

A NEW SPECIES OF SUNDEW (*DROSERA*, DROSERACEAE), WITH WATER-DISPERSED SEED, FROM THE FLOODPLAINS OF THE NORTHERN AMAZON BASIN, BRAZIL

Fernando Rivadavia¹, Alberto Vicentini² & Andreas Fleischmann^{3*}

¹Daniel Burnham Ct., San Francisco, 94109, USA

²Center for Tropical Forest Science, Smithsonian Tropical Research Institute, Apdo 0843-03092, Panama, Panama

³LMU Munich, Systematic Botany, Menzinger Strasse 67, D-80638 Munich, Germany

Abstract. *Drosera amazonica* Rivadavia, A. Fleischm. & Vicent. (Droseraceae) is described from the northern Amazon Basin in northeastern Amazonas State and central Roraima State, Brazil. The morphological characteristics which distinguish this new species are discussed, together with its distribution and ecology. Hydrochory is assumed for this new species, which would be the first record in the genus *Drosera*.

Key words: Brazil, Amazon, new species, sundews, Droseraceae, *Drosera*, hydrochory, flower scent.

Resumo. *Drosera amazonica* Rivadavia, A. Fleischm. & Vicent. (Droseraceae) é descrita da bacia norte do Rio Amazonas do nordeste do estado do Amazonas e do centro do estado de Roraima, Brasil. As características morfológicas que distinguem esta espécie nova são discutidas, junto com sua distribuição e ecologia. Presume-se que esta espécie nova possui hidrocoria, sendo este o primeiro registro para o gênero *Drosera*. Accepted 26 March 2009.

Palavras chaves: Brasil, Amazonas, espécie nova, Droseraceae, *Drosera*, hidrocoria, odor da flor.

INTRODUCTION

The c. 200 species of sundews (*Drosera*, Droseraceae) are distributed worldwide, occurring mostly in open boggy or wet sandy habitats. In tropical and subtropical climates, *Drosera* species are especially abundant in highlands where open habitats with low vegetation are more common. In Brazil, the few *Drosera* species that occur in lowlands are mostly found in sandy coastal habitats known as *restingas* and only a few of them occur in inland lowland habitats, including *D. capillaris* Poir. in northern Brazil (the authors regard *D. biflora* Willd. ex Roem. & Schult. as conspecific with *D. capillaris*), *D. cayennensis* Sagot ex Diels in western and northern Brazil, and *D. sessilifolia* A. St.-Hil. which is abundant in central, western, northeastern, and the northernmost tip of Brazil (F. Rivadavia, pers. obs.).

In late 1998, herbarium specimens of an unidentified *Drosera* species were found and studied at the

Instituto Nacional de Pesquisas da Amazônia in Manaus (INPA). In the attempts to determine the exact location of origin of these specimens collected between 1961 and 1992, the area was revisited in late 2006 (F. Rivadavia) and two sites were found around 500 m apart. An additional new collection of this species was made in late 2006 in the State of Roraima and studied at INPA in 2008 (A. Vicentini). Based on studies carried out in the field and with herbarium specimens, this new species of *Drosera* is described below.

SPECIES DESCRIPTION

Drosera amazonica Rivadavia, A. Fleischm. & Vicent. *sp. nov.*

Affin. *Drosera felix* Steyerem. & L.B. Sm. *et similis* *D. roraimae* (Klotzsch ex Diels) Maguire & J. R. Laundon *sed scapis defectis, floribus solitariis brevipedicellatis et semina ovoideo-globosa foveata differt.*

Typus: Brazil, Amazonas, Rio Cuieiras, igarapé da Cachoeira, 15 Nov. 1964, *Rodrigues 6042* (Holotypus, INPA).

* e-mail: fleischmann@lrz.uni-muenchen.de

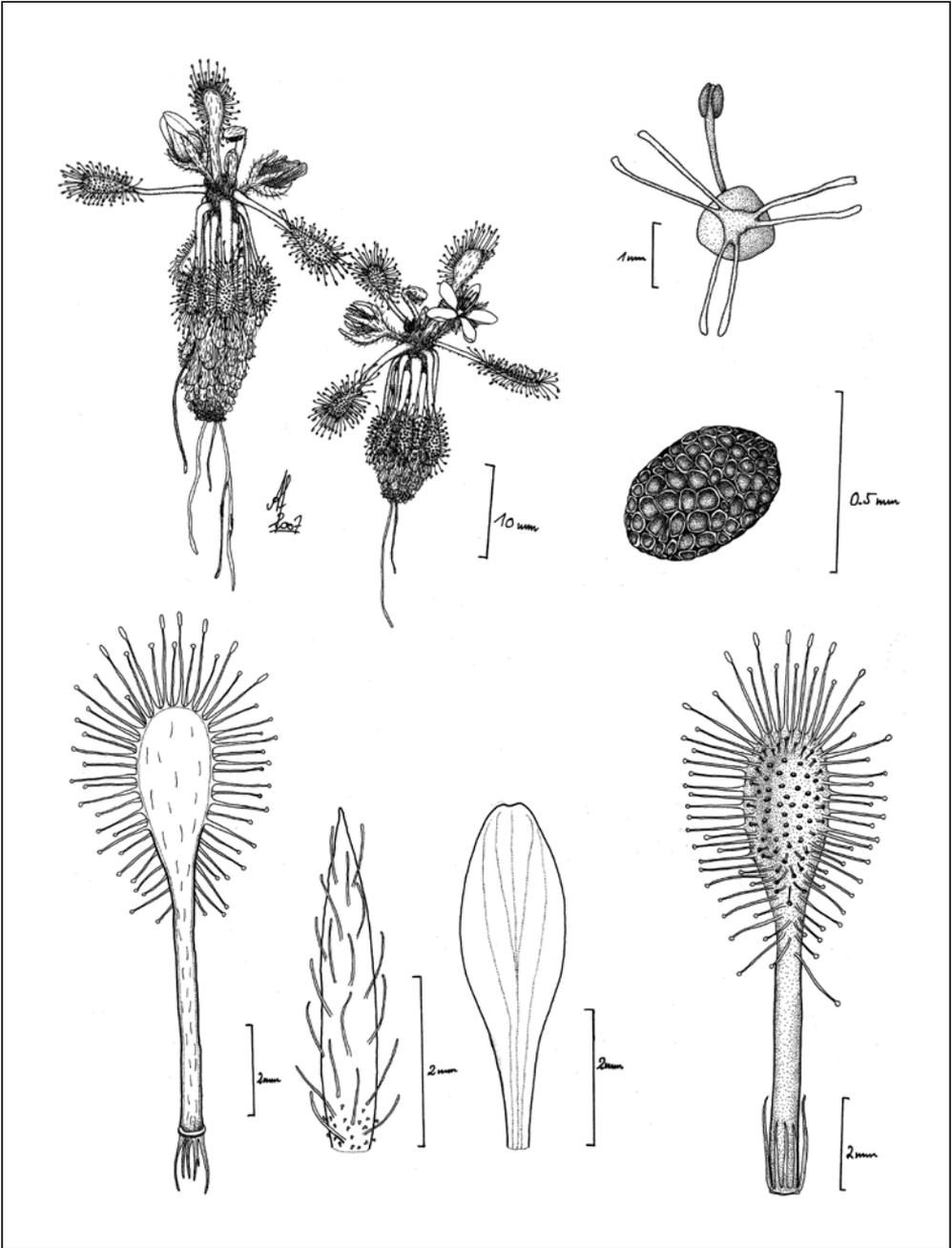


FIG. 1. *Drosera amazonica*. A. Habit of plant. B. Above view of ovary with style-arms and one anther. C. Leaf lower surface, stipule bent backwards. D. Leaf upper surface. E. detached sepal. F. detached petal. G. Seed. A drawn from photographs, B–G from dried material (Rivadavia & Azevedo 2460, 2461 (SPF)). Drawings by Andreas Fleischmann.

Stem-forming perennial. Stems short, up to 10 cm long, unbranched, covered by dried leaves. Internodes barely visible in smaller specimens and up to 0.5–1 mm in larger specimens. Leaves rosulate, glabrous, only in young developing leaves lower surface sparsely covered by sessile translucent glands or by short, appressed white or red hairs of c. 0.5 mm length; stipules papery, lacerate, divided to the base into 5 fimbriate segments, segments c. 0.1 mm wide at the base, outer segments slightly longer, c. 1.5–2 mm long, the 3 inner segments c. 1 mm long; petiole plane, 5–10 mm long, 1–2 mm wide, slightly broader at the base and tapering gradually to the apex, glabrous, margins minutely reflexed; lamina spatulate to obovate, 2.5–5 mm long, 1–3 mm wide. Flowers solitary, depauperated, almost sessile or short pedunculate, bracteate; peduncle, bract, pedicel, and sepals covered by short, appressed, white or red hairs c. 0.5 mm long; pedicel and lower part of sepals additionally covered by yellowish translucent short stalked glands; peduncle short, upright at anthesis but bent down in fruit, 1–3.5 mm long, c. 0.5 mm thick; bract subulate or filiform, with acute apex, 1–2 mm long, 0.1–0.5 mm wide; pedicel 0.5–1 mm long, c. 0.5 mm thick; sepals 5, subulate, acute, 2.5–4 mm long, up to 1 mm wide in the middle of their length; calyx campanulate at anthesis but sepals spreading in fruit; petals 5, oblong with apex acute to rotundate, 5–6 mm long, c. 0.5 mm wide at the base and at the tip, 1.5–2 mm wide at broadest, white; styles 3, dissected to the base, style arms 2 mm long; ovary subglobose, c. 1 mm in diameter; stamens 5, anthers white, filaments 2–2.5 mm long, 0.1 mm wide, pollen yellow. Peduncle bent downwards in fruit and covered by subsequent leaves, capsule subglobose, c. 2 mm in diameter, loculicidal. Seed ovoid to subglobose, 0.2–0.5 mm long, 0.2–0.3 mm wide, black, foveate (Figure 1).

Distribution. *Drosera amazonica* is known from a few collections along the Igarapé Cachoeira, a small tributary of the Cuieiras River, which empties into the Rio Negro around 100 km upriver from Manaus, northeastern Amazonas State. When visiting this site in 2006, one of us (F. Rivadavia) found two extensive populations c. 500 m apart on opposite sides of the small river. These populations are located in the Parque Estadual do Rio Negro Setor Sul, a protected area relatively safe from deforestation.

Another population was discovered c. 450 km north of this area in the Viruá National Park in the

central part of Roraima State, where it is sympatric with *D. capillaris* (Vicentini 1477 at INPA). Thus, according to these known populations, *D. amazonica* distribution may be limited by the Amazon River in the south and the Rio Negro in the west. This species is apparently not found on the western margins of the Rio Negro in nearby locations such as the Jaú National Park where *D. capillaris* has been collected (Vicentini 1371 at INPA). The Rio Branco might also be the limit of its distribution to the north and the west, although the extensive white-sand flooded savanas on both sides of this river, partially included in the Viruá National Park, are potentially a core area for *D. amazonica* (Figure 2).

Etymology. The epithet “amazonica” refers to the biogeographic region this species is endemic to: the northern Amazon Basin in Amazonas and Roraima States of Brazil.

Taxonomic affinities. *Drosera amazonica* belongs to *Drosera* subgenus *Drosera* sect. *Drosera* (sensu Seine & Barthlott 1994). Its closest relative seems to be *D. felix* Steyerl. & L.B. Sm., a species with which it shares generative characters, such as a few- or single-flowered inflorescence on a short scape, a calyx covered with non-glandular hairs, a sweet flower fragrance, and ovoid to subglobose seeds. However, *Drosera felix* differs from *D. amazonica* in having flat leafy rosettes, a suborbicular lamina, petioles that are transversely elliptic in cross section, up to 3 flowers per scape, and seed capsules that open cup-like.

Sterile plants of *D. amazonica* are reminiscent of *D. roraimae* (Klotzsch ex Diels) Maguire & Laundon or even large specimens of *D. communis* A. St.-Hil., as both these species are stem-forming perennials with a broadly linear plane petiole and a spatulate to obovate lamina. However, flowering specimens of *D. roraimae* and *D. communis* can easily be distinguished from *D. amazonica* in having ascending multi-flowered racemose inflorescences on well-developed scapes up to 30 cm long. *Drosera amazonica* is unlikely to be confused with *D. meristocaulis* Maguire & Wurdack, a species native to the plateaus on the Neblina Massif of the Brazil-Venezuela border. Although *D. meristocaulis* also forms compact rosettes with similarly shaped leaves and has single flowers on nearly sessile scapes, it has pink petals that are broadly oblanceolate, much larger stipules and stems, and is unique among New World *Drosera* species in having 3 undivided styles.

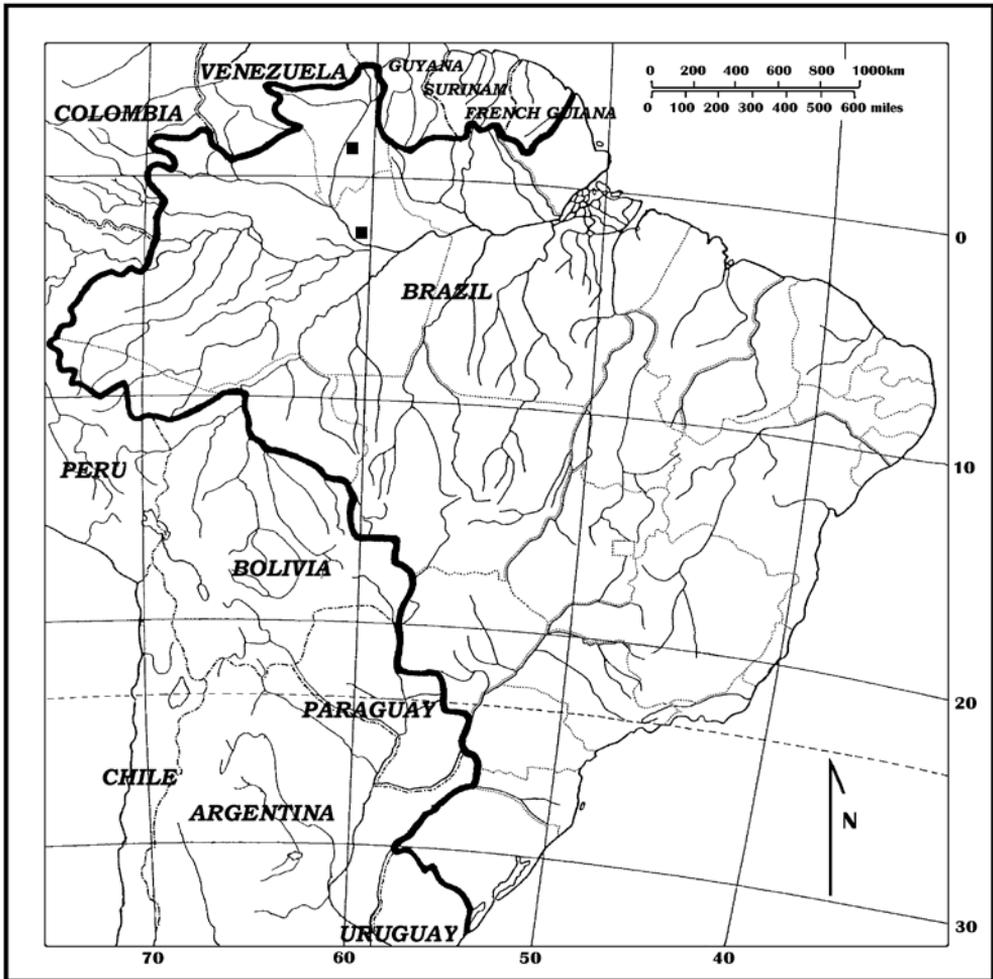


FIG. 2. Map showing the two known locations where *D. amazonica* occurs.

Material examined. BRAZIL. **Amazonas:** Manaus, Rio Cuieiras, Igarapé Cachoeira, 19 Dec 1961, *Rodrigues & Wilson* 3996 (INPA); Novo Airão, Igarapé Cachoeira, Rio Cuieiras 16 Dec 2006, *Rivadavia & Azevedo* 2458, 2460, 2461 (SPF); Rio Cuieiras, Igarapé da Cachoeira, 15 Nov 1964, *Rodrigues* 6042 (holotype, INPA); Rio Negro, Rio Cuieiras, Igarapé da Cachoeira, 22 Jun 1992, *Mori & Gracie* 22444 (INPA, NY). **Roraima:** Caracaraí, Parque Nacional do Viruá, 5 Dec 2006, *Carvalho & Nascimento* 1129 (INPA).

ECOLOGICAL NOTES

Drosera amazonica, like other *Drosera* species in the Amazonian area, is found on white quartz sand savannas that are seasonally flooded or that become flooded during heavy rains. The soil is highly acidic and extremely poor in nutrients, consisting either of deep sand sediment or shallow soils associated with sandstone outcrops. This type of vegetation is part of an ecological gradient defined by these soil characteristics and different flooding regimes, which determine vegetation structure. Forests, scrublands, and



FIG. 3. Dense stand of *Drosera amazonica* in open sand vegetation at the Igarapé Cachoeira, Rio Cuieiras, northeastern Amazonas. Accompanying plants are *Lycopodiella* sp. and species of Cyperaceae.

savannas occur along this gradient and correspond to the vegetation types known in the lowlands of Brazilian Amazon as *campina*, *igapó*, *chavascal*, and *campinarana*. These ecological conditions are found both in the lowlands and the highlands of the Guayana Shield, and these areas share many genera of plants that have adapted to and diversified in these conditions. The patchy, island-like distribution of these vegetation types (particularly the savannas) creates heterogeneity in species composition on a local scale, with the relative abundance of species varying greatly between neighboring sites (A. Vicentini, pers. obs.), and with many species that are endemic to certain regions (Vicentini 2004, and references therein; Oliveira *et al.* 2001).

The areas inhabited by *Drosera amazonica* are usually open and dominated by grasses and/or sedges with scattered trees and shrubs that sometimes form small “islands” within the open grassland. Herba-

ceous plants common in these areas are members of the genera *Alboboda* (Xyridaceae), *Syngonanthus* (Eriocaulaceae), *Utricularia* (Lentibulariaceae), *Epistephium* and *Duckeella* (Orchidaceae), *Panicum* (Poaceae), *Lagenocarpus* (Cyperaceae), *Cephalostemon* (Rapateaceae), *Lycopodiella* (Lycopodiaceae), and *Schizaea* (Schizaeaceae). Shrubs and trees frequently found in these areas belong to the genera *Humiria* (Humiriaceae), *Platycarpum*, *Pagamea* and *Retinhi-phyllum* (Rubiaceae), *Cyrilla* (Cyrillaceae), *Pachyloma* and *Macairea* (Melastomataceae), *Gongylolepis* (Asteraceae), *Ternstroemia* (Ternstroemiaceae), *Ilex* (Aquifoliaceae), and *Rhodognaphalopsis* (Malvaceae), and a few palms (Arecaceae) like *Bactris campestris* Poepp. and *Mauritiella aculeata* (H.B. & K.) Burret. Most members of these taxa are endemic to this type of vegetation on oligotrophic soils (Vicentini 2004).

Drosera amazonica occurs in large populations, the individuals often growing very close together



FIG. 4. Habit of *Drosera amazonica* at Igarapé Cachoeira. The tall stems and long internodes may represent an adaptation to occasional flooding. The small green subulate leaves on the ground around the *Drosera* belong to the carnivorous plant *Utricularia subulata* L. (Lentibulariaceae).

(Figures 3 & 4). It has been collected in flower in the months of January, December, and June, suggesting that this species does not have a specific flowering period.

The flowers of *D. amazonica* (Figure 5) are sweetly perfumed, a character this species shares with at least four more New World species of *Drosera*: *D. arenicola* Steyerl., *D. felix*, *D. kaieteurensis* Brumm.-Ding., and *D. solaris* A. Fleischm., Wistuba & S. McPherson, all of which are highland species from the Guayana Shield north of the Amazon. These species have in common a rather short and stiff flower scape, and flowers of *D. amazonica*, *D. solaris*, *D. felix* (frequently) and *D. arenicola* (occasionally) are borne solitary on very short peduncles and pedicels, so that they are nested almost sessile within the rosette of the plant. Flower odor may have evolved among these species in order to attract pollinators to the nearly

sessile flowers, thus keeping them away from the surrounding visually attractive sticky carnivorous leaves. The white flowers of *D. amazonica*, *D. arenicola*, *D. felix*, *D. kaieteurensis*, and *D. solaris* close early in the afternoon, therefore olfactory-oriented nocturnal pollinators can be excluded.

As is common for all species of *Drosera* sect. *Drosera*, each flower of *D. amazonica* only opens for one day, usually only in the morning, after which the corolla and calyx lobes close. After anthesis, the pedicels of *D. amazonica* bend downwards and the scape is additionally pressed further down by consecutively produced leaves, so that the ripe seed capsule is eventually on its side or facing downwards (Figure 6). The seed is therefore shed on the soil underneath the mother plant, and as the flowers are almost sessile the seed grains are likely to be deposited very close to the stem of the same fruiting plant.



FIG. 5. Flower of *Drosera amazonica* at the Viruá National Park, Roraima. (Photograph by Fernanda Antunes Carvalho, used with permission).

However, the foveate seed surface (Figure 7) may represent a specialized strategy to help disperse the seed a greater distance. Our ontogenetic studies reveal that the pitted testa sculpture of *D. amazonica* develops from papillate testa outgrowths that collapse when the seed matures. In water, air bubbles are captured in the pits of the testa by capillary effects (Figure 8), giving additional buoyancy to the seed grains so that these are able to float and thus can be carried for a certain distance by flowing water. Thus the seed of *D. amazonica* is probably water-dispersed either by flowing ground water of the open seepage habitats or by the heavy tropical rainfalls common to that area (hydrochory: nautochory). If true, this dispersal mechanism would be unique among New World *Drosera*.

Interestingly, *Selenicereus wittii* (Schum.) R.D. Rowley, an epiphytic cactus endemic to the Rio Negro of Amazonian Brazil, which grows in the same area as *D. amazonica*, also has a water-dispersed seed, a feature unique in Cactaceae (Barthlott *et al.* 1997).



FIG. 6. Fruiting capsule of *Drosera amazonica*. Note the tip of the capsule pointing to the side, as the short pedicel bends downwards after anthesis.

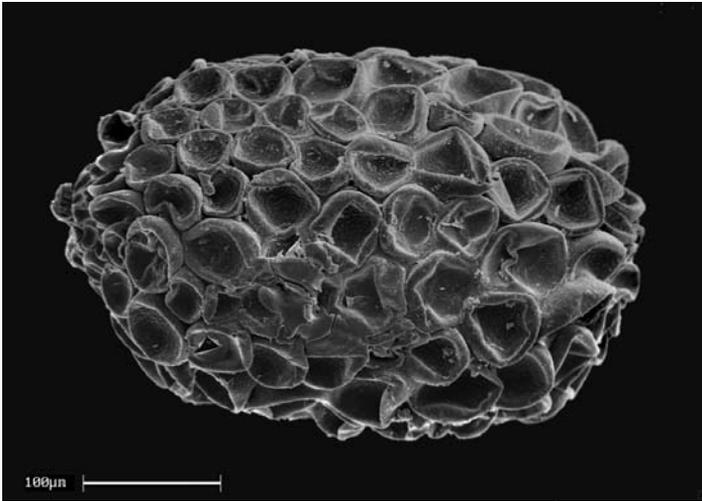


FIG. 7. The foveate seed of *Drosera amazonica* (SEM).

The remaining South American *Drosera* taxa with short scapes also seem to rely heavily on water as a vector for seed dispersal (whereas wind dispersal can be assumed for the majority of other *Drosera* species). *Drosera felix*, *D. kaieteurensis*, and *D. solaris* have short, stiff and upright pedicels, in combination with ovoid seeds, and cup-like seed capsules, which act as “splash-cups” for seed dispersal by the impact of raindrops (hydrochory: ombrochory). (Rivadavia 1999, Fleischmann *et al.* 2007).

ACKNOWLEDGMENTS

We would like to thank Paulo Gonella, São Paulo, for helping with measurements from herbarium specimens; Fernanda Antunes Carvalho, Manaus, for helping with information regarding the *D. amazonica* population in Roraima; and Dr. Eva Facher, Munich, for assistance with SEM photography. Dr. John Conran and an anonymous reviewer are thanked for useful suggestions on the manuscript.

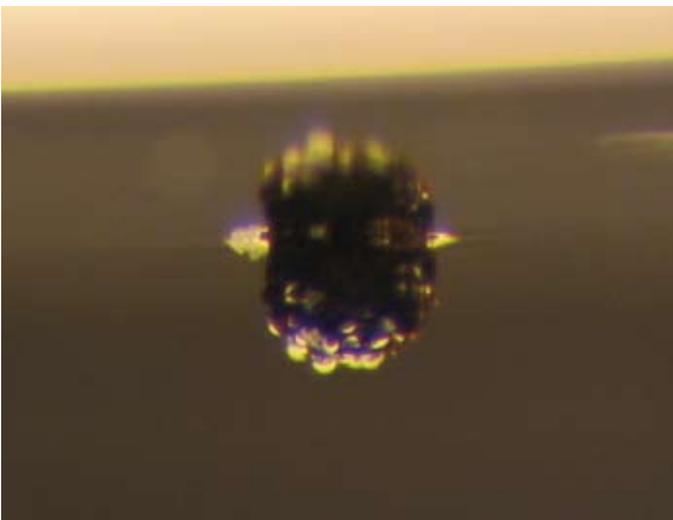


FIG. 8. Seed of *Drosera amazonica* buoyant on the water surface by the aid of capillary air bubbles adhering to the pits of the testa.

REFERENCES

- Barthlott, W., Porembski, S., Kluge, M., Hopke, J., & L. Schmidt. 1997. *Selenicereus wittii* (Cactaceae): an epiphyte adapted to Amazonian Igápo inundation forests. *Plant Syst. Evol.* 206: 175–185.
- Fleischmann, A., Wistuba, A., & S. McPherson. 2007. *Drosera solaris* (Droseraceae), a new sundew from the Guayana Highlands. *Willdenowia* 37(2): 551–555.
- Oliveira, A.A., Daly, D., Vicentini, A., & M. Cohnhaft. 2001. Vegetação sobre solos arenosos. Pp. 179–219 *in* Oliveira, A.A., & D. Daly (eds.). *As florestas do Rio Negro*. Companhia das Letras, São Paulo.
- Rivadavia, F., 1999. Neblina expedition part 5. Listserve Archives of the Carnivorous Plant Discussion Group Mailing List; <http://www.omnisterra.com/botany/cp/list/cp99all.d/0609.htm>
- Seine, R., & W. Barthlott. 1994. Some proposals on the infrageneric classification of *Drosera* L. *Taxon* 43: 583–589.
- Vicentini, A. 2004. A vegetação ao longo de um gradiente edáfico no Parque Nacional do Jaú. Pp. 117–143 *in* Borges, S.H., Iwanaga, S., Durigan, C.C., & M.R. Pinheiro (eds.). *Janelas para a biodiversidade no Parque Nacional do Jaú: uma estratégia para o estudo da biodiversidade na Amazônia*. Fundação Vitória Amazônica (FVA), WWF, IBAMA, Manaus.