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New records expand the ranges of *Christisonia siamensis* and *Christisonia scortechinii*, the latter species being new to Thailand

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ABSTRACT. The range of *Christisonia siamensis* Craib, formerly thought to be restricted to Thailand, is expanded due to new records to include India and China. A detailed comparison of already-described largely white flowered species of *Christisonia* with new records of such material from Thailand reveals that Thai material is *Christisonia scortechinii* Prain: this species is, therefore, newly recorded for Thailand. A revised key to the holoparasitic Orobanchaceae of Thailand including *Christisonia scortechinii* and the newly described *Aeginetia flava* J.Parn. is provided.

KEY WORDS: *Christisonia*, *Aeginetia*, Orobanchaceae, Holoparasites, flora of Thailand, flora of Vietnam, flora of China, key to holoparasitic Orobanchaceae of Thailand.

INTRODUCTION

The Orobanchaceae was formerly considered to comprise ca 15–16 genera and 150–200 species worldwide (Parnell, 2001) but the concept of the family has now been expanded to comprise ca 90 genera and 2100 species worldwide (McNeal et al., 2013). Parnell's (2008) account of the family for Thailand, based around the old family concept, recognised that two holoparasitic genera (*Aeginetia* L. and *Christisonia* Gardner) with a total of three species occurred in the country. Since then a new species of *Aeginetia*, *A. flava* J.Parn., has been described (Parnell, 2012). Furthermore, a number of new collections and new records for the very poorly known *Christisonia siamensis* Craib have been made that considerably expand its known range and pattern of variation. Finally, material of *Christisonia* that is largely white-flowered has recently been discovered in a number of locations in Thailand and Vietnam. All this suggests that it is appropriate to gather these observations together to present an up-to-date comprehensive picture of the holoparasitic Orobanchaceae of Thailand.

Expansion of the range of *Christisonia siamensis*

At the time of Parnell's (2001) treatment only 10 collections of *Christisonia siamensis* were known, all from Thailand: the species being recorded from the Northern, North-eastern, South-western and Peninsular regions. There are still no

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records of this species from the Eastern, South-eastern and Central regions of Thailand. Further afield, Benniamin et al. (2012) have recorded *Christisonia siamensis* from Tuensang, Nagaland, India. This area is very near the border with Myanmar but confirmation of its occurrence in that country is awaited. It has also been reported from China (Yunhong, 2013).

Morphological variation in *Christisonia* in Thailand and elsewhere

The species of *Christisonia* are very difficult to identify, especially when dried. Indeed, Hooker (1885) states 'I find it impossible to determine the species from dried specimens'. Nevertheless, there are a number of morphological characters visible in dried material that appear to be critical as species determinants in *Christisonia*. These characters are: the shape of the calyx and the number of calyx teeth (if present), the shape of the stigma (peltate or bifid), the presence of stamens of two different shapes and the shape and ornamentation of any sterile anther appendages.

Parnell (2008) reports that the calyx of *Christisonia siamensis* is '3-toothed, (reportedly up to 5-toothed)'. In fact, virtually all of the material seen at that time by Parnell possessed a 3-toothed or, very rarely, a 4-toothed calyx. Images of a collection of *Christisonia siamensis* from Chumphon by David Middleton, however, are of a plant with a 2-toothed calyx. Equally, plants, found in bamboo forest and grassland, and very similar to *Christisonia siamensis* collected on 22nd August 2012 from 642 m altitude in the Central Highlands of Vietnam in Bidoup Nui Ba National Park (NP) Lam Dong Province (*Nguyen, Q.D, Nguyen, T.Q.T. & Nguyen, L.X.B. BN_PI_001, BN_PI_002, BN_PI_003, BN_PI_004, BN_PI_005, BN_PI_006, BN_PI_007, BN_PI_008, BN_PI_009*; **TCD!**, **SGN!**), and plants collected on 17th May 2006 from 1400 m growing in Banana clumps in Phu Suan Sai NP, Loei by Charun Maknoi (*C. Maknoi 925*; **TCD!**, **QBG**) clearly have a 5-toothed calyx. The colour of the corolla in these latter collections is, however, very unusual in lacking all violet pigmentation. The corolla is largely white but with an obvious yellow internal stripe running along the length of the middle of the abaxial lip and sometimes with patches of yellow on the lateral lobes at the mouth of the flower. These plants are, however, in every other morphological feature within the normal range of variation of *Christisonia siamensis*: possessing a peltate stigma and an anther appendage that is more or less conical with a tiny peg-like projection from near its end on the dorsal side. The anther appendage, therefore, somewhat resembles that of *Christisonia hookeri* C.B.Clarke ex Hook. shown in Fig. 20F of Beck von Mannagetta und Lerchenau's (1956) monograph. Additionally, the largely white flowered *Christisonia* (*Strijk 1128* from Khao Khitchakut NP, Chanthaburi; **BKF**, **TCD!**), has a distinct yellow stripe on the lower lip of the corolla, anthers with a peg, a large peltate stigma and a 4-toothed calyx with one of the teeth much shallower than the others and probably derived from splitting of one of the larger teeth (Fig. 1). Furthermore, on 18th June 2009 Bob Harwood discovered a similar white flowered *Christisonia* on Khao Soi Dao, Chanthaburi at ca 1200 m altitude having also recorded similar plants from Khao Khitchakut at 1200 m. Finally, Sukontip Sirimongkol has provided photographs of very similar plants found growing at 1655 m on Doi Phu Kha, Nan on 28th May 2014 (*Sirimongkol, S., Chamchumroon, V., Strijk, J.S. & Poopath, M. 633*; **BKF**). These latter plants are of interest as the anthers in one of the plants have distinct small purplish, discontinuous patches (Fig. 2a). It is clear that these six latter collections are very similar in perianth colour, the presence of a peg on the anther connective and the absence of a tuft of hairs at the point of attachment of the anthers. They differ only in that the material from Khao Khitchakut NP has a 4-toothed calyx whilst the materials from Bidoup Nui Ba NP, Vietnam and Phu Suan Sai NP, Thailand have a 5-toothed calyx. The combination of a four to five-toothed calyx and white corolla with a yellow stripe is highly distinctive and very different from typical material of *Christisonia siamensis*. Three of the collections of this material were made in the South-eastern region of Thailand, one from the North-eastern region and one from the Northern region. Therefore, material with this combination of characters, though rare, appears fairly widely distributed in Thailand.

There are a number of species with white flowers in *Christisonia* (*e.g.* the enigmatic Sri Lankan *Christisonia albida* Thwaites - for an

extensive discussion of the confusion surrounding the description of this species and the use of this epithet see Petch, 1924). Of these species there are two that appear, at first sight, to be of grossly similar morphology to the white flowered material mentioned above: *Christisonia hookeri* from the Himalayas and *Christisonia scortechinii* Prain from Peninsula Malaysia.

Photographs from China, labelled *Christisonia hookeri* (see: http://www.plantphoto.cn/list?latin=Christisonia%20hookeri), appear similar to the material from Vietnam and Thailand. The images of *Christisonia hookeri* differ from Vietnamese and Thai material, however, in that the corolla has a slight violet tinge on its rim, the yellow stripe/spot is fainter, the anther appendages are of a somewhat different shape, appear to lack the distinctive peg and the number of calyx teeth appears to vary (?3–5) even on the same plant. The plants in the photographs differ from the type description in that the flowers lack the distinctive base colour of the calyx (violet) and the stigma is peltate rather than unequally bilobed (Hooker, 1885; Beck von Mannagetta und Lerchenau, 1956). Supposed isosyntype material of *Christisonia hookeri* (**M** *image @ http://plants.jstor.org/specimen/m0185511?s=t*) differs from the type description in that the calyx appears 2-toothed. Hooker (1885) and Benniamin et al. (2012), however, indicate that the calyx of *Christisonia hookeri* is 5-toothed. Equally, the stigma of material in **TCD** morphologically similar to, and with the same collection information as, that in **M** is peltate rather than bilobed. Therefore, assignment of isosyntype status to the material of *Christisonia hookeri* in **M** is probably premature.

A species with white flowers, *Christisonia scortechinii*, also appears similar to the material under discussion from Vietnam and Thailand – see: http://www.parasiticplants.siu.edu/Orobanchaceae/images/Christisonia1.jpg of unknown provenance and a plant photographed by M. Poopath from Waeng District, Narathiwat (Fig. 2b). The calyx in both images is either 2- or 3- (?4-)toothed and the stigma is clearly peltate in the second image. In the image of the plant from Narathiwat the yellow mark on the lower lip of the corolla has a reddish hue, absent in the Vietnamese and Loei material under study: the hue may, however, be a photographic artifact.

Prain (1904), when describing *Christisonia scortechinii*, refers to *Scortechini 2121*, and states that his (*i.e.* Scortechini's) specimens are not good but that the calyx is spathaceous rupturing into 2 to occasionally 4 lobes and not 5-toothed or 5-lobed (see also King & Gamble, 1905) and that the stigma is peltate. Details of the structure of the stamens are, unfortunately, sketchy though the anther appendages are reported as acute (Prain, 1904; King & Gamble, 1905; Beck von Mannagetta und Lerchenau, 1956) with no mention made of a peg-like projection. Potential type material of *Christisonia scortechinii* located in **K** (K000899781) (http://apps.kew.org/herbcat/getImage.do?imageBarcode=K000899781) is of an unnumbered Scortechini collection in poor condition. Some features on the **K** material remain observable. The calyx on one flower on that sheet is certainly spathaceous splitting into two lobes/teeth, with one other flower having 3 lobes/teeth, and the stigma is always broadly peltate. Unfortunately, the specimens are damaged and it is impossible to tell what the anther appendages are like. As Prain commenced work in **K** in 1905, after describing *Christisonia scortechinii* in 1904, the Scortechini material (CAL0000025048! Image) in **CAL** (Fig. 3) where he previously worked and bearing the number 2121 is, more likely to be the material on which he based his description. This is unfortunate as whilst the material in **K** is not in good condition that in **CAL** is in a very poor state of preservation, being barely recognizable as a Christisonia. It is, however, impossible to prove that Prain did not see or use the material now in **K** when writing his description (that material could, for example, have been sent to **K** after Prain had seen it). Therefore, both the material in **K** and **CAL** should be considered for lectotypification. Given the poor state of relevant material so far found of Scortechini, Parnell believes that it would be unwise to designate either the **K** or **CAL** material as a lectotype at this point in time. Also, if either is designated as a lectotype it may prove necessary to designate an epitype: to do so now would, however, also be premature.

Though it is clear that both *Christisonia hookeri* and *C. scortechinii* are poorly understood

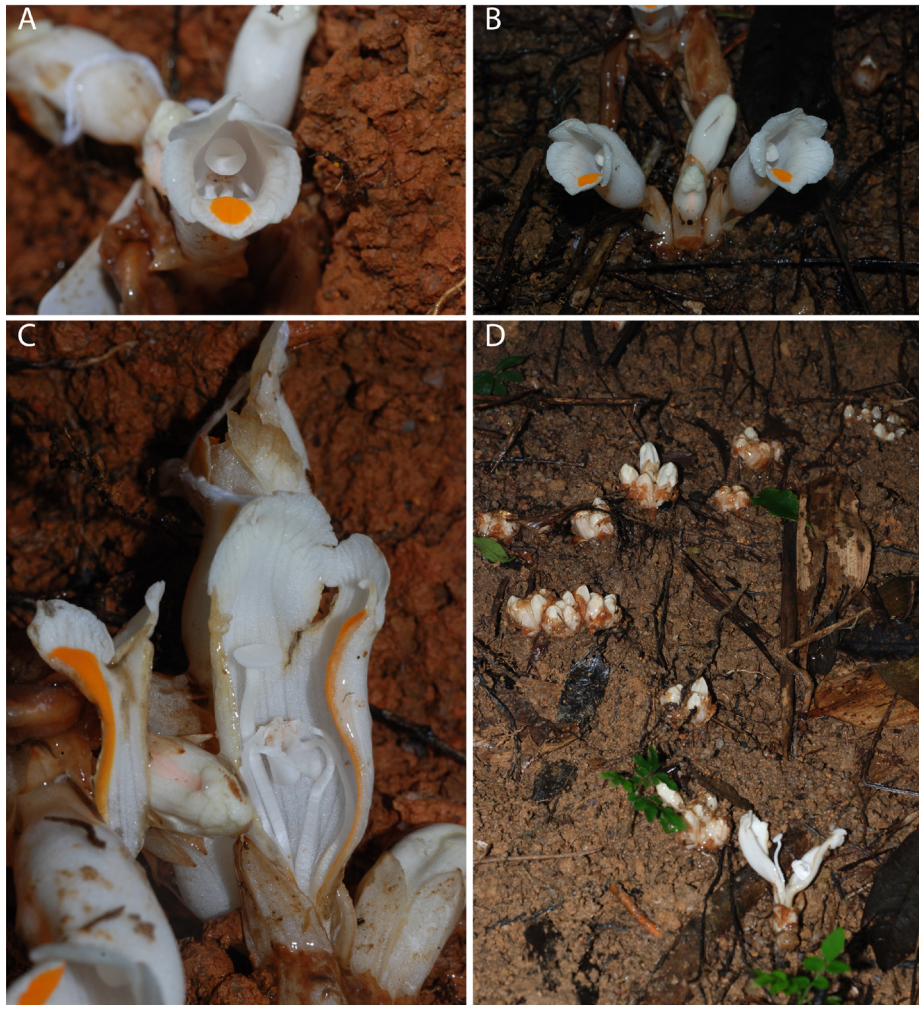

Figure 1. Plants of *Christisonia scortechinii*, *Strijk 1128* from Khao Khitchakut NP, Chanthaburi showing slime on buds and white corolla with a yellow stripe (a,b & c), close-up of dissected flower (c) and habit and habitat (d). Photographs J.S. Strijk.

Figure 2. A. Plants of *Christisonia scortechinii*. Photograph S. Sirimongkol, 28th May 2014, Doi Phu Kha, Nan; B. Plant of *Christisonia scortechinii* . Photograph M. Poopath, 2nd September 2002. Waeng District, Narathiwat. Image available at http://web3.dnp.go.th/botany/detail.aspx?words=ดอกดิน&typeword=group or

http://web3.dnp.go.th/botany/detail.aspx?wordsnamesci=Christisonia

Figure 3. Type material of *Christisonia scortechinii* Prain (CAL0000025048) in **CAL**. Reproduced with kind permission of the Director, Botanical Survey of India, India.

species native to areas outside the range of *C. siamensis*, it is also clear that *C. hookeri* differs from typical *C. siamensis* in the colour of its flowers, its 5-toothed calyx, the lack of a peg on the anther appendage and its bilobed, as opposed to peltate, stigma. *Christisonia scortechinii* differs from typical *C. siamensis* in the colour of its flowers and its spathaceous or maximally 4-lobed calyx (Table 1).

It is clear that *Christisonia siamensis* and *C. scortechinii* are morphologically very similar. It also appears that the number of calyx lobes is variable in both species. Therefore, the only diagnostic difference between these species so far detected is in the presence or absence of a peg-like projection near the end of the anther appendage. *Christisonia hookeri* with its bifid stigma and 5-toothed calyx is more obviously dissimilar to *C. siamensis* and *C. scortechinii*.

It is therefore apparent that the materials from Bidoup Nui Ba National Park, Doi Phu Kha, Phu Suan Sai NP, Khao Soi Dao and Khao Khitchakut NP and probably from Narathiwat may represent an as yet undescribed taxon similar to *Christisonia siamensis* and to *C. scortechinii* (Table 1). Given the current state of knowledge of species limits in *Christisonia* sub-specific rank within *C. siamensis* for this taxon might appear justified. Indeed when this article was first being written the first author was going to assign these materials such status. Now, however, we believe that too little is known about *Christisonia scortechinii* to be sure that these new materials are not conspecific with that species. Therefore we treat the materials mentioned above as new records forming a range extension for *Christisonia scortechinii* and we expand the upper value for calyx-tooth number in this species to 5. The available habitat information seems to indicate that *Christisonia siamensis* may occur at lower altitudes (300–800 m) than *C. scortechinii* (ca. 1200 m) and in drier mixed deciduous forests.

Christisonia scortechinii is, therefore, herein recognized as a species new to Thailand occurring in the Northern region (Doi Phu Kha, Nan), North-eastern region (Phu Suan Sai, NP, Loei), South-eastern region (Khao Soi Dao and Khao Khitchakut NP, Chanthaburi) and Peninsular region (Waeng District, Narathiwat).

Unfortunately, one side effect of our work is that the distinction between the spathaceous calyx of *Aeginetia* and the toothed calyx of *Christisonia* appears to break-down as young flowers of *C. scortechinii* have a spathaceous calyx. Given the appalling state of some of the type material of *Christisonia* and the lack of information on the morphology of many of the described species (Beck von Mannagetta und Lerchenau, 1956) the acquisition of new characters, particularly DNA sequences, is critical. These data will, along with studies of further collections of *Christisonia scortechinii* from the centre of its range, confirm the characters separating it from *C. siamensis* and confirm the status of many of the other species in this troublesome genus. Similarly, acquisition of DNA data may be useful in determining the separation of *Aeginetia* from *Christisonia*. The following keys are therefore provisional.

Table 1. Table of morphological differences between *C. siamensis*, *C. scortechinii* and *C. hookeri*.

	C. siamensis	*C. scortechinii*	*C. hookeri*
Ground colour of corolla	Lilac	White	White
Usual number of calyx teeth	3 (rarely 2 or 4)	Spathaceous or 2 (rarely 3 or 4)	5
Stigma	Peltate	Peltate	Bifid
Peg present on anther appendage	Yes	? possibly absent	No
Tuft of hairs at point of attachment of anthers	Yes	?	?

Revised keys to holoparasitic species of Thai Orobanchaceae

Given the above discoveries and descriptions it is appropriate to revise Parnell's (2008) keys to *Aeginetia* and *Christisonia* in Thailand as follows:

Revised key to genera of holoparasitic Orobanchaceae in Thailand

1. Calyx always spathaceous; emerging buds without a covering of transparent slime **1. Aeginetia**
1. Calyx sometimes spathaceous when young, becoming (2?–)3–5-toothed; emerging buds covered in transparent slime **2. Christisonia**

Revised key to *Aeginetia* in Thailand

1. Entire plant, including flowers, bright yellow **1. A. flava**
1. Entire plant, including flowers, not bright yellow, flowers usually partly purplish or reddish or rarely white
  2. Stems long (usually ≥10 cm), straight, unbranched and slender; corolla usually purplish or reddish, rarely white, middle of corolla narrowed with the lower surface ± geniculate; point of insertion of filaments hairless **2. A. indica**
  2. Stems short (usually ≤10 cm), sometimes somewhat flexuous, usually branched slender or stout; corolla with white, yellow and purple areas, somewhat curved but not geniculate; point of insertion of filaments with an obvious tuft of hairs **3. A. pedunculata**

Revised key to *Christisonia* in Thailand

1. Calyx usually 3-toothed, corolla usually largely purplish **1. C. siamensis**
1. Calyx spathaceous or (2?-)4–5-toothed; corolla usually largely white **2. C. scortechinii**

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