Dichocarpum hagiangensis - a new species and an updated checklist of Ranunculaceae in Vietnam

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ABSTRACT~~**Abstract**~~

Dichocarpum hagiangensis from Ha Giang province, northern Vietnam is described and illustrated. Diagnostic features of the new species are a short rhizomatous stem, (2–)3-foliolate or simple~~absent stem~~ leaves, and pink–purple flowers. The described species is distinct from closely allied *D. trifoliolatum* in having ~~shorter and bigger rhizomes, more leaves, longer~~

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~~petioles, retuse apex of central leaflet, dichasial inflorescences, more and bigger flowers, shorter flower stems, longer pedicels, pink purple and~~ longer sepals, shape and~~broadly~~ obcordate apex of petal limbs, ~~longer follicles,~~ shorter flower stem, number~~persistent styles, globose~~ and tooth shape of basal leaves;~~smaller seeds; and~~ differs from *D. basilare* and *D. carinatum* in having stem leaf, retuse apex and longer of central leaflet, number and (2–)3-foliated (or simple) of leaf. With supporting of molecular data, the new species was clearly distinguished from other species in the *Dichocarpum* group by 8 autapomorphic characters ~~of~~ in nrITS sequences.~~*basilare* in having longer rhizomes, usually 3-foliolate, longer petioles, longer and retuse central leaflet, smaller flower bracts, longer follicles, longer persistent styles, globose and smaller seeds.~~ A key to all species of *Dichocarpum* ~~in Vietnam~~ is provided. We suggest the IUCN conservation status of *D. hagiangensis* to be "Critically Endangered". A newest checklist of the family Ranunculaceae in Vietnam is updated.

INTRODUCTION

The flowering plant family Ranunculaceae comprises about 60 genera and 2500 species worldwide distribution but mainly in East Asia (*Tamura, 1993*; *Wang et al., 2001*). In Vietnam, Ranunculaceae has the presence of 11 genera and about 40 species (*Finet & Gagnepain, 1907*; *Gagnepain, 1938*; *Pham, 1999*; *Nguyen, 2003*).

The genus *Dichocarpum* W. T. Wang et Hsiao (1964: 323) (Ranunculaceae) includes ca. 19~~eighteen~~ species widely distributed across eastern Asia ranges from the eastern Himalayas to Japan (*Hsiao & Wang, 1964*; *Tamura & Lauener, 1968*; *Fu, 1988*; *Tao, 1989*; *Tamura, 1993*; *Tamura, 1995*; *Fu & Robinson, 2001*). Recently, plus two new species, *D. lobatipetalum* Wang & Liu (2015: 275) and *D. wuchuanense* S.Z. He (2015: 71) were described from China, the total species of the genus were increased (~~;~~ *Jiang et al., 2015; Wang & Liu, 2015*). However, a little while later, two names, *D. lobatipetalum* and *D. malipoense* were both combined with *D. hypoglaucum* Wang & Hsiao (1964: 327). At a recent time, based~~ing~~ on four DNA regions~~study~~, *Jiang et al. (2015)*, and *Xie, Yuan & Yang (2017)* ~~distanced~~excluded 18 species including *D. lobatipetalum* and *D. hypoglaucum*. A phylogenetic analysis of the remaining species and a taxonomic revision with morphological descriptions of the three complex species (*D. lobatipetalum, D. malipoense*, and *D. hypoglaucum*) should be studied. Surrounded (?) by 19 species, nine species appear in mainland China, one is found in Taiwan, one is recorded in eastern Himalayas, and eight occur in Japan (*Tamura, 1995; Fu & Robinson, 2001; Jiang et al., 2015*; *Wang & Liu, 2015*; *Xiang et al.,* ~~2017; Xie,~~ *2017*).

In Vietnam~~the country~~, some specimens of Ranunculaceae with the same label (No. 3725) ~~had~~ have been collected by P.A. Pételot since 1930 from Sa Pa town, Lào Cai province and deposited in Muséum national d'Histoire naturelle [MNHN-P-P00194832, MNHN-P-P00194833]. The specimens were first identified as *Isopyrum adiantifolium* Hook.f. & Thomson (1855: 42) (*Gagnepain, 1938*), but were later determined ~~to base~~ *I. sutchuenense* Franch (1894: 284). In 1973, *Lauener* defined these specimens as *Dichocarpum sutchuenense* (Franch.) W.T. Wang & P.K. Hsiao (1964: 328). In "Cây cỏ Việt Nam: an illustrated of flora of Vietnam", *Pham (1999)* only recorded this species (Fig. 1). After a botanical exploration in Ha Giang province in 2001,

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Phan, Averyanov & Nguyen et al., (2001) discovered *D. dalzielii* (J.R. Drumm. & Hutch.) W.T. Wang & P.K. Hsiao in a cloud forest at an elevation of about 1500 m a.s.l. (Fig. 1). In addition, in 2002, Averyanov, Loc, and Doan found an unknow *Dichocarpum* species in Van Ban district, Lao Cai province (Fig. 1). The plants had light blue-violet flowers growing on open wet granite rocks of a high waterfall at elevation 1300 m a.s.l. The specimens depositing at HN, LE, and MO should be examined (*HAL 2212*). To date, there are only two species of *Dichocarpum* recorded in Vietnam (*Pham, 1999*; *Phan, Averyanov & Nguyen, et al., 2001*). The genus is still scarcely known in the country.

During fieldwork in the Ha Giang province in northern Vietnam, in the same region of distribution of *D. dalzielii*, a small population of an unknown Ranunculaceae species was discovered. The specimens haved a short rhizomatous, unbranched stem, simple or (2–)3-foliolate leaves, 2–6-flowered inflorescence, 5 golden-yellow petals and much smaller than sepals, and carpels connate at the base. These characteristics suggested that the strange specimenspecies was a member of *Dichocarpum*. Detailed studies revealed that some characteristics of the newly collected species did not fit any of the previously reported *Dichocarpum* species described from Vietnam (*Pham, 1999*; *Phan, Averyanov & Nguyen, et al., 2001*), China, orand Japan (*Hsiao & Wang, 1964*; *Tamura & Lauener, 1968*; *Fu, 1988*; *Tao, 1989*; *Tamura, 1993*; *Tamura, 1995*; *Fu & Robinson, 2001*; *Jiang et al., 2015*; *Wang & Liu, 2015*; *Xiang et al., 2017*; *Xie, Yuan & Yang, 2017*). Furthermore, it showed substantial morphological differences from closely allied species, *D. trifoliolatum* W.T. Wang & P.K. Hsiao (1964: 324), and *D. basilare* W.T. Wang & P.K. Hsiao (1964: 325) reported from China. Thus, we describe and illustrate this plant as a new species to science.

MATERIALS & METHODSMaterials & Methods

Sample collection and morphological analysis

The *Dichocarpum* specimens were collected in natural habitat in March 2018 and June 2020.. Collection and fixing specimen procedures were followed the usual procedures for botanical specimens (*Liesner, 1995*; *Maden, 2004*). Morphological descriptions follow *Hsiao & Wang (1964)*, *Radford et al. (1974)*, *Fu (1988)*, *Tamura (1993*; *1995)*, *Fu & Robinson (2001)*, *Harris & Harris (2006).)*, The study was based on literature *Hsiao & Wang (1964)*, *Tamura & Lauener (1968)*, *Fu (1988)*, *Tao (1989)*, *Tamura (1995)*, *Fu & Robinson (2001)*, *Pham (1999)*, *Phan, Averyanov & Nguyen et al. (2001)*, *Jiang et al. (2015)*, *Wang & Liu (2015)*, *Xiang et al. (2017)*, *Xie*, *Yuan & Yang (2017)* and the analysis of specimens at HN, HNU, VNMP, SGN, VAFS, and LE, MO, P virtual herbaria (acronyms according to *Thiers (2015)*. The distribution map of *Dichocarpum* species in Vietnam was made with SimpleMappr based on literature of *Phan, Averyanov & Nguyen (2001)* and voucher specimens of LE, MO, P. Conservation analysis was performed using criteria from the International Union for the Conservation of Nature (*IUCN, 2019*). The Extent of Occurrence (EOO) and Area of Occupancy (AOO) of each speciesstatus assessments were estimated using GeoCat (*Bachman et al., 2011*).based on limited and

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~~decline population (criterion C), according to IUCN Standards and Petitions Subcommittee (2017).~~ Collection permits were issued by the ‘‘Forest Protection Department of Ha Giang province” (applied by Fauna & Flora International - Vietnam Programme, no. 12/CV-FFI).

DNA extraction and sequencing

Total DNA was extracted from dried leaves using the DNeasy Plant Minikit. The ITS region was amplified using the forward primer dichFb 5’-CCT GCT CAA GCA GAA CGA C-3’ and dichRb 5’-TTG ACA TGC TTA AAT TCA GC-3’ designed based on the ITS sequence of *Dichocarpum* spp. obtained from GenBank. The PCR protocol comprised an initial denaturation at 95°C for 3min, 35 cycles of 50s at 95°C, 40 s annealing temperature for the primer at 51°C, 50s extension at 72°C, and 10min final extension at 72°C, then 4°C until used. After purification, DNA fragments were sequenced with a BigDye Terminator Cycle Sequencing Ready Reaction kit and run on an ABI PRISM 3100 Genetic Analyzer. The sequence was deposited in Genbank under accession number MT739412. The ITS sequence of *D. hangiangensis* was aligned using Clustal X 1.64 (*Thompson et al., 1997*) with ITS sequences of other species of *Dichocarpum* and *Isopyrum manshuricum* (EF437119) used as outgroup taxa (*Xiang et al., 2017*). The distance and equally weighted maximum parsimony (MP) and maximum likelihood (ML) analyses were performed using PAUP* (4.0 beta ver.) (*Swofford, 1998*). A heuristic search procedure was used with the following settings: ten replicates of random taxon addition, tree-bisection reconnection branch swapping, multiple trees retained, no steepest descent, and accelerated transformation. Gaps were treated as missing data, and there were no indels within the alignment for the *Dichocarpum* spp. sampled. Bootstrap analysis was carried out with 100 replicates. For ML analysis, the substitution model that best fitted the data set was determined by the Akaike information criterion (AIC) with MODEL Test 3.7 (*Posada & Crandall, 1998*). Bootstrap analysis with 100 replicates was conducted to assess the degree of support for ML tree clades.

Checklist preparation

The updated checklist is prepared by reviewing all scientific names of Ranunculaceae which had recorded in Vietnam from mainly four monographs – “Flore générale de l’Indo-Chine 1” (*Finet & Gagnepain, 1907*), “Supplément a la flore générale de l’Indo-Chine 1” (*Gagnepain, 1938*), “Cây cỏ Việt Nam: An Illustrated Flora of Vietnam 1” (*Pham, 1999*), and “Checklist of Plant Species of Vietnam 2” (*Nguyen, 2003*). The most widely accepted classification system, APG4 (*Chase et al., 2016*) ~~trich dan~~ is applied for the checklist. All the scientific names were nomenclature checked according to Shenzen code of International Association for Plant Taxonomy (*Turland et al., 2018*) together with online consulted from World Flora Online, The Plant List, and International Plant Names Index websites. The invalid names and cultivation species are not recorded in the checklist.

The electronic version of this article in Portable Document Format (PDF) will represent a published work according to the International Code of Nomenclature for algae, fungi, and plants

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(ICN), and hence the new names contained in the electronic version are effectively published under that Code from the electronic edition alone. In addition, new names contained in this work which have been issued with identifiers by IPNI will eventually be made available to the Global Names Index. The IPNI LSIDs can be resolved and the associated information viewed through any standard web browser by appending the LSID contained in this publication to the prefix "http://ipni.org/". The online version of this work is archived and available from the following digital repositories: PeerJ, PubMed Central, and CLOCKSS.

RESULTS

Molecular characteristics

The length of the *Dichocarpum* + outgroup taxa ITS sequence alignment was 608 base pairs. MP analysis of this alignment indicated that among 608 characters, 101 were parsimony informative. The phylogenetic trees obtained from MP (tree length 240) and ML (DNA model = GTR+G model, Ln likelihood = - 2191.48215), had similar topology (Fig. 2). In the phylogenetic tree, *D. hagiangensis* was clustered with *Dichocarpum* group (Fig. 2) including *D. arisanense*, *D. franchetii*, *D. adiantifolium*, *D. basilare*, *D. trifoliolatum*, *D. carinatum*, *D. sutchuense*, *D. auriculatum*, *D. dalzielii* and *Dichocarpum* sp. (*Xiang et al., 2017*).
The pairwise divergence between *Dichocarpum hagiangensis* and *Dichocarpum* group ranged from 0.3 to 5.9% (Table 1). *Dichocarpum hagiangensis* was clearly distinguished from other species in the group by 8 autapomorphic characters (Supplemental Information).

Key to species of *Dichocarpum* ~~in Vietnam~~

1. Basal leaves present……..……..…… 2
2. Sepal white with purple striation; petal limb bilobed reflexed …….. *D. dicarpon*
2′. Sepal white, yellow of pink; petal not reflexed……..…..……..……..…… 3
3~~1~~. Basal leaves simple, or 1–~~Leaves (2–)~~3-foliolate ~~or simple, sepals pink purple……..*D. hagiangensis*~~……..…… 4
4. Leaflet margin 3-loped ……..……5
5. Terminal leaflet 15-20 mm long; seed smooth ……..*D. hakonense*
5′. Terminal leaflet 5-15 mm long; seed granular-roughened or dorsally slightly ridged ……..6
6. Sepal elliptic; seed 1 mm in diam., granular-roughened ……..*D. trachyspermum*
6′. Sepal narrowly ovate; seed ca. 0.75 mm in diam., dorsally slightly ridged ……..……*D. arisanense*
4′. Leaflet margin crenate or coarse teeth ……..……..…… 7
7. Central leaflet 6–14 × 3–6.5 cm, apex attenuate; sepal white …… *D. wuchuanense*

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7′. Central leaflet 3.0–4.0 × 2.4–2.8 cm, apex retuse; sepal pink purple, pinkish……..8
8. Inflorescence dichasial; flower diam. 2.0–2.3 cm; petal limp broadly obcordate ……. *D. hagiangensis*
8′. Inflorescence monochasial; flower diam. ca. 0.7 cm; petal limp flabellate ……. *D. trifoliolatum*
3′.~~1′~~ Basal leaves~~Leaves~~ 5–15-foliolate (rarely 3-foliolate in *D. basilare*)……9~~, sepals white~~ ……~~2~~
9. Leaflet apex long acuminate …… *D. hypoglaucum*
9′. Leaflet apex obtuse, rounded or retuse ……10
10. Leaflet apex retuse …… 11
11. Leaflet suborbicular to subflabellate, apically 5-toothed; flower diam. 4.2–6 mm, stamens 20–45 …… *D. franchetii*
11′. Leaflet broadly rhomboid, apically slightly lobed; flower diam. 6–10 mm, stamens 5–10 …… *D. adiantifolium*
10′. Leaflet apex obtuse, rounded ……12
12. Leaflet margin 3–5-lobulate or toothed ……13
13. Central leaflet subrhombic to rhombic-ovate …… *D. carinatum*
13′ Central~~Stem leaves present, central~~ leaflet reniform to flabellate, suborbicular-obovate
~~2~~. to flabellate-obovate ……1
~~4~~…… ~~*D. sutchuenense*~~
14. Petal limb funnelform; stamens 10 …… *D. fargesii*
14′. Petal limb suborbicular; stamens 20-45 …… *D. sutchuenense*
12′. Leaflet margin distally crenate or lobulate ……15
15. Basal~~Stem~~ leaves 11–15-foliolate ……
~~2′ absent, central leaflet rhombic~~ …… *D. dalzielii*
15′. Basal leaves 5-foliolate, rarely 3-foliolate ……16
16. Stem leaves present; follicles 11–15 mm long ……17
17. Sepal yellow, oblonga obtusa; petal limb peltate-saccate…… *D. pterigionocaudatum*
17′ Sepal white, obovate-elliptic; petal limb broadly obovate …… *D. auriculatum*
16′. Stem leaves absent; follicles 7.5–10 mm long …… *D. basilare*
1′. Basal leaves absent ……18
18. Terminal leaflets broadly ovate, retuse; sepal yellowish-white…… *D. numajirianum*
18′. Terminal leaflets cuneate-obovate or cuneate-oblong, obtuse to sub rounded, or rhomboid-ovate; sepal creamy yellow, pale greenish-yellow, or sometime with a purple hue ……19
19. Inflorescences 2–3-flowered; flowers diam. 12-15 mm; petal limb entire, reflexed …… *D. stoloniferum*
19′. Inflorescences few-more than 10-flowered; flowers diam. 7-10 mm; petal limb bilabiate, not reflexed …… *D. nipponicum*

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Species description

Dichocarpum hagiangensis **K.L. Phan & V.T. Pham, sp. nov.**
(Figs. 3, 4~~1~~ and 5~~2~~)

Type
Vietnam. Ha Giang: ~~Mun.~~ Tung Vai commune, Quan Ba district, forest on limestone mountain, 1297 m, 23°03′53″~~03°53″~~N 104°50′20″~~50°20″~~E, 19 March 2018, *Pham Van The* and *Trinh Ngoc Bon*, *TB060* (Holotype: VNM-VNM00023655;~~HNU!;~~ Isotype: HNU!) (Fig. 5).~~SGN!).~~

Paratype
Vietnam. Ha Giang: Tung Vai commune, Quan Ba district, primary evergreen broad-leaved very humid forest, 1200–1400 m, around point 23°03′42″N 104°50′42″E, 22 April 2018, *Averyanov et al., VR607* [LE-LE01049587].

Diagnosis. According molecular characters new species belong to sect. *Dichocarpum*, subsect. *Dichocarpum*. *Dichocarpum hagiangensis* is morphologically most similar to *D. trifoliolatum*, but differs in having longer sepals, shape and obcordate apex of petal limbs, shorter flower stem, number and tooth shape of basal leaves. However, *D. hagiangensis* differs from *D. basilare* and *D. carinatum* in having stem leaf, retuse apex and longer of central leaflet, number and (2–)3-foliated (or simple) of leaf. ~~***Diagnosis***~~
~~*Dichocarpum hagiangensis* is characterized by a short rhizomatous stem, absent stem leaves and pink purple flowers.~~

Description.
Perennial herb, glabrous. Rhizome stout, creeping and ascending, 4–9 cm, 0.5–0.8 cm in diam., densely scaly, unbranched; scales green-black when fresh, gray-black when dry, broadly ovate, 2–3 × 5–6 mm, apically rounded. Basal leaves~~Leaves~~, 4–6~~, basal~~, (2–)3-foliolate or sometimes simple, slightly thick, abaxially whitish green, adaxially dark green, apically toothed; abaxial veins inconspicuous, adaxial veins distinct; petiole cylindrical, 3.3–10.5 cm, 1–1.5 mm in diam.; 3-foliolate compound leaves with leaflet base cuneate, margin distally crenate, apex retuse, lateral leaflets obliquely rhombic 2.5–3.6 × 0.8–2.4 cm, petiolule 0.3-0.7 cm long, ca. 1.2 mm in diam., grooved, central leaflet rhombic-ovate 3.0–4.0 × 2.4–2.8 cm, petiolule 0.7–1.8 cm long, ca. 1.2 mm in diam., grooved; 2-foliolate compound leaves with leaflets unequal in size, lower leaflet obliquely rhombic, 3.6–5 × 1.8–3 cm, base cuneate to broadly cuneate, petiolule 0.3–0.7 cm long, 1.2–1.5 mm in diam., grooved, upper leaflet obliquely rhombic or semi-orbicular, 4–7 × 2.5–5.8 cm, base cuneate or oblique, petiolule 0.6–0.8 cm long, 1.2–2.0 mm in diam., grooved; simple leaves with leaf blade nearly orbicular, broadly ovate or broadly cuneate, 2.9–5.2 × 2.5–5.4 cm, base rounded. Stem leaves 2–3, 3-lobed or entire, smaller than basal leaves, petiole ca. 1–2 mm long and 0.5 mm in diam., winged, central leaflet ca. 2 × 2 cm, lateral leaflets and simple leave ca. 1 × 1 cm. Flowering stem cylindrical, 9.5–14.5 cm tall, ca. 1.5 mm in diam. Inflorescences dichasial, 2–6-flowered; bracts foliaceous, ~~petiole ca. 1–2 mm long and 0.5 mm in diam., winged~~opposite, rounded, ca. ~~; lower bracts 3-lobed or entire, ca. 1 × 1 cm; upper bracts simple, ca.~~ 0.4 × 0.4 cm, petiole ca. 0.5 mm.~~,~~ Flowers 2.0–2.3 cm in diam., glabrous; pedicel 1.7–9.0 cm; sepals 5, pink~~,~~ purple, elliptic to oval, 10.5–11.5 × 5.5–7.0 mm, apex obtuse; petals 5, petal limbs broadly obcordate, golden-yellow, apex obcordate, 1.2–1.4 × 1.6–1.8 mm, claw 1.8–2.3 mm long; stamens ca. 30–40, 3–4 mm; anthers broadly ellipsoid, ca. 0.8 × 0.6 mm. Ovary 2–3-carpels, free, base connate~~conate~~, narrowly oblong, ca. 5.5 × 1 mm; follicles 2–3,

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narrowly oblong, sessile, 10–14 mm long; persistent styles ca. 2 mm long. Seeds 14 or 15 (sometime up to 9 regenerate seeds), yellowish dark green, globose, ca. 0.7 mm in diam., smooth. Flowering and fruiting in March to April.

Phenology.

Flowering and fruiting were observed in March to April.

~~**Distribution**~~

~~The species is only known from Ha Giang Province of Vietnam.~~

Habitat and ecology.

The new species grows in disturbed primary evergreen forest on a limestone mountain at elevations of 1297 m, as a lithophytic herb on large wet mossy boulders and cliffs on steep slopes (Fig. 42).

Distribution and Conservation status.

Dichocarpum hagiangensis was only recorded from one small population in Ha Giang province of Vietnam (Fig. 1). ~~.~~ The existing population is facing the risk of extinction in the wild, since the area where this species is found does not belong to any protected forest. The habitat is highly disturbed by the local people for cardamom and *Lysimachia foenum-graecum* cultivations, collecting timber, firewood and non-timber forest products. The species is very rare and only known from one population of less than 50 mature individuals, in a habitat that is seriously threatened. According~~Therefore, we propose the conservation status of *D. hagiangensis* to be "Critically Endangered" (CR) under~~ IUCN Standards and Petitions Subcommittee (2019) criteria B1ab(ii) + B2ab(ii), with EOO (Extent of Occurrence) = 0 km^2 and AOO (Area of Occupancy) = 4.000 km^2, this species should be classified as ''critically endangered'' (CR~~C2a (i) (IUCN 2017~~).

Etymology.

The species epithet 'hagiangensis' refers to Ha Giang province, the only site where the species is currently known.

Remarks

Based on our molecular data and according to the phylogenetic study of *Xiang et al. (2017)*, the ~~The~~ described species belongs to *Dichocarpum* subclade of *Dichocarpum* section in clade II which clade includes two sections including *Fargesia*. The new species is closely allied to *D. trifoliolatum*, ~~and~~ *D. basilare*, and *D. carinatum* from China in habit and some morphologic characteristics, such as the present rhizome, few~~absent stem~~ leaves, ~~leaves 3-foliolate, bracts 3-lobed, and~~ central leaflet shape, or sometimes 3-flowered inflorescence. ~~.~~ However, *D. hagiangensis* ~~it~~ differs from *D. trifoliolatum* in having ~~shorter and bigger rhizomes, more leaves, longer petioles, retuse apex of central leaflet (*vs.* rounded), dichasial inflorescences, more and bigger flowers, shorter flower stems, longer pedicels, pink purple (*vs.* pinkish) and~~ longer sepals, shape and~~broadly~~ obcordate apex of petal limbs ~~(*vs.* flabellate), longer follicles~~, shorter flower stem, number~~persistent styles, globose (*vs.* ellipsoid)~~ and tooth shape of basal leaves. However, *D. hagiangensis*~~smaller seeds; and~~ differs from *D. basilare* and *D. carinatum* in~~by~~ having stem leaf, retuse apex and longer of

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central leaflet, number and (2–)3-foliated (or simple) of leaf.~~longer rhizomes, usually 3-foliolate (*vs.* 5-foliolate), longer petioles, longer and retuse (*vs.* obtuse) central leaflet, smaller flower bracts, longer follicles, longer persistent styles, globose (*vs.* subglobose) and smaller seeds.~~ A detailed comparison between *D. hagiangensis* and related species, *D. trifoliolatum*, ~~and~~ *D. basilare*, and *D. carinatum* are given in Table ~~1~~2.

Additional material examined. Vietnam. Ha Giang: Tung Vai commune, Quan Ba district, forest on limestone mountain, 1298 m, 23°03′54″N 104°50′20″E, 23 June 2020, *Chu Xuan Canh Chuong Duc Thanh, & Pham Van The, PVT1009* (VNMN!)

The updated checklist of Ranunculaceae in Vietnam

Nearly 17 years since the last publication of *Nguyen* in 2003, this newest checklist records 11 genera, 45 species and two varieties of Ranunculaceae in Vietnam according to *APG4 classification system (2016)*. Of which, one variety of *Aconitum*, one species of *Actaea*, four species of *Anemone*, 18 species and one variety of *Clematis*, one species of *Consolida*, three species of *Coptis*, two species of *Delphinium*, two species of *Dichocarpum*, four species of *Naravelia*, eight species of *Ranunculus*, and two species of *Thalictrum*. Although four species *Naravelia dasyoneura* Korth., *N. laurifolia* Wall. ex Hook.f. & Thomson, *N. siamensis* Craib, and *Ranunculus blumei* Steud. are recorded in the checklist but their taxonomic revision is recommended.

Each species or variety in the checklist is provided with an accepted scientific name, followed~~follows~~ by origin publication, and literature~~references in parentheses~~ or other names and literature which were recorded~~bracket symbols~~ for Vietnam~~purpose of name tracking~~.

Aconitum carmichaelii var. ***truppelianum*** (Ulbr.) W.T. Wang & P.K.Hsiao, *in* Fl. Reipubl. Popul. Sin. 27: 268 1979; Pham, An Illust. Fl. Vietnam 1: 325 1999. - *A. fortunei* Hemsl., J. Linn. Soc., Bot. 23: 20 1886; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 16 1938; Nguyen, Checkl. Pl. Spec. Vietnam 2: 154 2003.

Actaea cordifolia DC., Syst. Nat. 1: 383 1817. - *Cimicifuga racemosa* var. *cordifolia* (DC.) A.Gray, Syn. Fl. N. Amer. 1(1): 55 1895; Pham, An Illust. Fl. Vietnam 1: 324 1999.

Anemone chapaensis Gagnep., Bull. Soc. Bot. France 76: 315 1929; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 11 1938; Pham, An Illust. Fl. Vietnam 1: 320 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 154 2003.

Anemone poilanei Gagnep., Bull. Soc. Bot. France 76: 315 1929; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 11 1938; Pham, An Illust. Fl. Vietnam 1: 321 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 155 2003.

Anemone rivularis Buch.-Ham. ex DC., Syst. Nat. 1: 211 1817; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 9 1938; Pham, An Illust. Fl. Vietnam 1: 321 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 155 2003.

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Anemone sumatrana de Vriese, Pl. Jungh. 76 1851; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 9 1938; Pham, An Illust. Fl. Vietnam 1: 321 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 155 2003.

Clematis armandii Franch. Nouv. Arch. Mus. Hist. Nat. II, 8: 184 1885; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 3 1907; Pham, An Illust. Fl. Vietnam 1: 315 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 155 2003.

Clematis brevicaudata DC., Syst. Nat. 1: 138 1817; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 4 1938; Pham, An Illust. Fl. Vietnam 1: 318 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 155 2003.

Clematis buchananiana DC., Syst. Nat. 1: 140 1817. - *Clematis bucamara* Buch.-Ham. ex DC., Syst. Nat. 1: 140 1817; Pham, An Illust. Fl. Vietnam 1: 316 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 155 2003.

Clematis cadmia Buch.-Ham. ex Hook.f. & Thomson, Fl. Brit. India 1: 2 1872; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 7 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 6 1938; Pham, An Illust. Fl. Vietnam 1: 316 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 156 2003.

Clematis chinensis Osbeck, Dagb. Ostind. Resa 205 1757; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 5 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 6 1938; Pham, An Illust. Fl. Vietnam 1: 316 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 156 2003.

Clematis fasciculiflora Franch., Pl. Delavay. 5 1889; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 3 1938; Pham, An Illust. Fl. Vietnam 1: 316 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 156 2003.

Clematis florida Thunb., Syst. Veg. ed. 14 512 1784. - *Anemone japonica* Houtt., Nat. Hist. 2(9): 191 1778; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 8 1938; Pham, An Illust. Fl. Vietnam 1: 321 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 154 2003.

Clematis fulvicoma Rehder & E.H.Wilson, Pl. Wilson. 1: 327 1913; Pham, An Illust. Fl. Vietnam 1: 316 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 156 2003.

Clematis gialaiensis Serov, Bot. Zhurn. (Moscow & Leningrad) 79(7): 106 1994; Pham, An Illust. Fl. Vietnam 1: 319 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 156 2003.

Clematis gouriana Roxb. ex DC., Syst. Nat. 1: 138 1817; Pham, An Illust. Fl. Vietnam 1: 319 1999. - *Clematis vitalba* var. *gouriana* (Roxb. ex DC.) Finet & Gagnep., Bull. Soc. Bot. France 50: 532 1903; Pham, An Illust. Fl. Vietnam 1: 319 1999.

Clematis hagiangensis N.T. Do, Acta Phytotax. Sin. 44: 595 2006.

Clematis henryi Oliv., Hooker's Icon. Pl. 19: t. 1819 1889; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 6 1938; Pham, An Illust. Fl. Vietnam 1: 316 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 157 2003.

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Clematis leschenaultiana DC., Syst. Nat. 1: 151 1817; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 6 1907; Pham, An Illust. Fl. Vietnam 1: 315 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 157 2003.

Clematis loureiroana DC. Syst. Nat. 1: 144 1817; Pham, An Illust. Fl. Vietnam 1: 316 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 157 2003.

Clematis meyeniana var. ***granulata*** Finet & Gagnep., Bull. Soc. Bot. France 50: 530 1903; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 4 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 3 1938; Pham, An Illust. Fl. Vietnam 1: 316 1999. - *Clematis granulata* (Finet & Gagnep.) Ohwi; Acta Phytotax. Geobot. 6: 147 1937; Pham, An Illust. Fl. Vietnam 1: 316 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 156 2003.

Clematis smilacifolia Wall., Asiat. Res. 13: 402 1820; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 3 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 3 1938; Pham, An Illust. Fl. Vietnam 1: 318 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 157 2003. - *Clematis petelotii* Gagnep., Notul. Syst. (Paris) 15: 36 1955; Pham, An Illust. Fl. Vietnam 1: 318 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 157 2003. - *Clematis subpeltata* Wall., Pl. Asiat. Rar. 1: 19 1829; Pham, An Illust. Fl. Vietnam 1: 318 1999.

Clematis subumbellata Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 39(2): 61 1870. - *Clematis umbellifera* Gagnep., Bull. Soc. Bot. France 82: 477 1935 publ. 1936; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 4 1938; Pham, An Illust. Fl. Vietnam 1: 319 1999

Clematis uncinata Champ. ex Benth., Hooker's J. Bot. Kew Gard. Misc. 3: 255 1851; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 2 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 3 1938; Pham, An Illust. Fl. Vietnam 1: 319 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 157 2003.

Clematis vietnamensis W.T.Wang & N.T.Do, Acta Phytotax. Sin. 44: 680 2006.

Consolida ajacis (L.) Schur, Verh. Mitth. Siebenbürg. Vereins Naturwiss. Hermannstadt 4(3): 47 1853. - *Delphinium ajacis* L., Sp. Pl. 531 1753; Pham, An Illust. Fl. Vietnam 1: 324 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 159 2003.

Coptis chinensis Franch., J. Bot. (Morot) 11: 231 1897; Pham, An Illust. Fl. Vietnam 1: 325 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 158 2003.

Coptis quinquesecta W.T.Wang, Acta Phytotax. Sin. 6: 219 1957; Nguyen, Checkl. Pl. Spec. Vietnam 2: 158 2003.

Coptis teeta Wall., Trans. Med. Soc. Calcutta 8: 87 1836; Pham, An Illust. Fl. Vietnam 1: 325 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 158 2003.

Delphinium ambiguum L., Sp. Pl. ed. 2 749 1762. - *Delphinium nanum* DC., Syst. Nat. 1: 349 1817; Pham, An Illust. Fl. Vietnam 1: 325 1999.

Delphinium anthriscifolium Hance, J. Bot. 6: 207 1868; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 14 1938; Pham, An Illust. Fl. Vietnam 1: 324 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 157 2003.

Formatiert ...

Dichocarpum dalzielii (J.R.Drumm. & Hutch.) W.T.Wang & P.K.Hsiao, Acta Phytotax. Sin. 9: 327 1964; *Phan, Averyanov & Nguyen, ~~et al.~~ 2001.*

Dichocarpum sutchuenense (Franch.) W.T.Wang & P.K.Hsiao, Acta Phytotax. Sin. 9: 328 1964. Pham, An Illust. Fl. Vietnam 1: 324 1999.

Naravelia dasyoneura Korth., Ned. Kruidk. Arch. 1: 208 1848; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 8 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 7 1938; Pham, An Illust. Fl. Vietnam 1: 319 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 159 2003.

Naravelia laurifolia Wall. ex Hook.f. & Thomson, Fl. Ind. 1: 3 1855; Pham, An Illust. Fl. Vietnam 1: 320 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 159 2003.

Naravelia siamensis Craib, Bull. Misc. Inform. Kew 1915: 419 1915; Pham, An Illust. Fl. Vietnam 1: 320 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 160 2003.

Naravelia zeylanica (L.) DC. Syst. Nat. 1: 167 1818; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 8 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 7 1938; Pham, An Illust. Fl. Vietnam 1: 320 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 160 2003. - *Atragene zeylanica* L., Sp. Pl. 542 1753; Pham, An Illust. Fl. Vietnam 1: 320 1999.

Ranunculus blumei Steud., Nomencl. Bot. ed. 2, 2: 432 1841; Pham, An Illust. Fl. Vietnam 1: 322 1999.

Ranunculus cantoniensis DC., Prodr. 1: 43 1824; Pham, An Illust. Fl. Vietnam 1: 322 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 160 2003.

Ranunculus diffusus DC., Prodr. 1: 38 1824; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 12 1938; Pham, An Illust. Fl. Vietnam 1: 323 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 160 2003.

Ranunculus japonicus Langsd. ex DC., Prodr. [A. P. de Candolle] 1: 38 1824; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 10 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 12 1938.

Ranunculus pensylvanicus L. f., Suppl. Pl. 272 1781; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 10 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 13 1938; Pham, An Illust. Fl. Vietnam 1: 323 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 160 2003.

Ranunculus sceleratus L., Sp. Pl. 551 1753.; Finet & Gagnepain, Flore générale de l'Indo-Chine 1: 11 1907; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 13 1938; Pham, An Illust. Fl. Vietnam 1: 323 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 161 2003.

Ranunculus silerifolius H. Lév., Repert. Spec. Nov. Regni Veg. 7(146–148): 257 1909; Pham, An Illust. Fl. Vietnam 1: 323 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 161 2003.

Ranunculus sundaicus (Backer) H.Eichler, Biblioth. Bot. 124: 94 1958; Pham, An Illust. Fl. Vietnam 1: 323 1999.

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Thalictrum foliolosum DC., Syst. Nat. 1: 175 1817; Pham, An Illust. Fl. Vietnam 1: 322 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 161 2003.

Thalictrum ichangense Lecoy. ex Oliv., Hooker's Icon. Pl. 18(3): pl. 1765 1888; Gagnepain, Supplément a la Flore générale de l'Indo-Chine 1: 7 1938; Pham, An Illust. Fl. Vietnam 1: 322 1999; Nguyen, Checkl. Pl. Spec. Vietnam 2: 161 2003.

DISCUSSION

According to a recent report, *Dichocarpum* species usually have potential value for pharmacy (*Hao, 2018*), therefore this research could open a chance for medicinal herb studying. Besides, the new species was found in the forest of limestone mountain where some ~~has recorded some~~ new and interesting plant species ~~for science and the flora of Vietnam~~ were recorded in recent years such as *Paraboea villosa* (Gesneriaceae), *Loropetalum flavum* (Hamamelidaceae), Magnolias, or Orchids (*Tu et al., 2015*; *Averyanov et al., 2018*; *2019*; *2020*). Also, ~~a~~ Vietnam's second-largest population of Critically Endangered Tonkin Snub-nosed Monkey (*Rhinopithecus avunculus*) with about 15–21 individuals has~~ve~~ been recorded in this area (*MOST & VAST, 2007*; *Le, 2010*; *Schwitzer et al., 2015*; *Nguyen et al., 2016*; *Quyet et al., 2020*). Despite the high value of biodiversity, the natural forest is strongly impacted by large-scale deforestation for the cultivation of Tsao-ko Cardamom (*Amomum tsao-ko*) and Ling Xiang Cao (*Lysimachia foenum-graecum*) (*Le, 2010*). For this reason, this study could give additional scientific value for the provincial manager's decision for planning protection of this forest as the establishment of a "Species and Habitat Conservation Area" and application of community-based forest conservation for long-term sustainable biodiversity conservation.

~~On the other hand, this study was impacted by COVID-19 when the authors tried to collect fresh samples from the wild for molecular analysis at the social distancing happening, and slowly transportation of kit DNA extraction, kit PCR, kit sequence. This information may be useful for researchers who study on the effect of the coronavirus to science.~~

CONCLUSION

~~This paper will be an impressive study for *Dichocarpum* taxonomy since there were very few new species of the genus discovered in the last twenty years.~~ With this discovery, a total of ca. 20 species of the genus *Dichocarpum* ~~has found in the world~~are known, and three species are recorded for Vietnam. ~~The key to species of all *Dichocarpum* species is the newest and easy for identification.~~ On the other hand, the checklist of the Ranunculaceae of Vietnam is a good reference for oversea researchers while limited international language literature from the country. In contrast, the species from Lao Cai province with label no. *HAL 2212* (HN, LE, MO) is needed to recollect to determine exactly species name.

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REFERENCES

Averyanov LV, Endress PK, Nguyen KS, Thai TH, Maisak TV, Averyanova AL, & Diep LN. 2018. *Loropetalum flavum* (Hamamelidaceae), a new species from northern Vietnam. *Phytotaxa* **385(2)**: 94–100. https://doi.org/10.11646/phytotaxa.385.2.5

Averyanov LV, Nguyen VC, Nguyen KS, Maisak TV, & Truong BV. 2019. New orchids (Orchidaceae) in the flora of Vietnam I. Epidendroideae. *Taiwania* **64(2)**: 176–188. https://doi.org/10.6165/tai.2019.64.176.

Averyanov LV, Xu WB, Nguyen KS, & Maisak TV. 2020. *Paraboea villosa* (Gesneriaceae), a new species from Northern Vietnam. *Taiwania* **65(1)**: 33–36. https://doi.org/10.6165/tai.2020.65.33

Bachman S, Moat J, Hill A, de la Torre J, Scott B. 2011. Supporting Red List threat assessments with GeoCAT: Geospatial conservation assessment tool. *ZooKeys* **150:** 117–126. https://doi.org/10.3897/zookeys.150.2109.

Chase MW, ~~M. W.,~~ Christenhusz MJM, ~~M. J. M.,~~ Fay MF, ~~M. F.,~~ Byng JW, ~~J. W.,~~ Judd WS, ~~W. S.,~~ Soltis DE, ~~D. E.,~~ ... & Stevens PF. ~~P. F. (~~2016~~).~~ An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* ~~,~~ **181(1)**: ~~).~~ 1–20.

Finet EA, Gagnepain F. 1907. Ranunculaceae. In: Lecomte H ed. *Flore générale de l'Indo-Chine 1*. Paris: Masson et Cie, 1–11.

Fu DZ, Robinson OR. 2001. *Dichocarpum* W.T. Wang & P.K. Hsiao. In: Wu ZY, Raven PH, eds. *Flora of China 6*. Science Press, Beijing & Missouri Botanical Garden Press, St. Louis, 302–305.

Fu D.Z. 1988. A study on *Dichocarpum* (Ranunculaceae). *Acta Phytotaconomica Sinica* **26**: 249–264.

Gagnepain F. 1938. Ranunculaceae. *Supplément a la Flore générale de l'Indo-Chine 1*. Paris: Masson et Cie, 2–17.

Hao DC. 2018. *Ranunculales medicinal plants: Biodiversity, chemodiversity and pharmacotherapy*. Elsevier, 1–404. doi:10.1016/C2017-0-01185-0

Harris JG, Harris MW. 2006. *Plant identification terminology: an illustrated glossary*. Spring Lake, Utah: Spring Lake Publishing, 1–216.

Hsiao PK, Wang WT. 1964. A new genus of Ranunculaceae—*Dichocarpum* W.T. Wang et Hsiao. *Acta Phytotaconomica Sinica* **9**: 315–334.

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IUCN Standards and Petitions Subcommittee. 20192017. Guidelines for Using the IUCN Red List Categories and Criteria, Version 13. Prepared by the Standards and Petitions Subcommittee. *Available at https://www.iucnredlist.org/resources/redlistguidelines* (accessed on 18 February 2019).

Jiang WE, Ding L, Zhou T, He SZ, Li YC, Huang L.Q. 2015. A new species of *Dichocarpum* (Ranunculaceae) from Guizhou, China. *Phytotaxa* **227**: 66–74. DOI 10.11646/phytotaxa.227.1.7.

Le TD. 2010. *Report on the survey of Tonkin snub-nosed Rhinophyllum avunculus in the Tung Vai-Ta Van-Cao Ma Po area of Quan Ba district, Ha Giang province*. Technical Report, FFI-Vietnam, Hanoi, Vietnam.

Liesner R. 1995. Field techniques used by Missouri Botanical Garden. *Available at http://www.mobot.org/MOBOT/molib/fieldtechbook/pdf/handbook.pdf* (accessed on 26 March 2020).

Maden K. 2004. Plant collection and herbarium techniques. Our Nature **2(1)**: 53–57.

MOST & VAST. 2007. *Vietnamese Red Data Book, Part 2: Plant*. Sci. Tech. Publishing House, Hanoi, Vietnam, 0–611.

Nguyen TB. 2003. *Ranunculaceae*. In: Nguyen TB, ed. *Checklist of Plant Species of Vietnam 2*. Hanoi: Agric. Publ. House, 155–161.

Nguyen VT, Pham CL, & Le TD. 2016. *Preliminary report on the survey of Tonkin Snub-nosed Monkeys (Rhinopithecus avunculus) in Tung Vai, Ta Van, Cao Ma Bo, Quan Ba district, Ha Giang province*. Technical Report, FFI-Vietnam, Hanoi, Vietnam.

~~**Liesner R. 1995.** Field techniques used by Missouri Botanical Garden.~~

Pham HH. 1999. *Ranunculaceae*. In: Pham HH, ed. *Cây cỏ Việt Nam: An Illustrated Flora of Vietnam 1*. Ho Chi Minh: Tre Publishing House, 315–325.

Phan KL, Averyanov LV, Nguyen TH. 2001. Some new records of the family Ranunculaceae Juss. from Vietnam. *Selected works on ecological and Bio-Resources studies 1996-2000*. Hanoi: Agriculture Publishing House, 79–83.

Posada D, Crandall KA. 1998. Modeltest: testing the model of DNA substitution. *Bioinformatics Applications note* **14**: 817–818.

Quyet LK, Rawson BM, Duc H, Nadler T, Covert H, & Ang A. 2020. *Rhinopithecus avunculus*. The IUCN Red List of Threatened Species 2020: e.T19594A17944213. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T19594A17944213.en. Downloaded on 21 July 2020.

Radford AE, Dickison WC, Massey JR, Bell CR. 1974. *Vascular Plant Systematics*. New York: Harper & Row Publishers.

Schwitzer C, Mittermeier RA, Rylands AB, Chiozza F, Williamson E.A, Wallis J, & Cotton A, (eds.). 2015. *Primates in Peril: The World's 25 Most Endangered Primates 2014-2016*. IUCN SSC Primate Specialist Group (PSG), International Primatological Society (IPS), Conservation International (CI), and Bristol Zoological Society, Arlington, VA, iv+1–93.

Swofford DL. 1998. *PAUP* Phylogenetic analysis using parsimony*. Version 4. Sinauer, Sunderland, MA, 1–128.

Tamura M, Lauener LA. 1968. A revision of *Isopyrum*, *Dichocarpum* and their allies. *Notes from the Royal Botanic Garden, Edinburgh* **28**: 267–273.

Tamura M. 1993. *Ranunculaceae*. In: *Flowering Plants Dicotyledons*. Berlin: Springer, Heidelberg, 563–583

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Tamura M. 1995. *Dichocarpum*. In: Hiepko P, ed. *Die natürlichen Pflanzenfamilien 17a IV*. Berlin: Duncker and Humblot, 468–473.

Tao DD. 1989. A new species of *Dichocarpum* from Yunnan, China. *Acta Phytotaxonomica et Geobotanica* **40(5-6)**: 179–180.

Thi N. 2006. *Clematis hagiangensis* NT Do, a new species of Ranunculaceae from Vietnam. *Acta Phytotaxonomica Sinica* **44(5)**: 595–597.

Thiers B. 2015. *Index herbariorum: a global directory of public herbaria and associated staff*. New York: New York Botanical Garden. *Available at http://sweetgum.nybg.org/science/ih/* (accessed on 10 February 2019).

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The ClustalX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* **24**: 4876–4882.

Tu BN, Nguyen QH, & Nguyen TH. 2015. *Five new records of Magnolia Juss. for the flora of Vietnam*. In*: Proceedings of the 6th National Conference on Ecology and Biological Resources*. Sci. Tech. Publishing House, Hanoi, Vietnam, 243–248.

Turland NJ, Wiersema JH, Barrie FR, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Kusber W-H, Li D-Z, Marhold K, May TW, McNeill J, Monro AM, Prado J, Price MJ, Smith GF (eds.). 2018. *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017*. Regnum Vegetabile 159. Glashütten: Koeltz Botanical Books. DOI 10.12705/Code.2018.

~~**Wang WT. 2006.** A revision of *Clematis* sect. *Naraveliopsis* (Ranunculaceae). *Acta Phytotaxonomica Sinica* **44(6)**: 670–699.~~

Wang WT, Fu DZ, Li LQ, Bruce B, Anthony RB, Bryan ED, Michael GG, Yuichi K, Orbélia RR, Tamura M, Michael JW, Zhu GH, Svetlana NZ. 2001. *Ranunculaceae*. In: Wu ZY, Raven PH, eds. *Flora of China 6*. Science Press, Beijing & Missouri Botanical Garden Press, St. Louis, 133–438.

Wang WT, Liu B. 2015. *Dichocarpum lobatipetalum*, a new species of Ranunculaceae from Yunnan, China. *Plant Diversity and Resources* **37**: 275–277.

Wang WT. 2006. A revision of *Clematis* sect. *Naraveliopsis* (Ranunculaceae). *Acta Phytotaxonomica Sinica* **44(6)**: 670–699.

Xiang KL, Zhao L, Erst AS, Yu SX, Jabbour F, Wang W. 2017. A molecular phylogeny of *Dichocarpum* (Ranunculaceae): Implications for eastern Asian biogeography. *Molecular phylogenetics and evolution* **107**: 594–604 DOI 10.1016/j.ympev.2016.12.026.

Xie SN, Yuan Q, Yang QE. 2017. *Dichocarpum lobatipetalum* and *D. malipoense* (Ranunculaceae) are both merged with *D. hypoglaucum*. *Phytotaxa* **298(2)**: 181–186 DOI 10.11646/phytotaxa.298.2.8.

Table 1. Pairwise distance between taxa in *Dichocarpum hagiangensis* and closely *Dichocarpum* species (below diagonal: total character differences, above diagonal: mean character differences adjusted for missing data).

	Species	1	2	3	4	5	6	7	8	9	10	11
1	*D. hangiangensis*	-	4,9	5,4	5,3	5,9	5,8	5,7	5,2	4,4	5,2	5,4

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2	*D. dalzielii*	29	-	3,7	3,7	4,1	4,1	5,2	4,6	1,5	2,7	3,4
3	*D. basilare*	32	22	-	0,3	2,5	2,4	3,7	3,1	3,2	2,9	2,2
4	*D. trifoliolatum*	31	22	2	-	2,5	2,4	3,7	3,1	3,2	2,9	2,2
5	*D. adiantifolium*	35	24	15	15	-	2,5	4,1	3,4	3,6	3,2	2,7
6	*D. carinatum*	34	24	14	14	15	-	4,4	3,7	3,6	3,4	2,5
7	*D. arisanense*	34	31	22	22	24	26	-	0,7	4,7	4,7	4,1
8	*D. franchetii*	31	27	18	18	20	22	4	-	4,1	4,1	3,4
9	*D. auriculatum*	26	9	19	19	21	21	28	24	-	2,2	3,1
10	*D. sutchuenense*	31	16	17	17	19	20	28	24	13	-	3,1
11	*Dichocarpum* sp.	32	20	13	13	16	15	24	20	18	18	-

Table 2: Comparison of diagnostic features of *Dichocarpum hagiangensis* with *D. trifoliolatum*, *D. basilare*, and *D. carinatum*

Characteristic	*D. hagiangensis*	*D. trifoliolatum*	*D. basilare*	*D. carinatum*
Rhizome				
Length (cm)	4–9	16	1	8–10
Diameter (cm)	0.5–0.8	0.4	0.6	0.5–0.6
Leaf				
Number	4–6	3	3–5	2
Foliated	(2–)3 or simple	3 or simple	(3–)5	12–15
Petiole length (cm)	3.3–10.5	6.2–8.3	2–4.7	to 12
Basal leaf				
Central leaflet size (cm)	3.0–4.0 × 2.4–2.8	3.7–4.3 × 2.3–2.8	1.2–2.7 × 0.8–2.8	1.8–2.8 × 0.9–2
Central leaflet apex	retuse	rounded	obtuse	obtuse
Leaflet marin	distally crenate	distally crenate	distally crenate	3-lobed
Stem leaf present	yes	no	no	no
Inflorescence				
Type	dichasial	monochasial	–	–
Flowered	2–6	3	3–5	3–5
Flowering stem height (cm)	9.5–14.5	23–25	6–19	–
Pedicel length (cm)	1.7–9.0	0.4–1.7	–	–
Sepal				
Color	pink purple	pinkish	white	pinkish
Length (mm)	10.5–11.5	3.5	–	–
Petal limb				
Shape	broadly obcordate	flabellate	–	–
Length (mm)	1.2–1.4	2.5	–	–
Apex	obcordate	retuse	–	–
Stamen				
Number	30–40	–	–	–
Length (mm)	3–4	3.5	–	–

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Follicle				
Length (mm)	10–14	8–10	7.5–10	–
Persistent styles length (mm)	2	2.5	1.5	–
Seed				
Shape	globose	ellipsoid	subglobose	subglobose
Diam. (mm)	0.7	2.5	1.5	1

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