

Potamogeton × *fluitans* (*P. natans* × *P. lucens*) in the Czech Republic I. Morphology and anatomy

Potamogeton × *fluitans* (*P. natans* × *P. lucens*) v České republice I. Morfologie a anatomie

Zdeněk Kaplan

Institute of Botany, Academy of Sciences of the Czech Republic, CZ 252 43 Průhonice, Czech Republic, e-mail: kaplan@ibot.cas.cz

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Potamogeton × *fluitans* Roth (*P. natans* L. × *P. lucens* L.) was discovered in NE Bohemia as a new taxon for the Czech Republic. In the site, the hybrid grew together with both its parents. The revision of herbarium specimens proved that all previous records of “*P. fluitans*” from the Czech Republic were erroneous. Morphological and anatomical characters of the hybrid are described, together with those of its parents and other morphologically similar taxa. *P. fluitans* differs from *P. natans* especially in having submerged leaves with a distinct lamina and petioles of floating leaves without a flexible section at the junction with the lamina. From *P. lucens*, it is distinguished by the capability of developing floating leaves and by long, narrowly oblong submerged leaves. While stem anatomical pattern of *P. fluitans* is intermediate between those of its parents, it is easily distinguishable from that of morphologically the most similar *P. nodosus* Poir. The hybrid is sterile and no trace of developed fruits has been found among the Czech material.

Key words: *Potamogeton*, taxonomy, morphology, stem anatomy, nomenclature, Czech Republic

Introduction

In July 1997 J. Rydlo located a population of outstanding broad-leaved *Potamogeton* in a fishpond at the WSW margin of the Arnoštice settlement near Žehrov village in the Český ráj region, NE Bohemia, Czech Republic. He collected a plentiful material for his herbarium and showed the dried specimens to me soon after their preparation. The plants resembled *P. nodosus* Poir. in their general appearance but differed particularly in the shape of submerged leaves which were long and extremely narrow, some of lower ones even almost reduced to phyllodes. The character of habitat did not correspond to where *P. nodosus* is usually found in the Czech Republic either. This species is confined to a few rivers or abandoned sand pits filled with water but has never been found in fishponds in the Czech Republic. I tentatively identified the material as a hybrid between *P. natans* L. and *P. lucens* L.

I visited the site soon after its discovery in September that year. The fishpond was relatively eutrophic and towards the end of the season the water surface was almost entirely overgrown with filamentous algae. I found the plants with outstanding appearance there, growing in water about 80 cm deep, accompanied by the following species of pondweeds: *Potamogeton acutifolius* Link, *P. natans* L., *P. lucens* L., *P. pusillus* L., and *P. trichoides* Cham. et Schlechtend. A few shoots of the putative hybrid were taken for cultivation and for further study. The detailed examination of its morphology and anatomy proved the identity with *P. fluitans*, a recent hybrid between *P. natans* and *P. lucens*. The identifica-

tion was consequently published in a report on wetland flora and vegetation of ponds in the area of Český ráj (Rydlo 1999). I checked the state of the water vegetation in the pond in 1999 again. Several species that I recorded in 1997 and that were reported also by Rydlo (1999) disappeared in the meantime due to rapid successional changes in the eutrophic water reservoir but a few plants of the hybrid still grew there.

Morphology

The following description (Fig. 1) is based on fresh material, herbarium specimens and cultivated samples from the fishpond in Český ráj: Rhizome slender to robust, terete, perennial, overwintering with short shoots or fascicles of phyllodial leaves in the leaf axils of old shoots. Stem unbranched or sparingly branched, slender to robust, terete. Submerged leaves petiolate; lamina narrowly oblong to narrowly elliptical, that of the lowest leaves reduced to phyllodes, 70–170 mm long, 2–16 mm wide, 8–30 times as long as wide, bright-green, 5–13-veined, without rows of lacunae bordering the midrib, entire or very obscurely denticulate at margins, narrowly cuneate at base, acute to mucronate at apex; petiole 65–170 mm long, 0.4–1.4 times as long as the lamina. Intermediate leaves often present, narrowly lanceolate, long petiolate. Floating leaves petiolate; lamina narrowly oblong to broadly elliptical, 55–155 mm long, 10–36 mm wide, 2.6–11.2 times as long as wide, opaque, (sub)coriaceous, yellow-green to dark green, sometimes with a brownish tinge, 7–21-veined, narrowly cuneate to rounded at base, acute to mucronate with excurrent midrib at apex; petiole 45–170 mm long, 0.3–1.4 times as long as the lamina, rarely with a trace of a pale section at the junction with the lamina but without a flexible junction. Stipules axillary, convolute, 45–85 mm long, translucent, persistent, at least near the base with two narrowly winged ribs along the abaxial side. Peduncles 40–55 mm long, 1.5–1.9 times as long as the flowering spike, thicker than the stem. Spikes cylindrical, 24–35 mm long in flower, contiguous. Flowers numerous, with 4 carpels. Fruits not developed, plants sterile.

Potamogeton ×fluitans can be easily distinguished from its parents. The submerged leaves are clearly intermediate between those of *P. lucens* with an oblong to broadly elliptical lamina on the short petiole and those of *P. natans* always reduced to linear phyllodes. The hybrid is in the general appearance and the shape of floating leaves more similar to *P. natans*. *P. ×fluitans* differs from that latter species in having submerged leaves with distinctly developed lamina (except for those from near the base of the stem which are often reduced to phyllodes but decay later in the season), and in petioles of floating leaves without the flexible junction between the petiole and the lamina. The floating leaves of *P. natans* have mostly, though not invariably, a well developed discoloured section and a flexible junction between the petiole and the lamina. Because they lack this flexible section, the floating leaves of *P. ×fluitans* tend to point to the same direction whereas those of *P. natans* do not and are usually variously orientated on the water surface unless the plants grow in running water. The hybrid is unlikely to confuse with *P. lucens*. The best characters for separating *P. ×fluitans* from this species are the shape of the lamina of submerged leaves, longer petioles, ± entire margins (in contrast to distinctly denticulate leaves of *P. lucens*) and, in particular, the capacity to produce floating leaves.



Fig. 1. – General appearance of *Potamogeton × fluitans* Roth (Kaplan 97/915, PRA); scale bar = 3 cm.

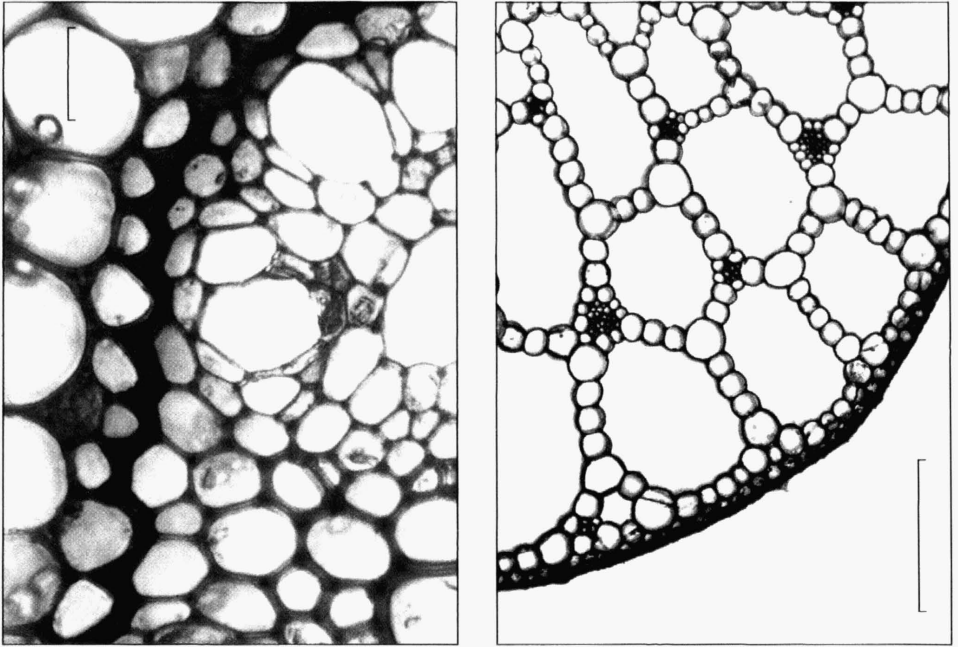


Fig. 2. – Stem anatomy of *Potamogeton × fluitans* Roth: left – endodermis cells of U-type, scale bar = 10 μm ; right – cortex with interlacunar and subepidermal bundles, pseudo-hypodermis present, scale bar = 100 μm .

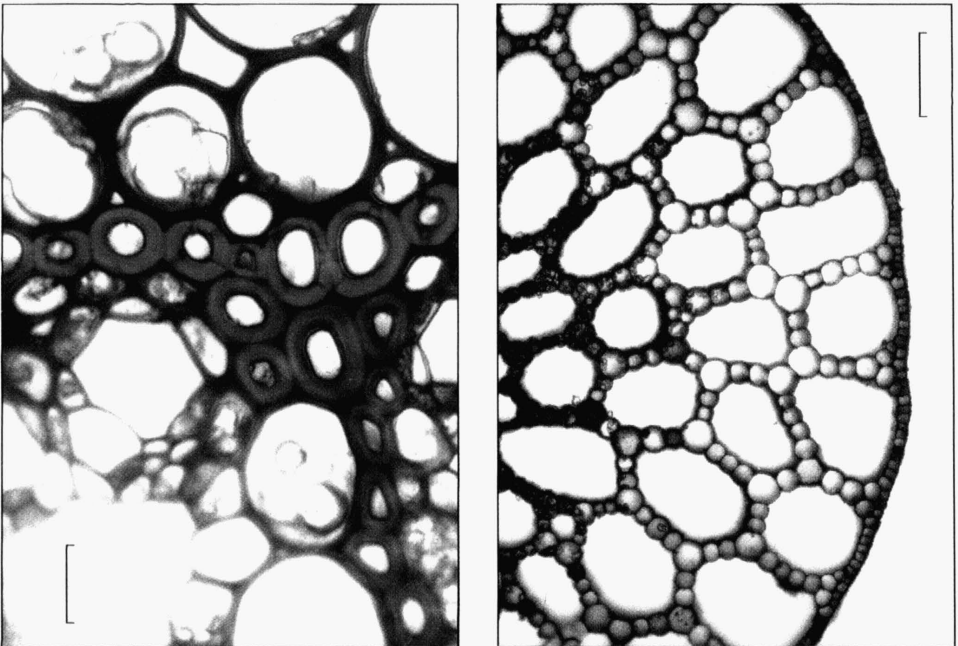


Fig. 3. – Stem anatomy of *Potamogeton nodosus* Poir.: left – endodermis cells of O-type, scale bar = 10 μm ; right – all cortical bundles absent, pseudo-hypodermis absent, scale bar = 100 μm .

Potamogeton ×fluitans is more difficult to separate from the unrelated species *P. nodosus* than from its parents. However, that species never has the lowest leaves reduced to phyllodes, has in average more veins in lamina of submerged leaves (11–21), and longer petioles (usually 60–250 mm). *P. ×fluitans* has stipules with two narrow wings at least at the base, sometimes extending for most of the length of the stipule. This character is derived from *P. lucens*, which has stipules with winged ribs on the abaxial side for most of their length. *P. nodosus* forms at most two smooth ridges along the back of the stipules. However, fragmentary material or extreme phenotypes are often difficult to distinguish or their hybrid nature may be easily overlooked (cf. Kaplan 2001). In such cases, study of stem anatomy pattern is the most fruitful and effective way to identify the plants (see below).

All species differ from *P. ×fluitans* in their capacity to produce numerous well-formed fruits. On the other hand, it must be understood that although fertility can be used to rule out the possibility of a plant being a hybrid, sterility is of little use in identifying a hybrid since many populations of *Potamogeton* are only found in vegetative state (Preston 1995a).

Other *P. natans* hybrids could be confused with *P. ×fluitans* (cf. Fischer 1904, 1907, Hagström 1916, Preston 1995a, b, Preston et al. 1998). All of them differ in having stipules with ridges which are not winged on the abaxial side. In addition, *P. ×schreberi* G. Fisch. (*P. natans* L. × *P. nodosus* Poir.) has longer petioles of submerged leaves [(60–) 100–350 mm] and the midrib bordered by lacunae, *P. ×sparganifolius* Laest. ex Fr. (*P. gramineus* L. × *P. natans* L.) differs by its even narrower and longer submerged leaves and sometimes developed discoloured section at the base of the lamina of floating leaves, and *P. ×gessnacensis* G. Fisch. (*P. natans* L. × *P. polygonifolius* Pourr.) by having submerged leaves only 1–4 mm wide and only 1–2 pairs of lateral veins. None of these hybrids have been proved to occur in the Czech Republic. An unpublished record of “a hybrid of *P. natans* × *P. nodosus*” by Nováková (1978) from the Labe lowland (a water reservoir 1 km ENE of Sokoleč) was, after the revision of authentic material preserved at PRC, found to be based on a joint occurrence of both species but without any trace of hybridization. Most specimens designated with this hybrid formula belong to *P. nodosus*, the rest to *P. natans*. In a brief diagnosis, the author pointed out about the putative hybrid that “all plants in the locality set fruit quite freely”. However, *P. ×schreberi* has never been observed with mature fruit. The list of hybrid combinations in Dostál (1989) is to be understood as an (incomplete and inexact) account of names proposed in the literature but in no way as an overview of hybrids confirmed for the Czech Republic.

Anatomy

The importance of stem anatomical characters for systematics in *Potamogeton* was revealed by Raunkiaer (1896, 1903) and subsequently successfully utilized for solution of taxonomic difficulties by Fischer (1904, 1905, 1907), Hagström (1916), Ogden (1943), Symoens et al. (1979), and Wiegleb (1990a, b). A detailed review is provided by Wiegleb (1990c). Descriptive terms related to the stem anatomy were also explained by Wiegleb & Kaplan (1998).

The stem anatomy pattern was studied using my herbarium specimens and fresh material from cultivation. Short pieces of stems were cut off from the internode of the upper part of flowering stems. Cross sections were cut by hand and stained with toluidine blue.

The following characters are regarded as taxonomically important: type of the stele, shape of endodermis cells, presence of interlacunar and subepidermal bundles, and presence of the pseudohypodermis. The hybrid *P. ×fluitans* shows the stem anatomy pattern which combines the characters of both putative parents. The stele is of the eight bundles or the complex oblong type, the endodermis of U-type, interlacunar bundles present in 2–4 circles, multicellular, subepidermal bundles present, even though in incomplete circle, and pseudohypodermis present, 1(–2)-layered (Fig. 2). The construction of the stele in the hybrid is generally intermediate between *P. natans* (trio or complex oblong type) and *P. lucens* (mostly of oblong type, but sometimes also of proto or trio type). The shape of the endodermis cells in both parents is of U-type. Both species also show well developed interlacunar bundles (mostly 3–4 circles in *P. natans* and 1–3 circles in *P. lucens*) and subepidermal bundles (usually a full circle of strong bundles in *P. natans* and often an incomplete circle in *P. lucens*). The pseudohypodermis is also developed in both parents.

In contrast, *P. nodosus*, morphologically the most similar taxon known from the Czech Republic, shows quite different pattern of stem anatomy. The most frequent stelar type is the eight bundles type, but also proto type can be rarely found. The endodermis consists almost always of O-cells, only occasionally a few intermediate O-U-cells are admixed. The cortical bundles are almost always absent, only rarely a few faint interlacunar and subepidermal bundles are present. The pseudohypodermis is absent (Fig. 3).

Nomenclature

The name *Potamogeton fluitans* was introduced by Roth (1788) who based his description on plant material from “fossis profundis lente fluentibus et in Hunte fluvio Ducatus Oldenburgensis”. Unfortunately, the original description does not provide enough data on exact identity of the original plants. This fact caused difficulties with the interpretation of the name. Besides the fertile species with a wide distribution, nowadays known under the name *P. nodosus* Poir., several morphologically extremely similar sterile hybrids of *P. natans* L. with other broad-leaved species also occasionally occur. Raunkiaer (1896) was the first who revealed the importance of stem anatomical characters for systematics in *Potamogeton*. Later he adopted this approach when studying the *P. fluitans* problem and distinguished two entities, i.e. the fertile species (now *P. nodosus*) and the sterile hybrid intermediate between *P. natans* L. and *P. lucens* L. (Raunkiaer 1903). Raunkiaer was followed by Fischer (1904, 1907) who detected additional hybrids hidden under the name *P. fluitans* from Germany, namely *P. ×schreberi* G. Fisch. (*P. natans* L. × *P. nodosus* Poir.) and *P. ×gessnacensis* G. Fisch. (*P. natans* L. × *P. polygonifolius* Pourr.).

Nomenclature of the group has been further obscured by the lack of the type specimen of the name *P. fluitans* Roth. That is why some authors have used the Roth's name for the fertile species while others have applied it to the sterile hybrid *P. natans* × *P. lucens*. Others have rejected it completely and followed Hagström (1916) who called the species *P. nodosus* and proposed a new name *P. ×sterilis* Hagstr. for the hybrid *P. natans* × *P. lucens*.

Nowadays, the name *P. fluitans* is generally used in the sense of the hybrid between *P. natans* and *P. lucens*, and so it was adopted also for Flora Europaea (Dandy 1980), recent revision of British *Potamogeton* (Preston 1995a) as well as for the world-wide account of *Potamogeton* species (Wiegleb & Kaplan 1998). That is why it is adopted also here.

Distribution

Records of the occurrence of “*P. fluitans*” in the Czech Republic are not rare. The name appeared already in the works of Bohemian botanists of early 19th century with lists of exact localities in Bohemia and in Moravia as well (e.g. Berchtold & Presl 1821, Opiz 1823, Kosteletzky 1824). Later on, “*P. fluitans*” was included also in a monograph of Bohemian *Potamogeton* by Fieber (in Berchtold & Fieber 1838). Many herbarium specimens from the Czech Republic have been labelled with this name since then, including exsicate collections such as that of Petrak (Fl. Bohem. Morav. Exs., Lfg. II, no. 106). “*P. fluitans*” was included in all important Floras covering the Czech Republic before the first half of the 20th century (e.g. Opiz 1852, Čelakovský 1867, Formánek 1887, Polívka 1902, Hejný 1950).

Revision of herbarium specimens of most of the Czech public herbaria including BRNM, BRNU, HR, LIM, LIT, MJ, MMI, MP, OL, OLM, OP, PL, PR, PRC, and ROZ proved that all previous records of “*P. fluitans*” from the Czech Republic were either misapplication of this name for plants of *P. nodosus*, or related to misidentified material mostly of *P. natans*, *P. alpinus* and rarely also of other species. That is why the recent discovery of the hybrid *P. natans* × *P. lucens* in the Český ráj must be considered as the first record for the Czech Republic. Voucher herbarium specimens from this site are preserved at ROZ and in the project's herbarium at PRA.

Outside the Czech Republic *P. ×fluitans* has been known only from a few countries in the central part and northern half of Europe. Hagström (1916) cited localities of checked herbarium specimens from Sweden, Denmark, Germany, Austria, England, and with obvious hesitation also from Russia. Dandy (1975) reported the occurrence in England, Austria, Denmark, Germany, Russia, and Sweden. Besides specimens from all the above named countries, I have seen also herbarium specimens of this hybrid from the Netherlands and Poland.

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Souhrn

V červenci 1997 nalezl J. Rydlo při botanickém průzkumu rybníků v Českém ráji mezi vodními rostlinami i kolonie morfologicky zajímavých rdestů a přinesl mi ukázat jejich herbarňové položky. Jednu kolekci jsem předběžně určil jako křížence druhů *Potamogeton natans* L. a *P. lucens* L. Determinaci jsem potvrdil při návštěvě lokality o pár týdnů později. Zmíněný kříženec, pro něhož jsem přijal jméno *P. ×fluitans* Roth, rostl na lokalitě spolu s oběma předpokládanými rodiči. Vzhledem k omezené možnosti identifikace některých skupin rdestů pouze na základě makromorfologických znaků byly sebrané vzorky rostlin podrobeny studiu anatomických znaků lodyhy. Uspořádání stéle a přítomnost cévních svazků v kortexu jednoznačně ukazovaly na hybridní původ nalezených rostlin, zatímco morfologicky nejvíce podobný druh *P. nodosus* Poir. má stavbu lodyhy naprosto odlišnou. Vzhledem k tomu, že všechny starší literární údaje o výskytu „*P. fluitans*“ u nás se během revize herbarií ukázaly být mylné, jedná se o nový taxon pro květenu České republiky. Tento hybrid se liší od *P. natans* zvláště přítomností čepele u ponořených listů a nepřítomností flexibilního kloubu na přechodu řapíků vzplývavých listů v čepel. Od *P. lucens* se odlišuje schopností vytvářet vzplývavé listy a tvarem ponořených listů, které jsou úzce podlouhlé. Na rozdíl od obou druhů je tento kříženec sterilní a nevytváří plody.

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