Carniflora Australis

Journal of the Australasian Carnivorous Plant Society Inc.

Volume 8 No. 3, March 2012

ISSN 1448-9570 PRICE $8.00 Free with Membership

Subscription

All members, single, family and overseas $AU25.00

Please make cheques or money orders payable to the Australasian Carnivorous Plant Society Inc. Membership and correspondence should be forwarded to the Secretary via the following addresses or pay online with PayPal

www.carniflora.com

PO BOX 4009
Kingsway West NSW 2208 (Australia)

Meeting are held on the second Friday of each month
Time: 7.30 p.m.—10.00 p.m.
Venue: Woodstock Community Centre
Church St, Burwood
Ph. (02) 4684 3478

Contents

Front Cover: *Utricularia leptoplectra*. **Photo Adam Cross**

Back Cover: *Drosera banksii.* **Photo Greg Bourke**

UPCOMING SPEAKERS AND EVENTS

Date	Subject	Speaker(s)
13th April 2012	New discoveries in the Philippines	Stewart McPerson
11th May 2012	*Sarracenia and Darlingtonia cultivation*	John Neilson
8th June 2012	Forums and Blogs	John Neilson
13th july 2012	General meeting	
10th August 2012	General meeting	
14th September 2012	The Top End	Greg Bourke
12th October 2012	New *Sarracenia* imports	Greg Bourke
9th November 2012	America	Robert Gibson

Committee 2012

President:	Stewart McPherson
Vice President:	Peter Biddlecombe
Secretary:	Jessica Biddlecombe
Treasurer:	Steve Moyle
Committee Members:	Greg Bourke Marina Chong Robert Gibson Kirk Hirsch Jenssen Turnowsky Terry Watts

Respiration study on carnivorous plants: Pygmy *Drosera* gemmae and *Drosophyllum* roots

LUBOMÍR ADAMEC

Trebon, Czech Republic
Email: adamec@butbn.cas.cz

SUMMARY

Dark respiration (RD) was measured in gemmae of 4 pygmy *Drosera* species and in roots of *Drosophyllum lusitanicum* as a criterion of the intensity of metabolism of these organs. RD values of gemmae are quite comparable with those found in leaves or traps of terrestrial carnivorous plants or reported for leaves of non-carnivorous herbs. RD values of young parts of fine lateral roots of *Drosophyllum* ranged from 16.2 to 22.6 mmol.kg$^{-1}_{FW}$.h^{-1}. These values are comparable with recordly high RD in *Drosera rotundifolia* or even slightly higher.

Key words: aerobic respiration, *Drosera scorpioides, D. roseana, D. ericksoniae, D. pulchella, Drosophyllum lusitanicum*

INTRODUCTION

In ecophysiological studies, the rate of aerobic dark respiration (RD) of an organ is considered a criterion of the intensity of its metabolism and physiological functions. In terrestrial carnivorous plants (CPs), RD was systematically studied in roots (Adamec, 2005) and leaves or traps (Pavlovič et al., 2007; Adamec, 2010; Hájek & Adamec, 2010), while in aquatic CPs, in dormant or germinating turions or non-dormant winter apices (Adamec, 2003, 2008). RD values of CP roots per unit fresh weight (FW) were somewhat higher (6.7-20.2 mmol O_2.kg^{-1}.h^{-1}) than those in non-carnivorous plant roots and this phenomenon of high metabolic activity in CP roots was supported by finding comparatively high rates of their water exudation (Adamec, 2005). On the contrary, RD values of leaves or traps of 12 terrestrial CP species measured as CO_2 exchange per unit dry weight (DW; range 22-160, mean about 60-80 mmol.kg^{-1}.h^{-1}; Hájek & Adamec, 2010) and O_2-based RD values of 9 terrestrial CP species (range 8-90, mean about 20 -30 mmol.kg^{-1}.h^{-1}; Adamec, 2010) were comparable with those reported for leaves of non-carnivorous herbs (e.g. Givnish, 1988; Loveys et al., 2003).

RD has never been measured in gemmae of pygmy sundews. Gemmae in Australian pygmy *Drosera* species are green, vegetative, non-dormant propagules, which are developed in the apical shoot region of the plant in the quantity of several dozens and raise on special leaves consisting only of petioles (Lowrie, 1989; Hirsch, 2008). Their size is about 1-2 mm, they consist of a oval, fleshy, modified leaf protecting initials of new leaves and a root (Lowrie, 1989). Gemmae are produced as response to a few week period of chilly nights but there is a suspicion that some species require only a mild autumnal cool drop (Hirsch, 2008). Gemmae can be spread very easily from the mother plant. They sprout rapidly on wet soil and at higher temperatures. Unlike seeds or turions, their life-span even at low temperatures in a refrigerator is only several weeks. It is probable that relatively high RD is responsible for this short life-span.

Drosophyllum lusitanicum (L.) Link (Portuguese dewy pine; Droseraceae) is the only carnivorous plant with distinctly xerophytic features even during the growing season, in great contrast to other carnivorous plants (Juniper et al., 1989). It grows sporadically in a limited area in the subtropical Southern and Western parts of the Iberian Peninsula in Spain and Portugal as well as at the northernmost tip of Africa in Morocco (e.g., Müller & Deil, 2001; Garrido et al., 2003). *Drosophyllum* occurs in an area with very hot and seasonally arid conditions, with summer periods of up to three months without rain. Temperatures of the air or the topsoil within plant stands may exceed 40 ºC (Adlassnig et al., 2006). It is a perennial herb or short-lived subshrub up to 90 cm high (Carlquist & Wilson, 1995). The exact morphology of the root has been described recently (Adamec, 2009): relatively thick woody taproot being on average 22.2 cm (range 15-37 cm) long is prolifically branched and reaches to around 18 cm (range 10-33 cm) soil depth. Guttenberg (1968; see also Adlassnig et al., 2005) presented cross-sections of lateral roots of *Drosophyllum* and pointed out some peculiarities: the secondary endodermis is heavily suberized, while the rhizodermis is lignified. Carlquist & Wilson (1995) classified the wood anatomy of *Drosophyllum* roots as xeromorphic. As compared to root systems of most carnivorous plants, that of *Drosophyllum* is relatively well-developed and its mean proportion to the total plant biomass is around 23.3 % (range 14.2-38.0 %; Adamec, 2009, cf. Adamec, 1997). The whole root system is very fragile and vulnerable. Many carnivorous plant growers know that adult plants cannot be transplanted. Moreover, it is also well-known by growers that the root system of adult plants is very sensitive to permanently wet soil in the pot and, therefore, a dual pot system with a peat serving as a wick is usually used for its growing. In this way, the soil is only slightly moist.

The aim of this paper was to measure RD in gemmae of 4 pygmy *Drosera* species and in roots of *Drosophyllum lusitanicum* as a criterion of the intensity of metabolism of these organs.

METHODS

Plants of *Drosera scorpioides, D. roseana, D. ericksoniae* and *D. pulchella* var. Orange Flower were grown in plastic pots in a mixture of brown peat with sand in a naturally lit heated greenhouse. The pots stood in rain water. During the European winter season, the air temperature at the level of plants ranged from 6 to 15 °C and relative air humidity from 60 to 95 %. Subadult plants of *Drosophyllum lusitanicum* about 20 cm high (origin from S Spain) were grown outdoors in dual ceramic pots (diam. 12-15 cm) in a mixture of sand and brown peat (v/v 10:1). The pots stood in a 1 cm deep water on the topsoil.

Aerobic RD of ripe gemmae (13-45 gemmae of 3-4 adult plants, FW 7-21 mg) was measured in a 50 times diluted mineral nutrient solution in a 2.1-ml stirred thermostatted chamber, using a Clark-type oxygen sensor and a pen recorder (for all details see Adamec, 2005). Before the measurement, gemmae were thoroughly washed by tap water and attached air was expelled in the syringe using negative pressure. RD of gemmae was first measured at 10.0±0.1 °C and then at 25.0±0.1 °C. All measurements were repeated 3 times. RD was measured at 25.0±0.1 °C in 1-3 cm long, young apical segments of *Drosophyllum* roots and in lateral roots at the level of 2-3 cm below the root hook in 4-8 repetitions (FW 31-32 mg; see Figs. 1, 2). After measurements, DW (80 °C) of plant material was estimated. The root system of *Drosophyllum* was scanned in a Petri dish under water using a desktop scanner. All results are expressed in mmol O_2.kg$^{-1}_{FW}$.h^{-1} as mean ±1.SE. In gemmae, temperature quotient (Q_{10}) is shown.

RESULTS AND DISCUSSION

After the high values of the DW to FW proportion (37-43 %; Tab. 1), ripe gemmae of pygmy sundews should be considered storage organs full of carbohydrates (cf. turions; Adamec, 2003, 2008) (**Fig. 1**). Yet their FW-based RD values at 25 °C are very high (13-47 mmol.kg$^{-1}_{FW}$.h^{-1}) and the DW-based values (31-108 mmol.kg$^{-1}_{DW}$.h^{-1}) are quite comparable with those found in leaves or traps of terrestrial carnivorous plants (cf. Adamec, 2010; Hájek & Adamec, 2010) or reported for leaves of non-carnivorous herbs (Givnish, 1988; Loveys et al., 2003). The values of Q_{10} of the gemmae were around 2 which is a common value found in leaves of various plants and in turions (Loveys et al., 2003; Adamec, 2008). Gemmae of pygmy sundews exhibit no dormancy and can germinate and sprout rapidly under favourable conditions. Due to the high RD rate even at lower temperatures, the life-span of the gemmae is limited to only several weeks. On the other hand, it is possible that also their net photosynthetic rate is relatively high, which can contribute to their rapid sprouting.

RD values of young, physiologically active parts of fine lateral roots of *Drosophyllum* ranged from 16.2 to 22.6 mmol.kg$^{-1}_{FW}$.h^{-1} (**Tab. 1**). As compared to those values measured in young root segments of 5 carnivorous plant species of 3 genera (Adamec, 2005), the values found in *Drosophyllum* are comparable with recordly high RD in *Drosera rotundifolia* or even slightly higher. As shown on (**Figs. 2 and 3**) *Drosophyllum* roots in the pot culture were very fine and prolifically branched. The youngest, functional apical parts of fine lateral roots are distinctly light and non-lignified. The roots have dense root hairs. It is therefore obvious that younger, fine lateral roots of *Drosophyllum* are physiologically very active in terms of water and nutrient transport provided that the soil is still slightly moist. It was exactly the situation during the growth of the experimental plants when the soil was never completely dry. However, under natural summer conditions and with periods of up to three months without rain (Adlassnig et al., 2006), when the temperature of the stony or sandy topsoil within plant stands may exceed 40 °C and is very dry, the roots cannot function and root hairs are dead. Then, the plant probably relies on condensation of dewy water from night fogg on plant tentacles, its uptake and storage into foliar tissues, minimal daily transpiration water losses (Adamec, 2009), and on the uptake of mineral nutrients from prey carcasses. The xeromorphic character of *Drosophyllum* is further supported by finding a relatively low net photosynthetic rate (Hájek & Adamec, 2010). Obviously, the combination of fragility with high respiratory activity of roots renders *Drosophyllum* roots extremely vulnerable for transplanting.

ACKNOWLEDGEMENTS

Sincere thanks are due to Dr. Brian G. McMillan for language correction.

Figure 1: A gemmae of *Drosera barbigera* sprouting. Photo Greg Bourke

Table 1. Oxygen-based dark respiration rate (per unit FW) of adult gemmae of pygmy *Drosera* species and in apical and basal lateral segments of *Drosophyllum lusitanicum* roots. Means±1.SE intervals are shown; n=3. Q_{10}, temperature quotient.

Species	DW	Dark respiration ($mmol.kg^{-1}.h^{-1}$)		Q_{10}
	(% FW)	10 °C	25 °C	
***Drosera* gemmae**				
D. scorpioides	41.3	4.23±0.56	12.7±0.2	2.12±0.17
D. roseana	38.2	7.52±0.14	23.6±0.9	2.14±0.04
D. ericksoniae	36.9	10.3±0.6	21.9±1.2	1.65±0.01
D. pulchella var. Orange Flower	42.9	15.5±1.4	46.5±2.7	2.09±0.12
***Drosophyllum lusitanicum* roots**				
D. l. roots - apic.	11.6	--	22.6±1.6 (n=8)	--
D. l. roots - basal	16.7	--	16.2±4.3 (n=4)	--

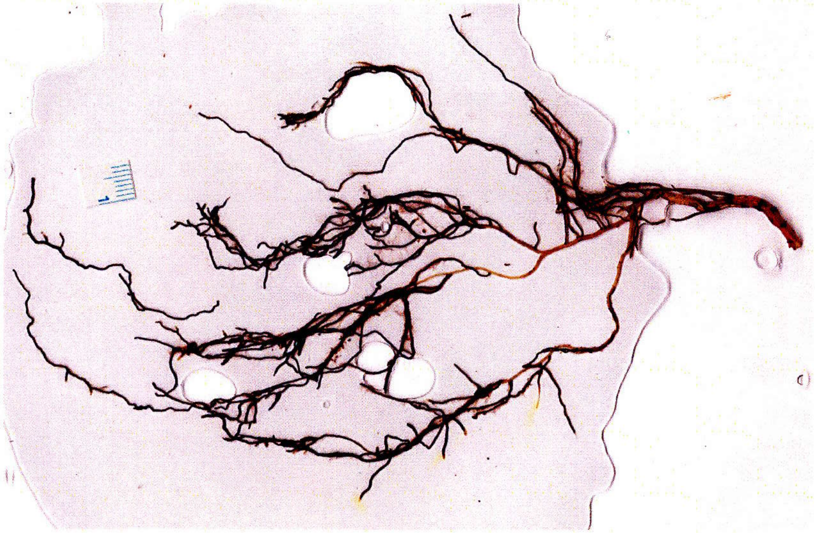


Figure 2: Root system of an experimental plant *Drosophyllum lusitanicum*; scale ticks 1 mm

Figure 3: Detail of branched lateral roots of *D. lusitanicum*. Note dense root hairs and light root tips; scale ticks 1 mm.

REFERENCES

Adamec, L. (1997) 'Mineral nutrition of carnivorous plants: A review'. Bot. Rev. 63: 273-299.

Adamec, L. (2003) 'Ecophysiological characterization of dormancy states in turions of the aquatic carnivorous plant *Aldrovanda vesiculosa*'. Biol. Plant. 47: 395-402.

Adamec, L. (2005) 'Ecophysiological characterization of carnivorous plant roots: oxygen fluxes, respiration, and water exudation'. Biol. Plant. 49: 247–255.

Adamec, L. (2008) 'Respiration of turions and winter apices in aquatic carnivorous plants'. Biologia 63: 515-520.

Adamec, L. (2009) 'Ecophysiological investigation on *Drosophyllum lusitanicum*: Why doesn't the plant dry out?' Carniv. Plant Newslett. 38: 71-74.

Adamec, L. (2010) 'Dark respiration of leaves and traps of terrestrial carnivorous plants: are there greater energetic costs in traps?' Cent. Eur. J. Biol. 5: 121-124.

Adlassnig, W., Peroutka, M., Eder, G., Pois, W. & Lichtscheidl, I.K. (2006) 'Ecophysiological observations on *Drosophyllum lusitanicum'*. Ecol. Res. 21: 255 -262.

Adlassnig, W., Peroutka, M., Lambers, H. & Lichtscheidl, I.K. (2005) 'The roots of carnivorous plants'. Plant Soil 274: 127-140.

Carlquist, S. & Wilson, E.J. (1995) 'Wood anatomy of *Drosophyllum* (Droseraceae): Ecological and phylogenetic considerations'. Bull. Torrey Bot. Club 122: 185-189.

Garrido, B., Hampe, A., Maranon, T. & Arroyo, J. (2003) 'Regional differences in land use affect population performance of the threatened insectivorous plant *Drosophyllum lusitanicum* (Droseraceae)'. Divers. Distrib. 9: 335-350.

Givnish, T.J. (1988) 'Adaptation to sun and shade: A whole plant perspective'. Aust. J. Plant Physiol. 15: 63–92.

Guttenberg, H. von (1968) 'Der primäre Bau der Angiospermenwurzel'. 2nd Edition. Gebrüder Borntraeger, Berlin, Stuttgart.

Hájek, T. & Adamec, L. (2010) 'Photosynthesis and dark respiration of leaves of terrestrial carnivorous plants'. Biologia 65: 69-74.

Hirsch, K.F. (2008) 'Do some species of Pygmy *Drosera* require chilling in order to produce gemmae? Carniflora Australis 11: 4-6.

Juniper, B.E., Robins, R.J. & Joel, D.M. (1989) 'The Carnivorous Plants'. Academic Press, London, England.

Loveys, B.R., Atkinson, L.J., Sherlock, D.J., Roberts, R.L., Fitter, A.H. & Atkin, O.K. (2003) 'Thermal acclimation of leaf and root respiration: an investigation comparing inherently fast- and slow-growing plant species'. Glob. Change Biol. 9: 895–910.

Lowrie, A. (1989) 'Carnivorous Plants of Australia'. Volume 2. Univ. West. Australia Press, Nedlands, WA.

Műller, J. & Deil, U. (2001) 'Ecology and structure of *Drosophyllum lusitanicum* (L.) Link populations in the south-western of the Iberian Peninsula'. Acta Bot. Malacit. 26: 47-68.

Pavlovič, A., Masarovičová, E., Hudák, J. (2007) Carnivorous syndrome in Asian pitcher plants of the genus *Nepenthes*'. Ann Bot. 100: 527-536.

Carnivores of the North Kimberley

ADAM CROSS

Kings Park and Botanic Gardens,
The University of Western Australia
Email: Adam.Cross@bgpa.wa.gov.au

Located in the far north of Western Australia, the Kimberley is a huge, ancient region of exceptional biodiversity and breathtaking scenery (**Fig. 1**). A wide mosaic of landform and habitat type has resulted in over 300 vegetation associations recognised for the region, many with high levels of floral endemism and a rapid species turnover between habitats. Soils are generally shallow and skeletal, heavily leached from the harsh annual cycle of long dry winters and monsoonal summer rains, and with fire a characteristic part of the landscape the Kimberley represents one of the harshest ecosystems in Australia. The far north Kimberley in particular, where most of my research is conducted, experiences an extremely seasonal climate: areas of cracked clays and desiccated, fire-prone savannah change into flooded and verdant swampy grasslands almost immediately after the first wet season rains, if only for a brief few months

Figure 1: The breathtaking landscape of the far north Kimberley

Figure 2: An expansive field of *Byblis liniflora*, a common post-fire sight in low-lying sandstone herb fields

Though most of my work focuses on vernal aquatic flora and the processes governing plant survival in such a harsh and dynamic landscape, carnivorous plants have always been my passion. The Kimberley is therefore something of a treasure chest: creeks choked with any of a dozen species of *Utricularia;* huge fields of *Byblis liniflora* dotted with tall *Drosera indica* and the ubiquitous *Utricularia* (**Fig. 2**); even muddy quad bike tracks are often fringed with *Byblis* or *Drosera* interspersed with tiny colourful *Utricularia* and other interesting genera such as *Stylidium* and *Goodenia.* On a recent trip I pointed out the small *D. burmanni* to my field assistant whilst combing a swampy herb field for new *Eriocaulon* species, and for the rest of the week she lamented the difficulty in simply walking around attempting not to step on the abundant carnivore.

The seasonal climate, variety of soil types and short persistence of water results in the north Kimberley possessing one of the greatest carnivorous plant diversities in Australia. Some three species of *Byblis* (**Fig. 3**), 13 species of *Drosera*, and 26 species of *Utricularia* are recorded from the north Kimberley, as well as several recently unverified records of *Aldrovanda vesiculosa.* The latter species is one that I have studied extensively over the last four years, but which to date continues to elude us throughout the state's top end. This is certainly not for lack of effort, and is likely a product of the highly transient nature of *Aldrovanda* populations throughout Australia's tropical regions.

Over the next few pages are just a few of the species I've come across over the last two years of research trips, with a short note on the particular habitat in which they were found. This list is likely to expand however: several of my herbarium collections are still awaiting classification and are likely to represent new species, and subsequent trips further afield will hopefully uncover some of the remaining range-restricted flora.

Drosera

Drosera are found in the most diverse array of habitats, from seasonally flooded blacksoil lowlands to dry sandy savannah and shallow sandstone seepage areas, as well as along creek banks, throughout inundated swampy areas and even clinging to algae covering bare rock in shallow runoff areas.

Drosera banksii

Throughout seasonally wet lowland herbfields on lightly cracking clays, with *Eriocaulon concretum, E. fistulosum, E. tortuosum, Drosera indica, D. burmanni, Utricularia leptoryncha, U. chrysantha, U.* aff. *kenneallyi, U. minutissima* and *U. leptoplectra.* Also along creek banks and seasonal floodplains. A pure white form also exists.

Drosera burmannii

One of the most widespread species of *Drosera* throughout much of the Kim-

Figure 3: Small sandstone creeks are often crowded with interesting flora, many of them carnivorous. *Byblis liniflora* is often one of the more dominant species along sandstone areas such as this

berley, occurring on clays, blacksoil, and sand from creeks, seasonally wet lowlands and drainage areas to along roads and the cleared areas of tracks (**Fig. 3 & 4**).

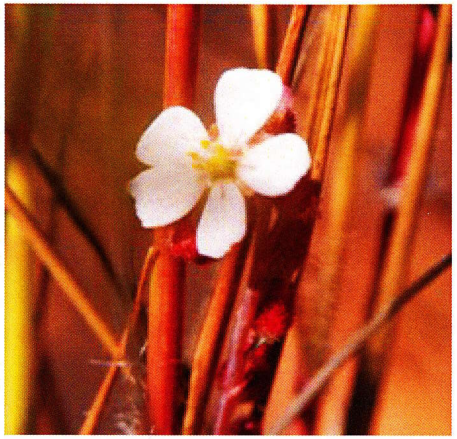


Figure 3 (above) & 4 (below) : *Drosera burmanni* habit and flower

Drosera dilatato-petiolaris

Similar in distribution and habitat preference to *D. burmanni, D. dilatato-petiolaris* is common throughout drier lowland areas and on shallow sandy soils but is generally absent from rivers and creeklines. In open *Eucalyptus* dominated woodland areas, the species can form impressive clumps and produce spectacular floral displays (**Fig. 5 & 6**).

Figure 5: *Drosera dilatato-petiolaris* habit

Drosera indica

Another widespread species, *D. indica* is found throughout most seasonally wet habitats; particularly low lying herbfields and on the margins of sandstone creeks. Several varieties exist, each very likely representing new species, and often two or three forms will co-occur (**Fig. 8, 9 & 10**).

Figure 6: *Drosera dilatato-petiolaris* flower

Figure 7: A tiny red form of *Drosera indica*, with small pink flowers

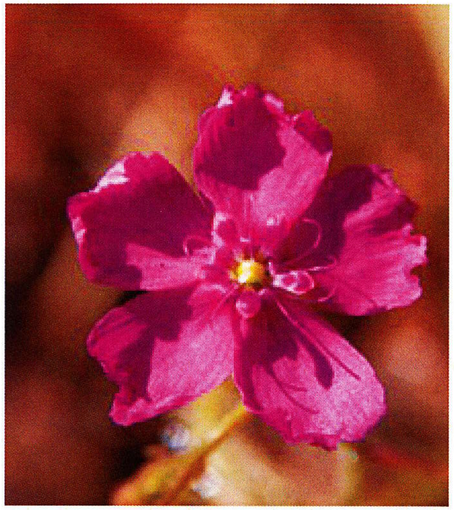


Figure 8: Examples of strong floral variation between two of the most common *Drosera indica* varieties (above and below)

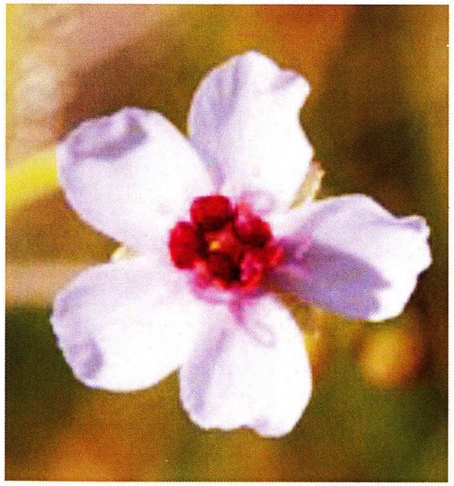


Figure 9: The typical green, large pink-flowered form of *Drosera indica*, growing on the margins of a small creek

Figure 10: A deep red colour variant of *Drosera indica* from near Kununurra in the east Kimberley, growing alongside the typical green form.

Drosera ordensis

A relatively rare species compared to others with similar growth habit, *D. ordensis* appears to inhabit much drier areas of grassy woodland (**Fig. 11**).

Figure 11: *Drosera ordensis* habit

Drosera paradoxa

Much like *D. burmanni*, *D. paradoxa* is abundant throughout most seasonally wet swampy lowland areas and sometimes sandy flats, often occuring in large numbers between small annual herbs and grasses (**Fig. 12 and 13**).

Figure 12 (top): *Drosera paradoxa* with *Utricularia sp. Theda and Drosera banksii.*
Figure 13 (above): *Drosera paradoxa* growth habit

Drosera petiolaris

Similar in habitat to *D. ordensis, D. petiolaris* is often found on seasonally wet clays and blacksoil areas, often side by side with *D. dilatato-petiolaris* (**Fig. 14 and 15**).

Figure 14 (above): Flower of *Drosera petiolaris*.

Figure 15 (below): *Drosera petiolaris*, growing in close association with *D. dilatato-petiolaris* along an access track

Drosera subtilis

A peculiar and rather unique species, *D. subtilis* has been found growing among thick annual grasses on the littoral zone of sandstone creeks, and also virtually submerged in the slowly flowing water of sandstone pavement seepage zones (**Fig. 16 and 17**).

Figure 16: The characteristic four partite flowers of *Drosera subtilis*

Figure 17: The small sandstone form of *Drosera subtilis*, growing nearly submerged with *Utricularia quinquedentata*

Byblis

Byblis filifolia

Generally found sparsely distributed throughout drier, sandier areas than *B. liniflora*, this species commonly grows on the areas fringing sandstone pavement and in shallow soils amongst tall annual grasses (**Fig. 18**).

Figure 18: The flowers of B*yblis filifolia*

Figure 19: *Byblis liniflora* habit

Byblis liniflora

Very abundant throughout seasonally wet areas of sandstone, blacksoil and sandy muds, as well as along creek lines and drainage areas. Frequently found with *Eriocaulon cinereum, Drosera indica, D. subtilis, D. burmanni, Utricularia chrysantha, U. kenneallyi, U. lasiocaulis, U. leptorhyncha,* and *U. kimberleyensis,* as well as annual herbs and grasses.

Byblis rorida

Similar habitat to *B. liniflora*, being generally sandy seepage areas and on the margin of creeks and small rivers.

Utricularia

Utricularia antennifera

Usually found in the shallow sediments fringing sandstone creeks, or in shallow sandstone depressions along seepage lines (**Fig. 20 and 21**). A very unusual but highly charismatic species similar to *U. dunstaniae* and the very rare *U. dunlopii.*

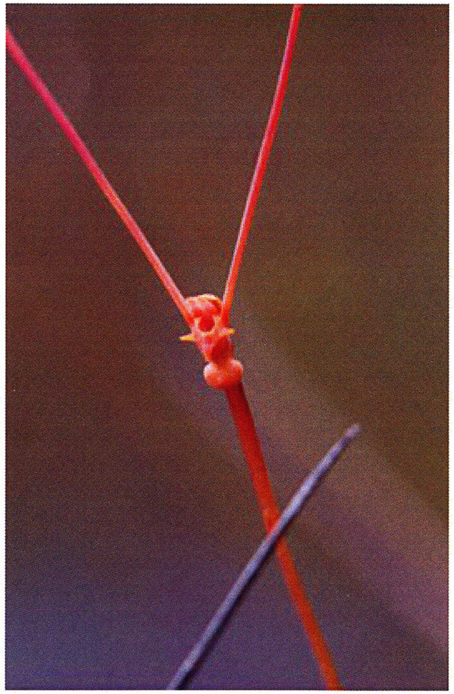


Figure 20: The peculiar flower of *Utricularia antennifera*

Figure 21: A huge population of *Utricularia antennifera* in flower along a seepage line in a remote sandstone range

Utricularia arnhemica

Found so far in only a single location of blacksoil lowland between basalt ridges, with mixed grasses and annual herbs.

Utricularia australis

Rarely found in sandstone creeks and deep billabongs, among *Nymphoides indica*, *Nymphaea violaceae, Marsilea drummondii and Utricularia gibba.* Morphologically quite different to southwest and eastern Australian forms.

Utricularia bifida

In a deep sandstone rockpool experiencing seasonal flooding, throughout the muddy fringing zone amongst *Utricularia gibba, U. fistulosa, U. antennifera,* and *Eriocaulon* aff. sp. *Morgan River.*

Utricularia caerulea

A tiny and relatively uncommon species flowering solitarily on shallow sediments or in damp sandy patches near creeks. A pure white form appears as abundant as the standard blue form.

Figure 22: *Utricularia caerulea*

Utricularia chrysantha

Throughout seasonally wet lowland herbfields on lightly cracking clays, with *Eriocaulon concretum, E. fistulosum, E. tortuosum, Drosera indica, D. burmanni, Utricularia leptoryncha, U. minutissima, U.* aff. *kenneallyi* and *U. leptoplectra*. Also along creek banks and seasonal floodplains, and often forms fields of yellow flowers in drier sandy areas.

Utricularia dunstaniae

Very similar in morphology to *U. antennifera*, and often found in similar habitat though somewhat uncommon (see cover).

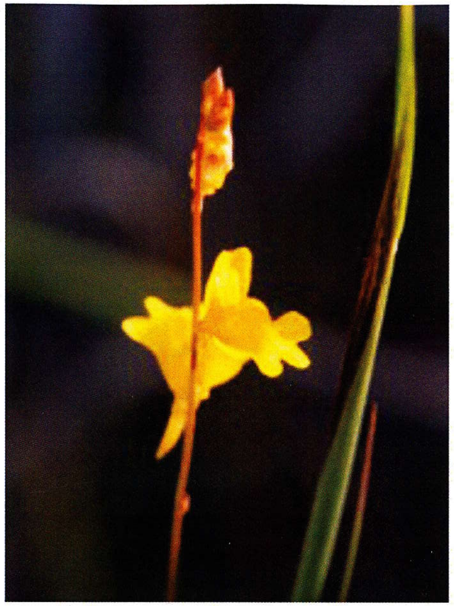


Figure 23: *Utricularia chrysantha*

Utricularia fistulosa

In a deep sandstone rockpool experiencing seasonal flooding, throughout the muddy fringing zone amongst *Utricularia gibba, U. bifida, U. antennifera,* and *Eriocaulon* aff. sp. *Morgan River*. Also in the deeper waters of seasonal sandstone creeks, with inflorescences to nearly half a metre long.

Utricularia georgei

An uncommon species occurring generally in small patches, often in shallow sandy areas on seasonally wet sandstone pavement among *Eriocaulon scullionii*, and occasionally among annual herbs and grasses throughout damp lowlands and herbfields (**Fig. 24**).

Figure 24: *Utricularia georgei*

Utricularia gibba

Ubiquitous and widespread throughout large perched billabongs on heavily textured cracking clays, sandstone creeks and blacksoil swampland. Often among *Nymphoides indica*, *Nymphaea violaceae, Najas tenuifolia, Marsilea drummondii and Utricularia australis.*

Utricularia hamiltonii

A very showy species with large flowers, only present on the landscape for very short periods, generally in seasonally inundated lowlands. *U.* sp. *Theda* was initially regarded as a white form of this species.

Utricularia kenneallyi

Another widespread species throughout blacksoil areas and lowlying damplands.

Utricularia kimberleyensis

Rather similar in size and habit to *U. hamiltonii*, known throughout the Kimberley along water courses. A rare white flowered form is found along a creek near one of my key sites.

Utricularia lasiocaulis

Generally found co-occuring with *U. kenneallyi* in blacksoil areas amongst low annual herbs including *Eriocaulon* and with *Drosera indica* and *D. banksii.*

Utricularia leptoplectra

Throughout seasonally wet lowland herbfields on lightly cracking clays, with *Eriocaulon concretum, E. fistulosum, E. tortuosum, Drosera indica, D. banksii, D. burmanni, Utricularia lep-*

Figure 25: Typical *Utricularia leptoplectra*

toryncha, U. chrysantha, U. aff. *kenneallyi* and *U. minutissima*. Also along creek banks and seasonal floodplains (**Fig. 25**). A pure white form also exists (**Fig. 26**) .

Figure 26: The rare white form of *Utricularia leptoplectra*

Utricularia leptorhyncha

Throughout seasonally wet lowland herbfields on lightly cracking clays, with *Eriocaulon concretum, E. fistulosum, E. tortuosum, Drosera indica, D. banksii, D. burmanni, Utricularia minutissima, U. chrysantha, U.* aff. *kenneallyi* and *U. leptoplectra*.

Utricularia limosa

Found scattered throughout an extensive area of heavily textured cracking clays, with numerous small depressions up to 10 m^2 and 40 cm deep interspersed with infrequent larger depressions to 120 cm deep. Vegetation predominantly *Eucalyptus tectifica* woodland over a dense grassy understory, with *U. limosa* amongst *Eriocaulon cinereum, E. scullionii* and *Eleocharis triquetra* (**Fig. 27**). The area frequently experiences seasonal bushfires.

Figure 27: *Utricularia limosa*

Utricularia minutissima

Throughout seasonally wet lowland herbfields on lightly cracking clays, with *Eriocaulon concretum, E. fistulosum, E. tortuosum, Drosera indica, D. burmanni, D. banksii, Utricularia leptoryncha, U. chrysantha, U.* aff. *kenneallyi* and *U. leptoplectra*.

Figure 28: *Utricularia minutissima* with an equally diminutive *Goodenia* species

Utricularia quinquedentata

A rather rare species known from only a handful of sites on remote sandstone pavement areas, among *Drosera subtilis* on shallow seepage lines and among various annual herbs (**Fig. 29**).

Utricularia sp. Theda

Another large, showy species, the inflorescences of which bend and bury themselves into sediment upon fruit maturation. Only known from one or two locations in remote sandstone herbfields.

Figure 29: The diminutive *Utricularia quinquedentata*

Book Review: 'Australian Carnivorous Plants' by Greg Bourke and Richard Nunn

ROBERT GIBSON

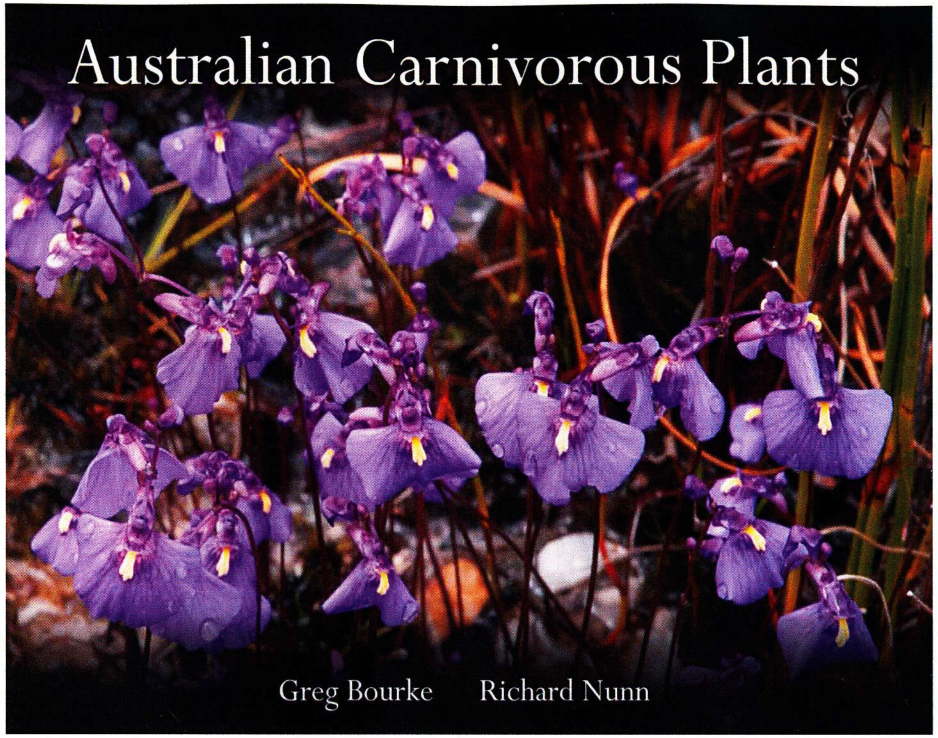
Gosford, Australia
Email: drsundew@ihug.com.au

Greg Bourke and Richard Nunn have produced a superbly illustrated coffee-table book on Australian carnivorous plants. The book (ISBN 978-1-908787-02-6) has been published on February 2012 by Redfern Natural History Productions, which is well-known for beautifully illustrated and high quality books. The following review carefully looks over this publication and describes the book first in terms of its physical properties, then on its text and photos with some suggestions on how the next edition of the book may be improved) and ends with my reaction in reviewing this work.

The main objectives of the book are to present high quality photos of a large number of carnivorous plants in the wild, to show the beauty of the plants, some of the range in morphology within and between groups and to be a useful reference to those with more than a passing interest in these plants. In addition, this book included photos of several poorly-known species that have not been published before.

Physically the book is about 32 cm x 24.8 cm x 2.2 cm in dimension with a hardcover and a dust jacket. It contains 208 printed pages with 226 photos. The book is available through the publisher's website: http://www.redfernnaturalhistory.com/books/name/australian_carnivorous_plants and has a retail price of £29.99 (unsigned) or £34.99 (signed). The high-density paper is sturdy and has a lovely feel to it. The printing is clear and crisp and the colours appear to have come true from most of the original photos.

The first nine pages of the book comprise a forward, table of contents, acknowledgements and a section listing the camera equipment used. The forward has been written by Allen Lowrie, the author of the three-volume (so far) set of 'Carnivorous Plants of Australia' (University of Western Australia Press, Perth) as well as many published papers. Next up is a general introduction that provides a summary of the different types of carnivorous plants in Australia. It includes a table listing all 187 currently recognized species of native Australian carnivorous plants by family and genus. It highlights what many already know, that Australia is a centre of diversity for carnivorous plants, especially of the genus *Drosera* (116 species, 23 subspecies and 2 varieties) and of



Utricularia (59 species). The listing includes two naturalized exotic species: *D. capensis* and *U. sandersonii,* both of which have recently been found near Sydney. The bulk of the book is formed by six chapters, each dedicated to a genus of native Australian carnivorous plants. The book ends with a short but important section about the conservation status of native carnivorous plants. The final pages of the book contain a bibliography, an index of species illustrated in the work, a biography of the authors, and finishes with a summary of some of the other publications produced by Redfern Natural History.

The chapter for each of the genera begins with a page of text which introduces them (*Aldrovanda*, *Byblis*, *Cephalotus*, *Drosera*, *Nepenthes* and *Utricularia*), their general botanical history, overall plant structure, trapping mechanism, global and Australian distribution, habitat and some of the challenges in photographing plants in situ. The pages that follow are filled with large, often full-page photos, each with its own figure caption. The treatment of the largest native genus, *Drosera*, is broken into four groups based roughly of plant morphology and ecology (Pygmy *Drosera*, Tuberous *Drosera*, *Drosera petiolaris* complex and 'Other Australian *Drosera*'). The last pages of the *Drosera* section (pages 146-147, and 169) discuss Sundew Bugs (*Setocoris* spp.).

The last chapter discusses the conservation status of carnivorous plants in Australia in light of the main threats. Thankfully many species appear to have a relatively secure long-term future, but for several species with more restricted ranges their medium to long-term future persistence in the wild cannot be guaranteed (such as *Drosera oreopodion*); already one Pygmy sundew is recorded as recently having become extinct in the wild.

My overall review is that this book contains an abundance of top quality photos, many of which are of taxa for which few photos have so far been published (such as some of the tropical species of *Utricularia*). I particularly like the pages in which flowers or plants of different species are presented side-by-side to illustrate differences between them (such as on pages 38-39, 50-51, 94-95, and 174-175). The range of habitat photos show some of the environments in which these plants grow, many being starkly different to habitats for some of the better-known carnivorous plants of the Northern Hemisphere (e.g. Figure 110). This book contains few flaws but the main criticism I have of the photos is that a few of them appear to be a little over-exposed, at least in part, such as *D. zigzagia* (Figure 68) and *D. burmanni* (Figure 155). This could be due to the printing process or simply reflects the challenge of macro photography in the field.

The format for this book has the photos speaking for themselves. The text provides context, which highlights features in photos that may not be immediately obvious (in, e.g. the tree roots with *Drosera binata* growing on them in Figure 4). In some cases it provides additional insights into aspects of the plants (such as the use of *Nepenthes* pitchers by Indigenous Australians to store and transport honey).

By design the text in this book has been kept to a minimum, and this is also the part of the book with the most room for improvement. There are a few minor errors, such as the transposed positions of Augusta and Cape Richie in relation to the range of *Cephalotus follicularis* (page 22); the use of the term 'strain' to describe temporary, reversible phenotypic variability of *Drosera spatulata* growing in different environments (page 117); and the misspelling of *Drosera burmanni* (see Australian National Botanic Gardens, 2011). In a few cases the Figure captions are hard to read against the photo background, particularly in the case of *Drosera gigantea* ssp. *gigantea* (Figure 70).

In places the text is a little cumbersome, and could be rewritten for a crisper result; for instance, the double reference to single plants of *Utricularia* having up to (a very impressive!) 60, 000 traps (page 1). Some sections of text contain some bold statements, such as the reported role of low nutrient soils as a causal factor of the diversity of carnivorous plants in Australia (page 1). This hypothesis may be so, but long residence time of lineages and drastic changes in climate, such as during the Tertiary Period may have also played a role too (Hopper, 1979).

A second edition of the book could be improved by revising parts of the text, perhaps replacing a few photos (such as Figures 68 and 155), adding a photo of *Aldrovanda* in flower, including a map showing all of the places named in the text, and perhaps adding three more pages of text and photos to cover additional species and to fill the blank pages at the end of the current edition.

In conclusion it is a beautiful book. A range of visitors have perused a copy of this book at home already. It seems to appeal to those with a keen interest in these plants as well as to those with a passing interest in botany. The large page size does present the abundance of superb photos well. I particularly like the information presented on the camera equipment used for the photos. I can relate to many of photographic challenges that the authors must have faced when vying for that perfect image. I was also pleased to see photos and information on some poorly known species, particularly a range of tropical species of *Utricularia*. The few problems I had with the book are minor, and can be readily addressed in any second edition. They do not prevent the book from achieving its aims. Therefore, I highly recommend purchasing a copy of this book, which may be purchased directly from the publisher, through some carnivorous plant societies, and from bookshops in selected botanic gardens.

Drosera arcturii from Australian Carnivorous Plants. Photo. Greg Bourke

REFERENCES

Australian National Botanic Gardens (2011) Australian Plant Name Index – APNI. Last unpdated 6 July 2011. Australian National Botanic Gardens, Canberra. http://www.cpbr.gov.au/apni/ Viewed 7 July 2012.

Hopper, S. (1979) 'Biogeographical aspects of speciation in Southwest Australian Flora'. Annual Review of Ecology and Systematics, **10**: 399-422

How many I's in *Drosera burmannii*

GREG BOURKE

PO Box 3049, Bilpin NSW 2758
Email: orders@captiveexotics.com

While editing the text for *Australian Carnivorous Plants* Richard Nunn and I came across a problem. Was it *Drosera burmanni* Vahl or *Drosera burmannii* Vahl? A debate started which included botanical and *Drosera* experts from around the globe and included Dr. Jan Schlaur, Andreas Fleischmann, Allen Lowrie and Alastair Robinson.

This may seem a little repetitive but firstly I will introduce you to the species. *Drosera burmannii* was first described by Johannes Burman in 1737 in his publication on the flora of Ceylon. The species epithet zeylonensis was used by Burman to describe the species. It wasn't until 1794 however that a formal description was made. Martin Vahl named the species in honour of the Burman family as *D. burmanni.*

Now, the most complete explanation which was presented beautifully by Dr. Schlaur and also published on the CP discussion group web page (several times over the past few years) as follows:

"this is a question of almost religious belief rather than science. The core of the problem is divergent opinions on what is a correct latinisation of a fundamentally non-Latin name. The epithet refers to the Burman family of Dutch Botanists. At their time it was fashionable to use latinised names in correspondence/print, and their own latinisation was "Burmannus". Needless to say this is against all extant ICBN rules, but one of the reasons may be that formal rules for Botanical nomenclature were virtually nonexistent at that time. Burman himself (Joannes Burmannus http://www.botanicus.org/page/622504) got away (in Thesaurus Zeylanicus: 207, 1737 http://www.botanicus.org/page/622821) with calling the plant in question "Ros solis foliis circa radicem in orbem dispositis", a rather cumbersome pre-Linnaean phrase name that is entirely and deservedly forgotten today. From the Burmans' latinisation (and/or from their Dutch name in various spelling variants) a number of plant names were derived, e.g. the genus name _Burmannia_ or the species epithets _burmanni_, _burmannii_, _burmani_ (illegitimate), _burmanii_, and _burmannian-a/-us/-um_. Linnaeus only introduced the genus _Burmannia_ in Species Plantarum (1753), the nomenclatural starting point of Botany. Even later he apparently avoided using the genitive for Burman-derived names (possibly he was uncomfortable with the Burmans' eccentric latinisation). With respect to the Burman-derived genitive, three major and essentially irreconcilable schools of Botanists exist today: The first one respects the original spelling "Burmannus" and accepts the genitive "burmanni" as correct Latin. The second applies ICBN rules to a (virtual) original "Burmann", in which case "burmannii" would be correct. The third derives epithets from the original non-Latin "Burman", so "burmanii" would be correct. The Danish Botanist Martin Vahl (a pupil of Linnaeus just like J. Burman's son) was the first to describe _D. burmannii_ with a legitimate binomial. Linnaeus himself mentioned the same plant only on p. 50 of his pre-Linnaean Flora Zeylanica of 1747, http://www.archive.org/stream/carolilinniflor00dassgoog#page/n80/mode/1up, where he confused it with the temperate _D. rotundifolia_, so it did not enter Species Plantarum as a distinct entity. Vahl obviously belonged to group one ("burmanni"). I personally tend to join group two because of Linnaeus' precedent. If Linnaeus had accepted "Burmannus" as correct, his genus would rather have become _Burmanna_. But as Linnaeus himself did not venture into the genitive directly Group one could claim compatibility with Linnaeus to some degree as well. To make things even more complicated, group three is likewise perfectly compatible with the ICBN (but not so much with Linnaeus). Thus, I do not blame anyone for using "burmanni". But I am not inclined to adopt this "animal" spelling (the zoological code ICZN has slightly different latinisation rules) for a plant.

As mentioned above, this topic is not a new one and has previously been tackled also by Barry J. Conn from Adelaide, Australia (Conn, B.J. (1980). His conclusion opposes ours.

In Summary, Although both names can be used and both are correct, the decision was made to follow ICBN rules that two I's are more appropriate than one.