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## The genus *Equisetum* (Equisetaceae) in the flora of Mongolia

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**Summary.** Based on field surveys and herbarium specimens, we studied the genus *Equisetum* in Mongolia, where it has not been thoroughly studied previously. A total of nine species of *Equisetum* belonging to two subgenera are confirmed for the flora of Mongolia. We found several new distribution points of some *Equisetum* species in the phytogeographical regions: *E. variegatum* for the Khangai, Khovd and Mongolian Altai regions, *E. heyemale* for Khentei region, and *E. pratense* for Middle Khalkh region. Furthermore, we evaluated the regional conservation status for each *Equisetum* species by using GeoCAT program. Based on our results, according to the IUCN criteria, *E. ramosissimum* is categorized as Critically Endangered (CR), *E. variegatum* as Endangered (EN), *E. sylvaticum* as Vulnerable (VU), and *E. heyemale* as Near Threatened (NT), while the remaining five species (*E. arvense*, *E. fluviatile*, *E. palustre*, *E. pratense*, and *E. scirpoides*) are categorized as Least Concern (LC). An identification key, information on the regional conservation status, as well as distribution maps and photographs of each species are provided.

**Род *Equisetum* (Equisetaceae) во флоре Монголии**

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**Ключевые слова:** морфология, распространение, сохранение, таксономические заметки, флора Монголии.

**Аннотация.** На основе полевых исследований и критической ревизии гербарных коллекций уточнён таксономический состав и распространение недостаточно изученного в Монголии рода *Equisetum*. Подтверждено наличие во флоре Монголии девяти видов *Equisetum*, относящихся к двум под родам. Впервые установлено произрастание трёх видов в отдельных ботанико-географических районах Монголии: *E. variegatum* в Хангайском, Ховдском районах и Монгольском Алтае, *E. hyemale* в Хэнтэе и *E. pratense* – в Средней Халхе. С помощью программы GeoCAT проведена оценка регионального охранного статуса каждого вида *Equisetum*. На основании полученных результатов, согласно критериям МСОП, *E. ramosissimum* отнесён к категории «находящиеся в критическом состоянии» (CR), *E. variegatum* – к категории «исчезающие» (EN), *E. sylvaticum* – к категории «уязвимые» (VU), а *E. hyemale* – к категории «близкие к уязвимым» (NT); оставшиеся пять видов (*E. arvense*, *E. fluviatile*, *E. palustre*, *E. pratense* и *E. scirpoides*) отнесены к категории «вызывающие наименьшие опасения» (LC). Приводятся ключ для определения видов, сведения о природоохранном статусе каждого из них в стране, а также карты распространения и фотоиллюстрации.

**Introduction**

The genus *Equisetum* L. (horsetails) in Equisetaceae Rich. ex DC. has long attracted the attention of botanists and palaeontologists, because it is considered a key element in understanding vascular plant evolution and for interpretation of fossils of Equisetophyta (Hauke, 1978). This genus contains about 18 species which are distributed almost all over the world, especially in wet places of the northern hemisphere (Hauke, 1963; Zhang et al., 2007; Christenhusz et al., 2019). Among these, *E. arvense* L. as weedy species has been introduced in Australia and New Zealand with modern agriculture (CRC Weed Management, 2003; Christenhusz et al., 2019).

Morphologically, *Equisetum* is divided into two subgenera including *Equisetum* L. and *Hippochaete*

(Milde) Baker (Hauke, 1963, 1969, 1974, 1978, 1979, 1983, 1993; McIver, Basinger, 1989; Zhang, 2004; Christenhusz et al., 2019). Recently, this genus is split into three subgenera based on the molecular evidence by Christenhusz et al. (2019): *Paramochaete* Christenh et Husby (one species: *E. bogotense* Kunth), *Equisetum* (eight species: *E. arvense* L., *E. braunii* Milde, *E. diffusum* D. Don, *E. fluviatile* L., *E. palustre* L., *E. pratense* Ehrh., *E. sylvaticum* L., *E. telmateia* Ehrh.), and *Hippochaete* (nine species: *E. giganteum* L., *E. hyemale* L., *E. laevigatum* A. Braun et Engelm., *E. myriochaetum* Schltld. et Cham., *E. praealtum* Raf., *E. ramosissimum* Desf., *E. scirpoides* Michx., *E. variegatum* Schleich. ex F. Weber. et D. Mohr., *E. xylochaetum* Mett.).

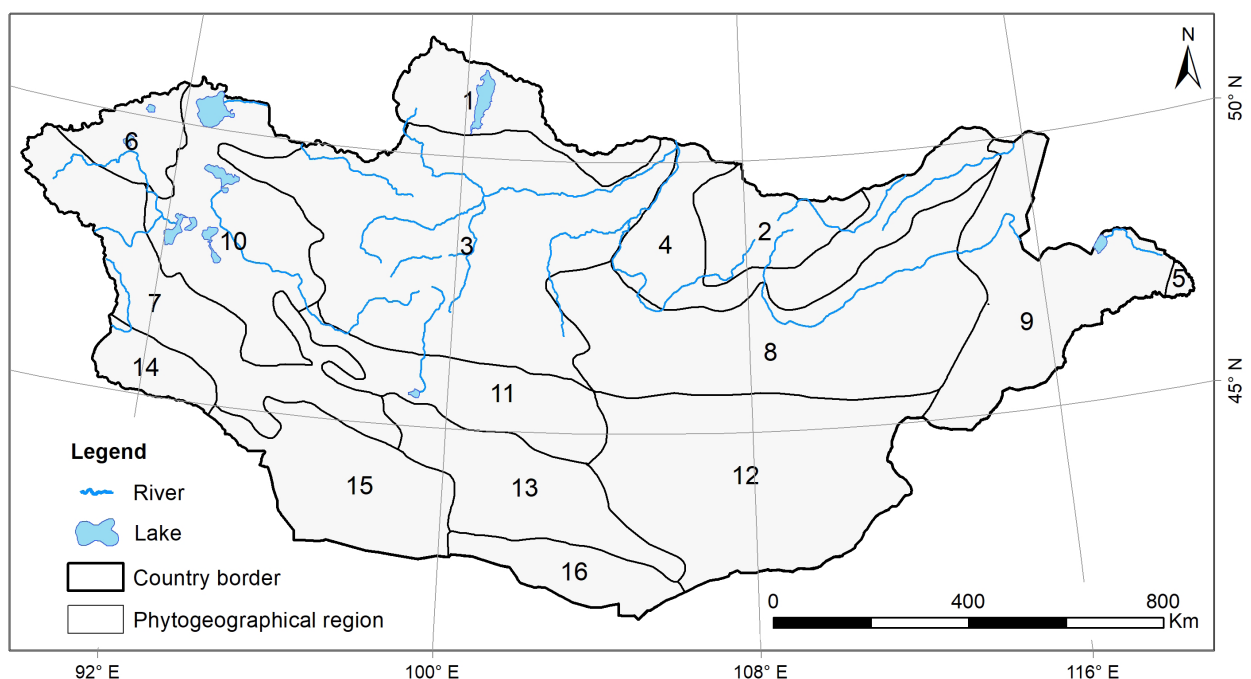
To date, approximately 3050 taxa of vascular plants belonging to 653 genera and 111 families have been recognized in Mongolia (Grubov, 1982;

Urgamal et al., 2014; Javzandolgor et al., 2021; Baasanmunkh et al., 2022). Recently, several research studies have been conducted on the species diversity, regional conservation status, distribution map, and taxonomic notes on the selected genera, such as *Primula* (Baasanmunkh et al., 2020), as well as families Orchidaceae (Baasanmunkh et al., 2021) and Apiaceae (Urgamal et al., 2024). However, there are numerous genera and families remaining above mentioned studies. In this work, we studied the genus *Equisetum* in Mongolia due to we collected a number of herbarium samples and photographs during our field observations.

In Mongolia, there are seven to nine *Equisetum* species based on various sources (Grubov, 1955; Gubanov, 1996; Urgamal et al., 2014; Ulziikhutag et al., 2015; Baasanmunkh et al., 2022). The first taxonomic key and distribution on *Equisetum*

including 8 species were published by Grubov (1982). Since then, however, most of the publications provided only primarily checklist with the distribution of phytogeographical regions (Gubanov, 1996; Urgamal et al., 2014; Ulziikhutag et al., 2015; Baasanmunkh et al., 2022). In general, *Equisetum* mostly occurs in humid vegetations such as river basins, swamps, meadows, deciduous and mixed forests across several phytogeographical regions in Mongolia (Grubov, 1982; Ulziikhutag et al., 2015) (Fig. 1.).

The aim of this study is to update the taxonomy of *Equisetum* genus along with a taxonomic key, distribution map, general habitat, and description in Mongolia. In addition, we evaluate the regional conservation status for all known species according to IUCN Red List categories and criteria (IUCN Standards and Petitions Committee, 2024).



**Fig. 1.** The phytogeographical regions in Mongolia (following Grubov, 1982): 1 – Khuvsgul; 2 – Khentei; 3 – Khangai; 4 – Mongolian Dauria; 5 – Foothills of Great Khingan; 6 – Khovd; 7 – Mongolian Altai; 8 – Middle Khalkh; 9 – East Mongolia; 10 – Depression of Great Lakes; 11 – Valley of Lakes; 12 – East Gobi; 13 – Gobi Altai; 14 – Dzungarian Gobi; 15 – Transaltai Gobi; 16 – Alashan Gobi.

### Material and methods

We collected the herbarium specimens and wild photographs of *Equisetum* in Mongolia during field expeditions between 2019 and 2023. In addition, we crosschecked the herbarium specimens of *Equisetum* from UBA, UBU, MW, PE (Thiers, 2021) and “Virtual Guide of Mongolia” (Flora GREIF, 2010). The distributional map of each species was

created by ArcGIS v.10.4 (ESRI, 2015), based on the phytogeographical regions outlined by Grubov (1982). We marked the new records with an asterisk. Morphological features of the strobilus and the sheath teeth were observed and photographed from herbarium specimens.

For the regional conservation status, we used the IUCN Red List criterion B as a geographic range and evidence of population decline, fragmentation,

or fluctuations to assess extinction risk. In general, there are five evaluation criteria defined by the IUCN (2024): population size reduction (criterion A); geographic range size fragmentation, few locations, range decline, or population fluctuations (B); small and declining population size and fragmentation, fluctuations, or few subpopulations (C); very small population or very restricted distribution (D); and quantitative analysis of extinction risk (E). Among these, criterion B – severity of fragmentation – is suitable for estimating conservation status, even if data is limited and the distribution of a taxon is known from only a few georeferenced records. In this study, we used the criterion B, because distribution records of all *Equisetum* species were relatively well known. The sub-criteria B1 – extent of occurrence (EOO) and B2 – area of occupancy (AOO) were estimated using the GeoCAT (<http://geocat.kew.org/>; Bachman, 2011). The minimum AOO was estimated based on a user defined grid cell of 2 km<sup>2</sup> as recommended by IUCN Standards and Petitions Committee (2024).

### Results and Discussion

In the present study we provide the regional conservation status, taxonomic key, distribution on the genus *Equisetum* in Mongolia. Based on our results, a total of nine *Equisetum* species belonging to two subgenera – *Equisetum* (*E. arvense*, *E. fluviatile*, *E. pratense*, *E. palustre*, and *E. sylvaticum*) and *Hippochaete* (*E. hyemale*, *E. ramosissimum*, *E. scirpoides* and *E. variegatum*) – were recorded in the country. There are 18 accepted species in *Equisetum*, and many interspecific hybrids were found in the wild. However, none interspecific hybrids have been currently discovered in Mongolia. The distribution map of each species was given in Figures 5–7. In general, most of *Equisetum* species occur frequently in north, east, west, and central Mongolia. However, we did not find any *Equisetum* species in the Valley of Lakes, East Gobi, Gobi Altai, Transaltai Gobi, and Alashan Gobi regions. We identified new distribution points for *E. hyemale* in the Khentei, *E. pratense* in the Middle Khalkh, and *E. variegatum* in the Khangai, Khovd, and Mongolian Altai regions based on our own field research and herbarium data.

Assessments of the species conservation status are considered as effective tools to aid conservation planning and to evaluate conservation options (Orsenigo et al., 2018; Wagensommer et al., 2020). Therefore, we assessed all *Equisetum* species at

the regional conservation status. Among these, three species were classified as threatened (one as Critically Endangered, one as Endangered, one as Vulnerable), whereas six taxa were classified as non-threatened (one as Near Threatened and five as Least Concern; Table 1).

### Taxonomic key

1. Stems evergreen, rarely branched; strobilus relatively short, acute at tip .....  
..... 2. *Equisetum* subg. *Hippochaete*  
+ Stems summer green, always branched; strobilus more often oblong, obtuse .....  
..... 5. *Equisetum* subg. *Equisetum*
2. Stems 20–80(–100) cm tall; many sheath teeth ..... 3  
+ Stems 5–20(–30) cm tall; 3–4 or 6 sheath teeth ..... 4
3. Stems 2–4 mm in diameter, branched, with 4–10 rounded ribs; sheath teeth without black line .....  
..... *E. ramosissimum*  
+ Stems 6–10 mm in diameter, unbranched, with 10–30 nearly rectangular ribs; sheath teeth with black line ..... *E. hyemale*
4. Stems 2–3 mm in diameter, straight, with 4–6 blunt ribs; sheath teeth 4–6, triangular with acute apex ..... *E. variegatum*  
+ Stems 0.5–0.8 mm in diameter, often curved, with 3–4 rough ribs; sheath teeth 3(4), slender with long apex ..... *E. scirpoides*
5. Stems isomorphic, all stems similar, green ... 6  
+ Stems dimorphic, fertile stems yellowish or pale brown in spring, no chloroplasts in cells, different from green sterile summer stems ..... 7
6. Stems 50–150 cm tall, 5–10 mm in diameter; sheath teeth more than 11, linear-lanceolate, light-brown, occasionally with narrow white margin .....  
..... *E. fluviatile*  
+ Stems 20–60 cm tall, 2–4 mm in diameter; sheath teeth 5–8, lanceolate, dark brown at the middle and white at margin ..... *E. palustre*
7. Sheath teeth small, 0.3–8(10) mm long, teeth tips dark brownish ..... 8  
+ Sheath teeth large, 1–3 cm long, teeth tips reddish brown ..... *E. sylvaticum*
8. Main stems with minute prickles; sheath teeth narrowly triangular, dark brown at the middle and light brown at margin ..... *E. pratense*  
+ Main stems smooth and without prickles; sheath teeth lanceolate, black, mainly fused by 2–3, without white margin ..... *E. arvense*

*Equisetum arvense* L., 1753, Sp. Pl. 2: 1061.

**Description.** Plant small to medium-sized and bright green (Fig. 3C). Aerial stem dimorphic, lateral branches slender, flattened, with 3 or 5 narrow and tall ridges abaxially with cross grains, sheath teeth 3–5, green, lanceolate, margin membranous, persistent (Figs. 2F, 3C, 3C2). Strobilus terete, apex blunt (Figs. 3C, 3C1).

**Habitat.** Forests, forest margins, under bushes, meadows, bank of rivers and streams, open fields.

**General distribution.** West Bhutan, China, North India, Japan, Korea, Mongolia, Nepal, Russia; Central and South West Asia, Europe, North America (including Greenland); introduced in South America, Australia (POWO, 2025).

**Distribution in Mongolia.** Khuvsgul, Khentei, Khangai, Mongolian Dauria, Foothills of Great Khingan, Khovd, Mongolian Altai, Middle Khalkh, East Mongolia, Depression of Great Lakes, Dzungarian Gobi.

**Notes:** This species aboveground parts are used for medicine. That is often considered a weed in croplands and often leads to reduced crop yields.

*Equisetum fluviatile* L., 1753, Sp. Pl. 2: 1062.

**Description.** Waterside-aquatic large plant. Aerial stem monomorphic. Lateral branches absent or present, if present then slender (Fig. 3B), straw-colored or grayish green, 4–7-ridged, ridges arc-shaped abaxially and glabrous or with small cross grains, sheath teeth 4–7, straw-colored or light brown, thinly leathery, persistent (Figs. 2B, 3B, 3B2). Strobilus shortly clavate or ellipsoid, apex blunt (Figs. 3B, 3B1), stalk prolonged when mature.

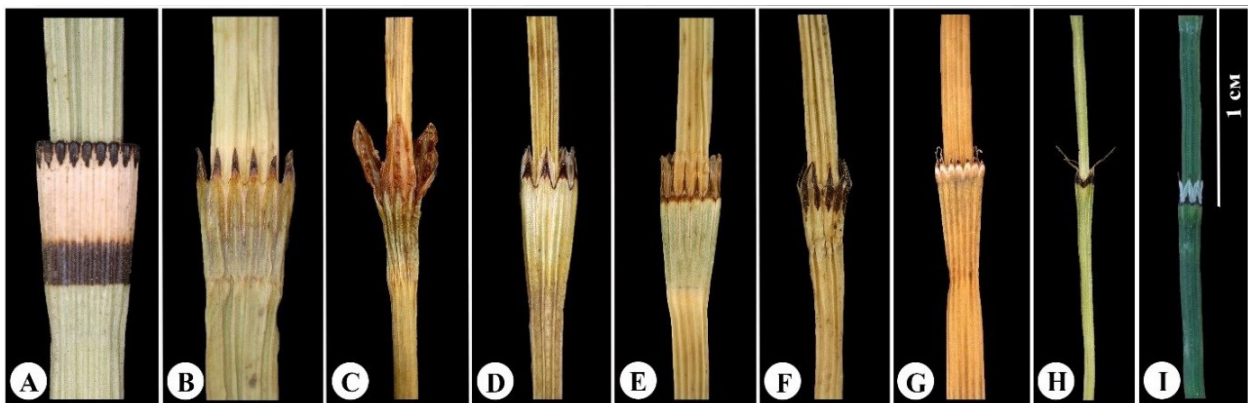
**Habitat.** Riverbanks and lake coasts, margins of small bogs and drying basins, bottom land meadows.

**General distribution.** China, Japan, Korea, Mongolia, Russia; Central and South West Asia, Europe, North America (POWO, 2025).

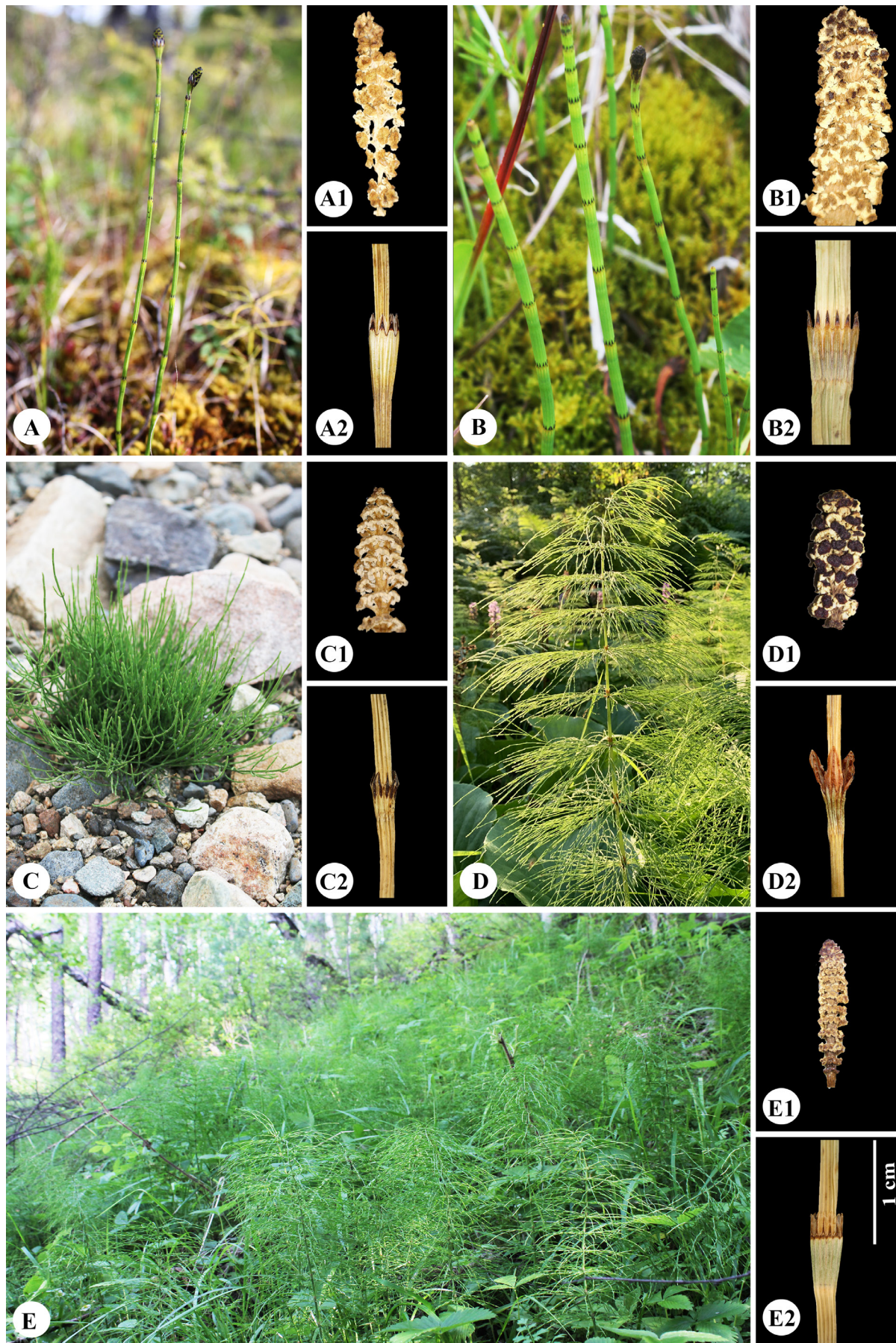
**Table 1.** The phytogeographical distribution and threat status (according to IUCN criteria) of *Equisetum* in Mongolia

No	Taxon name	Number of Records	EOO km <sup>2</sup>	AOO km <sup>2</sup>	Threat Category and Criteria	Phytogeographical Regions (following Grubov, 1982), see Fig. 1
1	<i>E. ramosissimum</i>	3	–	8	CR B2ab(i,ii)	14
2	<i>E. variegatum</i>	6	120096	20	EN B2ab(ii)	1, 3*, 4, 6*, 7*
3	<i>E. sylvaticum</i>	5	7134	16	VU B1+B2a	1, 2, 3, 4, 5, 8, 9
4	<i>E. hyemale</i>	14	24798	44	NT	2*, 3, 4, 5
5	<i>E. arvense</i>	225	1441424	588	LC	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14
6	<i>E. fluviatile</i>	59	672238	120	LC	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14
7	<i>E. palustre</i>	48	578054	140	LC	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14
8	<i>E. pratense</i>	80	677798	224	LC	1, 2, 3, 4, 5, 6, 7, 8*, 9, 10
9	<i>E. scirpoides</i>	18	321910	40	LC	1, 2, 3, 4, 6

Note: \*Regions where relevant species are first recorded in this study (since Baasanmunkh et al., 2022).



**Fig. 2.** Photographs of sheath teeth: A – *Equisetum hyemale*; B – *E. fluviatile*; C – *E. sylvaticum*; D – *E. palustre*; E – *E. pratense*; F – *E. arvense*; G – *E. ramosissimum*; H – *E. scirpoides*; I – *E. variegatum*.



**Fig. 3.** Plants of subgen. *Equisetum*: 1 – strobilus; 2 – sheath teeth; A – *E. palustre*; B – *E. fluviatile*; C – *E. arvense*; D – *E. sylvaticum*; E – *E. pratense*.

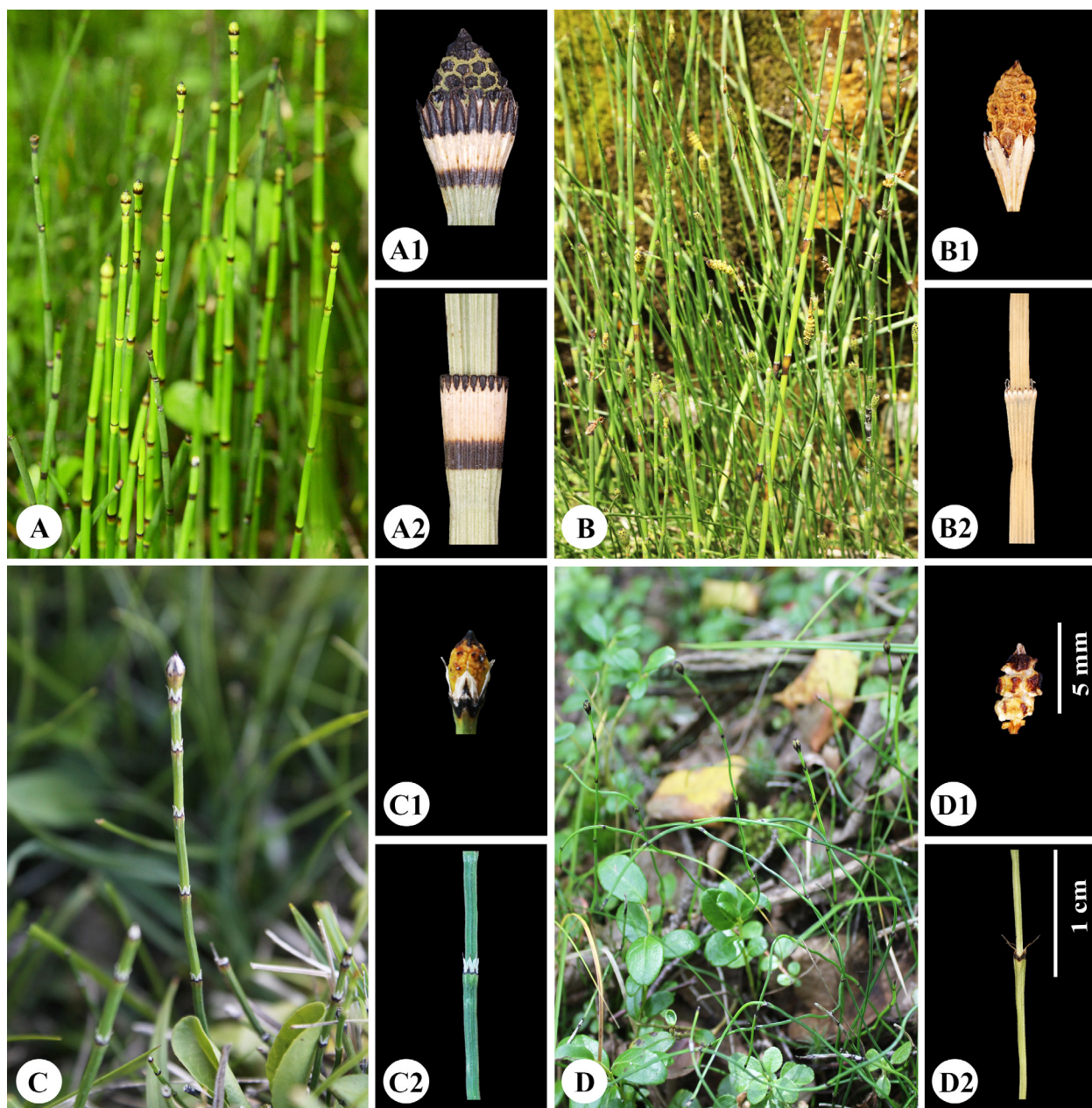


Fig. 4. Plants of subgen. *Hippochaete*: 1 – strobilus; 2 – sheath teeth; A – *E. heyemale*; B – *E. ramosissimum*; C – *E. variegatum*; D – *E. scirpoides*.

*Distribution in Mongolia.* Khuvsgul, Khentei, Khangai, Mongolian Dauria, Foothills of Great Khingan, Khovd, Mongolian Altai, Middle Khalkh, East Mongolia, Depression of Great Lakes, Dzungarian Gobi.

*Equisetum hyemale* L., 1753, Sp. Pl. 2: 1062.

*Description.* Plant large. Aerial stem monomorphic, main stem robust (Fig. 4A). Sheath teeth 16–22, lanceolate small, teeth of distal portion light brown, membranous, aristate, caducous, teeth of lower portion blackish brown, thinly leathery, abaxially 3-ridged at base, persistent or

falling off early with sheath (Figs. 2A, 4A, 4A2). Strobilus ovate, apex with small acute tip, sessile (Figs. 4A, 4A1).

*Habitat.* Forests, stream banks.

*General distribution.* China, Japan, Korea, Mongolia, Russia; Central and South West Asia, Europe, Central and North America (POWO, 2025).

*Distribution in Mongolia.* Khentei\*+, Khangai, Mongolian Dauria, Foothills of Great Khingan.

*New distribution point.* Khentei region, “Selenge province, Yuruu soum, Nariin davaa. Forest. 49.3987N, 107.1665E. 22 VIII 2020. C. Javzandoglor, D. Manidari. 20200822162” (UBA).

*Notes:* This species aboveground parts are used for medicine.

*Equisetum palustre* L., 1753, Sp. Pl. 2: 1061.

*Description.* Plant gray-green or rather glaucous (Fig. 3A). Aerial stem monomorphic. Sheath teeth 4–6, grayish green, lanceolate, thinly leathery, persistent (Figs. 2D, 3A, 3A2). Strobilus ellipsoid or terete, apex blunt (Figs. 3A, 3A1), stalk prolonged when mature.

*Habitat.* Riverbanks, meadows, spring bogs, under bushes.

*General distribution.* China, Japan, Kashmir, Korea, Mongolia, North Pakistan, Russia, Central and South West Asia, Europe, North America (POWO, 2025).

*Distribution in Mongolia.* Khuvsgul, Khentei, Khangai, Mongolian Dauria, Foothills of Great Khingan, Khovd, Mongolian Altai, Middle Khalkh, East Mongolia, Depression of Great Lakes, Dzungarian Gobi.

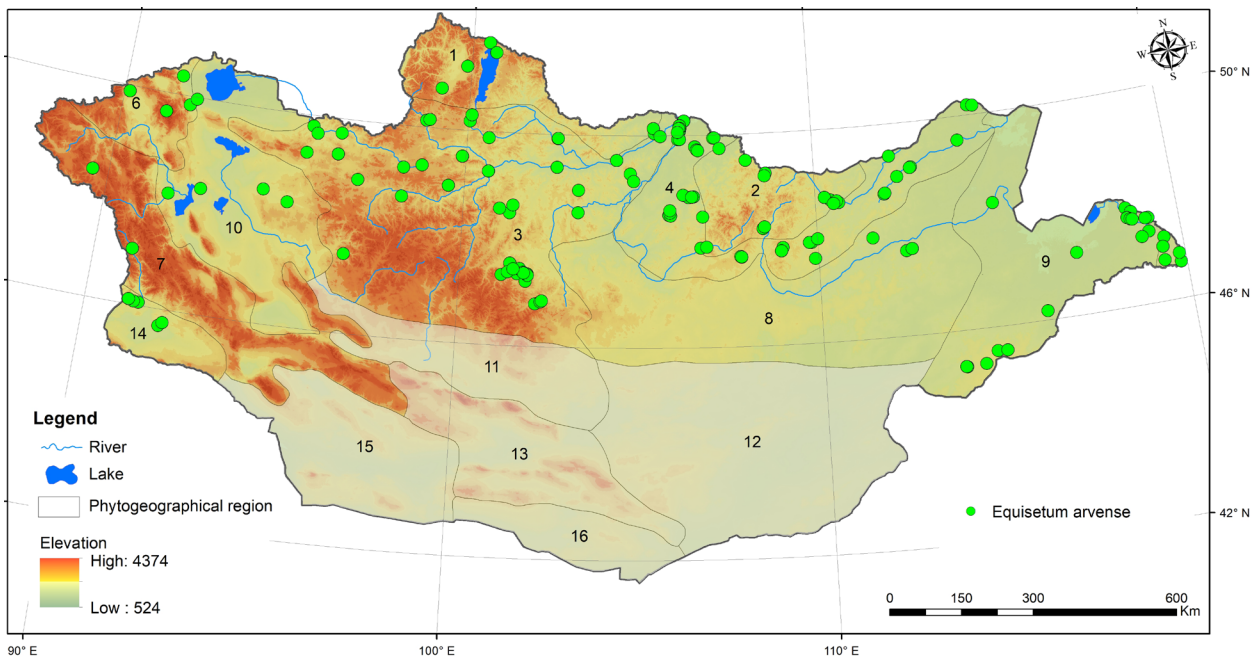


Fig. 5. Distribution map of *Equisetum arvense* in Mongolia.

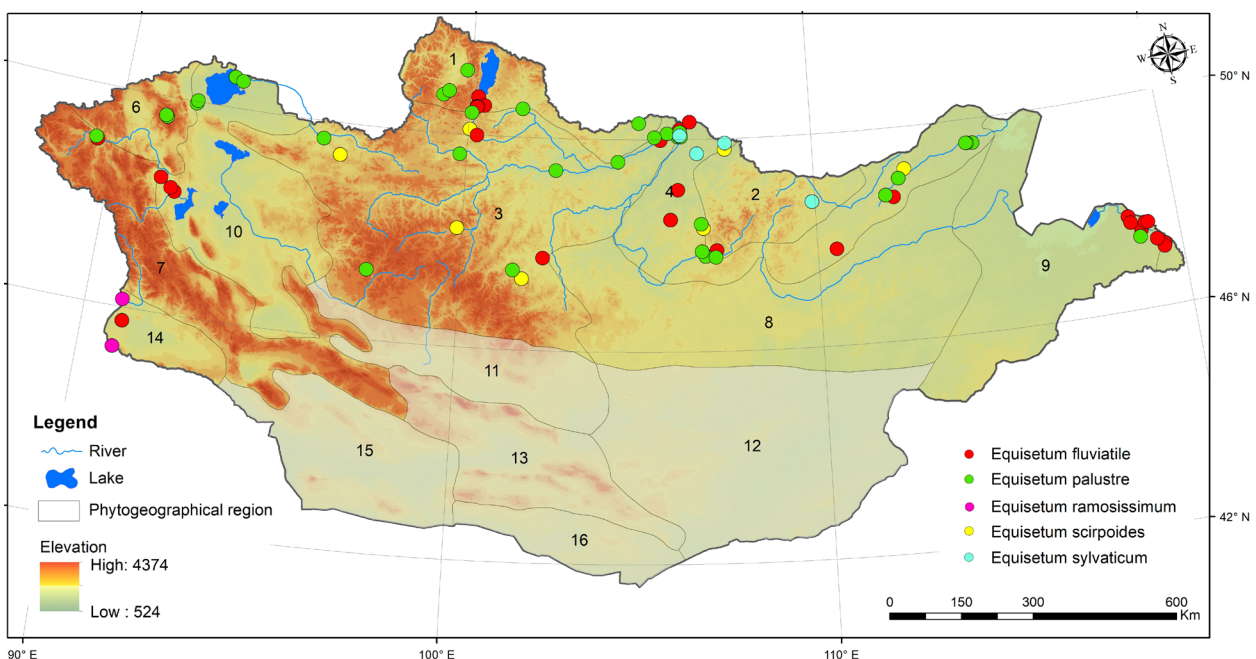


Fig. 6. Distribution map of *Equisetum fluviatile*; *E. palustre*; *E. ramosissimum*; *E. scirpoides*; *E. sylvaticum* in Mongolia.



*Equisetum pratense* Ehrh., 1784, Hannover. Mag. 22: 138.

**Description.** Plant medium sized. Aerial stem dimorphic, sterile stems green, often branching (Fig. 3E). Lateral branches slender, complanate, with 3 or 4 narrow and tall ridges, ridges abaxially, sheath teeth not open (Figs. 2E, 3E, 3E2). Strobilus ellipsoid-terete, apex blunt (Figs. 2E, 2E1), stalk prolonged when mature.

**Habitat.** Birch-aspen forests, forest margins and riverbanks.

**General distribution.** China, Japan, Mongolia, Russia; Central Asia, Europe, North America (POWO, 2025).

**Distribution in Mongolia.** Khuvsgul, Khentei, Khangai, Mongolian Dauria, Foothills of Great Khingan, Khovd, Mongolian Altai, Middle Khalkh\*, East Mongolia, Depression of Great Lakes.

**New distribution point.** Middle Khalkh region, “Khentei province, Undurkhaan soum, Kherlen river. River basin. 47°12'46"N, 110°33'28"E. 03 VII 1979. V. I. Grubov, A. Muldashev” (UBA0002679241).

*Equisetum ramosissimum* Desf., 1799, Fl. Atlant. 2: 398.

**Description.** Plant small to medium-sized, gray-green (Fig. 4B). Aerial stem monomorphic. Sheath teeth 5–10, upper portion brown, lanceolate, leathery but membranous at margin, usually persistent (Figs. 2G, 4B, 4B2).

Strobilus shortly clavate or ellipsoid, at middle, apex with small acute tip, sessile (Figs. 4B, 4B1).

**Habitat.** Wet places, riverbanks and streams.

**General distribution.** Afghanistan, Bangladesh, Bhutan, China, India, Indonesia, Japan, Kashmir, Korea, Laos, Malaysia, Mongolia, Myanmar, Nepal, New Guinea, Pakistan, Philippines, Russia, Singapore, Sri Lanka, Thailand, Vietnam; Africa, Central and South West Asia, Europe, South Pacific Islands; introduced in North America (POWO, 2025).

**Distribution in Mongolia.** Dzungarian Gobi (Bulgan river).

*Equisetum scirpoides* Michx., 1803, Fl. Bor.-Amer. 2: 281.

**Description.** Plant small, stems very thin (Fig. 4D). Aerial stem monomorphic. Sheath teeth 3(5), broadly lanceolate, apex long aristate, teeth of middle portion blackish brown, margin light brown, membranous persistent (Figs. 2H, 4D, 4D2). Strobilus terete, small, apex with an acute tip, sessile (Figs. 4D, 4D1).

**Habitat.** Moss bogs, bogged forests and riverbanks.

**General distribution.** North China, Japan, Mongolia, Russia (European part, Far East, Siberia); North Europe, North America (including Greenland); introduced in Belgium, and Great Britain (POWO, 2025).

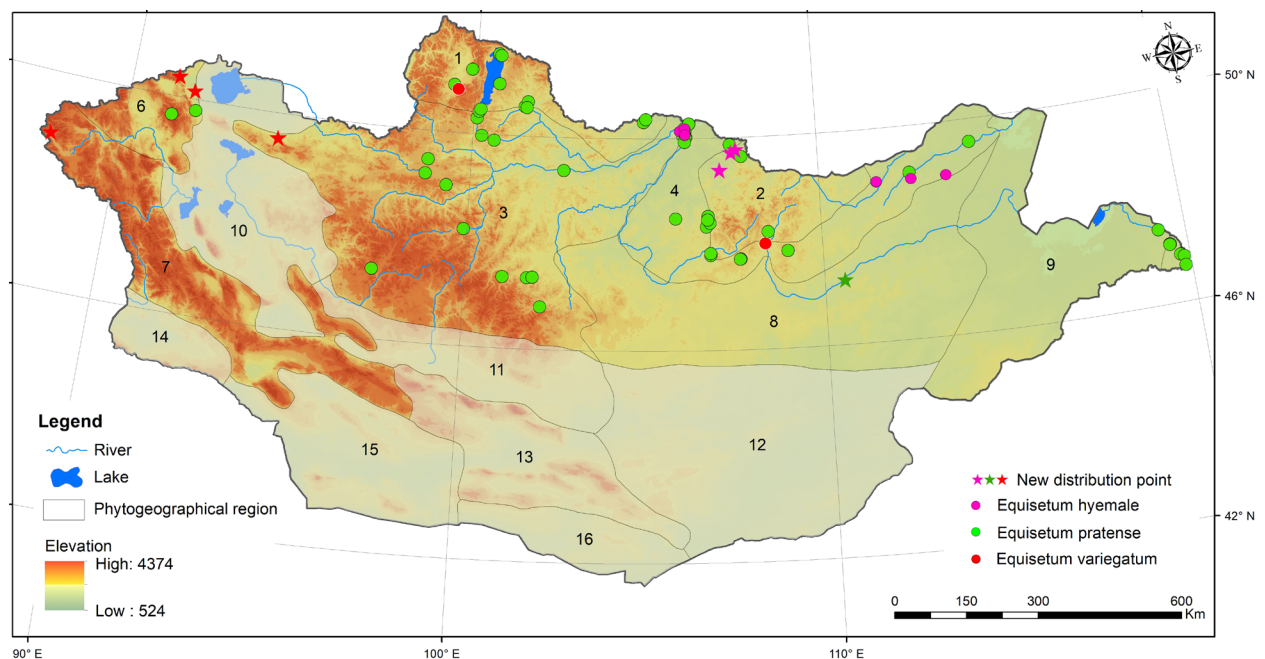


Fig. 7. Distribution map of *Equisetum heyemale*; *E. pratense*; *E. variegatum* in Mongolia. Newly records marked by asterisk.

*Distribution in Mongolia.* Khuvsgul, Khentii, Khangai, Mongolian Dauria, Khovd.

***Equisetum sylvaticum*** L., 1753, Sp. Pl. 2: 1061.

*Description.* Plant large or medium sized. Aerial stem annual, dimorphic (Fig. 3). Sheath teeth 3 or 4 broad, reddish brown, ovate-deltoid (Figs. 2C, 3D, 3D2). Strobilus terete, apex blunt (Figs. 3D, 3D1), stalk prolonged when mature.

*Habitat.* Forests, damp taiga.

*General distribution.* China, Japan, Mongolia, Russia; Central Asia, Europe, North America (including Greenland) (POWO, 2025).

*Distribution in Mongolia.* Khuvsgul, Khentii, Khangai, Mongolian Dauria, Foothills of Great Khingan, Middle Khalkh, East Mongolia.

***Equisetum variegatum*** Schleich. ex F. Weber et D. Mohr, 1807, Bot. Taschenbuch, 60, 447.

*Description.* Plant small to medium sized (Fig. 4C). Aerial stem monomorphic. Sheath teeth 6–8, usually, spreading, deltoid, teeth of middle portion blackish brown, white at margin, membranous (Figs. 2I, 4C, 4C2). Strobilus ellipsoid, apex with acute tip, sessile (Figs. 4C, 4C1).

*Habitat.* Forests, forest belt and meadows.

*General distribution.* China, Japan, Mongolia, Russia; South West Asia, Europe, North America (including Greenland) (POWO, 2025).

*Distribution in Mongolia.* Khuvsgul, Khangai\* Mongolian Dauria, Khovd\*, Mongolian Altai\*.

***New distribution points.*** Khangai region, “Uvs province, Tsagaankhairkhan soum, Khan Khukhii nuruu, Gants modnii am. Forest. 49°25'28.58"N, 94°26'18.33"E. 15 VI 2021. C. Javzandolgor. 20210615018” (UBA). Khovd region, “Uvs province, Sagil soum, Bayanzurkhiin baruun salaa. River basin. 50°19'13"N, 91°36'52"E. 19 VIII 1967. s. I.” (UBU.0024934). Mongolian Altai region, “Bayan-Ulgii province, Tsengel soum, Khurgan lake. Meadow. 49°03'41.70"N, 91°01'31.80"E. 14 VIII 2022. V. Gundegmaa. 20220814065” (UBA).

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