Notes on some little known carnivorous plants from Madagascar

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Keywords: travelogue: *Drosera*, Madagascar, *Genlisea margaretae*, *Nepenthes masoalensis*, *Utricularia*.

Introduction

Madagascar has a high rate of endemism thanks to the early separation from the mainland (Gondwana). Sixteen percent of the 500-1000 plant genera and 79% of the 5500-6100 plant species in the eastern part of the island are exclusively found in Madagascar (White, 1983).

Although wealthy in biodiversity, the natural areas in Madagascar are highly threatened by human activity. Southeast Asians were the first people to colonize Madagascar, arriving approximately 1000-2000 years ago. With them came deforestation and abusive land practices causing desertification and astronomic rates of erosion that can be seen today. Presently, less than 9.9% of the vegetation remains relatively untouched, and Madagascar scores highly among the eight hottest hotspots for endangered biodiversity (Myers, *et al.*, 2000, Brummitt & Lughadha, 2003).

Surprisingly, the carnivorous plants of Madagascar are not as isolated as might be expected. While many species have been described for the country, most were subsequently identified as being species already discovered and described. *Drosera burkeana, D. natalensis, D. indica,* and *D. madagascariensis* occur as well in continental Africa (Keraudren-Aymonin in Humbert (ed.) 1982). Of the 19 species of *Lentibulariaceae* in Madagascar, none are endemic. One of these is a species of *Genlisea—G. margaretae*—and the rest are *Utricularia;* comprising the terrestrial *U. caerulea, U. bisquamata, U. firmula, U. welwitschii, U. arenaria, U. livida, U. folveolata, U. prehensilis, U. scandens U. appendiculata, U. subulata*; and the aquatic *U. benjaminiana, U. cymbantha, U. foliosa, U. gibba, U. inflexa, U. reflexa,* and *U. stellaris* (ordered according to Taylor (1989)). The only carnivorous plant species confined to Madagascar are *Drosera humbertii, Nepenthes madagascariensis,* and *N. masoalensis.*

Sea Shore Forest: Andranoanala

Within walking distance from the village of Ambodirafia on Madagascar's eastern cape is an area that hosts some of the threatened littoral forest. This parcel (la Parcelle détachée d'Andranoanala) was declared part of the Parc National de Masoala, mainly to protect one of the few occurences of *N. masoalensis*. *Nepenthes masoalensis* was described as a new species by Schmid-Hollinger (1977). It can easily be identified by the cylindrical upper pitchers (see Front Cover), whereas the closely related *N. madagascariensis* has typically funnel-shaped upper pitchers. *Nepenthes masoalensis* may be the most ancestral species, because it has the lowest number of nectar and digestion glands. The intermediate pitchers of *N. madagascariensis* are similar to upper pitchers of *N. masoalensis*.

N. madagascariensis is found in swamps along the east coast from Tolagnaro (James, 1988) to Maroansetra on the western side of the Masoala Peninsula (Schmid-Hollinger, in Humbert, 1982). The distribution of *N. masoalensis* is limited to a few coastal localities on the Masoala Peninsula in north-eastern Madagascar (Lecoufle 1985). It is estimated that there are less than 2500 adult *N. masoalensis* plants left, therefore it has been added to the IUCN's Red List as endangered (Clarke *et al.*, 2004). The forests of this area are still relatively undisturbed, but the isolated parcel is highly threatened by escaped fires that may result from "tavy," i.e. Malagasy for the common agricultural practice of slash and burn. In fact, signs of recent burns are found inside the park.

After our arrival at the airport of Antalaha, the nearest city, I was surprised to be welcomed by a botanically accurate painting of *N. masoalensis* on the wall of the waiting hall. We rented a Renault 4 for the time consuming drive towards the park. This small but popular car, known as

"quadrelle", has the reputation to be able to go anywhere. The next day, we waited some hours until we finally asked for the guide; a hilarious request since it was raining cats and dogs, but we had a packed time schedule. The heavy rain was disturbing, because we had already gotten our car stuck in the sandy road on the way here, and that was on a dry day—chances were, the road on the way back would be impassable. But as soon as the guide arrived the sun came out! During the so-called "dry season" the rain is unpredictable.

We passed village fields and crossed a shallow river where *U. arenaria* and *U. subulata* thrived in the occasionally flooded grasslands bordering the river. *Utricularia arenaria* is closely related to *U. livida*, but is much less variable. Another sterile aquatic bladderwort was casually observed but not identified due to our hypochondriacal fear of Schistosomiasis (Bilharzia, a serious disease spread by flukes carried by snails) and cowardice of crocodiles.

We entered the littoral forest on foot, but our progress was often interrupted by having to climb or otherwise bypass trees felled in March 2004 by an extremely destructive cyclone ("Gafilo"), which also devastated 95% of Antalaha. *Nepenthes masoalensis* was found to be locally abundant in a small area. Unlike the forest farther inland, seashore forest grows on sand, and is influenced by tidal water levels, but not by salt water. Here it supports a stand of short trees (including *Pandanus* sp.) and heather (Ericaceae); the *Nepenthes masoalensis* thrived in the forest openings. The *Nepenthes* displayed healthy growth with both very nice green upper pitchers with sometimes red lids. The winged uniformly brown-red lower pitchers were attached to very long straight tendrils, hiding among the leaf litter on the ground. Only few old, dried up, male flowers were seen. Insects seemed to prefer munching on the leaves of the accompanying vegetation instead of the *Nepenthes* plants.

The maintenance of the park is poor because only few tourists visit and there is no money to keep the track clear. Development is hindered by the frequent cyclones that destroy the infrastructure (for example accommodations, roads, and bridges; the two largest rivers can only be crossed by unmotorized ferries). Only few basic accommodations exist. On the other hand, tourists with a tight budget will enjoy a romantic, wooden, *Ravenala*-covered bungalow. For two persons it was rented out for as little as 3000 Ariary (ca. 2 US$) per day, which included candle light, bucket shower with water brought from a hole dug near the beach, and hand sized spiders all around.

Falling Water: Marojejy

After our safe return, we continued to Sambave, the world capital of vanilla production, where we arrived covered with brick-red dust from the road construction. We passed several military checkpoints that try to control the organized crime that comes with the high price for vanilla. Our next destination was the Marojejy range, located in north-eastern Madagascar, about 50 km from the Indian Ocean. These mountains compete with Masoala for the highest precipitation rate in Madagascar. They receive more than 3000 mm (120 inches) of rain annually. Marojejy is the only remaining large mountain range of Madagascar that has all four of the major Madagascar zones of vegetation types intact. Outside the reserve, the forest has been transformed into an overexploited, agricultural area. The pressure on the remaining forest inside the reserve is great.

Marojejy is in a national park, open to all paying visitors, and is managed by the Association Nationale pour la Gestion des Aires Protégées and the World Wildlife Fund. The trailhead can quite easily be reached taking advantage of a taxi brousse from Sambave towards Andapa. A 'taxi brousse' is a good place to get in contact with the locals. However, this van sized vehicle for shared transportation offers little comfort, because it is stuffed with no less than 20 to 30 people (plus luggage on the roof).

The park has a bad reputation for being infested with leeches and can only be accessed by walking 4 to 5 hours from the road. Each day we met only a handful of people. Our ascent was made during the dry season (mid-September), but in this area, no month is really dry. While on the mountain it rained one way or another the entire time. It was windy and cold (5-9°C) near the summit; here the night time lows may be just above 0°C during winter. Many tourists visit the rainforest exclusively to observe lemurs, endemic monkey-like animals with fluffy fur that perform acrobatic jumps high above the forest floor or stare back at the tourists with beady eyes. The white silky sifaka (a diurnal lemur) was a rare sight, but the other Malagasy fauna (chameleons, shiny green millipedes and a good number of bird species) were routinely spotted.

The trail to the summit was eventful, and involved fording two rivers without bridges, crawl-

Figure 1: *Drosera humbertii*, 2100 m a.s.l., eastern summit of Marojejy, Antsiranana.

Figure 2: *Utricularia livida*, 1400 m a.s.l., central highlands, Antananarivo.

Figure 3: *Genlisea margaretae*, 1400 m a.s.l., central highlands, Antananarivo.

ing under fallen tree trunks that blocked the path, jumping from root to root with the eroded forest floor some feet below, and hanging onto branches or roots where the trail was very slippery and steep. After three days hiking in the rain, my perpetually water-filled boots started to fall apart. Maybe I will wear sandals next time, as did our guide.

Little has changed from the time of Henri Humbert, a French botanist who was the first to scientifically explore the nature in this area in 1955. As we ascended the park mountains, the land changed from cultivated fields to evergreen rainforest (75 to 900 m a.s.l.), then to mountainous rainforest (up to 1400 m a.s.l.), and sclerophyllous (i.e. lichen- and moss-covered) montane forest (up to 1800 m a.s.l.), that suddenly gave way to the treeless montane shrub of the summit. Even the weather was the same as Humbert reported: clouds and rain.

The first carnivorous plant was encountered at Camp Marojejya at 800 m right behind the open-air-kitchen: a medium sized *D. madagascariensis* accompanied by a green flowered orchid (*Habenaria* sp.) was growing where water seeped down the steep gneiss-escarpment. Farther down, the river banks were covered with an unidentified species of *Utricularia*, most likely a large form of *U. livida*, that was just about to send up some flower spikes.

However, I was impatient and very curious to see the little known *D. humbertii*, that is reported from isolated mountain tops at 1400-2130 m a.s.l.. The guide hesitated to make the ascent to the summit because of the rain. But the unpleasant climb was rewarded by the interesting vegetation and finally the discovery of *D. humbertii*. It turned out to grow prolifically in wet spots on quartzite silt and in seeps among grasses, sedges, and needle or scale leaved ericoid vegetation all the way from 1800 m to the mountain top. *Drosera humbertii* has been compared to *D. capensis* (Exell, 1956), because it has a superficially similar growth habit and leaf shape. But its laciniate stipules, almost smooth scapes, and smaller, but robust constitution set it clearly apart. *Drosera humbertii* is known to form rather woody stems (3-7 cm), but some plants reaching an impressive length of up to 20 cm were found (see Figure 1). The compact growing tip often has only 3 to 7 active leaves (ca. 2 cm long), the older ones bend down, soon decaying, revealing the bald stem. Other caulescent *Drosera* from tropical Africa (*D. bequaertii, D. madagascariensis, D. katangensis, D. affinis, D. elongata*) have thinner stems and an increasingly more elongated growth in order to compete with the surrounding vegetation (Degreef, 1990). Considering the temperatures, the compact growth and the length of the stem, it is not unlikely that the tall *D. humbertii* were already growing there when Humbert visited this place. But old growth like this was rather the exception and frequently many young plants were found. No flowers and very few old scapes were present. Only a few plants were about to develop scapes; these emerged laterally from the rosette, then curved to become erect. The flowering season for this species as well as for many orchids is November to March (i.e., the wet season).

Very few compact rosettes of *D. natalensis* were also found. In Madagascar this species was often erroneously identified as *D. burkeana*. But the latter is not as common in Madagascar; it has suborbicular leaves and ovoid seed while in *D. natalensis* the leaves are spatulate and the seed is ellipsoid-fusiform (Exell, 1956). *Drosera humbertii* is clearly not merely *D. burkeana f. angustifolia*, nor is it a hybrid between *D. madagascariensis* and *D. burkeana* (or *D. natalensis*) as suggested by a note on the type herbarium sheet. *Drosera humbertii* has broad petioles like *D. natalensis* and an upright growth and leaves not quite as long as in typical *D. madagascariensis*, but the leaf shape is very different (linear, elongated lamina), not intermediate. *Drosera madagascariensis* was last seen at 1200 m and *D. humbertii* is a common *Drosera* near the summit.

Humbert also collected *U. gibba* (Manantenina) and *U. appendiculata* (Marojejy), the latter being unique among the *Utricularia* species because its climbing scapes twine in the opposite circular direction from all other species. While *Utricularia* was found whenever it was wet and open, often alongside the path, only two types of flowers were observed: Between 1400 m and 1900 m a few green flower scapes, approximately 15 cm tall with pale purple-bluish corollas were seen. The lower corolla rims were flat (*ca.* 12 mm broad), the palate raised, with two crests and a central yellow blotch. A second kind of seape with pale violet flowers and darker centers on the lower lips were found flowering sparsely near the summit. These had upper corolla lips that closed over the white rimmed palate. The scapes were *ca.* 5 cm tall and green near the base, turning bright red towards the flowers. The two types of flowers were very different from each other, and while they were found in several locations they were not very variable. It took a while studying Taylor (1964) to conclude that they are both one and the same species: *U. livida*, but apparently very different from the commonly cultivated forms. *Utricularia livida* is well known as an easy to grow, happily

flowering, cute little bladderwort with a remarkable distribution (Africa and Mexico). In the field it is very variable and known to have forms restricted to some mountains that appear to be distinct. Almost a dozen taxa were described from Madagascar alone, but found synonymous with *U. livida* (Taylor 1964).

Water of Life: Andranovelona

Another eye-catching, surprisingly large flowered form of *U. livida* was found after our return to the capital and a two-hours drive northwest from Antananarivo, within the central highlands of Madagascar. Its strangely long scapes (40 cm) reached high above the grass, and they moved so much in the wind that taking photographs of their crowded inflorescences was nearly impossible (see Figure 2). This plant, with long curved spurs, was first listed as *U. spartea* by Perrier de la Bathie (1954). The corolla is homogeneously violet-blue with the exception of a small yellow blotch on the palate, and another white stripe along the center of the lower corolla.

Two more species of *Utricularia* were found in flower. The first was a very small, typical *U. subulata* with a few yellow flowers and many seed capsules on zigzag scapes approximately 4 cm tall. The second species was more interesting, with longer peduncles, but even smaller purplish flowers with bright yellow palates. Determining the identity of this plant was difficult. The few flowers present were malformed, but as some of the scapes were twining, I supposed it was the form of *U. welwitschii* that was described as *U. aberrans* by Bosser (1958). But after reading Bosser's original publication it became clear that the corolla of this form of *U. welwitschii* is more extremely reduced in size. *Utricularia firmula* has small flowers and a long curved spur, however it invariably has a yellow corolla (Taylor, 1989). The only remaining described species that this could be is *U. bisquamata*. The scapes were quite long, but based upon the corolla size it certainly is not the giant form reported from the northwest of the island (Taylor, 1989). It was also unusual in having a long acute spur (which, by the way, is also found in the giant form from South Africa). No traps were seen, but the seed shape (ovoid, smooth, slightly reticulate) finally confirmed this being *U. bisquamata.*

An isolated occurance of *Genlisea margaretae* was refound at this special location in 1988 (Klotz, 1991; Fischer, 2000). Formerly classified as a new endemic species (*G. recurva*) by Bosser (1958), its original collection site was found destroyed in 1973. *Genlisea margaretae* is an uncommon species that is closely related to the smaller *G. glandulosissima*, and the two species are known to hybridize in Africa (Taylor, 1991). Both have seed capsules on strongly recurved and densely glandulous pedicels (see Figure 3). However *G. margaretae* has taller scapes (15-35 cm) that are almost glabrous, unlike the evenly gland-covered scapes of *G. glandulosissima.*

Numerous compact rosettes of *Genlisea margaretae* with densely packed scale-like leaves were found, most of which were flowering and setting seed. The treeless vegetation in the area is mostly specialized to very dry conditions (xerophytic). Carnivorous plants were confined to the watercourse, with the highest concentration of plants occurring where water seeped onto smooth stone outcrops. The ecotone between light brown grassland (*Fimbristylis* sp.) and grey granite was highlighted by red *D. madagascariensis*; a good indicator where the other more elusive species could be found. This botanically interesting site certainly deserves a higher grade of protection.

Conclusions

On one hand side I wished the national parks were more frequented by tourists so more money would be at hand to protect these ecosystems, increase park-related employment, and to buy the appreciation of the local population who would rather like to use these areas for agriculture. On the other hand, I was very glad to see that the remote areas we visited were not yet spoiled by heavy tourist-traffic. Transportation and infrastructure was surprisingly good, but certainly not meeting western standards. I enjoy remembering this very special vacation: altogether eleven carnivorous plant species were observed in their unique natural habitats, and some in unexpected places such as the ponds next to the famous baobab alley near Morondava. I also fondly remember the friendly people and excited children calling out, "Salu vasaha," which means "Hello stranger!"

Permit notes: None of the travels reported in this paper required special permits to enter sensitive areas.

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