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A new species of *Tetragonia* (Aizoaceae) from arid Australia

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Abstract

Gray, M. (Australian National Herbarium, Centre for Plant Biodiversity Research, CSIRO, GPO Box 1600, Canberra, ACT 2601 Australia) 1997. A new species of Tetragonia *(Aizoaceae) from arid Australia.* Telopea *7(2):119–127.* **Tetragonia moorei**, previously included in the widespread *T. tetragonioides* (Pallas) Kuntze is described, and the history of both species as potential stock poisons, medicinal plants and human food is briefly discussed.

Introduction

The most recent general treatment of *Tetragonia* in Australia is that of Prescott (1984). Since then the rare and extremely localised *T. coronata* has been described from Western Australia (Rye & Trudgen 1996) and the introduced *T. microptera* Fenzl from southern Africa has been recorded for New South Wales (Jacobs & Highet 1990). The description of the following species brings the number of species in Australia to 11, four of which have been introduced from southern Africa.

Tetragonia moorei *M. Gray*, **sp. nov.**

T. tetragonioidi (Pallas) Kuntze affinis, a qua praecipue differt projecturis fructus unguiculatis et incurvatis vel interdum erectis, segmentis perianthii in fructu non accrescentibus et apicem super fructus nunquam conspicue projectis, staminibus 4–8, et floribus in axillis semper solitariis.

Type: South Australia: Lake Eyre Region: sand dunes and swales just SE of Less Hill, c. 25 km S of Stuart Creek H.S., 30°55'S, 137°04'E, dominant species *Acacia* sp. and *Atriplex spongiosa, K.Chorney (Czornij) 1161*, 7 Oct 1978; holo AD (AD 97342259); iso CANB, NSW.

[*T. tetragonioides* p.p. auct. austral. non (Pallas) Kuntze: Bentham, *Fl. Austral*. 3: 325 (1867) (as *T. expansa*); Toelken, H.R. in Jessop, J.P. (ed.), *Fl. Central Australia:* 39, fig. 60B (1981); Jacobs, S.W.L. in Morley, B.D. and Toelken, H.R. (eds), *Flowering Plants in Australia*: fig. 38 e,f (1983); Prescott, A. in George, A.S. (ed.), *Fl. of Australia* 4: 42–3, fig. 11f (1984); Jessop, J.P. in Jessop, J.P. and Toelken, H.R. (eds), *Fl. South Australia* edn 4, 1: 205 (1986).]

Succulent papillate annual from a slender taproot, basicauline fruits often present; stems erect, prostrate or decumbent and trailing to 50 cm or more long, the young shoots pubescent; leaves usually narrowly to broadly ovate, elliptic or rhombic, ± gradually narrowed to the petiole (occasionally triangular-ovate and ± abruptly contracted to a cuneate base which narrows to the petiole in luxuriant specimens); flowers greenish yellow, solitary in the axils; perianth segments 4, distinct, c. 1–2 mm long, pubescent on the outside; stamens 4–8, the filaments 0.5–0.8(–1) mm long, the anthers c. 0.4–0.5 mm long; styles (5–)8–13, c. 0.5–1 mm long; ovules as many as styles; fruit c. 6–14 x 6–10(–14) mm, broadly to transversely ovate or elliptic (rarely obovate or transversely oblong) in outline, and usually elliptic or oblong in T.S., rounded at the base or truncate with the sides ± expanded and projecting below with the pedicel inserted in a basal groove or depression, variably ribbed on the sides, usually with two large lateral and 2–6(–10) smaller ± incurved claw-like projections, or the projections subequal or occasionally erect, the persistent perianth segments not or only shortly fused at the base, incurved and ± inconspicuous at the base of the projections. (Fig. 1).

Distribution: arid and semi-arid areas of Queensland, New South Wales, Victoria, South Australia and Western Australia (Fig. 2). The species will very likely be found in the Northern Territory portion of the Simpson Desert.

Habitat: found in a variety of habitats eg. sand dunes and swales, and on both light- and heavy-textured soils from red sands to grey cracking clays, particularly in areas subject to periodic inundation e.g. floodplains, creek and stream banks, gilgais, claypans etc.

Selected specimens examined: Queensland: Blackall, fairly common on sand ridges near town, *Everist 1347*, 29 Aug 1935 (BRI); c. 55 miles [88 km] WNW of Birdsville, 25°35'S, 138°35'E, *Boyland 301*, 26 Sep 1966 (BRI); South Galway, *Everist 7428*, 2 Aug 1963 (BRI); Warrego R at Cunnamulla, *Briggs 1855*, 27 July 1968 (NSW).

New South Wales: 1.5km E Gumhole Tank, 35 km NW Tibooburra, 29°17'S, 141°43'E, *Pickard s.n.*, 24 July 1973 (NSW 148771); near Goonery Bore, 65 miles E of Wanaaring, *Moore 5782*, 18 Apr 1971

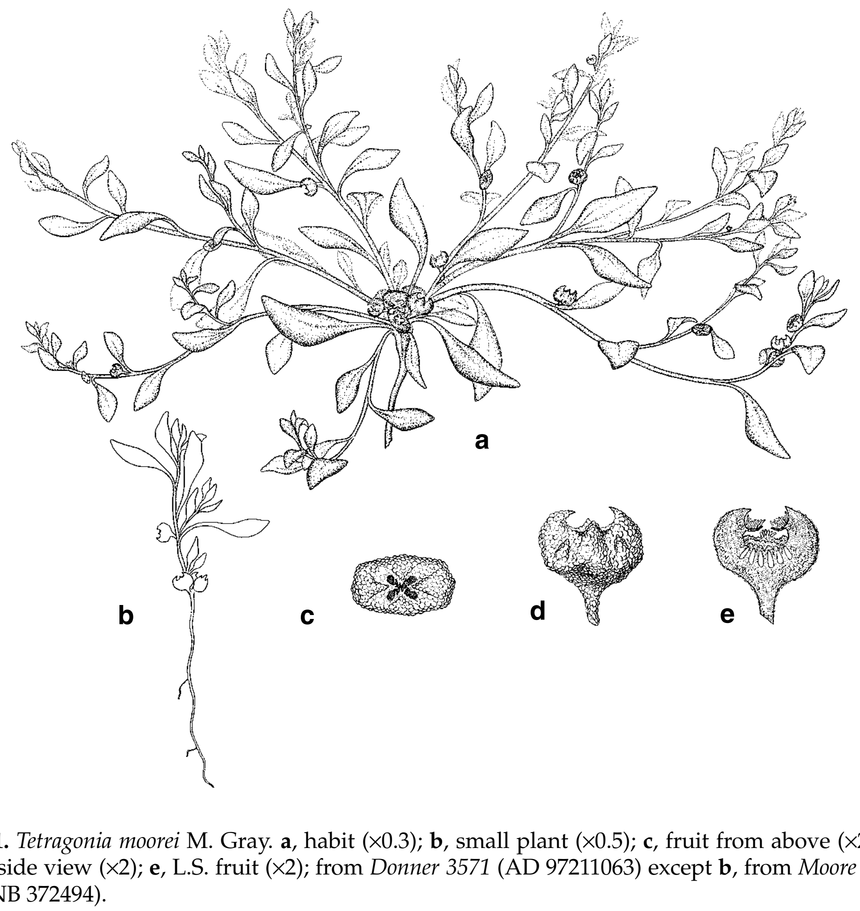

Fig. 1. *Tetragonia moorei* M. Gray. **a**, habit (×0.3); **b**, small plant (×0.5); **c**, fruit from above (×2); **d**, fruit side view (×2); **e**, L.S. fruit (×2); from *Donner 3571* (AD 97211063) except **b**, from *Moore 8532* (CANB 372494).

(CANB); 'Mulya' about 40km SE of Louth, 30°46'S, 145°17'E, *Moore 8008*, 24 Sep 1978 (CANB); 35miles NW of Cobar, *Moore 4260*, 26 Sep 1966 (CANB); Koonenberry Gap, 30°30'S, 142°18'E, *De Nardi 862*, 29 Sep 1971 (NSW); 90km N on Tilpa road from Cobar–Wilcannia road, *Cunningham & Milthorpe 898*, 12 Aug 1973 (NSW); Fowlers Gap near Broken Hill, 31°05'S, 141°40'E, *Jacobs 2107*, 5 Oct 1975 (NSW); near Darling R. 16 km NNE of Wentworth and 2km S of Tapio Station, 33°58'S, 141°57'E, *Muir 5849*, 30 Aug 1978 (MEL).

Victoria: 9 km SSE of Robinvale PO., Mallee Study Area, *Beauglehole 56191*, 5 May 1977 (MEL); Hattah Lakes National Park, E side of Lake Hattah, *Beauglehole 19877*, 11 Sep 1960 (MEL); Wimmera, *Eckert s.n.*, 1892 (MEL 99845); Lost Lake, Wyperfeld National Park, apparently rare, *Beauglehole & Finck, ACB 29427*, 10 Nov 1968 (MEL).

South Australia: c. 35 km SW of Cowarie Homestead on Warburton R., *Chalmers* & *de S. Disney s.n.*, 16 June 1967 (AD 96951050); Simpson Desert, Christmas Water, c. 32 km N of North Lake Eyre, *Ashton s.n.*, Aug–Sept 1961 (AD 96218094); c. 5 km S of Patchawara Ck., 27°22'S, 140°40'E, *Weber 4681*, 29 Aug 1975 (AD); c. 11km N of Mungeranie Homestead, c. 190 km NNE of Marree, *Lothian & Francis 335*, 24 Aug 1960 (AD); near Glenmanyie Bore, c. 90 km NE of Frome Downs Homestead, *Donner 3571*, 28 July 1971 (AD); Strzelecki Track, c. 165 km NW of Murnpeowie Station, at Tinga-Tingana Station crossing, c. 100 km NE of Leigh Ck., *Kuchel 2511*, 17 Aug 1968 (AD).

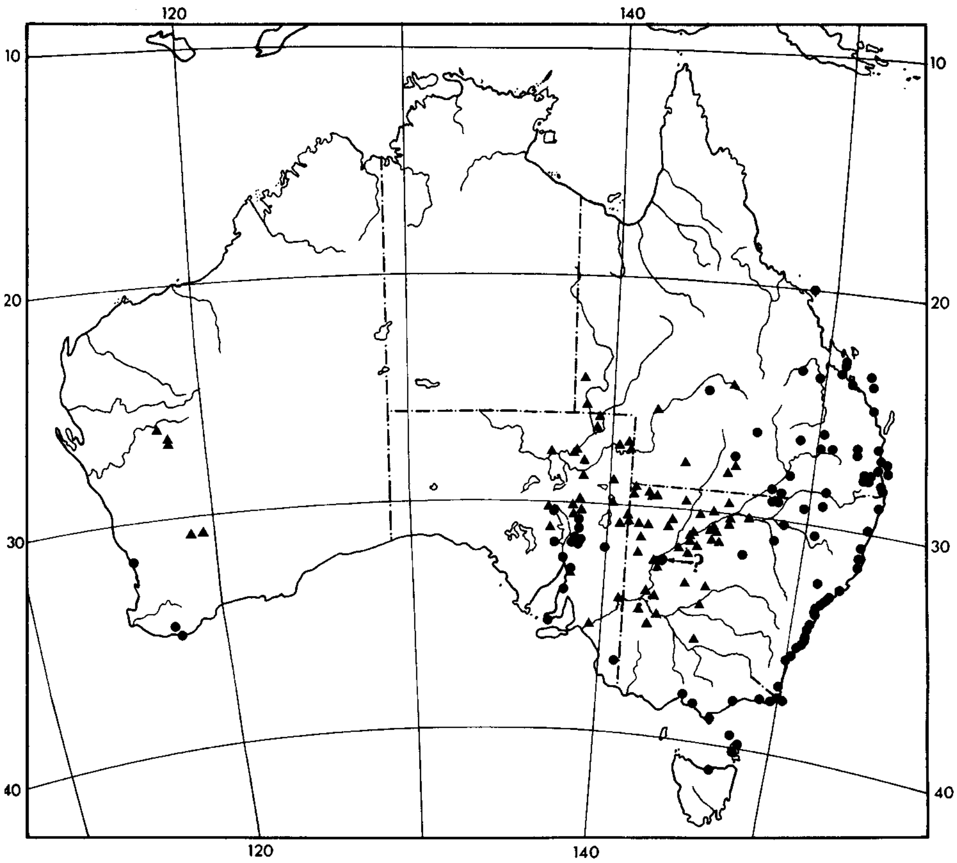

Fig. 2. Distribution of *T. moorei* ⊠, and of *T. tetragonioides* ⊠ in mainland Australia and Tasmania.

Western Australia: Murdabool Hill, Belele Station, *Cranfield 5921*, 26 Aug 1986 (PERTH); Donkey Well, Yoothapina Station, 26°35'S, 118°19'E, *Cranfield 5558*, 9 Aug 1986 (PERTH); Meekatharra, *Stuchey s.n.*, Aug–Sep 1926 (AD 97203049); Nannine, between Mt Magnet and Meekatharra, *W.V. Fitzgerald s.n.*, Sep 1903 (PERTH); boundary Ennuin(sic) (=Eeuin?) Station along Mt. Jackson road, *Cranfield & Spencer 7736*, 5 Sep 1989 (P ERTH); Glenn Rhynn Rocks, c. 24km NNE of Koolyanobbing, *Newbey 9072*, 24 Sep 1981 (PERTH).

Etymology: named after my colleague C.W.E. Moore who recognised the distinctiveness of this species (Moore 1986) and whose ecological studies and abundant collections have enriched the Australian National Herbarium.

Notes: one of the specimens quoted by Bentham ('in the interior at the camp at Meninville (*sic*), *Victorian Expedition*') is probably MEL 99856, labelled 'Camp at Menindee, Octob. 19, 1860, V.E.Exped.' The specimen is initialled 'B' on the inturned top left-hand corner, indicating that it had been seen by Bentham, and was probably collected by Dr H. Beckler who was the physician and botanist on the Victoria Exploring Expedition, more commonly known as the 'Burke and Wills Expedition'. The botanical results of this journey have been recorded in detail by Willis (1962). This specimen consists of two fragments, the left hand one of which is *T. tetragonioides* and the right hand one *T. moorei*. This locality is rather a 'wide' for *T. tetragonioides* (Fig. 2) and the two fragments do have a different aspect. It is possible that the specimens could have been mixed in the folder before mounting; however, if the species was indeed collected at this locality, the seed could have been brought down the Darling River in flood.

T. moorei may be distinguished from *T. tetragonioides* by the following key:

1. Projections of the fruit claw-like and incurved or sometimes erect (if the projections reduced then the fruit ± elliptic or oblong in T.S.); persistent perianth segments in fruit not or only shortly fused at the base and always incurved and inconspicuous; leaves usually narrowly to broadly ovate, elliptic or rhombic and gradually narrowed to the petiole (occasionally as in *T. tetragonioides* in well-grown specimens); flowers solitary in the axils; stamens 4–8. .... **T. moorei**

1* Projections of the fruit horn-like and ± divergent at least at the base (if the projections reduced or absent then the fruit ± rhombic to broadly rhombic to circular in T.S.); persistent perianth segments in fruit often accrescent, yellow on the inside, ± fused at the base and ± conspicuously projecting above the fruit apex, or as in *T. moorei*; leaves usually triangular-ovate, ± abruptly narrowed to a cuneate base which narrows to the petiole (occasionally as in *T. moorei* in depauperate specimens); flowers 1–2 in the axils; stamens (4–)8–22. .... **T. tetragonioides**

There has been some confusion with regard to the spelling of the specific epithet of *T. tetragonioides.* Some authors, e.g. Jacobs (1983), Prescott (1984), Jacobs & Highet (1990), Taylor (1994) adopt the original spelling of Pallas (1781), i.e. *Demidovia tetragonoides.*

It seems reasonable to assume, as does Green (1994) and many others, that Pallas meant the epithet to indicate 'like *Tetragonia*' since he mentions in the protologue that he received the original seeds under the name of *Tetragonia cornuta.*

Since Pallas cited the genus *Tetragonia* and spelled it correctly, the incorrect epithet formation '*tetragonoides*' should be treated as an orthographic error that is to be corrected under Article 60 of the International Code of Botanical Nomenclature (Tokyo Code 1994).

Tetragonia is derived from the Greek 'tetra' (four) and 'gonia' (angle), referring to the shape of the fruits. Stearn (1992 : 260b) points out that in Greek adjectival compound construction the 'i', as in 'gonia', is not to be elided even before another vowel, e.g. in the suffix '-oides'.

Kuntze (1891), when making the original combination in *Tetragonia,* partially made the required correction; however, he incorrectly used the suffix '-odes', i.e. *T. tetragoniodes.*

Since the original spelling is 'tetragonoides', restitution of the 'i' logically results in the corrected spelling *'tetragonioides'* which has been adopted by many authors and is used throughout this paper.

T. tetragonioides sometimes has accessory flowers or leaves arising from the surface or projections of the fruit (Prakash 1967); however, this feature has not been observed in any of the specimens of *T. moorei* so far examined. The anther filaments of *T. tetragonioides* tend to be longer than those of *T. moorei*, i.e. (0.5–)1–2 mm, and are often swollen and micropapillate towards the base. Basicauline fruit, found near the base of the stem (Fig. 1) and the result of flowering in the rosette stage, are a common feature of *T. moorei* but are uncommon in *T. tetragonioides.*

The fruits of *T. tetragonioides*, which are rather variable throughout its total range, show particular variation in Australia. For example the common littoral and subcoastal form usually has the persistent perianth segments of the fruit accrescent, erect, fused at the base and more or less conspicuously projecting above the apex of the fruit. This corresponds to the common form found elsewhere throughout its range in the Pacific region, and is illustrated in Green (1994, fig. 39B). However, some specimens, particularly from the more arid parts of its range in Australia, have the segments incurved, relatively inconspicuous and only shortly fused at the base, approaching the state found in *T. moorei*. This tendency is particularly evident for example, in the area between Port Augusta, Lake Torrens and the Flinders Ranges in South Australia, where some specimens appear to show morphological convergence in other characters as well. This suggests that, although the two species are well separated both morphologically and geographically throughout most of their range, some introgression may have occurred where their ranges overlap, and this area in South Australia would be particularly favourable in this regard since the two species have probably co-existed here for a considerable period of time. Specimens from this area can be separated when the fruit projections are developed; however, occasional populations have the projections rudimentary or absent (e.g. in specimens of *T. inermis* F. Muell., a synonym of *T. tetragonioides*), and a combination of other characters may be required to distinguish them.

T. tetragonioides is a widespread littoral and estuarine species of the Pacific region from South America to Japan and south-east China, Australia (including Norfolk and Lord Howe Islands), New Zealand, the Kermadec Islands, New Caledonia, Hawaii and other Pacific islands. In South America it is found naturally on both the south-eastern and south-western coasts from central Chile and Uruguay southward to about 45°S (Taylor 1994), and is also widely naturalised in temperate and subtropical parts of the world as an escape from cultivation, e.g. along the west coast of the USA from California to as far north as Oregon. The fruits are dispersed by water and can remain viable for more than a month in salt water (Taylor 1994). Its distribution in mainland Australia and Tasmania, plotted from herbarium specimens, is shown in Fig. 2.

Although typically littoral and estuarine throughout most of its natural range, it is also found in salty soils in some subcoastal and inland areas in Australia; for example, it is commonly found after rains in burned, cleared or drought-affected parts of the Brigalow belt of northern NSW and southern and central Queensland (Everist 1981). Examination of herbarium specimens also confirms that *T. tetragonioides* s.str. is the plant reported by Kleinschmidt and Johnson (1977) as being a serious weed in wheat on the Darling Downs in Queensland in some years, and a specimen from the Leichhardt District (Wandoan district, *Philp s.n.,* 16 Sep 1964 (BRI 084952, MEL, CANB)) has the following information: 'weed in cultivation … causing serious trouble in wheat crop almost ready for harvest. Wheat is stunted due to dry conditions early in season and *Tetragonia* is vigorous and succulent following rain in September.'

The high levels of soluble oxalates reported (under *T. expansa*) by Mathams and Sutherland (1952) were from plants collected at Goondiwindi in Queensland and therefore probably belong to *T. tetragonioides* since *T. moorei* has not been found as far east as this (Fig. 2). These levels are sufficiently high to cause poisoning in stock, especially if young green plants are eaten (Everist 1981, McBarron 1977); however, Everist points out that 'livestock rarely eat this plant when it is green and succulent, preferring to leave it until the stems and leaves are dry and presumably low in oxalate'. Ross in Stanley & Ross (1983) also states that this species 'contains oxalates in the green state at potentially poisonous levels'. *T. tetragonioides* is also reported to contain alkaloids and significant amounts of saponin (Hurst 1942) and nitrates (McBarron 1972), the latter especially high in the young seedling stages (McBarron 1977).

The deaths of sheep at White Cliffs and Broken Hill associated with the ingestion of *Tetragonia* containing high levels of oxalate (expressed as 16.1% and 14.8% calcium oxalate respectively) was reported by McBarron (1978, 1983). The suspect plants were probably *T. moorei* (Fig. 2) not *T. tetragonioides,* which he chose to illustrate but which occurs only in the north-easterly part of the area designated in his 1978 publication.

Oxalate in both *T. tetragonioides* and *T. moorei* is mostly soluble, mainly as potassium and/or sodium oxalate (P.W. Michael pers. comm.) and as such, certainly has the propensity to be toxic to animals and humans (Sanz & Reig 1992).

Similarly, the following remarks under *T. tetragonioides* in Cunningham et al. (1981), except for the north-eastern part of the area covered in their book, no doubt refer mainly to *T. moorei* (Fig. 2). These authors, after discussing the forage and toxicological status of these plants, state that 'in the normal grazing situation however, sheep grazing pastures containing a high proportion of the plant will suffer no more than varying degrees of scouring; the risk of incurring more serious consequences increases when hungry animals are allowed access to lush stands'.

A specimen of *T. moorei,* obviously collected in the dry state (Urisino-Thurloo Downs N.S.W., *Boorman s.n.*, Nov 1912 (NSW 148779)), has the note: 'very common in the interior and much relished by stock'; however, a rather luxuriant specimen (Grassmere Station, Broken Hill, *Andrews s.n.*, 25 July 1968 (NSW 178855)) notes: 'suspected of producing hypocalcaemia.'

As reported by Maiden (1889), Gilbert (1966), Cribb & Cribb (1976) and Low (1989), *T. tetragonioides* (sometimes under *T. expansa*) was among the first Australian plants used as food by Europeans from Captain Cook and Sir Joseph Banks onwards, being boiled and eaten like spinach, and it is possible that at least some of the inland localities of this species (Fig. 2) may be due originally to introductions from the coast for use as a vegetable. Cook also made use of the plant as an antiscorbutic both in New Zealand and Australia.

Low (1989) further indicates that *T. tetragonioides* became the first Australian food plant to be cultivated overseas, the seeds having been taken to Kew Gardens by Banks in 1771. Seeds were later distributed from Kew to Europe and North America, and plants grown at Malmaison in France were etched by Redouté in 1803 (Cooper & Cambie 1991). These latter authors also report that *T. tetragonioides* contains 'betain, alkaloids, saponins, and tetragonin, a yeast growth regulator. The plant also exhibits carbonic anhydrase activity, and this apparently has the opposite effects of the sulphonamide drugs. More recently the plant has been shown to contain cerebrosides, compounds which have anti-ulcerogenic properties.' It has been used in traditional medicine in far eastern Asia for the treatment of oesophageal and stomach cancer (P.W. Michael pers. comm.).

Notes on several specimens of *T. moorei* (e.g. Broken Hill, *Morris 2369*, 28 Aug 1928 (BRI)), indicate that it has been used as a 'spinach' by Europeans in the same way as *T. tetragonioides.* However, some authors state that at least some tribes of Aborigines did not use either species as food. Mann (1811), referring to 'Botany Bay Greens' (*T. tetragonioides*), wrote 'esteemed a very good dish by the Europeans, but despised by the natives'. Cleland & Johnston (1939) (under *T. expansa*) reported from the northern Flinders Ranges, where both species are likely to be found (Fig. 2): 'Used as a source of moisture in steaming cresses (see under Cruciferae). Not utilised as a food formerly by the natives, but now used after boiling (or after cooking in a hole).' The same authors, Johnston & Cleland (1943), most likely referring to *T. moorei* from the general area indicated (Fig. 2), state: 'Native name not known by informant. It is now eaten, its use being made known by the white man, according to our informant.' This makes sense in view of the fact that the Aborigines had no utensils in which food could be boiled (Eyre 1845), and this would have been the most efficient way of reducing potentially dangerous levels of oxalates, etc.

A specimen of *T. moorei,* (Mt Lyndhurst S.A., *Koch s.n.* (MEL 99863)), has the information: "'native spinach', valuable fodder, also an article of food both for European settlers and the aboriginal natives, who call it 'Paldroo' or 'Muna narranarra' in the Dieyeric dialect of Central Australia." ('Dieyeri' or 'Dieri' is now spelled 'Diyari' – see Austin 1981). This specimen, which consists of fruit only, may well have been collected from dried-off plants and is probably the voucher for the reference in Koch (1898), under *T. expansa*. In this paper Koch gives the additional information that the plant was 'also used as a pot-herb by Europeans as well as blacks.' 'Pot-herb' is an old term referring to plants which were boiled before eating.

In view of the above, recent trends to use these plants as a raw salad vegetable, e.g. in restaurants under the names 'New Zealand Spinach' or 'Warrigal Greens' (Low 1989), might need to be treated with some degree of caution, especially since young succulent plants would probably be selected for this purpose. This would apply particularly to the increasing numbers of people adopting 'alternative lifestyles', often involving varying degrees of vegetarianism and an increasing interest in 'wild foods'. Although Sanz & Reig (l.c.) indicate that 'the incidence of poisoning by plants containing oxalic acid is very low, and deaths due to ingestion of this type of plant are rare', they do quote cases of young children having been poisoned, sometimes fatally, from eating plants high in soluble oxalates.

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