

## Novitates Bruneienses, 9. A synopsis of *Epirixanthes* (Polygalaceae) in Brunei Darussalam and notes on species elsewhere

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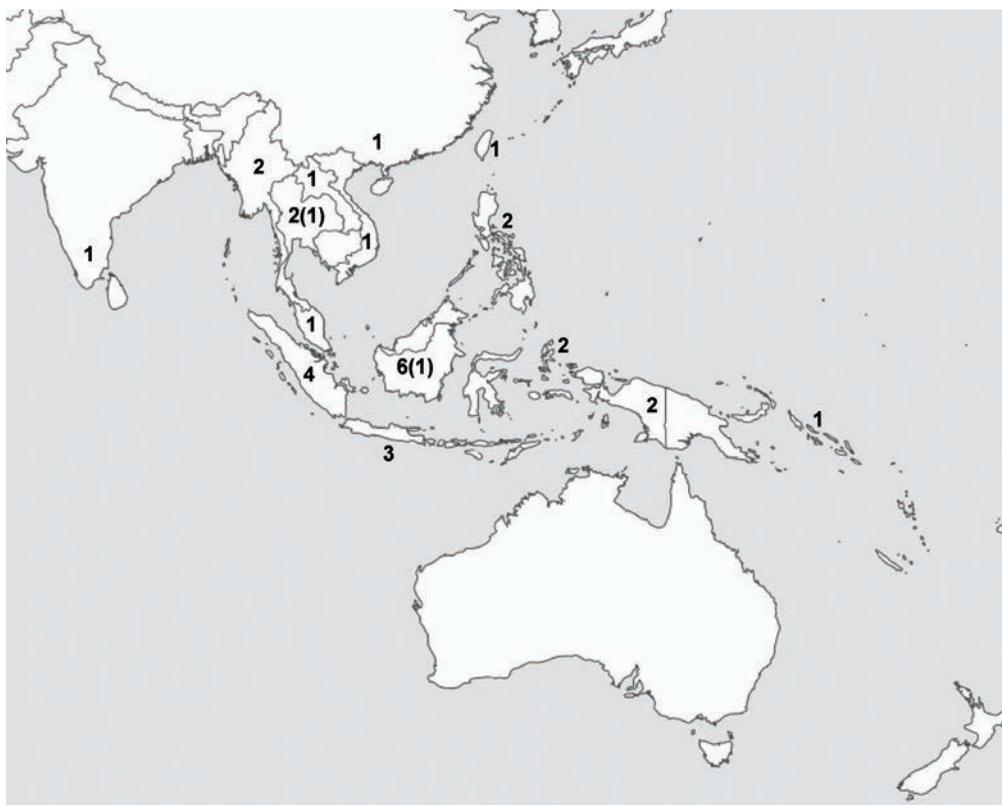
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**ABSTRACT.** The genus *Epirixanthes* Blume is revised for Brunei Darussalam. Four species are recognised for the country: *Epirixanthes cylindrica* Blume, *E. elongata* Blume, *E. kinabaluensis* T.Wendt and *E. papuana* J.J.Sm., with the two latter species being newly recorded for the Brunei flora. A single collection from Brunei that was formerly identified as *Epirixanthes pallida* T.Wendt is now confirmed as *E. papuana*. A revised key for the genus is included.

**Keywords.** Distribution, herbs, Malesia, mycoheterotrophic plants, north-western Borneo, taxonomy, understorey

### Introduction

*Epirixanthes* Blume is a species-poor genus of holomycoheterotrophic herbaceous plants from the family Polygalaceae which inhabit the understorey of tropical rainforests (Van der Meijden, 1988; Merckx et al., 2013). It is sister to the autotrophic genus *Salomonina* Lour. with which it shares several synapomorphies such as spike-like terminal inflorescence and three antesealous stamen primordia (Van der Meijden, 1988; Mennes et al., 2015). Members of the genus are generally tiny plants with reduced bract-like leaves and dense spike-like inflorescences (Van der Meijden, 1988). Due to the reduction of vegetative organs as a result of mycoheterotrophy, the set of morphological characters useful for species determination is very limited and includes mostly reproductive organs (i.e., bracts, bracteoles, sepals and fruits). Currently, only seven species of *Epirixanthes* are recognised worldwide, and all of them are endemic to Indo-Malesia (Van der Meijden, 1988; Pendry, 2010; Tsukaya et al., 2016). The centre of its taxonomic diversity lies in Borneo where six of the species co-occur, with one of them apparently endemic to the island (Fig. 1). In the *Checklist of the Flowering*



**Fig. 1.** Global distribution and diversity of *Epirixanthes* with number of species for each region and number of endemic species in parentheses.

*Plants and Gymnosperms of Brunei Darussalam* (Coode et al., 1996), three species of *Epirixanthes* are reported from the country, namely *E. cylindrica* Blume, *E. elongata* Blume and *E. pallida* T.Wendt. During our recent ecological research activities in Kuala Belalong (Ulu Temburong National Park, Temburong district), we frequently encountered *Epirixanthes* plants in the lowland dipterocarp forest understorey. However, some of the observed plants did not match with any of the three species reported from Brunei Darussalam by Coode et al. (1996), indicating they possibly belong to unrecorded species. We therefore decided to clarify the taxonomic status of these plants and present a revision of *Epirixanthes* in the country.

### Material and methods

We examined specimens deposited in BRUN (Brunei National Herbarium) as well as our field collections from Brunei Darussalam deposited in OL (Herbarium of the Department of Botany at Palacký University in Olomouc). Available duplicates kept in K (Royal Botanic Gardens Kew) and AAU (Science Museums, Aarhus University)

were also seen. The identification of each specimen was checked and the identifications updated when necessary. All cited specimens have been seen. Bruneian localities from herbarium labels are sorted below according to the current administrative districts of Brunei Darussalam.

## Results

Four species of *Epirixanthes* were found to occur in Brunei Darussalam, namely *E. cylindrica*, *E. elongata*, *E. kinabaluensis* T.Wendt and *E. papuana* J.J.Sm. The two former species were previously known from the country while the two latter species are new additions to the country's flora. *Epirixanthes pallida* should be excluded from the Brunei checklist as all three duplicates (deposited in BRUN, K, and AAU) of the single collection (*Poulsen* 3) cited in Coode et al. (1996) consist of misidentified plants of *E. papuana*. All four species co-occur in the Lowland Mixed Dipterocarp forest of the Ulu Temburong National Park in the Temburong district, which further highlights the floristic and conservation significance of this area.

### The *Epirixanthes* species of Brunei Darussalam

#### 1. *Epirixanthes cylindrica* Blume, Cat. Gew. Buitenzorg 82 (1823). (Fig. 2A)

*Global distribution.* Its range includes Myanmar, Sumatra, Java, Borneo and New Guinea (Van der Meijden, 1988).

*Distribution in Brunei Darussalam.* It is documented only from the Temburong district in a few localities in Kuala Belalong – Bukit Belalong area. Its known elevational range in Brunei Darussalam is from c. 100 m a.s.l. up to 850 m a.s.l.

*Specimens examined.* BRUNEI DARUSSALAM: **Temburong:** Amo, Ulu Belalong, L.P. 382, north-facing slopes below campsite, 18 Jan 1994, *Coode* 7845 (BRUN); Amo, Bukit Belalong, hill dipterocarp forest on Setap Shales ridgetop, 24 Feb 1992, *Dransfield* 1246 (BRUN); Amo, Bukit Belalong, hill dipterocarp forest steep slope near valley bottom, 25 Feb 1992, *Dransfield* 1266 (BRUN); Bukit Belalong, east ridge, 20 Jul 1989, *de Vogel* 8989 (BRUN); Batu Apoi Forest Reserve, ridge between K. Belalong and Bt. Belalong, Jalan Tengga, damp, flat area below Bukit Belalong, 21 Mar 1992, *Poulsen* 304 (AAU, BRUN); Kuala Belalong, Batu Apoi Forest Reserve, upstream the Sungai Belalong river from the Kuala Belalong Field Studies Centre, along path, 10 Nov 1991, *Hansen* 1540 (BRUN); Kuala Belalong, E ridge of Sungai Belalong, ca. 0.9 km ESE from its confluence with Sungai Temburong, ecological plot 1, 13 Jan 2014, *Dančák* 2014/161 (OL); *ibidem*, 30 Jan 2016, *Dančák* 2016/367 (OL).

*Notes.* This species is distinguished by a rather short and thick inflorescence. The apex of the inflorescence is covered by imbricate bracts. As most of the specimens come from middle altitudes this species seems to be rare in true lowlands.



**Fig. 2.** *Epirixanthes* species of Brunei Darussalam. **A.** *Epirixanthes cylindrica* Blume. **B.** *E. elongata* Blume. **C.** *E. kinabaluensis* T.Wendt. **D.** *E. papuana* J.J.Sm. **E.** *E. pallida* T.Wendt. A–D, all from Kuala Belalong, Brunei Darussalam; E from Kelabit Highlands, Sarawak. (Photos: A: Ondřej Popelka, B, C: Michal Hroneš, D, E: Michal Sochor)

**2. *Epirixanthes elongata* Blume, Cat. Gew. Buitenzorg 82 (1823). (Fig. 2B)**

*Global distribution.* The species range extends from eastern India and southern China to the Moluccas (Van der Meijden, 1988; Chen et al., 2008).

*Distribution in Brunei Darussalam.* It is documented from various locations across the Temburong district. Outside Temburong, it has only been collected from a single locality around Labi in the Belait district. Its known elevational range in Brunei Darussalam is from c. 40 m a.s.l. up to 420 m a.s.l.

*Specimens examined.* BRUNEI DARUSSALAM: **Belait:** Labi, Sungai Rampayoh, ca. 3.5 km above road towards Waterfall No. 2, 9 Jan 1994, *Coode 7784* (BRUN). **Temburong:** Batu Apoi Forest Reserve, ridge W of Kuala Belalong Field Studies Centre, in Danish Plot, mixed dipterocarp forest, 1991, *Poulsen 224* (AAU, BRUN); Kuala Belalong, E ridge of Sungai Belalong, ca. 1.5 km SE from its confluence with Sungai Temburong, depression NW of ecological plot 2, 13 Feb 2015, *Hédl & Chudomelová RH132015* (OL); Kuala Belalong, E ridge of Sungai Belalong, ca. 0.9 km ESE from its confluence with Sungai Temburong, ecological plot 1, 13 Jan 2014, *Dančák 2014/6* (OL); ibidem, 13 Jan 2014, *Dančák 2014/125* (OL); ibidem, 13 Jan 2014, *Dančák 2014/160* (OL); ibidem, 13 Jan 2014, *Dančák 2014/180* (OL); ibidem, 4 Feb 2015, *Hroneš & Koblrová 702015* (OL); Sungai Temburong at Kuala Belalong, 23 Jun 1989, *Dransfield 1007* (BRUN); Apan, ridge to the north of the river, 13 Jul 1993, *Sands 5786* (BRUN); Amo, southeast of LP 297 Bkt. Lutut, 6 Apr 2004, *Ariffin et al. BRUN 20797* (BRUN); Labu, Peradayan F. R., 5 Feb 2002, *Ariffin et al. BRUN 19913* (BRUN).

*Notes.* This is the most common species of *Epirixanthes*. It is locally abundant elsewhere in Borneo, and is presumably also common in Brunei Darussalam. In Kuala Belalong it is almost ubiquitous and by far the most abundant species of *Epirixanthes*. This species is easily recognised among Bruneian *Epirixanthes* as its bracts are shed well before the flowers open and the inflorescence is very long and narrow. One of the specimens studied (*Hroneš & Koblrová 702015*) is a very pale-coloured plant conspicuously different from the typical brownish-purple plants of *E. elongata*. Such pale ivory individuals are known to occur within populations of *E. elongata* and they were described from West Kalimantan as *E. elongata* f. *alba* Tsukaya & H.Okada (Tsukaya & Okada, 2012).

**3. *Epirixanthes kinabaluensis*** T.Wendt, Fl. Males., Ser. 1, Spermat. 10(3): 491 (1988). (Fig. 2C)

*Global distribution.* The species is found in Sumatra and Borneo (Van der Meijden, 1988).

*Distribution in Brunei Darussalam.* It is known only from two locations in the immediate vicinity of the Kuala Belalong Field Studies Centre in the Temburong district. Its known elevational range in Brunei Darussalam is very narrow as it is recorded only from altitudes around 100 m a.s.l., even though its type locality, the slopes of Mt. Kinabalu in Sabah, lies at around 900–1200 m a.s.l. We have observed the species in the Kelabit Highlands of Sarawak up to c. 1300 m a.s.l.

*Specimens examined.* BRUNEI DARUSSALAM: **Temburong:** Kuala Belalong, Sungai Esu valley, at its confluence with Sungai Belalong, 9 Jan 2014, *Dančák 2014/162* (OL); ibidem, 18 Jan 2014, *Dančák 2014/343* (OL); Kuala Belalong, Sungai Esu, clayey bank near its confluence with Sungai Belalong, 21 Jan 2017, *Dančák 2017/46* (BRUN); Kuala Belalong, Earthwatch ecological plot ca. 0.3 km W from the Kuala Belalong Field Studies Centre, 28 Jan 2016, *Dančák 2016/292* (OL).

*Notes.* This species is the most robust of all Bruneian *Epirixanthes*, although *E. elongata* is usually taller. It has a rather thick inflorescence with long bracts which sometimes persist on the axis of the inflorescence after the fruits are shed.

**4. *Epirixanthes papuana*** J.J.Sm., Repert. Spec. Nov. Regni Veg. 10: 486 (June 1912). (Fig. 2D)

*Global distribution.* It is distributed throughout Malesia from Sumatra to the Solomon Islands (Van der Meijden, 1988).

*Distribution in Brunei Darussalam.* It is known only from a few locations immediately surrounding the Kuala Belalong Field Studies Centre in Temburong district and one locality in the Bukit Sawat area in Belait district. However, its actual distribution in the country could be much more extensive. Like most of the other species of *Epirixanthes*, this species is likely to be overlooked by collectors and therefore poorly represented in herbaria. Its known elevational range in Brunei Darussalam is rather narrow, reaching from c. 20 m a.s.l. up to 180 m a.s.l. However, the species might potentially also occur at higher elevations because the type collection from New Guinea comes from altitudes from 500 m a.s.l. up to 1800 m a.s.l.

*Specimens examined.* BRUNEI DARUSSALAM: **Belait:** Labi, Bukit Sawat, Sungai Malayan, 10 Jun 2003, *Ariffin et al. BRUN 20353* (BRUN). **Temburong:** Batu Apoi Forest Reserve, ridge W of Kuala Belalong Field Studies Centre, mixed dipterocarp forest, 18 Mar 1991, *Poulsen 3* (AAU, BRUN, K); Kuala Belalong, in Sungai Mata Ikan gorge near its confluence with Sungai Belalong, 26 Jan 2015, *Hroneš & Koblřová 662015* (OL); ibidem, 21 Jan 2017, *Dančák 2017/55* (BRUN); Kuala Belalong, Sungai Mata Ikan valley ca. 0.5 km WNW from Kuala Belalong Field Studies Centre, 28 Jan 2016, *Dančák, M. 2016/291* (OL); Kuala Belalong, Sungai Baki valley near its confluence with Sungai Temburong, 18 Jan 2014, *Dančák 2014/342* (OL); Kuala Belalong, Sungai Esu, clayey bank near its confluence with Sungai Belalong, 21 Jan 2017, *Dančák 2017/47* (BRUN).

*Notes.* This species is distinguished by its paler colour (creamy brownish) and the rather short and narrow inflorescence with patent bracts that are turned-up at their apices.

#### Notes on other species of *Epirixanthes*

***Epirixanthes pallida*** T.Wendt, Fl. Males., Ser. 1, Spermat. 10(3): 492 (1988). (Fig. 2E)

*Global distribution.* The species is found in Borneo and Sulawesi (Van der Meijden, 1988).

*Notes.* The species was included in the Brunei Checklist (Coode et al., 1996) based on a single collection (*Poulsen 3*) originally identified as *Epirixanthes pallida* but which has been reidentified as *E. papuana*. Therefore *Epirixanthes pallida* should be excluded from the flora of Brunei Darussalam. *Epirixanthes pallida* is readily distinguished from the Bruneian species by large and very early caducous whitish or pinkish bracts. It seems that *Epirixanthes pallida* is a highland species and thus probably does not grow in lowland rainforests. Its known altitudinal range is from c. 600 m a.s.l. at the type locality up to c. 1200 m a.s.l. in the Kelabit Highlands of Sarawak. As its type locality (slopes of Gunung Api in Sarawak, Malaysia) is just a few kilometres from Brunei's borders, it might potentially occur at higher altitudes in the Temburong district. It is, however, unlikely that *Epirixanthes pallida* occurs in the Tutong and Belait districts because of the generally lower terrain in these areas. Even though the type locality is on a limestone bedrock, we have observed the species in the Kelabit Highlands in Sarawak at several localities on sandstone bedrock.

***Epirixanthes confusa*** Tsukaya et al., Phytotaxa 266(2): 147 (2016).

*Global distribution.* It is endemic to Borneo (Tsukaya et al., 2016).

*Notes.* This species is a recent addition to the genus and was described from Imbak Canyon in Sabah, Malaysia (Tsukaya et al., 2016). It undoubtedly belongs to the group of species with free sepals and wide fruits which also includes *Epirixanthes elongata*, *E. pallida* and *E. compressa* Pendry, but differs by its long-persistent bracts. So far it is known only from the type locality.

***Epirixanthes compressa*** Pendry, Thai Forest Bull., Bot. 38: 184 (2010).

*Global distribution.* It is endemic to Thailand (Pendry, 2010).

*Notes.* This biogeographically remarkable species is narrowly distributed in south-eastern Thailand (Chanthaburi Province) and is, therefore, the only member of the genus which does not occur in Malesia. Like the previous species, it belongs to the group of *Epirixanthes* with free sepals and wide fruits.

### Key to the species of *Epirixanthes*

The following key is adapted from Van der Meijden (1988), Pendry (2010) and Tsukaya et al. (2016).

- 1a. Sepals free; fruit wider than long ..... 2
- 1b. Sepals connate for  $\frac{1}{4}$ – $\frac{3}{4}$ ; fruit longer than wide or equal ..... 5

- 2a. Bracts caducous before the flowers open ..... 3
- 2b. Bracts persistent at least until the fruits mature ..... 4
- 3a. Both leaves and bracts hairy with glandular hairs; inflorescence apex  $\pm$  pointed, not fully covered by bracts; bracts narrowly triangular, c. 1.2 mm long and 0.5 mm wide, brown with central purple stripe ..... *E. elongata*
- 3b. Both leaves and bracts glabrous; inflorescence apex  $\pm$  rounded, completely covered in imbricate bracts; bracts ovate, 2–3 mm long and 1–1.5 mm wide, whitish or pinkish ..... *E. pallida*
- 4a. Bracts glabrous, some of them persistent after the fruits have fallen; inflorescence elongate, 2–6 cm long; corolla caducous; endemic to Sabah ..... *E. confusa*
- 4b. Bracts minutely ciliate, all of them shed with fruits; inflorescence shortly cylindrical, up to 2.5 cm long; corolla persistent; endemic to Thailand ..... *E. compressa*
- 5a. Each flower subtended by a bract and pair of subulate bracteoles; bracts  $\pm$  patent during anthesis, linear with sharply upturned obtuse apex; fruit longer than wide, much shorter than sepals ..... *E. papuana*
- 5b. Each flower subtended only by a bract, bracteoles absent; bracts  $\pm$  erect during anthesis, with straight acute or slightly curved apex; fruit as long as wide, as long as sepals or longer ..... 6
- 6a. Bracts lanceolate, 2–2.5 mm long and 0.5–0.6 mm wide, brown with purple central stripe, usually persistent after the fruits have fallen; inflorescence apex not completely covered by bracts; fruit as long as sepals ..... *E. kinabaluensis*
- 6b. Bracts ovate, 1.5–2 mm long and 0.8–1.2 mm wide, brown with basal purple patch, usually shed with fruits; inflorescence apex completely covered by imbricate bracts; fruit longer than sepals ..... *E. cylindrica*

### Conservation status of *Epirixanthes*

The forests of Borneo, including Brunei, Sabah and Sarawak, harbour the highest diversity of *Epirixanthes*. Six species have so far been reported from this island (Van der Meijden, 1988; Coode et al., 1996; Tsukaya et al., 2016). Similar to other mycoheterotrophic plants, all species of *Epirixanthes* are closely tied to primary or very lightly logged forests and as such are threatened by continuing deforestation. However, published data on their distribution and ecology are very scarce and most of the species are poorly represented in herbaria. For these reasons, we propose that all species of *Epirixanthes* in this study be evaluated as data deficient (DD, IUCN Standards and Petitions Subcommittee, 2016) which emphasises the need for further study and sampling.

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