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The primitive moss *TetrAPHIS pellucida* Hedw. (*TetrAPHIDACEAE*) new for the Canton of Geneva.

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The primitive moss *TetrAPHIS pellucida* Hedw. (*TetrAPHIDACEAE*) new for the Canton of Geneva. Saussurea, 41, p. 171-177.

Abstract

The moss *TetrAPHIS pellucida* Hedw. (*TetrAPHIDACEAE*, TetrAPHIDALES) is newly reported herein for the Canton of Geneva. This species has been collected from three localities in the Bois de Versoix (Commune of Versoix) and recorded from the Communes of Avully, Chancy, and Jussy. The distinctive morphological features of *T. pellucida* (bright glaucous green plants with ovate-lanceolate upper leaves, discoid gemmae produced in specialized gemmae-cups on the sterile stems, and its peristome composed of four wedge-shaped teeth), combined with its preference for moist and decaying tree stumps, means that it is easy to recognize when encountered in the field. This species is distributed across the Holarctic and is widespread in Switzerland within wooded areas on the plateau, in the Jura mountains and the pre-Alps. An illustration of this species, showing its key characteristics, is provided herein.

Une mousse primitive *TetrAPHIS pellucida* Hedw. (*TetrAPHIDACEAE*) nouvelle pour le Canton de Genève. Saussurea, 41, p. 171-177.

Recherche

Résumé

La mousse *TetrAPHIS pellucida* Hedw. (*TetrAPHIDACEAE*, TetrAPHIDALES) a été nouvellement notée pour le canton de Genève. Cette espèce a été récoltée dans trois localités différentes dans le Bois de Versoix et recensée dans les communes de Avully, Chancy et Jussy. La combinaison des caractères morphologiques de *T. pellucida* (plante vert glauque, feuilles apicales ovate-lancéolées, production fréquente de gemmules discoïdes dans des cupules à propagules ou sur les tiges stériles, péristome distinctif consistant en quatre dents étroitement triangulaires) avec ses préférences pour les troncs humides et en décomposition en font une espèce facilement reconnaissable sur le terrain. Cette espèce a une distribution holarctique et est commune en Suisse dans les forêts du Plateau, dans les montagnes du Jura et les Préalpes. Une illustration de cette espèce avec des caractères clés est donnée dans cet article.

Mots-clés

Inventaire des bryophytes
TetrAPHIS pellucida
mousse
Genève
Suisse

Keywords

Bryophyte inventory
TetrAPHIS pellucida
moss
Geneva
Switzerland

Introduction

Collecting efforts for the *Inventory of hepatics and mosses of Geneva* revealed a number of new and interesting bryophyte records for the canton (PRICE, 2003; BURGISSER et al., 2004; BURGISSER, 2007; CAILLIAU & PRICE, 2007; CAILLIAU, 2009; BURGISSER & PRICE, in prep.). One of these finds, reported here for the first time, is the rather distinctive moss *Tetraphis pellucida* Hedw. (Tetraphidaceae). *Tetraphis pellucida* is a species that grows on decaying tree stumps and in damp and shaded conditions within woodlands. It is characterised by its bright glaucous green, erect shoots; ovate, ovate-lanceolate to lanceolate, costate leaves that have entire margins; unistratose leaf laminae that have irregularly hexagonal, thick-walled cells; and the sporophytic features of small, conical operculae and long-exserted, cylindrical capsules with a peristome consisting of four wedge-shaped teeth (Figs. 1 & 2). In this species gemmae-cups are formed at the ends of sterile stems and numerous discoid gemmae are produced in each gemmae-cup.

The name *T. pellucida* is linked to the Conservatoire et Jardin botaniques de la Ville de Genève through the historically important collection of mosses of Johannes Hedwig (1732-1799), held in the general herbarium (G). Hedwig, who can be considered as the father of bryology, made many pioneering observations during his lifetime, such as on the sexual organs and capsules of mosses, but also on cryptogamic plants more generally (HEDWIG, 1782; 1784; 1785-1787; 1789; 1791-1792; 1797; 1798, see also PRICE, 2005a). He was the first to recognise the diversity of the mosses, as demonstrated in his work *Species muscorum frondosorum* (HEDWIG, 1801) which contained descriptions of 372 mostly Northern-hemisphere mosses, 84 of which were new to science, that were distributed in 35 genera, 24 of which were also new to science. His publication also represents one of the first works where morphological characters were used to develop a classification system of the mosses (see VITT, 2000).

The Hedwig herbarium is an internationally important collection of mosses as it is intrinsically linked to Hedwig's 1801 publication: *Species muscorum frondosorum*. In the early 1900's *Species muscorum frondosorum* was designated as the starting point of the nomenclature of mosses, excepting the

genus *Sphagnum* L. (MCNEILL et al., 2006 : Article 13; FLORSCHÜTZ, 1960; GEISSLER, 2000). As a consequence of this decision the Hedwig herbarium in G became of enormous international importance (GEISSLER, 2000; PRICE, 2002; PRICE, 2005b) because of the type specimens that it contained. Efforts to typify the Hedwig mosses have been made by many international bryologists (see review in PRICE, 2005b). To facilitate the ongoing typification process a catalogue of the type specimens in the Hedwig collection was recently published (PRICE, 2005a, b).

The name of *T. pellucida* nomenclaturally dates from 1801, although this entity can be traced back through the literature under various different names to the 1691 publication of Leonard PLUKENET (BRIDEL, 1798; PRICE, 2010). Two herbarium sheets containing original Hedwig specimens for *T. pellucida* are present in the Hedwig collection and the name of this species has recently been typified from amongst the material on one of these sheets (PRICE, 2010).

The systematic position of *Tetraphis*

The Tetraphidales of the Tetraphidopsida contains the Tetraphidaceae with its two genera: *Tetraphis* Hedw. (*Tetraphis geniculata* Milde and *T. pellucida*) and *Tetrodontium* Schwägr. (*Tetrodontium brownianum* (Dicks.) Schwägr., *T. ovatum* (Funck in Hoppe) Schwägr. and *T. repandum* (Funck in Sturm) Schwägr.). This group of mosses occupies an interesting systematic position due to its unique peristome structure (SHAW & ANDERSON, 1988). The Tetraphidales is recognised as one of the relatively primitive moss lineages (SHAW & RENZAGLIA, 2004; GOFFINET et al., 2008) that shares a number of features with the other basal groups: 1) peristome teeth made up of bundles of whole, thick-walled cells (a nematodontous peristome) with the Polytrichales and, 2) thalloid protonemata, also known as protonemal plates (GOODE et al., 1992 and see SCHNEIDER & SHARP, 1962), that are large, unistratose, broadly ovate, photosynthetic structures which germinate from the spores and similar to those observed in *Oedipodium* Schwägr. of the Oedipodiaceae (Oedipodiales), the Sphagnales and to a lesser extent the Andreaeales (GOODE et al., 1992). The flattened protonema of *T. pellucida* has been documented by HODGETTS (1915). The

Tetraphidales and Polytrichales have traditionally been placed together within classification systems based on their nematodontous peristomes (VITT, 1984; BUCK & GOFFINET, 2000; GOFFINET et al., 2008) with recent molecular analyses supporting this arrangement (NEWTON et al., 2000; GOFFINET et al., 2001; MAGOMBO, 2003; COX et al., 2004). However, unlike the Polytrichales, which have unique stem and leaf features (leaf lamellae, hydroids and leptoids), the gametophytic features of the Tetraphidales (leaves, leaf-cell size, shape and arrangement) are much more similar to the remainder of the mosses: the Bryopsida (GOFFINET et al., 2008).

Morphological characteristics of *Tetraphis pellucida*

Figure 1 (A-I) shows some of the characteristic features of *T. pellucida*. The gametophytes are characterised by bright green stems of 1-4 cm in length (**Fig. 1A**), ovate to lanceolate, loosely appressed leaves that often become more crowded at the stem apex (**Fig. 1A, B**). Leaves have entire margins, possess a single percurrent costa (**Fig. 1B**) and have an acute apex (**Fig. 1C**); leaf cells are irregularly hexagonal in shape with incrassate walls (**Fig. 1D**) throughout the leaf. In *T. pellucida* germinating spores initially give rise to branching filamentous protonema which then produce a protonemal plate. The young gametophores develop from the base or near the base of these protonemal plates. Specialized gemmae-cups are formed on sterile stems from orbicular leaves that are clustered together at the stem apex (**Fig. 1E**) or, less frequently, gemmae stalks develop from the stem apices. The discoid gemmae are lens-shaped and up to 40 µm in diameter (**Fig. 1F**). Sporophytes consist of an erect seta, up to 2-3cm in length, with cylindrical, symmetrical capsules that are around 2 mm in length; peristome teeth are four in number (**Fig. 1A**) and are composed of layers of whole cells; operculae are conical (**Fig. 1G**); calyptrae are mitrate (**Fig. 1H**); spores are spherical and 9-12 µm in diameter (**Fig. 1I**).

Ecology and reproduction

Tetraphis pellucida is usually found growing on moist, decaying coniferous or broad-leaved tree-stumps and rotten wood, often in shaded conditions,

where it can become locally abundant on these patchily distributed substrates (FORMAN, 1964; KIMMERER, 1993). This species has a life-history strategy that employs both sexual (spores) and vegetative (gemmae) reproduction. These two types of diaspores originate from two discrete stems which occur in two separate stages of the gametophyte generation. Firstly, the spores or discoid-gemmae germinate to produce filamentous protonemata and protonemal flaps. Young plants develop from just underneath these flaps. Then, these first generation gametophytes produce gemmae-cups or stalk-gemmae. Gemmae germinate in 2-4 days in culture (SCHNEIDER & SHARP, 1962) and cultured specimens can complete their vegetative cycle in 28 days (GOODE et al., 1992). The subsequent second generation of shoots, produced one year after the sterile shoots, bear the sexual organs and sporophytes (KIMMERER, 1991a, b).

In *T. pellucida* the spores and gemmae have different dispersal distances and germination success (KIMMERER, 1991a, b). Spores disperse further afield (found at 2 m from studied populations) but germinate less successfully than the gemmae which travel much shorter distances (up to 10 cm from studied populations) but which can establish themselves rapidly (KIMMERER, 1991a). Sexual reproduction in this species is important in long-distance dispersal via spores while asexual reproduction facilitates local dominance and population maintenance over time (KIMMERER, 1991a, b) or in re-colonisation after local substrate disturbances (KIMMERER, 1993).

New records of *Tetraphis pellucida* for Geneva

Tetraphis pellucida is now known from three localities on the North side of Lac Léman and the Rhône river in the Bois de Versoix (incorporating Grand Bois, Bois des Douves, Bois Prodrom, Bois de la Gueule, Bois de la Bâtie, Bois de Marcagnou) and one locality each in three communes to the South of the lake and Rhône river.

Specimen information - collections : Commune de Versoix, Bois de Versoix, trail from river to mesic forest and plateau, 430-450 m, 496.832 / 126.650, 03.11.2004, PRICE 3651-a (G) ; L'étang du Bois des Douves, dans le Bois de Versoix, 499.643 / 127.525, 11.09.2005, BURGISSER & CAILLIAU 12 (herb.

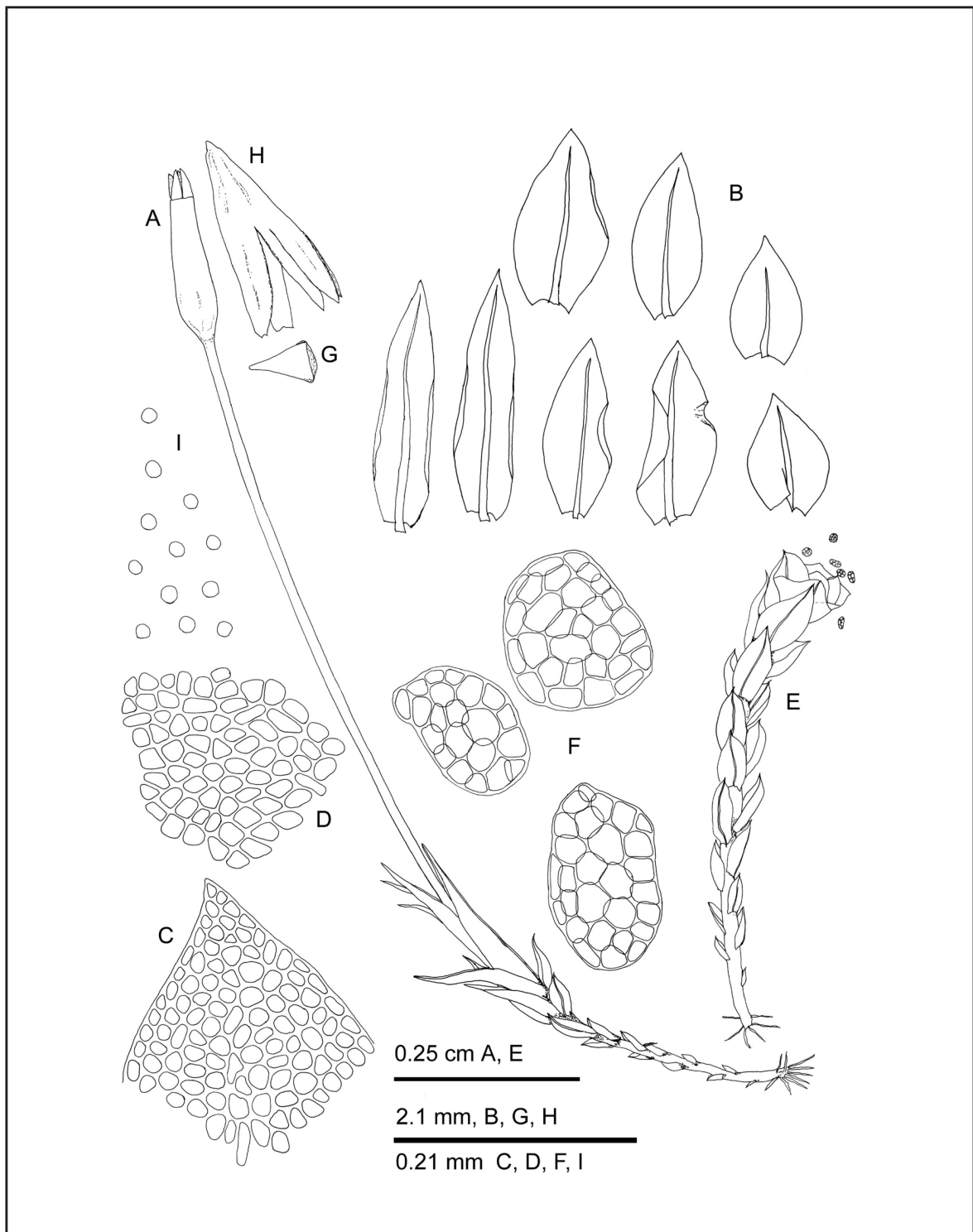


Figure 1 : Morphological features of *Tetraphis pellucida* Hedw. : **A**, fertile plant with sporophyte ; **B**, a selection of leaves ; **C**, leaf apex ; **D**, irregularly-shaped, incrossate leaf cells at mid-leaf ; **E**, sterile stem with gemmae-cup and gemmae ; **F**, discoid gemmae ; **G**, conical operculum ; **H**, mitrate calyptra ; **I**, spores. **A-H** drawn from PRICE & CLARK 2854 (G).

Burgisser); Bois Prodom, 19.06.2009, MAIER s.n. (G). These collections were all made from decomposing tree stumps.

Field records: Commune de Jussy: Prés de Villette, chemin longeant un drain, parallèle au chemin traversant le marais aux chênes asphyxiés, 510.886 / 122.972, 24.02.2006, CAILLIAU F45; Commune de Chancy: Vallon de la Laire, Bois des Crevasses 486.570 / 110.437, 12.09.2006, CAILLIAU F64; Commune d'Avully: Nant des Crues, 490.081 / 114.206, 19.06.2007, CAILLIAU F84; Nant des Crues 489.971 / 114.397 22.06, 2007 CAILLIAU F85. All these reports were based on plants seen growing on rotten tree stumps growing alongside hepatics such as *Lophocolea bidentata* (L.) Dumort. and *Lophocolea heterophylla* (Schrad.) Dumort. (CAILLIAU, pers. comm.).

An additional record of *T. pellucida* from the canton is given in the NISM database (NISM, 2008) as follows: "Gemeinde Presinge, Le Bois Blanchard, 495m, 510.60 / 119.80, Laubwald, auf Faulholz, 24.6.1990, Y. Veltman sub M2.05." However, the whereabouts of this specimen is uncertain as it is not present in either G or Z. The specimen has thus not been seen in the context of the Geneva Bryophyte Inventory project and this record remains unconfirmed.

Discussion

Based on the fragmentary data on bryophytes from the canton it is impossible to say whether *T. pellucida* is newly arrived in the canton or was previously overlooked. Since it is known from the Jura, Salève, and the Voirons, which surround the canton, its presence within Geneva is not surprising. *Tetraphis pellucida*, by its singular morphological characteristics, is unlikely to have been overlooked by the Geneva based bryologists Jean Etienne Auguste Guinet (1846-1928) and Henri Bernet (1850-1904) who collected and studied the bryophytes of the Canton during the 1800's (BERNET, 1888; GUINET, 1888). Herbarium records and published data indicate that Guinet had collected in the Bois de Versoix region during the mid-1800's (see BURGISSER & PRICE, 2005). The population density of *T. pellucida* within Geneva is low and likely to be dependant on habitat availability. Its presence in the canton may be linked to changes

in forestry practices, especially in the treatment of deadwood. In 1954 cantonal law banned the short-interval coppicing of forests (AESCHIMANN et al., 1984). The cessation of coppicing encourages the growth of mature standard trees with larger trunk sizes which result in larger stumps when the trees are harvested, thus creating habitats suitable for colonisation by *T. pellucida*.

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Figure 2 : *Tetraphis pellucida* growing on a rotten tree stump. Fertile plants with sporophytes grow alongside those with gemmae cups and gemmae stalks. Photo: Taken in the Jura, near Arzier, Vaud.

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