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Riccia sommieri Levier in Corsica, newly recorded in France, with morphological remarks

Vincent HUGONNOT[a] & Vincent SIMONT[b]*

[a]Le Bourg, 43380 Blassac, France

[b]219, rue de Bosc Mare, 76560 Berville, France

Abstract – *Riccia sommieri* Levier is reported for the first time in Corsica, France. The ecology of the species in Corsica is described. Several morphological characters are deeply examined and critically evaluated based on the analysis of the material collected in the new Corsican localities and 24 additional herbarium specimens from various origins. As a result, ventral strips called "bandelettes" in Jovet-Ast's publications are referred to remnants of ventral scales. The hypodermis of *Riccia sommieri* is unique in the genus *Riccia.* This might support a phylogenetically and taxonomically isolated position of the species.

***Riccia sommieri* / Ecology / Morphology / Corsica**

Résumé – *Riccia sommieri* Levier est signalé pour la première fois en Corse, France. L'écologie de l'espèce en Corse est décrite. Plusieurs critères morphologiques sont examinés en détail et évalués de manière critique sur la base du matériel collecté dans les deux nouvelles localités corses et de 24 spécimens d'herbier d'origines variées. Les bandelettes ventrales, nommées comme telles dans les travaux de Jovet-Ast, représentent en fait les résidus des écailles ventrales. L'hypoderme de *Riccia sommieri* est unique dans le genre *Riccia* et est en faveur d'une position phylogénétique et taxonomique isolée de *R. sommieri*.

***Riccia sommieri* / Ecologie / Morphologie / Corse**

INTRODUCTION

Riccia sommieri Levier is a West-Mediterranean taxon (Bischler, 2004) known from the South and West of the Iberian Peninsula (Jovet-Ast & Bischler, 1976; Sérgio *et al.*, 2007), northern Africa (Ros *et al.*, 1999), Italy (Cortini Pedrotti, 1996) including Sardinia (Bischler & Jovet-Ast, 1971-72; Bischler, 2004). The easternmost records are in Crete (Bischler & Jovet-Ast, 1979) and Greece (Düll, 1995; Blockeel & Nieuwkoop, 2016; Blockeel, 2017). It appears in Mediterranean enclaves but not in arid or semiarid zones, with temperate climatic range (Bischler, 2004).

Riccia sommieri has recently been collected in Corsica. Since this record is the first one in France, it is described fully in this paper. The fresh material collected in Corsica matches the morphological description of Jovet-Ast (1986). Yet it was thought useful to draw attention to some morphological characters, like ventral scales, epidermal cells, hypodermis etc., which have been variously interpreted by previous authors.

* Corresponding author: vincent.hugonnot@wanadoo.fr

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MATERIAL AND METHODS

Microscopic examination was carried out using traditional methods. The illustrations and the morphological description are based on Corsican material. The description of morphological characters is limited to those lacking or poorly included in literature.

This study is based on examination of all the herbarium material of *Riccia sommieri* stored in the cryptogamic herbarium of Paris PC (24 specimens from Spain, Portugal, Morocco, Algeria). This material has been determined or revised by Suzanne Jovet-Ast. The newly reported fresh collection from Corsica, France (see below for details of the locality) has been extensively studied by the authors (10 collects were examined).

Selected specimens examined of *Riccia sommieri* Levier : Spain, La Coruña, Torre Hércules, 1.VI.1969, *S. Jovet-Ast & H. Bischler*, PC0080958; Portugal, Alentejo, Castelo do Vide, 2.5.1934, *V. & P. Allorge*, PC0080968 ; Morocco, le long de la piste joignant Souk et Tleta à la piste de Sidi Bettache, 3.4.1953, *S. Jovet-Ast*, PC0080972; Algeria, Col d'Hafir, 16.3.1973, *S. Jovet-Ast & H. Bischler*, PC0080978.

The ventral appendages of *Riccia sommieri* were described and compared to those of other taxa of the genus *Riccia*. The specimens were stained with methylene blue, and slides were mounted with tap water. They were first compared to species where similar structures have been described, i.e. *Riccia violacea* M.Howe var. *violacea* and *R. australis* Steph. Then, a deliberate search for such structures was made in taxa whose ventral scales are deeply pigmented (*Riccia nigrella* D.C., *R. macrocarpa* Levier) or hyaline (*Riccia sorocarpa* Bisch.).

Riccia sorocarpa was additionally examined for the hypodermic thickenings since this is the only European species, apart from *Riccia sommieri*, where these features have been described.

The list of specimens of *Riccia macrocarpa*, *R. nigrella*, *R. sorocarpa*, *R. violacea* var. *violacea* and *R. australis* examined for comparison of morphological characteristics is available upon request.

RESULTS

The new French localities are the following ones:

France: Corsica, Suartone, Natural Reserve of Tre Padule, Campu Celi, shallow soil on rocky slope in Mediterranean environment, 24 April 2017, 100 m, *V. Hugonnot*, 41.4622 North; 9.2392 East (WGS 84); Corsica, Marinca, Gabbiole, Mediterranean grassland, 29 April 2017, 180 m, *V. Hugonnot*, 42.8369 North; 9.3191 East (WGS 84).

The first study site of Suartone is located at a short distance (1 km) from the Mediterranean Sea in Southern Corsica. *Riccia sommieri* is found on shallow soils originating from natural erosion of granitic bedrock. The climate is of thermo-mediterranean type with 600 mm/year of precipitation and a mean annual temperature near 15-16°C. The second one in Marinca is located in Northern Corsica, in Cap Corse, less than 500 m from the sea. *Riccia sommieri* is found there on detritic accumulations of schistose acidic outcrops. The climate of this locality is also of thermo-mediterranean type with slightly more precipitation (700 mm/year) and a mean annual temperature near 13,5°C.

Riccia sommieri grows on rocky slopes along surface water flows or in shallow moist hollows over thin acid soil around protruding rocks. It is typically observed in habitats where competition from vascular plants is low. *Riccia sommieri*

stands prolonged summer drought, and produces new apical growth on the return of more favorable weather. Associates include a significant number of species of the genus *Riccia* and other Marchantiales. The main associated bryophytes are (in order of decreasing frequency) *Riccia gougetiana* Durieu & Mont., *R. macrocarpa* Levier, *R. michelii* Raddi, *R. nigrella* DC., *R. sorocarpa*, Bisch., *Fossombronia maritima* (Paton) Paton, *Cheilothela chloropus* (Brid.) Broth., *Imbribryum alpinum* (Huds. *ex* With.) N.Pedersen, *Campylopus pilifer* Brid., *Trichostomum brachydontium* Bruch, *Ptychostomum pseudotriquetrum* (Hedw.) J.R.Spence & H.P.Ramsay ex Holyoak & N.Pedersen, *Archidium alternifolium* (Dicks. *ex* Hedw.) Mitt. and *Cephaloziella stellulifera* (Taylor *ex* Spruce) Schiffn.

From a phytosociological point of view, the vascular groupings have been characterized as two ephemeral associations named *Anagallo parviflorae-Bellidetum annuae* Paradis & Pozzo di Borgo 2005 and *Bellido annuae-Cicendietum filiformis* de Foucault 1988. *Bellis annua* L., *Leontodon tuberosus* L., *Trifolium nigrescens* Viv., *Lythrum hyssopifolia* L., *Juncus capitatus* Weigel, *J. pygmaeus* Rich., *Radiola linoides* Roth, *Cicendia filiformis* (L.) Delarbre, *Lotus conimbricensis* Brot. and *Romulea revelieri* Jord. & Fourr. are the most noteworthy associated vascular plants.

Cattle and boar may severely disturb superficial soil layers. We also noticed abundant excrements lying in temporary humid habitats where *Riccias* develop.

Morphological remarks

Dissection of the thallus apex of *Riccia sommieri* reveals two rows of ventral scales, extending to margins, strongly pigmented at base (with cells entirely violet), with a marginal band of yellowish cells 8-12 cells wide; cells of scales 20-32 × 35-92 µm; scales ventrally connected by a narrow strip of scale tissue obscured by a dense tomentum of dimorphic rhizoids. The two rows of marginal scales originate in a single median row that ruptures more or less regularly, giving rise further along the thallus to a widened appendage cut medially. The widening of the thallus further separates the two extremities of the ventral appendage (= the two rows of marginal scales), that finally appear simply connected (more or less continuously) by a narrow band of tissue (Figs 1, 2). This band of tissue is clearly made of scale tissue and is rather not apparent for being immersed in a dense felt of rhizoids. Comparable ventral connecting strips have been found in other species:

– In *Riccia macrocarpa*. In this species, they are of the same colour as the marginal scales.

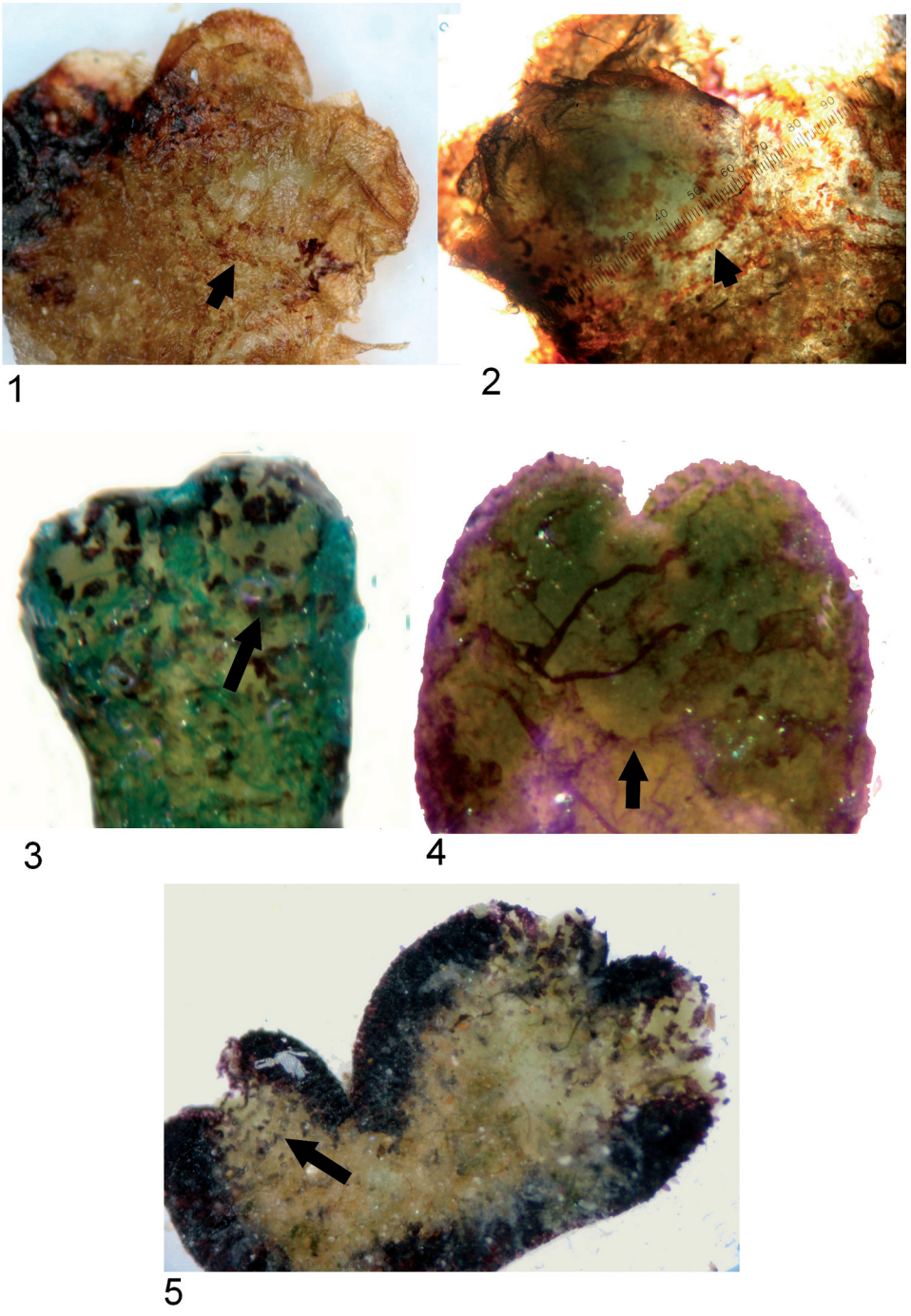
– In *Riccia nigrella*, by contrast, the marginal scales are of a deep black colour but the connecting strips are hyaline, hence making it notably difficult to detect.

– In *Riccia sorocarpa* the marginal scales and the connecting strip are generally hyaline.

– In *Riccia violacea* the two rows of scales are united by a median strip of discontinuous scale tissue which is set in a semicircle (Figs 3, 4).

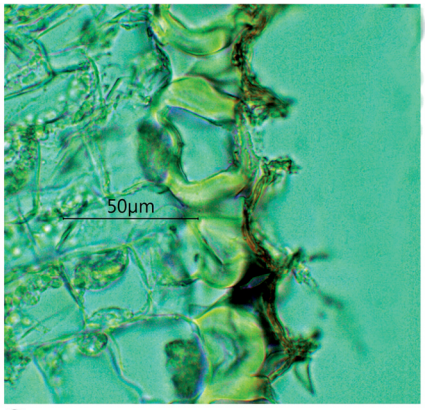
– In *Riccia australis* the ventral appendages are comparable though less apparent (Fig. 5).

– In *Riccia sommieri* the dorsal-longitudinal oblique plicae are only visible in old portions of the dorsal surface. They often anastomose and give rise in extreme case to prominent dorsal crests. Such leathery plicae are more apparent when the thallus is dry. In old parts, the parenchyma cells tend to collapse while the strongly thickened cells of the hypodermis remain unchanged.



Figs 1-5. **1-2.** Ventral surface of *Riccia sommieri* Levier showing ventral strips connected to marginal scales; **3-4.** ventral surface of *Riccia violacea* Howe var. *violacea*; **5.** ventral surface of *Riccia australis* Steph.

The hypodermis is constantly 1-stratose and very regular in outline, making a rigid functional epidermis once the true epidermis has vanished in *Riccia sommieri* (Fig. 6). The epidermis is fragile and early collapsing, composed of rounded cells with an orange content, with orange remnants remaining attached to the surface of the hypodermis. The hypodermis cells have only their anticlinal walls strongly thickened so that they appear forming a thick cylinder which is deeply tinged with yellow or orange in older parts (when young hyaline) where they seem to coalesce (Fig. 8). Only exceptionally do their periclinal walls become thickened. This is quite unlike the situation in *Riccia sorocarpa*, where the thickening affects the remnants of the epidermis cells, the periclinal external and the anticlinal walls of the



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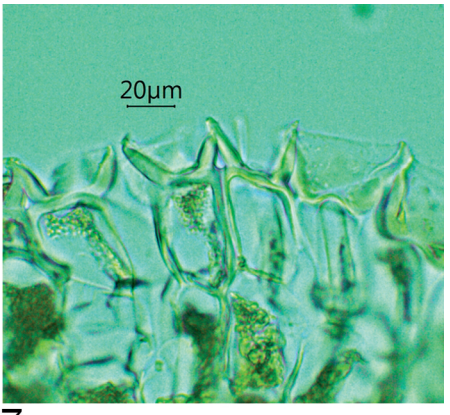

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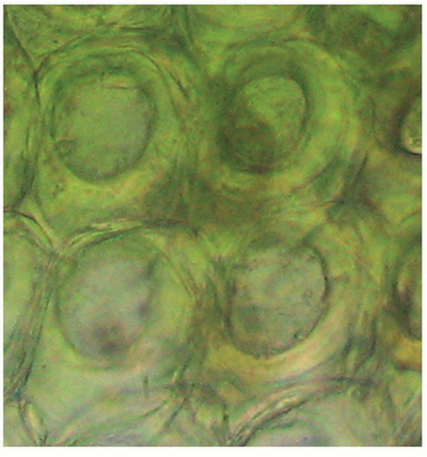

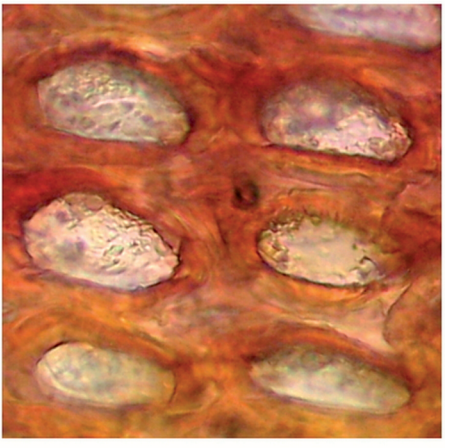

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Figs 6-8. **6.** Transverse section through the thallus showing the hypodermal cells of *Riccia sommieri* Levier; **7.** Transverse section through the thallus showing the hypodermal cells of *Riccia sorocarpa* Bisch.; **8.** Axial view of hypodermis in *Riccia sommieri* Levier (left: young sector of thallus; right: old sector).

hypodermis. This results in a very distinct transverse section, cup-shaped structures being held on the surface of the functional epidermis in *Riccia sorocarpa* (Fig. 7). It is worth noting that the thickening in *Riccia sorocarpa* is much less pronounced than in *R. sommieri* (less than 5 µm wide in *R. sorocarpa* vs often more than 10 µm in *R. sommieri*). The thickening in *Riccia sorocarpa* may also affect the rank of cells beneath the hypodermis which is never the case in *R. sommieri*.

Male thallus could not be studied in any of the two populations. Only spore-bearing individuals were seen with abundant sporophytes and spores.

DISCUSSION

Identification and morphology

The identification of *Riccia sommieri* is generally straightforward and involves no special difficulties. Levier (*in* Sommier, 1900), Trabut (1942), Müller (1954) and Jovet-Ast (1973, 1986) have provided descriptions of the species. It is readily distinguished by a set of both gametophyte and sporophyte characters among which the coriaceous and winged thallus, total lack of any cilia, very incrassate sub-epidermal cells (Jovet-Ast, 1973) and spores with low areolae are the most noteworthy. *Riccia macrocarpa*, a common associate, may share a perplexingly similar field appearance. It is easily distinguished in all instances by the absence of plicae in old part of thallus (vs presence in *R. sommieri*), and the absence of a differentiated hypodermis (strongly differentiated in *R. sommieri*). Jovet-Ast (1986) emphasized the presence of idioblasts in *Riccia macrocarpa*. Cells with orange content can be observed in *Riccia macrocarpa* but their origin is unclear to us. Cells with orange content are present in *Riccia sommieri* but a detailed study of these structures in the genus *Riccia* are needed to fully evaluate their taxonomic value. True idioblastic cells are reportedly absent in *Riccia sommieri* but this issue deserves further study. *Riccia gougetiana* and *R. ciliifera* Link ex Lindenb. also have prominent horizontal thallus wings but never show a thickened band of hypodermis. The main discriminant morphological characters are summarized in Table 1. *Riccia sorocarpa* shares with *R. sommieri* a reticulate-punctate dorsal surface due to a very regular arrangement of the hypodermal cells but, otherwise, there is no resemblance.

Jovet-Ast (1986) considers the ventral strips of *Riccia sommieri* well differentiated from marginal scales, as being unique in the genus and providing a powerful phylogenetic signal (Jovet-Ast, 1987). She calls such structures "bandelettes". In the light of our observations, these appendages have been misunderstood. The ventral scales are formed behind the growing point in a single median row and further on the scales rupture from the middle into two halves with the widening of the thallus. The parallel ventral strips observed in *Riccia sommieri* undoubtedly represent remnants of the median portion of the single developing row of scales after they are torn apart laterally. Thus, they are not independent structures but are clearly composed of scale tissue. In *Riccia violacea*, *R. australis*, *R. nigrella* and *Riccia sorocarpa,* the lateral scales are comparably united by a narrow strip of tissue adjoining two opposite scales. This suggests that the ventral strip of tissue is by no means restricted to *Riccia sommieri,* and that this is a rather generalized structure in the sub-genus *Riccia* where the one-ranked origin of the lateral scales seems to be the generalized condition (Hässel de Menéndez, 1962; Srivastava, 1964).

Table 1. Diagnostic morphological characters of species subject to confusion with *Riccia sommieri* Levier

	Riccia sommieri	*Riccia macrocarpa*	*Riccia gougetiana*	*Riccia sorocarpa*
Thallus colour	deep orange in old parts	orange in old part	brownish in old parts	greyish, rarely violet tinged
Wing	distinct in old part	distinct in old part	distinct in young part	absent
Idioblasts in the parenchyma	Absent	present	absent	absent
Dorsal surface	with plicae developing with age	without plicae	without plicae	without plicae
Epidermis	cells with orange content	cells without orange content	cells without orange content	cells without orange content
Epidermis remnants	thin orange remnants	thin hyaline remnants	thin hyaline remnants	thin hyaline remnants
Hypodermis	anticlinal cells strongly thickened and pigmented	thin walls	thin walls	anticlinal and periclinal cells thickened
Sexual condition	dioicous	dioicous	dioicous	monoicous
Spore diameter	92-98 μm	90-115 μm	130-190 μm	70-95 μm

The dorsal plication of the thallus of *Riccia sommieri* was noted by Jovet-Ast (1973, 1986) but is not mentioned in recent works. The formation of plicae is a consequence of the superposition of two distinct types of tissues that have an opposite response to dehydration. The rigid dorsal surface whose architecture is supported by strong thickenings does not change much due to drying, whereas the massive underlying parenchyma, made of large cells with thin walls, collapses severely in old parts. This results in lateral mechanical tensions that lead to plication of the coriaceous superficial layer. Thus, the differentiation of oblique crests is not an independent character because it is directly linked to the structural differentiation of hypodermis. Nonetheless, it is a practical field morphological character, unique among European members of the genus *Riccia*.

Schuster (1992) instated a new monotypic section, Sectio *Sommieri* Schust., to accommodate the supposedly isolated *Riccia sommieri* based on unisexual thallus, occurrence of horizontal wings etc. Our morphological observations support this placement since the hypodermis has no counterpart in the genus. Only *Riccia sorocarpa* shares such a differentiated dorsal layer but they are clear-cut species. The overall resemblance to *Riccia macrocarpa* is entirely superficial. Care should be taken because morphological observations can lead to misleading conclusions. A phylogenetic analysis of these taxa, using molecular tools, is highly advisable.

Ecology

The ecology of *Riccia sommieri* in the two Corsican localities is remarkably similar to that described in the entire range of the species, notably in Portugal, Sardinia and Morocco (Bischler & Jovet-Ast, 1973b). Not less than seven bryophyte taxa are common in Corsica and the ones described in that publication.

Distribution and conservation status

The occurrence of *Riccia sommieri* in South and North Corsica matches the known West-Mediterranean range for this species (Bischler, 2004). It was not mentioned in the checklist of Corsica (Sotiaux *et al.*, 2007) nor in the subsequent additions (Sotiaux *et al.*, 2008; Pioli, 2015). It is therefore a new record for the island and for mainland France. Corsica can be considered relatively well surveyed as far as bryophytes are concerned, so that *Riccia sommieri* is certainly very rare there. Bischler & Jovet-Ast (1973a) previously underlined its absence in Corsica. This rare occurrence is surprising since the species is well represented in Sardinia.

Riccia sommieri is widespread in Greece, with two reports from Crete, three from Lesbos, one from Andros and one from the NE mainland (Chalkidiki) (Tom Blockeel pers. comm). It is absent in Sicily perhaps due to lack of suitable substrates, a factor that can apply for other parts of the Mediterranean Basin.

Riccia sommieri is relatively frequent in the Western Iberian Peninsula but rare at the European level. It is included as potential candidate for the new European Red Data List (Hodgetts, 2015). Taking into consideration the apparent isolation of the two populations reported here, the fact that they are precariously small and because of the severe disturbance caused by cattle and boar, it is likely that the populations will be threatened in the near future. The conservation of *Riccia* populations relies on a subtle balance between limitation of vascular plant growth, and too severe anthropogenic disturbance (Gascón *et al.*, 2012; Zacharias *et al.*, 2007), which does not allow the *Riccia* thalli to complete their biological cycle. From one side trampling by cattle is reported to significantly contribute to the floristic richness of temporary humid habitats by limiting shading by vascular competitors (Bouahim *et al.*, 2010 ; Ferchichi-Ben Jamaa *et al.*, 2014) or creating small denudated gaps (Cogoni *et al.*, 2009) but the precise effects on *Riccia* assemblages should be studied further. For this, a monitoring campaign could evaluate the population dynamics and assess the impact of herbivores in the Corsican localities.

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