Taxonomic paper

Chromosome studies in the aquatic monocots of Myanmar: A brief review with additional records

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Abstract

Myanmar (Burma) constitutes a significant component of the Indo-Myanmar biodiversity hotspot, with elements of the Indian, the Indochina, and the Sino-Japanese floristic regions, yet thus far only a few reliable sources of the country's flora have been available. As a part of a contribution for the floristic inventory of Myanmar, since it is important in a floristic survey to obtain as much information as possible, in addition to previous two reports, here we present three more chromosome counts in the aquatic monocots of Myanmar: Limnocharis flava with 2n = 20, Sagittaria trifolia with 2n = 22 (Alismataceae), and Potamogeton distinctus × P. nodosus with 2n = 52 (Potamogetonaceae); the third one is new to science. A brief review of cytological researches in the floristic regions' 45 non-hybrid aquatic monocots plus well investigated two inter-specific hybrids that are recorded in Myanmar is given, indicating that the further works with a focus on species in Myanmar that has infra-specific chromosome variation in the floristic regions will address the precise evolutionary history of the aquatic flora of Myanmar.

Keywords

Aquatic plants, chromosome counts, Limnocharis, Myanmar, Potamogeton, Sagittaria

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Introduction

With its wealth of plant diversity, Myanmar (Burma) constitutes a significant component of the Indo-Myanmar biodiversity hotspot with elements of the India, the Indochina, and the Sino-Japanese floristic regions (ca, 13,500 vascular plants: Van Dijk et al. 2004; Tanaka 2010). Yet, while neighboring countries’ floristic diversity has been exposed through international projects, such as Flora of China, Flore du Cambodge, du Laos et du Vietnam, and Flora of Thailand, thus far no reliable sources of Myanmar’s flora have been published except a checklist of spermatophytes contributed by Kress et al. (2003). In order to revise the flora of Myanmar, a decade-long continuous inventory has been conducted by Japanese botanists (Tanaka 2005), which thus far partly contributed a local checklist (Mt. Popa: Tanaka et al. 2006) and a taxon-specific checklist (aquatic plants: Ito and Barfod 2014).

The aim of floristic research is not only to count the total number of species but also to evaluate the native flora’s evolutionary origins by comparing with related floristic regions. From this aspect, it is useful to obtain as much information as possible, e.g., chromosome data (Sanders et al. 1983). This is especially important for floristic surveys for aquatic plants, in which infra- or inter-specific chromosome variation is widely known (Les and Philbrick 1993). The proportion of species for which the chromosome number is known is less than 1% in some little-collected tropical areas (Stace 2000), probably including the southeast Asian country of Myanmar.

Aquatic plants, which is polyphyletically evolved in fern and fern allies, basal angiosperms, monocots, and eudicots, is known as having numerous chromosomal variation, thus an excellent model for this aim. Here, in addition to the previous contributions of chromosome counts for new or noteworthy aquatic plants from Myanmar (Najas tenuis: Ito et al. 2014b; Nechamandra alternifolia: Ito et al. 2009), we present three more chromosome counts for the aquatic monocots of Myanmar: Limnocharis flava (Alismataceae), Sagittaria trifolia (Alismataceae), and Potamogeton distinctus × P. nodosus (Potamogetonaceae). A brief review of cytological researches in 45 non-hybrid aquatic monocots plus two well-investigated inter-specific Potamogeton hybrids in Myanmar is also given with a broad focus on those distributed in neighboring areas, i.e., the Indian, the Indochina, and the Sino-Japanese floristic regions.

Materials and methods

Chromosome observation

Plant materials of Limnocharis flava (Alismataceae), Sagittaria trifolia (Alismataceae), Najas tenuis (Hydrocharitaceae), Nechamandra alternifolia (Hydrocharitaceae), and Potamogeton distinctus × P. nodosus (Potamogetonaceae) were collected in the expeditions to Myanmar (Bago Division and Shan State) in 2008. The collections were rigorously identified based on morphological characters using the original protologues as
well as a previous taxonomic treatment by Cook (1996). *Potamogeton distinctus × P. nodosus* (Potamogetonaceae) was identified by DNA barcoding method (Ito et al. 2014a). The first set of the voucher specimens was retained in Forest Department Office, Ministry of Environmental Conservation and Forestry, Union of Myanmar (RAF); the duplicates are deposited in two Japanese herbaria: Makino Botanical Garden (MBK) and the University of Tokyo (TI).

Root tips collected in the field were pretreated with 0.002 M 8-hydroxyquinoline at 4 °C in 12 h, and fixed with freshly mixed Carnoy’s fixative (3: 1 ethyl alcohol: acetic acid) for at least 30 min, and then preserved at 4 °C in 12 h. For microscopic observation, root tips were soaked in 1 N HCl for 1 h followed by 10 min at 60 °C. After being immersed in tap water, the materials were stained in a drop of 1.5% orcein acetate solution on a slide glass in 5 min., and then squashed. Then somatic chromosome numbers of the three taxa were obtained by light microscopic examination. For each species, at least two cells were used to confirm the numbers.

Distribution for each species follows Ito and Barfod (2014).

**Literature review**

Chromosome researches for aquatic monocots of Myanmar were reviewed with a broad focus on Myanmar and related floristic regions, i.e., the Indian, the Indochina, and the Sino-Japanes floristic regions. The focal species include 45 non-hybrid aquatic monocots listed in Ito and Barfod (2014), Ito et al. (2014a) as well as well-investigated two inter-specific *Potamogeton* hybrids (Ito et al. 2014a). Initial literature search was carried out with Fedorov (1969) as well as Index to Plant Chromosome Numbers (Missouri Botanical Garden, [http://mobot.mobot.org/W3T/Search/ipcn.html](http://mobot.mobot.org/W3T/Search/ipcn.html)), followed by extensive literature review with original references. For some species, mostly cosmopolitan ones, only a few representative literature references are given for each chromosome number. Since a comprehensive cytological review was given for aquatic plants (Les and Philbrick 1993), including almost all the taxa listed in the present study, our literature review focused on literature published in 1993 or later. Due to incapability of original references, some rare chromosome counts are not included; those references are mostly published in 1970 or earlier, and written not in English. No detailed references are given for Potamogetonaceae and *Ruppia* because an exhaustive cytological review was published by Kaplan et al. (2013), Talavera et al. (1993).
Chromosome counts for the aquatic monocots of Myanmar

Order Alismatales

Family Alismataceae

Genus *Limnocharis* Bonpl., 1808

*Limnocharis flava* (L.) Buchenau, 1868

Material

a. country: Myanmar; stateProvince: Bago; municipality: Pyat Township; locality: along the roadside, paddy field, ca. 30 km east of Pyat; verbatimLatitude: 18°49'44"N; verbatimLongitude: 95°18'06"E; eventDate: 7 Dec 2008; recordedBy: Y. Ito; collectionID: N. Tanaka & al. 080776; institutionCode: MBK, RAF, TI

Distribution: Native to Americas; naturalized to tropical Asia.

Notes: Chromosome counts: 2n = 20 (Fig. 1; obtained in this study).

![Figure 1.](image)

Somatic chromosome of *Limnocharis flava*. Bar indicates 5 μm.
Genus *Sagittaria* L., 1753

*Sagittaria trifolia* L., 1753

Material

a. country: *Myanmar*; stateProvince: *Shan*; verbatimLocality: *Pindaya*; verbatimLatitude: 20°59’57”N; verbatimLongitude: 96°39’59”E; eventDate: 1 Dec 2008; recordedBy: Y. Ito; collectionID: N. Tanaka & al. 080623

Distribution: Bangladesh, Bhutan, China (nationwide), India (nationwide), Indonesia (Borneo, Java, Sulawesi), Japan, Malaysia (Peninsular), Myanmar, Nepal, Pakistan, Philippines, Thailand; Oceania.

Notes: Chromosome counts: 2n = 22 (Fig. 2; obtained in this study).

![Figure 2.](image)

Somatic chromosome of *Sagittaria trifolia*. Bar indicates 5 μm.
Family Hydrocharitaceae

Genus *Najas* L., 1753

*Najas tenuis* Magnus, 1870

Material

a. country: Myanmar; stateProvince: Shan; verbatimLocality: Inlay Lake, Nyaung Shwe Township; verbatimLatitude: 20°32'02"N; verbatimLongitude: 96°53'53"E; eventDate: 3 Dec 2008; recordedBy: Y. Ito; collectionID: N. Tanaka & al. 080642; institutionCode: MBK, RAF, TI

Distribution: India (Central, Southern), Myanmar, Sri Lanka.

Notes: Chromosome counts: 2n = 24 (Fig. 3; After Ito et al. 2014b; reproduced with publisher's permission).

Figure 3.
Somatic chromosome of *Najas tenuis*. Bar indicates 5 μm.
Genus *Nechamandra* Planch., 1849

*Nechamandra alternifolia* (Roxb.) Thwaites, 1864

**Material**

a. country: Myanmar; stateProvince: Shan; verbatimLocality: Near Yae Aye Kan Dam, Yae Aye Kan, Kalaw Township; verbatimLatitude: 20°35'37"N; verbatimLongitude: 96°31'46"E; eventDate: 26 Nov 2008; recordedBy: Y. Ito; collectionID: N. Tanaka & al. 080058; institutionCode: MBK, RAF, TI

**Distribution:** Bangladesh, China (Southern), India (Eastern, Northern, Southern), Myanmar, Nepal, Sri Lanka, Thailand, Vietnam; Yemen, and Sudan.

**Notes:** Chromosome counts: 2n = 16 (Fig. 4; After Ito et al. 2009; reproduced with publisher's permission).

Figure 4. Somatic chromosome of *Nechamandra alternifolia*. Bar indicates 5 μm.

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Family Potamogetonaceae

Genus *Potamogeton* L., 1753

*Potamogeton distinctus* A. Benn. × *P. nodosus* Poir.

**Material**

a. country: Myanmar; stateProvince: Shan; verbatimLocality: Inle Lake; verbatimLatitude: 20°27'28"N; verbatimLongitude: 96°50'37"E; eventDate: 4 Dec 2008; recordedBy: Y. Ito; collectionID: N. Tanaka & al. 080662; institutionCode: MBK, RAF, TI
Notes: Chromosome counts: 2n = 52 (Fig. 5; obtained in this study). The chromosome count for this taxon is new to science.

![Somatic chromosome of *Potamogeton distinctus* × *P. nodosus.* Bar indicates 2.5 μm.](image)

**Analysis**

The chromosome counts given for 45 non-hybrid species of aquatic monocots of Myanmar as well as well-investigated two *Potamogeton* hybrids among them were reviewed with a focus on infra-specific chromosome variation (Table 1). The cited literature references also include chromosome counts obtained from related floristic regions, i.e., the Indian, the Indochina, and the Sino-Japanese floristic regions. For widespread species, cytological information from other regions is cited.
Table 1.
The chromosome counts given for 45 non-hybrid species of aquatic monocots of Myanmar as well as well-investigated two *Potamogeton* hybrids among them. Those recorded from neighboring regions are also provided. The species that have no chromosome counts anywhere in the world are shown with n/a. For some species, mostly cosmopolitan ones, only a few representative literature references are given for each chromosome number. Note that due to incapability of original references, some rare chromosome counts are not included in this table: 2n = 18, 42, 48 for *Acorus calamus*; 2n = 18, 22 for *Acorus gramineus* (Acoraceae), 2n = 28 for *Pistia stratiotes* var. cuneata Engl.; 2n = 28 for *Pistia* stratiotes var. spathulata (Michx.) Engl.; 2n = 20, 50, 60, 80 for *Lemma aequinoctialis*; 2n = 44 for *Lemma trisulca*; 2n = 30, 50 for *Spirodea polyrrhiza* (Araceae); n = 14 (2n = 28), 2n = 10, 12 for *Alisma plantago-aquatica*; 2n = 22 for *Caldesia pannassifolia*; 2n = 26, 39 for *Limnocharis flava*; 2n = 22 for *Sagittaria trifolia* var. longiloba (Turr.) Mak.; 2n = 22 for *Sagittaria trifolia* var. sinensis Sims; 2n = 22 for *Sagittaria trifolia* var. edulis (Sieb.) Ohwi (Alismataceae); 2n = 24 for *Blyxa auberti*; 2n = 60 for *Najas marina*; 2n = 12+1B for *Najas marina* var. intermedia (Gorski) A. Braun; 2n = 22, 52, 72, 88, 132 for *Ottelia alismoides*; 2n = 16, 22, 28, 33 for *Vallisneria spiralis* (Hydrocharitaceae); 2n = 64 for *Eichhornia crassipes*; 2n = 26, n = 40 (2n = 80) for *Monochoria vaginalis* (Pontederiaceae); 2n = 60 for *Typha angustifolia* (Typhaceae). Also refer to previous cytological reviews (aquatic plants: Les and Philbrick 1993; Potamogetonaceae: Kaplan et al. 2013; *Ruppia*: Talavera et al. 1993).

| Order      | Family       | Species                        | Chromosome number | Floristic region            | Others                  |
|------------|--------------|--------------------------------|-------------------|-----------------------------|-------------------------|
| Acorales   | Acoraceae    | *Acorus calamus* L.            | 2n = 24           | Subramanian and Munian (1988) | Chepinoga et al. (2008) |
| Acorales   | Acoraceae    | *Acorus calamus* L.            | 2n = 35           |                             | Krahulcová (2003)       |
| Acorales   | Acoraceae    | *Acorus calamus* L.            | 2n = 36           |                             | Packer and Ringius (1984) |
| Acorales   | Acoraceae    | *Acorus calamus* L.            | 2n = 44           |                             | Wang et al. (2001)       |
| Acorales   | Acoraceae    | *Acorus calamus* L.            | 2n = 45           | Ramachandran (1978)         |                         |
| Acorales   | Acoraceae    | *Acorus calamus* L.            | 2n = 66           |                             | Wang et al. (2001)       |
| Acorales   | Acoraceae    | *Acorus gramineus* Sol. ex Aiton | 2n = 24          |                             | Wang et al. (2001)       |
| Acorales   | Araceae      | *Cryptocoryne crispatula* Engl. | 2n = 36           | Arends et al. (1982)        |                         |
| Acorales   | Araceae      | *Cryptocoryne crispatula* Engl. | 2n = 54           | Jacobsen (1977)             |                         |
| Acorales   | Araceae      | *Cryptocoryne cruciadasiana* Prain | n/a              |                             |                         |
| Acorales   | Araceae      | *Pistia stratiotes* L.         | 2n = 28           | Ramachandran (1978), Subramanian and Munian (1988) |                         |
| Kingdom       | Class           | Genus             | Species               | Chromosome Numbers | Authors            |
|--------------|-----------------|-------------------|-----------------------|--------------------|-------------------|
| Acorales     | Araceae         | Landoltia         | punctata (G. Mey.) Les & D.J. Crawford | n/a                |                   |
| Acorales     | Araceae         | Lemna             | equinocalis          | 2n = 40            | Urbanska-Worytkiewicz (1975) (L. perpusilla Torr.) |
| Acorales     | Araceae         | Lemna             | trisulca L.          | 2n = 20            | Urbanska-Worytkiewicz (1975) |
| Acorales     | Araceae         | Lemna             | trisulca L.          | 2n = 40            | Urbanska-Worytkiewicz (1975) |
| Acorales     | Araceae         | Lemna             | trisulca L.          | 2n = 60            | Urbanska-Worytkiewicz (1975); Löve and Löve (1981) |
| Acorales     | Araceae         | Lemna             | trisulca L.          | 2n = 80            | Urbanska-Worytkiewicz (1975) |
| Acorales     | Araceae         | Spirodela         | polyrrhiza (L.) Schleid. | 2n = 40            | Löve and Löve (1981), Al-Bermani et al. (1993) |
| Acorales     | Araceae         | Spirodela         | polyrrhiza (L.) Schleid. | 2n = 42            | Chepinoga et al. (2008) |
| Acorales     | Araceae         | Spirodela         | polyrrhiza (L.) Schleid. | 2n = 80            | Geber and Schweizer (1988) |
| Acorales     | Araceae         | Wolffia           | globosa (Roxb.) Hartog & Plas | n/a                |                   |
| Alismatales  | Alismataceae    | Alisma            | plantago-aquatica L. | 2n = 14            | Mehra and Pandita (1984) |
| Alismatales  | Alismataceae    | Caldesia          | pammassifolia (Bassi ex L.) Parl. | n/a                |                   |
| Alismatales  | Alismataceae    | Limnocharis       | flava (L.) Buchenau  | 2n = 20            | This study |
| Alismatales  | Alismataceae    | Sagittaria        | trifolia L.          | 2n = 22            | This study |
| Alismatales  | Hydrocharitaceae| Blyxa             | auberti Rich.        | 2n = 40            | Uchiyama (1989) |
| Alismatales  | Hydrocharitaceae| Blyxa             | echinosperma (C.B. Clarke) Hook. f. | 2n = 42            | Wang (1986) |
| Alismatales  | Hydrocharitaceae| Blyxa             | echinosperma (C.B. Clarke) Hook. f. | 2n = 74            | Uchiyama (1989) |
| Alismatales | Hydrocharitaceae | Species | ploidy | Authors |
|-------------|------------------|---------|--------|---------|
| Alismatales | Hydrocharitaceae | *Blyxa japonica* (Miq.) Maxim. ex Asch. & Güra | 2n = 42 | Harada (1956) |
| Alismatales | Hydrocharitaceae | *Blyxa japonica* (Miq.) Maxim. ex Asch. & Güra | 2n = 72 | Uchiyama (1989) |
| Alismatales | Hydrocharitaceae | *Egeria densa* (Planch.) Casp. | 2n = 46 | Uchiyama (1989), Nakata and Nagai (1998) |
| Alismatales | Hydrocharitaceae | *Egeria densa* (Planch.) Casp. | 2n = 48 | Löve and Löve (1961) |
| Alismatales | Hydrocharitaceae | *Elodea nuttallii* (Planch.) H. St. John | 2n = 48 | Simpson (1986) |
| Alismatales | Hydrocharitaceae | *Hydrilla verticillata* (L. f.) Royle | 2n = 16 | Chaudhuri and Sharma (1978), Pandita and Mehra (1984), Wang (1986), Uchiyama (1989), Langeland et al. (1992) |
| Alismatales | Hydrocharitaceae | *Hydrilla verticillata* (L. f.) Royle | 2n = 24 | Chaudhuri and Sharma (1978), Langeland et al. (1992), Langeland et al. (1992) |
| Alismatales | Hydrocharitaceae | *Hydrilla verticillata* (L. f.) Royle | 2n = 32 | Langeland et al. (1992), Langeland et al. (1992) |
| Alismatales | Hydrocharitaceae | *Hydrocharis dubia* (Blume) Backer | 2n = 16 | Pandita and Mehra (1984), Uchiyama (1989) |
| Alismatales | Hydrocharitaceae | *Najas graminea* Delile | 2n = 12 | You et al. (1991) |
| Alismatales | Hydrocharitaceae | *Najas graminea* Delile | 2n = 24 | Wang (1985), Uchiyama (1989) |
| Alismatales | Hydrocharitaceae | *Najas graminea* Delile | 2n = 36 | Uchiyama (1989) |
| Alismatales | Hydrocharitaceae | *Najas indica* (Wild.) Cham. | n/a | |
| Alismatales | Hydrocharitaceae | *Najas marina* L. | 2n = 12 | Wang (1985), Uchiyama (1989) |
| Alismatales | Hydrocharitaceae | *Najas marina* L. | 2n = 24 | Viinikka et al. (2008) |
| Alismatales | Hydrocharitaceae | *Najas tenuis* Magnus | 2n = 24 | Ito et al. (2014b) |
| Alismatales | Hydrocharitaceae | *Nechamandra alternifolia* (Roxb.) Thwaites | 2n = 16 | Sharma and Chatterjee (1967), Ito et al. (2009) |
| Alismatales | Hydrocharitaceae | *Ottelia alismoides* (L.) Pers. | 2n = 44 | Harada (1956), Uchiyama (1989) |
| Alismatales | Hydrocharitaceae | *Ottelia alismoides* (L.) Pers. | 2n = 66 | Chaudhuri and Sharma (1978) |
| Order               | Family               | Genus               | Species                        | ploidy | References                      |
|---------------------|----------------------|---------------------|--------------------------------|--------|---------------------------------|
| Alismatales         | Hydrocharitaceae     | Ottelia             | alismoides (L.) Pers.          | 2n = 68| Chaudhuri and Sharma (1978)     |
| Alismatales         | Hydrocharitaceae     | Ottelia             | cordata (Wall.) Dandy          | n/a    |                                 |
| Alismatales         | Hydrocharitaceae     | Vallisneria         | spiralis L.                    | 2n = 20| Wang (1986)                     |
| Alismatales         | Hydrocharitaceae     | Vallisneria         | spiralis L.                    | 2n = 24| Chaudhuri and Sharma (1978)     |
| Alismatales         | Hydrocharitaceae     | Vallisneria         | spiralis L.                    | 2n = 30| Chaudhuri and Sharma (1978)     |
| Alismatales         | Hydrocharitaceae     | Vallisneria         | spiralis L.                    | 2n = 40| Chaudhuri and Sharma (1978), Sarkar et al. (1980) |
| Alismatales         | Aponogetonaceae      | Aponogeton          | lakphonensis A. Camus          | n/a    | Kaplan et al. (2013), Kaplan et al. (2013) |
| Alismatales         | Potamogetonaceae     | Potamogeton         | crispus L.                     | 2n = 52| This study                      |
| Alismatales         | Potamogetonaceae     | Potamogeton         | maackianus A. Benn.            | 2n = 56| Kaplan et al. (2013), Kaplan et al. (2013) |
| Alismatales         | Potamogetonaceae     | Potamogeton         |distinctus A. Benn. × P. nodosus Poir.| 2n = 52| Kaplan et al. (2013), Kaplan et al. (2013) |
| Alismatales         | Potamogetonaceae     | Potamogeton         |lucens L.                       | 2n = 56| Kaplan et al. (2013), Kaplan et al. (2013) |
| Alismatales         | Potamogetonaceae     | Potamogeton         | nodosus Poir.                  | 2n = 52| Kaplan et al. (2013)           |
| Alismatales         | Potamogetonaceae     | Potamogeton         | octandrus Poir.                | 2n = 28| Uchiyama (1989), Nakata and Nagai (1998), Kaplan et al. (2013) |
| Alismatales         | Potamogetonaceae     | Potamogeton         |wrightii Morong                 | 2n = 52| Kaplan et al. (2013)           |
| Alismatales         | Potamogetonaceae     | Stuckenia           | pectinata (L.) Börner          | 2n = 78| Kaplan et al. (2013)           |
| Alismatales         | Potamogetonaceae     | Stuckenia           | pectinata (L.) Börner          | 2n = 84| Uchiyama (1989)                |
| Alismatales         | Ruppiaceae           | Ruppia              | maritima L.                    | 2n = 20| Kaplan et al. (2013)           |
| Ruppiaceae          |                      | Ruppia              | maritima L.                    | 2n = 40| Kaplan et al. (2013)           |
| Ruppiaceae          |                      | Ruppia              | maritima L.                    | 2n = 40| Harada (1956), Ito et al. (2010) |
| Ruppiaceae          |                      | Ruppia              | maritima L.                    | 2n = 40| Ito et al. (2010)              |
| Ruppiaceae          |                      | Stuckenia           | maritima L.                    | 2n = 40| Ito et al. (2010)              |
| Ruppiaceae          |                      | Stuckenia           | maritima L.                    | 2n = 40| Ito et al. (2010)              |
| Class             | Family            | Genus          | Species            | Chromosome | Author(s)                          |
|-------------------|-------------------|----------------|--------------------|------------|------------------------------------|
| Asparagales       | Amaryllidaceae    | Crinum         | thaianum J. Schu.  | n/a        |                                    |
| Commelinales      | Pontederiaceae    | Eichhornia     | crassipes (Mart.) Solms | 2n = 32    | Pedrosa et al. (1999)              |
| Commelinales      | Pontederiaceae    | Monochoria     | hastata (L.) Solms | 2n = 28    | Patwary et al. (1989)              |
| Commelinales      | Pontederiaceae    | Monochoria     | hastata (L.) Solms | 2n = 80    | Patwary et al. (1989)              |
| Commelinales      | Pontederiaceae    | Monochoria     | vaginalis (Burm.f.) C. Presl ex Kunth | 2n = 24    | Christopher (1983) (var. plantaginea (Roxb.) Solms); Patwary et al. (1989) |
| Commelinales      | Pontederiaceae    | Monochoria     | vaginalis (Burm.f.) C. Presl ex Kunth | 2n = 48    | Wang and Kusanagi (1996) (var. angustifolia G.X.Wang) |
| Commelinales      | Pontederiaceae    | Monochoria     | vaginalis (Burm.f.) C. Presl ex Kunth | 2n = 52    | Christopher (1983), Patwary et al. (1989) |
| Commelinales      | Typhaceae         | Typha           | angustifolia L.     | 2n = 30    | Löve and Lőve (1981)              |
| Poales            | Eriocaulaceae     | Eriocaulon     | setaceum L.        | n/a        |                                    |

**Discussion**

Of 45 non-hybrid aquatic monocots and two interspecific hybrids among them, more than two thirds have no chromosome variation. Meanwhile, the following nine species have infra-specific chromosome variation, i.e., *Acorus calamus, Cryptocoryne crispatula, Blyxa echinosperma, Hydrilla verticillata, Najas graminea, Ottelia alismoides, Vallisneria spiralis, Monochoria hastata*, and *M. vaginalis* (Table 1). Among the cytologically variable aquatic monocots are *A. calamus, O. alismoides, V. spiralis*, and *M. vaginalis*, for which unique chromosome counts are obtained from each floristic region. Myanmar is known as including borders among the Indian, the Indochina, and the Sino-Japanese floristic regions (Tanaka 2010), yet in the aquatic flora, it is unknown which flora is more influenced. Future research with a focus on such species will address this issue.

*Potamogeton* is known as having numerous inter-specific hybrids, and each parental combination is varied from infra-ploidy crosses to inter-ploidy ones (Kaplan et al. 2013). The present study revealed *P. distinctus × P. nodosus* as another intra-ploidy hybrid of *Potamogeton* at tetraploid level.
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Author contributions

Conceived and designed the study: YI NT. Collected the samples in the field: YI NT. Performed the chromosome observation: YI. Analyzed the data: YI. Wrote the paper: YI. Corrected and revised manuscript: NT.

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