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Brazilian bladderwort *Utricularia reniformis* is a blend of two species

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Abstract: A new species from south-eastern Brazil similar to *Utricularia reniformis* Saint-Hilaire is described, but with a different seed shape, completely different manner of germination, bladder morphology and other attributes. This species is well-known, but it is not differentiated. Initially, the ontogeny of the actual *U. reniformis* is described, i.e. plants corresponding to the nomenclatural type.

Keywords: *Utricularia reniformis*, species nova, seedling morphology.

Introduction

As a species, *Utricularia reniformis* Saint-Hilaire is represented by isolated populations in various mountain ranges of south-eastern Brazil in the states of Minas Gerais, Rio de Janeiro, São Paulo, Santa Catarina, Paraná and Rio Grande do Sul. The vertical range extends from 750 to 2500 metres in elevation. At the same time, they are mentioned in part as a population of very vigorous plants, indicated from the northernmost sections of the area, and in part as a population of relatively small plants (TAYLOR 1980, 1989). Yet for all that, *U. reniformis* is a species with great variety in dimensions. Examination of cultivated plants, however, has revealed indications that perhaps there is a blend of two species under the name *U. reniformis*, similar only in the most remarkable attributes, such as flowers and leaves, but differing in adaptations important for survival strategies (STUDNIČKA 2004). In 2000 and again in 2005, I travelled to Brazil to study the population of very large plants in the mountain range of Serra dos Órgãos, and to attempt to find another population in the Serra da

Mantiqueira mountains. I examined these terrestrial carnivorous plants, which do not have any roots, in the terrain and in cultures. I concentrated on the problem of seeds, the study of which in old references is not at all uniform (Fig. 1), of generative propagation and in the morphology of the trap organs (bladders).

Material and methods

The morphology, including microscopic images of trap organs from live material using a mobile microscope, was observed in the following habitats: 1. Serra dos Órgãos, eastern slope of Pedra do Sino, rocky bushy glade in the tropical cloud forest zone, 2100 m in elevation; 2. Serra dos Órgãos, the peak section of Pedra do Sino with alpine vegetation (campos de altitude), 2250 m in elevation; 3. Serra da Mantiqueira, on granite cliffs along the highway to the northern border of Parque Nacional do Itatiaia, 2140 m in elevation; 4. Serra da Mantiqueira, in alpine vegetation on the peak plateau between Agulhas Negras and Prateleiras, 2400 m in elevation, peaty substrate on granite; 5. Serra da Mantiqueira, on bushy and mossy granite cliffs below the peak of Pico do Itapeva (at the village of Campos do Jordão), 2030 m in elevation. The seeds for research-seedlings came from habitats No. 1, 4 and 5. The trap organs for arranging micro-photography were selected from cultivated plants originating from habitats 1 and 4. During photography, and also in the case of seedlings, 16x magnification was used on the photomicroscope (Figs. 2-5 and 9-10).

The seeds collected at habitats 4 and 5 were placed in water 10 days after harvesting and were displayed in the climatron of the Botanical Garden in Liberec (Czech Republic) with automatic light and temperature condition management corresponding approximately to the relevant conditions in nature. Immediately upon pod rupture, more seeds were harvested from fertile cultivated plants originating from habitat 1 and planted in the same manner. Over the course of ontogeny, a transfer to a wet substrate from cut peat moss was conducted, which is specified in connection with subsequent observations.

The nomenclatural type of the species *Utricularia reniformis* is deposited in the Herbiér Muséum Paris (National Museum of Natural History) under number P00603383 and a complete photocopy was provided for study, including a measuring gauge. A license for use of this photocopy has been provided for the purposes of this article.

Results

a) Different morphology

The populations from Serra dos Órgãos (noted below as SO) are distinguished from the populations of Serra da Mantiqueira (noted below as SM) and recognized in 3 habitats during a general survey according to leaves. In the first mountain range, the plants have large laminae up to 17.5 x 13.5 cm, grey-green and very rigid. In the second mountain range, I discovered that the leaves are much smaller; the largest had a lamina measuring 10.5 x 8.5 cm (i.e. about

40% smaller than those from the previously mentioned mountain range). These leaves were soft and yellow-green.

In each particular habitat, it was possible to observe many dozens of flowers. On the lower lip of the purple flower are two parallel linear signal spots. On robust plants in SO, these are orange, whereas on smaller plants in SM, they are pale yellow and broadly bordered in white (doc. archive of author). I did not find any intermediary types and therefore the attribute is marked as diacritical.

The third attribute differentiating the populations of both mountain ranges, similarly entirely consistent (both in nature and in culture) is seen with a microscope on the underground trap bladders. Those in plants from SM have two very long antennae, which are annulated by curved arcs along the neck sides. They extend beyond the stalk of the bladder (Figs. 2 and 3), whereas plants from SO have very short antennae in the underground traps of diverse shape, which do not extend far to the stalk (Fig. 4). In addition, robust plants from SO have another characteristic: trap dimorphism. If they manage to send out a branch emerging from the soil into open water, the bladders have longer antennae than the underground bladders. These longer antennae, however, are not curved in beyond the stalk but spreading out forwards, what clearly differentiates them from plants from SM (Fig. 5). This antennae position is similar to bladders of floating bladderwort species, specialized in hunting plankton, e.g. *U. australis* R. Br., *U. gibba* L. etc. In the case of the robust bladderwort from SO, this trap dimorphism still depends on specialisation of two different prey: edaphones and plankton. The difference between underground bladders of plants from SM and SO may have the same cause – specialisation for different prey.

b) Seeds and seedlings

The displayed seeds of *U. reniformis* are not homogenous, while the known accuracy of draftsmen may be relied upon in the period these depictions originated (Fig. 1). I uncovered the origin of this divergence when I compared the seeds from plants from SM and from SO. The difference between them is the same as in drawings (Figs. 6 and 7). Two plants then stand out under the name *U. reniformis*, differing in the appearance of the seeds. Types of prickly seeds, with remarkably large protuberances, are more frequent in the context of the *Utricularia* family. Bryophilous species have this adaptation, germinating between moss fronds on cliffs. In the section *Iperua* P. Taylor, forming the closest relative species to *U. reniformis*, *U. geminiloba* Benj. has such seeds (STUDNIČKA 2005).

Seedlings attributed to the *U. reniformis* species are found in the literature at least twice in original drawings (GOEBEL 1893, MERL 1925). They have several embryonic leaves (cotyledons), which serve as floats. This type of germination in the entire abundant *Utricularia* family (more than 200 species) only occurs in the species *U. humboldtii* Schomb. and *U. nelumbifolia* Gardner, and these species have natant seedlings (STUDNIČKA 2005). Thanks to this, it has been possible to capture phytotelmata in leaf rosettes of certain plants of the *Bromeliaceae* family and in the case of the last species, this relationship is obligatory (STUDNIČKA

2006). New knowledge has been introduced by experiments in germinating seeds of both types. The claviform tuberculate seeds of plants from SO (Fig. 7) began to germinate in water after 17 hours and after another 12 hours natant seedlings appeared with 6-8 cotyledons (Fig. 8), corresponding to the aforementioned drawings (GOEBEL 1893, MERL 1925). On the other hand, the prickly seeds from plants from SM placed in water did not germinate even after 2 weeks (Fig. 6). However, as soon as these were removed and placed on the surface of a wet substrate, they germinated together over a period of 2 days (Fig. 9). Still more surprisingly, the process continued when after 17 days from germination, all the seedlings still had just a single leaf. However, these had already created the first trap bladder. Simultaneously from the embryo, a colourless stolon began to emerge (Fig. 10). Other bladders were formed later. If we compare this to development of the same period with developing natant seedlings from SO, basic bladders are seen but the stolon is not developed at all (Fig. 11). Seedlings from SO and SM, aged 33 days after germination, differ even more. First, they had well-developed assimilation surfaces at the ends of all uteral leaves and the first kidney-shaped leaves opened out into the open space (Fig. 12). In this stage, stolons also began to form in these seedlings. The second seedlings from SM still had only one leaf, the lamina of which began to acquire a kidney-shaped form (Fig. 13).

c) Data about the nomenclatural type

It is necessary to engage in the question of which investigated plants (from SO and SM) are actual *U. reniformis* Saint-Hilaire, because they appear the same as the type which Auguste de Saint-Hilaire acquired during an expedition in the years 1816-1821. From analyses, the following arises: The collection site (*locus classicus*) is referred to in the label by reference in the literature as “in Voyage Prov. Rio de Janeiro et Minas Geraes 1: 224, 1830.” TAYLOR (1980) writes more in detail: “Serra da Caraça, Minas Gerais.” A herbarium specimen equipped with a scale of 100 mm contains one separate inflorescence with a length of 611 mm including the stalk. In the inflorescence is one blossom, one calyx (post floral) and floral bracts not captured in places, or buds not developed. Further the specimen contains one 329 mm long piece of rhizome with one leaf, but without bladders. The leaf has a petiole 128 mm long and a lamina in dimensions of 54 x 25 mm.

It is unknown whether the author selected specimens of common size or such that fitted into the herbal paper. Also, it is not certain that the inflorescence was truly detached from the enclosing rhizome. Although the specimen involves a relatively small plant rather in the form of plants from SM, reliable confirmation is not possible. Indeed, if we compare the specimen with published colour photographs from the mountain range of Serra da Caraça, the location of the *locus classicus*, it is possible to learn more (RIVADAVIA 1991). A photographed plant shows pale yellow stripes on the lower lip of the flower with broad white bands, the same as those on plants from SM.

Discussion

Plants from SM have characteristics of the actual species *U. reniformis*. Plants from SO differ from these in several morphological characteristics and can be justifiably considered being another species. In the monograph of the genus, it is mentioned by the synonym *U. janthina* J. D. Hook (rightly *U. ianthina*), but this concerns a cultivated plant, attested by a copperplate (TAYLOR 1989). This name is also evidently not legitimate for the plants described here from SO.

The unnamed robust plants from SO have already been mentioned in the literature in connection with the interesting fact that the maximum known dimensions of leaves still change on the basis of measuring cultivated specimens (STUDNIČKA 2006). A lamina measuring 24.4 x 20.7 cm was prepared as a document and is enclosed in the herbarium record.

If these are hitherto considered two taxons of *U. reniformis*, the differentiation of which I have attempted here, it is not possible to determine whether or not they are sympatric. The only certain thing is that in the investigated mountain ranges (SO and SM), according to my knowledge, they exist independently and separately. In regard to the recognised characteristics of the seeds and seedlings, there is a small probability of propagation between various habitats and it is possible that these taxons do not meet in any of the habitats. It will be interesting experimentally to investigate whether these taxons can be crossed and whether there is any reproductive barrier between them in this regard.

Both types of germination documented here at one or the other taxon are known at the nearest related species from the *Iperua* section: The actual *U. reniformis* has a method of germination like *U. nephrophylla* Benj. (MERL 1925, as “Dusenii”) and *U. geminiloba* (STUDNIČKA 2005); the different taxon from SO has a seedling with a float, which is a germination like *U. nelumbifolia*. In the old literature, correct images were noted (GOEBEL 1893, MERL 1925) and described by name, which for them, according to the results of my research, were inappropriate. The name *U. reniformis* is put to use once more by one archaic drawing of a seedling with a float (LUETZELBURG 1910). According to the bifurcated leaves, in fact this certainly concerns a seedling of *U. nelumbifolia* (cf. MERL 1915, STUDNIČKA 2005).

From the disputed circumstances, it follows that the robust plants from SO could not be named *U. reniformis* and it is not even possible to use another hitherto established botanical name. According to the well-established rules, it is necessary to find a new name for it and in regard to the typical short horns on the underground bladders, which are distinguished from similar species, it will appear as *Utricularia cornigera*.

Utricularia cornigera Studnička, species nova

Herba carnivora, perennis, rhizomatosa. *Utricullariae reniformis* St.-Hil. similis sed magis robusta, lamina usque ad 17,5 cm (plus quam 24 cm in culturis) lata. Utriculi subterranei duabus brevis antennis instructi (utriculus bicornis). Utriculi aquatici antennis longioris non usque ad petiolus attingens instructi (contra *U. reniformis* disparatum). Corolla bilabiata violacea, aurantiaco-signata. Semina

claviformia, tuberculata (non horrida). Embryo viridis; cotyledones 6 usque ad 8; plantula fluitans est.

Holotypus: Brasilia austo-orientalis; montes Serra dos Orgaos, mons Pedra do Sino, altitudo 2100 m; planta culta in Hort. bot. Liberec (Czech Rep.), 20.11. 2005, M. Studnička (PRC).

Acknowledgments

I would like to thank Dr. Jean-Noël Labat from the Muséum national d´Histoire naturelle for his particular willingness when providing the type specimen, and Dr. Fernando Rivadavia from São Paulo for his introduction to the botanical habitat in Serra da Mantiqueira.

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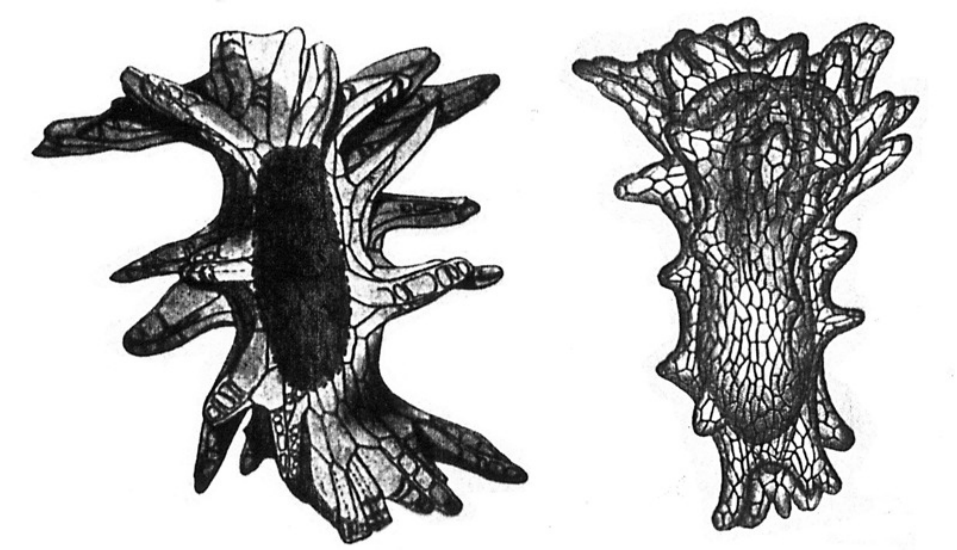

Fig. 1. Image reproduction of *Utricularia reniformis* seeds from very old references. The seed on the left belongs to a small form (MERL 1915); on the right is a seed of an unspecified form (GOEBEL 1893).

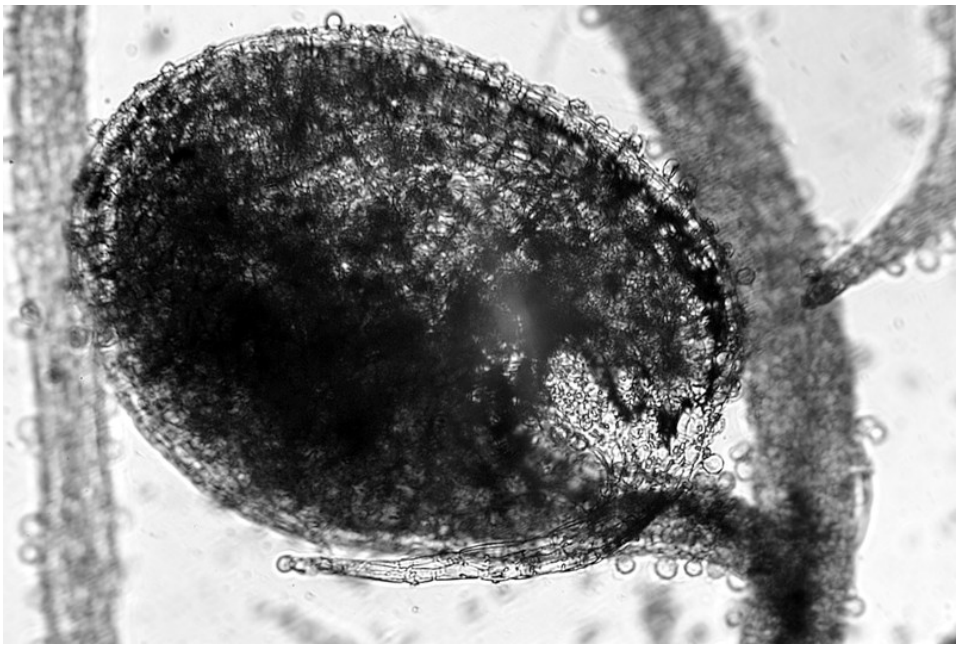

Fig. 2. Underground bladderwort vesicle from Serra da Mantiqueira, lateral view.

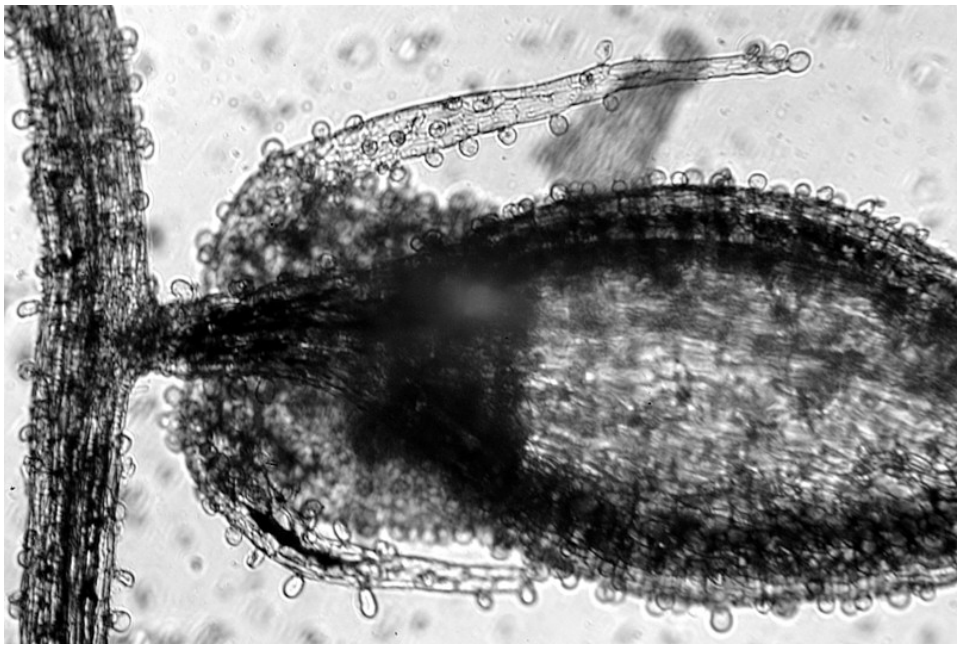

Fig. 3. Underground bladderwort vesicle from Serra da Mantiqueira, ventral view.

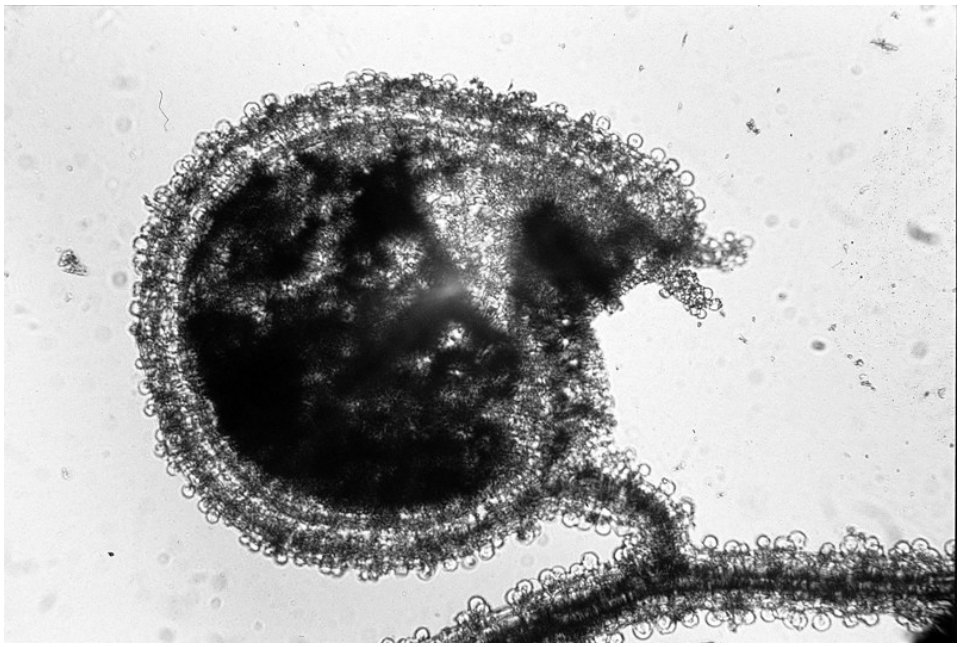

Fig. 4. Underground bladderwort vesicle from Serra dos Órgãos.

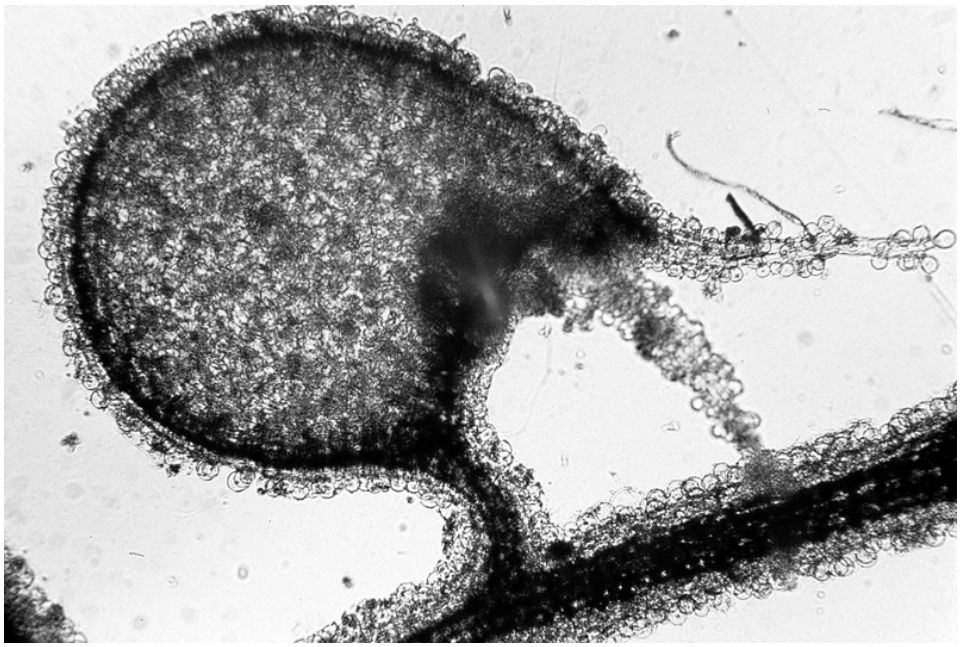

Fig. 5. Water bladderwort vesicle from Serra dos Órgãos.

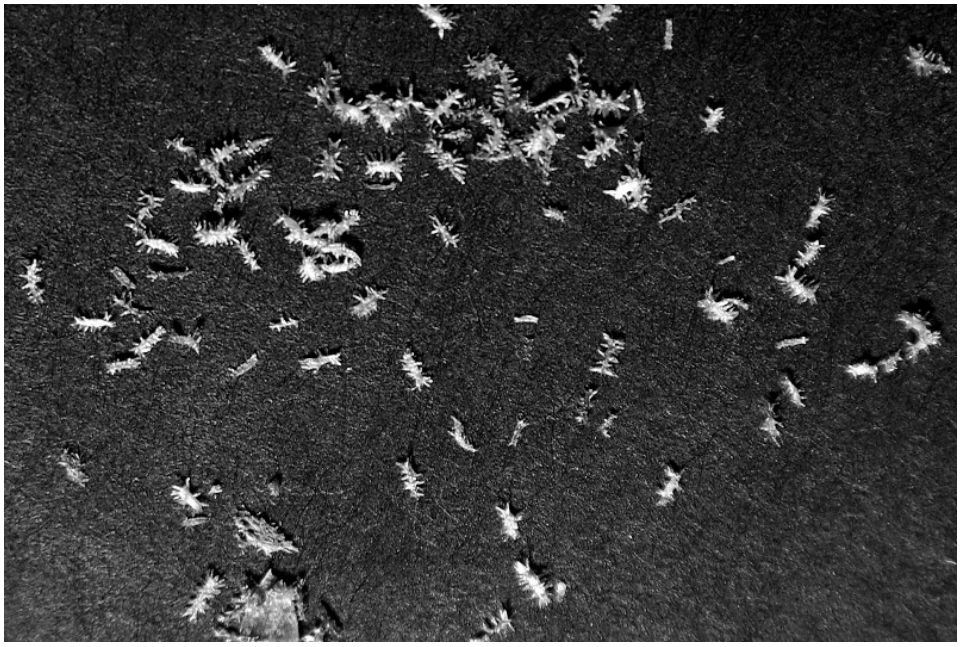

Fig. 6. Bladderwort seeds from Serra da Mantiqueira.

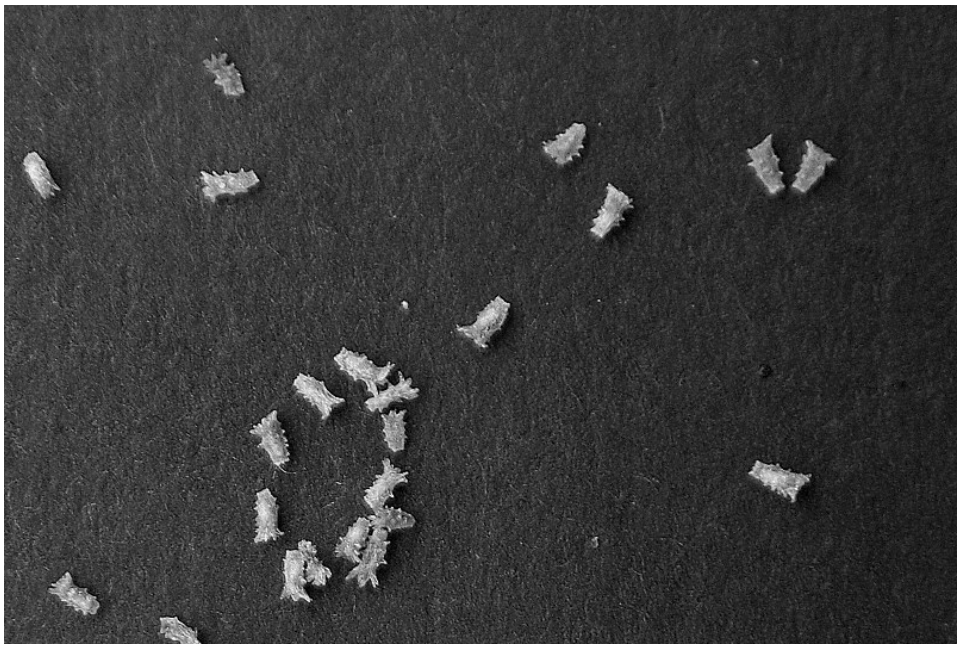

Fig. 7. Bladderwort seeds from Serra dos Órgãos.

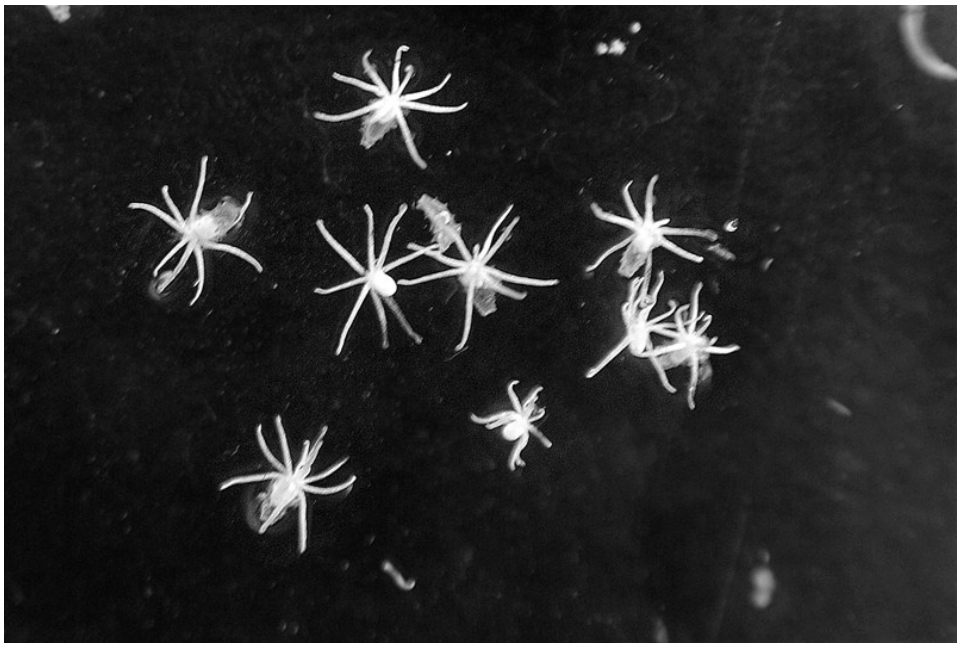

Fig. 8. Newly germinated bladderwort from Serra dos Órgãos.

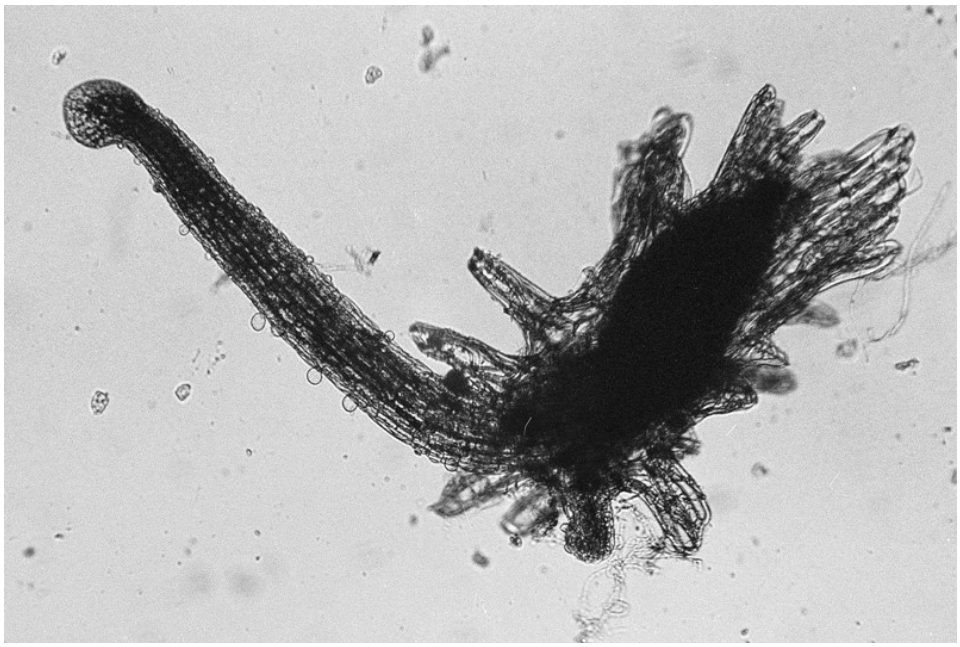

Fig. 9. Newly germinated bladderwort from Serra da Mantiqueira.

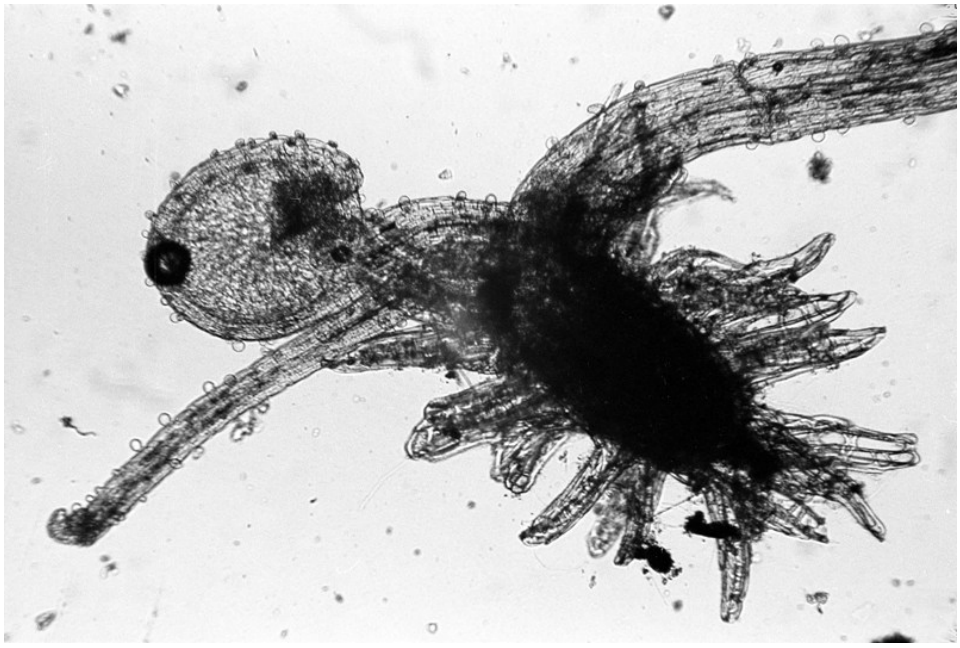

Fig. 10. Bladderwort seedling from Serra da Mantiqueira, 17 days old (stolon on the left, vesicle in the middle, leaf on the right, prickly testa below).

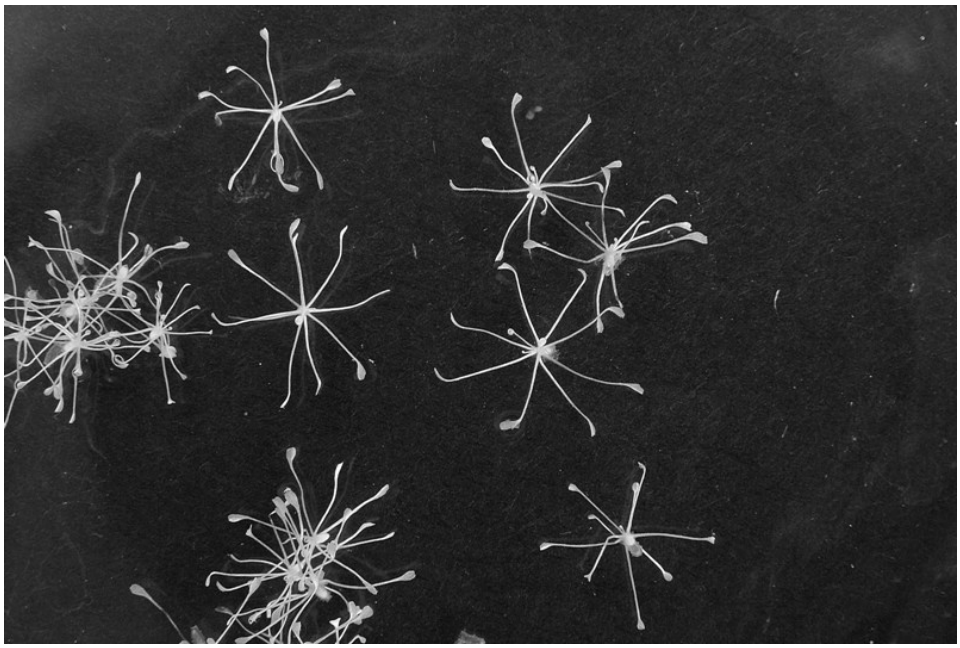

Fig. 11. Bladderwort seedlings from Serra dos Órgãos 17 days old.

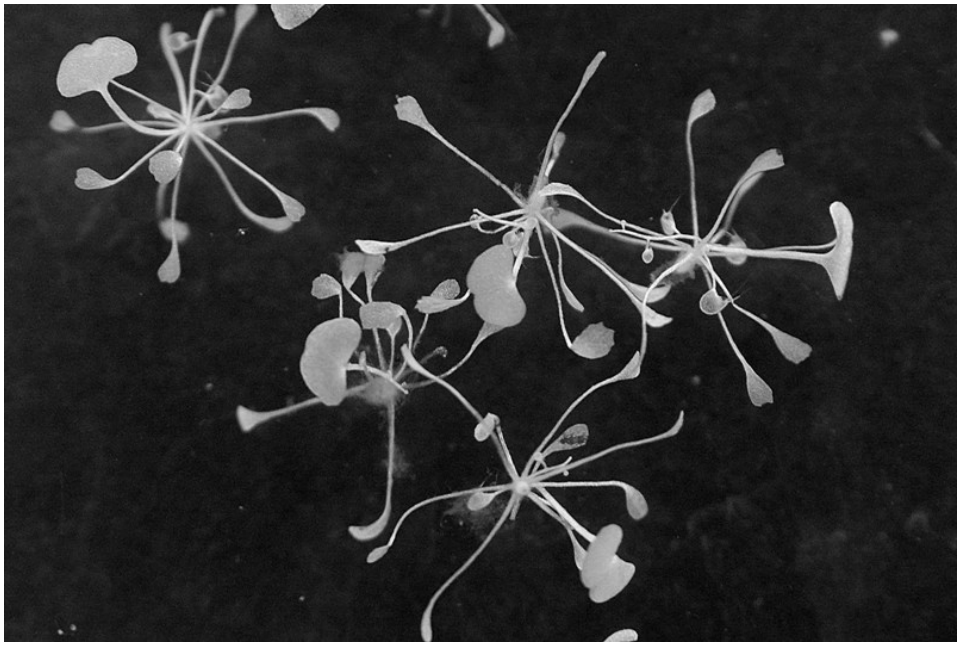

Fig. 12. Bladderwort seedlings from Serra dos Órgãos 33 days old.

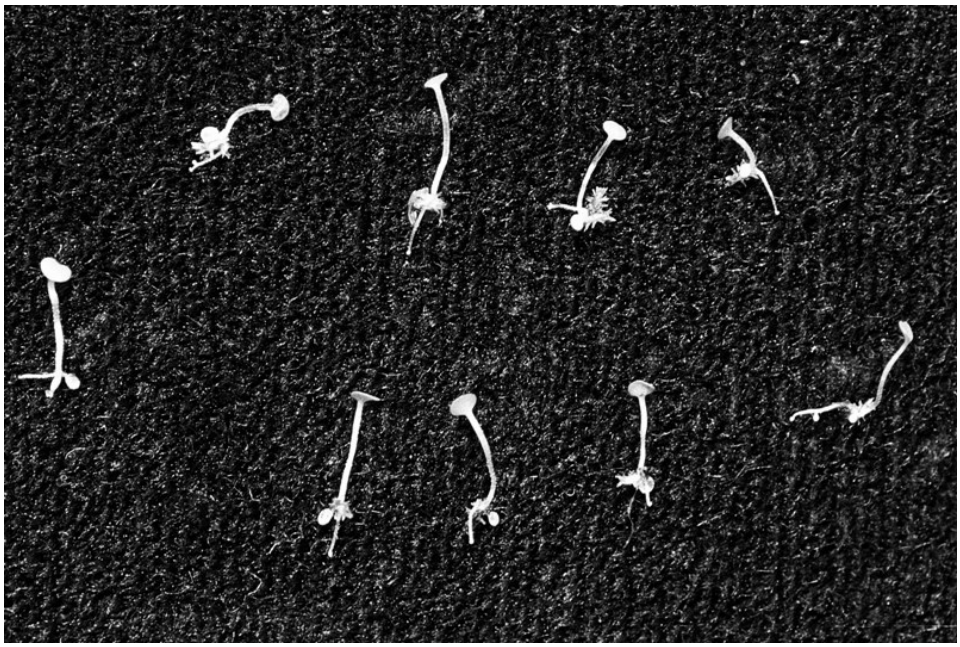

Fig. 13. Bladderwort seedlings from Serra da Mantiqueira 33 days old.

Tab. 1. Diacritical attributes between bladderworts from two mountain ranges in south-eastern Brazil.

Organ	Serra dos Órgãos	Serra da Mantiqueira
Seeds	club-shaped	oval
Testa	tuberculate	with tabular protuberances
Embryo	6-8 leaf primordia	1 leaf primordium
Early stage seedling	with float; whorl of leaves	without float; single leaf
Seedling in growing stage with first traps	without stolon	with stolon
Maximum size lamina found in natural populations	17.5 x 13.0 cm	10.5 x 8.5 cm
Lamina	Grey-green, thick and rigid	Yellow-green, soft and often wrinkled
Bladders	dimorphous (soil and water)	uniform
Bladder antennae	not twisted towards the stalk; by underground bladders short, horned	long, always twisted with an arch toward the stalk and beyond
Corolla	rich orange linear spots on the lower lip	pale yellow linear spots with a broad white edge on the lower lip

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