

A TAXONOMIC STUDY OF THE GENUS *SYNTRICHIA* BRID. (POTTIACEAE, MUSCI) IN THE MEDITERRANEAN REGION AND MACARONESIA

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ABSTRACT. A taxonomic revision of the genus *Syntrichia* Brid. (Pottiaceae, Musci) in the Mediterranean Region and Macaronesia has been carried out, thus contributing to knowledge of its distinguishing morphological characters, geographic distribution and nomenclature. Some 3000 specimens, including the most of type material, were studied. An identification key, morphological descriptions, photographs and numerous observations on taxonomic and nomenclatural problems of the 23 taxa accepted in the study area, are provided. New records for some countries of the Mediterranean basin and Macaronesia are given. Five new synonyms are proposed. The designations of 11 new lectotypes are included and the name *Syntrichia aciphylla* var. *calva* J.J. Amann is excluded from the genus *Syntrichia*.

I. INTRODUCTION

The family Pottiaceae is the largest in the class Bryopsida. It consists of acrocarpous mosses usually characterized by small, papillose leaf lamina cells, spherical, ovoid or cylindrical capsules, generally long setae, cucullate calyptrae and, when present, a simple peristome usually consisting of lanceolate or filamentous teeth. The family occurs mainly in temperate and mountainous regions, where the majority of its members grow on soil in a great variety of environments, and form a large component of ruderal vegetation in arid regions and alpine zones where desiccation is frequent (Cárdenas 1995).

With the intention of assisting accurate identification of members of the Pottiaceae in the Mediterranean Region, this work is centred on a taxonomic revision of the genus *Syntrichia* Brid., which until now has been the subject of partial treatises only.

The complexity of the genus *Syntrichia* is due to two factors: firstly, the high degree of polymorphism that the most of its taxa show, and secondly, its close relationship to the genus *Tortula* Hedw., another complex genus, which is regarded by many authors as congeneric with *Syntrichia*. Owing to its cosmopolitan distribution, it appears in most regional bryophyte treatments. There is not, however, a uniform use of differentiating characters, which would be desirable.

The most significant morphological character in these taxa is the anatomy of the costa, and for many authors that is the fundamental character for separating *Tortula* from *Syntrichia* (Kramer 1980, Ochyra 1992, Zander 1993). The structure of the costa is clearly seen in transverse section. In *Syntrichia*, the following groups of cells can be distinguished, in order from dorsal to ventral surface: 1–9 dorsal stereid rows, the presence or absence of

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substereids, the presence or absence of hydroids, 1-4 guide cell rows and 1 layer of cells similar to those of the lamina, which form a ventral epidermis (Fig. 1a-e). In *Tortula* a layer of sub-stereid dorsal cells form the characteristic dorsal epidermis of the genus (Fig. 1f), whereas *Syntrichia* lacks this differentiated dorsal epidermis. The shape of the dorsal stereid band in the transverse section of the costa has also been used to differentiate these two genera (Zander 1989). Crescent-shaped stereid bands are characteristic of *Syntrichia* (Fig. 1a-e), while those of *Tortula* are semicircular or rounded (Fig. 1f). Another character that differentiates *Syntrichia* from *Tortula* is the colour of the cell walls of the leaf lamina, after treatment with 2% KOH (Zander 1993). Thus, *Syntrichia* becomes reddish, as opposed to yellow or, more rarely, orange in *Tortula*. Zander (1993) recognises the taxonomic value of a sclerodermis and a hyalodermis in the stems, features which are present in *Syntrichia* but absent from *Tortula*. With regard to sporophyte characters, the height of the basal membrane of the peristome and the disposition of peristome teeth have been used to differentiate between *Tortula* and *Syntrichia*. According to Agnew & Vondráček (1975), Husnot (1884-1890), Mönkemeyer (1927) and Zander (1989), a high basal membrane, forming a tube at the base of the peristome, is characteristic of *Syntrichia*, whereas the lack of this structure, or a short membrane, characterizes *Tortula*. This distinction is not given emphasis in the present study, since some species of *Tortula* genus possess high, tubular peristome membranes (*T. inermis* (Brid.) Mont and *T. subulata* Hedw.), while others of *Syntrichia* have a short structure (*S. sinensis* (Müll. Hal.) Ochyra, *S. fragilis* (Taylor) Ochyra or *S. norvegica* F. Weber). As regards the peristome teeth, according to Agnew & Vondráček (1975) and Zander (1993), in *Syntrichia* these are spiral, comprising at least one turn, whereas in *Tortula* they are spiral with no more than one turn.

In the Mediterranean area and Macaronesia, the disparity of opinions on the attribution of species to *Syntrichia* and *Tortula*, is exemplified by two taxa: *T. bolanderi* (Lesq. & James) M. Howe and *T. inermis*. Some authors (Cortini-Pedrotti 2001, Kürschner 2000a, Zander 1993) consider them to be species of *Syntrichia*, *S. bolanderi* (Lesq. & James) R.H. Zander and *S. inermis* (Brid.) Bruch. However, following study and typification of type material of both taxa, Cano & Gallego (2003) concluded that they are two species of *Tortula*, since they possess a dorsal epidermis on the costa and an orange KOH reaction. Subsequently, Werner et al. (2003) verified this conclusion by a molecular study.

Zander (1993), in his general treatise on the family Pottiaceae, recognizes 82 species (150 taxa including varieties and forms) within the genus *Syntrichia* and Kramer (1980) in his monograph on the *Rurales* De Not. section of genus *Tortula* in the east Holartic region, accepts 16 species (29 taxa including varieties and subspecies). The present account recognizes 18 species and 5 varieties in the genus *Syntrichia* for the circum-Mediterranean area and Macaronesia: *Syntrichia calcicola* J.J. Amann, *S. caninervis* Mitt. var. *caninervis*, *S. caninervis* var. *abranchesii* (Luisier) R.H. Zander, *S. caninervis* var. *gypsophila* (J.J. Amann ex G. Roth) Ochyra, *S. caninervis* var. *pseudodesertorum* (Vondr.) M.T. Gallego, *S. echinata* (Schiffn.) Herrnst. & Ben-Sasson, *S. fragilis*, *S. handelii* (Schiffn.) S. Agnew & Vondr., *S. laevipila* Brid., *S. latifolia* (Bruch ex Hartm.) Huebener, *S. minor* (Bizot) M.T. Gallego, J. Guerra, M.J. Cano, Ros & M.C. Sánchez-Moya, *S. montana* Nees var. *montana*, *S. montana* var. *calva* (Durieu & Sagot ex Bruch & Schimp.) J.J. Amann, *S. norvegica*,

S. papillosa (Wilson) Jur., *S. papillosissima* (Copp.) Loeske, *S. princeps* (De Not.) Mitt., *S. rigescens* (Broth. & Geh.) Ochyra, *S. subpapillosissima* (Bizot & R.B. Pierrot ex W.A. Kramer) M.T. Gallego & J. Guerra, *S. ruralis* (Hedw.) F. Weber & D. Mohr var. *ruralis*, *S. ruralis* var. *ruraliformis* (Besch.) Delogne, *S. sinensis* and *S. virescens* (De Not.) Ochyra.

II. HISTORICAL REVIEW OF THE GENUS

The genus *Syntrichia* was established by Bridel (1801). Previously, some species of the genus had been included in *Barbula* Hedw., namely *B. ruralis* Hedw., *B. agraria* Hedw. and *B. ericetorum* With. Later, Weber & Mohr (1803) transferred the first two of these species to the genus *Syntrichia* and Bridel (1826) did the same with the third. Almost two centuries later, Zander (1995) transferred *B. agraria* to the genus *Hyophiladelphus* (Müll. Hal.) R.H. Zander, under the binomial *H. agrarius* (Hedw.) R.H. Zander. Over the years, most of the taxa that at present conform to the genus *Syntrichia*, have been considered, at different levels, to belong to genus *Tortula*. Thus, many authors have considered taxa within *Syntrichia* under a diversity of infrageneric levels within *Tortula*. For example, Lamarck & De Candolle (1806), created section *Syntrichia*, Chevalier (1827) designated subgenus *Syntrichia* and De Notaris (1838) described the *Rurales* section of the genus *Tortula*. Bruch et al. (1842) likewise placed *Syntrichia* in section *Rurales*, but this time in the genus *Barbula* Hedw. Nine years later, Bruch et al. (1851) treated *Syntrichia* as a subgenus of *Barbula*. Müller (1849) and Lesquereux & James (1884) defined two new sections for *Barbula*, named *Syntrichia* and *Syntrichiae*, respectively. Kindberg and Müller (1897) described two new sections, the *Ruraliformes* section of *Barbula* and the *Crispatae* section of *Syntrichia*, respectively. Currently, the first one corresponds to the genus *Syntrichia* and the second one corresponds to *Calyptopogon* (Mitt.) Broth. Monkemeyer (1927) describes two new sections for *Syntrichia*, named *Eusyntrichia* and *Zygotrichia*. Later, the section *Zygotrichia* was considered as the genus *Desmatodon* Brid. (Wijk et al. 1969) and the genus *Tortula* (Zander 1993), but not within the genus *Syntrichia*. Zander (1993) expanded the list of taxa placed in *Syntrichia* with the *Vallidens* section of the genus *Barbula* (described by Müller 1879), by transferring *Barbula percanosa* Müll. Hal., the type of this section, to the genus *Syntrichia*. Finally, Zander (1993) describes two new sections for *Syntrichia*, named *Collo-tortula* R.H. Zander and *Aesiotortula* R.H. Zander. Neither of these is accepted in this work, as will be further explained in the "Taxonomic treatment", with respect to the species *S. papillosa* (Wilson) Jur. and *S. laevipila* Brid. There are many authors who do not regard *Syntrichia* as a distinct genus from *Tortula* Hedw. (cf. Catcheside 1980, Crum & Anderson 1981, Lawton 1971, Magill 1981, Mishler 1994, Noguchi 1988, Saito 1975). Others, such as Augier (1966), Bilewsky (1965), Brotherus (1924) or Dixon (1970) regard the genus *Syntrichia* as the section *Rurales* of the genus *Tortula*. Kramer (1980) and Corley et al. (1981) group the species of the genus *Syntrichia* in this section, although they do not agree on the taxa that should be included. Zander (1989, 1993) ascribed this section to the genus *Syntrichia*, providing convincing characters that *Syntrichia*, (with *S. ruralis* var. *ruralis* as type species) should be regarded as a separate genus from *Tortula*.

Following Anderson (1997), Gallego et al. (2002a), Ochyra (1992), Smith (2004) and Zander (1989, 1993) in the present study the combination of characters that define *Syn-*

trichia are regarded as sufficient to justify its segregation as a separate genus.

III. GENERAL MORPHOLOGY

Material and Methods

This study is based on herbarium specimens from circum-Mediterranean countries, held in 60 herbaria in Europe, North America and Australia. The results and conclusions are derived from an analysis of approximately 3000 specimens of genus *Syntrichia*, including the majority of types of the 23 taxa that occur in the study area and their synonyms. In addition, the nature of the type is indicated (holotype, lectotype, etc.) and the herbarium where it is placed. When the type material has not been located, the herbaria from which this material was requested are indicated and the locotypic indication (Ind. loc.) is specified. When the material has been seen, the herbarium is indicated with “!”. When type material has been requested from the author’s herbarium, and no response has been received, the herbarium acronym is followed by “?”. The majority of studied specimens were borrowed from B, BCB, BCC, BM, BR, C, CANM, COL, DUKE, E, EGR, FH, FI, G, GE, GZU, H, H-BR, H-SOL, HBG, JNA, JE, K, L, LE, LISU, LU, M, MADJ, MAK, MA-Musci, MEL, MGC, MICH, MO, MUB, NY, O, OXF, PAD, PAL, PC, PO, PRC, PRE, RO, SALA-Bryo, SIENA, SOM, TFC, TR, TUB, U, UPS, VAB, W, WVA, ZT, herb. T.L. Blockeel, herb. J.-P. Frahm, herb. W. Frey, herb. H. Kürschner, herb. R.B. Pierrot, herb. C.C. Townsend, herb. B.O. van Zanten.

General morphology was examined using a Zeiss-Stemi 1000 light microscope. Photomicrographs were taken with a camera attached to an Olympus-BH2 light microscope. Comparative observations of the leaf surface and of peristome structures were made with a Jeol JSM-6100 scanning electron microscope. Peristomes were sampled from mature capsules. The material was fixed in 3% glutaraldehyde with 0.1 M cacodylate buffer at 4°C, washed in cacodylate and saccharose buffer, dehydrated in an increasing acetone gradient (30%–50%–70%–90% and 100%), critical-point dried and sputtered with a gold layer of 200–300 Å before being photographed with a Jeol JSM-6100 microscope, using 10–25 kv acceleration.

In “Selected specimens examined” only two or three specimens per geographical area have been listed. A complete list of specimens studied is available upon request from the author. For Mediterranean and world-wide distributions, the work of Düll (1984, 1992) and Hill et al. (1992) have been followed. In addition, available checklists of Mediterranean countries have been consulted and floristic works of countries which do not have checklists, such as Albania and France (Table 1).

For some species, very few collections or only the type locality are known and thus the data are incomplete.

The geographical records are supported by herbarium material, or they are bibliographic, as indicated by round brackets. If a geographic locality is unclear from the literature, the record is followed by “?”.

Table 1. Bibliographic references used for circum-Mediterranean and Macaronesian Islands distribution.

Country	Checklists or floristic works*
Albania	Karpati & Vajda (1961)*
Andorra	Gallego (2002)
Algeria	Ros et al. (1999)
Bosnia-Herzegovina	Düll et al. (1999)
Bulgaria	Ganeva & Düll (1999)
Cyprus	Frey & Kürschner (1991); Blockeel (2003)
Croatia	Düll et al. (1999)
Egypt	El Saadawi et al. (1999)
Slovenia	Düll et al. (1999)
Spain	Gallego (2002)
Balearic Islands	Casas et al. (2001); Gallego (2002)
Canary Islands	Losada-Lima et al. (2001); Gallego (2002)
France	Augier (1966)*
Corsica	Hébrard (1986) *
Greece	Düll (1995)
Crete	Düll (1995)
Israel	Frey & Kürschner (1991); Herrnstadt et al. (1991)
Italy	Cortini-Pedrotti (2001)
Sardinia	Cortini-Pedrotti (2001)
Sicily	Cortini-Pedrotti (2001)
Jordan	Frey & Kürschner (1991)
Lebanon	Frey & Kürschner (1991)
Libya	El-Hinshiri & Nizamuddin (1986); Ros et al. (1999)
Macedonia	Düll et al. (1999)
Morocco	Ros et al. (1999)
Portugal	Sérgio & Carvalho (2003)
Azores	Eggers (1982)
Madeira	Eggers (1982)
Syria	Frey & Kürschner (1991)
Tunisia	Ros et al. (1999)
Turkey	Uyar & Çetin (2004)
Yugoslavia	Düll et al. (1999); Sabovljevic & Stevanovic (1999)

Results and Discussion

The main morphological characters that define and differentiate the taxa of the genus *Syntrichia* in the study area are presented, with special attention to the taxonomic value of each character at generic and specific levels.

I. Habit

All the treated species grow forming more or less dense turfs, depending on the substrate on which they have developed, and the environmental conditions to which they have been exposed. For that reason, this character lacks taxonomic value.

2. Colour of the plants

The photosynthetically active leaves, are generally bright green to olive-green in colour, becoming a darker blackish-brown with increasing age or exposure to adverse conditions. Young gametophytes sometimes have a reddish brown tone to their upper parts due to the greater thickness of the cell walls, perhaps providing protection from the high solar radiations they have to withstand.

In general, when papillae on the leaf cells are large, a glaucous tone is observed in the gametophyte, as in *Syntrichia echinata*, *S. minor* and *S. papillosissima*.

3. Size of the plants

Shoots vary from 0.15 to 9 cm in length. Taxa like *Syntrichia caninervis* var. *caninervis*, *S. caninervis* var. *abranchesii*, *S. latifolia*, *S. minor*, *S. papillosa* and *S. virescens* do not usually reach more than 2 cm in length. However, others like *S. caninervis* var. *pseudodesertorum*, *S. ruralis* and *S. subpapillosissima* generally exceed 2 cm.

4. Rhizoids

All species possess smooth, branched rhizoids at the basal zone of the stems, varying from brown to reddish brown in colour. Taxa of greater size (*Syntrichia ruralis* var. *ruraliformis*, *S. ruralis* var. *ruralis* or *S. princeps*) have tomentose stems, a feature which has not been observed in smaller plants 1 cm in length (*S. caninervis* var. *caninervis*, *S. latifolia*, *S. papillosa* and *S. virescens*).

5. Stems and branching pattern

The stems are erect and generally branched. Although no direct relationship has been established, those of a smaller size are usually unbranched. Sometimes the ramifications develop as basal innovations. Stems are rounded in transverse section, with or without a differentiated central strand, sometimes displaying a sclerodermis or hyalodermis (Zander 1993).

6. Leaves

6.1. Orientation

When dry, the leaves are spirally twisted, crisped or loosely appressed. When moist, they vary from erecto-patent to squarrose. This character serves to differentiate two great groups of species within the genus *Syntrichia*: those that generally have erectopatent, patent or spreading leaves when moist (*S. calcicola*, *S. caninervis* var. *abranchesii*, *S. echinata*, *S. fragilis*, *S. latifolia*, *S. montana*, *S. papillosa*, *S. princeps*, *S. sinensis* and *S. virescens*) and those that usually have recurved or squarrose leaves (*S. caninervis* var. *pseudodesertorum*, *S. minor*, *S. norvegica*, *S. papillosissima*, *S. ruralis* and *S. subpapillosissima*). A third group of taxa exists in which the leaves may be spreading or patent when moist, and sometimes appear recurved (*S. caninervis* var. *caninervis*, *S. caninervis* var. *gypsophila*, *S. handelii*, *S. laevipila* and *S. rigescens*).

6.2. Shape

This is a very variable character within the genus. The leaves can be ovate (*Syntrichia caninervis* var. *caninervis*), ovate-lingulate (*S. calcicola*, *S. rigescens*, *S. ruralis* var. *ruralis*), ovate-lanceolate (*S. caninervis* var. *pseudodesertorum*, *S. ruralis* var. *rurali-*

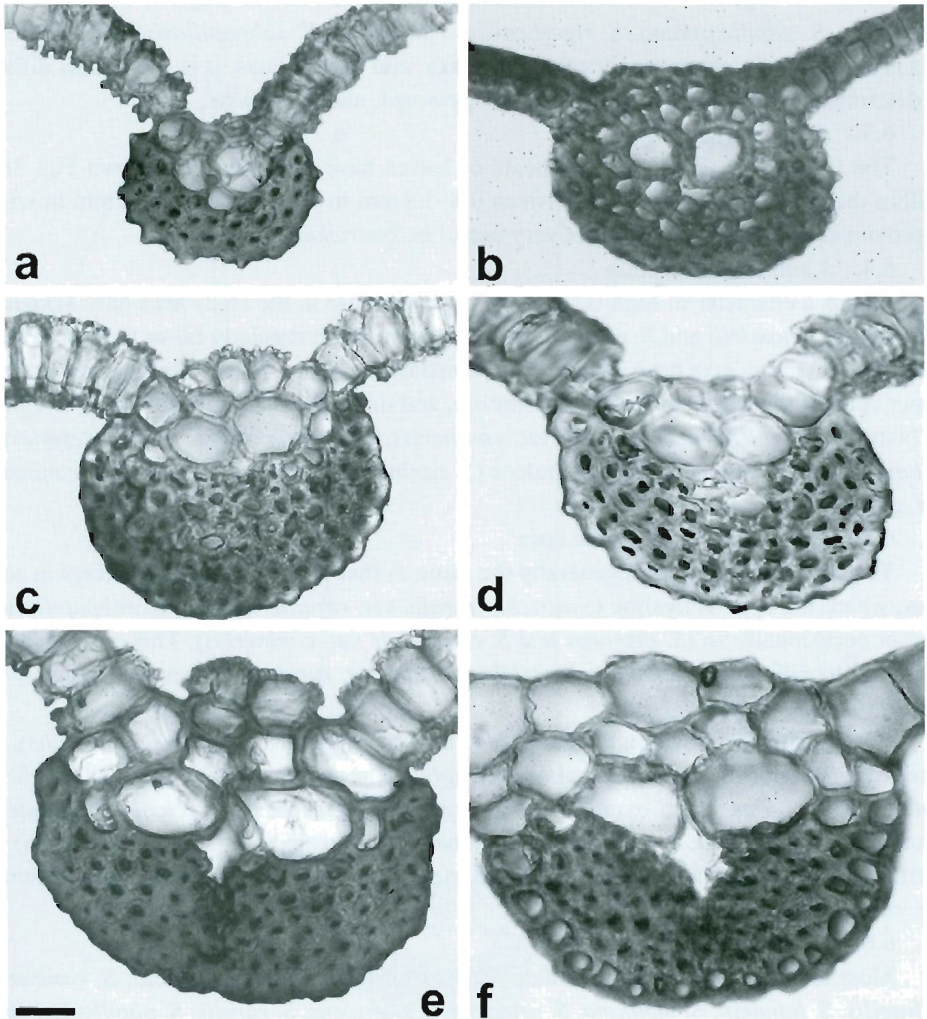


Fig. 1. Light microscope photographs of transverse section in the middle of the leaves: a. *Syntrichia ruralis* (MUB 2717); b. *S. caninervis* var. *gypsophila* (MUB 4365); c. *S. laevipila* (MUB 5744); d. *S. montana* (MUB 11391); e. *S. princeps* (MUB 11851); f. *Tortula inermis* (VAB 4091). Scale bars: a=25 μ m; b–f=16 μ m.

formis), ovate-elliptical (*S. papillosissima*), lingulate (*S. montana*, *S. norvegica*, *S. princeps*), lingulate-spathulate (*S. fragilis*, *S. latifolia*, *S. virescens*) or spathulate (*S. papillosa*). The shape may vary within a taxon, for example in *S. laevipila* (from lingulate to spathulate) or in *S. echinata* (from ovate to lingulate-spathulate).

A useful character within the genus is midleaf constriction, which serves to separate two large groups, those that have constricted leaves (*Syntrichia echinata*, *S. laevipila*, *S. latifolia*, *S. minor*, *S. montana*, *S. sinensis* and *S. virescens*) and those that do not have a

constriction at midleaf (*Syntrichia calcicola*, *S. caninervis*, *S. fragilis*, *S. handelii*, *S. norvegica*, *S. papillosissima*, *S. rigescens*, *S. ruralis* and *S. subpapillosissima*). Although this is an important character for separating taxa, and even groups, it is sometimes difficult to determine, for example, in *S. echinata*, *S. princeps*, and *S. sinensis*.

6.3. Size

The length and width measurements of leaves have been taken as shown Fig. 2c-d. Within the genus, leaf size varies between 0.8–5.8 mm in length and 0.3–2.2 mm in width, approximately. This character is not very useful in *Syntrichia*.

6.4. Lamina stratification

This is a character of high taxonomic value, because in the study area only *Syntrichia caninervis*, *S. handelii* and *S. rigescens* possess leaves with regularly bi- or tristratose laminae. The remaining taxa have leaves with a unistratose lamina. These three species have the upper zone of the leaves bi- or even tristratose, and the midleaf zone, regularly or irregularly bistratose (*Syntrichia caninervis* var. *caninervis*, *S. caninervis* var. *pseudodesertorum*, *S. handelii* and *S. rigescens*) or unistratose (*S. caninervis* var. *abranthesii* and *S. caninervis* var. *gypsophila*).

6.5. Colour and shape of the apex

The colour of the apex is generally the same as that of the leaf lamina, except in some taxa, where the apex is hyaline (*Syntrichia ruralis* var. *ruraliformis* and *S. subpapillosissima*) or occasionally so (*S. princeps* and *S. caninervis* var. *caninervis*). This is a diagnostic character to differentiate between *Syntrichia ruralis* var. *ruralis* and *Syntrichia ruralis* var. *ruraliformis*.

Apex shape varies within the genus, and may be rounded (*S. papillosa*, *S. ruralis*), obtuse (*S. princeps*, *S. sinensis*), apiculate (*S. fragilis*, *S. montana* var. *calva*), cucullate (*S. caninervis* var. *caninervis*, *S. caninervis* var. *gypsophila*), acute (*S. calcicola*, *S. handelii*), emarginate (*S. latifolia*, *S. virescens*), acuminate (*S. norvegica*, *S. subpapillosissima*), tapering into a hair point (*S. papillosissima*, *S. ruralis* var. *ruraliformis*) or dentate (*S. ruralis* var. *ruraliformis*, *S. subpapillosissima*).

6.6. Margins

Most taxa have papillose-crenulate leaf margins (*Syntrichia calcicola*, *S. caninervis*, *S. fragilis*, *S. handelii*, *S. montana*, *S. princeps*, *S. rigescens*, *S. ruralis*, *S. papillosissima*, *S. sinensis*, *S. subpapillosissima*, etc.) or papillose margins (*S. echinata*, *S. latifolia*, *S. minor*, *S. papillosa* and *S. papillosissima*). Entire margins occur only in some forms of *S. laevipila* which have a differentiated border of smooth cells. The remainder of the species do not have differentiated leaf margins. Therefore, this character serves only to separate *S. laevipila* from the rest of the taxa, not in all cases, since there are forms of *S. laevipila* that lack differentiated margins. The curvature of the margins is, however, a very useful character which separates taxa into two large groups: taxa that usually have plane leaf margins (*S. laevipila*, *S. latifolia*, *S. minor*, *S. papillosa* and *S. virescens*) and those that have recurved margins (*Syntrichia calcicola*, *S. caninervis*, *S. echinata*, *S. fragilis*, *S. handelii*, *S. montana*, *S. norvegica*, *S. papillosissima*, *S. princeps*, *S. rigescens*, *S. ruralis*, *S. sinensis*, *S. subpapillosissima*). *Syntrichia sinensis* and *S. norvegica* are variable in this respect. Only *S. papillosa* shows incurved margins, and only occasionally.

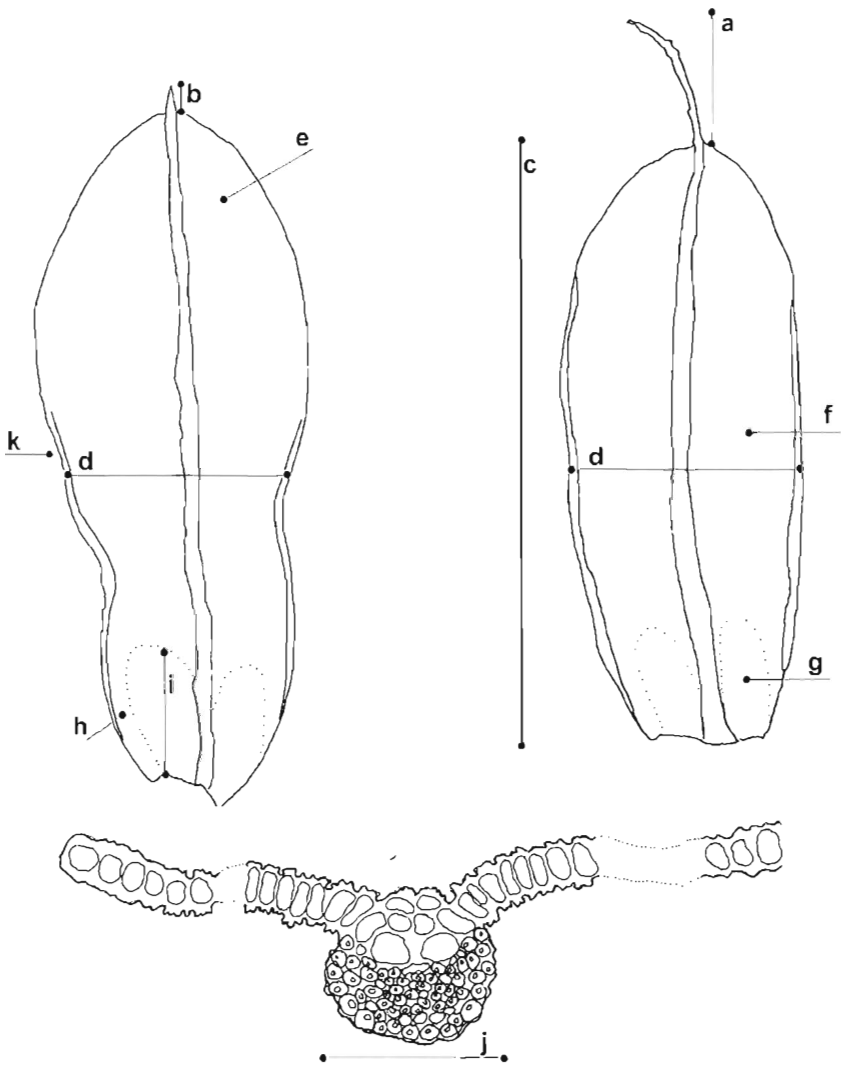


Fig. 2. Illustrations for measurements and terms: a. Hair point length. b. Mucro length. c. Leaf length. d. Leaf width. e. Upper lamina cells. f. Mid-lamina cells. g. Juxta-costal basal cells. h. Marginal basal cells. i. Differentiated hyaline area. j. Costa width. k. Area of transverse section of the leaf.

The length of the margin curvature with respect to the overall length of the leaf is a character of high diagnostic value. The margins may be recurved in the lower third of the leaf only (*S. sinensis*), as far as mid leaf (*S. norvegica*, *S. montana*), as far as the upper third (*S. echinata*, *S. fragilis*, *S. princeps*) or until the leaf apex (*S. caninervis*, *S. handelii*, *S. papillosum*, *S. rigescens*, *S. ruralis*, *S. subpapillosum*).

6.7. Hair point

This is a useful character in the taxonomy of the genus, not only in terms of its presence or absence, but also in the variability of its ornamentation. Four taxa lack a hair point (*Syntrichia caninervis* var. *abrangesii*, *S. fragilis*, *S. latifolia* and *S. montana* var. *calva*). For those that possess a hair point, the ornamentation varies from smooth (*S. laevipila*, *S. papillosa* and *S. sinensis*), spinulose (*S. calcicola*, *S. minor*, *S. norvegica*, *S. rigescens* and *S. virescens*) to strongly spinose (*S. caninervis* var. *caninervis*, *S. caninervis* var. *gypsophila*, *S. caninervis* var. *pseudodesertorum*, *S. echinata*, *S. handelii*, *S. montana*, *S. papillosissima*, *S. princeps*, *S. ruralis* and *S. subpapillosissima*).

The colour of the hair point is diagnostic only in the case of *S. norvegica*, which has orange or reddish hair points. The rest of the taxa present hyaline hair points throughout, although the base or up to the middle of hair point is sometimes brown.

6.8. Costa

The number of stereid rows and the presence/absence of substereid rows and hydroids, as seen in costa transverse section, differentiates certain taxa. Those with few stereid rows, *S. caninervis* var. *abrangesii*, *S. minor* and *S. virescens* with 1–2(3) stereid rows and *S. latifolia* with 2–3, can be distinguished from *S. echinata*, *S. laevipila* and *S. princeps* with 3–7 rows, and *S. montana* with (4)5–9 rows. The presence of substereid rows (Fig. 1b) is a characteristic of *S. caninervis*, *S. handelii* and *S. rigescens*, and may sometimes be seen in *S. virescens*.

The absence (Fig. 1a) or presence of hydroids (Fig. 1b–e) divides the taxa into two groups: those that have hydroids (*S. caninervis*, *S. echinata*, *S. fragilis*, *S. handelii*, *S. laevipila*, *S. latifolia*, *S. montana*, *S. papillosa*, *S. princeps*, *S. rigescens* and *S. sinensis*) and those that lack them (*S. calcicola*, *S. minor*, *S. norvegica*, *S. papillosissima*, *S. ruralis*, *S. subpapillosissima* and *S. virescens*).

Another useful character is the papillosity of the dorsal side of the costa. The papillae may be simple (*S. fragilis*) (Fig. 3a), bifurcate (*S. latifolia*) (Fig. 3b) or branched (*S. caninervis* var. *caninervis*) (Fig. 3c), and pedicellate or not. Papillae may be bifurcate but not pedicellate (*S. norvegica*, *S. princeps*, *S. ruralis*) (Fig. 3d), bifurcate and pedicellate (*S. caninervis* var. *pseudodesertorum*, *S. papillosa*) (Fig. 3e) or branched and pedicellate (*S. caninervis* var. *gypsophila*, *S. papillosa*) (Figs. 3f, e). In addition, within the *S. caninervis*, *S. handelii* and *S. rigescens*, the disposition of this last type of papilla is a diagnostic character, since papillae may be located only in the distal third of the costa (*S. caninervis* var. *abrangesii* and *S. caninervis* var. *gypsophila*) or throughout (*S. caninervis* var. *caninervis*, *S. caninervis* var. *pseudodesertorum* and *S. rigescens*). Only in *S. laevipila* is the abaxial surface of the costa always smooth. In other species, *S. montana* and *S. sinensis*, the costa is normally papillose, but may sometimes appear smooth.

Measurements of costa width have been taken at midleaf (Fig. 2j) and range from 60 to 188 μm .

6.9. Areolation: size and shape

Lamina cell shape has no taxonomic value. Measurements of width and length were made from basal juxtacostal, upper and mid-lamina cells (Fig. 2g, e, f).

With reference to the size of the upper and mid-lamina cells, it has been found that

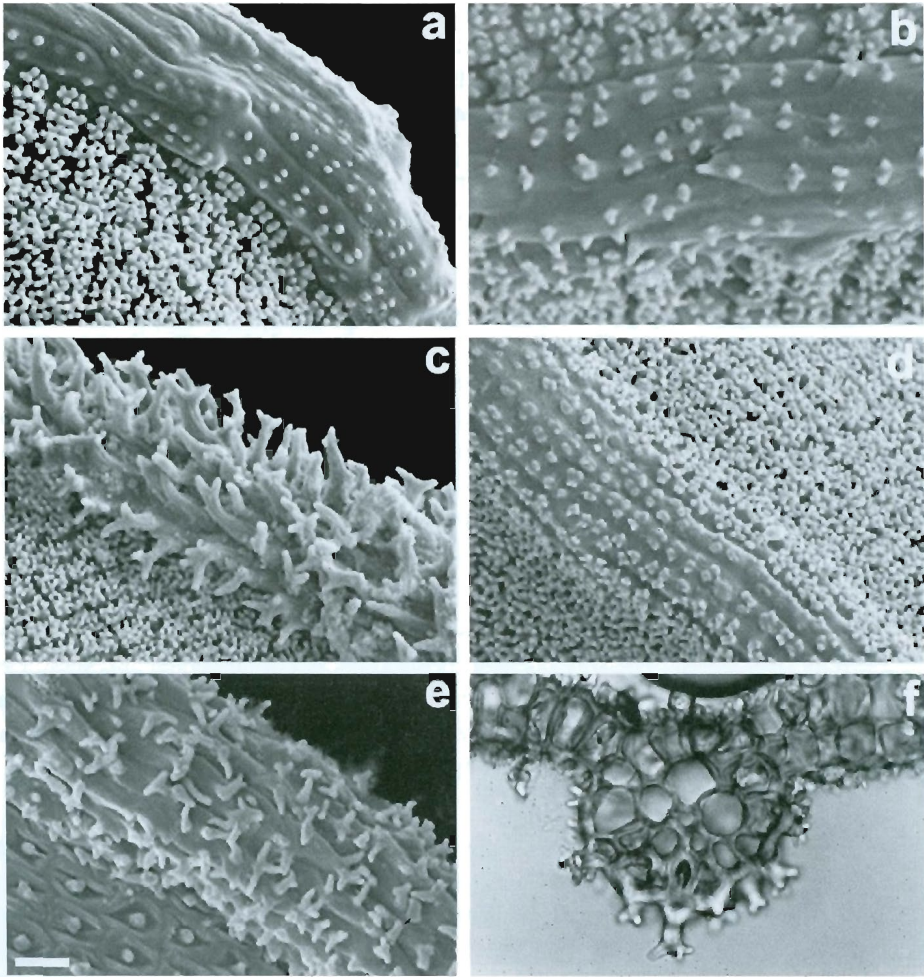


Fig. 3. SEM and light microscope photograph of the papillosity of the back of the costa: a. *Syntrichia fragilis* (MUB 11753); b. *S. latifolia* (LISU 154561); c. *S. caninervis* (Staiton & Henderson 5161A, E); d. *S. norvegica* (BCB 26799); e. *S. papillosa* (MUB 5695); f. *S. caninervis* var. *gypsophila* (MUB 4365), upper part of the leaf. Scale bars: a = 18 μm ; b = 30 μm ; c = 15 μm ; d = e = 25 μm ; f = 20 μm .

cell length is more or less uniform, while the width varies between 5 and 22.5 μm and may be used to differentiated closely related taxa, such as *S. montana* and *S. princeps*, or *S. calcicola*, *S. papillosissima*, *S. ruralis* and *S. subpapillosissima*.

6.10. Number, length, position and shape of the papillae of lamina cells in the distal part and at midleaf.

Lamina cell papillosity is a very important character in the genus *Syntrichia* but only recently has its taxonomic importance been recognised. This character has been used to

differentiate between *S. calcicola*, *S. papillosissima*, *S. ruralis* and *S. subpapillosissima* and between *S. virescens* and *S. minor*, two related species which can be easily distinguished by the type and number of papillae per cell (Gallego et al. 2000). Likewise, distinction can be made between *S. princeps* and *S. echinata*, and between *S. papillosa* and *S. subpapillosa* (Matteri 1994).

The number of papillae per cell ranges from 1 (*S. echinata*, *S. minor*, *S. papillosa* and *S. papillosissima*) to 12 (*S. princeps* and *S. sinensis*), on both the dorsal and ventral surfaces of the leaf.

Syntrichia papillosa has papillae on the dorsal side only (Fig. 4a) and may thus be distinguished from all the other taxa, which have papillae on both dorsal and ventral surfaces of the lamina (Fig. 4b).

Papillae length ranges from 2.5 μm (*S. ruralis*) to 22.5 μm (*S. echinata*).

Three basic papilosity shapes on the cell surface can be distinguished in *Syntrichia*: (1) simple unbranched papillae, sometimes verrucose, as in *S. papillosa* (Fig. 4c); (2) bifurcate papillae (or mammillae), pedicellated (*S. subpapillosissima*) (Fig. 4d) or not (*S. princeps*) (Fig. 4e); (3) branched pedicellated papillae (or mammillae), (*S. echinata*, *S. minor*, *S. papillosissima*) (Fig. 4f). The cells may be unipapillose or multipapillose.

7. Seta

The seta is elongate, erect and spirally twisted to the right above and to the left below, or to the right throughout. The way the seta forms knots is not taxonomically significant. Seta colour changes from yellowish-green when young to reddish-brown at maturity. Seta length ranges from 0.45–3.1 cm. *Syntrichia laevipila*, *S. latifolia*, *S. minor* and *S. papillosa* have short setae, while *S. princeps* has the longest.

8. Capsule

The shape of the capsule varies from ovoid (*Syntrichia norvegica*), ovoid-cylindrical (*S. caninervis* var. *caninervis*, *S. papillosa* and *S. virescens*) to cylindrical (*S. laevipila*, *S. latifolia*, *S. montana* and *S. sinensis*). Capsules are erect (*S. calcicola*, *S. caninervis*, *S. handelii* and *S. papillosa*) or slightly curved (*S. latifolia*, *S. norvegica*, *S. ruralis* and *S. sinensis*). Their size varies between 1.3–6 mm in length and 0.3–1.1 mm in width. *Syntrichia princeps* has the longest and narrowest capsules, while *S. papillosa* has the widest and shortest capsules. Commonly, *Syntrichia* capsules have a brown or reddish-brown colour at maturity. The exothecial cells are smooth, quadrate or rectangular, with thin or thickened walls and have no taxonomic value. The annulus cells are quadrate, rounded or rectangular, from 12.5 to 17.5 μm width and differentiated in 1–4 rows.

9. Peristome

The peristome is formed by 32 filamentous teeth and a differentiated basal membrane formed by 3–42 rows of papillose cells. The teeth are densely spiculate, with many articulations, are yellowish to reddish-brown in colour, and are spirally twisted when dry. The length of teeth has no taxonomic value, although *S. fragilis* and *S. virescens* usually have short teeth, and *S. ruralis* the longest. The taxonomic value of the peristome lies in the length of the basal membrane, which varies from 0.09 to 1.4 mm. *Syntrichia fragilis*, *S. minor*, *S. norvegica*, *S. sinensis* and *S. virescens* have a short basal membrane, which does

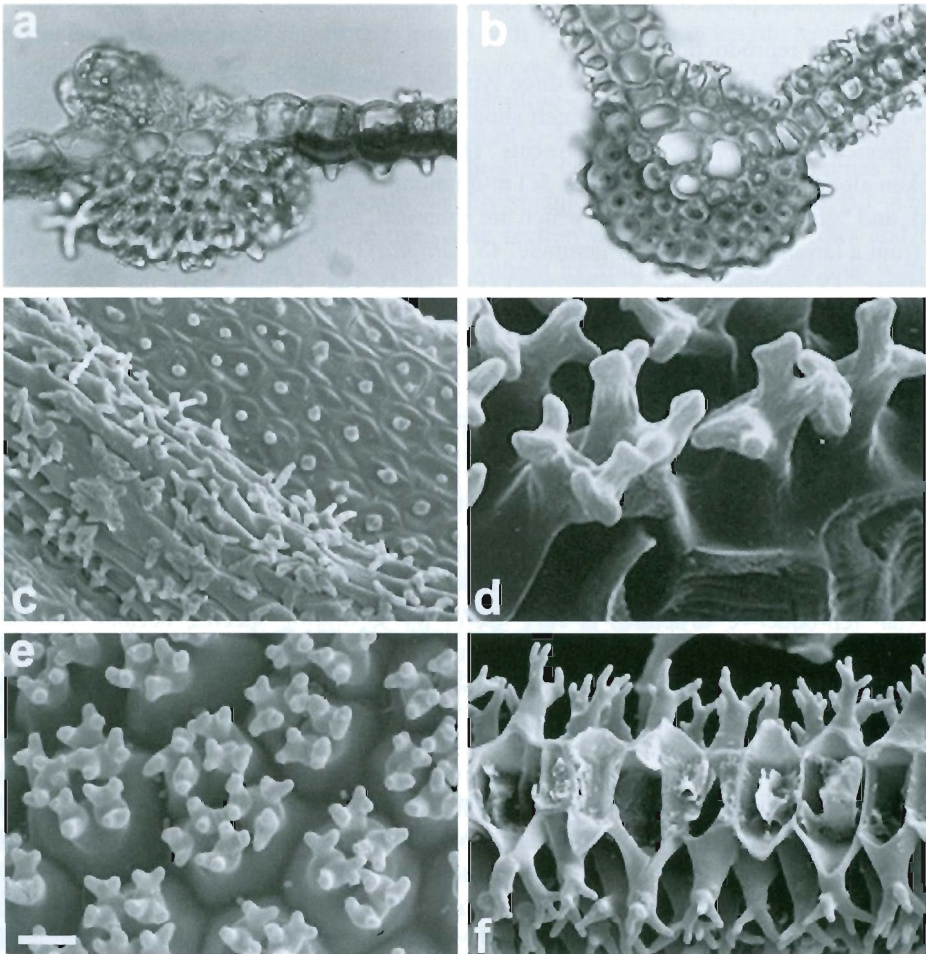


Fig. 4. SEM and light microscope photographs of the papillosity of the leaf cells: a, c. *Syntrichia papillosa* (MUB 5695); b. *S. papillosissima* (MUB 10100); d. *S. subpapillosissima* (MGC 885); e. *S. princeps* (BR 182310); f. *S. echinata* (David & Polunin 25942b, E). Scale bars: a=22 μm ; b=20 μm ; c=25 μm ; d=6 μm ; e=8 μm ; f=15 μm .

not exceed 0.35 mm in length, while this length is exceeded in the rest of the taxa.

10. Operculum

The opercula are all conic, their length varying from 1 to 2.7 mm.

11. Calyptra

All taxa have cucullate and conic calyptra, from 3 to 4.5 mm in length.

12. Spore

Viewed with the light microscope, most of spores are spherical, light brown and with a papillose ornamentation. Spore size varies from 5 μm to 25 μm (*S. laevipila*). In *Syn-*

trichia laevipila, spores of two different sizes in the same capsule have been observed.

13. Asexual reproduction

Species of *Syntrichia* produce three types of vegetative diaspore (Newton & Mishler 1994): “brood leaves” (Fig. 5a), which show a similar morphology to the young leaves of the species (*S. laevipila*); “leaf fragments” (Fig. 5b), which are produced when leaves are broken along lines of weakness (Fig. 5c) into random fragments or individual cells (*S. fragilis*); and “gemmae” sensu stricto, which are spherical, ovoid or rounded and may be initiated from a lamina cell, “laminar gemmae” (*S. latifolia*) (Fig. 5d) or from costa cells, “costal gemmae” (*S. papillosa* and *S. rigescens*) (Fig. 5e–f). Two of these have the same type of papillosity as leaves, while gemmae are smooth. The vegetative diaspores are pluricellular and sessile, unicellular diaspore being very rare in Pottiaceae (Zander 1993). Their position varies depending on the type of asexual diaspore. Brood leaves arise at the apex of the stem or in the axils of the upper leaves. Gemmae apparently arise individually on the ventral side of the leaves, on the costa, or throughout the lamina surface, and although according to Correns (1899), they can be grouped in rows of from 2 to 6 gemmae, this has not been observed in the present study.

Gemma size varies from 25 to 50 μm long and 27.5 to 50 μm wide, and the brood leaves from 150 to 600 μm long and 70 to 200 μm wide. The presence or absence of these asexual reproductive structures is very useful for separating species, because generally, they are always present in taxa that produce them. Only *S. laevipila* is an exception, since this species may produce brood leaves or not, perhaps as a response to stress, and hence they have no taxonomic relevance (Gallego et al. 2004).

14. Sexual condition

The terminology used in this paper is that proposed by Wyatt (1985) and recommended by Zander (1993). Species treated in this work may be dioicous, synoicous or autoicous. Perichaetial leaves of *Syntrichia* are not substantially different from vegetative leaves, except sometimes they may be of greater length. Perichaetia are invariably terminal. The perigonial leaves are generally smaller and wider than vegetative leaves, and they sometimes lack a hair point, or it is short. In autoicous plants perigonia are axillary, and are sometimes very difficult to locate.

IV. TAXONOMIC TREATMENT

Syntrichia Brid., J. Bot. (Schrader) 1: 299. 1801.

Lectotype: *Syntrichia ruralis* (Hedw.) F. Weber & D. Mohr var. *ruralis*, designated by Zander (1989)

Etymology: According to Zander (1993) “the peristome teeth are fused at the base into a cone”.

Plants 0.2–9 cm high, growing in dense or open turfs, generally olive-green, occasionally reddish, reddish brown or glaucous. Stems erect, branched, sometimes with basal innovations, with or without a differentiated central strand. Leaves spirally twisted, crispate or appressed when dry, from erecto-patent to squarrose when moist, 0.9–5.8 \times 0.3–2.2 mm, ovate, ovate-lanceolate, lanceolate, ovate-lingulate, lingulate, lingulate-spathulate or spathulate, constricted or not at midleaf, unistratose or bistratose, sometimes tristratose in

upper third; apex rounded, obtuse, acute or emarginate, sometimes tapering into hair point, dentate, cuculate, apiculate, mucronate, mucro with 17.5–105 μm in length, hyaline or concolorous with the lamina; margins plane or recurved one third, half, or two thirds of the length of the leaf, sometimes totally, usually papillose-crenulate, sometimes smooth, unistratose, bordered or not, with border consisting of 2–5 rows of thicker-walled and less papillose cells, sometimes smooth, brown or yellowish; hair point hyaline, sometimes brown at base, red or orange coloured, smooth, weakly spinulose or strongly spinose, 0.1–4 mm; costa 60–188 μm wide at midleaf, in transverse section with 1–4 guide cell rows and 1–9 crescent-shaped dorsal stereid rows, with or without hydroids; on the dorsal side with or without papillae; when present papillae are from simple not pedicellate to branched and pedicellate, 2.5–37.5 μm high, ventral epidermis present, the dorsal absent; upper and mid-lamina cells quadrate, rectangular, hexagonal or rounded, thin or thick walls, 5–27.5 \times 5–22.5 μm , with 1–12 papillae per cell, bifurcate, trifurcate or branched, pedicellate or not, 2.5–22.5 μm high, rarely smooth; juxtacostal basal cells quadrate or rectangular, 20–137.5 \times 7.5–50 μm , hyaline or chlorophyllose, with thin or thick walls, sometimes colenchymatous, smooth, forming a clearly differentiated hyaline area, up to 14–50% of leaf length, or sometimes scarcely differentiated; marginal basal cells chlorophyllose, in 3–24 columns, generally smooth. Vegetative diaspores (brood leaves) multicellular, generally present, at the stem apex or in the axils of the upper leaves, often forming a rosette there, lanceolate, elliptical or ovate, 110–500(900) \times 35–300 μm , apical hyaline cell with or without papillae, 20–100 μm long, with or without costa, green, papillose; (costal gemmae) multicellular, generally present, on the ventral side of the costa in the upper half or third of the leaf, globular, elliptical, ovate or rounded, 25–75 \times 27.5–50 μm , sessile, green or brown, smooth; (laminar gemmae) multicellular, generally present, on the ventral side of the leaf on the lamina, globular, ovate or rounded, 25–45 \times 25–37.5 μm , sessile, green or brown, smooth. Dioicous, autoicous or synoicous. Seta erect, 0.45–3.1 cm long, spirally twisted to right above, to left below or to right throughout, reddish brown. Capsule erect, sometimes inclined, cylindrical or ovoid-cylindrical, 1.3–6 \times 0.3–1.1 mm, brownish, exothecial cells quadrate, rectangular, with thin or thick walls, smooth; annulus of 1–4 rows of quadrate to rectangular cells, 12.5–17.5 μm in width. Peristome of 32 papillose, spirally twisted teeth, 0.2–1.8 mm high; basal membrane of 3–42 rows of cells, 0.09–1.4 mm high. Operculum long conical, 1–2.7 mm high. Calyptra cucullate, long conical, 2–4.5 mm high. Spores spherical, 7.5–25 μm in diameter, papillose. Laminal KOH colour reaction reddish or brick red.

KEY TO THE MEDITERRANEAN AND MACARONESIAN TAXA OF *SYNTRICHIA*

- | | |
|--|------------------------|
| 1. Plants with vegetative diaspores | 2 |
| 1. Plants without vegetative diaspores | 5 |
| 2. Vegetative diaspores in the form of brood leaves, at the stem apex or in the axils of the upper leaves, often forming a rosette at the shoot apex | 1. <i>S. laevipila</i> |
| 2. Vegetative diaspores globular, ovate or rounded, smooth, arising on the ventral side of the leaf (laminar or costal gemmae) | 3 |
| 3. Leaf without hair point; laminar gemmae | 2. <i>S. latifolia</i> |

- 3. Leaf with hair point; costal gemmae 4
- 4. Upper and mid-lamina cells with 1–2 simple, sometimes bifurcate, papillae per cell, only on dorsal side of the lamina; lamina unistratose; leaf margins plane or slightly incurved to the apex 3. *S. papillosa*
- 4. Upper and mid-lamina cells with 6–10 bifurcate papillae per cell, on dorsal and ventral side of the lamina; upper third and middle zone of the lamina irregularly bistratose; leaf margins recurved up to the upper third of the apex 4. *S. rigescens*
- 5. Upper third of lamina bistratose 6
- 5. Upper third of lamina unistratose 10
- 6. Lamina regularly or irregularly bistratose at midleaf. 7
- 6. Lamina unistratose at midleaf 9
- 7. Dorsal side of the costa weakly papillose, with simple, not pedicellate papillae; leaf margins recurved up to the upper third, sometimes up to the apex, sometimes constricted at midleaf; costa generally without substereids 5. *S. handelii*
- 7. Dorsal side of the costa strongly papillose, with simple, bifurcate, or pedicellate and branched papillae; leaf margins recurved to the apex, not constricted at midleaf; costa generally with substereids 8
- 8. Plants 0.4–1.1 cm high; leaves mostly patent or spreading, rarely recurved when moist; costa 75–115 μm wide, with simple, bifurcate, or pedicellate and branched papillae on the dorsal side, 2.5–30 μm high 6. *S. caninervis* var. *caninervis*
- 8. Plants 2.5–7 cm high, leaves mostly recurved, rarely spreading when moist; costa 120–135 μm wide, with bi-trifurcate, pedicellate and stellately branched papillae on the dorsal side, (15)17.5–25 μm 7. *S. caninervis* var. *pseudodesertorum*
- 9. Leaf without hair point; costa with bifurcate or branched papillae in the upper third of the dorsal side, 5–12.5 μm high, smooth below 8. *S. caninervis* var. *abbranchesii*
- 9. Leaf with hair point; costa with branched papillae in the upper third of the dorsal side, 12.5–37.5 μm high, with simple or bifurcate papillae below, 2.5–5 μm high 9. *S. caninervis* var. *gypsophila*
- 10. Costa without hydroids 11
- 10. Costa with hydroids 18
- 11. Hair point orange or reddish; row of dorsal surface cells in upper third of costa, similar to those of the lamina 10. *S. norvegica*
- 11. Hair point hyaline, brown at base; row of dorsal surface cells in upper third of costa, stereids 12
- 12. Costa transverse section with 1–2(3) dorsal stereid rows; leaves constricted at midleaf; margins plane or slightly recurved up to midleaf 13
- 12. Costa transverse section with (2)3–6 dorsal stereid rows; leaves not constricted at midleaf; margins recurved up to the upper third or up to the leaf apex 14
- 13. Mid-lamina cells with 4–6(8) bifurcate, not pedicellate papillae per cell, 2.5 μm high 11. *S. virescens*
- 13. Mid-lamina cells with 1 branched, pedicellate papilla per cell, 10–15(17.5) μm high 12. *S. minor*
- 14. Leaves margins revolute up to the upper third, rarely up to midleaf; mid-lamina cells 12.5–17.5 μm wide 13. *S. calcicola*
- 14. Leaves margins revolute up to near the apex, sometimes up to upper third; mid-lamina cells (5)7.5–12.5 μm 15
- 15. Papillae on mid-lamina cells not pedicellate, 2.5 μm high 16

15. Papillae on mid-lamina cells pedicellate, 5–12.5(15) μm high 17
 16. Leaf apex not hyaline, generally rounded, not tapering into a hair point
 14. *S. ruralis* var. *ruralis*
 16. Leaf apex usually hyaline and acuminate, tapering into a hair point
 15. *S. ruralis* var. *ruraliformis*
17. Mid-lamina cells with only one pedicellate, branched, star-shaped papilla per cell; papillae on the dorsal side of the costa pedicellate and branching as a star-shape, or bifurcate, rarely simple, 2.5–7.5 μm high. 16. *S. papillosissima*
17. Mid-lamina cells with (2)4–6 bifurcate, sometimes pedicellate, rarely branched star-shaped papillae; papillae on the dorsal side of the costa simple, 2.5–5 μm
 17. *S. subpapillosissima*
18. Hair point smooth, rarely weakly spinulose 19
 18. Hair point spinose or leaf without hair point. 20
19. Peristome basal membrane 0.25–0.6 mm high; leaves bordered or not, with border consisting of 2–5 rows of thicker-walled less papillose cells, sometimes smooth; hair point (0.2)0.5–1(1.7) mm high; plants mainly epiphytic 1. *S. laevipila*
19. Peristome basal membrane 0.09–0.16 mm high; leaves not bordered; hair point 0.1–0.5 mm high; plants mainly terricolous or saxicolous 18. *S. sinensis*
20. Mid-lamina cells (5)7.5–12.5(15) \times 5–10(12.5) μm ; plants dioicous 21
 20. Mid-lamina cells (10)12.5–17.5(22.5) \times (10)12.5–15(17.5) μm ; plants synoicous or dioicous 22
21. Leaves with hair point; hair point (0.3)0.7–2.4 mm long 19. *S. montana*
21. Leaves mucronate; mucro 20–60 mm long 20. *S. montana* var. *calva*
 22. Leaves fragile, usually broken, with mucro, not constricted at midleaf. 21. *S. fragilis*
 22. Leaves not fragile, intact, with hair point, usually constricted at midleaf 23
23. Upper and mid-lamina cells with (4)6–8(10) bifurcate, not pedicellate papillae per cell, 2.5–5 μm high 22. *S. princeps*
23. Upper and mid-lamina cells with one bifurcate, trifurcate or branched and pedicellate papilla per cell, (10)15–17.5(22.5) μm high. 23. *S. echinata*

1. *Syntrichia laevipila* Brid., Muscol. Recent. Suppl. 4: 98. 1818 [1819] (Figs. 1c; 5a)

Tortula laevipila (Brid.) Schwägr., Sp. Musc. Frond., Suppl. 2: 66. 1823–*Tortula ruralis* var. *laevipila* (Brid.) Hook. & Grev., Edinburgh J. Sci. 1: 293. 1824–*Syntrichia ruralis* var. *laevipila* (Brid.) Spreng., Syst. Veg. 4: 177. 1827–*Barbula laevipila* (Brid.) Garov., Bryol. Austr. Excurs.: 37. 1840. TYPE: ITALY, Circa Romam and Napolin, 1803 [lectotype: B!, designated by Gallego et al. (2004)].

Barbula laevipila var. *meridionalis* Schimp., Syn. Musc. Eur.: 699. 1860–*Syntrichia laevipila* var. *meridionalis* (Schimp.) Jur., Laubm.-Fl. Oesterr.-Ung.: 141. 1882–*Tortula laevipila* var. *meridionalis* (Schimp.) Wijk & Margad., Taxon 8: 75. 1959. TYPE: ITALY, Gombo, *De Notaris* [lectotype: BM!, designated by Gallego et al. (2004)].

Tortula laevipilaeformis De Not., Musci Ital. 1: 7. 1862–*Tortula laevipila* var. *marginata* Lindb., Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 21: 245. 1864–*Syntrichia laevipilaeformis* (De Not.) Cardot, Bull. Soc. Roy. Bot. Belgique 22: 162. 1883–*Barbula laevipila* var. *laevipilaeformis* (De Not.) Husn., Muscol. Gall.: 114. 1886, *nom. illeg.* [article 52.1, Greuter et al. (2000)]–*Tortula laevipila* var. *laevipilaeformis* (De Not.) Limpr., Laubm. Deutschl. 1: 680. 1888, *nom. illeg.* [article 52.1, Greuter et al. (2000)]–*Barbula laevipila* var. *marginata* (Lindb.)

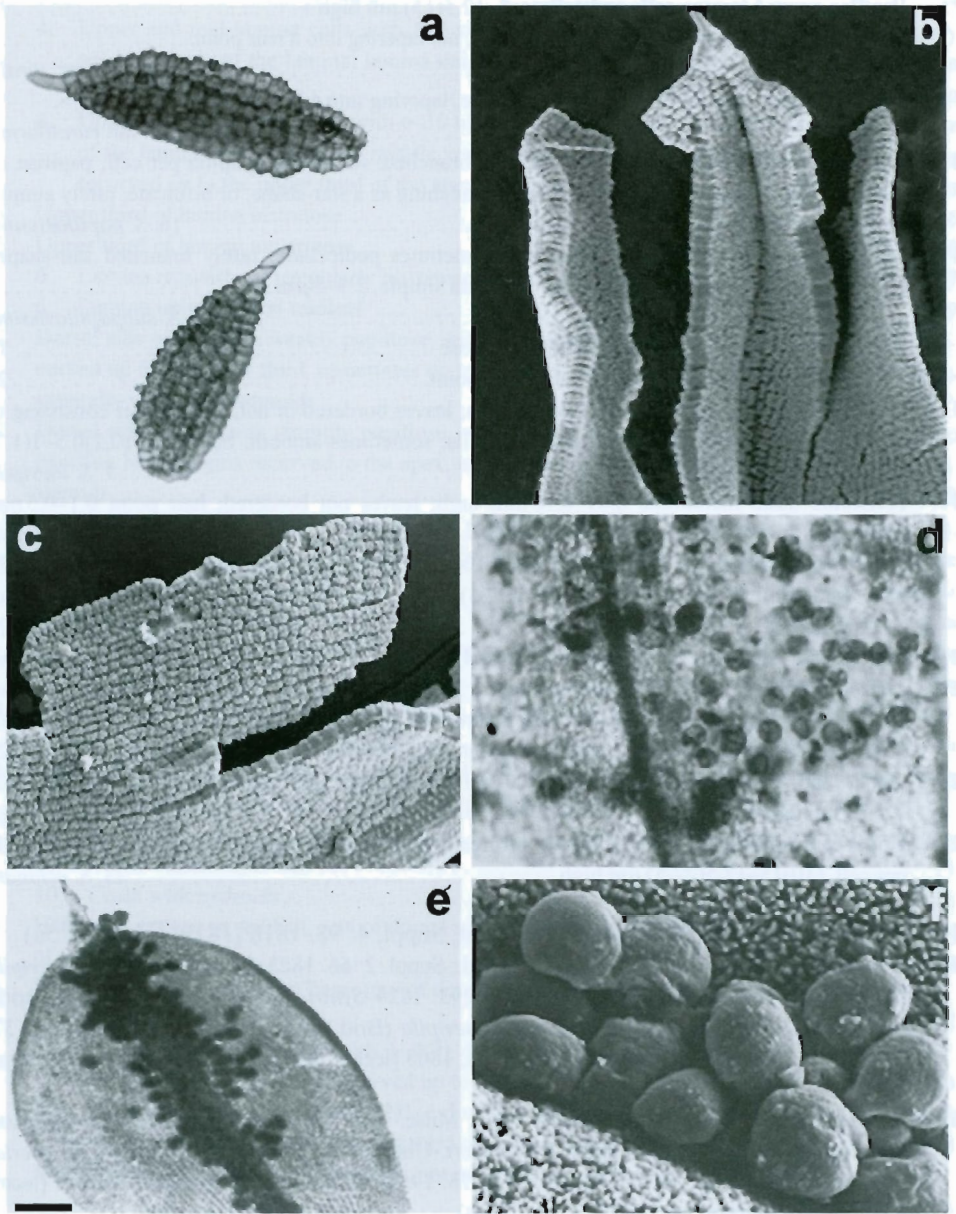


Fig. 5. SEM and light microscope photographs of vegetative diaspores in the genus *Syntrichia*: a. Brood leaves, *S. laevipila* (LISU 181553); b-c. Leaf fragments, *S. fragilis* (MUB 11753); d. Laminar gemmae, *S. latifolia* (VAB 1075); e. Costal gemmae, *S. papillosa* (MUB 5695); f. Costal gemmae, *S. rigescens* (MUB 11278). Scale bars: a=60 μm ; b-c=70 μm ; d=80 μm ; e=230 μm ; f=15 μm .

Baroni, Nuovo Giorn. Bot. Ital. 23: 313. 1891—*Syntrichia laevipila* var. *laevipilaeformis* (De Not.) J.J. Amann, Fl. Mouss. Suisse 2: 117. 1918, *nom. illeg.* [article 52.1, Greuter et al. (2000)] — *Tortula laevipila* subsp. *laevipilaeformis* (De Not.) Giacom., Atti Ist. Bot. Univ. Pavia ser. 5, 4: 216. 1947. TYPE: ITALY, pr. Sassari, Sardinia, 1835, *De Notaris* [lectotype: RO!, designated by Gallego et al. (2004)].

Barbula pagorum Milde, Bot. Zeitung (Berlin) 20: 459. 1862—*Tortula laevipila* var. *propagulifera* Lindb., Oefvers. Förh. Finska Vetensk.-Soc. 21: 245. 1864—*Tortula pagorum* (Milde) De Not., Atti Reale Univ. Genova 1: 542. 1869—*Syntrichia laevipila* var. *propagulifera* (Lindb.) Jur., Laubm.-Fl. Oesterr.-Ung.: 141. 1882—*Barbula laevipila* var. *pagorum* (Milde) Husn., Muscol. Gall.: 115. 1886, *nom. illeg.* [article 52.1, Greuter et al. (2000)]—*Barbula alpina* var. *pagorum* (Milde) Kindb., Eur. N. Amer. Bryin. 2: 247. 1898, *nom. illeg.* [article 52.1, Greuter et al. (2000)]—*Syntrichia pagorum* (Milde) J.J. Amann, Fl. Mouss. Suisse 2: 117. 1918—*Tortula alpina* var. *propagulifera* (Lindb.) E.B. Bartram, Bull. Torrey Bot. Club 51: 337. 1924—*Syntrichia laevipila* var. *pagorum* (Milde) Mönk., Laubm. Eur.: 309. 1927, *nom. illeg.* [article 52.1, Greuter et al. (2000)]. TYPE: ITALY, Villa Maurer bei Grafch bei Meran, 2.11.1861, *Milde* [lectotype: H!, designated by Barkman (1963); isolectotypes BM!, H!, M!, RO!].

Tortula saccardoana De Not., Atti Reale Univ. Genova 1: 752. 1869—*Barbula saccardoana* (De Not.) Grav., Rev. Bryol. 10: 23. 1883—*Tortula laevipila* var. *saccardoana* (De Not.) Barkman, Phytosociol. & Ecol. Cryptog. Epiph.: 531. 1958. TYPE: ITALY, Selva, Treviso, Caneda, 1864, *Saccardo*, n° 19 [lectotype: PAD!, designated by Barkman (1963)].

Tortula laevipila var. *notarisii* Barkman, Phytosociol. & Ecol. Cryptog. Epiph.: 531. 1958. TYPE: ITALY, Lucca, 1858, *Bicchi 173* [lectotype: L!, designated by Barkman (1963); isolectotypes FI!, L!].

Tortula laevipila var. *wachterii* Barkman, Phytosociol. & Ecol. Cryptog. Epiph.: 531. 1958. TYPE: HOLLAND, Zuid Holland, Goeree Island, Goederede, 15.4.1952, *Barkman 3543* [lectotype: L!, designated by Barkman (1963)].

Plants (0.15)0.5–1.5(2.5) cm high, growing in dense, sometimes open olive-green turfs. Stems erect, branched. Leaves spirally twisted when dry, spreading or patent, sometimes weakly recurved when moist, 0.8–3.8×0.3–1.4 mm, lingulate to spatulate, constricted at midleaf, sometimes weakly, unistratose; apex rounded, obtuse, emarginate; margins plane or slightly recurved at midleaf, rarely from base up to upper third of leaf, papillose-crenulate or smooth, unistratose, bordered or not, with border formed of 2–5 rows of thicker walled and less papillose cells, sometimes smooth, brown or yellowish; hair point hyaline, smooth, sometimes weakly spinulose and brown at base, (0.2)0.5–1(1.7) mm; costa 60–135 μm wide, in transverse section with 1–2 guide cell rows and 3–5(7) dorsal stereid rows, with hydroids; without papillae on the dorsal side; upper and mid-lamina cells quadrate, rectangular or rounded, thin walled, (10)12.5–15(25)×(7.5)10–15(17.5) μm, with 4–8 bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells quadrate or rectangular, 25–95×12.5–35 μm, hyaline or chlorophyllose, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 18–40% of leaf length, sometimes scarcely differentiated; marginal basal cells chlorophyllose, in 4–9 columns, generally smooth. Vegetative diaspores (brood leaves) multicellular, generally present, at the stem apex or in the axils of the upper leaves, often forming a rosette in the upper leaves, lanceolate, elliptical or ovate, with shape of leaves, 110–500(900)×35–300 μm,

apical hyaline cell with or without papillae, 20–100 μm long, with or without costa, green, papillose. Dioicous or autoicous. Seta erect, 0.45–1.5 cm long, spirally twisted to right above, to left below or to right throughout, reddish brown. Capsule erect, cylindrical, 1.4–4.7 \times 0.3–1.1 mm, brownish. Peristome of 32 papillose, spirally twisted teeth, 0.4–1.3 mm long; basal membrane of 10–20 rows of cells, 0.25–0.6 mm high. Operculum long conical, 0.9–1.9(2.1) mm long. Spores spherical, (5)10–17.5(25) μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 8); Gallego et al. (2004, pp. 221, 223, 225, 226); Kramer (1980, pl. 2, 9, 17, 20, as *Tortula laevipila-pagorum* group); Lawton (1971, pl. 48); Mishler (1994, pp. 338, as *Tortula pagorum*); Saito (1975, pp. 526); Stone (1971, pp. 275, as *Tortula pagorum*); Zander (1993, pp. 265).

World distribution. Africa; North, Central and South of South America; Asia; Australia; Europe; New Zealand.

Mediterranean and Macaronesia area distribution. Algeria: (Azores, Eggers 1982); Balearic Islands; Bulgaria; Canary Islands; Corsica; Crete; Croatia; Cyprus; France; Greece; (Israel, Bilewsky 1965); Italy: (Lebanon, Bizot 1955); (Libya, Pampanini 1931); (Macedonia, Düll et al. 1999); Madeira; Morocco; Portugal; Sardinia; Sicily; (Slovenia, Düll et al. 1999); Spain; (Syria, Schiffner 1913); Tunisia; Turkey; (Yugoslavia, Sabovljevic & Stevanovic 1999).

Habitat and elevation: This is a corticolous, rarely saxicolous species, found from 30 to 4000 m a.s.l., frequently in localities where the environment has been influenced by man (Anderson 1943, Stone 1971, Magill 1981, Studlar et al. 1984), it is probably only rupestral when conditions are exceedingly favorable for its growth (Anderson 1943).

Selected specimens examined. ALGERIA. Argel, 12.1839, *Kiaer* (O). Argel, Boujareal, 3.1869, *Reuter* (GE). Tizi Ouzou, 28.10.1894, *Gruef* (O). Blida near Algiers, 2.4.1976, *Rojkowski 456* (CANM 267486). BULGARIA. Bulgaria austr., reserv. Tisata prope urbe Kresna, 24.11.1987, *Ganeva* (SOM). CROATIA. Istria, prope Buje, 1843 (BR 181406). Istria, Rovinj, Niederung gegen S. Felice an der Mündung des Lemekanales, 26.3.1924, *Baumgartner* (MA-Musci s.n.). Insel Rab, Cap Fronte, 30 m, 30.3.1975, *Frahm 10075* (GZU). CYPRUS. Paphos Forest, a few km east of Pano Panayia, 4.4.1997, *Blockeel 26-189* (Herb. T.L. Blockeel). FRANCE. Montpellier, dans le Jardin Botanique, 9.6.1965, *Stormer* (O). Nice, Alpes Maritimes, 4.1886, *Noddy* (E). Pyrénées Orientales, Consolation Hermitage près Collioure, 150 m, 18.6.1965, *Stormer* (O). Corcega, Porto Vecchio, 20.5.1976, *Hübschmann* (Herb. J.-P. Frahm). Var. Fayence, 43°40'N, 0°14'E, 14.4.2001, *Gallego* (MUB 11392). GRECE. Attiki, 7.11.1871 (GE). Creta, Distr. Chaniá, Katsimatádos, S. of Topólia, 300 m, 16.4.1967, *Gradstein & Snittenberg* (BR 276763–22). De Egira a Oassi, 38°07'47"N, 22°20'43"E, 250 m, 21.3.1999, *Cano et al.* (MUB 11371). Peloponnese, near the Museum, Olympia, 27.5.1963, *Townsend* (Herb. C.C. Townsend). Ins. Rhodos, Mount Profitas Elias, 3.5.1970, *Townsend 70/162* (Herb. C.C. Townsend). ITALY. Campania, Pompeii, the ruins, 17.10.1975, *Stormer* (O). Cerdeña, Cagliari, Tal des Rio Giurturu Mannu, N-exponierte Quarzit-Wand 5 km W der Kreuzung Ciri Foddi, 170 m, 18.7.1985, *Nimis & Poelt* (GZU). Nápoles, Castellamare di Stabia, *Giordano* (BR 181454). Roma, Villa Borghese, 26.5.1868, *Kiaer* (O). Sicilia, prov. Palermo, Bosco del Cappelliere, 10.05.1992, *Campisi* (PAL). Sudtirol, Etschial, Castel Feder S Auer, 350 m, 29.10.1989, *Köckinger* (GZU). Toscana, Lucca, 1858, *Bicchi* (FI). MOROCO. A 4 km de Azrou a Marrakech, 22.4.1984, *Ros* (MUB 12821). Ifrane, 22.4.1984, *Ros* (MUB 12822). Atlas Medio, Refugio de Taffert, 33°39'N, 4°09'W, 1890 m, 15.6.1998, *Cano et al.* (MUB 12799). PORTUGAL. Algarve, SE facing slope immediately above the village, Caldas de Monchique, 27.3.1989, *Townsend 89/168* (Herb. C.C. Townsend). Alto Alentejo, Estremoz, 11.10.2002, *Gallego* (LISU 181548). Trás-os-Montes e Alto Douro, Parque Natural de Montezinho, Moinhos do Rio, próximo do Terroso, Alto

do Bandoleiro, PG73, 723 m, 10.7.2002, *Gallego* (LISU 181553). Madeira, Serra de Água, valley of the Ribeira Brava, 15.3.1988, *Arts 15.936* (LISU 181467). SPAIN. Alicante, carretera Alcolecha-Penáguila, km 2 (Penáguila), 700 m, YH3084, 3.1994, *Cano* (MUB 5744). Almería, Tabernas, Sierra de Alhamilla, cercanías a El Puntal, 900 m, WF5394, 17.5.1991, *García-Zamora & Ros* (MUB 8170). Islas Baleares, Mallorca, Ses Tres Creus, 120 m, 39°45'N, 2°43'E, 14.4.1999, *Cano et al.* (MUB 11490). Islas Canarias, Las Palmas, Lanzarote, Caldera del Corazoncillo, 310 m, 27.12.1978, *Malme 725* (O). TUNISIA. Bei Ain Draham, nördlich des Ortes, um 700 m, 11.4.1968, *Poelt* (GZU). TURKEY. Antalya, 3 km north east of Yavi, ca. 30 km east of Kas, 530 m, 10.4.1972, *Nyholm & Crundwell 1412* (E). Mugla, Yilanli Mts. E. of Mugla, Yemis Dere, Dipsiz, 600 m, 13.3.1997, *Kürschner et al.* (Herb. H. Kürschner 6277). Istanbul, in the grounds of the Seraglio, 24.5.1963, *Townsend* (Herb. C.C. Townsend).

Observations. *Syntrichia laevipila* is characterized by a high phenotypic plasticity. From the Mediterranean Region infraspecific taxa have been described, such as the varieties, var. *meridionalis* (Schimper 1860), var. *notarisii*, var. *wachterii* and var. *saccardoanu* (Barkman 1963), var. *propagulifera* (Lindberg 1864) and var. *gemmifera* (Squ Coast de Carondelet 1962). A morphological study of this complex of taxa, shows that they simply are a group of propaguliferous forms that appear as different transitional stages of the normal development of the propagules as a response to environmental stress. They represent a stage in their survival strategy, in which *S. laevipila* reproduces asexually (Gallego et al. 2004) and, in a study of 90 specimens from Portugal representing all varieties of *S. laevipila*, Gallego et al. (2005) found no consistent morphological characters to distinguish between the taxa, which may therefore be recognized as a single species of high morphological variability.

Since 1862, when Milde described *Barbula pagorum*, the taxonomic status of this moss has been controversial. In this work *Syntrichia pagorum* is considered to be a synonym of *S. laevipila* (for explanation see Gallego et al. 2004).

Zander (1993) described the section *Aesiotortula*, within the genus *Syntrichia*, the type of which is *Syntrichia pagorum*. The section comprises small plants with leaf-shaped propagules, plane leaf margins and a semicircular costa transverse section. This section includes the one known species from Australia, *S. baileyi* (Broth.) R.H. Zander; two from America, *S. epilosa* (Broth. ex Dusén) R.H. Zander and *S. bartramii* (Steere in Grout) R.H. Zander; two from Africa and America, *S. chisosa* (Magill, Delgad. & L.R. Stark) R.H. Zander and *S. ammonsiana* (H.A. Crum & L.E. Anderson) Ochyra; one from America and Australia, *S. pygmaea* (Dusén) R.H. Zander; one from Australia and New Zealand, *S. phaea* (Hook.f. & Wilson) R.H. Zander; and the only member that appears in Europe, *S. pagorum*. Zander (1993) did not include *S. laevipila* in the section *Aesiotortula* because he did not consider it as a propaguliferous species, including it instead in the typical section of the genus *Syntrichia*. In this work, *S. laevipila* is not considered as a member of the section *Aesiotortula*, mainly because Zander (1993) does not include in this section the non-propaguliferous forms of this taxon, which he considered to be members of the typical section of genus *Syntrichia*.

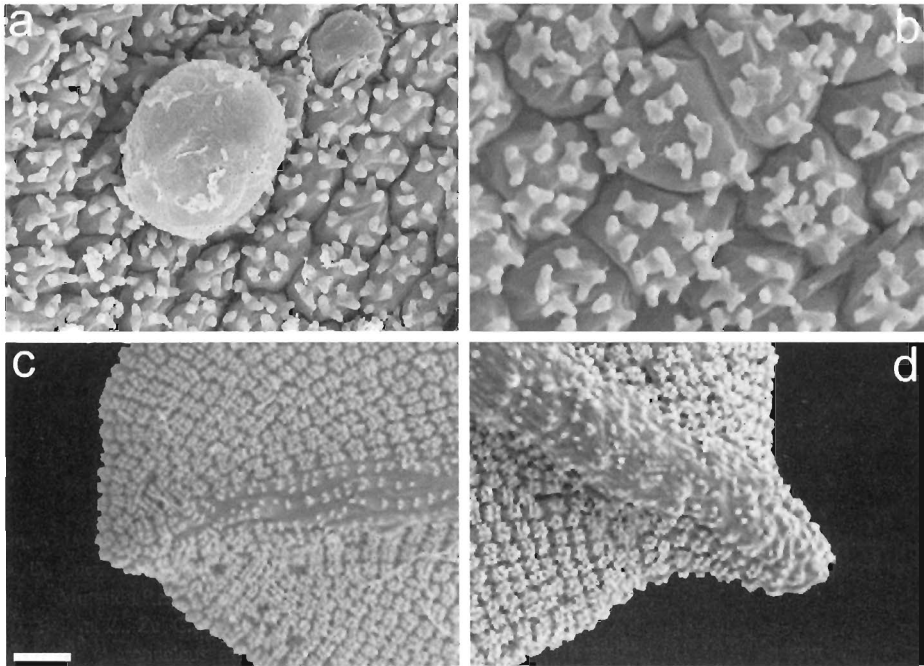


Fig. 6. Scanning electron micrographs of *Syntrichia latifolia* (LISU 154561): a. Lamina gemmae on the ventral side of the leaf on the lamina; b. Mid-lamina cells; c–d. Leaf apex. Scale bars: a=16 μm ; b=7 μm ; c–d=65 μm .

2. *Syntrichia latifolia* (Bruch ex Hartm.) Huebener, Muscol. Germ. 342. 1833 (Figs. 3b; 5d; 6a–d)

Tortula latifolia Bruch ex Hartm., Handb. Skand. Fl., ed 2: 322. 1832–*Barbula latifolia* (Bruch ex Hartm.) Huebener, Muscol. Germ.: 342. 1833, *nom. illeg.* [article 53.1, Greuter et al. (2000)].
TYPE: SWEDEN. Lund in Salice, 28.3.1825, *Ahnfelt* [lectotype: UPS!, designated by Kramer (1980)].

Syntrichia laevipila var. *mutica* Bruch ex Schultz, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carl Nat. Cur. 11: 230. 1823–*Tortula mutica* (Bruch ex Schultz) Lindb., Musci Scand.: 20. 1879, *nom. illeg.* [article 53.1, Greuter et al. (2000)]–*Tortula ruvalis* var. *latifolia* Bruch ex Arn., Mem. Soc. Linn. Paris 5: 269. 1826 *nom. illeg.* [article 52.1, Greuter et al. (2000)]–*Syntrichia ruvalis* var. *latifolia* Bruch ex Spreng., Syst. Veg. 4: 177. 1827 *nom. illeg.* 52.1. Ind. loc.: “Biponti ad truncos arborum lecta est a Bruchio” [type: not located, not at: H, LY, ROST].

Plants 0.4–2.1 cm high, growing in dense dark green turfs. Stems erect, branched or not. Leaves spirally twisted, crispate when dry, spreading or patent when moist, 1.8–2.6 \times 0.6–0.8 mm, spatulate, lingulate or lingulate-spatulate, constricted at midleaf, unistratose; apex rounded, obtuse, sometimes emarginate; margins plane or slightly recurved up to midleaf, papillose, unistratose, unbordered; without hair point; costa 75–87.5 μm wide, in transverse section with 1–2 guide cell rows and 2–3 dorsal stereid rows, with hydroids; with simple, not pedicellate papillae on the dorsal side, 2.5 μm high;

upper and mid-lamina cells quadrate, rectangular or rounded, thin walled, $12.5\text{--}20.0 \times 12.5\text{--}17.5 \mu\text{m}$, with 4–6 bifurcate, not pedicellate papillae per cell, $2.5 \mu\text{m}$ high; juxtacostal basal cells rectangular, $20\text{--}90 \times 15\text{--}35 \mu\text{m}$, hyaline, thin walled, collenchymatous, forming a clearly differentiated hyaline area up to 18–26% of the leaf length; marginal basal cells chlorophyllose, in 6–9 columns, generally smooth. Vegetative diaspores (laminar gemmae) multicellular, generally present, on the ventral side of the leaf lamina, globular, ovate or rounded, $25\text{--}45 \times 25\text{--}37.5 \mu\text{m}$, sessile, green or brown, smooth. Dioicous. Seta erect, 0.6–1.0 cm long, spirally twisted to right above and below, reddish brown. Capsule slightly recurved, cylindrical, $2.6\text{--}3.0 \times 0.65\text{--}0.85 \text{ mm}$, reddish brown. Peristome of 32 papillose, spirally twisted teeth, 0.55–1.0 mm long; basal membrane of (8)–10–17 rows of cells, 0.3–0.6 mm high. Operculum long conical, 1.1–1.9 mm long. Spores spherical, (8)10–15(20) μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 10); Krameř (1980, pl. 3, 9, 17); Lawton (1971, pl. 48); Smith (2004, pp. 386).

World distribution. North America; South West of Asia; Europe.

Mediterranean and Macaronesia area distribution. (Bosnia Herzegovina, Düll et al. 1999); (Bulgaria, Düll et al. 1999); (Croatia, Düll et al. 1999); France; (Italy, Cortini-Pedrotti 2001); (Macedonia, Düll et al. 1999); Portugal; (Sicily, Cortini-Pedrotti 2001); (Slovenia, Düll et al. 1999); Spain; (Turkey, Uyar & Cetin 2004); (Yugoslavia, Sabovljevic & Stevanovic 1999).

Habitat and elevation. This is an epiphyte species. Also found on wet rocks. It occurs from 400 to 1050 m a.s.l.

Selected specimens examined. FRANCE. Sarthe, Le Mans, 1891 (E). Circa Jurançon, *Spruce* (E). Saône-et-Loire, Vallée de la Loire, Iguerande, 7.9.1959, *Bonnot* (BCB 19000). PORTUGAL. Alto Alentejo, Ponte de Sôr, Vale de Arco, a 1 km para Vale de Água, ND85, 14.4.1993, *Jones et al.* (LISU 178981). Beira Alta, Serra da Estrela, Folgozinho, PE28, 8.6.1996, *Sérgio 10392* (LISU 176523). Trás-os-Montes e Alto Douro, Bragança, Vinhais, en la orilla de la carretera del pueblo, PG63, 10.07.2002, *Gallego* (LISU 178978). Beira Baixa, Fundão, Outeiro, 9.1906, *Luisier 28* (COI). Beira Baixa, Fundão, Outeiro do Bispo, 8.1906, *Luisier 95* (COI). SPAIN. La Rioja, 1 km al E de Briones, orilla del Río Ebro, 13.10.2001, *Cano 780* (MUB 12747). Málaga, cercanías de El Colmenar, 10.3.1985, *Guerra* (VAB 1075). *Ibidem* (MGC 857). Madrid, 5.1923 (MA-Musci 11157); Madrid, Puerto de Hierro (BCB 9542). Salamanca, Ciudad Rodrigo, Valdecanes, Sierra de Camaces, 19.4.1918, *Luisier* (INA); Canillejas, 21.4.1913, *Luisier* (INA). Zamora, Mayalde, *Luisier* (INA).

Observations. *Syntrichia latifolia* is a very distinctive species, distinguished by the usual presence of vegetative diaspores on the ventral side of the leaf lamina, “laminar gemmae” according to Newton & Mishler (1994), and by the absence of a hair point. The lamina of *S. latifolia* is unistratose with plane or slightly recurved margins up to midleaf. The leaves are constricted at midleaf, spatulate, lingulate or lingulate-spatulate and the costa is percurrent or sub-percurrent. The transverse section of the costa has 2–3 dorsal stereid rows, with hydroids.

This species has the same type of laminar gemmae as *S. papillosa* and *S. rigescens*, i.e., multicellular, globular, ovate or rounded, sessile, green or brown and smooth gemmae on the ventral side of the leaf lamina. However, the gemmae differ in location from those of *Syntrichia papillosa* and *S. rigescens* in which they occur on the costa, while in

S. rigescens they are only found in the upper third of the leaf. Furthermore, *S. latifolia* is readily distinguished from *S. papillosa* by the absence of a hair point on the leaf, by the plane or weakly recurved leaf margins and by the transverse section of the costa, with 2–3 dorsal stereid rows. In addition, the dorsal side of the costa in *S. latifolia* has simple, not pedicellate papillae, 2.5 μm high, while *S. papillosa* has simple, bifurcate or branched, pedicellate papillae, 12.5–28 μm high. *Syntrichia rigescens* differs from *S. latifolia* in the following characters: (1) recurved margins up to the upper third of the leaf; (2) leaves sometimes constricted, with the lamina irregularly bistratose in the upper third and at midleaf; (3) weakly spinose hyaline hair point; (4) costa on the dorsal side with pedicellate, bi-trifurcate, stellately branched papillae, 10–17.5(35) μm high.

Milde (1871) described a new variety for *Barbula latifolia* Brid., *B. latifolia* var. *propagulifera* Milde, from Poland (Silesia; historical region of Europe), based exclusively on the presence of identical propagules to *B. papillosa* Wils. Later, Amann et al. (1912) reported it from Switzerland and transferred it to genus *Syntrichia* as *S. latifolia* var. *propagulifera* (Milde) J.J. Amann, without any new data on its taxonomy or systematics, simply recording that it is more robust than *S. papillosa*, with multicellular propagules on the limb. The type material of *B. latifolia* var. *propagulifera* has not been located (requested from U, BP, NY and S). The absence of data is probably the reason for the subsequent lack of recognition that *S. latifolia* var. *propagulifera* has enjoyed among most authors.

One specimen from Portugal has differentiated leaf margins as in *S. laevipila* (LISU 178725), a character which is otherwise unknown in *S. latifolia*.

3. *Syntrichia papillosa* (Wilson) Jur., Laubm.-Fl. Oesterr.-Ung. 141. 1882 (Figs. 3e; 4a, c; 5e; 7a–f)

Tortula papillosa Wilson, London J. Bot. 4: 193. 1845–*Barbula papillosa* (Wilson) Müll. Hal., Syn. Musc. Frond. 1: 598. 1849–*Barbula laevipila* subsp. *papillosa* (Wilson) Bouvet. Bull. Soc. Études Sci. Angers 26: 81. 1896. TYPE: UNITED KINGDOM. In C. Howard park, 7.1843. *Wilson* [topotype: BM!].

Tortula papillosa var. *meridionalis* Warnst., Krýpt.-Fl. Brandenburg, Laubm. 2: 265. 1904, **syn. nov.** –*Syntrichia papillosa* var. *meridionalis* (Warnst.) Podp., Consp. Musc. Eur.: 254. 1954. TYPE: ITALY. Unterhalb Camnago-Volta (Valleta di S. Martino) bei Como an Maulbeerbäumen, 260–280 m, 10.04.1898. *Artaria* [lectotype: B!, designated here; isolectotype: FH!].

Plants 0.3–0.8 cm high, growing in dense dark green turfs. Stems erect, usually not branched. Leaves spirally twisted, appressed when dry, spreading or patent when moist, 1.6–3.1 \times 0.8–1.3 mm, spatulate or lingulate-spatulate, constricted at midleaf, sometimes weakly, unistratose; apex rounded or obtuse; margins plane or slightly incurved up to the leaf apex, papillose, unistratose, unbordered; hair point hyaline, smooth, sometimes weakly spinulose and brown at base, 0.2–0.6 mm; costa 80–150 μm wide, in transverse section with 1–2 guide cell rows and 3–5 dorsal stereid rows, with hydroids; with simple or bifurcate, branched, pedicellate papillae on the dorsal side, 12.5–28 μm high; upper and mid-lamina cells quadrate, rectangular or rounded, thin or thick walls, 17.5–27.5 \times (12.5) 15–22.5 μm , with 1–2 simple, sometimes bifurcate, not pedicellate papillae per cell, on dorsal side of lamina only, 2.5 μm high, sometimes smooth; juxtacostal basal cells rec-

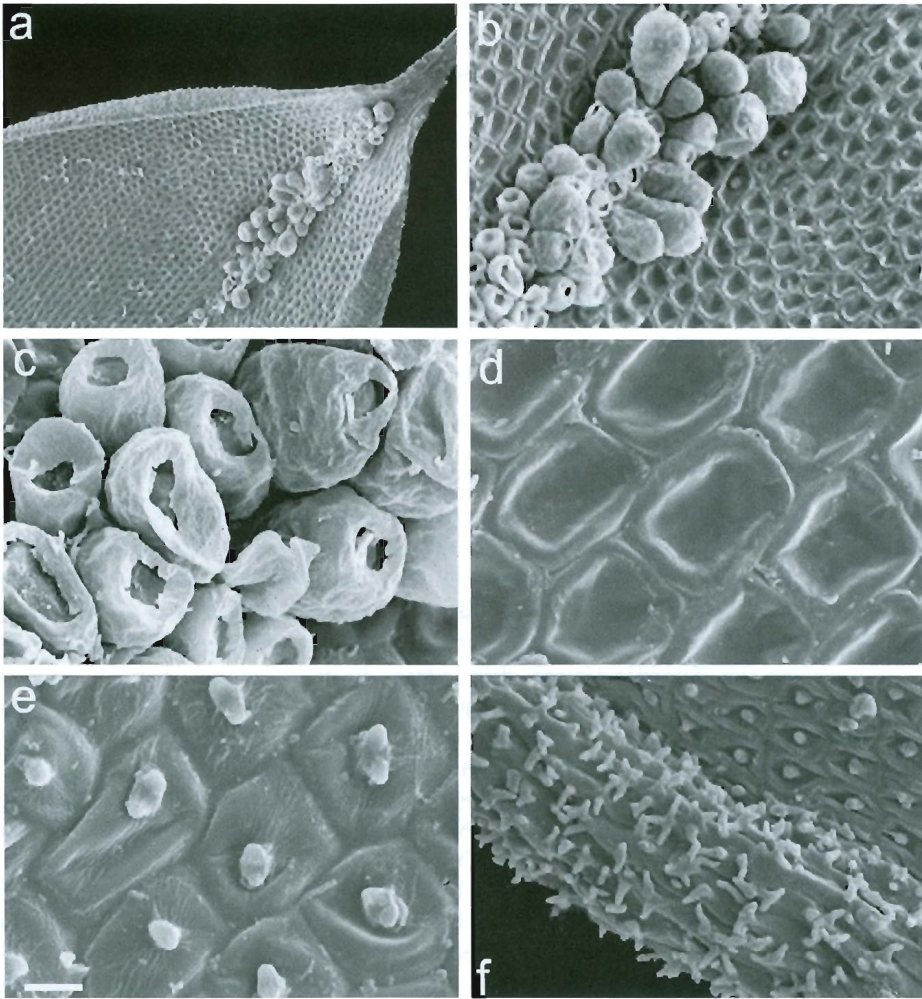


Fig. 7. Scanning electron micrographs of *Syntrichia papillosa* (MUB 5695): a. Leaf apex with costal gemmae on the ventral side of the costa; b. Details of the costal gemmae; c. Details of the "initial cell" of the vegetative diaspores; d. Leaf cells from the ventral side of the lamina; e. Leaf cells from the dorsal side of the lamina showing only one papilla per cell; f. Dorsal side of the costa in the midleaf. Scale bars: a = 125 μm ; b = 40 μm ; c = 13 μm ; d–e = 9 μm ; f = 25 μm .

tangular, quadrate, 20–90 \times 15–35 μm , hyaline or yellowish, with thick walls, collenchymatous, forming a clearly differentiated hyaline area up to 14–23% of leaf length, sometimes weakly differentiated; marginal basal cells chlorophyllose, in 6–11 columns, generally smooth. Vegetative diaspores (costal gemmae) multicellular, generally present on the ventral side of the costa in the upper half of the leaf, globular, ovate or rounded, 50–75 \times 30–50 μm , sessile, green or brown, smooth. Dioicous. Seta erect, 0.65–0.85 cm long, spirally twisted to right above, reddish brown. Capsule erect, cylindrical or ovate-

cylindrical, 1.3–2.5×0.9–1.1 mm, reddish-brown. Peristome of 32 papillose, spirally twisted teeth, 0.7–1.8 mm long; basal membrane of 10–15 rows of cells, 0.2–0.5 mm high. Operculum long conical, 0.9–1.9 mm long. Spores spherical, (10)12.5–15 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 10); Kramer (1980, pl. 7, 14); Magill (1981, pp. 220); Mishler (1994, pp. 337); Smith (2004, pp. 386); Zander (1993, pp. 265).

World distribution. North? (Ros et al. 1999), Central and South Africa; America; South West and Central Asia; Australia; Europe; Macaronesia; New Zealand.

Mediterranean and Macaronesia area distribution. (Bosnia Herzegovina, Düll et al. 1999); Bulgaria; (Canary Islands, Dirkse et al. 1993); (Corsica, Düll 1984); (Croatia, Düll et al. 1999); France; Greece; Italy; Portugal; (Sicily, Lo Giudice 1994); (Slovenia, Düll et al. 1999); Spain; Turkey; (Yugoslavia, Blockeel et al. 2000).

Habitat and elevation. This is an epiphyte species that occurs from 100 to 1500 m a.s.l. Rarely on rocks (Crum & Anderson 1981, Lo Giudice 1994, Smith 2004) and artificial walls (Wearmouth et al. 1984). According to Wearmouth et al. (1984), human activity appears to contribute to its growth by supplying nitrogen. However, the plant is either absent or is only occasionally found in urban areas, especially when subject to atmospheric pollution (Smith 1978).

Selected specimens examined. BULGARIA. Bulgaria austr., reserv. Tisata prope urbe Kresna, 24.11.1987, *Ganeva* (SOM). FRANCE. Pyrénées-Atlantiques, Parc de Pau, 1845–46, *Spruce* (E). Orne, Alençon, 5.1883, *Duerie* (E). Hérault, Lodève, às ost for byen, 300 m, 11.6.1965, *Stormer* (O). Vaucluse, commune de Bonnieux domaine de la Chambarelle, au S de Bonnieux, 480–580 m, 9.6.1984, *Ros* (MUB 1101). Brittany, Finistère, Brasparts village, 100 m, 3.4.1993, *Long* 23379 (E). Fayence, 14.4.2001, *Gallego* (MUB 11393). GREECE. Pella, Edessa, 10.1980, *Blockeel* (Herb. T.L. Blockeel). Epirus, near the Archeological Museum, Ioannina, 29.4.1990, *Townsend 90-179* (Herb. C.C. Townsend). ITALY. Südtirol, Meran, 15.3.1884, *Glowacki* (GZU). Prov. Comensis, Como, 10.12.1897, *Artaria* (CANM 132699). Genova, im Botanischen Garten, 11.1923, *Sbarbaro* (CANM 132719). Latium, Villa Adriano in Tivoli, 12.10.1975, *Stormer* (O). Tuscany, Appenino Toscano Emiliano, by the roadside of San Marcello Pistoiese, 600 m, 18.3.1983, *Townsend 83-28* (Herb. C.C. Townsend). PORTUGAL. Alto Alentejo, entre Portel e Vera Cruz de Marmelar, PC13, 10.12.1990, *Sim-Sim & Sérgio M33* (LJSU 161369). Beira Litoral, Aveiro, Azurva, Azenhas de Baixo, NE39, 4.5.1988, *Sérgio, Sim-Sim & Máguas* (LJSU 160351). Trás-os-Montes e Alto Douro, Bragança, Vinhais, en la orilla de la carretera del pueblo, 10.07.2002, *Gallego* (MUB 15669). SPAIN. Alicante, Alcoy, Sierra de Menechaor, Santuario de la Font Roja, 1050 m. YH1482, 1.2.1993, *Guerra et al.* (MUB 5847); Agres, Sierra de Mariola, Santuario Virgen de Agres, 770 m, YH1594, 30.3.1993, *Cano et al.* (MUB 5695). Lérida, Ribera de Cardós, 27.9.1981, *Ros* (MUB 612). Salamanca, Saucelle, salto, subida a Hinojosa de Duero, 18.4.1992, *Rupidera* (SALA-Bryo 1308); Mieza, subida al pueblo desde el Salto de Aldeadávila, 1.11.1992, *Rupidera* (SALA-Bryo 1307). TURKEY. Prov. Rize, near Ardesen, 8.5.2000, *Townsend 00-29* (Herb. C.C. Townsend).

Observations. *Syntrichia papillosa* is a very well-defined species characterized by: (1) lamina papillae (1 or 2 simple, not pedicellate papillae, sometimes bifurcate, on the dorsal side of each cell), (2) costa papillosity (dorsal side of costa strongly papillose in all its length, with pedicellate, branched, bifurcate or simple papillae, 12.5–28 μm tall), (3) leaf margins curvature (plane or weakly incurved up to the apex), (4) presence of costal gemmae (multicellular, globular, ovate or rounded, sessile, green or brown, smooth) on the ventral side of the costa in the upper half of the leaf arising from an “initial cell” (Correns 1899) (Fig. 7 b–c). According to Correns (1899) the vegetative diaspores can appear in fila-

ments of up to six.

Zander (1993) assigns *S. papillosa* to the *Collotortula* section of genus *Syntrichia* due to the presence of “medial upper laminal cells usually somewhat thickened at the corners or even trigonous, leaf margins usually recurved, papillae sometimes simple, and propagula when present clavate or elliptical”. In the present work the section *Collotortula* has not been recognized because the character combinations that Zander (1993) proposes as distinctive for this section has not been observed.

Matter (1994) records the presence in South America of two taxa close to *S. papillosa* var. *papillosa*: *S. subpapillosa* (Cardot & Broth.) Matter and *S. papillosa* var. *chilensis* (Thér.) R.H. Zander. The best diagnostic features for distinguishing *S. subpapillosa* from *S. papillosa* var. *papillosa* are as follows: (1) differentiation of the leaf margins (*S. subpapillosa* shows bordered leaf margins, consisting of several rows of thicker walled smooth cells; *S. papillosa* has unbordered leaf margins); (2) papilosity of the dorsal side of the costa (weakly scabrous in *S. subpapillosa* and strongly papillose in *S. papillosa*); (3) upper laminal cells size ($14\text{--}20 \times 12\text{--}14 \mu\text{m}$ in *S. subpapillosa* and $16\text{--}40 \times 14\text{--}24 \mu\text{m}$ in *S. papillosa*); (4) number of papillae per cell (2–4 in *S. subpapillosa* and 1–2 in *S. papillosa*); (5) position of the papillae on the leaves (papillae present on dorsal and ventral sides of the lamina in *S. subpapillosa*, while in *S. papillosa* they occur on the dorsal side only).

Syntrichia papillosa var. *chilensis* was described by Thériot (1921), and is known only from the type specimen (Central Chile). Matter (1994) considers it to be “a minor variant of *S. papillosa* var. *papillosa*”, which hardly differs from var. *papillosa* in its larger size and longer hair point. After comparing the type material of *S. papillosa* var. *chilensis* (PC!) and *S. papillosa* var. *papillosa* (BM!), it is concluded that they are the same taxon.

Brotherus (1891) described *Tortula baileyi* Broth. from Australia, with the same gametophytic and sporophytic characters as in *S. papillosa*, and vegetative diaspores as in *S. laevipila* (Catcheside 1980, as *S. pagorum*). Apparently, the only specimens that exist of this taxon are the types from Australia, the other samples identified as *T. baileyi* being *S. laevipila* (Catcheside 1967, as *S. pagorum*). Study of the type specimen shows that this material is *Syntrichia papillosa*, with the typical costal gemmae of that species and not with the brood leaves of *S. laevipila* (= *S. pagorum*). For this reason, *Tortula baileyi* is proposed here as a new synonym of *S. papillosa*.

Sporophytes of *Syntrichia papillosa* are known only from Australia, New Zealand and Tasmania (Mishler 1994). These specimens have not been studied for this work, and so the sporophyte description is based on the type material of *Syntrichia baileyi* [*Tortula baileyi* Broth., Australia. South Australia, Adelaide, 1888, *Bailey* 472 (H-BR!)].

Warnstorf (1904) described a new variety of *Tortula papillosa* (*T. papillosa* var. *meridionalis*), collected by A. Artaria in North Italy, near Como (“In Oberitalien sammelte Artaria unweit Como an alten Maulbeerbaumen...”). It was described as an epiphytic taxon 8 mm up on a mulberry tree, with leaves 3.5–4 mm long and a hair point 0.57–0.60 mm long. Two syntypes have been found in B and FH herbaria, which represent duplicates from a homogeneous collection of Fleischer & Warnstorf numbered as “227” (“Bryotheca Europ. meridion. Cent. III. 1906”). All syntypes are in accordance with Warnstorf’s description. The better preserved material is from B, and therefore has been selected as lecto-

type. After study of these two syntypes, it is concluded that *Tortula papillosa* var. *meridionalis* is a synonym of *Syntrichia papillosa*.

4. *Syntrichia rigescens* (Broth. & Geh.) Ochyra, *Fragm. Florist. Geobot.* 37: 212. 1992 (Fig. 5f)

Tortula rigescens Broth. & Geh., *Allg. Bot. Z. Syst.* 9: 188. 1903. ТИПЪ: ЕGYPT. Sinai-Halbinsel, Auf Granit am Dschebel Kathirin, ca. 1900 m, 5.4.1902, *Kneucker s.n.* [lectotype: H, designated by Kramer (1980); isolectotypes: JE, M!]

Plants 1–2 cm high, growing in dense olive-green turfs. Stems erect, weakly branched. Leaves lightly spirally twisted when dry, mostly patent, spreading or recurved when moist, 1.6–2.8×0.5–0.9 mm, ovate-lingulate, lingulate, sometimes constricted at midleaf, irregularly bistratose in the upper third and at midleaf; apex rounded, obtuse, sometimes emarginate; margins recurved up to upper third of leaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, spinulose, sometimes brownish at base, 1.2–2.6 mm; costa 100–137.5 μm wide, in transverse section with 2–3 guide cell rows and 3–5 dorsal stereid rows, sometimes with substereids, with hydroids; with pedicellate, bi-trifurcate, stellately branched papillae on the dorsal side, 10–17.5(35) μm high; upper and mid-lamina cells quadrate, rectangular, with thin walls, 7.5–10(12.5)×7.5–10(12.5) μm, with 6–10 bifurcate, not pedicellate papillae per cell, on dorsal and ventral side of the lamina, 2.5 μm high; juxtacostal basal cells rectangular, quadrate, 30–125×10–25 μm, hyaline, with thick walls, not collenchymatous, forming a clearly differentiated hyaline area up to 26–33% of leaf length; marginal basal cells chlorophyllose, in 10–24 columns, generally smooth. Vegetative diaspores (costal gemmae) multicellular, generally present on the ventral side of the costa in the upper third of the leaf, elliptical, 25–45×27.5–37.5 μm, sessile, brownish, smooth. Dioicous. Sporophyte unknown.

Illustrations. Boudier (1992, pp. 2); El-Oqlah et al. (1988, pp. 28); Gallego et al. (2002b, pp. 646); Zander (1993, pp. 266).

World distribution. North Africa; South West Asia; Europe.

Mediterranean and Macaronesia area distribution. Egypt; (France, Boudier 1992); (Israel, Herznstadt et al. 1991); Jordan; Morocco.

Habitat and elevation. This species appears on granite and calcareous rocks, also epiphyte on *Juniperus oxycedrus* L. stumps; it occurs from 1200 to 1900 m a.s.l.

Specimens examined. EGYPT. Sinai Peninsula, Dschebel Kathirin, 5.4.1902, *Kneucker* (M). JORDAN. Karak, Tafilah, Dhana, Umm el-Sarab, 23.4.1987, *El-Oqlah* (ex Nr. 771 Yarmouk Univ. Herb. in MUB 3082). *Ibidem* (Herb. Kurschner 2894). MOROCCO. Jbel Touchka, 8 km al N. de las Cascadas Imaouzzar-Ida-Outanen. 30°43'N, 9°26'W, 12.3.2001, *Cano & Munoz* (MUB 11378).

Observations. This species is characterized by leaves with the margins recurved up to the upper third, sometimes constricted at midleaf, the lamina partially bistratose, the hair point spinulose and hyaline, the dorsal side of the costa strongly papillose throughout, and the presence of multicellular elliptical brown sessile costal gemmae situated on the ventral side of the costa in the upper third of the leaves (*Gallego et al.* 2002b).

It is a species close to *S. caninervis* var. *pseudodesertorum* and *S. handelii* (Kramer 1980), although it differs from the former by the constriction and stratification of the lami-

na and the recurvature of the leaf margins, and from the latter, mainly by the papillosity of the costa and the lamina stratification. According to El-Oqlah et al. (1988), *S. rigescens* could come from an ancestral *Tortula pseudohandelii* J. Froehl. (= *S. caninervis* var. *pseudodesertorum*) from SW Asia, in a separate evolutionary line from the gemmiferous *Syntrichia* taxa. The presence of laminar gemmae is the most obvious character of this taxon and that which has been most used to differentiate it (Boudier 1992, El-Oqlah et al. 1988, Kramer 1980). However, it should be used with caution because gemma production may be merely the response of the plant to stress, as is the case in other *Syntrichia* taxa (Gallego et al. 2004, Ignatov et al. 2002, Sérgio 1981).

Another variety of *Syntrichia caninervis* that is distinctive in its gemma production is *S. caninervis* var. *astrakhanica* Ignatov, Ignatova & Suragina, which is only known from Astrakhan and Volgograd Provinces (Ignatov et al. 2002). This taxon produces gemmae on long branched filaments in leaf axils (*S. rigescens* produces them on the upper third of the ventral side of the leaf lamina), and the gemmae of *S. caninervis* var. *astrakhanica* are stalked (not sessile, as in *S. rigescens*).

5. *Syntrichia handelii* (Schiffn.) S. Agnew & Vondr. var. *handelii*, Feddes Repert. 86: 401. 1975

Tortula handelii Schiffn., Ann. Naturh. Hofmus. Wien 27: 485. f. 34–39. 1913–*Syntrichia montana* subsp. *handelii* (Schiffn.) Podp., Consp.: 258. 1954–*Tortula intermedia* subsp. *handehi* (Schiffn.) Wijk & Margad., Taxon 14: 198. 1965. TYPE: TURKEY. Kurdistania occidentalis: Taurus Cataonicus. Prope vicum Kjachta districtus Mamuret-ül-Asis, Kaoti, ca. 800 m, 10 Jul 1910, *Handel-Mazzetti* 1978. [lectotype: W!, designated by Gallego et al. (2002b); isolectotype: FH!].

Plants 1.3–3 cm high, growing in dense olive-green turfs. Stems erect, branched. Leaves lightly spirally twisted or appressed when dry, mostly patent, sometimes recurved when moist, 2.4–2.8 × 0.4–0.8 mm, lingulate, lingulate-lanceolate, sometimes constricted at midleaf, regularly bistratose or sometimes tristratose in the upper third, irregularly bistratose at midleaf; apex rounded, acute, obtuse, sometimes emarginate; margins recurved up to the upper third of leaf, sometimes up to the apex, papillose-crenulate, unistratose, sometimes bistratose in the upper part of the leaf, unbordered; hair point hyaline, strongly spinose, sometimes brownish at base, 0.5–1.5 mm long; costa 75–105 μ m wide, in transverse section with 1–2 guide cell rows and (2)3–4 dorsal stereid rows, generally without substereids, with hydroids; with simple, not pedicellate papillae on the dorsal side, 2.5 μ m high; upper and mid-lamina cells quadrate, hexagonal or rounded, with thin walls, 5–7.5(10) × 5–7.5(10) μ m, with 4–6 bifurcate, not pedicellate papillae per cell, 2.5 μ m high; juxtacostal basal cells rectangular, 35–87 × (7.5)15–17.5 μ m, hyaline, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 26–36% of the leaf length; marginal basal cells chlorophyllose, in 6–17 columns, generally smooth. Dioicous. Seta erect, 1.0–1.5 cm long, spirally twisted to right throughout, reddish brown. Capsule erect, cylindrical, 2.8–4.1 × 0.6–0.8 mm, reddish brown. Peristome of 32 papillose, spirally twisted teeth, 0.6–0.8 mm long; basal membrane of 12–17 rows of cells, 0.3–0.6 mm high. Operculum long conical, 1.5–1.9 mm long. Spores spherical, (10)12.5–7.5(17.5) μ m in diameter, papillose.

Illustrations. Gallego (2002, pp. 13); Gallego et al. (2002b, pp. 650); Kramer (1980, pl. 4, 5, 11, 18).

World distribution. North Africa; South West Asia; Europe.

Mediterranean and Macaronesia area distribution. (Algeria, Hébrard & Pierrot 1994); Crete; Cyprus; (France, Boudier & Pierrot 1992); Greece; Italy; (Israel, Herrnstadt et al. 1982); Morocco; Syria?; Sicily; Spain; Turkey; Yugoslavia. This taxon is cited for first time from Yugoslavia.

Habitat and elevation. This taxon grows on limestone rocks from 800 to 1800 m. a.s.l.

Selected specimens examined. CYPRUS. Between Pano Platres and Troodos village, 24.3.1997, *Blockeel* (Herb. T.L. Blockeel 26-78). IRAQ. Mosul Liwa, 7.1961, *Agnew* (BCB 5967). GREECE. Creta, Iraklion, slopes above the Nida Plain, Mt. Ida, 10.1992, *Blockeel* (Herb. T.L. Blockeel 21-382). Creta, Pr. Rethimnon, 8.3 km südlich oberh. Anogia bei d.kl. Kirche Hochmont, 3.4.1972, *Düll 108* (Herb. J.-P. Frahm). Sterea Ellada, Viotia, Mt. Parnassos, below the Kellaria Ski Centre, 4.1990, *Blockeel* (Herb. T.L. Blockeel 19-94). Peloponnese, Arkadia, Mt. Parnon, 5 km north-east of Kosmas, 11.3.1995, *Blockeel* (Herb. T.L. Blockeel 24-101). ITALY. Sicilia, Bosco di Ficuzza, 10 km south of Marineo, 9.4.1999, *Blockeel* (Herb. T.L. Blockeel 28-86). MOROCCO. Jbel Bouhalla, cordillera del Rif, 35°07'31"N, 5°08'10"W, 15.6.1997, *Cano & Ros* (MUB 11352). Jbel Bouhalla, cordillera del Rif, 35°08'17"N, 5°08'20"W, 16.6.1997, *Cano & Ros* (MUB 10876). SPAIN. Málaga, Puerto del Viento, entre Ronda y El Burgo, 5°03'22", 36°45'56", 13.4.1988, *Hébrard* (BCB 31835). Málaga, serranía de Ronda, Puerto del Viento, 13.10.2000, *Guerra* (MUB 11341). SYRIA. Mesopotamia, Dschebel Abd el Asis, Gharra, 900 m, 22.6.1910, *Handel-Mazzetti 1796* (W). TURKEY. Prov. Antalya, dist. Akseki, Gorge below Erenkaya between Manavgat and Akseki, 10.4.1956, *Davis & Polunin 25802* (E). Prov. Gaziantep, 25 km W. of Gaziantep, 13.9.1956, *McNeill 834* (E). Prov. Hakkari, Cilo Dag in Diz deresi, 6.8.1954, *Davis & Polunin 23874, 24011* (E). Prov. Maras, Elbistan, 6.5.1957, *Davis & Hedge 27658* (E). Prov. Mersin, Findikpinari above Mersin, 7.4.1956, *Davis & Hedge 26480* (E). YUGOSLAVIA. Prizren, 10.1893, *Dieck 73* (JE).

Observations. This species is characterized by the presence of simple, non-pedicellate papillae on the dorsal side of the costa, the leaves sometimes constricted at midleaf and patent when moist, and the margins recurved to the upper third of the leaves (Gallego et al. 2002b).

Syntrichia handelii has been considered a subspecies of *Syntrichia montana*: *Syntrichia montana* subsp. *handelii* (Podpěra 1954), *Tortula intermedia* subsp. *handelii* (Wijk & Margadant 1965). These two species share some morphological characters, such as cell size, leaf constriction, the presence of hydroids, and the position of the leaves when moist. But they differ in the stratification of the lamina (unistratose in *S. montana*), the recurvature of the leaf margins (never exceeding the upper third in *S. montana*) and the position of the leaves when moist (never recurved in *S. montana*) (Gallego et al. 2002b).

A very closely related taxon occurs in Central Asia: *S. handelii* var. *ferganensis* (Laz.) Ochyra, which is known from the type locality only [Uzbekistán. Fergana, 19.6.1928, Lazarenko (lectotype HBG!; isolectotype LE!)]. This taxon is characterized by its mucronate leaf apex, dorsal side of the costa with simple papillae and leaf margins recurved to the upper third of the leaf. It differs from the typical variety mainly in the absence of a leaf hair point. As in *S. caninervis* var. *abanchesii*, *S. handelii* var. *ferganensis* has no leaf hair point but there are important differences with regard to: (1) leaf shape (carinate, ovate-lingulate to lingulate and greater length in *S. handelii* var. *ferganensis*); (2) papillosity of the

dorsal side of the costa (simple papillae in *S. handelii* var. *ferganensis*); (3) lamina stratification (regularly bistratose in the upper and midleaf in *S. handelii* var. *ferganensis*); (4) transverse section of the costa (with 3–6 dorsal stereid rows in *S. handelii* var. *ferganensis*) and (5) leaf apex (with a long mucro in *S. handelii* var. *ferganensis*; moreover, in the var. *ferganensis* the mucro is formed by the costa and part of the adjacent lamina, rather than by the costa alone, as in *S. caninervis* var. *abranchesii*) (Gallego et al. 2002b).

6. *Syntrichia caninervis* Mitt. var. *caninervis*, J. Proc. Linn. Soc. Bot. Suppl. 1: 39. 1859 (Fig. 3c)

Barbula caninervis (Mitt.) A. Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1871–72: 453. 1873–*Tortula desertorum* Broth., Bot. Centralbl. 34: 24. 1888–*Barbula desertorum* (Broth.) Paris, Ind. Bryol. 71. 1894–*Tortula caninervis* (Mitt.) Broth., Nat. Pfl. 1(3): 435. 1902–*Tortula desertorum* Podp., Sborn. Klub. Prirod. Brno 5: 123. 1923, *hom. illeg.* [article 53.1, Greuter et al. (2000)]–*Syntrichia desertorum* (Broth.) J.J. Amann, Fl. Mouss. Suisse 3: 39. 1933. TYPE: PAKISTAN. Tibet, Rondu, *Thomson 174* [lectotype: BM!, designated by Kramer (1980); isolecotype: NY!]

Tortula bornmuelleri Schiffn., Oesterr. Bot. Zeitschr. 47: 128. 1897–*Barbula bornmuelleri* (Schiffn.) Paris, Ind. Bryol. Suppl. 21. 1900. TYPE: IRAN. Persia borealis. In planitie ad Teheran, c. 1200 m, 8.2.1892, *Bornmüller 4456* [lectotype: BM!, designated by Gallego et al. (2002b); isolecotype: E!].

Tortula saharae Trab., Bull. Soc. Hist. Nat. Afr. Nord 18: 12–13. 1927. Ind. loc.: “Figuig, Avril 1906”. [type: not located; not at: AL?, B, G?, GOET, H, MPU]

Tortula bistratosa Flowers, Bryologist 54: 278. 1–10. 1951. TYPE: USA. Utah, Salt Lake County, about 12 miles west of Salt Lake City. Highway 40, 4200 feet elev, 1.4.1950, *Flowers 7412* [isotype: FH!].

Tortula pseudodesertorum J. Froehl., Ann. Naturhist. Mus. Wien 67: 155. 1964–*Syntrichia pseudodesertorum* (J. Froehl.) S. Agnew & Vondr., Feddes Repert. 86: 402. 1975. TYPE: AFGANISTAN. Prov. Mazar-i Sharif, in faucibus fluvii Balkh supra Aq Kupruk, 36°05'N, 66°52'E, ca. 700–800 m, 7–8.6.1962, *Rechinger 19675* [holotype: W!, isotype: W!].

Plants 0.4–1.1 cm high, growing in dense olive-green, whitish turfs. Stems erect, branched. Leaves lightly spirally twisted or appressed when dry, mostly patent or spreading, rarely recurved when moist, 1.5–2.6 × 0.6–1.2 mm, ovate, ovate-lingulate, not constricted at midleaf, regularly bistratose in the upper third and at midleaf; apex rounded, acuminate, cucullate, sometimes hyaline and tapering to the base of the hair point; margins recurved from base to near the apex, papillose-crenulate, unistratose, unbordered; hair point hyaline, strongly spinose, sometimes brownish at base, 0.6–2.3 mm long; costa 75–115 μm wide, in transverse section with (1)2–3 guide cell rows and (1)2–4(5) dorsal stereid rows, sometimes with substereids, with hydroids; with simple, bifurcate or pedicellate and branched papillae on the dorsal side, 2.5–30 μm high; upper and mid-lamina cells quadrate, rectangular or rounded, with thick walls, 7.5–10 × 7.5–10 μm, with 4–6 bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, 50–75 × 10–17.5 μm, hyaline, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 28–38% of leaf length; marginal basal cells chlorophyllose, in 10–14 columns, generally smooth. Dioicous. Seta erect, 0.6–1.4 cm long, spi-

rally twisted to right above, to left below, reddish brown. Capsule erect, ovoid-cylindrical, 2.5–2.6×0.6–0.7 mm, reddish brown. Peristome of 32 papillose, spirally twisted teeth, 0.7–0.8 mm long; basal membrane of 10–12 rows of cells, 0.3–0.4 mm high. Operculum long conical, 1.5 mm long. Spores spherical, 7.5 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 13); Gallego et al. (2002b, pp. 650); Kramer (1980, pl. 4, 10, 15, 17, 24, 25); Zander (1993, pp. 266, as *Syntrichia pseudodesertorum*).

World distribution. North Africa; North America; Asia; Europe.

Mediterranean and Macaronesia area distribution. (Algeria, Jelenc 1954); Greece; Israel; (Italy, Cortini-Pedrotti 2001); Jordan; Lebanon; Morocco; Spain; Syria; Turkey; (Yugoslavia, Sabovljevic & Stevanovic 1999). This taxon is cited for first time from Greece and Israel.

Habitat and elevation. Usually on gypsum-rich soils; also on bare basic soils and rocks but rarely on acidic substrates, not collected as an epiphyte. It grows from 650 to 1300 m. a.s.l.

Selected specimens examined. GREECE. Pélouponèse, Taygète, mont Proph. Ilias, au N du refuge, 2200 m, 26.5.1983, *Margot* (BR 276755-14). ISRAEL. Negev, Maale Arod S. Har Ramon, 900 m, 5.5.1989, *Frey & Kürschner 89-147* (Herb. H. Kürschner 3415). JORDAN. Dana Reserve, 24.3.2000, *Hooper* (Herb. C.C. Townsend). Bei El Hesheh, 20 km N Petra, 1200 m, 16.03.1993, *Frey & Kürschner* (Herb. H. Kürschner 4551). LEBANON. Below columns of the Temple of Jupiter and facing the Temple of Bacchus, Baalbek, 24.4.1967, *Townsend* (Herb. C.C. Townsend). Hillside above Baalbek, 5.5.1974, *Townsend* (Herb. C.C. Townsend). MOROCCO. Ifrane, 8.4.1969, *Davis & Davis 49306e* (BM). SPAIN. Albacete, Los Yesares, XJ0932, 3.1991, *Guerra & Ros* (MUB 4536). Alicante, Sierra de Aitana, 13.4.1982, *Casas* (BCB 6818). Almería, c. 16 km W of Sorbas, Los Yesos, near gypsum mine S of N340 road, 37°5'N, 2°18'W, 28.4.1990, *Jury & Maunder* (BCB 30034). Murcia, Caravaca, Royos de Abajo, 8.6.1983, *Ros* (MUB 1199). Navarra, Los Arcos, 23.2.1975, *Fuertes & Garcia* (MA-Muscú 1598). Palencia, Villaviudas, vertiente sur, 28.4.1983, *Fuertes* (MA-Muscú 1599). Tarazona, Baix Camp, Prades, muntanyes de Els Rancs, 21.2.1989, *Casals* (BCB 46722). Zaragoza, Bujaraloz, Torcal del Ciervo, 24.4.1977, *Casas* (BCB 5923). SYRIA. Jebel Abd-el Aziz, W von Hasseke, Pass nach Medfaa, 600 m, 15.8.1983, *Frey & Kürschner 83-779* (Herb. H. Kürschner 7205). Schlucht des Barada, 30 km W Damaskus, 800 m, 9.8.1983, *Frey & Kürschner 83-651* (Herb. H. Kürschner 7191). Jebel Abd-el Aziz, W von Hasseke, Pass nach Medfaa, 600 m, 15.8.1983, *Frey & Kürschner 83-779* (Herb. H. Kürschner 7105). TURKEY. Prov. Ankara, shore of Tuz Gölü 25 km north of Kochisar, 28.7.1956, *McNeill 305* (E). Prov. Corum, at the Hittite site of Alcahyuh, 16.5.2000, *Townsend* (Herb. C.C. Townsend). Prov. Malatya, Kangal-Hekimhan, 7.6.1960, *Staiton & Henderson 5392* (E). Prov. Sivas, Pinarbasi, 25.6.1960, *Staiton & Henderson 5161* (L). Prov. Van, old town of Van, 1.10.1956, *McNeill 722* (E).

Observations. *Syntrichia caninervis* var. *caninervis* is a variable taxon. The leaves when moist can be patent or spreading, but are sometimes recurved. Plant size varies from 0.4 to 1.1 cm high. The leaves are usually ovate, and the hair point in relation to lamina length is the longest in the group. Two important distinguishing features are the stratification of the lamina (bistratose throughout) and the papillosity of the dorsal side of the costa (generally with longly pedicellate and branched papillae in the upper part of the costa and non-pedicellate and bifurcate papillae in the basal part).

The papillosity on the dorsal side of the costa is a very variable character in *S. caninervis*. Samples of *S. caninervis* var. *caninervis*, which show the same type of papillosity as var. *pseudodesertorum*, can be distinguished by the larger size of the latter and by the cur-

vature of the leaves (recurved when moist in var. *pseudodesertorum* and patent or spreading in var. *caninervis*) (Gallego et al. 2002b).

7. *Syntrichia caninervis* var. *pseudodesertorum* (Vondr.) M.T. Gallego, Syst. Bot. 27(4): 649

Syntrichia handelii var. *pseudodesertorum* Vondr., Bull. Soc. Amis Sci. Lett. Poznan, Sér. D, Sci. Biol. 6: 121. f. 6. 1965 [1966]. Ind. loc.: "Iraq: Pira Magrun, distr. Sulaimania, 21.10.1960, leg. E. Hadač" [type: not located, not at: PL, BUH].

Tortula pseudohandelii J. Froehl., Ann. Naturhistor. Mus. Wien 67: 155. 1964—*Syntrichia pseudohandelii* (J. Froehl.) S. Agnew & Vondr., Feddes Repert. 86: 401. 1975. TYPE: AFGANISTAN. Prov. Mazar-i Sharif, in faucibus fluvii Balkh supra Aq Kupruk, 36°05'N, 66°52'E, ca. 700–800 m, 7–8.6.1962, *Rechinger 19673* [holotype: W!; isotype: GZU!].

Plants 2.5–7 cm high, growing in dense olive-green turfs. Stems erect, branched. Leaves lightly spirally twisted or appressed when dry, mostly recurved, rarely spreading when moist, 3.2–4×0.9–1.1 mm, ovate-lingulate, ovate-lanceolate, not constricted at midleaf, regularly bistratose in the upper third and at midleaf; apex rounded, obtuse, sometimes cucullate; margins recurved from base to near the apex, papillose-crenulate, unistratose, unbordered; hair point hyaline, strongly spinose, sometimes brownish at the base, 1.4–2.1 mm long; costa 120–135 μm wide, in transverse section with 2–3 guide cell rows and 2–5 dorsal stereid rows, sometimes with substereids, with hydroids; with bi-trifurcate, pedicellate and stellately branched papillae on the dorsal side, (15)17.5–25 μm high; upper and mid-lamina cells quadrate or hexagonal, with thin walls, 7.5–10×(5)7.5–10 μm, with 6–8 bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, 47.5–100×7.5–12.5 μm, hyaline, with thin walls, rarely collenchymatous, forming a clearly differentiated hyaline area up to 29–35% of leaf length; marginal basal cells chlorophyllose, in 10–15 columns, generally smooth. Dioicous. Sporophyte unknown.

Illustrations. Gallego et al. (2002b, pp. 650); Kramer (1980, pl. 5, 11, 15, 18, as *Tortula pseudohandelii*).

World distribution. South West Asia.

Mediterranean and Macaronesia area distribution. (Israel, Herrnstadt et al. 1982); (Jordan, El-Oqlah et al. 1988); Syria: Turkey.

Habitat and elevation. This taxon appears on limestone rocks, from 700 to 1900 m. a.s.l.

Selected specimens examined. SYRIA. Jebel Abd-el Aziz, W von Hasseke, Pass nach Medfaa, 700–800 m, 15.8.1983, *Frey & Kürschner 83-786* (Herb. H. Kürschner 7195). TURKEY. Prov. Ankara, Gerede-Ankara nr. Kizilcahamam, 22.7.1956, *McNeill 286* (E).

Observations. This is a distinct, relatively robust variety of *Syntrichia caninervis* characterized by the long pedicellate, bi-trifurcate stellately branched papillae covering the whole of the dorsal surface of the costa and the recurved leaves when moist. This taxon differs from *S. ruralis* which is similar in appearance but has bistratose leaves, pedicellate, bi-trifurcate, stellately branched papillae, (15)17.5–25 μm high on the dorsal side of the costa, hydroids and substereids.

According to Vondráček (1965) the holotype of *Syntrichia handelii* var. *pseudodesertorum* is deposited in his herbarium (herb. Vondráček), with the number Hč B. 339 and

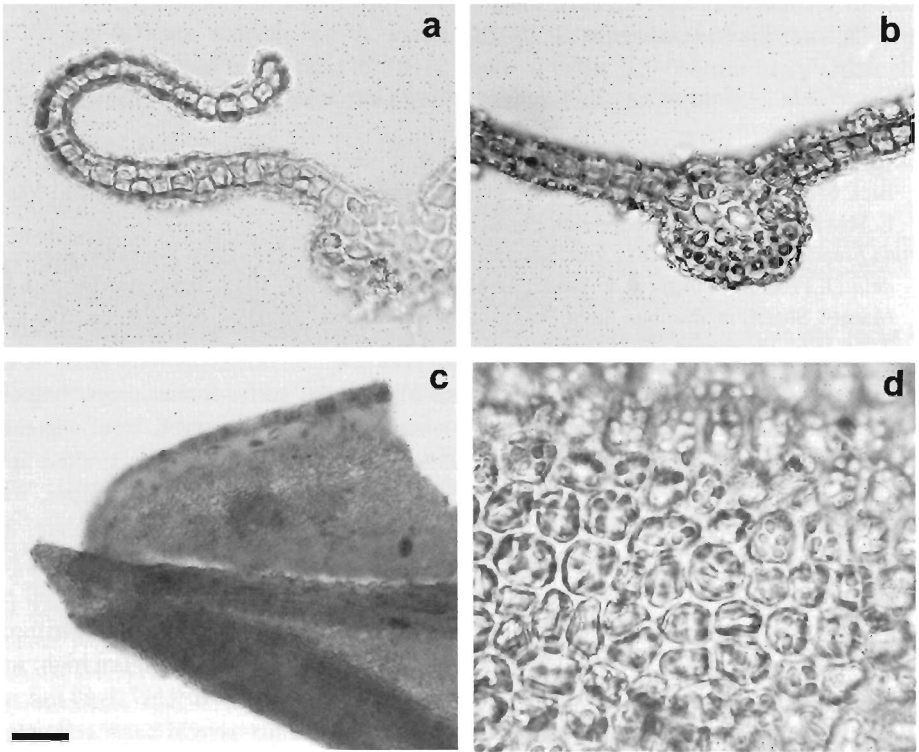


Fig. 8. Light microscope photographs of *Syntrichia caninervis* var. *abrangesii*: a. Transverse section of the costa in the upper part of the leaf. b. Transverse section of the costa in the midleaf. c. Apex of the leaf. d. Mid-lamina cells. Scale bars: a–b=25 μ m; c=70 μ m; d=12 μ m.

there is an isotype in BUH. It has been requested from PL where, according to Vitt et al. (1985), the Vondráček herbarium is deposited, and BUH, but without success.

8. *Syntrichia caninervis* var. *abrangesii* (Luisier) R.H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 267. 1993 (Fig. 8a–d)

Tortula abrangesii Luisier, Broteria ser. Bot. 14: 115. 3. 1916–*Syntrichia montana* subsp. *abrangesii* (Luisier) Podp., Consp.: 259. 1954–*Tortula caninervis* subsp. *spuria* var. *abrangesii* (Luisier) W.A. Kramer, Bryophyt. Biblioth. 21: 108. 1980–*Syntrichia abrangesii* (Luisier) Ochyra, Fragm. Florist. Geobot. 37: 212. 1992. TYPE: SPAIN, Salamanca, prope La Flecha, 03.1915, Luisier *s.n.* [lectotype: BM, designated by Kramer (1980); isolectotypes: LISU!, BCB!].

Plants 0.5–1.2 cm high, growing in loose olive-green or brownish turfs. Stems erect, branched. Leaves appressed when dry, mostly spreading when moist, 1.9–2.3 \times 0.8–1.0 mm, ovate, ovate-lingulate, not constricted at midleaf, irregularly bistratose in the upper third, unistratose at midleaf; apex rounded, obtuse, sometimes cucullate, apiculate or mucronate, up to 25–38 μ m long; margins recurved from base up to the apex, papillose-crenulate, unis-

trattose, unbordered; without hair point; costa 65–90 μm wide, in transverse section with 1 guide cell row and 1–2(3) dorsal stereid rows, sometimes with substereids, with hydroids; with bifurcate or branched papillae on the dorsal side, 5–12.5 μm high in the upper third, smooth in the lower part; upper and mid-lamina cells quadrate, rectangular or rounded, with thin walls, 10–12.5 \times (7.5)10(12.5) μm , with 2–4 simple, bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, 60–85 \times 10–20 μm , hyaline, with thin walls, rarely collenchymatous, forming a clearly differentiated hyaline area up to 22–33% of leaf length; marginal basal cells chlorophyllose, in 8–12 columns, generally smooth. Dioicous. Sporophyte unknown.

This description was prepared from the type material which is the only known specimen.

Illustrations. Kramer (1980, pl. 4, 11); Luisier (1916, pp. 116).

World distribution. Europe.

Mediterranean and Macaronesia area distribution. Spain.

Habitat and elevation. Terricolous species known only from Spain.

Specimens examined. SPAIN. Salamanca, La Flecha, 3.1915, Luisier (BM). *Ibidem* (LISU) *Ibidem* (BCB 30397).

Observations. Plants of *Syntrichia caninervis* var. *abranthesii* are similar in general appearance to plants of *S. montana* var. *calva* as these two taxa have leaves without a hair point and are of similar size. Moreover, they share small lamina cells and the presence of hydroids. However, the former taxon has a distinctly different papilosity of the costa (with bifurcate or branched papillae on the dorsal side, 5–12.5 μm high in the upper third, smooth in the basal part), stratification of the lamina (irregularly bistratose in the upper third, unistratose at midleaf), constriction of the leaf (not constricted at midleaf) and margins (recurved from base up to the apex).

9. *Syntrichia caninervis* var. *gypsophila* (J.J. Amann ex G. Roth) Ochyra, *Fragm. Florist. Geobot.* 37: 212. 1992 (Figs. 1b; 3f)

Tortula ruralis var. *gypsophila* J.J. Amann ex G. Roth, *Hedwigia* 57: 135. 1915–*Tortula gypsophila* J.J. Amann ex G. Roth, *Hedwigia* 57: 135. 1915, nom. inval. [article 34.1(c), Greuter et al. (2000)]–*Tortula spuria* J.J. Amann, *Bull. Murith., Soc. Valais. Sci. Nat.* 39: 351. 1916–*Syntrichia ruralis* var. *gypsophila* (J.J. Amann ex G. Roth) J.J. Amann, *Fl. Mouss. Suisse* 2: 118. 1918–*Syntrichia spuria* (J.J. Amann) J.J. Amann, *Fl. Mouss. Suisse* 2: 119, 384. 1918–*Tortula ruralis* subsp. *spuria* (J.J. Amann) Giacom., *Atti Ist. Bot. Univ. Lab. Crit. Pavia ser.* 5, 4: 217. 1947–*Syntrichia ruralis* var. *spuria* (J.J. Amann) Podp., *Consp.* 257, 1954, nom. illeg.–*Tortula caninervis* subsp. *spuria* var. *gypsophila* (J.J. Amann ex G. Roth) W.A. Kramer, *Bryoph. Biblioth.* 21: 106. 1980–*Syntrichia caninervis* var. *spuria* (J.J. Amann) R.H. Zander, *Bull. Buffalo Soc. Nat. Sci.* 32: 267. 1993, nom. illeg. TYPE: SWITZERLAND. Valais, murs de vignes et rochers, Sion-Montorge, 550–600 m, 8.12.1912. Amann s.n. [lectotype: ZT!, designated by Kramer (1980)].

Syntrichia hadacii Vondr., *Bull. Soc. Amis Sci. Lett. Poznan, Sér. D, Sci. Biol.* 6: 121. f. 3. 1965 [1966]; *Ind. loc.*: Iraq: in steпа inter Hadhar et Sharqat, 24.2.1961, *Hadač B. 344* [type: not located, not at: PL, BUH?].

Plants 0.3–1.6 cm high, growing in dense olive-green, whitish turfs. Stems erect,

branched. Leaves lightly spirally twisted or appressed when dry, mostly patent or spreading, sometimes recurved when moist, $0.9\text{--}2.4 \times 0.6\text{--}1.1$ mm, ovate, ovate-lanceolate, not constricted at midleaf, irregularly bistratose in the upper third, unistratose at midleaf; apex rounded, obtuse, sometimes cucullate or hyaline; margins recurved from base to near the apex, sometimes up to upper third of the leaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, strongly spinose, $0.3\text{--}1.8(2.6)$ mm long; costa $60\text{--}112$ μm wide, in transverse section with 1–2 guide cell rows and (1)3–4 dorsal stereid rows, sometimes with substereids, with hydroids; with branched papillae, $12.5\text{--}37.5$ μm high in the upper third, and with simple or bifurcate papillae, $2.5\text{--}5$ μm high in the lower part on the dorsal side; upper and mid-lamina cells quadrate, hexagonal or rounded, with thick walls, $7.5\text{--}10(12.5) \times (5)7.5\text{--}10(12.5)$ μm , with (2)4–5 bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, $25\text{--}75 \times 10\text{--}20$ μm , hyaline, with thin walls, forming a clearly differentiated hyaline area up to 28–48% of leaf length; marginal basal cells chlorophyllose, in 8–15 columns, generally smooth. Dioicous. Seta erect, $1.3\text{--}1.8$ cm long, spirally twisted to right above, to left below, reddish brown. Capsule erect, cylindrical, $2.8\text{--}3.2 \times 0.6\text{--}0.8$ mm, brownish. Operculum long conical, 1.5 mm long. Spores spherical, 7.5 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 13); Gallego et al. (2002b, pp. 648); Kramer (1980, pl. 4, 10).

World distribution. North Africa; South West Asia; Europe.

Mediterranean and Macaronesia area distribution. France; Italy; Morocco; Spain; (Turkey. Kramer 1980).

Habitat and elevation. It is characteristic of gypsiferous soils, although it may also be found on bare calcareous, clayey or sandy soils, on limestone and walls. *Syntrichia caninervis* var. *gypsophila* appears rarely as a comophyte and has never been found as an epiphyte. It grows from 550 to 1500 m. a.l.s.

Selected specimens examined. FRANCE. Département des Hautes-Alpes, Saint-Crépin, friche audehors du cimetier, 27.6.1991, *Pierrot & Pierrot* (MUB 4772). ITALY. Südtirol, Vinschgau, Sonnenberg zw. Eyrs und Spondinig, 28.10.1989, *Köckinger* (GZU). MOROCCO. Ifrane, 8.3.1969, *Davis & Davis 49306* (E). Anti-Atlas, Sebti-Boumaamane, $29^{\circ}28'N$, $9^{\circ}50'W$, 4.3.2001, *Cano & Muñoz* (MUB 11625). SPAIN. Albacete, Yesos de Montealegre del Castillo, carretera a Bonete, 20.4.1991, *Martínez-Sánchez & Ros* (MUB 4533). Alicante, El Majmó, 19.3.1991, *Ros & Moya* (MUB 4365). Almería, Tabernas, Venta de los Yesos, 20.11.1988, *Martínez-Sánchez et al.* (MUB 3077). Ciudad Real, Castillo de Peñarroya, 17.4.1973, *Casas* (BCB 5944). Cuenca, Mota del Cuervo, $39^{\circ}30'N$, $2^{\circ}52'E$, 14.10.2000, *Cano* (MUB 10976). Granada, entre Cúllar y Baza, 1.2.1990, *Guerra & Ros* (MUB 3825). Huesca, Alberó Alto, 15.2.1973, *Casas* (BCB 5943). Murcia, Archivel, Puntal la Vieja, WH81, 10.3.1985, *Ros* (MUB 3522). Teruel, Arcos de Salinas, 1.4.1974, *Casas* (BCB 5935). Valencia, Jarafuel, *Puche & Gimeno* (VAB 2720).

Observations. *Syntrichia caninervis* var. *gypsophila* is very close to *S. caninervis* var. *caninervis*, but has shorter, less stout hyaline hair points, thinner cell walls and an irregularly stratose lamina (since it is only irregularly bistratose in the upper third) (Gallego et al. 2002b).

Syntrichia caninervis var. *gypsophila* was reported erroneously by Kürschner (2000b) from Syria, based on a misdetermined specimen of *S. caninervis* var. *caninervis* (Frey & Kürschner 83-779).

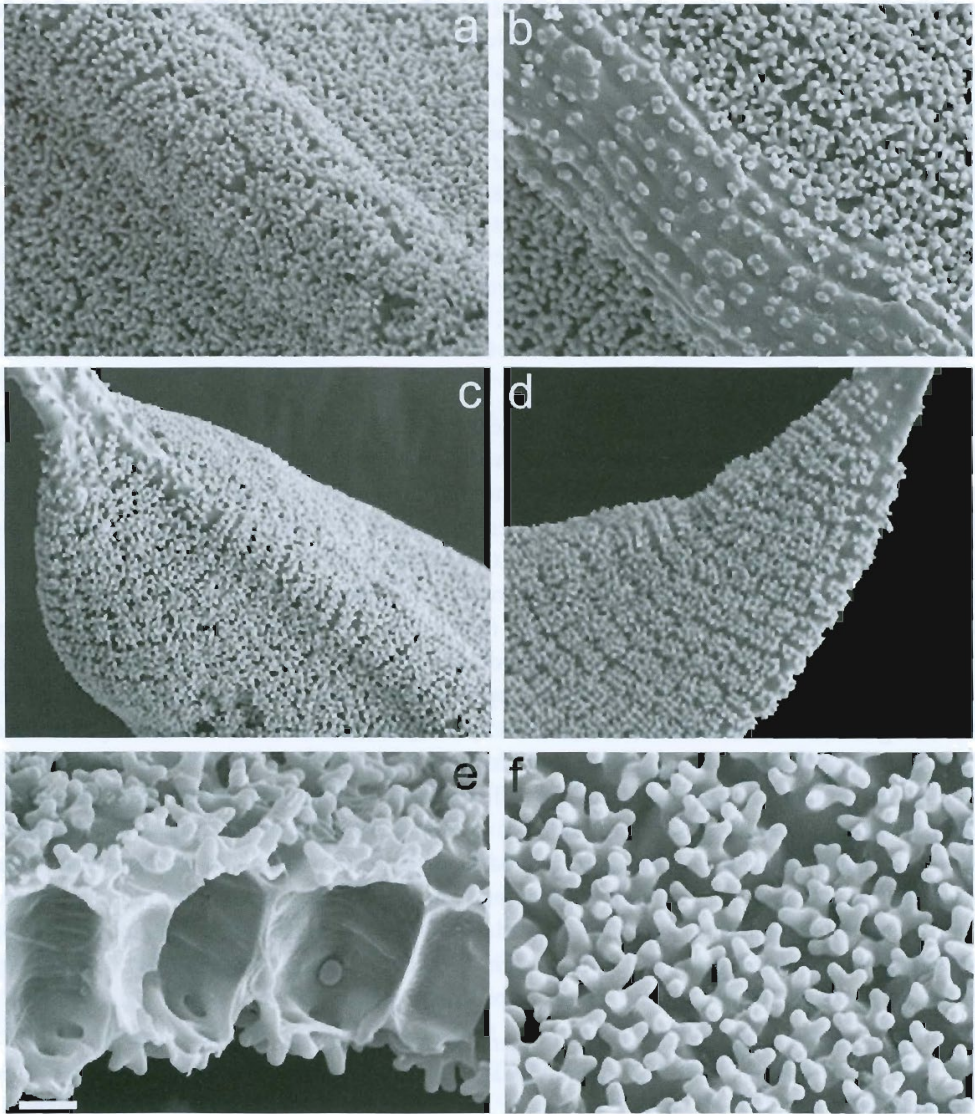


Fig. 9. Scanning electron micrographs of *Syntrichia norvegica* (BCB 26799): a. Dorsal side of the costa in the upper part of the leaf; b. Dorsal side of the costa in the midleaf; c–d. Leaf apex; e. Transverse section of the lamina in the midleaf; Mid-lamina cells. Scale bars: a–b=23 μ m; c–d=50 μ m; e–f=9 μ m.

10. *Syntrichia norvegica* F. Weber, Arch. Sist. Naturgesch. 1: 130. 1804 (Figs. 3d; 9a–f) *Syntrichia ruralis* var. *norvegica* (F. Weber) Steud., Nomencl. Bot. 2: 406. 1824–*Barbula norvegica* (F. Weber) Lindb., Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 20: 387. 1863–*Tortula norvegica* (F. Weber) Lindb., Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 21: 245. 1864–*Tortula ruralis* subsp. *norvegica* (F. Weber) Dixon, Stud. Handb. Brit. Mosses (ed. 3): 204. 1924–*Syn-*

trichia ruralis var. *norvegica* (F. Weber) Mönk., Laubm. Eur.: 312. 1927, *nom. illeg.* [article 53.1, Greuter et al. (2000)]. Ind. loc.: "E Norvegia" [type: not located, not at: B, BM, H-SOL, M, S, W].

Tortula ruralis var. *alpina* Wahlenb., Fl. Carpat. Princ.: 338. 1815. Ind. loc.: "in alpinis prope terminum Mughi copiose" [type: not located, not at: UPS, S, H?].

Barbula aciphylla Bruch & Schimp., Bryol. Eur. 2: 104. 1842—*Tortula aciphylla* (Bruch & Schimp.) Hartm., Handb. Skand. Fl. ed. 5: 381. 1849—*Syntrichia aciphylla* (Bruch & Schimp.) Jur., Laubm.-Fl. Oesterr.-Ung.: 142. 1882—*Barbula ruralis* subsp. *aciphylla* (Bruch & Schimp.) Boulay, Musc. France: 405. 1884. Ind. loc.: "In alpinis germanicis, helveticis et pyrenaicis ubi in casarum vicinitate ad muros et saxa umbrosa, plurimo tempore socia Leskea incurvata caespitose hospitat" [type: not located, not at: BM, JE, LY].

Tortula remotifolia Takaki, J. Jap. Bot. 26: 237. 1951. TYPE: JAPAN. 2450 m, Aug. 5. 1950, n° 9551, Herb. N. Takaki [holotype: B20049 MAK!].

Plants 0.8–3.5 cm high, growing in dense olive-green turfs. Stems erect, branched. Leaves spirally twisted or appressed when dry, recurved when moist, rarely spreading, 2.2–3.5×0.8–1.3 mm, lingulate, ovate-lingulate, not constricted at midleaf, unistratose; apex acuminate, acute or obtuse, sometimes tapering into hair point; margins slightly recurved at midleaf, sometimes from base up to upper third of leaf or plane, papillose-crenulate, unistratose, unbordered; hair point orange or reddish, spinulose, sometimes hyaline at apex, 0.5–1.2 mm; costa 75–105 μm wide, in transverse section with 2–3 guide cell rows and 2–4 dorsal stereid rows, without hydroids; with simple or bifurcate, not pedicellate papillae on the dorsal side, 2.5 μm high; upper and mid-lamina cells quadrate, rectangular or hexagonal, thin walls, 17.5–22.5×12.5–15(22.5) μm , with 4–8 bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, 65–95×20–35 μm , hyaline, with thin walls, forming a clearly differentiated hyaline area up to 25–33% of leaf length; marginal basal cells chlorophyllose, in 8–10 columns, generally smooth. Dioicous. Seta erect, 0.6–1.8 cm long, spirally twisted to right above, to left below, reddish-brown. Capsule erect, sometimes curved, cylindrical, ovoid, 1.4–3.2×0.4–1.0 mm, reddish-brown. Peristome of 32 papillose, spirally twisted teeth, 0.9–1.1 mm long; basal membrane of 8–10(12) rows of cells, 0.25–0.35 mm high. Operculum long conical, 0.8–1.0 mm long. Spores spherical, 10–15 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 15); Kramer (1980, pl. 13, 14, 19); Mislher (1994, pp. 349).

World distribution. North and South Africa; North and Central America; Asia; Europe; Macaronesia.

Mediterranean and Macaronesia area distribution. Andorra; (Bosnia Herzegovina, Düll et al. 1999); Bulgaria; (Corsica, Düll 1984); France; Greece; (Israel, Herrstadt et al. 1991); Italy; Madeira; Morocco; Portugal; (Sicily, Cortini-Pedrotti 2001); (Slovenia, Düll et al. 1999); Spain; Turkey.

Syntrichia norvegica was cited by Sérgio (1968–1969) from mainland Portugal [Beira Alta, Serra do Caramulo, 1966, Sérgio 160 (COI)], but according with Gallego et al. (2002c), this material is *S. ruralis* var. *ruraliformis*, so, *S. norvegica* only has been recorded in Portugal from Madeira.

Habitat and elevation. It is a terricolous species, on stony, exposed and sunny soils. Also in moist and shady places. Saxicolous, mainly on calcareous substrata. *Syntrichia norvegica* grows from 1800 to 3500 m a.s.l.

Selected specimens examined. BULGARIA. Rila, reserv. Parangalitsa, Junipereta si Jiricae, 6.7.1994, *Ganeva* (SOM). FRANCE. Port de la Glère, Garonne, Aoiût, *Fourcade et al.* (Herb. Husnot 456 in BM). GREECE. Monte Olimpo, subida a pico Míticas, 2200 m, 40°05'N, 22°24'E, 6.8.1999, *Cano* (MUB 11394). ITALY. Pordoi in Fassa, Croda rotta supra Ampezzo, 1863, *Molendo* (BR 182070). MOROCO. Alto Atlas, Toubkal, Refugio de Neltner, 3250 m, 31°03'49"N, 7°56'15"W, 20.6.1998, *Cano et al.* (MUB 8308). PORTUGAL. Madeira, Ribeiro Frio, 1938, *Barreto* (Herb. H.N. Dixon 108 in BM). SPAIN. Cantabria, Vega de Liebana, Pena Prieta, tercera Laguna subiendo desde Cubit de Cau, 2300 m, 30TUN5865, 16.8.1987, *Muñoz* (BCB 26799). Gerona, Vilallonga de Ter, Torrent de Medras, 2300 m, 31TDG3691, 27.7.1984, *Lloret* (BCB 26795). Granada, Sierra Nevada, Peñones de San Francisco, 2600 m, 24.4.1980, *Long* (E). Sierra Nevada, Collado del Veleta, Capileira, 3200 m, VG6700, 37°03'03"N, 3°22'12"W, 15.9.2000, *Jiménez & Ros* (MUB 11480). Huesca, montis Maladeta, in valle de Comascou, 1800–2133 m, 1845–46, *Spruce* (E). Navarra, Monte Orhi, 1850 m, 30TXN6261, 8.8.1985, *Ederra* (MUB 2376). TURKEY. Prov. Van, Artos Dagh, northern slopes above Gevas, 2750 m, 2.9.1956, *MceNeill 777b* (E).

Observations. *Syntrichia norvegica* is easily recognized from the colour of its hair point, it being the only species that has an orange or reddish hair point (Augier 1966, Crum & Anderson 1981, Dixon 1970, Lawton 1971, Mishler 1994, Noguchi 1988, Nyholm 1989, Steere 1937). The most important diagnostic character, however, is the cellular differentiation of the dorsal side of the costa in the upper third of the leaf, where the cells are similar to lamina cells (Fig. 9a, c, d), as is the case in the genus *Tortula*. In the middle or the basal part of the leaf, the costa is typical of genus *Syntrichia*, with dorsal stereids.

As in *Ruralis* group, *S. norvegica* has leaves which are recurved when moist, not constricted at midleaf, with recurved margins up to the upper third (although normally they are recurved up to lower midleaf) and without hydroids. For this reason, some authors (Kramer 1980, Nyholm 1989) include this species in the *Ruralis* group which includes (*Syntrichia calcicola*, *S. papillosissima*, *S. subpapillosissima* and *S. ruralis*). However, the lamina cell differentiation of the dorsal side of the costa in the upper third, the laminal cell size ($17.5\text{--}22.5 \times 12.5\text{--}15(22.5)\ \mu\text{m}$ in *S. norvegica* in contrast to $5\text{--}17.5\ \mu\text{m}$ in *Syntrichia calcicola*, *S. papillosissima*, *S. subpapillosissima* and *S. ruralis*), the hair point colour (orange or reddish in *S. norvegica*; hyaline, sometimes brownish up to midpart in *Syntrichia calcicola*, *S. papillosissima*, *S. subpapillosissima* and *S. ruralis*) and the shorter length of the peristome membrane (0.25–0.35 mm high in *S. norvegica* and 0.4–1.1 mm high in *Syntrichia calcicola*, *S. papillosissima*, *S. subpapillosissima* and *S. ruralis*) are all characters which separate *S. norvegica* from *Syntrichia calcicola*, *S. papillosissima*, *S. subpapillosissima* and *S. ruralis*.

11. *Syntrichia virescens* (De Not.) Ochyra, *Fragm. Florist. Geobot.* 37: 213. 1992 (Fig. 10a–e)

Tortula ruralis var. *virescens* De Not., *Mem. Reale Accad. Sci. Torino* 40: 290. 1836–*Barbula ruralis* var. *virescens* (De Not.) Bertol., *Fl. Ital. Crypt.*: 217. 1858–*Tortula virescens* (De Not.) De Not., *Musci Ital.* 1: 41. 1862–*Barbula virescens* (De Not.) Lorentz, *Bryol. Notizb.*: 89. 1865. *nom. illeg.* [article 53.1, Greuter et al. (2000)]. TYPE: ITALY. Mediolani ad Iruncos 1833, *De Notaris* [lectotype: RO!, designated by Ochyra (1994)].

Barbula pulvinata Jur., *Verh. Zool.-Bot. Ges. Wien* 13: 501. 1863–*Barbula intermedia* var. *pulvinata*

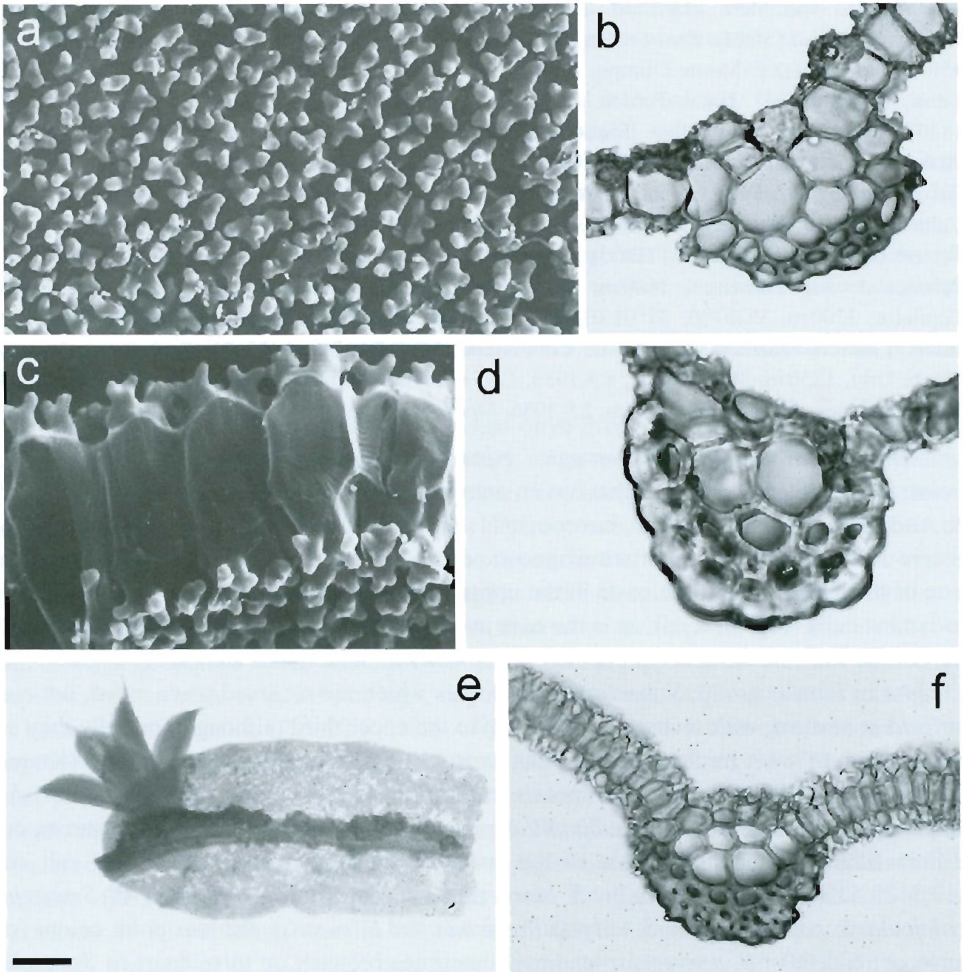


Fig. 10. SEM and light microscope photographs of *Syntrichia virescens* and *S. minor*: a. Upper lamina cells of *S. virescens* (MUB 5846); b. Transverse section of the costa in upper part of the leaf of *S. virescens* (MUB 11370); c. Transverse section of the lamina in the midleaf of *S. virescens* (MUB 5846); d. Transverse section of the costa in midleaf of *S. virescens* (MUB 11370); e. Leaf of *S. virescens* showing vegetative reproduction structures on the ventral side (MUB 17768); f. Transverse section of the costa in midleaf of *S. minor* (MUB 11855). Scale bars: a, c = 10 μm ; b = 16 μm ; d = 14 μm ; e = 235 μm ; f = 30 μm .

(Jur.) Milde, Bryol. Siles. 129. 1869—*Barbula ruralis* var. *pulvinata* (Jur.) Limpr., Krypt.-Fl. Schlesien 1: 167. 1876—*Syntrichia pulvinata* (Jur.) Jur., Laubm.-Fl. Oesterr.-Ung.: 144. 1882—*Barbula ruralis* subsp. *pulvinata* (Jur.) Boulay, Musc. France: 406. 1884—*Tortula pulvinata* (Jur.) Limpr., Laubm. Deutschl. 1: 683. 187. 1888. TYPE: Austria. "Vindabanae", Oct. 1859, Juratzka [lectotype: 2012 027H-SOL!, designated here; syntypes: BM!, JE!].

Barbula danica M.T. Lange. Bot. Tidsskr. 3: 20. 1869—*Tortula danica* (M.T. Lange) C. Hartm., Laubm. Deutschl. 1: 683. 1887—*Tortula ruralis* var. *danica* (M.T. Lange) M.T. Lange. Nomencl. Fl. Danic. 107. 1887—*Tortula ruralis* subsp. *danica* (M.T. Lange) C. Hartm., Handb. Skand. Fl. (ed. 10) 2: 88. 1871. TYPE: DENMARK. Skalkendrup 9/67 [lectotype: herb M.T. Lange in C!, designated here].

Tortula virescens subsp. *virescens* var. *iranica* W.A. Kramer, Bryophyt. Biblioth. 21: 101. 1980. syn. nov.—*Syntrichia virescens* var. *iranica* (W.A. Kramer) R.H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 270. 1993. TYPE: IRAN. Prov. Fars: 72 km nach Shiraz, in Richtung Kazerun, 2080–2150 m. 18.3.1972, Frey 1-1601A [holotype: TUB!].

Tortula ruralis var. *substereidosa* W.A. Kramer, Bryophyt. Biblioth. 21: 125. 1980—*Syntrichia ruralis* var. *substereidosa* (W.A. Kramer) R.H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 337. 1993. TYPE: IRAN. Damavand, E-Flanke, 3450–3700 m, 18.8.1969, Frey 1-1645 [holotype: TUB!].

Plants 0.2–2.5 cm high, growing in dense or lax olive green turfs. Stems erect, branched or not. Leaves weakly spirally twisted or appressed when dry, patent or erectopatent when moist, 1.3–2.8 × 0.5–1.0 mm, spatulate or lingulate-spatulate, constricted at midleaf, unistratose; apex rounded or emarginate; margins plane or slightly recurved up to midleaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, spinulose, sometimes brownish at base, 0.25–1.2 mm; costa 65–107 μm wide, in transverse section with 1–3 guide cell rows and 1–2(3) dorsal stereid rows, sometimes with substereids, without hydroids; with simple or bifurcate, not pedicellate papillae on the dorsal side, 2.5 μm high; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thin or thick walls, (10)12.5–20 × 12.5–15(17.5) μm , with 4–6(8) bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, quadrate, 30–82.5 × 12.5–20 μm , hyaline, with thin or thick walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 20–45% of leaf the length; marginal basal cells chlorophyllose, in 4–12 columns, generally smooth. Vegetative diaspores (costal gemmae) multicellular, rarely present, on the ventral side of leaf on the costa, globular, ovate or elliptical, 50–75 × 30–50 μm , sessile, green or brown, smooth. Dioicous. Seta erect, 0.5–1.1 cm long, spirally twisted to right above and left below, reddish brown. Capsule erect, ovate-cylindrical, 1.6–2.6 × 0.4–0.8 mm, reddish-brown. Peristome of 32 papillose, spirally twisted teeth, 0.3–0.4 mm long; basal membrane of 8–13 rows of cells, 0.17–0.3 mm high. Operculum long conical, 1.2–1.8 mm long. Spores spherical, 10–15 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 15); Kramer (1980, pl. 3, 9, 17; pl. 6, 13, 19b as *Tortula ruralis* subsp. *ruralis* var. *substereidosa*; and pl. 7, 19c as *Tortula virescens* subsp. *virescens* var. *iranica*); Smith (2004, pp. 384); Zander (1993, pp. 268).

World distribution. North Africa; North America; South West and Central Asia; Europe; Macaronesia.

Mediterranean and Macaronesia area distribution. (Algeria, Ros et al. 1999); (Balearic Islands, Düll 1992); (Bosnia Herzegovina, Düll et al. 1999); (Bulgaria, Düll et al. 1999); (Canary Islands: Corsica; (Crete, Düll 1984); (Croatia, Düll et al. 1999). France; Greece; Italy; Morocco; Portugal (Gallego & Cano 2002); (Sardinia, Cortini-Pedrotti 1983); Sicily; (Slovenia, Düll et al. 1999); Spain; Turkey; (Yugoslavia, Sabovljevic & Stevanovic 1999). *Syntrichia virescens* is reported from Corsica for first time.

Habitat and elevation. *Syntrichia virescens* usually grows on trees. Also saxicolous on basalt,

granite, quartz, etc. mainly in rock fissures. Rarely on soil. This species appears from 35 to 3500 m. a.s.l.

Selected specimens examined. FRANCE. Vosges, 26.1.1924, *Henry & Dismier* (MGC 246). Seine-et-Oise, Versailles, 1.6.1965, *Stømer* (O). Corsica, 3 km après bergiere de coscione vers Zicavo, 1400 m, 20.7.1983, *Hébrard* (MUB 1161). GREECE. Oros Pilio, Kato Gadzea, 35 m, 39°18'46"N, 23°05'40"E, 23.3.1999, *Cano et al.* (MUB 11370). ITALY. Sicilia, prov. Trapani, Monte Bonifato (Alcamo), 700 m, 22.08.1998, *Dia & Campisi* (PAL). Südtirol, Etschtal, castel Feder S Auer, 370 m, 29.10.1989, *Köckinger* (GZU). Campania, prov. Salerno, Piaggine, 620 m, 18.11.1994, Long 25753 (E). MOROCCO. Bab Taza, ascensión al Jbel Bouhalla, 1700 m, 35°08'09"N, 5°08'27"W, 17.3.1997, *Cano et al.* (MUB 10901). Alto Atlas, Toubkal, subida desde Arnt hacia el refugio de Neltner, 2800 m, 31°07'N, 7°55'W, 19.6.1998, *Cano et al.* (MUB 9032). Jbel Touchka, 8 km al N de las Cascadas Imaouzer-Ida-Outanen, 1400 m, 30°43'N, 9°26'W, 12.3.2001, *Cano & Muñoz* (MUB 11375). PORTUGAL. Trás-os-Montes e Alto Douro, Miranda do Douro, 400 m, 41°30'N, 6°16'W, 15.4.2001, *Cano* (MUB 11399). Bragança, Vinhais, en la orilla de la carretera del pueblo, 29TPG63, 10.7.2002, *Gallego* (LISU 178978, MUB 14018). Espinhosela, Parque Natural de Montesinho, 29TPG7837, 10.7.2002, *Gallego* (MUB 14019). SPAIN. Albacete, Cancarix, 550 m, XH2252, 17.3.1996, *Ros & Guerra* (MUB 6060). Alicante, Alcoy, santuario de la Font Roja, Sierra de Menechaor, 1050 m, YH1482, 1.2.1993, *Guerra et al.* (MUB 5848). Badajoz, La Morera, Sierra de María Andrés, 450 m, 29SQC06, 22.4.1992 (Herb. J.-P. Frahm). Burgos, Cubillo de Butron, VN43, 800 m, *Casas et al.* (BCB 26782). Granada, Alhambra, 5.1936 (B 227120). Guadalajara, Salto de Poveda, 1000 m, 30TWL8600, 18.11.2000, *Cano* (MUB 11640). Huesca, entre Jaca y Orce, 22.5.1960, *Casas* (BCB 19007). Logroño, 1500–1600 m, 15.7.1974, *Casas* (BCB 6097). Santa Cruz de Tenerife, Tenerife, Estrato de la Junquera, Las Cañadas, 2150 m, 1.3.1984, *González & Socorro* (TFC 4091). Segovia, jardines del Alcázar, 980 m, 30TVL0434, 6.7.1986, *Gómez & Lara* (MA-Musci 7324). Soria, Vozmediano, Moncayo, 900–1000 m, WN9731, *Casas & Cros* (BCB 8303). Valencia, Puebla de San Miguel, Cerro Calderón, 1800 m, 30TXK6238, *Segarra* (VAB 4034). TURKEY. Prov. Trabzon, 2 miles S. of Trabzon, 16.05.1960, *Stanton & Henderson* (E).

Observations. *Syntrichia virescens* is easily separated from other Mediterranean and Macaronesian species of *Syntrichia* by the transverse section of its costa, formed by 1–2(3) stereid rows and without hydroids. It has plane or weakly recurved margins up to midleaf, a spinulose hyaline hair point, constricted leaves and upper and mid-lamina cells (10)15–20×12.5–15(17.5)µm. *Syntrichia virescens* could perhaps be confused with the forms of *S. calcicola* that have few dorsal stereid rows, since this latter species also has a spinulose hair point and does not possess hydroids. However, these two species are distinguished by: (1) margin curvature (*S. calcicola* shows recurved leaf margins up to the upper third while in *S. virescens* they are plane or weakly recurved up to midleaf); (2) constriction of the leaf (not constricted in *S. calcicola*, strongly constricted in *S. virescens*); (3) length of the differentiated hyaline juxtacostal basal area (19–25(33)% of leaf length in *S. calcicola* and 20–45% in *S. virescens*); and (4) the habitat (*S. virescens* grows mainly as an epiphyte, while *S. calcicola* is a saxicolous or terricolous species).

Syntrichia virescens is somewhat similar to *S. laevipila* in habitat, leaf constriction, lamina cell size and curvature of the leaf margins, but differs in: (1) transverse section of the costa (*S. laevipila* has hydroids and 3–5(7) dorsal stereid rows, as opposed to the absence of hydroids and the presence of 1–2(3) dorsal stereid rows in *S. virescens*); (2) pres-

ence/absence of bordered leaf margins (*S. laevipila* shows bordered or unbordered leaf margins whereas *S. virescens* is always unbordered); (3) spore size (*S. laevipila* has spores from 5 to 25 μm in diameter and *S. virescens* from 10 to 15 μm in diameter); (4) vegetative diaspores, which when they occur, appear as brood leaves in *S. laevipila* and as costal gemmae in *S. virescens*. Although vegetative diaspores are present in only one specimen from Spain [Salamanca, Ciudad Rodrigo, Valdecanes, Sierra de Camaces, 19.04.1918, Luisier (Herbarium of Luisier in INA)], many authors have commented on the presence of these asexual reproduction structures in *S. virescens* (Correns 1899, Demaret & Castagne 1959, Hill et al. 1992, Heinrichs et al. 2000). Thus, Limpricht (1890) demonstrated the presence of cylindrical propagules and a small plant on the costa in *S. virescens*. Correns (1899) confirmed the growth of secondary protonema in culture from ventral cells of the costa, although he doubted the existence of propagules in *S. virescens*. Demaret & Castagne (1959) mentioned the occasional presence of propagules, as did Blockeel (1992). Other authors, such as Kramer (1980), Frahm & Frey (1983), Frey et al. (1995) and Touw & Rubers (1989), do not make reference to these structures of vegetative reproduction in *S. virescens*.

Recently, Heinrichs et al. (2000) demonstrated the presence of spherical gemmae, consisting of 1–6 cells and 20–35 μm in diameter, similar to those of *S. latifolia*, both on the dorsal and ventral side of the lamina. Moreover, they indicated the existence of other forms of vegetative reproduction, such as caducus “juvenile plants” on the ventral side of the costa and on the apex of the leaves. Seemingly, in *S. virescens* these vegetative reproductive structures are induced by a “stress mechanism” that stimulates the regenerative potential of the plant (Heinrichs et al. 2000). In the material studied for this work, only two specimens have been found with vegetative reproductive structures, one from Portugal [Trás-os-Montes e Alto Douro, Espinhosela, Parque Natural de Montezinho, 29TPG7837, 10.07.2002, Gallego (MUB 17768)] and the other one from Spain [Salamanca, Ciudad Rodrigo, Valdecanes, Sierra de Camaces, 19.04.1918, Luisier (INA)] with a “juvenile plant” on the costa and with costal gemmae (Fig. 10e).

Kramer (1980) described *Tortula ruralis* var. *substereidosa* based on its costal structure, considering this taxon to be very similar to smaller forms of *Tortula ruralis* subsp. *ruralis* var. *ruralis*, but with substereids up to the leaf apex. Study of the type material, has shown that *T. ruralis* var. *substereidosa* is morphologically identical to *Syntrichia virescens*, because they share the following characters: (1) transverse section of the costa without hydroids, with 1–2(3) dorsal stereid rows, sometimes with substereids; (2) leaves constricted, with hyaline hair point spinulose, margins plane or weakly recurved up to the midpart; (3) lamina cells size and (4) type of papillosity. For this reason, *Tortula ruralis* var. *substereidosa*, was proposed by Gallego et al. (2002a) to be a synonym of *S. virescens* var. *virescens*, and was excluded from the *Ruralis* group (*Syntrichia calcicola*, *S. papillo-sissima*, *S. subpapillo-sissima* and *S. ruralis*). In addition, On the basis of costa structure and the papillosity of the dorsal side of the costa, Kramer (1980) described a new variety of *T. virescens*: *T. virescens* var. *iranica*, with substereids, and papillae on the dorsal side of the costa like those of the lamina cells. Study of type material shows that the transverse section of the costa is the same as that of *S. virescens*, since the substereids can appear or not in *S. virescens*. With reference to the papillosity of the dorsal side of the costa, it has

been observed that *S. virescens* can show both bifurcate papillae, not pedicellate (like those of the lamina) and simple papillae. Furthermore, in the type material of var. *iranica*, the dorsal side of the costa is covered with simple papillae. So, in this study *T. virescens* var. *iranica* has been synonymized with *S. virescens*.

Juratzka (1863) described *Barbula pulvinata* but without any reference to the locality for the species, referring only to a specimen that Mr Bartsch sent to him by post "Die neuestens von Wilson als Barb. intermedia in lit. versendete Pflanze, von der mir Herr Fr. Bartsch eine Probe gütigst mittheilte, ist von *B. pulvinata* kaum verschieden". A search in the herbaria where the majority of Juratzka's specimens are kept (W, L) was unsuccessful. Syntypes have been located in H-SOL, BM and JE. In H-SOL there is one specimen which is in complete accord with the description. It was collected by Juratzka in October of 1859 in "Vindbanæ". In BM there are deposited three samples of *Barbula pulvinata*: the first from Hampe's herbarium, collected by Juratzka in "Wolksberg, near Vienna" on 26 October of 1862, the second is from Wilson's herbarium and collected by Juratzka in Vienna on 24 April of 1861, and the third is number 670 from Rabenhorst, Bryotheca europaea, also collected by Juratzka in Vienna. In JE there are deposited two samples of *Barbula pulvinata*, one from Vienna collected by Juratzka without collection date, and the other is number 670 of Rabenhorst, Bryotheca europaea. Since the H-SOL 2012 027 specimen is completely in accordance with the protologue and is the best conserved material, it has been selected as lectotype.

Five syntypes of *Barbula danica* from M.T. Lange herbarium kept at C, which are in accordance with Lange's description, have been studied. There are four sheets of this specimen from Skalkendrup with the number "9/67" (probably the collection date), but only one marked "Hb. M.T. Lange", and another sheet from Nyborg with the number "10/67". All these specimens bear the earlier name *Barbula ruraliformis*, an epithet that had already been used by Beschereille for a completely different species. The specimen from Skalkendrup marked by "Hb. M.T. Lange" is here selected as lectotype of *Barbula danica*.

12. *Syntrichia minor* (Bizot) M.T. Gallego, J. Guerra, M.J. Cano, Ros & M.C. Sánchez-Moya. Bryologist 103: 375–378. 2000 (Fig. 10f)

Tortula papillosissima var. *minor* Bizot, Rev. Bryol. Lichénol. 23: 268. 1954–*Tortula laevipila* var. *minor* (Bizot) Bizot, Rev. Bryol. Lichénol. 25: 270. 1956–*Tortula bizotii* Laz., Vopr. Evol. Biogeogr. Genet. Sel.: 145. 1960, *nom. inval.* [article 33.2, Greuter et al. (2000)]–*Tortula virescens* subsp. *bizotii* (Laz.) W.A. Kramer, Bryoph. Biblioth. 21: 102. 1980, *nom. inval.* [article 33.2, Greuter et al. (2000)]–*Tortula virescens* subsp. *minor* (Bizot) Ochyra, J. Hattori Bot. Lab. 64: 343. 1988–*Tortula virescens* subsp. *bizotiana* W.A. Kramer, J. Hattori Bot. Lab. 65: 123. 1988, *nom. inval.* [article 33.2, Greuter et al. (2000)]–*Syntrichia virescens* var. *minor* (Bizot) Ochyra, Frag. Florist. Geobot. 37: 213. 1992–*Syntrichia virescens* var. *bizotiana* (W.A. Kramer) R.H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 270. 1993, *nom. illeg.* [article 52.1, Greuter et al. (2000)]. TYPE: LEBANON. Liban. Jebel. *Reichert 15* [lectotype, herb. Bizot 8909 in PC!, designated by Gallego et al. (2000); isolectotype: PC!].

Plants 0.3–1.0 cm high, growing in lax glaucous turfs. Stems erect, branched or not. Leaves weakly spirally twisted or appressed when dry, recurved, sometimes patent when

moist, 1.2–2.5×0.4–0.9 mm, lingulate, constricted at midleaf, unistratose; apex rounded; margins plane or slightly recurved up to midleaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, spinulose, sometimes brownish at base, 0.7–1.0 mm; costa 70–100 μm wide, in transverse section with 1–2 guide cell rows and 1–2(3) dorsal stereid rows, without hydroids; with simple or bifurcate, not pedicellate papillae on the dorsal side, 2.5 μm high; upper and mid-lamina cells quadrate or rectangular, with thin walls, 10–12.5 × (7.5)10–12.5 μm , with 1 branched, pedicellate papilla per cell, 10–15(17.5) μm high; juxtacostal basal cells rectangular, 37–45 × 15–18 μm , hyaline, with thin walls, rarely collenchymatous, forming a clearly differentiated hyaline area up to 25–45% of the leaf length; marginal basal cells chlorophyllose, in 4–12 columns, generally smooth. Dioicous. Seta erect, 0.7–0.9 cm long, spirally twisted to right above and below, reddish brown. Capsule erect, ovate-cylindrical, 1.5–2.1 × 0.6–0.7 mm, reddish-brown. Peristome of 32 papillose, spirally twisted teeth, 0.5–0.6 mm long; basal membrane of 10–13 rows of cells, 0.2–0.3 mm high. Operculum long conical, 1.1–1.3 mm long. Spores spherical, (7.5)12.5–15.0 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 15); Gallego et al. (2000, pp. 376–377); Kramer (1980, pl. 4, 10, 17).

World distribution. North Africa; South West Asia; Europe; Macaronesia. The localities from South Spain were the first record from Europe (Gallego et al. 2000). Previously, it had been reported from Iran (Frey & Kürschner 1991) and Lebanon (type locality), but according to Gallego et al. (2000) the sample from Iran (herbarium Frey 1-1663) is a misinterpretation of *S. virescens*, so, the known distribution area of *S. minor* from Asia, is reduced to Lebanon.

Mediterranean and Macaronesia area distribution. Canary Islands; Cyprus; Greece; Lebanon; Morocco; Spain.

Habitat and elevation. This species grows both as an epiphyte and saxicolous (in fissures with accumulated soil) from 100 to 2100 m a.s.l.

Selected specimens examined. CYPRUS. Troodos mountains, upper slopes of Mt. Olympus, 1700–1800 m, 30.3.1997, *Blockeel 26-166* (Herb. T.L. Blockeel). GREECE. Peninsula Helénica, carretera de Eratini a Galaxidi, 100 m, 38°21'03"N, 22°20'40"E, 22.3.1999, *Cano et al.* (MUB 11372). LEBANON. Liban Jebel, *Reichert 119* (Herb. Bizot 8908 in PC). Liban Jebel, *Reichert 83* (Herb. Bizot 8911 in PC). Liban Jebel, *Reichert 144* (Herb. Bizot 8910 in PC). MOROCCO. Tizi Imilil, 1650 m, 29°43'N, 8°50'W, 7.3.2001, *Cano & Muñoz* (MUB 11855). SPAIN. Cádiz, between Grazalema and Ronda, 22.4.1980, *Long* (E). Jaén, River valley above Cazorra, 16.4.1981, *Long* (E); Sierra de Segura, Orcera, proximidades arroyo de las Herrerías, 1300 m, 30SWH3638, 13.11.1996, *Sánchez-Moya et al.* (MUB 8149); Sierra de Segura, Segura de la Sierra, El Yelmo, 1700 m, 30SWH2934, 14.11.1996, *Sánchez-Moya et al.* (MUB 8150). Santa Cruz de Tenerife, La Palma, Caldera de Taburiente, Pinos Gachos, 2100 m, 28°45'N, 17°54'W, 26.7.2000, *Cano* (MUB 11642); La Palma, Caldera de Taburiente, Mirador de los Andenes, 1983 m, 28°46'N, 17°52'W, 2.8.2000, *Cano* (MUB 11641).

Observations. One branched pedicellate papilla per cell, 10–15(17.5) μm high, leaves constricted at midleaf, margins plane or weakly recurved up to midleaf, a spinulose hyaline hair point and transverse section of the costa with 1–2(3) dorsal stereid rows and without hydroids assist in identification of this species. From its papillae, *Syntrichia minor* could only be confused with *S. papillosissima* (Copp.) Loeske and *S. echinata* (Schiffn.) Herrnstadt & Ben-Season and the differences between them are given after the the description of

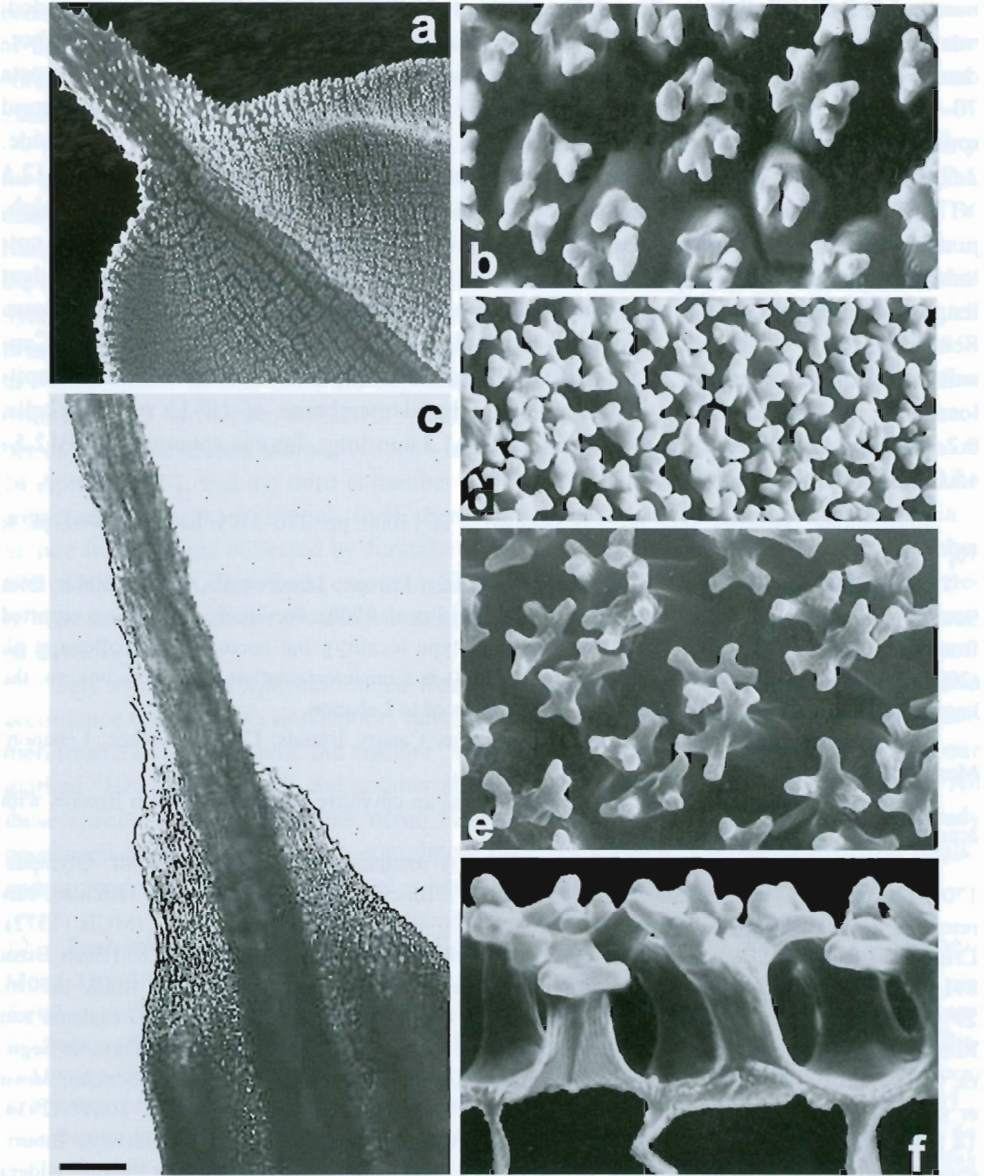


Fig. 11. Scanning electron micrographs and light microscope photograph of *Syntrichia ruralis* (MUB 2717), *S. calcicola* (MUB 10382), *S. ruralis* var. *ruraliformis* (MUB 1139), *S. subpapillosissima* (MGC 885) and *S. papillosissima* (MUB 3357): a. Leaf apex of *S. ruralis*; b. Mid-lamina cells of *S. calcicola*; c. Leaf apex of *S. ruralis* var. *ruraliformis*; d. Mid-lamina cells of *S. ruralis* var. *ruraliformis*; e. Mid-lamina cells of *S. subpapillosissima*; f. Transverse section of the lamina in the midleaf of *S. papillosissima*. Scale bars: a=75 μm ; b, d, e=8 μm ; c=90 μm ; f=4 μm .

the latter two species.

13. *Syntrichia calcicola* J.J. Amann, Fl. Mousses Suisse 2: 119. 1918 (Fig. 11b)
Tortula calcicola Grebe, Hedwigia 49: 1910 [1909], *nom. illeg.* [article 53.], Greuter et al. (2000)]—*Syntrichia montana* subsp. *calcicola* (J.J. Amann) J.J. Amann, Fl. Mousses Suisse 2: 386. 1918—*Syntrichia ruralis* var. *calcicola* (J.J. Amann) Mönk., Laubm. Eur.: 312. 1927—*Tortula ruralis* subsp. *calcicola* (J.J. Amann) Giacom., Atti Ist. Bot. Lab. Crittog. Univ. Pavia ser. 5, 4: 217. 1947—*Tortula ruralis* var. *calcicola* (J.J. Amann) Barkman, Phyt. Ecol. Cryp. Epiphyte: 625. 1958—*Tortula calcicolens* W.A. Kramer, Bryophyt. Biblioth. 21: 90. 1980—*Tortula ruralis* var. *calcicolens* (W.A. Kramer) Düll, Bryol. Beitr. 4: 83. 1984—*Syntrichia ruralis* subsp. *calcicolens* (W.A. Kramer) Düll, Bryol. Beitr. 8/9: 56. 1992. TYPE: GERMANY. Hofgeismar auf sterilem sonstigen Muschelkalk, 15.05.1905. Grebe [lectotype: JE!, designated by Gallego et al. (2002a)].

Plants 0.4–2.3 cm high, growing in dense or lax olive green turfs. Stems erect, branched or not. Leaves spirally twisted when dry, spreading or patent when moist, 1.7–3.8×0.6–1.6 mm, ovate-lingulate, lingulate, or elliptical-lingulate, not constricted at midleaf, unistratose; apex generally rounded, sometimes obtuse, not tapering into hair point, not hyaline; margins revolute from the base up to the upper third of the leaf, rarely to midleaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, spinulose, sometimes brownish at base, 0.2–1.7 mm; costa 70–112.5 μm wide, in transverse section with (1)2–3 guide cell rows and (2)3–5 dorsal stereid rows, without hydroids; with simple or bifurcate, not pedicellate papillae on the dorsal side, 2.5 μm high; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thick walls, 12.5–15(17.5)×12.5–15(17.5) μm , with 4–6(8) bifurcate, not pedicellate papillae per cell, 2.5–5(7.5) μm high; juxtaposed basal cells rectangular, 62.5–92.5×12.5–25 μm , hyaline, with thin or thick walls, rarely collenchymatous, forming a clearly differentiated hyaline area up to 19–25(33)% of the leaf length; marginal basal cells chlorophyllose, in 8–14 columns, generally smooth. Dioicous. Seta erect, 0.9–2.0 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, cylindrical, 2.0–3.6×0.5–0.8 mm, reddish-brown. Peristome of 32 papillose, spirally twisted teeth, 0.6–0.8 mm long; basal membrane of 11–25 rows of cells, 0.4–0.5 mm high. Operculum long conical, 1.3–1.6 mm long. Spores spherical, 10–12.5 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 21); Gallego et al. (2002a, pp. 217); Kramer (1980, pl. 2, 9, 16, 22).

World distribution. North Africa; South West Asia; Europe; Macaronesia.

Mediterranean and Macaronesia area distribution. (Albania, Karpati & Vajda 1961); Andorra; Balearic Islands; (Bulgaria, Düll et al. 1999); Corsica; (Crete, Düll 1992); Cyprus, France; Greece; (Israel, Bilewsky 1977); Italy; (Lebanon, Charouk 1982); (Madeira, Düll 1992); Morocco; (Sardinia, Cortini-Pedrotti 1983); (Sicily, Cortini-Pedrotti 2001); Spain; (Syria, Rungby 1959); Turkey. *Syntrichia calcicola* is reported from Corsica and Cyprus for first time.

Habitat and elevation. On basic, more rarely acidic, nitrified, open, sandy or stony soils. Less often on gypsiferous or humiferous soils. Usually in holm oak or pine forest. Saxicolous on calcareous rocks or on sandstone. Sometimes on soil in fissures of rocks, once in a bog, and rarely on trunk bases. *Syntrichia calcicola* grows from 0 to 2000 m a.s.l.

Selected specimens examined. ANDORRA. Andorra, 16.4.1973, *Sérgio* (LISU 179067); Canillo,

pr. Soldea, pr. Do rio Serge, 17.4.1981, *Sérgio* (LISU 179066). CYPRUS. Kekomallis, near Louvaras, 3000', 10.5.1962. *Meikle* (Herb. C.C. Townsend). FRANCE. Corse, Ponte Leccia, sortie ouest de la ville, 21.3.1980, *Sloover* (BR 276759-18). Dep. Haute-Saône, Faucogney Felsen und Brückenmauern an der Strasse nach Esmoulières, ca. 450 m, 23.3.1993, *Frahm* (sub *Tortula densa*, in Herb. J.-P. Frahm). GREECE. Oros Parnitha, 750 m, 38°08'22"N, 23°43'41"E, 14.3.1999. *Cano et al.* (MUB 11360). Carretera de Epidauras a Methana, prox. a Fanari, 400 m, 37°32'42"N, 23°12'39"E, 15.3.1999, *Cano et al.* (MUB 11363). Râhes (dirección a Volos), 0 m, 38°54'31"N, 22°50'06"E, 22.3.1999, *Cano et al.* (MUB 11366). ITALY. Rég. Marche, prov. Macerata, monti Sibillini, c. 4 km SE of Visso on road to Castelsantago, 17.7.1985. *Jury et al.* (BCB 29993). Emilia-Romagna. Prov. Ravenna, Apennino Tosco-Emiliano. Zattaglia, Mt. Mauro, 500–520 m, 12.5.1995. *Nimis & Poelt* 95/437 (GZU). MOROCCO. Ifrane, c. 1700 m, 8.4.1969, *Davis & Davis 49306e* (BM). Bab-Taza, ascension al Jbel-Bohualla, 1600 m, 35°08'17"N, 5°08'20"W, 16.6.1997, *Cano & Ros* (MUB 10875). Alto Atlas, Toubkal, subida desde Arnt hacia el refugio de Neltner, 2000 m, 19.6.1998, *Cano et al.* (MUB 8394). Anti-Atlas, Igherm, 1800 m, 30°04'N, 8°27'W, 8.3.2001, *Cano & Muñoz* (MUB 11375). SPAIN. Islas Baleares, Mallorca, El Nudo de la Corbata, 725 m, 15.4.1999, *Cano et al.* (MUB 10382). Jaén, Sierra de Cazorla, summit of pass above Iruela, nr Cazorla, 1200 m, 15.4.1980, *Long 8920* (E). Lérida, Pirineos, Seo de Urgell, Sierra del Cadi, Barranco de Ortedó, 1050 m, 17.7.1998, *Cano et al.* (MUB 10464). Navarra, Yerri, Idoya, Azcona, 8.11.1969, *López* (TFC 164). Valencia, Cofrentes, carretera Requena a Cofrentes, 500 m, XJ6745, 2.5.1991, *Puche & Gimeno* (VAB 2721). TURKEY. Prov. Denizli, Nr. Cukurköy, 1200 m, 4.4.1956, *Davis & Polunin 25613* (E).

Observations. *Syntrichia calcicola* is easy to recognize due to its lamina cell size, up to 17.5 μm wide, leaf margins recurved up to upper third, shorter and spinose hair point, leaves spreading or patent when moist and juxtacostal basal cells forming a clearly differentiated hyaline area up to 19–25(33)% of the leaf length. *Syntrichia calcicola* has sometimes been confused with *S. ruralis*, *S. princeps* or *S. montana*. It differs from the former in the size of its leaf cells (smaller in *S. ruralis*), the curvature of leaf margins (recurved up to the apex in *S. ruralis*), length and ornamentation of the hair point (longer and strongly spinose in *S. ruralis*) and the length of the hyaline basal area formed by the juxtacostal cells in the leaf lamina (up to 27–45% in *S. ruralis*). This species differs from *S. princeps* and *S. montana* in the absence of hydroids, no constriction of the leaf, ornamentation of the hair point (both *S. princeps* and *S. montana* have strongly spinose hair points) and in the length of the hyaline basal area formed by the juxtacostal cells in the leaf lamina (up to 23–38% in *S. princeps* and 20–34% in *S. montana*). Moreover, *S. princeps* is a synoicous or dioicous species and *S. montana* has smaller laminal cells [(5)7.5–12.5(15) \times 5–10 (12.5) μm] at midleaf.

Frahm & Gallego (2001) described a new species from Germany close to *S. calcicola*, *S. glabra* J.-P. Frahm & M.T. Gallego, but with several gametophytic differences that make these taxa easy to separate. *Syntrichia glabra* shares with *S. calcicola* the size and ornamentation of the hair point, lamina cell size and curvature of the leaf margins. However, *S. glabra* has 1–2(4) simple mamillae per lamina cell which are shorter than 2.5 μm , with the oldest leaves sometimes bearing 1–3 bifurcate papillae. On the other hand, *S. calcicola* has 4–6(8) bifurcate, not pedicellate papillae per cell, from 2.5 to 7.5 μm high.

14. *Syntrichia ruralis* var. *ruralis* (Hedw.) F. Weber & D. Mohr, Ind. Mus. Pl. Crypt.: 2.

1803 (Figs. 1a; 11a)

Barbula ruralis Hedw., Spec. Musc.: 121. 1801–*Bryum ruralis* (Hedw.) With., Syst. Arr. Brit. Pl., ed. 4, 3: 819. 1801–*Tortula ruralis* (Hedw.) P. Gaertn., B. Mey. & Schreb., Oek. Techn. Fl. Wetterau 3(2): 91. 1802–*Tortula ruralis* subsp. *alaskana* (Kindb.) Paris, Ind. Bryol., ed. 2, 5: 56. 1906. TYPE: *Bryum rurale* specimen marked 1c [lectotype: G, designated by Geissler & Frahm (1995)].

Plants (0.6)1–5(8) cm high, growing in dense olive green turfs. Stems erect, branched. Leaves spirally twisted when dry, generally recurved when moist, sometimes spreading or patent at lower part of stem, 2.2–3.8(5.4) × 0.5–1.5 mm, ovate-lingulate, ovate-lanceolate, not constricted at midleaf, unistratose; apex rounded, sometimes obtuse or acute, not tapering into hair point, not hyaline; margins revolute from the base up to the apex, sometimes up to near the apex, papillose-crenulate, unistratose, unbordered; hair point hyaline, strongly spinose, sometimes brownish at base, 0.4–2.8 mm; costa 70–125 μm wide, in transverse section with (1)2–3 guide cell rows and (2)4–5 dorsal stereid rows, without hydroids; with simple or bifurcate, not pedicellate papillae on the dorsal side, 2.5 μm high; upper and mid-lamina cells quadrate, rectangular or rounded, with thin walls, (5)7.5–10(15) × (5)7.5–10(12.5) μm, with (4)6–8 bifurcate, not pedicellate papillae per cell, 2.5–7.5 μm high; juxtacostal basal cells rectangular, 37–128 × 12.5–20 μm, hyaline, with thin or thick walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 27–45% of leaf length; marginal basal cells chlorophyllose, in (9)13–20 columns, generally smooth. Dioicous. Seta erect, 1.0–2.1 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, sometimes curved, cylindrical, 3.0–4.5 × 0.5–0.95 mm, reddish-brown. Peristome of 32 papillose, spirally twisted teeth, 0.6–1.75 mm long; basal membrane of 22–34 rows of cells, 0.4–1.1 mm high. Operculum long conical, 1.2–2.7 mm long. Spores spherical, (10)–12.5(15) μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 21); Gallego et al. (2002a, pp. 218); Kramer (1980 pl. 6, 12, 14, 15, 18, 20, 28, 29); Zander (1993, pp. 259).

World distribution. Africa; North, Central, Northwestern and Southern South America; North-east, East, Southwestern and Central Asia; Australia; Europe; Macaronesia; New Zealand; Oceania.

Mediterranean and Macaronesia area distribution. (Albania, Düll 1984); (Algeria, Bizot 1973); Andorra; (Azores, Eggers 1982); Balearic Islands; Bosnia Herzegovina; Bulgaria; Canary Islands; Corsica; Crete; (Croatia, Düll et al. 1999); (Cyprus, Townsend 1965); France; Greece; (Israel, Bilevsky 1965); Italy; (Jordan, El-Oqlah et al. 1988); (Lebanon, Bizot 1955); (Macedonia, Düll et al. 1999); Madeira; Morocco; Portugal; Sardinia; Sicily; (Slovenia, Düll et al. 1999); Spain; (Syria, Brown 1937); (Tunisia, Jelenc 1955); Turkey; Yugoslavia.

Habitat and elevation. A common taxon that appears in several habitats. On limestone, detriticus or acid rocks. Usually on rocks with accumulated soil and fissures. Terricolous, on limestone, gypsiferous, saline or sandy soils, sunny or shaded, dry or very moist river banks.

Epiphytic, mainly on the base of trees. Rarely on burned wood. It grows from 100 to 4300 m a.s.l.

Selected specimens examined. ANDORRA. Riu Madriu-Tal bei Escaldes, ca. 1300 m, 28.7.1966, *Pócs 4599* (BM). Andorra, Canillo, pr. Soldea, pr. Do rio Serge (LISU 178995). BOSNIA HERZEGOVINA. Motajica, bei Davor, Rijeka-Grabau, 20.7.1904, *Glowacki* (GZU). Plivatal, oberhalb von Jezero, 28.7.1904, *Glowacki* (GZU). BULGARIA. Montes de Rila, cima del Monte Mussala, 270 m, 25.7.1993,

Ros & Diill (MUB 4732). Bulgaria australis, reserv. Malau Kozhuh, 550 m, 23.3.1960, *Petrov* (SOM). FRANCE. Corse, Vizzavone, 4.1938, *Mosseray* (BR-182256). Savoie, Massif de la Vanoise, Pralognan, Vallée de Chavières, 1500 m, 18.8.1961, *Bonnot* (BCB 6114). Écrins, 100 m, DK 63 km, 1800 m, 14.7.1978, *Hébrard* (MUB 1160). GREECE. West-Macedonian, Distr. Kozani, Pieria-Gebirge, 1600–1800 m, 11.7.1959, *Rechinger* (Cryptogamae exsiccatae editae a Museo Hist. natur. Vindobonensi, 4500 BM). Oros Parnitha, 1150 m, 38°08'56"N, 23°43'27"E, 14.3.1999, *Cano et al.* (MUB 11361). Crete, near San Nicolaos, Mt. Psycros, 10.1971, *Holmen* (C). Monte Olimpo, junto refugio B, 2025 m, 40°05'N, 22°24'E, 6.8.1999, *Cano* (MUB 11397). ITALY. Reg. Marche, prov. Macerata, Monti Sibillini, c. 4 km SE of Visso on road to Castelsantango, 740 m, 17.7.1985, *Jury et al.* 6451 (BM). Sicily, Mt. Etna, Portella Mandrazzi, south of Novara di Sicilia, ca. 1100 m, 4.1993, *Blockeel* (Herb. T.L. Blockeel 22/166). Sardinia, Fonni, punta La Marmora, 3.6.2003, *Aedo* (MUB 15417). MOROCCO. Ifrane, cascadas des Vieges, 33°33'19"N, 5°06'51"W, 30SUC0314, 1500 m, 23.6.1997, *Alberheros et al.* (MUB 10456). Middle Atlas, forest above Azrou, 4.8.1972, *Delong 2112* (E). Bab Taza, ascensión al Jbel Bouhalla, 1700 m, 35°08'09"N, 5°08'27"W, 17.3.1997, *Cano et al.* (MUB 10884). PORTUGAL. Madeira, Pico do Arieiro, lado do Funchal, 4.4.1993, *Nóbrega* (MADJ 7729); Madeira, between Pico Arieiro and Pico Ruivo, 17.03.1993, *Arts 16.196* (LISU 181466). Beira Alta, serra da Estrela, Covão da Ametade, 1450 m, PE16, 9.3.1927, *Melo* (LISU 155029). Beira Litoral, Coimbra, Côja, Benfeita, Mata da Margaraça, 400–900 m, NE95, 8.5.1985, *Sérgio & Santos e Silva 5580* (LISU 155817). Trás-os-Montes e Alto Duoro, Montalegre, Pitões das Júnias, 1050 m, NG83, 21.6.1984, *Sérgio & Schumacker* (LISU 5272). SPAIN. Albacete, Sierra del Relumbrar, finca El Palomar, WH3278, 8.3.1986, *Heras & Ros* (MUB 2718). Islas Baleares, Mallorca, Lluch, replant avant le sommet du Piug Masanella, 1200 m, 11.4.1965 (BCB 6096). Jaén, Sierra de Cazorla, Pico Cabañas, 10.6.1976, *Casas* (BCB 6127). Santa Cruz de Tenerife, La Palma, Caldera de Taburiente, Roque de los Muchachos, 2435 m, 26.7.2000, *Cano* (MUB 10383). TURKEY. Prov. Antalya, dist. Akseki, Pass above Akseki, 1500 m, 9.4.1956, *Davis & Polunin 25794* (E). Prov. Hatay, dist. Belen (Amanus), Karlik tepe above Boguk Oluk, 1000–1200 m, 24.4.1957, *Davis & Hedge 27050* (BM). Prov. Maras, distr. Goksun, Binboga dag, in ravine on N.E. side of Isik dag, 1900 m, 16.7.1952, *Davis 20052 et al.* (E). YUGOSLAVIA. Montenegro, Crna Gora, Paß zw. Andrijevića und Babljak, 15.7.1974, *Mayrhofer* (GZU).

Observations. This species is characterized by densely papillose leaves, with bifurcate, not pedicellate papillae; small cells and recurved margins to the apex or upper third. Mishler (1985, 1994) and Crum & Anderson (1981) considers *Syntrichia montana* (= *Tortula intermedia*) to be a synonymous with *S. ruralis*. Steere (1937) comments that *S. montana* would be considered an underdeveloped form of *S. ruralis*. Magill (1981) affirms that in South Africa, the specimens of *Syntrichia ruralis* are not always clearly separated from *Syntrichia princeps*, particularly if they are sterile. Ochyra (1998) considers that *S. ruralis* has constricted leaves and large cells (14 µm) in the upper part, while in *S. princeps* leaves are not constricted and lamina cells are smaller (10 µm). In this work, it has been concluded that *S. ruralis* is clearly different from *S. princeps*, since *S. ruralis* does not have constricted leaves or hydroids in the costa; moreover the margins are recurved nearby up to the apex, its cells are smaller and the plants are always dioicous.

Syntrichia ruralis differs from *S. montana* in the following characters: (1) leaves not constricted at the middle, as opposed to constricted leaves in *S. montana*; (2) margins recurved up to the apex or near it, as opposed to recurved upper third or up to midleaf in *S. montana* and (3) the absence of hydroids in the costa of *S. ruralis*, while *S. montana* has

these cells clearly differentiated.

15. *Syntrichia ruralis* var. *ruraliformis* (Besch.) Delogne, Ann. Soc. Belg. Microscop. 9: 177. 1885 (Fig. 11c–d)

Barbula ruraliformis Besch., Bull. Soc. Bot. France 11: 335. 1864–*Barbula ruralis* var. *ruraliformis* (Besch.) Husn., Fl. Mousses Nord-Ouest: 87. 1873–*Barbula ruralis* subsp. *ruraliformis* (Besch.) Boulay, Musc. France: 404. 1884–*Tortula ruralis* subsp. *ruraliformis* (Besch.) Dixon, Stud. Handb. Brit. Mosses: 188. 1896–*Tortula ruralis* var. *ruraliformis* (Besch.) De Wild., Prodr. Fl. Belg. 2: 442. 1899–*Tortula ruraliformis* (Besch.) Ingham, J. Bot. 41: 119. 1903–*Syntrichia ruraliformis* (Besch.) Mans., Bull. Soc. Roy. Bot. Belgique 41(2): 184. 1904–*Tortula ruraliformis* (Besch.) Grout, Moss. Hand-lens Microsc.: 167. 1906, *nom. illeg.* [article 52.1, Greuter et al. (2000)]. TYPE: FRANCE. Fontainebleau (herbarium Bescherelle in BM) [lectotype: BM!, designated here; syntypes: BM!].

Tortula ruralis var. *arenicola* Braithw., Brit. Moss Fl. 1: 226. 1885, *nom. illeg.* [article 52.1, Greuter et al. (2000)]–*Syntrichia ruralis* var. *arenicola* J.J. Amann, Fl. Mousses Suisse 2: 118. 1918, *nom. illeg.* [article 52.1, Greuter et al. (2000)]. TYPE: UNITED KINGDOM. Cromer, 14.07.1884, Dixon (herbarium Braithwaite in BM) [lectotype: BM!, designated here].

Plants (0.5)1.5–5.5(8.0) cm high, growing in dense olive green or yellowish turfs. Stems erect, branched. Leaves spirally twisted, sometimes crisped when dry, generally recurved, squarrose when moist, sometimes spreading at lower part of stem, 2.3–4.8 × 0.5–1.5 mm, ovate-lanceolate, lanceolate, sometimes ovate-lingulate, not constricted at middle, unistratose; apex acuminate, rarely obtuse or acute, tapering into hair point, dentate or not, hyaline, or sometimes with the same colour as the rest of the lamina; margins revolute from the base up to the apex, sometimes up to the upper third of the leaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, strongly spinose, sometimes brownish at base, (0.4)1.2–2.8 mm; costa 80–125 µm wide, in transverse section with (1)2–3 guide cell rows and (2)3–5 dorsal stereid rows, without hydroids; with simple or bifurcate, not pedicellate papillae on the dorsal side, 2.5 µm high; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thin walls, (5)7.5–10(15) × (5)7.5–10(12.5) µm, with (4)6–8 bifurcate, not pedicellate papillae per cell, 2.5 µm high; juxtacostal basal cells rectangular, (50)70–90(100) × (10)12.5–15(20) µm, hyaline, with thin walls, sometimes collenchymatous, sometimes sinuose, forming a clearly differentiated hyaline area up to 28–36% of leaf length; marginal basal cells chlorophyllose, in 9–21 columns, generally smooth. Dioicous. Seta erect, 1.2–1.5 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, sometimes curved, cylindrical, 2.7–3.8 × 0.6–0.9 mm, reddish-brown. Peristome of 32 papillose, spirally twisted teeth, 0.6–1.6 mm long; basal membrane of 22–34 rows of cells, 0.4–1.1 mm high. Operculum long conical, 1.3–2.6 mm long. Spores spherical, (10)–12.5(15) µm in diameter, papillose.

Illustrations. Gallego (2002, pp. 21); Gallego et al. (2002a, pp. 218); Kramer (1980, pl. 5, 11, 18).

World distribution. Africa: North, Central, Northwestern and Southern South America; North-east, East, Central and Southwestern Asia: Australia; Europe; Macaronesia; Oceania; New Zealand.

Mediterranean and Macaronesia area distribution. (Albania, Düll 1984); (Algeria, Jelenc 1955); Andorra; Balearic Islands; Bosnia Herzegovina; Bulgaria, Canary Islands; (Crete, Düll 1984);

Cyprus: France: Greece: Italy: Madeira: Morocco: Portugal: (Sardinia, Cortini-Pedrotti 2001); Sicily: Slovenia; Spain; (Syria, Kürschner 2000b); (Tunisia, Jelenc 1955); Turkey; (Yugoslavia, Sabovljevic & Stevanovic 1999).

Habitat and elevation. In the Mediterranean Region this taxon appears both on stable dunes near the coast and on rocks, usually calcareous, although it has also been collected on siliceous rocks. One specimen only as an epiphyte on beech. Abundant on open, sunny, sandy, gypsiferous, lime or humiferous soils. *Syntrichia ruralis* var. *ruraliformis* grows from 5 to 1900 m a.s.l.

Selected specimens examined. ANDORRA. Riu Madriu-Tal bei Escaldes, ca. 1300 m, 28.7.1966, Pócs (BM). BOSNIA HERZEGOVINA. Plivatal, oberhalb von Jezero, 28.7.1904, Glowacki (GZU). Südlich von Sarajevo, Podstok, 7.8.1904, Glowacki (GZU). BULGARIA. Montes de Rila, cima del Monte Mussala, 270 m, 25.7.1993, Ros & Düll (MUB 4732). CYPRUS. High on Paphos, 4000 ft., 10.5.1962, Meikle (K). Kannoures Springs, 2.4.1974, Meikle (K). FRANCE. Sables maritimes du Cap Ferret, Gironde, 20.2.1869 (NY). Manche, Cherbourg, 6.1884, Duerte (E). Vaucluse, commune de Bonnieux domaine de la Chambarelle (au S de Bonnieux), 480–580 m, 9.6.1984, Ros (MUB 1082). Nemours (Seine et Marne), Mai, Bescherelle 457 (BM). Dunkerque, 1864 (BM). Barre (Maine et Loire) (Herbier H. de la Perraudière in BM). Angers Herbier (Herbier H. de la Perraudière in BM). St. Jacob de la Mer (E). GREECE. Prov. Voitoria, above the monastery Osios Loukas, 9.5.1982, Townsend 82/398 (Herb. C.C. Townsend). Peloponesia, Ahaia, lower slopes of Mt. Helmos, ca. 3 km north of Ano Lousi. SE of Kalavrita, 1100 m, 17.4.1995, Blockeel (Herb. T.L. Blockeel 24/222). Râhes (dirección a Volos), 0 m, 38°54'31"N, 22°50'06"E, 22.3.1999, Cano et al. (MUB 11367). ITALY. Völlan S von Meran, 10.5.1884, Glowacki (GZU). Sicily, Mt. Etna, Portella Mandrazzi, south of Novara di Sicilia, ca. 1100 m, 4.1993, Blockeel (Herb. T.L. Blockeel 22/166). MOROCCO. Ifrane, 1700 m, 8.4.1969, Davis & Davis 49305 (E). Bab Taza, ascensión al Jbel Bouhalla, 1700 m, 17.3.1997, Cano et al. (MUB 10884). PORTUGAL. Alto Alentejo, Portalegre. S. Mamede, junto a capela, 820–840 m, PD45, 3.6.1987, Sérgio et al. (LISU 165273). Beira Litoral, Reserva Natural das Dunas de São Jacinto, 0 m, 40°41'N, 8°44'W, 13.4.2001, Cano (MUB 11404). Estremadura, peniche, entre Praia da Consolação e Peniche, 16.2.1972, Silva & Tele (LISU 148910). Trás-os-Montes e Alto Douro, Miranda do Douro, 400 m, 41°30'N, 6°16'W, 15.4.2001, Cano (MUB 11400). Minho, Póvoa de Lanhoso, Castelo, 29TNG60, 17.3.1981, Sérgio 3009 (LISU 178976). Madeira, Pico do Arieiro, 16.03.1992, Fontinha (MADJ 7844). SLOVANIA. Bachergebire nahe Maribor, Frauhein, 28.10.1901, Glowacki (GZU). SPAIN. Albacete, Sierra del Calar del Mundo, umbría de la Fuente de las Raigadas, WH4551, 17.9.1984, Jiménez & Ros (MUB 1637). Granada, Sierra Nevada, Siete Lagunas, 8.1984, Guerra (MGC 740). Santa Cruz de Tenerife, La Palma, Caldera de Taburiente, Degollada de Hoyo Verde, 26.7.2000, Cano (MUB 10384). TURKEY. Prov. Adana dist. Pozanti, Bürücek, 1300 m, 3.4.1957, Davis & Hedge 26329 (E). Prov. Giresun, Tamdere-Yavuzkema, nr. Karınca, 1500 m, 13.8.1952, Davis 20770 et al. (E). Prov. Hatay dist. Belen (Amanus), 1400 m, 24.4.1957, Davis & Hedge 27052 (E). Kayseri, Erciyes Dagi, Dag Kulubesi, 2700 m, 12.07.1979, Carle & Kürschner (Herb. H. Kürschner 544).

Observations. This variety differs from *Syntrichia ruralis* var. *ruralis* mainly in the shape and colour of the leaf apex (Gallego et al. 2002a), although some authors, such as Mishler (1994), do not consider this character to be of taxonomic value. Others maintain this taxon at species level (Dixon 1970, Frey et al. 1995, Lawton 1971, Nyholm 1989, Steere 1937), or as a variety (Smith 2004, Zander 1993). It has been treated at varietal level (Gallego et al. 2000) as intermediate forms between the Bescherelle taxon and *S. ruralis*.

The first time that this taxon was correctly published at varietal level, was by Delogne (1885) (before 1 May 1885). A few months later (September–October 1885) Braithwaite (1885) published the var. *arenicola* at the same rank, and so, the correct name is *Syntrichia ruralis* var. *ruraliformis* (Besch.) Delogne.

Syntrichia ruralis var. *ruraliformis* usually grows on sandy soil near the coast and in gypsiferous areas. It has been cited by European authors typically from coastal dunes, growing on sand (Demaret & Castagne 1959, Dixon 1970, Smith 2004). In the Iberian Peninsula *S. ruralis* var. *ruraliformis* has only been found on coastal dunes in the north and west, while on the east and south coasts it appears more frequently on calcareous soil or on rock. In America it has not been seen on dunes, but has been observed as a terricolous or saxicolous taxon on other types of soil (Steere 1937).

Bescherelle (1864) cited different material collected by diverse botanists in the protologue: “In sabulosis disgregatis prope Fontainebleau, Epernon, Saint Maur, sterilem vidi; in arenosis maritimis prope Dunkerque, Calais, fructiferam legi; prope Le Verdon (Gironde) a cl. Durieu de Maisonneuve detecta; Barre, Angers (H. de la Perraudiere)”. Several syntypes of the name, which are in complete accord with the description, have been located in BM. It was kept in the Bescherelle (specimens marked with the letters “b”, “c” and “d”) and H. de la Perraudière (specimens marked with the letter “a” and with the numbers “1” and “2”) herbaria. The material marked “a” is sterile and is composed of two specimens marked “1” and “2”. These latter samples are from Barré and Angers, respectively. The material marked “c” is from Dunkerque and is mixed with *Syntrichia ruralis* var. *ruralis*. The sheet marked “b” was collected in 1864, probably in Saint Maur, and has sporophytes, but is difficult to interpret. The sheet marked “d” is from Fontainebleau and has no sporophytes. There is another sheet marked “e” that has no reference to any herbarium. This material is from Dunkerque, has sporophytes and was collected in 1864. The sheet marked “d” has been selected as the lectotype of *Barbula ruraliformis*.

16. *Syntrichia papillosissima* (Copp.) Loeske, Hedwigia 49: 44. 1910 (Figs. 4b; 11f)
Barbula papillosissima Copp., Bull. Séances Soc. Sci. Nancy, sér. 3, vol. 8, fasc. 3: 314. 1907–*Tortula papillosissima* (Copp.) Broth., Nat. Pfl. 1(3): 1196. 1909. Ind. loc.: “in fissures rupium calcarearum alpinarum in cacumine occidentali montis “Khelmos” (Aroania), 2100–2300 mètres, 12/8, n° 3403” [type: not located, not at: NCY, PC].
Borbula ruralis var. *hirsuta* Venturi, Rev. Bryol. 17: 52. 1890–*Tortula ruralis* var. *hirsuta* (Venturi) Paris, Ind. Bryol., ed.2, 5: 57. 1906–*Syntrichia ruralis* var. *hirsuta* (Venturi) Podp., Consp.: 256. 1954–*Tortula hirsuta* (Venturi) Laz., Bjull. Moskovsk. Obsc. Isp. Prir. Otd. Biol. 73(2): 146. 1968–*Tortula ruralis* subsp. *hirsuta* (Venturi) W.A. Kramer, Bryophyt. Biblioth. 21: 126. 1980.
 TYPE: ITALY. Sardegna, montis Genargentu, M. de Sardagna. [lectotype: TR!, selected by Gallego et al. (2002a)].

Plants (1)2–5(8) cm high, growing in dense olive green or yellowish turfs. Stems erect, branched. Leaves lightly spirally twisted when dry, generally recurved, squarrose when moist, sometimes at lower part of stem patent, 3–4.5×0.8–1.5 mm, ovate-lingulate or ovate-elliptical, not constricted at midleaf, unistratose; apex usually rounded or acuminate, rarely obtuse or acute, not tapering into hair point, not hyaline; margins revolute from the

base up to near the apex, sometimes up to the upper third of the leaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, strongly spinose, sometimes brownish at base, 0.5–4 mm; costa 92–138 μm wide, in transverse section with (1)2–3(4) guide cell rows and (2)3–5 dorsal stereid rows, without hydroids; with pedicellate and branching as a star-shape, or bifurcate, rarely simple papillae on the dorsal side, 2.5–7.5 μm high; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thin walls, 10–12.5 \times 10–12.5 μm , with 1 pedicellate, branched, star-shaped papilla per cell, (7.5)10–12.5(15) μm high; juxtacostal basal cells rectangular, 75–100 \times 12.5–17.5 μm , hyaline, with thin walls, sometimes collenchymatous, sometimes sinuose, forming a clearly differentiated hyaline area up to 29–45% of the leaf length; marginal basal cells chlorophyllose, in 10–24 columns, generally smooth. Dioicous. Seta erect, 0.9–1.5 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, cylindrical, 2.6–4.0 \times 0.7–0.9 mm, brownish. Peristome of 32 papillose, spirally twisted teeth, 0.5–1.0 mm long; basal membrane of 20–29 rows of cells, 0.5–0.8 mm high. Operculum long conical, 1.5–2.0 mm long. Spores spherical, 12.5 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 21); Gallego et al. (2002a, pp. 221); Kramer (1980, pl. 6, 12, 18, 26, as *Tortula ruralis* subsp. *hirsuta* var. *hirsuta*).

World distribution. North Africa; North America; Northeast, Central and Southwestern Asia; Europe.

Mediterranean and Macaronesia area distribution. Algeria, (Crete, Düll 1995); Cyprus; (Greece, Coppey 1907); Italy; (Jordan, El-Oqlah et al. 1988); (Lebanon, Henderson & Muirhead 1955); Morocco; Portugal; Sardinia; Sicily, Spain; Syria; Turkey. This taxon is reported for the first time from Algeria.

Habitat and elevation. Species usually growing on gypsiferous and sandy acidic soils (in *Juniperus thurifera* L., *Quercus rotundifolia* Lam. or pine forest). In soil accumulated on volcanic or calcareous rocks. Saxicolous on artificial walls or sandstone. It has not been seen as an epiphyte. *Syntrichia papillosissima* grows from 400 to 2100 m. a.s.l.

Selected specimens examined. ALGERIA. Ancien département de Constantine. Flanc N. du Djebel Tababor, 1950 m, 30.5.1952, *Fauvel AFN 52/277* (Herb. R.B. Pierrot). CYPRUS. Eastern Troodos, northern slopes of Mt. Kionia, 1100–1500 m, 28.3.1997, *Blockeel* (Herb. T.L. Blockeel 26/105). Nicosie, Mt. Makhairas, 1300 m, 25.5.1996 (BR 201793-33). Trypilos Peak, 4600', 28.4.1962, *Meikle* (Herb. C.C. Townsend). ITALY. Sicily, Palermo, Rocca Busambra, Versante settentrionale, 16.01.04, *Lo Re & Campisi* (PAL). MOROCCO. Tizi-n'-Test pass., 2100 m, 31.3.1969, *Davis & Davis* (BM). Grand Atlas, Ravin de Tarfeht, 15.4.1952, *Pazenet* (E). PORTUGAL. Miranda do Douro, 400 m, 15.4.2001, *Cano* (MUB 11405). SPAIN. Ávila, murallas de la ciudad, 3.11.1953, *Casas* (BCB 6060). Jaén. Head of valley above Cazorla, 1490 m, 16.4.1980 (E). Jaén, Cazorla, Barranco de la Canal, término de Quesada, 1600 m, WG0382, 7.3.1995, *Monreal-Mármol & Ros* (MUB 10100). Madrid, Arganda, 1980, *Casas* (BCB 30698). Madrid, Chinchón, 7.12.1975, *Casas* (BCB 6056). Málaga, Ronda, Puerto del Viento, 13.8.2000, *Guerra* (MUB 10410). Murcia, Sierra de Moratalla, Barranco Las Conchas, 1400–1500 m, WH6411, 16.4.1982, *Ros* (MUB 3357). Segovia, Arcones, 1100–1200 m, 5.10.1973, *Casas* (BCB 6055). Soria, Blacos, 5.10.1973, *Casas* (BCB 6064). Teruel, Terriente, 1250 m, 2.4.1974, *Casas* (BCB 6088). Valladolid, entre Boecillo y Viana de Ceca, 4.10.1973, *Casas & Brugués* (BCB 6061). SYRIA. Feesen (list. Hermel), 3000 ft., 24.4.1943, *Davis* (BM). *Ibidem Davis 5805* (E). Jebel ed-Druz, E von Suwayda Richtung Salé, 1400–1500 m, 5.8.1983, *Frey & Kürschner 83–569* (Herb. Kürschner 7197). TURKEY. Prov. Adana, dist. Bahce (N Amanus) between

Haruhiye and Fevzipass, 1150 m, 18.4.1975, *Davis & Hedge 26766* (BM). Ankara baraj, 12.4.1958, *Merton 4* (E). Alpes Alexandri, in valle fl. Schamsi, in declivibus reg. silv. super., 29.5.1896, *Brotherus 24* (E). Burdur, Burdur-Antalya, 1300 m, 11.6.1962, *Davis 35681c* (E). Capadocia, Nevsehir, 4.4.1997, *López-Vélez* (MUB 6550). Kültalya, Simav, Simav-Dağ, 1400 m, 18.6.1965, *Coode & Jones 2943* (E). Prov. Malatya, Mt. above Resadi, between Dagansehir and Pazarcik, 1400 m, 10.5.1957, *Davis & Hedge 2775* (BM). Prov. Mardin, 5 km of Mardin, 1200 m, 25.5.1957, *Davis & Hedge 28742* (E). Prov. Muğla, road Kozagaç, north of the town Muğla, 1100 m, 2.4.1970, *Crundwell et al. 508/71* (E). Oçel, d. Mut, Mağras Dağ, 1400 m, 11.5.1965, *Coode & Jones 2959* (E). Mut, Eğri Dağ, 12.5.1965, *Coode & Jones 2958* (E). Samsun, Vilayet, Havza, Sekizgöz, 1000 m, 1.5.1965, *Tabey 920* (E).

Observations. This species is characterized by its leaf papillosity, there being only one branched pedicellate papilla per cell. It could be confused with *S. echinata* and *S. minor*, but the former has leaves constricted at midleaf, recurved leaf margins up to the upper third, hydroids in the costa and a synoicous condition. *Syntrichia minor* has longer papillar branches, plane leaf margins, lamina constricted at midleaf and smaller leaves, a weakly spinulose hair point, and 1–2(3) dorsal stereids rows in the transverse section of the costa (Gallego et al. 2000).

The type of *Barbula papillosissima* was unavailable for study.

17. *Syntrichia subpapillosissima* (Bizot & R.B. Pierrot ex W.A. Kramer) M.T. Gallego & J. Guerra–Bot. J. Linn. Soc. 138: 221. 2002 (Figs. 4d; 11e)

Tortula ruralis var. *subpapillosissima* Bizot & R.B. Pierrot. Acta Bot. Acad. Sci. Hung. 18: 11. 1973, *nom. inval.* [article 37.3, Greuter et al. (2000)]–*Tortula ruraliformis* var. *subpapillosissima* Bizot & R.B. Pierrot ex W.A. Kramer, Bryophyt. Biblioth. 21: 120. 1980–*Syntrichia ruraliformis* var. *subpapillosissima* (Bizot & R.B. Pierrot) Ochyra, Fragm. Florist. Geobot. 37: 212. 1992–*Syntrichia ruralis* var. *subpapillosissima* (Bizot & R.B. Pierrot) R.H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 270. 1993. TYPE: ALGERIA. Djebel Belezma, 15 km W Batna, 1950–2000 m, 27.02.1967, Balazs (isoelectotype: EGR!).

Tortula ruralis var. *submamilliosa* W.A. Kramer, Bryophyt. Biblioth. 21: 127. 1980–*Syntrichia ruralis* var. *submamilliosa* (W.A. Kramer) R.H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 270. 1993. TYPE: TURKEY. Yozgat, 90 km E of Yozgat, W of Olugozü, 1240 m, 15.4.1972, *Uouila 15603*, [holotype: H!].

Plants (1)1.8–5(9) cm high, growing in dense olive green turfs. Stems erect, branched. Leaves lightly spirally twisted when dry, generally recurved, sometimes squarrose, spreading or patent when moist, 2.5–5.8×0.9–2.2 mm, lingulate to ovate-lingulate, not constricted at midleaf, unistratose; apex acuminate, rarely rounded, obtuse or acute, sometimes dentate and hyaline, tapering into hair point; margins revolute from the base up to near the apex, sometimes up to the upper third of the leaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, strongly spinose, sometimes brownish at base, 1–4 mm; costa 95–150 µm wide, in transverse section with (1)2–3 guide cell rows and 3–6 dorsal stereid rows, without hydroids; with simple papillae on the dorsal side, 2.5–5 µm high; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thin walls, 10–12.5×(7.5)10–12.5 µm, (2)4–6 bifurcate, sometimes pedicellate, rarely branched star-shaped papillae per cell, (5)7.5–10 µm high; juxtacostal basal cells rectangular, 75–112.5×

(10)12.5–25 μm , hyaline, with thin walls, sometimes collenchymatous, sometimes sinuose, forming a clearly differentiated hyaline area up to 28–33% of leaf length; marginal basal cells chlorophyllose, in 10–24 columns, generally smooth. Dioicous. Seta erect, 1.3–2.4 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, cylindrical, 3.8–5 \times 0.7–0.9 mm, brownish. Peristome of 32 papillose, spirally twisted teeth, 0.4–0.8 mm long; basal membrane of 28–35 rows of cells, 0.7–1 mm high. Operculum long conical, 1.3–2.6 mm long. Spores spherical, 10 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 21); Gallego et al. (2002a, pp. 221); Kramer (1980, pl. 5, 11, 18, 27, as *Tortula ruraliformis* var. *subpapillosissima*).

World distribution. North Africa; Southwestern Asia; Europe.

Mediterranean and Macaronesia area distribution. Algeria; Crete; (France, Boudier & Pierron 1992); Greece; Italy; Morocco; Portugal; Spain; Turkey. *Syntrichia subpapillosissima* is reported for the first time from Italy.

Habitat and elevation. Species usually growing on calcareous, exposed or protected soils, under *Quercus rotundifolia*, *Q. faginea* Lam., *Q. pyrenaica* Willd. or *Juniperus thurifera*. Sometimes on humiferous, sandy or stoney soils. Saxicolous on granites, slates or sandstones. Rarely epiphytic. It has been collected on Aphyllophorales. *Syntrichia subpapillosissima* grows from 400 to 4300 m. a.s.l.

Selected specimens examined. GREECE. Crete, route Kerà-Lagou, 800 m, 03.04.1980, *Lawalree* (BR 182311). ITALY. Südtirol, Vinschgau-Laas, 463758N, 104147E, 880 m, 07.8.2002, *Ros & Werner* (MUB 15433). MOROCCO. Ifrane, c. 1700 m, 8.4.1969, *Davis & Davis* (E). Anti-Atlas, prox. Askaoun, 1840 m, 10.3.2001, *Cano & Muñoz* (MUB 11374). PORTUGAL. Trás-os Montes e Alto Douro, Miranda do Douro, 400 m, 15.4.2001, *Cano* (MUB 11405) Beira Alta, Serra de Estrela, próximo de Valhelhas, 29TPE3373, 550–600 m, 21.3.2000, *Garcia & Sérgio* (LISU 178724). SPAIN. Alicante, Font Roja, 1200 m, 7.2.1983, *Sérgio et al.* (BCB 10201). Murcia, Jumilla, Sierra del Carche, pico El Carche, 1370 m, 3.3.1985, *Ros* (MGC 885). Teruel, Orihuela del Tremedal, 1600 m, 21.9.1977, *Casas* (BCB 6067). Toledo, Río Algodor. Finca del Quemadillo, 26.11.1977, *Casas* (BCB 6115). Palencia, Cervera del Pisuerga, pr. Peña Redonda, 18.9.1990, *Aedo* (MA-Musci 12912). TURKEY. Prov. Bitlis, Suphan Dag, above Adilcevaz, 4300 m, 27.8.1954, *Davis & Polunin* (BM). Prov. Maras, Elbistan, 1100 m, 6.5.1957, *Davis & Hedge* (BM). Prov. Nevsehir, Kaymakli (the “underground city”), 1220 m, 15.05.2000, *Townsend 00/79* (Herb. C.C. Townsend).

Observations. Traditionally, *Syntrichia subpapillosissima* has been considered as a variety of *S. ruralis* (Zander 1993) or *S. ruraliformis* (Kramer 1980; Frey & Kürschner 1991) but, according to Gallego et al. (2002a), it ranks as a species on the basis of the papillae of the lamina cells. It is the only Mediterranean *Syntrichia* taxon with papillae (5)7.5–10 μm high. Only three taxa have taller papillae (*S. papillosissima*, *S. echinata* and *S. minor*). Although *S. calcicola* has papillae 2.5–5(7.5) μm high, they are never branched or pedicellate.

18. *Syntrichia sinensis* (Müll. Hal.) Ochyra, *Fragm. Florist. Geobot.* 37: 213. 1992 (Fig. 12a–h)

Barbula sinensis Müll. Hal., *Nuovo Giorn. Bot. Ital.* 3: 100. 1896–*Tortula sinensis* (Müll. Hal.) Broth., *Nuovo Giorn. Bot. Ital.* 13: 279. 1906. Ind. loc.: “In saxis ad latera montium Lu-kia-puo, Junio 1894. Cum Bracysteleo polyphylloidi mixta in monte Si-ku-tziu-san” [type: not located, not at: BM, H, FH, NY. According to Kramer (1980), it was destroyed in the Second World

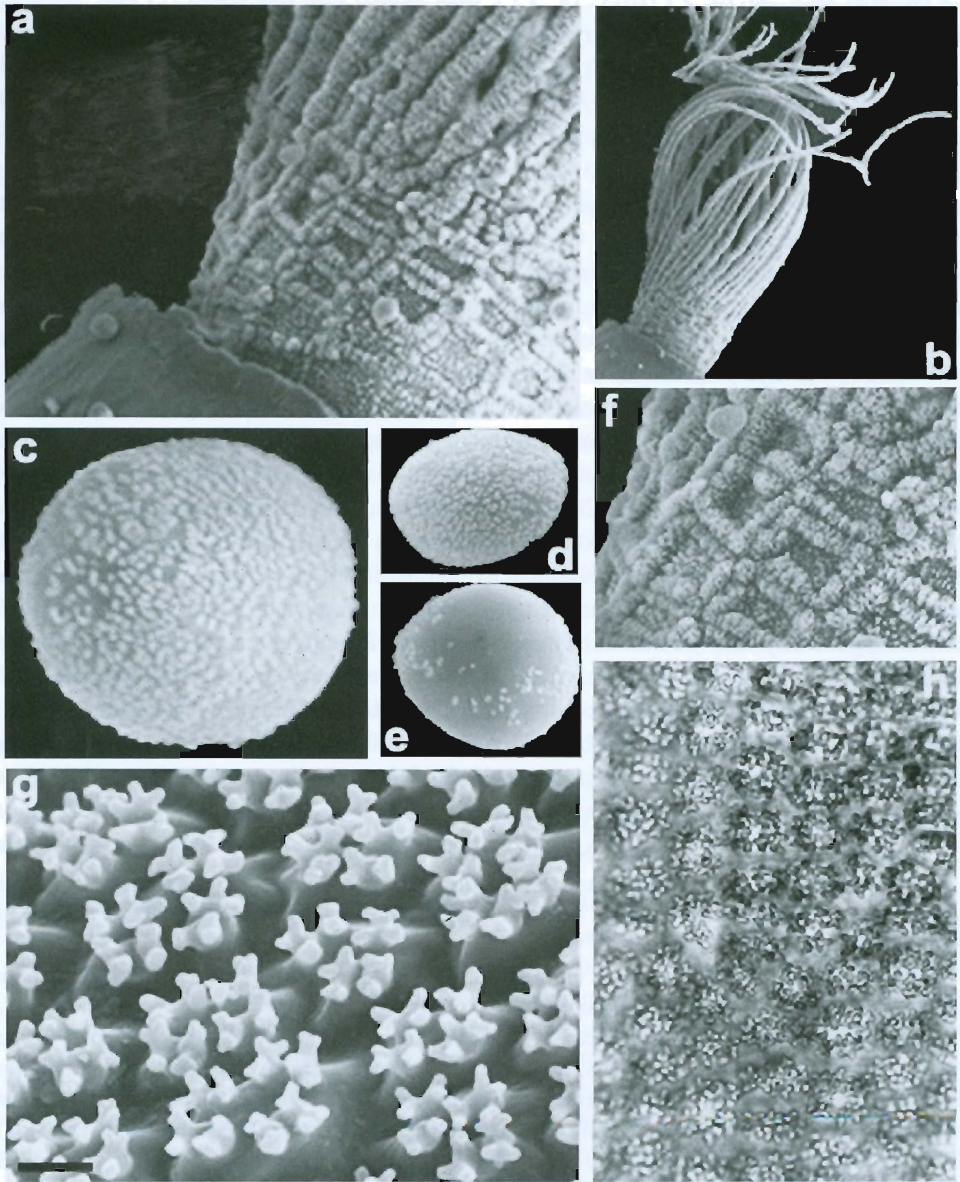


Fig. 12. Scanning electron micrographs and light microscope photograph of *Syntrichia sinensis* (BCB 26826): a. Membrane of the peristome; b. Peristome; c–e. Spores; f. Details of the membrane of the peristome; g. Upper lamina cells; h. Mid-lamina cells. Scale bars: a=50 μm ; b=200 μm ; c=3.5 μm ; d–e=6.5 μm ; f=33 μm ; g=6 μm ; h=20 μm .

War].

Barbula alpina Bruch & Schimp., Bryol. Eur. 2: 101. 1842—*Tortula alpina* (Bruch & Schimp.) Bruch, Musci Frond. Exsic.: 163. 1843—*Syntrichia alpina* (Bruch & Schimp.) Jur., Laubm.-Fl. Oesterr.-Ung.: 139. 1882, *nom. illeg.* [article 53.1, Greuter et al. (2000)]. TYPE: Austria. Kalkschiefer felsen bei Mittersill, 3000', Febr. 1838, *Sauter* [lectotype: BM!; designated here, syntypes: BM!].

Plants 0.4–1.5 cm high, growing in dense or open olive green turfs. Stems erect, branched. Leaves spirally twisted when dry, generally spreading or patent when moist, 1.9–4.6×0.6–1.6 mm, lingulate, lingulate-spathulate, constricted at midleaf, sometimes weakly, unistratose; apex obtuse or rounded; margins weakly recurved up to the middle or only up to basal third of the leaf, sometimes plane, papillose-crenulate, unistratose, unbordered; hair point hyaline, smooth or weakly spinulose, sometimes brownish up to the upper third, 0.1–0.5 mm; costa 60–95 μm wide, in transverse section with 1–2 guide cell rows and 3–5 dorsal stereid rows, with hydroids; with simple papillae, not pedicellate on the dorsal side, 2.5 μm high, sometimes smooth; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thin walls, 12.5–20×(10)12.5–20 μm , (6)8–12 bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, 50–115×17.5–35 μm , hyaline, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 30–50% of the leaf length; marginal basal cells chlorophyllose, in 5–9 columns, generally smooth. Autoicous. Seta erect, 1.4–2.5 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, sometimes curved, cylindrical, 3.0–3.8×0.5–0.8 mm, brownish. Peristome of 32 papillose, spirally twisted teeth, 0.8–1.1 mm long; basal membrane of 3–6 rows of cells, 0.09–0.16(0.2) mm high. Operculum long conical, 1.2–1.4 mm long. Spores spherical, 12.5–17.5 μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 25); Kramer (1980, pl. 1, 8, 15, 25).

World distribution. North Africa; North America; Asia; Europe.

Mediterranean and Macaronesia area distribution. (Cyprus, Koppe 1976); France: Italy: (Slovenia, Düll et al. 1999); Spain: (Tunisia, Ros et al. 1999); (Turkey, Uyar & Cetin 2004); (Yugoslavia, Sabovljevic & Stevanovic 1999).

Habitat and elevation. Saxicolous on exposed or protected rocks. Terricolous on acidic or basic substrates. *Syntrichia sinensis* grows from 1100 to 1500 m. a.s.l.

Selected specimens examined. FRANCE. Alpes Maritimes, *Philibert* (FH). ITALY. Lago de Como, "Monte Galaryola", 800 m, 2.10.1898. *Artaria* (INA). Veneto, Garda, the point of Sant Vigilio, 5.4.1975, *Een* (BCB 6156). SPAIN. Barcelona, Castellar de N'Hug, Fonts del Llobregat, 7.7.1983, *Sotiaux* (BCB 20404). Barcelona, Región de Castellar de N'Hug, 16.7.1983, *Sotiaux* (BCB 20403). Gerona, Vilallonga de Ter, Molló, 1500 m, 31TDG3991, 25.7.1984, *Lloret* (BCB 26824). Gerona, Vilallonga de Ter, Ripollés, Vall de Camprodon, carretera de Setcases a Camprodon, 1200 m, 31TDG4187, 25.1.1989, *Casals et al.* (MA-Musci 11591). *Ibidem* (MA-Musci 11594). Gerona, Vilallonga de Ter, Torrent Negre d'Abella, 1150 m, 31TDG4385, 3.6.1985, *Lloret* (BCB 19882).

Observations. The gametophytic morphological characters that separate this taxon from others are as follows: (1) leaves with short hair point (0.1–0.5 mm high), smooth or weakly spinulose; (2) margins weakly recurved up to the middle or the basal third of the leaf, sometimes plane; (3) transverse section of the costa with 3–5 dorsal stereid rows and

hydroids; and (4) upper and mid-lamina cells $12.5\text{--}20 \times (10)12.5\text{--}20 \mu\text{m}$, with (6)8–12 bifurcate, not pedicellate papillae per cell, $2.5 \mu\text{m}$ high.

Syntrichia laevipila shares with *S. sinensis* the leaf size, sexuality, curvature of leaves margins and structure of the costa. In this sense, they could be confused, although they are easily distinguished by the shorter hair point and basal membrane of the peristome, the greater number of papillae per cell in the lamina and the absence of bordered leaves and vegetative diaspores in *S. sinensis*. Moreover, *S. laevipila* is mainly an epiphytic taxon, whereas *S. sinensis* is terricolous or saxicolous.

As regard to the sporophyte, the most distinctive character in *S. sinensis* is the low number of rows of cells in the basal membrane of peristome (3–6 rows of cells, $0.09\text{--}0.16(0.2)$ mm high).

When Bruch et al. (1842) described *Barbula alpina*, they cited specimens collected by several botanists: “In alpebus Tyrolis (FUNK), Gastoniae Salisburgensis ad muros (ALEX. BRAUN), Pinzgaviae prope Mittersill, ubi in umbrosis arcis antiquae ad rupes calcareos copiose legit amic. DR. SAUTER”.

Seven syntypes from BM herbarium have been studied. There is one folder from Bruch's herbarium with four sheets collected by Sauter in Mittersill (of which only one has a collection date, “Feb. 1838”), one sheet collected by Funk and Müller (on which it is difficult to decipher the locality) and another sheet collected by Braun in 1828 “bei Gastein an Mauern”. Other folders, that do not belong to Bruch's herbarium, one with six sheets also collected by Sauter from Mittersill in April of 1842, and the latter folder collected by A. Braun in 1825 from “Gastein an Mauern”. There is also one folder from the Funk herbarium with six sheets collected in “prope Botzen” at 1835. All syntypes are in accordance with Bruch and Schimper's description. The specimens from the Bruch herbarium collected in Mittersill by Sauter and which have the collection date represent the best preserved material, and so have been selected as lectotype.

19. *Syntrichia montana* Nees var. *montana* Flora 2: 301. 1819 (Figs. 1d; 13a–b)

Tortula montana (Nees) Lindb., Musci. Scand.: 20. 1879, *nom. illeg.* [article 33.2, Greuter et al. (2000)]–*Barbula montana* (Nees) Corb., Mém. Soc. Sci. Nat. Cherbourg 26: 252. 1889, *nom. illeg.* [article 53.1, Greuter et al. (2000)]. Ind. loc.: “Excursion in die Gegend von Muggendorf von Herrn Präsident und Professor Nees von Esenbeck und seinen Zuhörern aus Erlangen... 10 July 1818” [type: not located, not at: B, E, G, GZU, L, LE, PC, S, STR, W].

Syntrichia intermedia Brid., Bryol. Univ. 1: 586. 1826–*Tortula intermedia* (Brid.) De Not., Syllab. Musc.: 181. 1838–*Barbula intermedia* (Brid.) A.W.H. Walther & Molendo, Laubm Oberfrank.: 122. 1868–*Barbula ruralis* var. *intermedia* (Brid.) Limpr., Krypt.-Fl. Sachsen 1: 167. 1876–*Barbula ruralis* subsp. *intermedia* (Brid.) Boulay, Musc. France: 405. 1884. TYPE: FRANCE. Avignon, 1820, Requien [lectotype: B!, designated here].

Tortula ruralis var. *crinita* De Not., Mem. Reale Accad. Sci. Torino 40: 291. 1838. Ind. loc.: “Ad arborum truncos in sylvis montanis Sardiniae” [type: not located, RO?].

Barbula ruralis var. *rupestris* Bruch & Schimp., Bryol. Eur. 2: 105. 1842, *nom. illeg.* [article 52.1, Greuter et al. (2000)]. TYPE: GERMANY. Bei Durlach, mart. 1836, Schimper [lectotype: BM!, designated here; syntypes BM!].

Plants 0.3–5 cm high, growing in dense or sometimes open olive green turfs. Stems

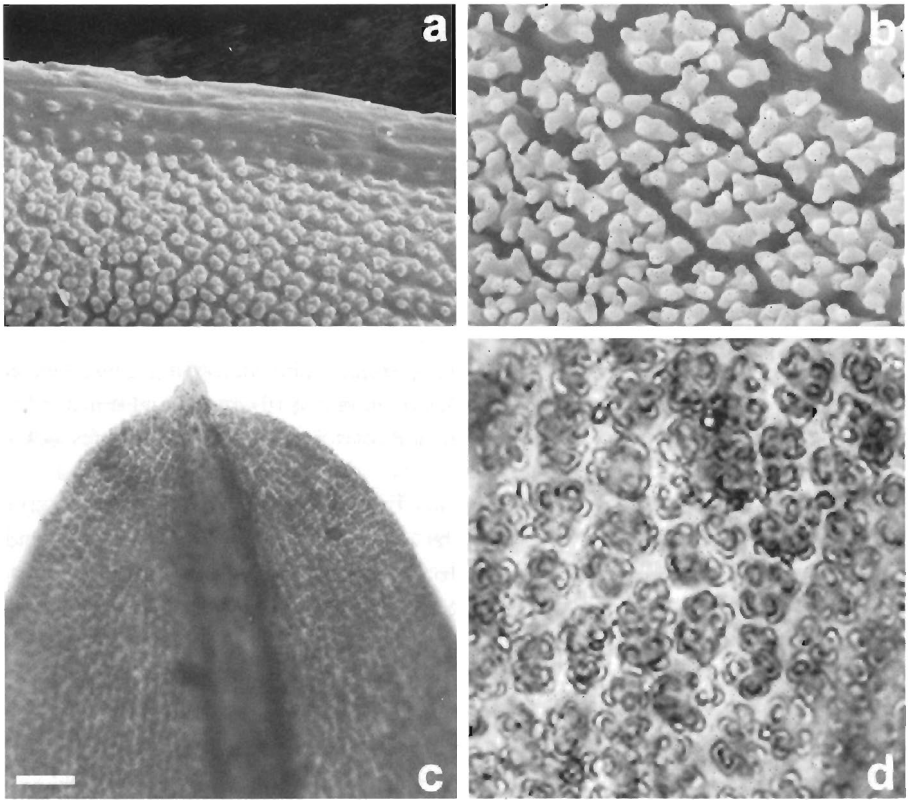


Fig. 13. Scanning electron micrographs and light microscope photographs of *Syntrichia montana* (VAB 4276) and *S. montana* var. *calva* (MUB 5574): a. Dorsal side of the costa in the midleaf of *S. montana*; b. Mid-lamina cells of *S. montana*; c. Leaf apex of *S. montana* var. *calva*; d. Mid-lamina cells of *S. montana* var. *calva*. Scale bars: a=16 μm ; b=6 μm ; c=57 μm ; d=10 μm .

erect, branched. Leaves spirally twisted, sometimes appressed when dry, generally spreading or patent when moist, 1.5–3.3 \times 0.5–1.5 mm, lingulate, lingulate-spathulate, constricted at midleaf, sometimes weakly, unistratose; apex obtuse, rounded or emarginate; margins recurved up to the midleaf, sometimes up to the upper third of the leaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, spinose, sometimes brownish at the base, (0.3)0.7–2.4 mm; costa 67–188 μm wide, in transverse section with 1–2 guide cell rows and (4)5–9 dorsal stereid rows, with hydroids; with simple or bifurcate papillae, not pedicellate, on the dorsal side, 2.5 μm high, rarely smooth; upper and mid-lamina cells quadrate, rectangular or rounded, with thin walls, (5)7.5–12.5(15) \times 5–10(12.5) μm , 4–6(8) bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, 45–125 \times 15–43 μm , hyaline, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 20–34% of the leaf length; marginal basal cells chlorophyllose, in 10–16 columns, generally smooth. Dioicous. Seta erect, 1.0–1.4 cm long, spi-

rally twisted to right above and to left below, reddish brown. Capsule erect, sometimes curved, cylindrical, $2.2\text{--}3.4 \times 0.5\text{--}1.0$ mm, brownish. Peristome of 32 papillose, spirally twisted teeth, $0.5\text{--}1.3$ mm long; basal membrane of 16–24 rows of cells, $0.25\text{--}0.7$ mm high. Operculum long conical, $1.2\text{--}2.0$ mm long. Spores spherical, $10\text{--}12.5(15)$ μm in diameter, papillose.

Illustrations. Gallego (2002, pp. 25); Kramer (1980, pl. 2, 3, 9, 16, 23).

World distribution. North and Central Africa; North and Central America; North, Central and South West Asia; Europe; Macaronesia.

Mediterranean and Macaronesia area distribution. (Albania, Karpati & Vajda 1961); (Algeria, Ros et al. 1999); (Azores, Smith 1978); Balearic Islands; Bosnia Herzegovina; Bulgaria; Canary Islands; (Corsica, Hébrard 1986); Crete; (Croatia, Düll et al. 1999); (Cyprus, Taylor 1952); France; Greece; (Israel, Herrnstadt et al. 1991); Italy; (Lebanon, Frey & Kürschner 1991); (Lybia, Ros et al. 1999); (Macedonia, Düll et al. 1999); (Madeira, Smith 1978), Morocco; Portugal; (Sardinia, Cortini-Pedrotti 1966); Sicily; (Slovenia, Düll et al. 1999); Spain; Tunisia; Turkey; (Yugoslavia, Sabovljevic & Stevanovic 1999).

Habitat and elevation. Usually a saxicolous taxon, on exposed or protected rocks. Terricolous in fissures with accumulated soil or on rocks. Mainly on basic substrates but also on acidic rocks, humiferous, stony, exposed and sunny soils. Sometimes, as an epiphyte on the base of tree trunks. According to Hill et al. (1992) in Great Britain it is a frequent taxon on artificial substrates. It grows from 100 to 2100 m a.s.l.

Selected specimens examined. BOSNIA HERZEGOVINA. Bosnia, Prozor, 1.9.1904, *Glowacki* (GZU). BULGARIA. Strandzha, prope urbe Malno Tarnovo, 280 m, 2.7.1955, *Petrov* (SOM). FRANCE. Pyrénées Atlantiques, prope Pau, Martio, 1845–46, *Spruce* (E). Châteauneuf sur Charente, 27.11.1977, *Brugués* (BCB 10396). Var, Monte Faron, Vallon de Baume, 300 m, 21.2.1980, *Hébrard* (MUB 1159). Provence, Seillans, 14.4.2001, *Gallego* (MUB 11390). Provence, Fayence, 14.4.2001, *Gallego* (MUB 11391). Alsacia, prope Barr, et in Monte Bastberg (E). GREECE. Ática, Pangeia-Klistón, 5.1908, *Maire* (BM). Kalkfelsen bei Derbend nördlich von Alexandruplis, 100–200 m, 27.4.1961, *Froehlich* (MA-Musci 6170). Sterea Ellada, Fokida, Gravia Pass, north of Amfissa, 4.1990, *Blockeel 19-047* (Herb. T.L. Blockeel). Creta, Oros Chelmos, Valle de Vouraikos, 150 m, $38^{\circ}09'09''\text{N}$, $22^{\circ}10'22''\text{E}$, 21.3.1999, *Cano et al.* (MUB 11369). ITALY. Genua, Val. Bisagno, von Serino bei S. Eusebio, 130 m, 3.1924, *Sbarbaro* (Bauer exiccata 1829a in BM). Bisagno, supra Ponte, 3.1924, *Sbarbaro* (BM). Sizilien, östl. Palazollo Acreide, Hybl. Tafel, 18.3.1972, *Frahm* (Herb. J.-P. Frahm). Sicilia, prov. Palermo, Monti Sicani, Cozzo Stagnataro, 1000 m, 30.09.2000, *Aiello* (PAL). MOROCCO. Bab-Taza, base del Jbel Bouhalla, 1250 m, $35^{\circ}05'45''\text{N}$, $5^{\circ}09'10''\text{W}$, 17.3.1997, *Cano et al.* (MUB 10878). Bab-Taza, ascensión al Jbel Bouhalla, 1235 m, $35^{\circ}06'21''\text{N}$, $5^{\circ}09'07''\text{W}$, 15.6.1997, *Cano & Ros* (MUB 10881). Bab-Taza, Jbel Bouhalla, 1700 m, $35^{\circ}08'36''\text{N}$, $5^{\circ}08'42''\text{W}$, 16.6.1997, *Cano & Ros* (MUB 10877). PORTUGAL. Algarve, gruta de Saides, NB72, 350 m, 6.12.1982, *Casas et al.* (BCB 10044). Estremadura. Serúbal, serra da Arrábida, 160 m, MC95, 8.1.1982, *Sérgio & Sim-Sim 19* (LISU 152575). Ribatejo, Torres Novas, H. Antonio, cerca de las grutas, 500 m, MD27, 3.7.1982, *Casas et al.* (BCB 7850). Beira Litoral, Pombal, Poios, Senhora da Estrela, 12.12.1984, *Sérgio et al.* (BCB 20796). SPAIN. Alicante, Sierra del Maigmó, 920 m, YH063652, 21.4.1989, *Ros & Moya* (MUB 4471). Albacete, Albacete, El Jardín, 1000 m, 23.2.1973, *Casas* (BCB 5968). Almería, Sierra de Cabrera, base del Mezquita, Turre, 850 m, WG9506, 21.1.1990, *García-Zamora & Ros* (MUB 8108). Badajoz, Sierra de Oliva, 29SQC4895, 11.2.1979, *Romero et al.* (MA-Musci 268). Cádiz, Sierra del Pinar de Grazalema, 6.1979, *Guerra* (MGC 133). Islas Baleares, Mallorca, Lluch, 5.12.1954, *Camp* (BCB 19008). Islas Canarias, Santa Cruz de Tenerife, La Palma,

Lomo de las Chozas, La Caldera, 1250 m, 9.12.1978, *Long* (E). Islas Canarias, Santa Cruz de Tenerife, La palma, Caldera de Taburiente, mirador de los Andenes, 1983 m, 28°46'N, 17°52'W, 2.8.2000, *Cano* (MUB 11807). TUNISIA. Djebel Goraa an der Strasse Thibar-Teboursouk, 720 m, 12.4.1968, *Poelt* (GZU). TURKEY. Prov. Adana, between Maraniye and Fevzipasa, 700 m, 18.4.1957, *Davis & Hedge* 26767D (BM). Prov. Antalya, dist. Akseki, between Manavgat and Akseki, 700 m, 10.4.1956, *Davis & Polunin* 25803a (BM). Prov. Hatay dist. Belen (Amanus), Karlık tepe above Boguk Oluk, 1000–1200 m, 24.4.1957, *Davis & Hedge* 27050h (E).

Observations. *Syntrichia montana* is distinguished by the following combination of characters: (1) upper and mid-lamina cells (5)7.5–12.5(15)×5–10(12.5) μm ; (2) leaves constricted at midleaf; (3) margins recurved up to the midleaf or up to the upper third of the leaf; (4) costa in transverse section with (4)5–9 dorsal stereid rows and with hydroids; (5) costa on the dorsal side with simple or bifurcate papillae, not pedicellate, 2.5 μm high, rarely without papillae; (6) hyaline hair point, strongly spinose and (7) dioicous sexual condition.

Syntrichia montana var. *montana* shares with *S. princeps* the type of hair point (hyaline and strongly spinose), curvature of leaf margins (recurved up to the upper third) and lamina papillosity (although *S. princeps* usually shows more papillae per cell than *S. montana*, while the same papillae are higher in *S. princeps*). However, these two taxa are easily separated on the base of the size of the upper and the mid-lamina cells [(17.5–22.5×(10)12.5–15(17.5) μm in *S. princeps* and (5)7.5–12.5(15)×5–10(12.5) μm in *S. montana*].

The protologue of *Barbula ruralis* var. *rupestris* includes a reference to the locality only, and not to any collector or date of collection: "in muris calcareis: prope Durlach, flor. badens., in saxis calcareis monte Bastberg prope Buchweiler Alsaciae, in Galia meridionali et septentrionali, in ditione Smyrnensi et ad Caput b. sp." Five sheets from the Bruch herbarium in BM all collected near Durlach, can be considered as syntypes. The syntype collected by Schimper in Durlach at 1836 was designated lectotype as it is the only one that includes date of collection and collector.

20. *Syntrichia montana* var. *calva* (Durieu & Sagot ex Bruch & Schimp.) J.J. Amann, Fl. Mouss. Suisse 2: 118. 1918 (Fig. 13c–d)

Barbula ruralis var. *calva* Durieu & Sagot ex Bruch & Schimp., Bryol. Eur. 2: 113. 167. 1851–*Tortula ruralis* var. *calva* (Durieu & Sagot ex Bruch & Schimp.) C. Hartm., Handb. Skand. Fl. ed. 9, 2: 60. 1864–*Barbula intermedia* var. *calva* (Durieu & Sagot ex Bruch & Schimp.) Milde, Bryol. Siles.: 129. 1869–*Syntrichia intermedia* var. *calva* (Durieu & Sagot ex Bruch & Schimp.) Delogne, Ann. Soc. Belge Microscop. 7: 129. 1883–*Tortula montana* var. *calva* (Durieu & Sagot ex Bruch & Schimp.) Limpr., Laubm. Deutschl. 1: 686. 1888–*Tortula intermedia* var. *calva* (Durieu & Sagot ex Bruch & Schimp.) Wijk & Margad., Taxon 7: 290. 1958. TYPE: FRANCE. Dept. Yonne, rocher de Mailly-chateau, 1850, *Sagot* [lectotype: BM!, designated here; syntypes BM!]

Plants 0.3–1.2 cm high, growing in open olive green turfs. Stems erect, branched. Leaves spirally twisted, appressed when dry, generally spreading or patent when moist, 1.7–2.6×0.6–0.8 mm, lingulate, lingulate-spathulate, spathulate, constricted at midleaf, unistratose; apex obtuse, rounded, apiculate, mucro 20–60 μm long; margins recurved up to midleaf, sometimes up to the upper third of the leaf, papillose-crenulate, unistratose, un-

bordered; without hair point; costa 60–115 μm wide, in transverse section with 1–2 guide cell rows and 4–6 dorsal stereid rows, with hydroids; with simple or bifurcate papillae, not pedicellate on the dorsal side, 2.5 μm high, rarely smooth; upper and mid-lamina cells quadrate, rectangular or rounded, with thin walls, 10–12.5 \times 5–7.5(10) μm , 4–6(8) bifurcate, not pedicellate papillae per cell, 2.5 μm high; juxtacostal basal cells rectangular, 25–40 \times 17.5–30 μm , hyaline, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 20–26% of leaf length; marginal basal cells chlorophyllose, in 5–10 columns, generally smooth.

Dioicous. Seta erect, 0.8–1.1 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, cylindrical, 2.1–3 \times 0.6–0.95 mm, brownish. Peristome of 32 papillose, spirally twisted teeth, 1–1.5 mm long; basal membrane of 14–20 rows of cells, 0.3–1.4 mm high. Operculum not seen. Spores spherical, 12.5–15 μm in diameter, papillose.

The sporophyte description is based on material collected by D.G. Long in La Palma (Canary Islands) and from syntypes (Dept. Yonne). These samples have not opercula.

Illustrations. Gallego (2002, pp. 25); Kramer (1980, pl. 3).

World distribution. North and Central Africa; Europe; Macaronesia.

Mediterranean and Macaronesia area distribution. (Albania, Düll 1984); (Algeria, Ros et al. 1999); Canary Islands; France; Spain; (Tunisia, Ros et al. 1999); Yugoslavia. This taxon is reported for the first time from Canary Islands.

Habitat and elevation. Saxicolous or terricolous. Usually on calcareous substratum (Demaret & Castagne 1959). *Syntrichia montana* var. *calva* grows from 300 to 1800 m a.s.l.

Selected specimens examined. FRANCE. Haute-Saone, Calmoutier E Vesoul, 300 m, 28.3.1995, Frahm (Herb. J.-P. Frahm). Yonne, Mailly-chateau, Sagot (BM). SPAIN. Alicante, carretera comarcal 3313, entre Callosa de Ensarriá y Alcoy, km 24, Confrides, 900 m, YH3586, 7.5.1992, Cano et al. (MUB 5574). Granada, Sierra Nevada, bei Estrella, 1800 m, 29.4.1908, Fleischer (B 55056). *Ibidem* (BM). Canary Islands, Santa Cruz de Tenerife, La Palma. Lomo de las Chozas, La Caldera, 1250 m, 9.12.1978, Long (E). YUGOSLAVIA. Prizren, 10.1893, Dieck 73 (JE).

Observations. This taxon is separated from the typical variety by the absence of a hair point. In *Syntrichia montana* var. *calva*, the leaf apex is mucronate or apiculate, with a mucro up to 20–60 μm long, whereas the var. *montana* has a hyaline spinose hair point, sometimes brownish at the base, (0.3)0.7–2.4 mm long.

According to Demaret & Castagne (1959), there are forms of *S. latifolia* with a short mucro that could be confused with *S. montana* var. *calva*, although these two taxa are easily separated on the basis of the laminar gemmae of the former (*S. montana* var. *calva* has no gemmae), the curvature of the leaf margins (plane or weakly recurved up to midleaf in *S. latifolia* and recurved up to midleaf or up to the upper third in *S. montana* var. *calva*), transverse section of the costa (with 2–3 dorsal stereid rows in *S. latifolia*, and 4–6 dorsal stereid rows in *S. montana* var. *calva*) and, finally, by the upper and mid-lamina cell size (12.5–20 \times 12.5–17.5 μm in *S. latifolia* and 10–12.5 \times 5–7.5(10) μm in *S. montana* var. *calva*).

One folder has been examined in BM herbarium with four sheets that can be considered as syntypes, all collected by Sagot in France, “Dept. Yonne, Mailly-château”. All

sheets correspond to the current usage of the name. Only one sheet has date of collection "1850", and so this specimen has been selected as the lectotype of *Barbula ruralis* var. *calva*.

21. *Syntrichia fragilis* (Taylor) Ochyra, *Fragm. Florist. Geobot.* 37: 212. 1992 (Figs. 3a; 5b–c)

Tortula fragilis Taylor, *London J. Bot.* 6: 333. 1847–*Barbula fragilis* (Taylor) Müll. Hal., *Syn. Musc. Frond.* 1: 634. 1849. TYPE: ECUADOR. On Pichincha, 11.1846. Jameson [lectotype :FH!; designated here, topotype: FH!].

Barbula alpina var. *inermis* Milde, *Bot. Zeitung (Berlin)* 20: 448. 1862–*Tortula alpina* var. *inermis* (Milde) De Not., *Atti Reale Univ. Genova*, 1: 544. 1869–*Syntrichia alpina* var. *inermis* (Milde) Jur., *Laubm.-Fl. Oesterr.-Ung.* 140. 1882. Ind. loc.: "...in der ganzen Gegend verbreitet und besonders häufig in Algund, Am 14 November fand ich eine einzige reife Kapsel im Dorfe Plarsch, sonst stets steril... Wurde in Rabenhorst's Bryotheca Europaea upter N° 456 von mir ausgegeben" [type: not located, not at: BP. GOET. U].

Syntrichia nutica Giacom., *Atti Ist. Bot. "Giovanni Briosi"* ser. 5, 9: 194. 1950. Ind. loc.: "...sempre sterile, sia nelle Alpi orientali che occidentali, di trovare alcune capsule mature Val di Susa, sopra Monpantero in una stazione molto tipica di roccia verticale ombreggiata" [type: not located, not at: PAV?].

Plants 0.4–3.5 cm high, growing in dense or open olive green turfs. Stems erect, branched. Leaves fragile spirally twisted, crispate or appressed when dry, erecto-patent or patent, sometimes spreading when moist, 1.7–3.7×0.6–1.4 mm, lingulate, lingulate-spathulate, spathulate, not constricted at midleaf, unistratose; apex obtuse, acute, apiculate, mucro 17.5–37.5(105) μm long; margins recurved up to the upper third, sometimes up to the midleaf, papillose-crenulate, unistratose, unbordered; without hair point; costa 60–90 μm wide, in transverse section with 1–2 guide cell rows and 3–5 dorsal stereid rows, with hydroids; with simple or bifurcate papillae, not pedicellate on the dorsal side, 2.5 μm high; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thin walls, 12.5–15(17.5)×(10)12.5–15(17.5) μm, 4–8 bifurcate, not pedicellate papillae per cell, 2.5–5 μm high; juxtacostal basal cells rectangular, 85–100×17.5–20 μm, hyaline, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 22–30% of the leaf length; marginal basal cells chlorophyllose, in 5–10 columns, generally smooth. Vegetative diaspores present (leaf fragments). Dioicous. Seta erect, 0.9–1.2 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, cylindrical, 2.5–3.3×0.5–0.8 mm, brownish, reddish brown. Peristome of 32 papillose, spirally twisted teeth, 0.2–0.5 mm long; basal membrane of 5–10 rows of cells, 0.1–0.3 mm high. Operculum long conical, 1.3–1.6 mm long. Spores spherical, 12.5–15 μm in diameter, papillose.

Illustrations. Crum & Anderson (1981, pp. 394); Gallego (2002, pp. 25); Kramer (1980, pl. 1, 8, 15); Mishler (1994, pp. 342).

World distribution. Africa; America; South Asia; Europe; Macaronesia.

Mediterranean and Macaronesia area distribution. (Algeria, Gauthier 1987); (Azores, Düll 1984); Canary Islands; (Slovenia, Düll et al. 1999); Italy; Portugal, Spain; (Syria, Frey & Kürschner 1991); Madeira; Morocco.

Habitat and elevation. In the study area this taxon is mainly saxicolous. In the Iberian Peninsula it has been collected on an acidic substrate (Lloret 1986), although in America (where this species is widely distributed) it also appears on basic rocks (Crum & Anderson 1981, Mishler 1994) and as an epiphyte (Steere 1937, Mishler 1994). *Syntrichia fragilis* grows from 250 to 1600 m a.s.l.

Selected specimens examined. ITALY. Bozen. 1803, *Lorentz* (M). Ebale von Meran. 10.1861, *Milde* (BP 79994). *Ibidem* (NY) Prov. Como, Santa Croce, auf sonnigen Kalkfelsen am nach Garloza, 300 m, 7.1991, *Artaria* (BR 181292). Prope Cedegolo Lombardia (Val Camonica), 20.8.1964, *Holler* (BR 181293). MOROCCO. Anti-Atlas. Prov. Ouarzazate, N side of Jbel Igthem, 25 km E of Bou Azzer, 1600 m, 14.4.1993, *Brooks et al.* (MUB 11753). PORTUGAL. Madeira. S. Vicente, Ribeira da Passo, 9.9.1946, *Nóbrega 1677* (LISU 149223). SPAIN. Gerona, Ripollés, Vall de Camprodon, Vilallonga de Ter, carretera de Setcases a Camprodon, 1200 m, 31TDG4187, 25.1.1989, *Casals et al.* (MA-Musci 11591). *Ibidem* (MA-Musci 11594). Gerona, Ripollés, Vall de Camprodon, Vilallonga de Ter, carretera de Tiegura, km 1.5, 1200 m, 31TDG4187, 20.5.1985, *Lloret* (MA-Musci 11592). Málaga, near Ojén, N of Marbella, 300 m, 21.4.1980, *Long* (E). Canary Islands, Santa Cruz de Tenerife, La Palma, roadside 2 km SW Los Sauces, 250 m, 30.11.1978, *Long* (E).

Observations. *Syntrichia fragilis* is a polymorphic species (Steere 1937) that varies widely in size and leaf shape (Mishler 1994). It is characterized by a mucronate leaf apex, leaves not constricted at midleaf, with recurved margins up to midleaf or up to the lower third, upper and mid-lamina cells 12.5–15(17.5) × (10)12.5–15(17.5) μm, transverse section of the costa with hydroids and with 3–5 dorsal stereid rows. However, the most obvious character of this taxon is the extreme fragmentation of its leaves. According to Mishler (1994), the fragility of the leaves should not be overemphasized as a diagnostic character, because *S. fragilis* also has firm leaves, and the leaves of other species (when old), may become broken. However, in the Mediterranean Region, this character appears constant only in *S. fragilis*. Sometimes, the unbroken leaves are sectored in polygonal areas marking lines of weakness and fragmentation (Crum & Anderson 1981) including the younger leaves (Fig. 5c). The detached fragments provide a vegetative reproduction mechanism (“leaf fragments”). Steere (1937) describes other vegetative reproduction structures for *S. fragilis* “vegetative propagation through ecostate, ovate-acuminate, verrucose propagula in the shape of imbricated brood leaves which are born on reduced branches found sparingly in the axils of the upper stem leaves”. Mishler (1994) has not seen brood leaves in Mexican *S. fragilis* plants. Neither have they been seen in the Mediterranean material examined in this study.

22. *Syntrichia princeps* (De Not.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 39. 1859 (Figs. 1e; 4e)

Tortula princeps De Not., Mem. Reale Accad. Sci. Torino 40: 288. 1838–*Barbula princeps* (De Not.) Müll. Hal., Syn. Musc. Frond. 1: 636. 1849. TYPE: ITALY, Sardinia, Balsamo [type: RO!, E!].

Barbula muelleri Bruch & Schimp., Bryol. Eur. 2: 106. 1842, *nom. illeg.* [article 52.1, Greuter et al. (2000)]–*Syntrichia muelleri* Bruch & Schimp., Bryol. Eur. 2: 106. 1842, *nom. inval.* [article 34.1(c), Greuter et al. (2000)]–*Tortula muelleri* Hook. f. & Wilson, Fl. Antarct. 1: 409. 1847, *nom. illeg.* [article 52.1 Greuter et al. (2000)]. TYPE: ITALY. In Sardinia meridionali ad truncos arborum, Mart. 1836, *De Notaris* [lectotype: BM!, designated here; syntype BM!].

Tortula muelleri var. *parnassica* Schiffn., Verh. Zool.-Bot. Ges. Wien 69: 336. 1919, *syn. nov.*–*Syn-*

Trichia princeps var. *parnassica* (Schiffn.) Podp., Consp. Musc. Eur. 259. 1954—*Tortula princeps* var. *parnassica* (Schiffn.) Wijk & Margad., Taxon 10: 26. 1961—*Tortula princeps* subsp. *parnassica* (Schiffn.) W.A. Kramer, Bryophyt. Biblioth. 21: 87. 1980. TYPE: GREECE. Fókida, Parnassos, Delphi, 1100 m, *Schiffner 86* [holotype: FH!].

Plants (0.7)1.3–3.5 cm high, growing in dense or open olive green turfs. Stems erect, branched. Leaves weakly spirally twisted or crisped when dry, generally spreading or patent when moist, 2.6–5.0×1.0–1.9 mm, lingulate, lingulate-spathulate, constricted at midleaf, sometimes weakly, unistratose; apex obtuse or rounded, sometimes tapering into hair point; margins recurved up to the upper third of leaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, spinose or strongly spinose, sometimes brownish at base, 0.2–2.7 mm; costa 92.5–150 μ m wide, in transverse section with (1)2–3 guide cell rows and 3–7 dorsal stereid rows, with hydroids; with simple or bifurcate papillae, not pedicellate on the dorsal side, 2.5 μ m high; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thin walls, 17.5–22.5×12.5–15.0(17.5) μ m, (4)6–8(12) bifurcate, not pedicellate papillae per cell, 2.5–5 μ m high; juxtacostal basal cells rectangular, 87.5–137.5×20–50 μ m, hyaline, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 23–40% of leaf length; marginal basal cells chlorophyllose, in 10–14 columns, generally smooth. Dioicous or synoicous. Seta erect, 0.8–3.1 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, sometimes curved, cylindrical, 2–6×0.3–0.9 mm, brownish. Peristome of 32 papillose, spirally twisted teeth, 0.6–1.4 mm long; basal membrane of 12–42 rows of cells, 0.4–1.4 mm high. Operculum long conical, 1–2.7 mm long. Spores spherical, (10)12.5–15(17.5) μ m in diameter, papillose.

Illustrations. Gallego (2002, pp. 25); Kramer (1980, pl. 1, 2, as *Tortula princeps* subsp. *parnassica*, and pl. 8, 16, 21); Mishler (1994, pp. 346).

World distribution. North, Central? (O'Shea 1999) and South Africa; North, Central and South (Si He 1998) America; Antarctica (Ochyra 1998); North and South Asia; Australia; Europe; Macaronesia; Oceania; New Zealand.

Mediterranean and Macaronesia area distribution. (Algeria, Ros et al. 1999); Andorra; Bosnia Herzegovina; (Bulgaria, Düll et al. 1999); Canary Islands; Corsica; Crete; (Cyprus, Taylor 1952); France; Greece; Israel; Italy; Jordan; Lebanon; (Macedonia, Düll et al. 1999); Madeira; Morocco; Portugal; Sardinia; Sicily; Spain; Syria; Turkey; (Yugoslavia, Sabovljevic & Stevanovic 1999). This taxon is reported for the first time from Andorra and Bosnia-Herzegovina.

Habitat and elevation. A widespread taxon that grows in a variety of habitats. Saxicolous on exposed or protected rocks, in fissures on basic or acidic rocks, with or without accumulated soil. Also on artificial walls. Terricolous on calcareous or acidic, sunny or shaded, dry or humiferous soils. Also on protected taluses. Epiphytic, mainly on the base of trunks. Grows from 300 to 2045 m a.s.l.

Selected specimens examined. ANDORRA. Ostpyrenäen, rio Madriu-Tal bei Escaldes, 1300 m, 28.07.1966, *Pocs* (M). BOSNIA-HERZEGOVINA. Südlich von Sarajevo, Govza potok bei Jeleč, 7.8.1904, *Glowacki* (GZU). FRANCE. Corsica. Ajaccio, 1850, *Fabre* (BM). Bastelica, 1853, *Fabre* (BM). GREECE. Mount Parnes, the car park of the first hotel by the ascent from Athens, 1188 m, 20.5.1966, *Townsend* (Herb. C.C. Townsend). Crete, Nemós Lasithion, Moni Kristalinias, 3.4.1980, *Lawalree* (BR 182310). Carretera de Epidauros a Methana, más próximo a Methana, 400 m, 37°33'34"N, 23°13'21"E, 15.3.1999, *Cano et al.* (MUB 11362). ISRAEL. Golan, bei Masada, Quercus-Offenwald,

1060 m, 5.5.1994, *Frey & Kürschner 94-212* (Herb. Kürschner 4766). 2 km E Kreuzung bet Shemesh, 23 km W Jerusalem, 300 m, 28.04.1989, *Frey & Kürschner 89-5* (Herb. Kürschner 3382). ITALY. Sardinia, 1835, *De Notaris* (BM). Insula Sicilia, in Montibus "Madonie", 8.1901, *Albo* (M). Sizilien, an der Ätnastrasse zwischen Nicolsi und der obersten Casa Cantoniera, 4.1952, *Poelt* (GZU). Sicilia, prov. Palermo, Monti Sicani, Pizzo Potorno, 750 m, 18.03.2000, *Aiello* (PAL). JORDAN. Levant Palestine, 31.3.1880, *Barbey 1081* (Herb. Reuter-Barbey in G). Irbid, Ajlun Berge, 200–900 m, 1.8.1980, *Frey & Kürschner* (Herb. Kürschner 542). Irbid, Almafraqa, Umejmal, 19.04.1983, *El-Oqlah s.n.* (Herb. Kürschner 2890). LEBANON. Baalbek, below columns of the Temple of Jupiter and facing the Temple of Bacchus, 24.4.1967, *Townsend* (Herb. C.C. Townsend). Amid the ruin of Baalbek, 24.4.1967, *Townsend* (Herb. C.C. Townsend). Near fruit orchard terraces overlooking the cascade above Farayya, 4250', 26.04.1967, *Townsend* (Herb. C.C. Townsend). MOROCCO. Bab-Taza, ascensión al Jbel Bouhalla, 1400 m, 35°06'58"N, 5°08'22"W, 15.6.1997, *Cano & Ros* (MUB 10882). Atlas Medio, Ifrane, 1550 m, 30STC9814, 33°33'01"N, 5°10'19"W, 23.6.1997, *Cano & Ros* (MUB 10454). *Ibidem* (MUB 10455). Ifrane, bosque Jaaba, 1500 m., 30STC9714, 33°33'17"N, 5°11'00"W, 23.6.1997, *Albertos et al.* (MUB 10466). Ifrane, Cascadas des Vierges, 1500 m, 30SUC0314, 33°33'19"N, 5°06'51"W, 23.6.1997, *Albertos et al.* (MUB 10468). PORTUGAL Trás-os-Montes e Alto Douro, Montalegre, 1100 m, PG03, 24.4.1984, *Sérgio & Schumacker 5072* (LISU 154582). Trás-os-Montes e Alto Douro, estrada Chaves-Bragança, 600 m, PG42, 29.10.1991, *Sim-Sim & Sérgio 87* (LISU 161398). Madeira, Pico Ruivo-Pico do Arieiro, 11.7.1984, *Nóbrega* (MADJ 5656). SPAIN. Al-bacete, Sierra del Relumbar, cerro de la Navaza, WH3773, 24.3.1985, de las *Heras & Ros* (MUB 2713). Alicante, Sierra del Maigmó, alto del repetidor, entre los picos Chimenea y Maigmonet, Tibi, 1180 m, YH0565, 21.4.1989, *Ros & Moya* (MUB 2268). Cáceres, Castañar de Ibor, 30STJ9289, 2.12.1979, *Viera* (LU 49). Murcia, Cehegín, Sierra de la Lavia, 950 m, XH1002, 31.1.1981, *Ros* (MUB 502). Santa Cruz de Tenerife. La Palma, Caldera de Taburiente, Roque Palmero, 2045 m, 28°45'N, 17°54'W, 26.7.2000, *Cano* (MUB 11854). SYRIA. Jebel ed-Druz, E von Suwayda, 1280–1300 m, 7.8.1983, *Frey & Kürschner 83-590b* (Herb. H. Kürschner 7206). TURKEY. Prov. Adana, Pozanti, Bürrücek, 1300 m, 3.4.1957, *Davis & Hedge 26328* (E). *Ibidem* (BM). Aydin, near the ruins of Aphrodisias, 6.5.1987, *Townsend 87-105* (Herb. C.C. Townsend). Prov. Denizli. Cukurköy, 1260 m, 4.4.1956, *Davis & Polunin 25612* (E). *Ibidem* (BM). Prov. Konya, NE side of Sultan Dağları, south of Ahsehir, 1180 m, 2.4.1972, *Nyholm & Crundwell 1170* (CANM 219623).

Observations. *Syntrichia princeps* is a worldwide taxon recognized by its lingulate or lingulate-spathulate leaves, constricted at midleaf, sometimes weakly, with margins recurved up to the upper third, a spinose hyaline hair point, transverse section of the costa with 3–7 dorsal stereid rows and with hydroids, upper and mid-lamina cells 17.5–22.5×12.5–15(17.5) μm, with bifurcate, not pedicellate papillae, 2.5–5 μm high. The most distinctive character of the sporophyte is its large size. *S. princeps* possesses the largest sporophytes of the genus *Syntrichia*, with the seta up to 3.1 cm high, the capsule 2–6 mm high and the operculum 1–2.7 mm high.

The synoicous sexual condition has been noted by several authors (Dixon 1970, Kramer 1980, Lawton 1971, Smith 2004, Steere 1937) as a relevant character that could be used as an identification key. However, in the Mediterranean Region *S. princeps* plants may be either synoicous or dioicous. Both Dixon (1923) and Sainsbury (1955) describe a similar condition in New Zealand plants, Ochyra (1998) for Antartica plants, and Lightowlers (1985, 1986) for *S. princeps* plants from South Georgia and Antartica.

In the Mediterranean Region there are two infraspecific taxa of *S. princeps*: *S. prin-*

ceps var. *parnassica* and *S. princeps* var. *brachycarpa*, described from Greece and Italy respectively. The former is known from Southwest Asia, Macaronesia and Europe, the second only from Europe (Düll 1984). The type material of *S. princeps* var. *parnassica* is a dioicous plant characterized by lingulate leaves, with recurved margins up to the upper third, weakly constricted at midleaf, a hyaline and spinose hair point 1–1.8 mm long, upper and mid-lamina cells 15–17.5×15–17.5 μm , with 4–6(8) bifurcate, not pedicellate papillae per cell and transverse section of the costa with 5–6 dorsal stereid rows, and thus not significantly different from *S. princeps* var. *princeps*. Accordingly, *S. princeps* var. *parnassica* is reduced to synonymy. The only existing data concerning *S. princeps* var. *brachycarpa* are the original description and the floristic studies of Cortini-Pedrotti (1983) and Dia et al. (1987), in Sardinia, the same locality that appears in original description (“in Sardinia, Canepa, 1865”), and Sicily respectively. A few years later, Cortini-Pedrotti (1992, 2001) in the Italian checklist, recognized only the typical variety of *S. princeps*, and she made no any reference to var. *brachycarpa*. De Notaris (1869), described the var. *brachycarpa*, on the basis of its lax-imbricate leaves and rounded-oblong capsule, from a specimen collected in 1865 by Canepa in Sardinia. The type material is composed of plants with the same morphological characters as *S. princeps* var. *princeps*. Plants are synoicous, with leaves crisped when dry and patent when moist, with capsule erect and cylindrical, 3.9×0.9 mm. The variety is here synonymized with *S. princeps* var. *princeps*.

In the protologue of *Barbula muelleri*, Bruch et al. (1842) cited material from Sardinia and Sicily: “In rupibus et arborum truncis Sardiniae, ubi cl. Müller eam anno 1825 detexit et De Notaris serius iterum legit; etiam in Sicilia observatam dicunt”. Two syntypes have been found in the Bruch herbarium in BM, collected by De Notaris in Sardinia, the first one in 1836 and the second in 1835. The sample collected in 1836 has been selected as lectotype due to its better state of preservation.

23. *Syntrichia echinata* (Schiffn.) Herrnst. & Ben-Sasson, Bryologist 85: 216. 1982. (Fig. 4f)

Tortula echinata Schiffn., Oesterr. Bot. Z. 65: 1–6. 1915—*Syntrichia princeps* subsp. *echinata* (Schiffn.) Podp., Consp. Musc. Eur.: 259. 1954—*Tortula princeps* var. *echinata* (Schiffn.) Bizot. Rev. Bryol. Lichénol. 25: 270. 1956—*Tortula princeps* subsp. *echinata* (Schiffn.) W.A. Kramer, Bryophyt. Biblioth. 21: 86. 1980—*Syntrichia princeps* var. *echinata* (Schiffn.) R.H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 269. 1993. Ind. loc.: “Distrikt Monophtasi; Felsen des Kophina, ca. 1200 m, c. cf., wachst daselbst gemeinsam und bisweilen im selben Rasen mit *T. montana*, ster. 5. VIII (Nr. 1275)” [type: not located; not at: BM, FH, JE, L, W].

Plants 0.7–3.0 cm high, growing in dense or open olive glaucous-green turfs. Stems erect, branched. Leaves weakly spirally twisted or crisped when dry, generally spreading or patent when moist, 2.6–4.5×1.0–1.6 mm, lingulate, lingulate-spathulate, ovate-lingulate, constricted at midleaf, sometimes weakly, unistratose; apex obtuse or rounded; margins recurved up to the upper third of leaf, papillose-crenulate, unistratose, unbordered; hair point hyaline, spinose or spinulose, sometimes brownish at base, 0.4–2.3 mm; costa 62.5–140 μm wide, in transverse section with (1)2–3 guide cell rows and 3–7 dorsal stereid rows, with hydroids; with bifurcate papillae, not pedicellate on the dorsal side, 2.5 μm

high; upper and mid-lamina cells quadrate, rectangular or hexagonal, with thin walls, (10)12.5–15×(12.5)15–17.5 μm , with 1 bifurcate or trifurcate, branched, pedicellate papilla per cell, (10)15–17.5(22.5) μm high; juxtacostal basal cells rectangular, 60–137.5×25–50 μm , hyaline, with thin walls, sometimes collenchymatous, forming a clearly differentiated hyaline area up to 30–41% of the leaf length; marginal basal cells chlorophyllose, in 10–14 columns, generally smooth. Synoicous. Seta erect, 0.9–2.1 cm long, spirally twisted to right above and to left below, reddish brown. Capsule erect, sometimes curved, cylindrical, 2–5×0.5–0.9 mm, brownish. Peristome of 32 papillose, spirally twisted teeth, 0.6–1.4 mm long; basal membrane of 17–23 rows of cells, 0.5–1 mm high. Operculum long conical, 1.3–2.3 mm long. Spores spherical, (10)12.5–15 μm in diameter, papillose.

Illustrations. Kramer (1980, pl. 1, 8, 16, as *Tortula princeps* subsp. *echinata*).

World distribution. South West Asia; Europe.

Mediterranean and Macaronesia area distribution. Crete; Cyprus; Greece; (Israel, Herrstadt et al. 1982); Jordan; Lebanon; Sicily; Turkey.

Habitat and elevation. Saxicolous species that grows from 1100 to 2000 m a.s.l.

Selected specimens examined. CYPRUS. Troodos, Olympus, auf Cypem, 2000 m, 5.1862, *Unger* (FH). Eastern Troodos, northern slopes of Mt. Kionia, 1100–1150 m, 28.3.1997, *Blockeel 26-106* (Herb. T.L. Blockeel). Yironas River above Sarandi, 2.4.1974, *Meikle* (Herb. C.C. Townsend). Kanoures Springs, 2.4.1974, *Meikle* (Herb. C.C. Townsend). Palekhor, 25.4.1962, *Meikle* (Herb. C.C. Townsend). Above Prodhromos, 5300', 11.6.1961, *Young 7398* (Herb. C.C. Townsend). Trypilos Peak, 4600', 28.4.1962, *Meikle* (Herb. C.C. Townsend). Kyparissovouno, 5000', 1.4.1962, *Meikle* (Herb. C.C. Townsend). Trypilos Hill, 3.1974, *Meikle* (Herb. C.C. Townsend). GREECE. Grecia, Creta, Distr. Selinos, Levka Ori, in altoplanitie Omalos, 10.1943, *Bickerich* (G 15025). JORDAN. Zwischen Ajlun und Jerash, bei Sarka, 900 m, 29.3.1990, *Frey & Kürschner 90-236* (Herb. H. Kürschner 3707). LEBANON. Jakar, above Baynu, 4000 ft., 24.4.1943, *Davis 5934* (E). *Ibidem* (BM). *Ibidem* *Davis 5939* (E). *Ibidem* (BM). TURKEY. Prov. Adana, Bahce, N Amamis, between Haruhiye & Fezipasa, 1150 m, 18.4.1957, *Davis & Hedge 26766 d* (E). Prov. Mersin, Anamur, Kaldöken dag above Anamur, 1500 m, 13.4.1956, *Davis & Polunin 25942 b* (E).

Observations. *Syntrichia echinata*, as for *S. minor* and *S. papillosissima*, is characterized by the presence of a single bifurcate or trifurcate, branched and pedicellate papilla per lamina cell, (10)15–17.5(22.5) μm high. These three species may be separated by the transverse section of the costa [*S. echinata* has hydroids, while *S. minor* and *S. papillosissima* lack them; moreover *S. echinata* has 3–7 dorsal stereid rows, *S. papillosissima* (2)3–5 and *S. minor* only 1–2(3)]. With reference to both sporophyte and gametophyte, *S. echinata* is similar in size to *S. papillosissima*, but bigger than *S. minor* (*S. echinata* has leaves 2.6–4.5×1–1.6 mm and *S. minor* 1.2–2.5×0.4–0.9 mm; the seta in *S. echinata* is 0.9–2 cm long, as opposed to 0.7–0.9 cm of *S. minor*). With respect to the leaf margins curvature, *S. echinata* is also different from *S. papillosissima* and *S. minor*, since it has the leaf margins recurved up to the upper third, while in *S. papillosissima* they usually extend up to the apex and in *S. minor* they are plane or weakly recurved up to the middle. *Syntrichia echinata* has a greater upper and mid-lamina cells size than *S. papillosissima* and *S. minor* [(10)12.5–15×(12.5)15–17.5 μm in *S. echinata*, as opposed to 10–12.5×10–12.5 μm in *S. papillosissima* and 10–12.5×(7.5)10–12.5 μm in *S. minor*]. Finally, these three species also differ with regard to their sexuality: *S. echinata* is synoicous while *S. minor* and *S. pa-*

villosissima are dioicous.

V. EXCLUDED NAME

Syntrichia aciphylla var. *calva* J.J. Amann, Bull. Soc. Vaud. Sci. Nat. 53: 91. 1920
Tortula norvegica var. *calva* (J.J. Amann) W.A. Kramer, Bryophyt. Biblioth. 21: 132. 1980—*Syntrichia norvegica* var. *calva* (J.J. Amann) Ochyra, Fragm. Florist. Geobot. 37: 212. 1992 TYPE: SWITZERLAND. Valais, Lämmerngletscher, Gemmi, 2500 m, Amann, Bryotheca Helvetica BH. 83. 5. 56 [holotype: ZT!].

Amann (1920) described a new variety for *Syntrichia aciphylla* (= *S. norvegica*) from Valais (Switzerland), on the sole basis that it lacked a hair point: *S. aciphylla* var. *calva*. Several years later Kramer (1980) made a new combination and attributed this taxon to *Tortula norvegica*, as *T. norvegica* var. *calva*. He observed that the holotype of *S. aciphylla* var. *calva* (Switzerland. Valais, Lämmerngletscher, Gemmi, 2500 m, Amann, Bryotheca Helvetica 83.5.56, ZT!) was not a *Syntrichia* and decided to choose a neotype for *S. aciphylla* var. *calva* (number 66 from the Bryotheca Helvetica, collected by Amann in the upper Alps to 2000 m, ZT!). That specimen had the same morphological characters as *S. norvegica*, but without a leaf hair point.

After study of the holotype of *S. aciphylla* var. *calva*, the present study confirms that it is not a *Syntrichia* taxon and therefore must be excluded from the genus.

In the area under study, forms of *S. norvegica* without a leaf hair point have not been observed, although they have been recorded from Switzerland (Kramer 1980) and North America (Düll 1992).

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