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Remarkable bark-dwelling species in a Hautes-Alpes *Juniperus thurifera* L. forest with the new finding for France of *Didymodon johansenii* (R.S.Williams) H.A.Crum

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Abstract – One of the most famous incense juniper (*Juniperus thurifera* L.) forest of western Alps, Saint-Crépin site, has been floristically surveyed focusing on corticolous assemblages. New data regarding the occurrence of *Didymodon johansenii* (R.S.Williams) H.A.Crum, a species newly recorded for France, *Pseudoleskeella tectorum* (Funck *ex* Brid.) Kindb. *ex* Broth., *Orthotrichum crenulatum* Mitt. and *Orthotrichum vittii* F.Lara, Garilleti *et* Mazimpaka are provided. The floristic originality of incense juniper's bark is underlined.

Bryophytes / Mosses / Hautes-Alpes / *Juniperus thurifera* L. / Bark

INTRODUCTION

The incense juniper (*Juniperus thurifera* L., Cupressaceae) is a xerophytic conifer restricted to the western Mediterranean region which in France is only present in the Pyrenees, Corsica and Alps. Only the Southern Alps host significant populations of this tree (Lathuillière, 1994; Gauquelin *et al.*, 1999; Cambecèdes *et al.*, 2005). In Hautes-Alpes Department, Durance valley, the Saint-Crépin site has been known for a long time for its most remarkable populations of incense juniper.

A significant number of remarkable bryophyte mentions were made in the Durance valley (Culmann, 1926a, b; Boudier & Pierrot, 1992a). *Syntrichia* is locally a genus of particular interest. Among the noticeable taxa, *Syntrichia caninervis* var. *gypsophila* (J.J.Amann *ex* G.Roth) Ochyra, *S. handelii* (Schiffn.) S.Agnew *et* Vondr., *S. subpapillosissima* (Bizot *et* R.B.Pierrot *ex* W.A.Kramer) M.T.Gallego *et* J.Guerra and *S. rigescens* (Broth. *et* Geh.) Ochyra have been recorded there (Boudier, 1992; Boudier & Pierrot, 1992a). Five *Didymodon* are known to occur in this site (unpublished data). More than 20 species of the predominantly epiphytic genus *Orthotrichum* are known to occur in the Durance valley. *Orthotrichum crenulatum* Mitt. is a noteworthy record, first mentionned for France in Hautes-Alpes (Boudier & Pierrot, 1992b sub *O. flowersii*) and subsequently found in Saint-Crépin incense juniper forest (Medina *et al*., 2010). *Orthotrichum vitii* was also recently mentioned in this locality (Medina *et al*., 2006). The Saint-Crépin locality and Durance valley should be considered hotspots of bryological diversity because of the co-occurrence of rare and higly specialized groups of taxa.

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Medina *et al.* (2010) recently underlined the distinctive epiphytic bryophyte flora of incense juniper forests which suggested that a detailed survey of bark-dwelling bryophytes in Saint-Crépin site would be of interest. Then, in the course of a bryological survey in Hautes-Alpes (France), we focused on incense juniper epiphytic species and had the opportunity to record several remakable or otherwise unknown species in France.

Nomenclature follows Hill *et al.* (2006) and Ros *et al.* (2013) for mosses, Kerguélen (1993) for vascular plants and Bardat *et al.* (2004) for syntaxa. All the samples were collected by the author and are deposited in the private herbarium of V. Hugonnot.

STUDY AREA

The location of the study area is: France: Hautes-Alpes, Saint-Crépin, Durance valley, in the incense juniper wood above the locality, Long. 6°36'27,00''; Lat. 44°42'52,92''; alt. 1100 to 1200 m, 15 july 2011.

The Saint-Crépin site is located in the department of the Hautes-Alpes in a small natural region which is called Guillestrois in the Durance valley. The site extends over mass of mixed fallen rocks and moraines, with local outcrops of limestones and flyschs. Located in the intra-alpine biogeographical zone, it is subjected to a mountain climate of marked continental type. It extends from 920 m to 1790 m. In the French southern Alps, only four major incense juniper woodlands are known, out of which Saint-Crépin is certainly the most remarkable.

The two most noteworthy habitats are the following ones:

— sub-continental steppe-like grassland [*Stipo capillatae-Poion carniolicae* Br.-Bl. 1961] ;

— incense juniper woodlands [*Juniperion thuriferae* Rivas-Martínez 1969].

A lot of rare and endangered species of vascular plants are known to occur in Saint-Crépin site, among which *Astragalus austriacus*, *Eryngium alpinum*, *Dictamnus albus*, *Cotoneaster atlanticus*, *Iberis linifolia* subsp *timeroyi*... are the most characteristic.

RESULTS

Four corticolous remarkable or otherwise unrecorded species were observed in Saint-Crépin site: *Didymodon johansenii* (R.S.Williams) H.A.Crum, *Pseudoleskeella tectorum* (Funck *ex* Brid.) Kindb. *ex* Broth., *Orthotrichum crenulatum* Mitt. and *Orthotrichum vittii* F.Lara, Garilleti *et* Mazimpaka.

Didymodon johansenii (R.S. Williams) H.A. Crum

Didymodon johansenii was observed on the bark of incense juniper. It was growing directly on the bark with a thin intercalated layer of calcareous dust. The colonies were made of small patches, 5 cm^2 large, growing on three trees.

Immediate associates were *Pseudoleskeella tectorum* (Funck *ex* Brid.) Kindb. *ex* Broth. and *Leucodon sciuroides* (Hedw.) Schwägr.

The specimens collected match in major morphological characters the description of this species provided in Jiménez (2006). Distinguishing details are emphasized in Spitale *et al.* (2012). Gametangia and sporophytes were absent in the collected specimens. The species was hitherto unrecorded in France (Ros *et al.*, 2013).

Didymodon johansenii is an addition to the 23 other species of the large genus *Didymodon* known to occur in France (Ros *et al.,* 2013). *Didymodon johansenii* has been mentioned in North America, the continental parts of Asia and Europe, where it is has been recorded in Svalbard, in the Carpathians and the Alps (Spitale *et al.*, 2012). The species has recently received a renewed interest because of both its recent findings in the Alps (Spitale *et al.*, 2012) and its Rare IUCN statut (ECCB, 1995).

Pseudoleskeella tectorum (Funck *ex* Brid.) Kindb. *ex* Broth.

Pseudoleskeella tectorum is a very typical bark-dwelling species which locally may achieve dominance on large portions of the trunk of incense juniper. The species colonize bare bark and accumulate a significant amount of organic material mixed with mineral dust. The variability of the specimens observed is high but still in accordance with the taxonomic concept expressed in Wilson & Norris (1989). Gametangia and sporophytes were absent in the collected specimens. The species was hitherto unrecorded in this site.

Pseudoleskeella tectorum is widely spread worldwide, being recorded in North America, Asia and Europe (Wilson & Norris, 1989). It is very rare in France (Augier, 1966) where it is only known from isolated localities in Auvergne, Jura, Vosges (Husnot, 1892-1894) and Pyrenees (Thouvenot, 2005).

Orthotrichum crenulatum Mitt.

Medina *et al*. (2010) recorded this species in Saint-Crépin site. Associated species include mostly *Orthotrichum schimperi*, *O. pumilum*, *O. diaphanum* and *O. lyellii*, *O. vitii*.

This species is by far much more abundant in anthropogenic habitats of the Durance valley, where it grows on *Fraxinus*, *Tilia*, *Malus* or other planted trees.

Orthotrichum vittii F. Lara, Garilleti *et* Mazimpaka

Medina *et al.* (2006) recorded first this species in France from the Saint-Crépin site. We are able to confirm that it is a typical colonist of incense juniper as it is very abundant locally. Cushions of this moss could be found on more than 100 trunks. Some of them harboured very significant populations made of tenth of fertile individuals. Associated species include mostly *Orthotrichum schimperi*, *O. pumilum*, *O. diaphanum* and *O. lyellii*.

Orthotrichum vitii was described as a new species from thurifer woodlands of Spain (Lara *et al.*, 1999). Later it was recorded in Morocco (Medina *et al.*, 2010) and Turkey (Erdağ *et al.*, 2004; Lara *et al.*, 2009). In France, this species is considered very rare, being only recorded from few localities of the south-east (Legland *et al.*, 2013).

DISCUSSION

Although most of the species of the genus *Didymodon* are found on a variety of habitats, they are mostly observed on soil or rocks at varying altitudes and in very contrasting environments. They are only recorded incidentally as epiphytic. *Didymodon insulanus* (De Not.) M.O.Hill, *D. luridus* Hornsch., *D. nicholsonii* Culm., *D. sinuosus* (Mitt.) Delogne and *D. rigidulus* Hedw. and other species of the genus, though not primarily linked to bark of living trees, are occasionally found on this type of substrate. In subarctic areas *Didymodon johansenii* was known to occur on tree bases (Cleavitt, 2002), but it has not been regularly observed growing on the bark of a living tree elsewhere. Rotten wood was also an habitat for *D. johansenii* in its Asian localities (Otnyukova, 2002).

Spitale *et al*. (2012) considered *Didymodon johansenii* a cryophilous xerophyte of subalpine and alpine belts of the Alps, but in the light of the new locality reported here, its ecological requirements could be very different in the western part of the Alps.

Incense juniper demonstrates a high degree of adaptation being very resistant to harsh climatic conditions, especially to drought and strong temperature fluctuations through the year. These forests usually exhibit a very open canopy, due to the scattering of juniper trees, which is favourable to a variety of light demanding species such as *Dydimodon johansenii.* Also the epiphytic flora of these forests is strongly influenced by drought and reflects a unique suite of stressful conditions acting upon the epiphytic bryophytes (Medina *et al.*, 2010). The bark of incense juniper offers physical peculiarities which seem very favourable to a significant number of taxa which are normally associated with occurrence of calcareous rock outcrops. *Grimmia anodon* Bruch *et* Schimp., *G. tergestina* Tomm. *ex* Bruch *et* Schimp., *Hypnum vaucheri* Lesq., *Orthotrichum cupulatum* Hoffm. *ex* Brid. var. *cupulatum*, *O. anomalum* Hedw., *Syntrichia subpapillosissima*, *Tortella tortuosa* (Hedw.) Limpr... are most often found growing at the base of incense juniper trees. Although predominantly saxicolous in North America (Wilson & Norris, 1989) or Europe (Augier, 1966; Frahm, 2002), *Pseudoleskeella catenulata* (Brid. *ex* Schrad.) Kindb. is mentionned as the sole member of this genus in Saint-Crépin locality (Medina *et al.*, 2006) but we found instead that *P. tectorum* (Funck *ex* Brid.) Kindb. *ex* Broth. is by far much more abundant there and very characteristic of somewhat rotten and spongious bark. *Pseudoleskeella tectorum* is also a rather constant inhabitant of incense juniper forests in south-eastern France (Hugonnot & Gattus, 2012) and is mentionned by Spitale *et al.* (2012) as a characteristic, though rare, accompanying species of *Didymodon johansenii* on calcareous rocks in the Alps. It would be interesting to make a conscious and systematic survey of the site in order to more precisely determine the ecological affinities of *Didymodon johansenii* and whether it is strictly linked to incense juniper bark of if it is also encountered growing on rocks, here or elsewhere in the upper Durance valley. A preliminary survey suggests that it is in fact not growing on calcareous outcrops in Hautes-Alpes. Remarkably saxicolous lichens are also recorded growing on incense thurifer bark in south-eastern France (Legland *et al.*, 2013).

Bark characteristics of incense juniper could play an important role because it is liable to retain some significant amount of calcareous dust, probably possesses very poor water holding capacity as well as a low pH value. This is not unlike the situation described in Spitale *et al*. (2012) where *Didymodon johansenii* appears to favour calcareous rocks with high silica contents. This issue should be studied in deeper details.

Spitale *et al.* (2012) postulated a Central Asian origin of *Didymodon johansenii*, which followed the cold steppes route during Pleistocene to reach the Alps. Durance valley is subject to a harsh continental climate which is characteristic of interior Alps and combined with the occurrence there of other remarkable steppe elements (*Syntrichia caninervis*, *S. handelii* or *S. rigescens*), it strongly reinforces this hypothesis. The occurence of *Didymodon johansenii* in incense juniper forest of Saint-Crépin could also be interpreted as a temporary escape from its primary habitats farther up the mountains. The apparent inability to reproduce sexually, the large propagula and the rarity of suitable habitats hinders further propagation. Phytogeographic patterns nevertheless invites deeper inquiry using molecular reconstruction methods.

Didymodon johansenii is a rare species worldwide. The very small size of the population and its high ecological specialization makes the species highly sensitive to any change at a small scale. Saint-Crépin site is included in the European network of the European Community Habitats Directive but, due to its unique status within Europe, surely should receive additional statutory conservation status.

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