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New or Noteworthy Plant Collections from Myanmar (3) *Caldesia parnassifolia*, *Nechamandra alternifolia*, *Potamogeton maackianus* and *P. octandrus*

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In the course of floristic research of Myanmar, some noteworthy aquatic monocots; *Caldesia parnassifolia* (Bassi ex L.) Parl. (*Alismataceae*), *Nechamandra alternifolia* (Roxb. ex Wight) Thwaites (*Hydrocharitaceae*), *Potamogeton maackianus* A. Benn. and *P. octandrus* Poir. (*Potamogetonaceae*) were collected. Of these, *C. parnassifolia*, *P. maackianus*, and *P. octandrus* are new to the flora of Myanmar and *N. alternifolia* has been re-collected after a long period. To compare them with other regional materials, chromosome count for *N. alternifolia* and chloroplast DNA sequencing for all but *P. octandrus* were conducted.

Key words: *Caldesia*, Flora, Myanmar, *Nechamandra*, *Potamogeton.*

With its wealth of plant diversity, Myanmar (Burma) constitutes a significant component of the Indo-Myanmar hotspot in terms of both land area and biodiversity (Dijk et al. 2004). Although ca. 11,800 species of spermatophyte have been reported from Myanmar (Kress et al. 2003), many more are likely to exist (Tanaka 2005). Recently, several new species, new records and noteworthy plant collections have been reported (Tanaka et al. 2006a, 2006b, 2007, 2009, Tanaka and Nagamasu 2006). In the course of ongoing inventory work in Myanmar we recognized four new or noteworthy species of aquatic monocots based on morphological characters, chromosome numbers and chloroplast DNA sequences. The importance and characteristics of these four aquatic species are noted below.

Materials and Methods

Materials of *Caldesia parnassifolia* (Bassi ex L.) Parl. (*Alismataceae*), *Nechamandra alternifolia* (Roxb. ex Wight) Thwaites (*Hydrocharitaceae*), *Potamogeton maackianus* A. Benn. and *P. octandrus* Poir. (*Potamogetonaceae*) were collected on expeditions in 2005 and 2008. The first set of the voucher specimens was retained in Tanaing Office, Forest Department, Ministry of Forestry, Union of Myanmar. The duplicates are deposited in the herbaria of Makino Botanical Garden (MBK) and the University of Tokyo (TI). Identifications were based on their morphological characters and, if available, chromosome numbers and chloroplast DNA sequences.

Table 1. Nucleotide sequence variation (substitutions) in the *matK* region of chloroplast DNA in *Caldesia*

Taxon	Accession number	Locality	*matK* (730 bp) *	
			420	728
C. parnassifolia	AB506767*	Myanmar	A	A
C. parnassifolia	EF088140	Austria	A	—
C. oligococca	AY952427	China?	G	G

* Sequence obtained in this study.

Chromosome observation of *Nechamandra alternifolia* was performed using the procedure of Ito et al. (submitted).

The chloroplast DNA sequences of *matK* from *C. parnassifolia*, *rbcL* from *N. alternifolia*, *rbcL*, *trnT-trnL*, *trnL* intron, and *trnL-trnF* from *P. maackianus* were obtained using the procedure of Ito et al. (submitted). Each target region was amplified by polymerase chain reaction (PCR) using the following primer pairs: *rbcL* Z1 (Wolf et al. 1994) and *rbcL* 1379R (Little and Barrington 2003) for *rbcL* of *C. parnassifolia* and *P. maackianus*; *rbcL* Z1 and rbcL 636R (P. G. Wolf, http://bioweb.usu.edu/wolf/rbcL%20primer%20map.htm) for *rbcL* intron of *N. alternifolia*; RM_749F (Ito et al. submitted) and 8R (Ooi et al. 1995) for *matK* of *C. parnassifolia*; a and b (Taberlet et al. 1991) for *trnT-trnL* of *P. maackianus*; c and d (Taberlet et al. 1991) for *trnL* intron of *P. maackianus*; e and f (Taberlet et al. 1991) for *trnL-trnF* of *P. maackianus*. Sequences determined in the present study were registered with the DNA Data Bank of Japan (DDBJ), which is linked to GenBank, and their accession numbers are given below (Tables 1, 2, 3).

To understand the geographic range of each species, the following literatures was investigated: Sugawara 1937, Hartog 1957, Hara and Williams 1978, Cuong and Vidal 1983, Leach and Osborne 1985, Chen 1992, Guo and Li 1992, Sun and Wang 1992, Kadono 1994, Rae and Long 1994, Philcox 1995, Cook 1996, Choi 2000, Kahina 2000, Timokhina 2000, Yang 2000a, 2000b, Guseev 2001, Hayens 2001a, 2001b, Tzvelev 2001, Matzenko 2002, Wiegleb 2002.

Results and Discussion

ALISMATACEAE

Caldesia parnassifolia (Bassi ex L.) Parl. in Fl. Ital. **3**: 599 (1860).

Voucher specimen: MYANMAR. Shan State: Inya Lake, north of Pyndaya, 20˚59′57″N, 96˚39′59″E, in deep lake, 1 Dec. 2008, N. Tanaka & al. 080624 (MBK, TI).

Distribution: Russia, Japan, China, Taiwan, Indonesia, East Timor, Vietnam, Thailand, Myanmar, Bangladesh, India, Nepal; Europe and Africa.

The genus *Caldesia* is reported from Myanmar for the first time. In *Caldesia*, four species are recognized in the world (Cook 1996). Although the plants collected in this study lack inflorescences, they are identified as *C. parnassifolia* (Bassi ex L.) Parl. based on their leaf characters: ovate leaf blade, deeply cordate leaf base, and nerves ascending ±60 degree to the veiw. In *matK*, the sequence of *C. parnassifolia* collected in this study is the same as that of *C. parnassifolia* from Austria although there are some missing data for the Austrarian specimen (728) and slightly differ from that of *C. oligococca* (F. Muell.) Buchenau (Table 1). This species is widely distributed in the northern hemisphere and some part of southern hemisphere as well.

HYDROCHARITACEAE

Nechamandra alternifolia (Roxb. ex Wight) Thwaites in Enum. Pl. Zeyl.: 332 (1864). [Fig. 1]

Voucher specimens: MYANMAR. Shan State: Near Yae Aye Kan Dam, Yae Aye Kan,

Table 2. Nucleotide sequence variation (substitutions) in the *rbcL* region of chloroplast DNA in *Nechamandra* and *Vallisneria*

Taxon	Accession number	Locality	*rbcL* (606bp)																						
			6	24	48	51	69	70	94	96	102	111	189	234	242	252	347	367	432	435	525	534	547	558	561	585
N. alternifolia	AB506768*	Myanmar	A	A	T	G	G	A	G	G	G	G	A	G	T	G	G	C	A	C	T	G	C	G	G	T
N. alternifolia	U80706	India	A	A	G	G	T	A	A	G	A	G	A	G	T	G	G	C	G	C	T	G	T	G	T	C
V. americana	U03726	U.S.A.?	A	G	G	T	T	G	G	C	G	A	G	G	C	A	T	C	A	C	C	A	C	A	T	C
V. asiatica	AB004898	Japan	G	A	G	T	T	A	G	C	G	A	G	A	C	A	G	C	A	C	C	A	C	A	T	C
V. rubra	EF143004**	Australia	—	—	G	T	T	A	G	C	G	A	G	G	C	A	G	C	A	C	C	A	C	A	T	C
V. spiralis	EF694963	Africa	G	A	G	T	T	A	G	C	G	A	G	G	C	A	G	T	A	T	C	A	C	A	T	C
V. spiralis	U80712	India?	G	A	G	T	T	A	G	C	G	A	G	G	C	A	G	T	A	T	C	A	C	A	T	C
V. sp.	DQ859177	Unknown	G	A	G	T	T	A	G	C	G	A	G	G	C	A	G	T	A	T	C	A	C	A	T	C
V. sp.	AF206832	U.S.A.?	A	G	G	T	T	G	G	C	G	A	G	G	C	A	T	C	A	C	C	A	C	A	T	C

* Sequence obtained in this study.

** Deposited as *Maidenia rubra*.

Table 3. Nucleotide sequence variation (substitutions, indels and mononucleotide repeats) in the *rbcL* and *trnT-trnF* regions of chloroplast DNA in *Potamogeton maackianus*

Accession number				Locality	*trnT-trnL* *** (891–898bp)									*trnL* intron (593bp)	*trnL-trnF* *** (408–409bp)	
rbcL **	*trnT-trnL*	*trnL*-intron	*trnL-trnF*		167	281	353	374	431	468–478	541–547	855	860	303	60	261–262
AB506769 *				Myanmar												
AB196944				Japan												
	AB506770*	AB506771*	AB506772*	Myanmar	T	G	A	T	T	T (10)	TAGTAGA	A	A	A	C	T (8)
	EF471044	EF428377	EF432067	China	T	G	A	T	T	T (10)	TAGTAGA	G	–	G	C	T (9)
	EF471066	EF428401	EF432091	China	C	G	A	C	C	T (11)	——	A	A	A	T	T (8)
	AB120550			Japan	T	G	A	T	T	T (10)	TAGTAGA	A	A			
	AB120551			Japan	T	A	G	T	T	T (11)	TAGTAGA	A	A			

* Sequences obtained in this study.

** No sequence variation in *rbcL* region.

*** Mononucleotide repeats (poly-T) are indicated as combination of nucleotide and its number of repeat. Deletions are indicated as "—".

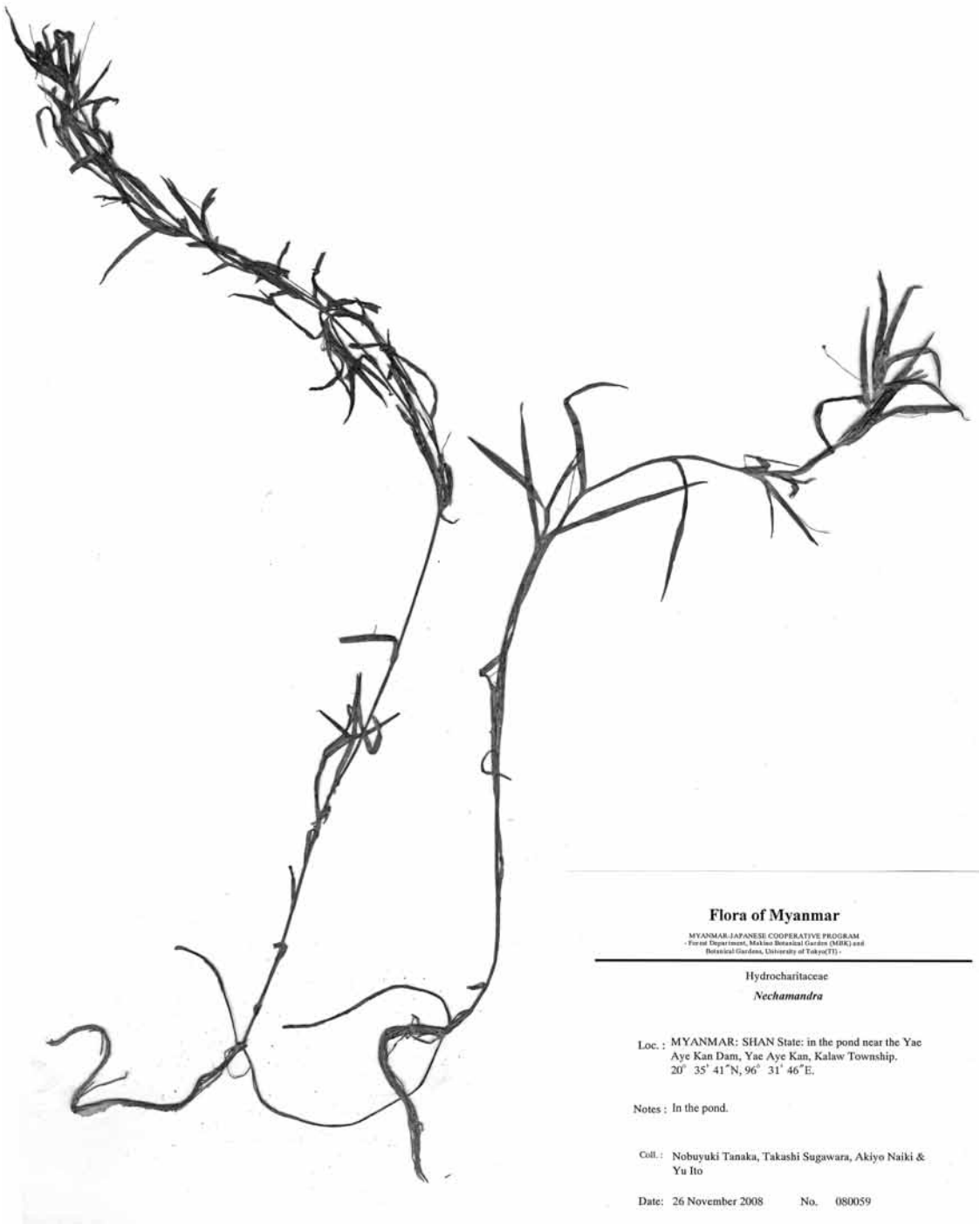

Fig. 1. Voucher specimen of Nechamandra alternifolia (female).

Fig. 2. Somatic chromosome of *Nechamandra alternifolia*. Scale bar = 10 μm.

Kalaw Township, 20°35′37″N, 96°31′46″E, in shallow pond, 0.5 m in depth. 26 Nov. 2008, N. Tanaka & al. 080058 (MBK, TI); Shan State: Inya Lake, north of Pyndaya, 20°59′57″N, 96°39′59″E, in deep lake, 1 Dec. 2008, N. Tanaka & al. 080635 (MBK, TI).

Distribution: China, Vietnam, Myanmar, Bangladesh, Sri Lanka, India, Nepal, Yemen and Sudan.

Chromosome number: 2n = 16 (Fig. 2; sex unknown).

The monotypic genus *Nechamandra* is distinguished from the related genus *Vallisneria* by the sessile (or very nearly so) female spathe, filiform hypanthium, narrowly conical to ovoid mature fruit, and horizontally borne stamens (Cook and Luond 1982). It has already been reported from Myanmar in the list of Kress et al. (2003), but no collections were deposited in major herbaria of the world as far as we investigated. Although both female and male individuals coexisted at one of two sites, mature fruits have not been found. The chromosome number of the material from one of two sites in Myanmar was revealed as 2n = 16, which is the same as those of previous studies (Fig. 2; Cook and Luond 1982). In *rbcL*, the sequences of *N. alternifolia* in this study and that in India were recognized to be differentiated from the sister genus *Vallisneria* including *Maidenia* (Les et al. 1997, Les et al. 2008) in nine substitutions

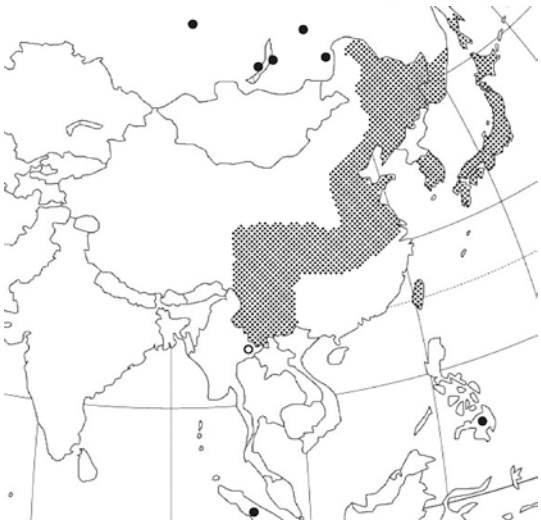

Fig. 4. Distribution of *Potamogeton maackianus*. Dotted area and solid circles are based upon several floras mentioned in the text. New locality is indicated with open circle.

Fig. 3. Distribution of *Nechamandra alternifolia*. Solid circles are based on Cook and Luond (1982) and several floras mentioned in the text. New locality is indicated with open circle.

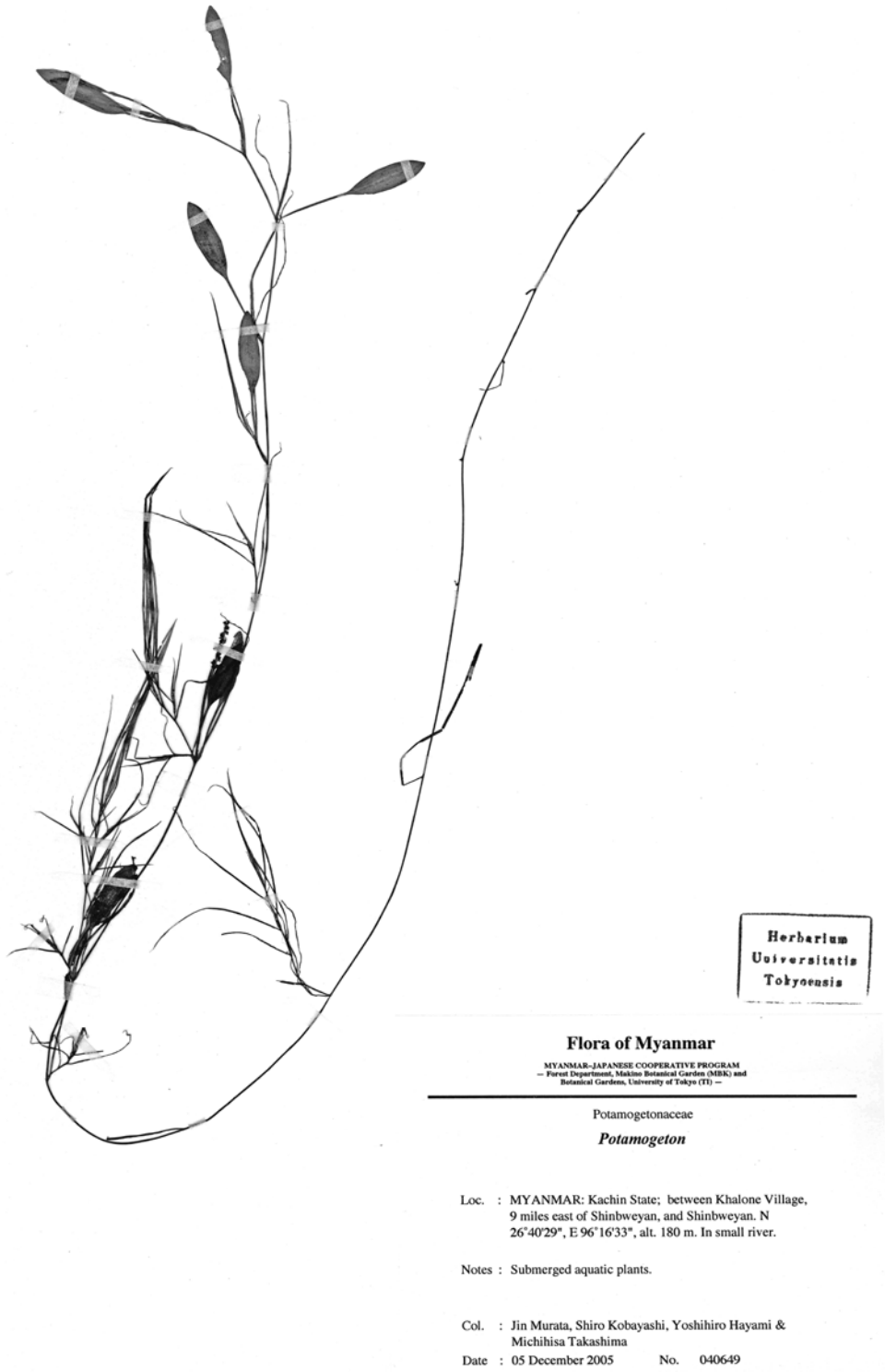

Fig. 5. Voucher specimen of *Potamogeton octandrus*.

(Table. 2). The main distribution range of this species is restricted to India and its adjacent areas, but few specimens were collected in Africa (Fig. 3; Cook and Luond 1982).

POTAMOGETONACEAE

Potamogeton maackianus A. Benn. in J. Bot. **42**: 74 (1904).

Voucher specimen: MYANMAR. Shan State: Yae Aye Kan Dam, Yae Aye Kan, Kalaw Township, 20˚35′37″N, 96˚31′46″E, in deep dam, up to 3 m in depth. 26 Nov. 2008, N. Tanaka & al. 080052 (MBK, TI).

Distribution: Russian Far East, Korea, Japan, China, Taiwan, Indonesia, Philippines, and Myanmar. (India was included in Fl. Malesiana, but the original literature has not been found).

Potamogeton maackianus was collected for the first time in Myanmar in our expedition during November–December 2008. Although the plants collected in this study had no reproductive organ, they were easily identified as *P. maackianus* by the leaf characters, especially denticulate margin of the leaves (Wiegleb and Kaplan 1998). All four regions of the DNA sequences of *P. maackianus* collected in this study are similar to those of Japanese and Chinese *P. maackianus* (Table 3). It is widely distributed in East Asia and the collection site of this study was located on the southeastern edge of the species' continental distribution range except two isolated localities in Indonesia and the Philippines (Fig. 4). Further investigation in south east Asia would be needed to reveal more detailed geographic distribution.

Potamogeton octandrus Poiret in Lamarck, Encycl. Meth. Bot., Suppl. **4**: 534 (1816).[Fig. 5]

Voucher specimen: MYANMAR. Kachin State: between Khalone Village, 9 miles east of Shinbweyan, and Shinbweyan, 26˚40′29″N, 96˚16′33″E, alt. 180 m, in small river. 5 Dec. 2005, J. Murata & al. 040649 (MBK, TI).

Distribution: Russian Far East, Mongolia, Korea, Japan, China, Taiwan, Indonesia, Papua New Guinea (as *P. javanicus* Hassk.), Vietnam, Myanmar, India, Bhutan, Nepal, Pakistan; Australia and Africa.

Potamogeton octandrus without mature fruits is easily confused with *P. cristatus* Regel & Maack, but the sparsely placed flowers of the present specimen indicate that it is most likely to be *P. octandrus* (Kadono 1994, Wiegleb 2002). Similar *Potamogeton* species, *P. pusillus* and *P. trichoides*, were listed in Kress et al. (2003), but it is easy to distinguish in the type of turion and whether or not floating leaves are present (Wiegleb and Kaplan 1998). This species is widely distributed in Asia, Australia and Africa.

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伊藤　優[a]，大井・東馬哲雄[a]，田中伸幸[b]，邑田　仁[a]：

ミャンマー植物についての新知見 (3)

日華区系の西端としての南ヒマラヤの植物多様性を解析する一連の研究で，いくつかの新産種を結果の一部として報告した（Tanaka et al. 2006a, 2006b, 2007, 2009, Tanaka and Nagamasu 2006）．その後，現在までに採集された水生植物標本を検討した結果，以下のような新知見が得られた．

(1) ミャンマー新産となるマルバオモダカ属 *Caldesia* を北東部シャン州にて採集した．生殖器官をつけた標本が得られていないものの，葉が縦長であること，主脈に対する側脈の角度が ±60° であることから，マルバオモダカ *C. parnassifolia* であると考えられる．

(2) ミャンマー北東部シャン州にて採集した *Nechamandra alternifolia* について染色体観察を行ったところ，インドからの報告と同じ 2n = 16 であることが明らかとなった．本種は，Kress et al. (2003) にリストアップされているものの，ミャンマーから採集された確実な標本記録は，本調査が初めてとなる．なお，採集地では雌株と雄株が混生する集団で採集を行ったが，成熟果実をつけた標本は得られなかった．

(3) 主にアジア温帯域に分布するセンニンモ *Potamogeton maackianus* が，ミャンマー北東部シャン州にも生育することが明らかとなった．ミャンマーは，分布の西南限であると考えられる．

(4) ミャンマー北部カチン州で採集した異形葉を付けるヒルムシロ属植物は，果実をつけた標本が得られていないものの，花が疎らにつく様子からホソバミズヒキモ *P. octandrus* であると考えられる．ミャンマー新産である．

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