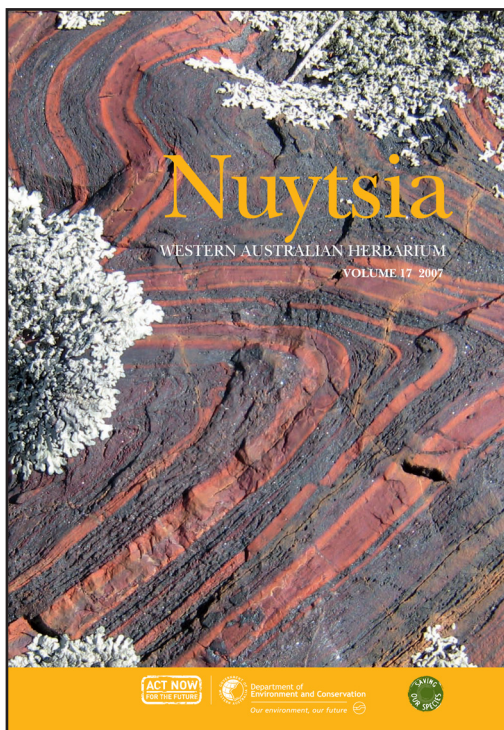


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A new species of *Neurachne* (Poaceae) from Western Australia

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Abstract

Macfarlane, T.D. A new species of *Neurachne* (Poaceae) from Western Australia. *Nuytsia* 17: 215–222 (2007). *Neurachne annularis* T.Macfarlane is described and illustrated with photographs and a distribution map. The new species forms *Triodia*-like hummocks and grows on and around banded ironstone ranges in the Yilgarn region of Western Australia where it is often dominant in the understorey. The species has the C₃ photosynthetic pathway and is diploid with n = 9, one of three species with that combination in a genus now of seven species. It is morphologically closest to *N. tenuifolia* S.T.Blake, from ranges in Central Australia.

Introduction

The *Neurachne* group of grasses, the tribe Neurachneae S.T.Blake (Poaceae subfam. Panicoideae) (Kellogg 2002), is endemic to Australia. There are 10 currently recognised species in three genera: *Neurachne* R.Br. with six species, *Paraneurachne* S.T.Blake with one species and *Thyridolepis* S.T.Blake with three species (Blake 1972). These grasses are characterised by compact spicate or racemose inflorescences representing reduced panicles, the spikelets lacking an involucre or associated bristles or spines, the glumes as long as the spikelet, at least partially strongly nerved and with conspicuous bands of long hairs or stout bristles, the fertile floret usually of softer texture than the glumes and with an un-awned lemma (Watson & Dallwitz 1992–; Kellogg 2002).

The Neurachneae are of considerable biological interest because there is variation between species as to whether they exhibit the C₃ or C₄ photosynthetic pathways. Whilst *Paraneurachne* and *Thyridolepis* each have only one pathway, C₄ and C₃ respectively, *Neurachne* has both C₃ and C₄ species and one species, *N. minor* S.T.Blake, which has intermediate photosynthetic characteristics as expressed both anatomically and physiologically (Hattersley *et al.* 1986). Genera known to have the two pathways among their species are rare, and species showing intermediacy are extremely rare. This photosynthetic variation is of interest because it may help throw light on how the major changes in anatomy and physiology necessary for transition from one photosynthetic pathway to the other can occur. It also suggests that much of the evolutionary history of the genus *Neurachne* is still extant.

The Neurachneae have been relatively well-studied. The taxonomy was comprehensively revised by Blake (1972) and no changes or additions have been made until now. Studies have been conducted on anatomy (Hattersley *et al.* 1982), photosynthetic physiology (e.g. Hattersley *et al.* 1986), and cytology and detailed species distribution (including predicted distributions) in relation to climate and ecological factors (Prendergast & Hattersley 1985).

Most *Neurachne* species occur in inland parts of the Australian arid zone but one species (*N. alopecuroidea* R.Br.) grows in the cooler and wetter Mediterranean climatic zone of southern Australia, from south-western Western Australia to south-eastern South Australia and western Victoria. In Western Australia the distribution of *N. alopecuroidea* coincides closely with the South Western Botanical Province of Beard (1980). This species is one of only a few species of the usually tropical subfamily Panicoideae native to south-western Western Australia. There is a broad gap between these two general distribution zones for *Neurachne* species coinciding with the shrublands and woodlands of the South Western Interzone of Beard (1980), where *Neurachne* species have scarcely been collected. In that gap region, a previously undescribed species informally named *Neurachne* sp. Helena & Aurora (K.R. Newbey 8972) has been collected a number of times in recent years. Its area of distribution is relatively limited so that it forms a discrete area separated from the other two zones of *Neurachne* distribution, except for a couple of outlying records of *N. alopecuroidea* growing at granite rocks which also lie in the gap (Figure 1). This species is described below as the new species *N. annularis* T.Macfarlane, the seventh species for the genus.

Superficially *N. annularis* looks like a species of *Triodia* R.Br., with its needle-like (though rather soft) leaves and tussock-forming habit which often develop a ring formation with age. The species was apparently first collected by K.R. Newbey in 1979 during field surveys for System 11 (Environmental Protection Authority 1975) but the specimen was sterile and identified as *Plectrachne* Henrard (now a synonym of *Triodia*). A collection by R.J. Cranfield in the 1980s, initially identified as *Triodia*, was the first of this species to be recognised as belonging to *Neurachne*. A third early collection, K.R. Newbey 8972 gathered in 1981, was initially identified as *Eriachne* R.Br. The misidentifications can be attributed to the unusual habit and the different appearance of this new species compared with the common south-western species *N. alopecuroidea* which differs in its distinctive grey capitate inflorescence and flat leaves. The species was also collected at the Mount Manning Range by G. Keighery and J. Alford in 1988, where it was described as common (Keighery *et al.* 1995; Gibson 2004).

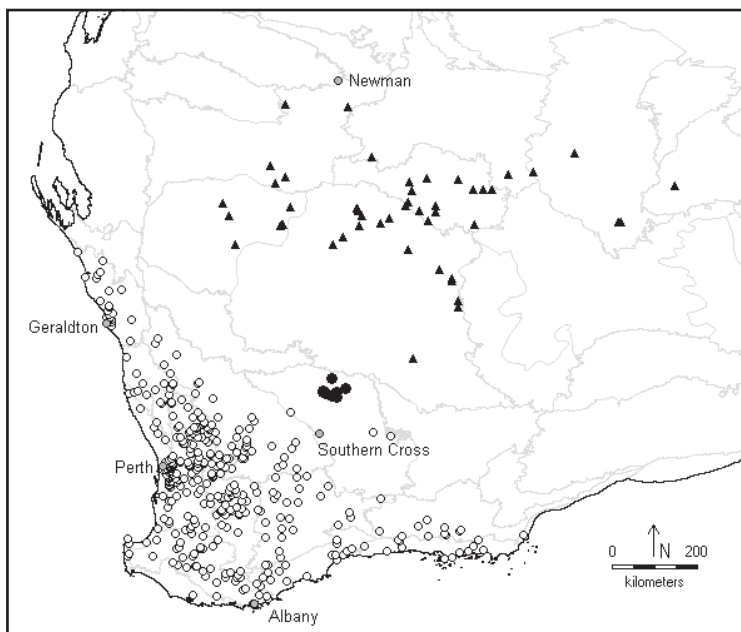


Figure 1. Distribution of *Neurachne annularis* (●) in relation to *N. alopecuroidea* (○) and the Arid Zone species collectively (*N. minor*, *N. lanigera*, *N. munroi*) (▲). Western Australian localities only, based on PERTH herbarium records.

Methods

Measurements in the description were taken from dried herbarium material for overall dimensions including leaves, and re-hydrated material for spikelets. Leaf anatomical observations for determining the photosynthetic pathway type were carried out with re-hydrated leaf material from a herbarium specimen (*T.D. Macfarlane & R.J. Cranfield* TDM 1940), hand-sectioned, mounted in glycerine and examined with a high- power microscope. The chromosome number was obtained from pollen mother cell meiosis (metaphase 1, anaphase 1) from a plant transplanted from the field and maintained in pot culture. The chromosome spreads were adequate to obtain clear number counts but inadequate for photography. Records from the Western Australian Herbarium (PERTH) were mapped using the software DIVA-GIS freeware Version 5.2.0.2.

Description

Neurachne annularis T.Macfarlane, *sp. nov.*

N. tenuifoliae S.T.Blake affinis sed inflorescentia non squarrosa, gluma inferiore in centro dorsi hirsuta; apicibus glumarum brevioribus et minus induratis; palea superiore laciniis auriculatis basalibus plus evolutis differt.

Typus: south-east of Allens Find toward Bungalbin Hill, south-east of Mt Jackson and *c.* 100 km north-north-east of Southern Cross, Western Australia, 3 October 1991, *T.D. Macfarlane & R.J. Cranfield* TDM 1940 (*holo*: PERTH 07636512 [sheet 1], PERTH 07636504 [sheet 2]; *iso*: BRI, CANB, DNA, K, NSW, PERTH, US).

Neurachne sp. (GJK & JA 1951): G.J. Keighery *et al.*, *Records W. Australian Mus. Suppl.* 49: 183–207 (1995); N. Gibson, *J. Roy. Soc. W. Austral.* 87: 35–47 (2004).

Neurachne sp. Helena & Aurora (K.R. Newbey 8972), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 111 (2000).

Plants forming tussocks, *c.* 30 cm diameter when young, later growing outward from a dying centre to form large ring formations. *Culms* *c.* 35–75 cm long, erect or usually decumbent and rooting for the first 10–20 cm before becoming erect, much-branched; lower internodes woolly hairy, largely concealed by cataphylls and leaf sheaths; upper internodes partially, often extensively, exposed, glabrous, striate with fine longitudinal grooves between numerous flattened ridges; nodes conspicuously woolly hairy. Cataphylls densely hirsute. *Lower leaf sheaths* with surface moderately ridged, the ridges separated by broad grooves, woolly for a short distance at the base and often concealed by overlapping sheaths, otherwise glabrous or occasionally sparsely hirsute, the exposed margin glabrous except densely ciliate just below the ligule; glabrous internally. *Upper sheaths* similar but lacking the woolly base. *Ligule* a dense row of cilia *c.* 0.5 mm long. *Leaf blades* 10–24 cm long, stiff, straight to somewhat flexuose, pointed, not pungent, tightly folded so that the blade is terete, 0.4–0.8 mm in diameter; abaxial surface sparsely long-hairy when young, the hairs stiff, erect, bulbous-based, usually soon lost, the bases remaining to make the leaf sparsely scabrous-tuberculate, the surface otherwise glabrous, striate with narrow grooves between low flattened ridges; adaxial surface villous for a short distance above the ligule, then becoming sparsely pubescent; margins glabrous except with long stiff spreading bulbous-based hairs sparsely distributed from the ligule for *c.* 1 cm, the hairs to 3 mm long, sometimes lost with

the base remaining as a tubercle. *Inflorescence* a compact linear spike 2.5–4 cm long, well exerted above the basal tuft of leaves by 10–30 cm, with 1 or 2 upper leaves below an elongated peduncle 10–30 cm long, or occasionally with an uppermost leaf just below the inflorescence. *Spikelets* 15–20 per inflorescence, 7–9 mm long, green or pinkish green, all fertile or 1 or 2 basal ones reduced and sterile. *Glumes* usually subequal with the lower one slightly longer, occasionally equal. *Lower glume* as long as the spikelet, 7–9 mm long, ovate but somewhat constricted at about 2/3 from the base, the apex acuminate, in the lower part more or less triangular and flattened, then with a short to elongated terete, scabrous mucro, the back flattened to slightly concave and with two lateral rounded shoulders or keels, with 5 visible ribs including the keels, 6 or 7 veins visible inside; the back with a submarginal band of hairs in the lower 2/3 or the middle 1/3, the hairs long, appressed to spreading with maturity, the hairs in tufts from bulbous bases, an additional band of hairs on either side of the midvein in the lower half, the hairs long, appressed to semi-erect, individual, the bases inconspicuously bulbous, sometimes the whole lower back appearing hairy, and a basal beard of hairs forming part of the ring of callus hairs, the back otherwise scabrous; margins ciliate from 1/4 of the length of the glume to the base of the scabrous awnlet. *Upper glume* more or less elliptical but widest slightly above the middle, acuminate, with a short to slightly elongated apical mucro up to 2 mm long, the back flattened to rounded, with rounded shoulders or keels, *c.* 7 visible ribs, 8 or 9 veins visible on the inside, with a submarginal band of hairs in the lower 1/2–3/4 on each side, the hairs long, appressed to spreading, the bases conspicuously bulbous, additional lines of hairs in the shallow furrows between ribs either side of the midvein or occasionally the whole lower back appearing hairy, the hairs long, appressed to semi-erect, the bases inconspicuously thickened, margins ciliate in upper half as far as the base of the scabrous apical point. *Lower floret* male, considerably shorter than the glumes; lemma 5.5–6 mm long, ovate, softer in texture than the glumes, translucent but not delicate, rounded to somewhat keeled on the back, strongly 6 or 7-veined with wide membranous sides, the back puberulous between the nerves, especially in the lower half, and pubescent or minutely puberulous near the margins in the upper third, otherwise glabrous, the apex narrow, truncate, ciliate, the margins ciliate in upper half; palea reduced to a very small membranous, irregularly toothed structure 0.8–1.5 mm long, slightly longer to twice as long as the lodicules; anthers 3, 2.5 mm long, a little shorter and narrower than those of the upper floret, greyish yellow. *Upper floret* bisexual, slightly shorter to subequal to the lower floret; lemma 4.7–5.7 mm long, ovate to lanceolate in outline, membranous, rounded on the back, 3-veined, the back puberulous at the margin or all over the upper third, otherwise glabrous, the apex acute or narrowly truncate; palea slightly shorter than the lemma, membranous, flat on the back, 2-veined, with two conspicuous auriculate side flaps near the base which are folded inward, glabrous or scabrous in upper 1/4, the apex notched or narrowly truncate; lodicules 2, 0.4–0.6 mm long, fleshy, veined; anthers 3, *c.* 3.5 mm long, pointed, not penicillate, greyish green to greyish yellow; ovary 2-lobed, with 2 styles free to the base. Chromosome number $n = 9$ (voucher *T.D. Macfarlane & R.J. Cranfield* TDM 1940). (Figure 2)

Other specimens examined. WESTERN AUSTRALIA: [localities withheld] 19 Nov. 2004, *V. Clarke* VC 500 (PERTH); 23 July 1995, *N. Gibson & M. Lyons* 3323 (PERTH); 23 Sep. 1995, *N. Gibson & M. Lyons* 3709 (PERTH); 10 Aug. 1988, *G.J. Keighery & J.J. Alford* 1951 (PERTH); 25 Sep. 1995, *B.J. Lepschi* 1995 (PERTH); 15 Sep. 1979, *K.R. Newbey* 5925 (PERTH); 23 Sep. 1981, *K.R. Newbey* 8972 (PERTH); 3 Oct. 1991, *T.D. Macfarlane & R.J. Cranfield* TDM 1941 (PERTH); 3 Oct. 1991, *T.D. Macfarlane & R.J. Cranfield* TDM 1942 (PERTH); 3 Oct. 1991, *T.D. Macfarlane & R.J. Cranfield* TDM 1944 (NSW, PERTH); 3 Oct. 1991, *T.D. Macfarlane & R.J. Cranfield* TDM 1945 (PERTH); 3 Oct. 1991, *T.D. Macfarlane & R.J. Cranfield* TDM 1946 (PERTH); 4 Oct. 1991, *T.D. Macfarlane & R.J. Cranfield* TDM 1962 (PERTH); 4 Oct. 1991, *T.D. Macfarlane & R.J. Cranfield* TDM 1957 (AD, MEL, PERTH).

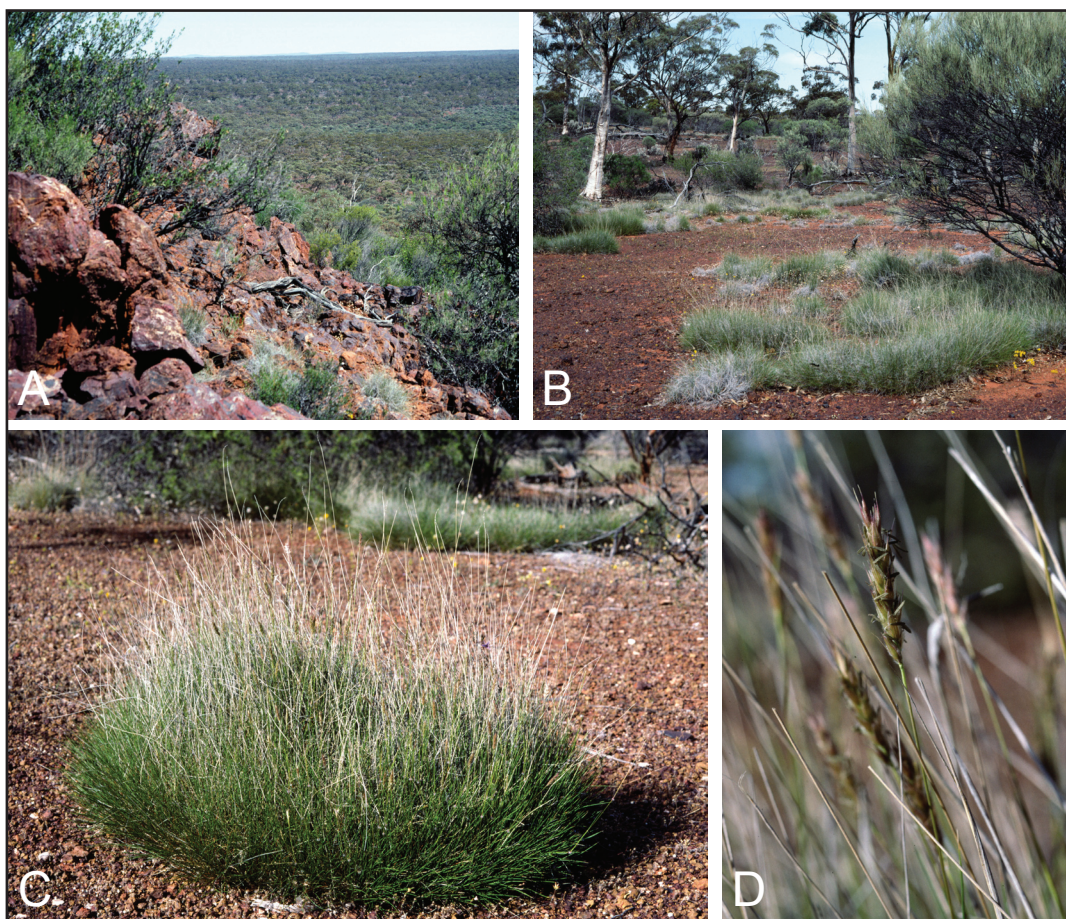


Figure 2. *Neurachne annularis*. A – habitat on hill site, *N. annularis* in foreground among broken rocks; B – habitat on lowland site, *Eucalyptus* woodland with ironstone gravel, *N. annularis* in foreground and middle-ground; C – habit; D – inflorescence. Photographs by T.D. Macfarlane: A, T.D. Macfarlane & R.J. Cranfield TDM 1945, Bungalbin Hill; B–D, T.D. Macfarlane & R.J. Cranfield TDM 1940, type locality, SE of Allens Find.

Distribution and habitat. The Yilgarn region of south-western Western Australia, extending for c. 55 km west to east from east of Mt Jackson eastward to the Hunt Range and north to Mt Manning Range, and including the banded ironstone ranges of Bungalbin Hill and Helena and Aurora Range (Figure 1). Grows among rocks in shallow red to brown sandy to loamy soils on the tops, sides and bases of banded ironstone ranges and on brown to red or yellowish red loamy soils, often with abundant ironstone gravel or stones which are often banded ironstone fragments, on low rises and outwash plains in the close vicinity or some distance away from banded ironstone ranges (Figure 2 A, B). *Neurachne annularis* is patchily distributed but often dominates the understorey, forming a hummock grassland, sometimes in association with the grass *Amphipogon caricinus* F.Muell. var. *caricinus*. The overstorey is usually an open woodland of various *Eucalyptus* trees and mallees of which *E. ebbanoensis* is most often cited, and medium to tall shrubs of various genera including *Acacia*, *Allocasuarina*, *Eremophila* and *Grevillea*.

Phenology. Flowering in September and October, but the occurrence and timing of flowering are affected by local seasonal conditions.

Conservation status. Listed by Atkins (2006) as Priority Three under Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora, under the name *N. sp.* Helena & Aurora (K.R. Newbey 8972). Although it can occur in very large populations, the range of distribution is relatively restricted, and it grows on (but is not restricted to) ironstone outcrops where it will be affected by any mining. It is known to occur in a conservation reserve, Mt Manning Nature Reserve.

Etymology. The specific epithet is from the Latin adjective *annularis* (ring-shaped, arranged in a circle) and refers to the distinctive habit of this species where older plants die out in the centre and clonal daughter plants grow outwards in a ring formation.

Relationships. *Neurachne annularis* is the second known species in the genus after *N. tenuifolia* S.T.Blake with a *Triodia*-like habit, forming dense rounded tufts with stiff terete pointed leaves. In *N. annularis* the tufts or hummocks develop with age into rings as the centre of the plant dies, another point of resemblance to *Triodia* which, however, is not exhibited by *N. tenuifolia*. From *N. tenuifolia* it differs by being less robust, possessing conspicuously hairy culm nodes instead of glabrous nodes, having spikelets that are generally smaller although overlapping in measurements, lower glumes that are broader and more clearly 5-ribbed rather than 3 (although both have more veins visible from the inside), shorter and less rigid glume awnlets so that the inflorescence lacks the squarrose look of *N. tenuifolia*, glumes with bands of long hairs which are lacking in *N. tenuifolia*, and better developed basal auriculate flaps on the upper palea. *Neurachne tenuifolia* occurs in a limited area of the Northern Territory, from Alice Springs to Mt Liebig in the Macdonnell Ranges. Another shared feature of these two species is their association with rocky hills, although not exclusively in the case of *Neurachne annularis*. Rocky sites and stony or skeletal soils are also sometimes mentioned by collectors for other species such as *N. minor* and *N. queenslandica* S.T.Blake, but less consistently (Prendergast & Hattersley 1985). The other species sharing the same combination of chromosome number and photosynthetic pathway, *N. lanigera* S.T.Blake, differs from *N. annularis* by having a tufted rather than hummock-forming habit, densely woolly leaf sheaths, hirsute leaf blades at maturity, and more conspicuously hairy spikelets with a continuous marginal fringe of hairs and a complete puberulous surface covering on the glumes.

Photosynthetic pathway. *Neurachne annularis* has leaf anatomy which is consistent with C_3 photosynthetic pathway rather than C_4 . The leaf in transection resembles that of *N. tenuifolia* as illustrated by Hattersley *et al.* (1982). Features bearing on the photosynthetic characterisation exhibited by *N. annularis* include: vascular bundles with two distinct and complete bundle sheaths, the inner one of small thickened cells without visible chloroplasts, the outer of larger thinner walled cells, also without visible chloroplasts. Outer bundle sheaths usually separated by up to three mesophyll cells (the maximum lateral cell count), and the maximum number of mesophyll cells separating individual mesophyll cells from the nearest outer bundle sheath cell (the maximum cells distant count) is four or more. No minor vascular bundles located right against major ones, as observed in *N. tenuifolia* by Hattersley *et al.* (1982), were seen in the limited material examined for *N. annularis*. The chlorenchyma was not radiate. These features indicate that *N. annularis* is C_3 , the only exception being the maximum lateral cell count of three, which is low for a C_3 species (a value of four or less is characteristic of C_4 grass species).

Discussion

The chromosome number is known for all species of *Neurachne* (Prendergast & Hattersley 1985; this paper). The new count of $n = 9$ reported here for *N. annularis* is the diploid number in this genus, a count which has also been found in its presumed closest relative *N. tenuifolia* and also in *N. lanigera* and *N. munroi* (F.Muell.) F.Muell. The latter two species are also known to exhibit polyploidy. Of the four species with $n = 9$, all but *N. munroi* are C_3 . The two presumed closely related diploid species *N. tenuifolia* and *N. annularis* are both of restricted range and occur in or near ranges of hills, which might suggest that they have undergone a period of restriction to refugia on the hills.

Neurachne alopecuroidea is geographically the most unusual species in the genus because of its occurrence in the higher and more regular rainfall Mediterranean climatic region whereas the rest of the Neurachneae occur in the Arid Zone, and because it is one of the few panicoid grasses in that climatic region and the only native C_3 panicoid in south western Australia. For these reasons it is reasonable to assume that *N. alopecuroidea* represents a dispersal from the Arid Zone (Prendergast & Hattersley 1985). It might also be assumed on geographical grounds that *N. annularis* represents an evolutionary link between *N. alopecuroidea* and the arid zone species. However, morphological appearances do not support this, with *N. alopecuroidea* having a greater resemblance to the inland *N. minor*, and *N. annularis* most closely resembling the central Australian *N. tenuifolia*.

The tribe Neurachneae has been comparatively well investigated, with much known about the characteristics of the various component taxa. However, detailed knowledge of generic and species inter-relationships are lacking, especially in *Neurachne*. As pointed out by Prendergast & Hattersley (1985) this group of grasses is small enough in number of taxa and has a sufficiently restricted and well defined geographic distribution that it may be readily understandable in evolutionary terms. It is therefore an excellent candidate for a molecular phylogenetic study.

Acknowledgements

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