasping ½ of the stem, not decurrent	Base clasping ¾ of the stem, not decurrent	Base rounded to cordate, clasping > ½ of the stem, not decurrent
Lower pitchers	22-27 cm high × 7-9.5 cm wide, tendrils always attached from side, broadly infundibular to urceolate, hip close to peristome, reddish to royal burgundy and faintly speckled	Up to 20 cm high × 7 cm wide, tendrils attached from front or slightly from side, ovoid or broadly cylindrical, hip close to the midsection, greenish to dark reddish and heavily speckled	Up to 28 cm high × 9 cm wide, ovoid to broadly infundibular below hip, and cylindrical above, hip close to the midsection, yellowish green to reddish, heavily speckled	Up to 25 cm high × 8.5 cm wide, amphora-shaped to urceolate, hip close to peristome, yellowish green to red and heavily speckled
Peristome	Highly developed, ribbed, flattened and expanded or semi-flared, widest at rear (3.5-4 cm wide), teeth present and conspicuous towards posterior part of peristome	Flattened, expanded towards the rear (up to 2.5 cm wide) teeth distinct (up to 5 mm long near the apex)	Sub-cylindrical to flattened (up to 2.0 cm wide) teeth minute (ca. 1 mm long)	Sub-cylindrical, ribbed, widest at rear (up to 1.5 cm wide), teeth conspicuous
Ventral wings of lower pitcher	Arising as two rows of fringed wings from the bottom of the pitcher, progressing into four rows of wings above the hip line and close to the peristome, each pair may merge at the top to form spathulate structures	Two rows of ventral fringed wings running the entire length of the pitcher	Two rows of ventral fringed wings running the entire length or only the upper half of the pitcher	Two rows of ventral fringed wings running the entire length of the pitcher
Lid of lower pitchers	Reniform (base strongly cordate), 8.5-9 cm wide × 7.5-8 cm long, flat or slightly saucer-shaped, slightly raised basal appendage	Ovate or elliptical (base barely or not cordate), up to 3.5 cm wide × 5 cm long, flat to saddle-shaped or dome-shaped, no appendage	Sub-orbicular to ovate, up to 6.2 cm wide × 6.5 cm long, flat or slightly wavy, held slightly upturned, no appendage	Sub-orbicular (base cordate), 4.5-7 cm wide × 5.0-8.5 cm long, held horizontally or slightly upturned, no appendage
Hairs on abaxial surface of lid	Very fine hairs, concentrated mostly at the centre (1 mm long), longest at the basal appendage (2 mm long) and shortest towards the margin (0.5 mm long)	Fine hairs (1-3 mm long), shortest at the centre, longest at the lateral veins or towards the margin	Fine hairs (1-2 mm long), longest at the centre and apex	Fine hairs, evenly distributed, equal length (up to 2 mm long), absent at the margin

Dichotomous key to the seven species of the *Nepenthes macfarlanei* group

1a Lids with thickened abaxial hairs ≥5 mm long……...2
1b Lids with fine abaxial hairs ≤3 mm long……3

2a Upper pitchers wholly infundibular, hip close to peristome, whitish appearance throughout with green base; lower pitchers with abaxial lid hairs evenly distributed…….……...…… ***N. macfarlanei***
2b Upper pitchers broadly cylindrical, hip at the midsection, white with dark speckles; lower pitchers with abaxial lid hairs aggregated towards the apex and peripheral margin ……. ***N. berbulu***

3a Upper pitchers small (ca. 12 cm high), whitish to pale yellow throughout; lower pitchers small (ca. 7 cm high), dark purplish throughout……***N. alba***
3b Pitchers typically large (18-28 cm high) ……4

4a Pubescent or velvety stem internodes; upper pitchers wholly infundibular, hip at the midsection or close to peristome, whitish appearance throughout with green base……***N. sericea***
4b Glabrescent stem internodes…….……5

5a Non-decurrent leaf attachment; lower pitchers wholly ovoid, amphora-shaped, hip very close to the peristome, peristome sub-cylindrical (<1.5 cm wide) ……...……...***N. ulukaliana***
5b Decurrent leaf attachment; lower pitchers broadly infundibular; peristome flattened (>2 cm wide) …….……...6

6a Leaf base of lower stems decurrent angling up to 4 mm; lower pitchers broadly infundibular below and cylindrical above the hip, hip at the midsection, peristome flat and not flared (≤2.5 cm wide), lids ovate or elliptical, lid abaxial hairs longest at the lateral veins or towards the lid margin, lids without appendage, ventral wings arise in two rows……. ***N. gracillima***
6b Leaf base of lower stems decurrent up to 4 cm; lower pitchers broadly infundibular, hip above the midsection and usually close to peristome, peristome expanded or semi flared (≥3.5 cm wide), lids reniform or sub-orbiculate with cordate base, lid abaxial hairs longest at the basal appendage and shortest towards the margin, ventral wings arise in four rows close to peristome……. ***N.* Pesonawangsa223**

4. Conclusion

Intended as a reference for researchers studying the diversity of the Peninsular Malaysian *Nepenthes*, this article presents updated knowledge and concise overview of each known taxon. Drawing on taxonomic accounts and ten years of field observations, it provides essential details on all species while highlighting areas that warrant further examination, particularly concerning *N. sanguinea* var. *velutina*, the potential new distribution ranges of certain species, and the occurrence of new nothospecies. In addition to the 18 published species, the first documentation of *N.* Pesonawangsa223 (considered the 19th *Nepenthes* species in Peninsular Malaysia) is also revealed, which can be regarded as the most significant highlight of this paper. We describe its lower pitchers and stems, provide a provisional taxon label, and propose a binomial name to establish priority for the authors who first discovered and identified this peculiar pitcher plant. Nevertheless, since this article denotes the initial phase of its discovery, comprehensive research on *N.* Pesonawangsa223 is still ongoing. Hence, collaborations with interested parties are welcome to contribute to this endeavor.

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