

## A new species and section of *Utricularia* (Lentibulariaceae) from northern Australia

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### Abstract

A minute, reddish-purple-flowered, new species of *Utricularia* L. subgenus *Utricularia* (Lentibulariaceae) is described and illustrated: *Utricularia simmonsii* Lowrie, Cowie & Conran from the western Top End of the Northern Territory and near Lockhart River and Tozer's Gap, Iron Range in far north Queensland. The species represents possibly the world's smallest-flowered carnivorous plant. It shows some affinities to *Utricularia* sections *Enskide* and *Pleiochasia*, but possesses a combination of features not found in any other *Utricularia* species. The tiny flowers have an open, gullet throat, virtually lack a spur (both unusual features in the genus), the traps lack obvious trigger or guiding hairs, and the seeds have almost fingerprint-like swirled sculpturing. Because of its distinctness, it is placed into a new section: *Minutae* Lowrie, Cowie & Conran. A key to the *Utricularia* taxa found in Northern Australia is also provided.

### Introduction

The genus *Utricularia* with over 220 species worldwide is well represented in Australia with Taylor (1989) listing 64 species, and two more described since then (Lowrie 1998a, b, 2002), bringing the current total to 66 species in 13 sections. There are also numerous undescribed taxa from the Australian tropics (R. Barrett, D. Dixon and J. Clarkson pers. comm.).

The monsoonal Top End of the Northern Territory (NT) has been identified as a world centre of diversity for the genus *Utricularia* L. (Lentibulariaceae) with 36 taxa known



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from the area (Taylor 1989). Indeed, the area supports a diverse assemblage of specialist plant species on seasonally waterlogged, infertile, sandy soils particularly associated with the lowlands of the Koolpinyah Surface of Williams (1969) as well as the Western Arnhem Land Plateau. Many of the taxa involved are endemic to the NT (Woinarski et al. 2006). The habitat is extensive and finely divided by subtle gradients in soil texture, drainage, period of inundation and water flow. This in turn influences the species composition across the landscape and appears to have allowed a rich flora to develop. During studies of the effects of sand mining on this habitat an undescribed species of *Utricularia* was seen in the field and collections were subsequently made over a number of years.

Similarly, in October 2005, the same minute-flowered new species of *Utricularia* was found growing with cultivated material of a much larger-flowered *Utricularia* species from Turtle Creek crossing, Iron Range. It was also found near the Lockhart River community refuse site; and along the Lockhart River near Tozer's Gap in far north Queensland (Fig. 1).

When compared against Taylor's (1989) monograph of *Utricularia*, these collections clearly represented a new taxon quite unlike any previously described species. Taylor records six tiny-flowered *Utricularia* in his monograph: *U. albiflora* R.Br. (fig. 28, p. 151), *U. quinquedentata* F. Muell. (fig. 29, p. 153) from Australia; *U. cymbantha* Oliver (fig. 208, p. 680) from Africa; *U. naviculata* P. Taylor (fig. 209, p. 682) from South America; *U. biovularioides* (Kuhlum.) P. Taylor (fig. 210, p. 684) from South America; and *U. olivacea* Wright ex Griseb. (fig. 211, p. 687) from the Americas. *U. quinquedentata* and the closely-related *U. albiflora* were previously regarded as the smallest in the genus, but the new species is shorter in stature and has a smaller corolla. When these other species are compared to the new taxon, the minute corolla size of the latter easily make it the world's consistently smallest-flowered *Utricularia* (and carnivorous plant) species so far discovered.

Accordingly, the new species is named here and its affinities to the remainder of the genus are discussed. A key to the 45 *Utricularia* species found in northern Qld, the NT and the Kimberley Region of WA is provided here to enable identification.

## Methods

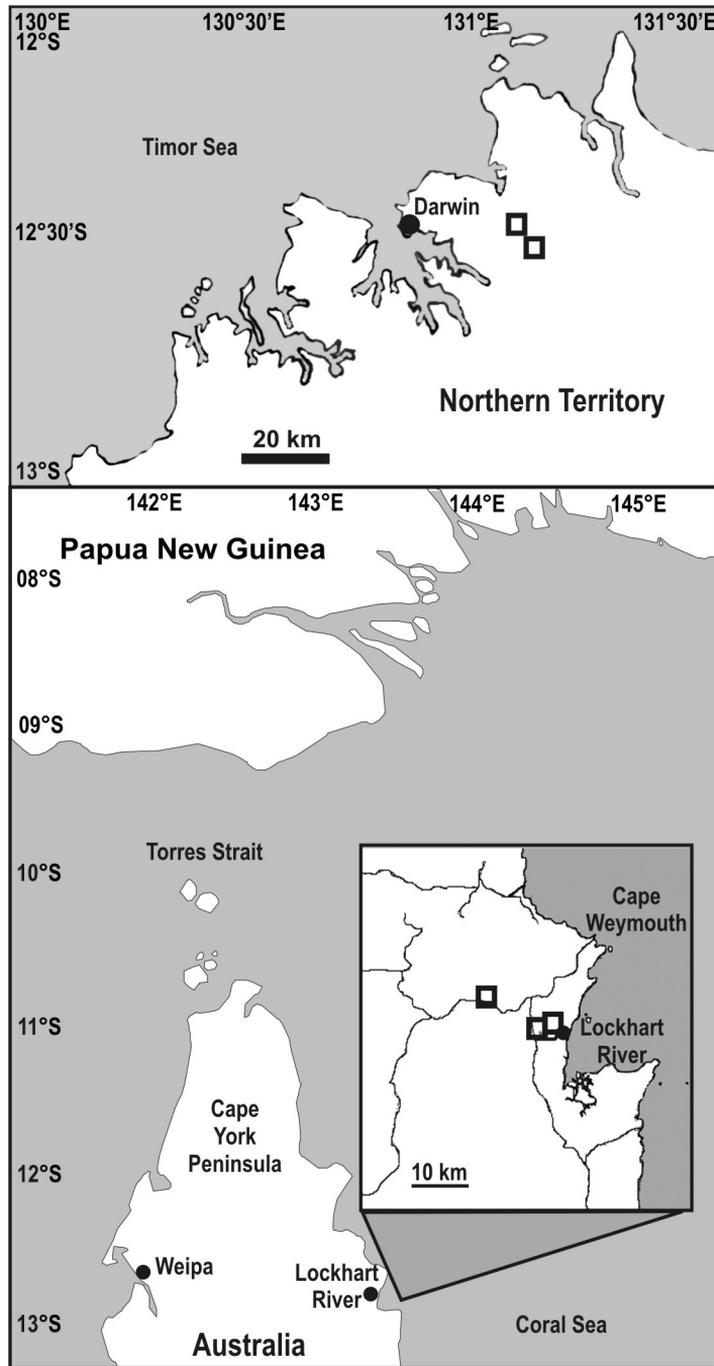
Morphological characters were examined at DNA and ADU using fresh, dried and spirit-preserved material, and seeds were examined under scanning electron microscopy.

The terminology used for *Utricularia* follows that generally accepted for the genus (Taylor 1989). Specifically, rhizoids in *Utricularia* resemble and function as roots; scales may be present on the peduncle (or inflorescence stalk); a bract can be found opposite or subtending each flower pedicel and often two bracteoles occur laterally to the bract.

## Taxonomy

*Utricularia simmonsii* Lowrie, Cowie & Conran *sp. nov.*

Herba minuta. Folia angustissima filiformia, rariora oblonga. Vesiculae nudaе glandulis sessilibus dispersis; appendix dorsalis singula; saetae irretitantes papillatae.



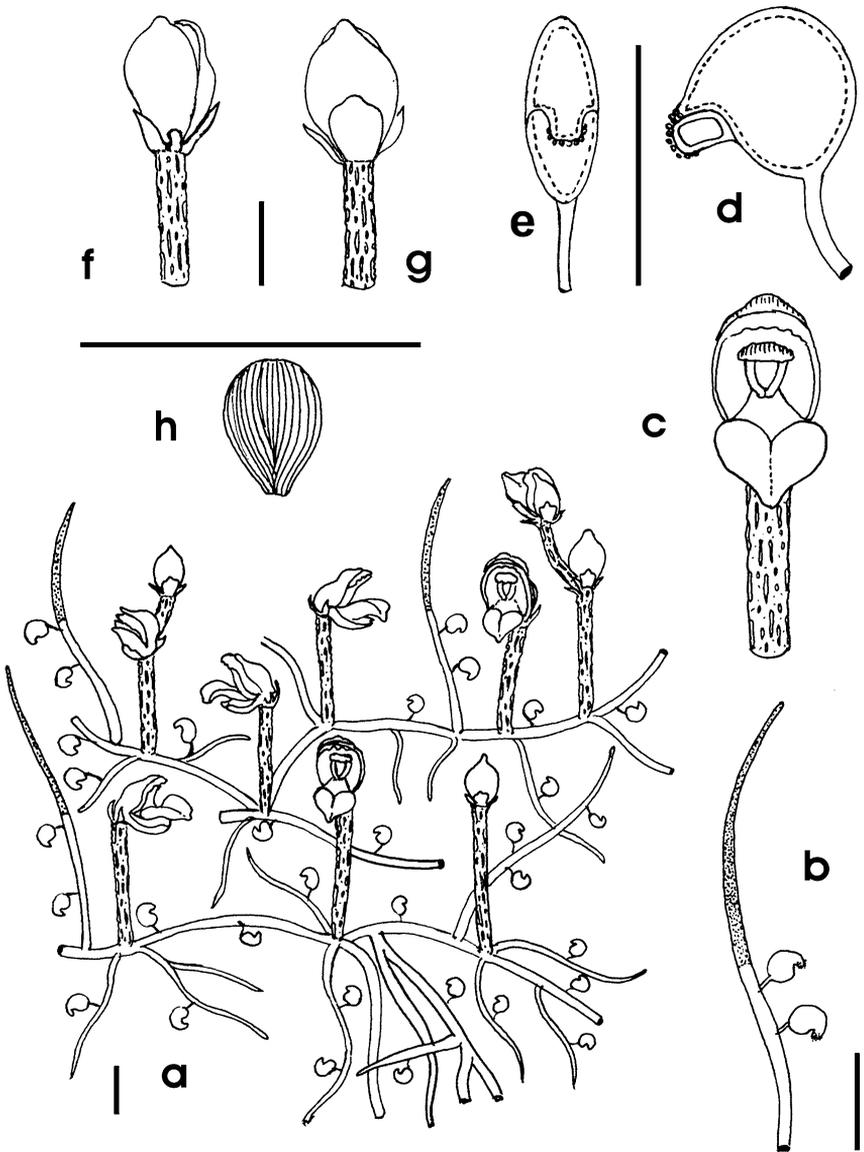
**Fig. 1.** Maps showing the current known distribution for *Utricularia simmonsii* in the Northern Territory and Queensland.

Flores 1–2(–3) minutissimi, purpureo-rubri. Corolla cucullata; calcar vel faux clausa deficiens; labium inferum integrum limbo diminuto. Stamina et stylus per corollam inclusus attamen conspicuus. Semina turbinata, mellea, testa longitudinaliter striata.

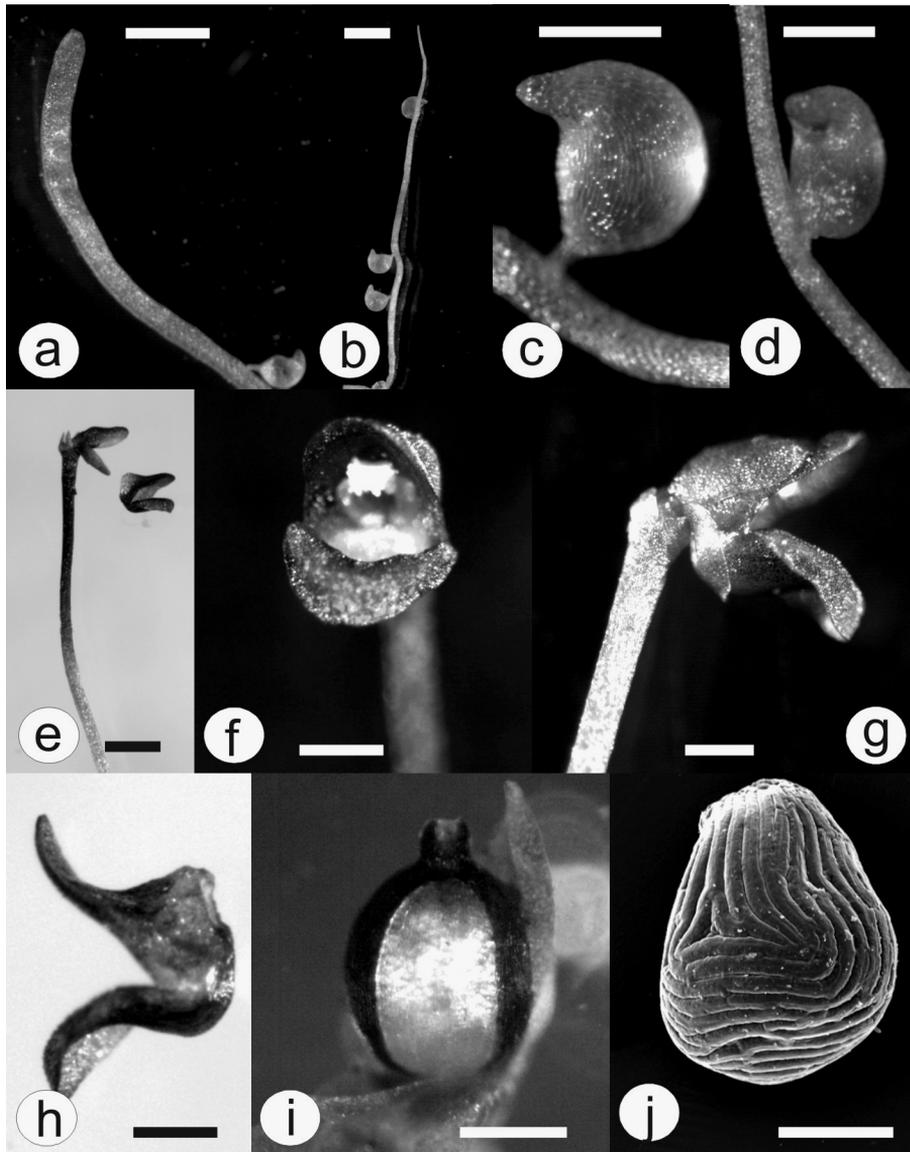
**Holotype:** Northern Territory: 1km north of Girraween Rd - Anglesey Rd corner, 12°30'S 131°06'E, R.K. Harwood 1550, 3 June 2006 (DNA). Isotypes: AD, BRI, CANB, K, MEL, MO, NSW, PERTH.

Small perennial or annual (some NT populations) *herb* forming colonies up to 1 m diameter and 3–8 mm tall above ground. *Rhizoids*, capillary, simple, to 8 mm long, tapering, 0.04–0.1 mm diam. *Stolons* reticulate, capillary, branched or not, c. 0.1 mm diam., internodes 1–3 mm long. *Leaves* solitary, 3.5–15 mm long in total, petiole indistinct, lamina linear, dimorphic, 1-nerved, mostly filiform, terete, apex acicular, rarely oblong and flattened, 0.3–0.4 mm wide, apex acute, sometimes rounded. *Traps* scattered on stolons and rhizoids with up to 6 on lower part of leaf margins, stipe 0.1–0.5 mm long, traps upwards-facing, dimidiate to ovate with a falcate apex, 0.2–0.5 mm long, 0.2–0.3 mm wide, glabrous or with scattered sessile glands; dorsal appendage short, obtuse, glabrous or papillate; lateral appendages and ventral wings absent; trap orifice hyaline or reddish-pink, threshold glands 1-armed, internal glands bifid, arms ellipsoid and ovoid c. 3 times as long as wide. *Inflorescence* erect, solitary, 1–2(rarely 3)-flowered, 6–17 mm long, peduncle terete, glabrous, 0.1–0.3 mm diam., green, red-purple (72B) towards apex, scales absent, with or without raised longitudinal verrucae scattered over the surface which shine silver in sunlight, otherwise glabrous. *Bracts* and bracteoles basifixed, glabrous, red-purple; bracts broadly ovate-deltoid, 0.3–0.5 mm long, apex acute or ± 3-lobed; bracteoles 2, opposite, basifixed, lanceolate or subulate, c. 0.25 mm (Qld) or 0.4–0.5 mm long (NT), c. 0.2 mm wide, apex acute. *Flowers* 1–3. *Calyx* lobes 2, unequal, red-purple (72B); upper lobe ± orbicular, strongly concavo-convex, 0.75–1 mm long and apex truncate (NT) or elliptic, apically ± acute and involute (Qld); lower lobe broadly elliptic, concavo-convex, 0.5–0.75 mm long (NT) or 1–1.2 mm long (Qld), 0.7–0.8 mm wide, apex rounded or emarginate, revolute. *Corolla* red-purple (72B), paler at very base, two lipped, connate at base, 0.7–1.3 mm long; upper lip ovate-oblong, 0.7–1 mm long, apex rounded to retuse (NT) or involute (Qld); lower lip 0.8–1.3 mm long, broadly elliptic, entire, the limb reduced to a narrow reflexed margin c. 0.5 mm long, apex obtuse to rounded, glabrous, without a conspicuous rim, shorter than lower calyx lobe; palate absent (Qld) or conspicuous and red-purple (NT); *Spur* virtually absent. *Stamen* filaments 2, white, supporting white anthers visible within the corolla hood, anthers posterior to the stigma, pollen white, 5–6-colporate, obloid, c. 22 µm long. *Style* red, lingulate, anteriorly stigmatic. *Ovary*, ovoid, unilocular, c. 0.3 mm long, placenta basal, free, globular. *Capsule* globose-ovoid, 0.6–0.8 mm long, 0.6–0.75 mm diam., red-purple (72B) with a paler single ventral, longitudinal, elliptic pore, drying stramineous and enclosed in fruit by persistent calyx lobes, dehiscent (NT) or indehiscent (Qld). *Seeds* numerous, stramineous to honey-brown, broadly ellipsoid to obovoid, sub-angular, or turbinate, 0.125–0.175 mm long, cells elongate, longitudinally striate-swirled, resembling a fingerprint. (Figs 2–4)

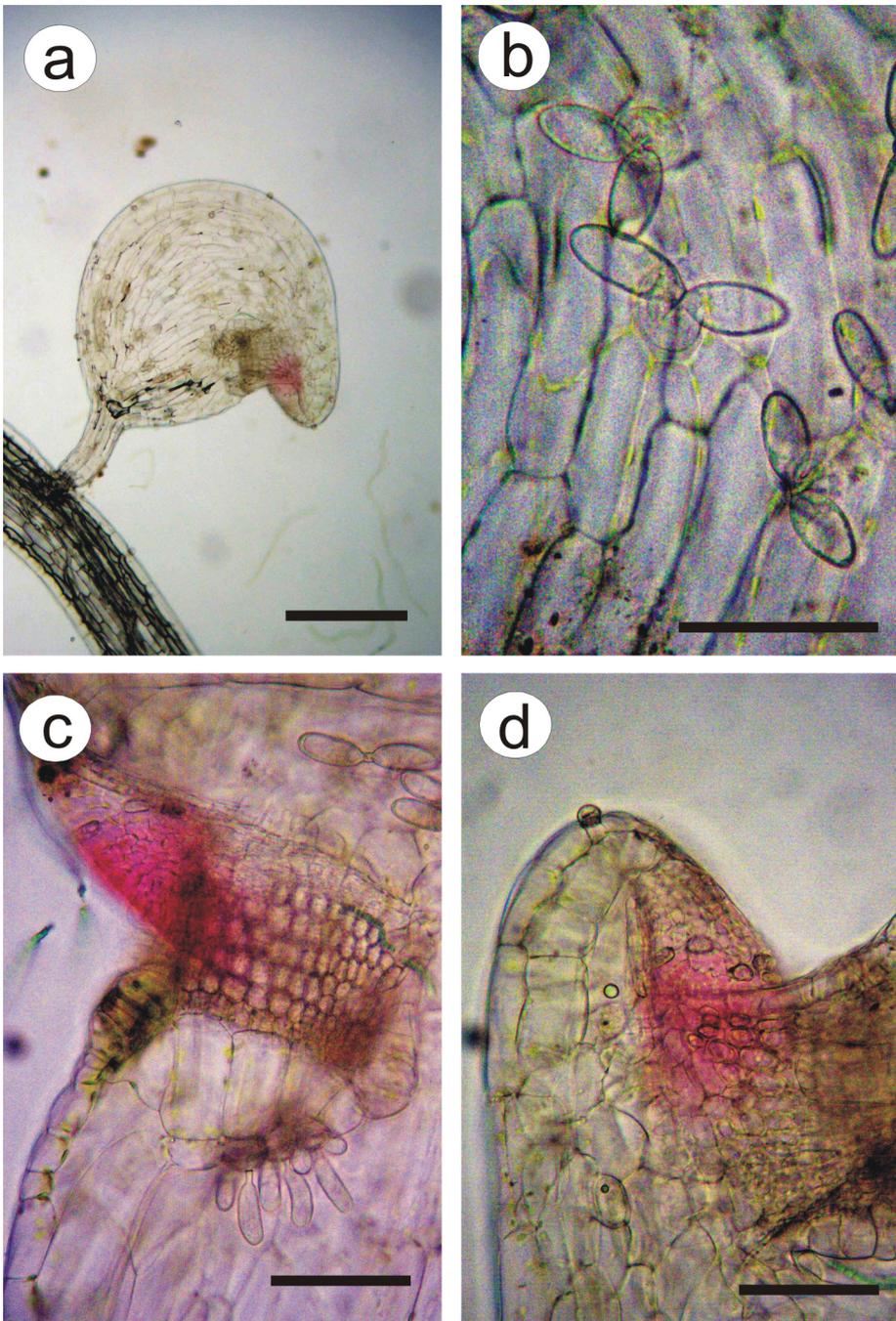
<sup>1</sup>Royal Horticultural Society London. 1966. R.H.S. Colour Chart in association with the Flower Council of Holland. Published by The Royal Horticultural Society LONDON and Flower Council of Holland LEIDEN.



**Fig. 2.** *Utricularia simmonsii*: **a**, plant; **b**, leaf; **c**, corolla; **d**, side view of trap; **e**, front view of trap; **f**, bracteoles; **g**, bract; **h**, seed; Scale bars for **d**, **e** & **h** = 0.5 mm, all other scale bars = 1 mm. Drawn from live, cultivated material, ex Paul Simmons, from Lockhart River, far north Queensland by A. Lowrie 2005. Voucher A. Lowrie 3159 & P. Simmons (BRI, PERTH, MEL. K).



**Fig. 3.** *Utricularia simmonsii*: **a**, leaf and trap; **b**, leaf and traps; **c**, trap, lateral view; **d**, trap; **e**, flowering peduncle; **f**, flower; **g**, flower, lateral view; **h**, corolla, lateral view; **i**, nearly mature capsule (enclosing calyx removed) showing lateral longitudinal pore; **j**, seed. Scale bars for **a**, **b** & **e** = 1, **c**, **d** & **i** = 0.25 mm, **f**–**h** = 0.5 mm, **j** = 50  $\mu$ m. Vouchers **a**–**h**, *Harwood 1550* (DNA); **i**–**j**, *A. Lowrie 3159* & *P. Simmons* (BRI, PERTH, MEL. K).



**Fig. 4.** *Utricularia simmonsii*: **a**, trap; **b**, trap internal bifid glands; **c**, trap orifice and 1-armed threshold glands; **d**, dorsal process of trap showing external glandular trichomes. All to indicated scales. Photographed from live, cultivated material, ex Paul Simmons, from Lockhart River, far north Queensland. Scale bar for a = 100 µm, b–d = 20 µm. Voucher A. Lowrie 3159 & P. Simmons (BRI, PERTH, MEL. K).

**Other specimens examined: Northern Territory:** Howard River Hunting Reserve, 12° 26'S, 131°04'E, 7 Jul 1995, *J.L. Egan* 5133 & *I.D. Cowie* (DNA); 1 km. N of Girraween Rd., 1 km. W of Howard River, 12°30'S, 131°06'E, 17 May 1996, *R.K. Harwood* 145 (DNA); 1km north of Girraween Rd - Anglesey Rd corner, 12°30'S 131°06'E, 3 May 2001, *R.K. Harwood* 1084 (DNA); 1km north of Girraween Rd - Anglesey Rd corner, 12°30'S 131°06'E, 7 May 2002, *I.D. Cowie* 10646 (DNA); 1km north of Girraween Rd - Anglesey Rd corner, 12°30'S 131°06'E, 16 Jun 2006, *R.K. Harwood* 1564 (DNA). **Queensland:** Turtle Creek crossing, Iron Range, c. 7.25 km NW of Lockhart River township, north Queensland, 12°46'S, 143°17'E, *A. Lowrie* 3159 & *P. Simmons*, 28 Oct 2005 (BRI, PERTH, MEL, K); Tozer's Flat, Pascoe River, c. 17.7 km NW of Lockhart River township, north Queensland, 12°43'S, 143°12'E, *A. Lowrie* 3213 & *P. Simmons*, 28 Oct 2005 (BRI, PERTH, MEL, K); Iron Range, near Lockhart River community refuse site, c. 1.2 km NW of Lockhart River township, north Queensland, 12°47'S, 143°20'E, *A. Lowrie* 3214 & *P. Simmons*, 28 Oct 2005 (BRI, PERTH, MEL, K).

**Distribution and ecology:** the species occurs in the NW Northern Territory and on Cape York Peninsula, Queensland (Fig 1). In the Northern Territory it is known from only two localities on sand sheets associated with the Howard River floodplain in the Darwin rural area, where it grows in short hermland with *Bergia pusilla* Benth. (Elatinaceae), *Centrolepis exserta* (R.Br.) Roem. & Schult. (Centrolepidaceae), *Eriocaulon cinereum* R.Br. (Eriocaulaceae), *Trithuria lanterna* D.A.Cooke (Hydatellaceae) and *Utricularia chrysantha* R.Br., on almost pure sand just above the receding water line. These populations occur in seasonally inundated depressions formed in abandoned sand extraction excavations, on the upper margin of a non-estuarine floodplain. The species appears to flower later and perhaps occurs in a seasonally more deeply inundated habitat than many other attached NT *Utricularia* species.

*Utricularia simmonsii* is also known from three locations near the town of Lockhart River (12°47'S 143°21'E), Iron Range on Cape York. There, the species grows in a mixture of fine sand and grey silt on seasonally dry flatlands that are variably waterlogged or covered by very shallow water in the wet season. The areas are drained by shallow seasonal creeks, watersheds, drainage ditches, and rivulets running throughout the topography. The vegetation consists mainly of low growing herbs including many other *Utricularia* species, *Byblis liniflora* Salisb. (Byblidaceae), *Drosera petiolaris* R.Br. ex DC. (Droseraceae), *Lindernia* All. (Linderniaceae) and *Mitrasacme* Labill. (Loganiaceae) species. Scattered low shrubs also occur, as well as abundant orchids and *Nepenthes mirabilis* (Lour.) Druce (Nepenthaceae).

**Phenology:** flowering and fruiting are recorded from May to July.

**Notes:** comparison of specimens from the two regions where they occur reveals that although they are very similar, there are a number of leaf, trap, inflorescence, floral and fruit differences between them (Table 1). This possibly reflects the considerable distance between the populations (although this may in part also reflect under-collection due to the cryptic nature of the species). In particular, the bright pink area associated with the trap mouth (Figs 4c,d) seen in the Qld populations is unusual, or at least not a previously reported feature in the genus, and may serve as a visual attractant to potential prey. Similarly, the fruits in the Qld plants are tardily if at all dehiscent, apparently releasing the seeds only once the fruits have rotted. Nevertheless, given the small number of populations sampled and the need for more collections in the Northern Territory and Gulf of Carpentaria region of Queensland, these morphs are presently being regarded as conspecific pending more information.

**Table 1. Comparison of features differing between the two regions where the new species occurs**

Feature	Northern Territory	Queensland
Traps: position	mainly on leaf bases, up to six per leaf	mainly on rhizome and rhizoids, up to two on leaf bases
Traps: dorsal appendage	glabrous	papillate on margin
Traps: orifice	hyaline	red
Peduncle	without verrucae	with light-catching, hyaline verrucae
Bracts	ovate-deltoid, acute to shortly acuminate	obovate, apically $\pm$ 3-lobed
Calyx lower lobe	0.5–0.75 mm long; 1/2 as long as lower corolla lobe or less	1–1.2 mm long; more than 1/2 as long as lower corolla lobe
Corolla upper lobe	apical margin rounded to retuse	apical margin involute
Palate	obvious, red-purple	absent or virtually so
Capsule and basal pore	dehiscent	indehiscent

*Utricularia simmonsii* is separated from other *Utricularia* spp. by its diminutive stature, peduncle lacking scales, 1–2 (rarely 3)-flowered inflorescence, small, red-purple hood-like flowers without a spur. Other features that characterise the species are the dimidiate, unadorned traps, obloid, 5–6-colporate pollen and a globular placenta attached at its geometric centre.

The species belongs in *Utricularia* subgenus *Utricularia* and shares some features with members of both section *Enskide* and section *Pleiochasia* but fits neither section well. The lack of scales on the peduncle, solitary or paired flowers, and the capsule dehiscing by an elliptic pore (albeit functionally indehiscent in the Queensland plants) suggest affinities to section *Pleiochasia*. This section is distributed across Australia, New Zealand and New Caledonia and includes 25 northern Australian species among them *U. capilliflora* F.Muell., *U. hamiltonii* F.E.Lloyd, *U. holtzei* F.Muell., and *U. rhododactylos* P.Taylor. However, the unadorned traps with a lateral orifice, the obloid, 5–6-colporate pollen and the globular placenta attached at its geometric centre suggest they it is also allied with section *Enskide*, which comprises the two northern taxa *Utricularia chrysantha* and *U. fulva*

Nevertheless, *U. simmonsii* is distinctive by possessing an open, hood-like corolla which clearly displays the anthers and stigma. The unique floral structure, especially the lack of a spur and the open-throated corolla makes it different not only from most other *Utricularia* species, but Lentibulariaceae in general, which are characterised in part by a basally spurred or saccate lower lip. This, combined with other unique shared features such as seed morphology, glandular hair types and position, and trap anatomy which are discussed below in more detail, justifies the erection of a new section to accommodate the species.

**Etymology:** the species is named in honour of Paul Simmons, schoolteacher, botanist, carnivorous plant and ant-plant enthusiast, who discovered the species in Queensland.

**Conservation status:** in the Northern Territory, the species is known from just

two locations near Darwin. Although plants were locally abundant with hundreds of flowering stems per square metre, little is known of the true size and extent of populations. Plants are very cryptic and not easy to see by casual observation, even when flowering. In addition, as discussed further below, it is likely that survey effort directed at other *Utricularia* species is mistimed for detection of this taxon.

The possible threat posed to this species by sand mining is unclear. Curiously, the species is only known from abandoned sand mining scrapes at two localities. Generally, the poorly drained sandy soils in the Darwin area continue to be heavily exploited as a source of fine sand for building and construction (Doyle 2001) and the long term conservation status of the flora they support is of some concern. Field observation suggests that in some areas, sand mining has altered the local drainage to favour species that prefer deeper water and a longer period of inundation. On the available evidence, there is some indication that sand mining can favour this species by providing areas of sandy substrate that stay wet for longer into the dry season. On the other hand, no other populations have been found despite extensive survey work targeted at *Utricularia* species in similar habitat in the Darwin area, including a number of mined areas. However, given the apparent later fertile period of *U. simmonsii* (May-early July) there is some doubt as to whether the timing of this survey effort was appropriate to detection of this species. In addition, areas of similar habitat extend to the east of Darwin to as far as Cobourg Peninsula and Maningrida, including Kakadu National Park. These areas have not been intensively surveyed at an appropriate scale or time of year. Experience with other apparently restricted taxa suggests that the species is very likely to be found elsewhere when suitable habitat is surveyed using an appropriate methodology.

The known populations occur on vacant free hold land which is proposed to become part of a bore field for the extraction of potable ground water for the City of Darwin and on the Howard River Hunting Reserve. In the short term, it appears it is at least offered some protection from clearing for residential or horticultural development, although the likely impacts of any adjacent development on site drainage and water quality are unknown. It is not anticipated that increased extraction of ground water will affect the species, as it is likely more influenced by the seasonal abundance of surface water. The Howard River Hunting Reserve has a history of surface mining for the extraction of sand, but it is not known if further mining is planned. The area is also used for waterfowl hunting in season, and for recreational 4wd driving.

In far north Queensland, *Utricularia simmonsii* is considered locally abundant at its three known locations and currently not under threat. The Tozer's Flat locality is presently protected from development and/or mining as it is situated c. 4 km to the N of Mt Tozer and c. 2.5 km to the W of North Pap and South Pap, well within the boundaries of the Iron Range National Park

Nevertheless, using IUCN (2001) Red list categories and guidelines, this species cannot be considered adequately surveyed and a conservation code of Data Deficient is thus recommended. However, given the uncertainty regarding the impact of further development of the rural area on the only known NT populations of this species, it requires interim protection until further survey is conducted and the species can be reassessed against IUCN criteria.

**Utricularia section *Minutae* Lowrie, Cowie & Conran, sect. nov.**

Herbae minutae. Vesiculae nudaе vel glandulis sessilibus dispersis; appendix dorsalis singula; saetae irretitantes papillatae. Corolla cucullata; calcar deficiens; labium inferum integrum limbo diminuto. Stamina et stylus per corollam inclusus attamen conspicuus. Pollinia obloidea, 5–6-colporata. Ovarium placenta globulari in centro geometrico affixa. Capsula poro ventrali longitudinali instructa. Semina testa longitudinaliter torquato-striata.

Minute herbs. Bladders naked or with scattered sessile glands; with a single dorsal appendage; trapping hairs papillate; threshold glands 1-armed, internal glands bifid, arms ellipsoid and ovoid, c. 3 times as long as wide. Corolla hooded, lacking a nectary spur or a closed throat; lower lip lacking lateral lobes or an expanded pollinator landing apron. Stamens and style fully enclosed by corolla, but clearly visible. Pollen obloid, 5–6-colporate. Placenta globular, attached at its geometric centre. Capsule with a ventral longitudinal pore. Seeds with elongated cells, appearing longitudinally swirled and striated.

**Type species.** *U. simmonsii* Lowrie, Cowie & Conran

The relationships of the section are uncertain, although it bears some similarities in trap structure to the native sect. *Enskide*, as well as to the mainly South American sects. *Benjaminia*, *Stomoisia* and *Stylotheca* in lacking lateral appendages or ventral wings, and in the presence of papillae (Fig. 4d). In addition, although the sampled members of *Benjaminia* and *Stomoisia* were part of the same broader clade in molecular analyses (Jobson & Albert 2002, Jobson et al. 2003, Müller et al. 2004, Müller & Borsch 2005), they did not form a monophyletic lineage. This makes naked bladders with a slight dorsal bulge (Figs 2d, 3c–d, 4a) a paraphyletic character (Jobson & Albert 2002), and thus not necessarily grounds for placing *U. simmonsii* within, or relating it closely to any existing section.

The extreme reduction of the spur is uncommon in the genus. This character is shared only by the African *U. rigida* Benj. and *U. tetraloba* P. Taylor. In these species, the spur region is shallowly saccate whereas in *U. simmonsii* the spur is virtually absent.

Seed and internal trap gland characters are taxonomically important in the genus (Thor 1988, Taylor 1989) and there are also some similarities in seed sculpturing to the above groups, although the fingerprint-like pattern in sect. *Minutae* differs from all of the others (Figs 2h, 3j). Similarly, the internal trap glands most closely resemble the pattern seen in sect. *Stomoisia*, with ovoid 1-armed threshold cells (Fig. 4c) and the remainder bifid (Fig. 4b). Nevertheless, there are again too many floral and other differences between sects *Minutae* and *Stomoisia* to warrant its inclusion in the latter.

The presence and location of stipitate glandular hairs can be taxonomically important (Taylor 1989), although the significance of the structures is little understood. In *U. simmonsii* there are scattered sessile glands on the outside of the traps (Fig. 4d). The peduncle is  $\pm$  glabrous, with raised longitudinal verrucae scattered over the surface which shine silver in sunlight.

Pollen morphology is generally consistent within sections in *Utricularia* and regarded as having considerable taxonomic importance (Taylor 1989). sect. *Minutae* has 5–6-colporate pollen, similar to sect. *Enskinde* (4–7 colporate), whereas sect. *Pleiochasia* has species with 3–4-colporate grains. Nevertheless, lower aperture numbers (3–8) are

characteristic of the less derived members of the genus and occur in at least 11 sections making up the basal clades U1–4 of Jobson et al. (2003), suggesting that the feature is plesiomorphic and not strongly indicative of affinity.

Fruit dehiscence is another taxonomically important characteristic in Lentibulariaceae with 17 different patterns recognised, many of which have diagnostic potential at the sectional level (Taylor 1989). sect. *Minutae* has fruits with a single, ventral longitudinal elliptic pore (Taylor's Type E), but although the sutures are prominent in near-mature fruits, once the fruit dries they effectively disappear and the fruits remain enclosed by the persistent sepals and are indehiscent (at least in the Qld populations). Taylor noted that Type E fruits were almost universal in sect. *Pleiochasia*, but also found that they were the most common type, occurring in a wide range of *Utricularia* species. Nevertheless, this feature is apparently plesiomorphic within the genus (Jobson et al. 2003), making it of limited phylogenetic value. Similarly, sutureless fruits are known in some members of sects. *Pleiochasia* and *Utricularia*, and as Taylor (1989) observed, even some species with apparent suture lines may be functionally indehiscent. In contrast, species in sect. *Enskinde* dehisce by a single ventral pandurate pore, a unique feature in the genus which differentiates them from sect. *Minutae*, despite their trap and pollen similarities.

Overall, sect. *Minutae* seems to be closer on morphology to members of subgen. *Bivalvia sensu* Müller and Borsch (2005), although this requires molecular analysis to confirm, as well as wider comparisons with other taxa, especially the under-sampled northern Australian members of the family. Nevertheless, because sect. *Minutae* shows intermediacy in characters between several different sections in the genus, its precise affinities are uncertain, pending the results of ongoing morphological and molecular studies.

### Key to the *Utricularia* species in tropical Australia

The key is derived from Taylor (1989) and the species are numbered according to his treatment to allow reference to descriptions there. Except where indicated, taxa occur in all regions (Western Australia, Northern Territory and Queensland). Species endemic to a particular state are indicated by an 'e' after the state abbreviation.

- 1 Plants free-floating or suspended in water; leaves usually much divided; bracteoles usually absent ..... 2
- 1\* Plants attached to substrate; leaves entire or 1–2(3)-divided; bracteoles usually present ..... 7
- 2 Inflorescence stem with a whorl of ellipsoid floats above middle ..... 3
- 2\* Inflorescence stem without a whorl of floats or with narrowly fusiform floats at, or near the base ..... 4
- 3 Floats shortly stipitate; calyx smaller than the capsule; seeds lenticular..... 193 *U. muelleri*
- 3\* Floats sessile; calyx larger than capsule; seeds prismatic, winged ..... 192 *U. stellaris*
- 4 Corolla pink; spur long and slender; bracts ovate ..... 23 *U. tubulata*
- 4\* Corolla yellow; spur conical to narrowly conical; bracts broadly ovate to orbicular ..... 5
- 5 Ultimate leaf segments 2–8; upper corolla lip larger than lower ..... 179 *U. gibba*
- 5\* Ultimate leaf segments 20–80; upper corolla lip smaller than lower ..... 6

- 6 Primary leaf divisions more than 2; scales absent; corolla pubescent outside ..... 190 *U. aurea*
- 6\* Primary leaf divisions 2; scales present on peduncle; corolla glabrous outside ..... 184 *U. australis*
- 7 Peduncle twining ..... 8
- 7\* Peduncle erect, not twining ..... 10
- 8 Corolla pale mauve, 3–4 mm long (NT, Qld) ..... 115 *U. foveolata*
- 8\* Corolla yellow, c. 5–15 mm long ..... 9
- 9 Corolla about 5 mm long, pale yellow (NT) ..... 108 *U. circumvoluta*
- 9\* Corolla 10–15 mm long, bright yellow (NT) ..... 84 *U. involvens*
- 10 Corolla with 2 vertical filiform lobes ..... 11
- 10\* Corolla lacking 2 vertical filiform lobes ..... 14
- 11 Capillary lobes arising laterally from the corolla lower lip base; flowers solitary ..... 12
- 11\* Capillary lobes arising from the corolla upper lip apex; flowers 1 or 3–5 ..... 13
- 12 Corolla lower lip reduced to 3 minute teeth; apex of spur rounded (WA e) ..... 36 *U. antennifera*
- 12\* Corolla lower lip a well developed triangular lobe 1/3 or more times length of spur, lateral lobes minute or absent; spur apex emarginate (WA, NT) ..... 35 *U. dunstaniae*
- 13 Corolla lower lip 5-lobed; flowers solitary (NT e) ..... 33 *U. capilliflora*
- 13\* Corolla lower lip 3-lobed; inflorescence 2–5-flowered (WA, NT) ..... 34 *U. dunlopji*
- 14 Scales present on peduncle ..... 15
- 14\* Scales absent ..... 26
- 15 Scales and bracts basifixed, bracteoles present ..... 16
- 15\* Scales and bracts medifixed (or nearly so), bracteoles present or absent ..... 22
- 16 Corolla white or mauve ..... 17
- 16\* Corolla yellow ..... 19
- 17 Corolla lower lip shallowly 3-lobed ..... 37 *U. minutissima*<sup>#</sup>
- 17\* Corolla lower lip entire, rounded or retuse ..... 18
- 18 Bracts more or less equal in width to bracteoles; spur conical, apex shortly and acutely bidentate (Qld, southern Aust.) ..... 40 *U. lateriflora*
- 18\* Bracts much wider than bracteoles; spur narrowly conical, apex acute ..... 92 *U. uliginosa*
- 19 Corolla spotted with dark red; upper lip with 2 broad lobes (NT e) ..... 81 *U. fulva*
- 19\* Corolla unspotted, but nerves may be red or brown; upper lip entire or emarginate ..... 20
- 20 Corolla lower lip 4-lobed; bracts cordate at base ..... 80 *U. chrysantha*
- 20\* Corolla lower lip entire or shallowly 2-lobed; bracts not cordate ..... 21
- 21 Corolla 6–10 mm long, upper lip narrower than the calyx; inflorescence 3–30 cm tall ..... 82 *U. bifida*
- 21\* Corolla 10–15 mm long, upper lip wider than the calyx; inflorescence 25–55 cm tall (NT) ..... 83 *U. odorata*
- 22 Corolla pale yellow; scales often ciliolate (NT) ..... 165 *U. subulata*
- 22\* Corolla white or blue to purple; scales glabrous ..... 23
- 23 Bracteoles present; corolla lower lip entire or obscurely lobed; leaves entire ..... 43 *U. caerulea*
- 23\* Bracteoles absent; corolla lower lip with 2 well developed lobes; leaves divided ..... 24

- 24 Corolla 10–25 mm long; spur 7–15 mm long; bracts 3–4 mm long (WA, NT) ..... 174 *U. leptoplectra*
- 24\* Corolla 4–10 mm long; spur 3–10 mm long; bracts 2.5 mm long or less ..... 25
- 25 Corolla dark blue-violet, 7–10 mm long; spur about as long as lower lip; leaf segments opposite (southern Qld) ..... 175 *U. biloba*
- 25\* Corolla white or pale, 3–6 mm long; spur longer than lower lip; leaf segments alternate ..... 173 *U. limosa*
- 26 Corolla lower lip 5-lobed ..... 27
- 26\* Corolla lower lip entire, crenate or 2–4-lobed ..... 30
- 27 Corolla white ..... 28
- 27\* Corolla pink or mauve ..... 29
- 28 Corolla 4–8 mm wide (NT e) ..... 30 *U. holtzei*
- 28\* Corolla about 2 mm wide ..... 29 *U. quinquedentata*
- 29 Corolla upper lip shorter than the upper calyx lobe; base of lower lip without ridges (NT e) ..... 32 *U. cheiranthos*
- 29\* Corolla upper lip longer than the upper calyx lobe; base of lower lip with 4 rounded ridges (NT e) ..... 31 *U. rhododactylos*
- 30 Corolla 4 mm long or less ..... 31
- 30\* Corolla 6 mm long or more ..... 32
- 31 Corolla c. 3 mm long, white to yellow, spur well developed and slightly longer than lower lip (Qld e) ..... 28 *U. albiflora*
- 31\* Corolla 1.5 mm long or less, dark pink to red, spur greatly reduced, apparently absent (NT, Qld) ..... *U. simmonsii*
- 32 Bracts and bracteoles medifixed (or nearly so), connate below the point of attachment and forming a tube around peduncle ..... 33
- 32\* Bracts and bracteoles medifixed or basifixed, when medifixed, free below the point of attachment and not forming a tube around peduncle ..... 34
- 33 Corolla lower lip with 3 equal, narrow oblong-obovate lobes, white to pale mauve (WA e) ..... 16 *U. georgei*
- 33\* Corolla lower lip entire or obscurely 3-crenate, mauve (WA, NT) ..... 15 *U. kimberleyensis*
- 34 Peduncle hairy, at least at base ..... 35
- 34\* Peduncle glabrous, at most minutely papillose at base ..... 38
- 35 Bracts and bracteoles ciliate; bracts basifixed ..... 24 *U. lasiocaulis*
- 35\* Bracts and bracteoles not ciliate; bracts basifixed or medifixed ..... 36
- 36 Corolla pale mauve, lower lip of 3 long oblong lobes; bracts medifixed (NT e) ..... 25 *U. kamienskii*
- 36\* Corolla mauve to purple, lower lip of 3 short rounded lobes; bracts basifixed or medifixed ..... 37
- 37 Flowers usually solitary; upper lip constricted near base, upper part elliptic, apex emarginate (WA e) ..... 26 *U. kenneallyi*
- 37\* Flowers 2–4, rarely 1; upper lip constricted in centre, upper part oblong, apex more or less deeply bifid (WA, NT) ..... 27 *U. leptorhyncha*
- 38 Corolla lower lip distinctly 3-lobed ..... 39
- 38\* Corolla lower lip entire or obscurely 2–4-lobed ..... 40
- 39 Lobes of lower lip as long as wide (WA<sup>‡</sup>, NT) ..... 19 *U. arnhemica*
- 39\* Lobes of lower lip 3 times longer than wide (WA e) ..... 20 *U. tridactyla*

- 40 Corolla spur not widely divergent from lower lip, erect, broadly obloid at base tapering to a dorsally flattened, narrow apex (WA<sup>†</sup>, NT) ..... 21 *U. singeriana*
- 40\* Corolla spur diverging widely from lower lip, usually deflexed and narrow, apex acute to obtuse ..... 41
- 41 Spur broadly conical, obtuse, distinctly longer than lower lip; flowers 1(–3) (WA, NT<sup>^</sup>) ..... 22 *U. fistulosa*
- 41\* Spur narrowly conical, cylindrical or cylindrical-subulate, straight or tapering gradually, equal to or shorter than lower lip; flowers 1–9 ..... 42
- 42 Flowers 2–9, rarely 1; bracts often with the base more or less swollen, sometimes free .. 43
- 42\* Flowers always solitary; bracts membranous to herbaceous ..... 44
- 43 Palate with 2–3 prominent ridges; apex of upper lip rounded to emarginate; leaf apex rounded to acute (Qld, southern Aust.) ..... 10 *U. dichotoma*
- 43\* Palate ridges not prominent; apex of upper lip shortly bilobed to emarginate; leaf apex subulate (NT e) ..... 18 *U. triflora*
- 44 Corolla 6–12 mm long, usually mauve, apex of upper lip divided into two deltoid lobes, lower lip 4-angled (WA<sup>o</sup>, NT) ..... 17 *U. hamiltonii*
- 44\* Corolla 15–20 mm long, white or very pale violet, apex of upper lip truncate to emarginate, lower lip transversely elliptic (Qld e) ..... 11. *U. terrae-reginae*

<sup>#</sup>There is also another very small flowered (c. 2 mm), apparently new taxon known from further north on Cape York (J. Clarkson pers. comm.) with purple, spurred, palated flowers similar to a tiny version of the widespread *U. minutissima* Vahl., but which requires further study to determine its identity and affinities.

<sup>†</sup> There is some doubt that this name has been applied correctly to WA specimens and the material is currently under study.

<sup>\*</sup> This taxon is now recorded for WA (R. Barrett pers. comm.; FloraBase 2007).

<sup>^</sup> *Utricularia fistulosa* has recently been recorded (K.G.Brennan 7275) from Macadam Range, in NT.

<sup>o</sup>In the Kimberley, an all-white-flowered form of *U. hamiltonii* has recently been discovered. The typical mauve-flowered *U. hamiltonii* common in the Northern Territory was not found at the Kimberley location (R. Barrett pers. comm.).

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