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There's gold in them thar hills! Morphology and molecules delimit species in *Xerochrysum* (Asteraceae; Gnaphalieae) and reveal many new taxa

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ABSTRACT

Golden everlasting paper daisies in the genus *Xerochrysum* Tzvelev are iconic Australian native plants grown worldwide. The *X. bracteatum* species complex has been regarded as taxonomically confusing and in need of revision for over 60 years. We applied morphological and molecular analyses to delimit species, detect common ancestry among populations, and identify putative hybrids in the genus *Xerochrysum* (Asteraceae: Gnaphalieae). Multiple lines of evidence provided strong support for the recognition of new taxa. Here we describe the following 11 new species: *X. andrewiae* T.L.Collins & J.J.Bruhl, *X. berarngutta* T.L.Collins & I.Telford, *X. copelandii* J.J.Bruhl & I.Telford, *X. frutescens* J.J.Bruhl & I.Telford, *X. gudang* T.L.Collins & J.J.Bruhl, *X. hispidum* T.L.Collins & I.Telford, *X. macsweeneyorum* T.L.Collins, *X. murapan* T.L.Collins & I.Telford, *X. neoanglicum* J.J.Bruhl & I.Telford, *X. strictum* T.L.Collins, and *X. wilsonii* T.L.Collins, reinstate *Helichrysum banksii* A.Cunn. ex DC. (as *X. banksii* (A.Cunn. ex DC.) T.L.Collins & I.Telford), lectotypify *X. banksii* and *X. papillosum* (Labill.) R.J.Bayer, and recircumscribe *X. bicolor* (Lindl.) R.J.Bayer to include *X. halmaturorum* Paul G.Wilson and some populations of *X. bracteatum sens. lat.* from mainland South Australia and Victoria. We also provide revised descriptions of all taxa in the genus, their conservation status, a dichotomous key, tables distinguishing closely related taxa and distribution maps.

Keywords: Australia, biodiversity, *Bracteantha*, Compositae, endemic, *Helichrysum bracteatum*, integrated taxonomy, paper daisy, systematics.

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Introduction

Background to the study

Golden everlasting paper daisies in the genus *Xerochrysum* Tzvelev are iconic Australian native plants grown worldwide. The *X. bracteatum* (Vent.) Tzvelev species complex has been regarded as taxonomically confusing and in need of revision for over 60 years. Thirteen species are currently recognised in *Xerochrysum*, with an additional four species being added by Wilson (2017; endorsed by the Council of Heads of Australasian Herbaria for inclusion in the Australian Plant Census, but not yet available in that dataset) since the studies by Schmidt-Lebuhn *et al.* (2015), and species are found in all Australian states and mainland territories, as well as the highlands of Papua New Guinea (CHAH 2020*a*; B. J. Conn, R. Banka, L. L. Lee, 'Plants of Papua New Guinea', see http://www.pngplants.org). *Xerochrysum* includes some of the showiest and most widely grown of Australia's native flora, yet taxonomic questions have persisted, alongside the widespread cultivation of many different cultivars, 'varieties' and 'forms', for over 60 years (Curtis 1956; Harden 1991; Flann 1998). First grown in England and Europe from the late 1700s (Andrews 1805), the type of *Xerochrysum* (as *Xeranthemum bracteatum* Vent.) was described by Ventenat (1803) from plants cultivated in the Empress Joséphine's orangerie at Malmaison. Ventenat expressed reservations in his prelude (Ventenat 1803) that *X. bracteatum* was enlarging Linnaeus' concept of *Xeranthemum*, and also saw taxonomic

issues in the inclusion of the new species in *Helichrysum* Mill.; however, the species was soon transferred to this genus by Andrews (1805). The publication of *Flora Australiensis* (Bentham 1867) recognised a broadly circumscribed *H. bracteatum* Vent. subsuming *H. viscosum* Sieber ex Spreng. (Sprengel 1826), *H. bicolor* Lindl. (Lindley 1835), *H. acuminatum* (Link) Sweet (Sweet 1826), *H. papillosum* Labill. (Labillardiere 1806), *H. banksii* A. Cunn. ex DC. (de Candolle 1838), and *H. macrocephalum* A. Cunn. ex DC., a species described as growing on 'the sandy shores of Moreton Bay' (de Candolle 1838, p. 188). Bentham's work (1867) remained the standard reference for over 120 years despite increasing taxonomic uncertainty (Curtis 1956; Burbidge 1970; Willis 1973). Anderberg (1991) drew on the prominent involucral bracts, hereafter referred to as phyllaries, and the large glabrous cypselae with barbellate pappus bristles to erect *Bracteantha* Anderb. & Haegi., but this was shown to be illegitimate (Bayer 2001) owing to the publication of *Xerochrysum* (Tzvelev 1990, cited in Bayer 2001) the previous year.

Phyllary indumentum characters have been informative when delimiting species of *Xerochrysum* (Flann 1998; Buchanan 2004; Wilson 2017) and, combined with root-system characters, have been used to separate *Xerochrysum* into two subgeneric groups (Wilson 2008, 2017). Initially, the two groups comprised the '*X. bracteatum* group' with a multi-veined claw, and the single-veined '*X. leucopsideum* group' (Wilson 2008). In the recent partial revision of *Xerochrysum*, Wilson (2017) modified the concept by defining the '*X. milliganii* (Hook.f.) Paul G.Wilson group' to contain those species with a single-veined claw, removing *Helichrysum leucopsideum* DC., which had been shown to be more closely related to some species of *Coronidium* Paul G. Wilson (Schmidt-Lebuhn *et al.* 2015). Wilson (2017) recognised four new species previously included in *X. bracteatum sens. lat.* and raised further taxonomic questions. Currently, *X. bracteatum* is a variable species, possibly including several unrecognised taxa, and distributed in a broad arc from the highlands of Papua New Guinea to the Eyre Peninsula in South Australia (Wilson 2017; Australia's Virtual Herbarium, see http://avh.chah.org.au, accessed 12 September 2020).

Taxonomic uncertainty

Most specimens of *Xerochrysum* in Australian herbaria have been determined to species or an accepted phrase-name taxon, yet limits of many of them remain unclear with consequent inconsistent application of names. Past species limits applied to *Xerochrysum* have drawn exclusively on morphological differences, and this approach has been unable to find disjunctions among some populations of polymorphic *X. bracteatum* (the *X. bracteatum* complex) occurring across over 8000 km^2 in eastern and southern Australia. For example, collections from the Barrington Tops National Park in NSW, occurring in distinct populations with white or yellow phyllaries, are treated as a separate entity by herbarium NE but have been variously determined by other Australian herbaria as either *X. bracteatum sens. lat.*, *X.* sp. Glencoe (M. Gray 4401) NE Herbarium, *X.* sp. New England (L. M. Copeland 3731) NE Herbarium, or *X. bracteatum* subsp. *barringtonense* Paul G. Wilson MS (Australia's Virtual Herbarium, see http://avh.chah.org.au; New South Wales Flora Online, see http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm).

Taxonomic uncertainty is not limited to the *X. bracteatum* species complex. *Xerochrysum boreale* Paul G.Wilson is a recently described perennial from northern Australia, with a scattered distribution across the northern Pilbara and the Kimberley in Western Australia and the northern end of the Northern Territory (the 'Top End'), occurring in a variety of habitats including coastal sands, seasonal swamps and sandstone escarpments. Not all specimens of *X. boreale* were considered distinguishable from Pilbara populations of *X. interiore* Paul G.Wilson (Wilson 2017; FloraBase – the Western Australian Flora, see https://florabase.dpaw.wa.gov.au/, accessed 29 August 2019), and one specimen cited as *X. boreale* came from mulga–eucalypt woodland in southern Queensland, well beyond its stated distribution (Wilson 2017).

Morphological variation has also been reported between the mainland populations and the Tasmanian populations of *X. subundulatum* (Sch.Bip.) R.J.Bayer, a subalpine to alpine species with disjunctions in distribution in Tasmania, Victoria and New South Wales (Wilson 2017). Collections from wetlands in Tasmania, Victoria and New South Wales have scabridulous outer abaxial phyllary surfaces but otherwise share similar morphological and ecological characteristics with *X. palustre* (Flann) R.J.Bayer, a slender, erect perennial occurring in lowland wetlands (Flann 1998). The scabridulous phyllary indumentum character has seen these populations included in *X. subundulatum* by herbaria HO, CANB and NSW.

Putative new taxa

In the 1970s, Nicholas Lander applied informal groupings (e.g. 'inland form', 'coastal ecotype', 'radical leaves') on determination slips and specimen annotations, to some populations of *X. bracteatum sens. lat.* [as *Helichrysum bracteatum*] but did not proceed to publication. Currently, Australian herbaria recognise phrase names for the following six putative new taxa in *Xerochrysum* (CHAH 2020*b*; Australia's Virtual Herbarium, see http://avh.chah.org.au): (1) *X. bracteatum* subsp. Mount Elliot (A.R.Bean 3593) Qld Herbarium; (2) *X.* sp. Glencoe (M.Gray 4401) NE Herbarium; (3) *X.* sp. Mount Merino (S.T.Blake 22869) NE Herbarium (synonym: *X. bracteatum* subsp. Mount Merino (S.T.Blake 22869) Qld Herbarium); (4) *X.* sp. New England (L.M.Copeland 3731) NE Herbarium; (5) *X.* sp. North

Stradbroke Island (L.Durrington 675) NE Herbarium (synonym: *X. bracteatum* subsp. North Stradbroke Island (L.Durrington 675) Qld Herbarium); and (6) *X.* sp. Point Lookout (I.R.Telford 12830) NE Herbarium. Examination of specimens at NSW and CANB suggest Lander's 'inland form' may represent the recently described *X. interiore* (Wilson 2017), whereas the 'coastal ecotype' corresponds to *X.* sp. North Stradbroke Island and possibly de Candolle's (1838) *H. macrocephalum*, whereas 'radical leaves' corresponds to *X.* sp. Glencoe.

Xerochrysum has been the subject of many unpublished taxonomic concepts, such as the proposed splitting of the genus and erection of *Diemenica* to include the '*X. milliganii* group' (annotated on some specimens of CANB; T. L. Collins, pers. obs., 2017). Within *Xerochrysum*, unpublished taxa and combinations include *X. leucopsideum ined.* (Wilson 2008), *X. bracteatum* subsp. *barringtonense ined.* (New South Wales Flora Online, see http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm) and *X. bracteatum* subsp. *dromedariense ined.*, *X. bracteatum* subsp. *eriophyllum ined.*, and *X. bracteatum* subsp. *lanatum ined.* (the last three annotated on some specimens at AD, BRI, CANB, MEL, and NSW; T. L. Collins, pers. obs., 2017–2019).

Wilson (2017) did not attempt to resolve the putative new taxa of *Xerochrysum* that have been under study for more than 10 years at the University of New England (Duley 2007; N.C.W. Beadle Herbarium (NE) database, see https://ncw-beadleherbarium.une.edu.au/). Phenetic analyses using continuous and discrete characters had suggested that there were up to seven distinct entities in the *X. bracteatum sens. lat.* species complex from eastern Australia (Duley 2007). The discovery of the putative new entity *X.* sp. Mount Kaputar, not included in the phenetic analyses, suspended publication of the results.

The Western Australian endemic *X. macranthum* (Benth.) Paul G.Wilson has a distribution from Geraldton to Albany and occurs in diverse habitats from dry woodland to forest swamps, mountain peaks and coastal limestone heath (Wilson 2017; Australia's Virtual Herbarium, see http://avh.chah.org.au). Most populations of *X. macranthum* have white phyllaries, yet, in the north of the range, yellow-phyllaried populations occur. Populations of *X. macranthum* restricted to mountain tops in the Stirling and Porungurup ranges in south-western Western Australia, an area known for very high endemism (Crisp *et al.* 2001), have broader leaves than do those at lower altitudes and latitudes, and morphological differences have been maintained under cultivation (G. J. Keighery, pers. comm., cited in Wilson 2017).

Putative hybrids

Species delimitation in complex groups can be complicated by the presence of hybrids, apomixes and polyploidy (Depypere *et al.* 2009; Schilling 2011). Wilson speculated that some populations of *X. bracteatum sens. lat.* were intergrading or hybridising with either *X. papillosum* (Labill.) R.J.Bayer, *Xerochrysum halmaturorum* Paul G.Wilson, *X. interiore* or *X. boreale*, and were morphologically similar to *X. bicolor* (Lindl.) R.J.Bayer and *X. macranthum*, but these hypotheses were not tested with molecular data (Wilson 2017). *Xerochrysum* sp. Blackfellows Gap (N.T.Burbidge 6926; currently treated as a synonym of *X. subundulatum;* CHAH 2020*a*), has been applied to specimens from the Brindabella Ranges on the Australian Capital Territory–New South Wales border. Collections assigned to this entity have unusual leaf and stem indumentum, and have been suggested to be hybrids between *X. subundulatum* and *X. viscosum* (Sieber ex DC.) R.J.Bayer (Burbidge 1970), or a putative new species (Wilson 2017).

Xerochrysum viscosum is a woodland species broadly distributed in south-eastern Queensland, central and eastern New South Wales, the Australian Capital Territory and Victoria. The presence of viscid glands and narrow leaves has been regarded as a distinctive feature of *X. viscosum* (Harden 1991; Wilson 2017). Some collections with leaf width intermediate between *X. viscosum* and *X. bracteatum sens. lat.* have been treated as hybrids between these two species (Wilson 2017).

Populations of *X. bracteatum sens. lat.* in the Barrington Tops New South Wales have been recorded with either white, white and pink, or yellow phyllaries. Intermediates with pale yellow or orange phyllaries, suspected to be hybrids, have been seen where these differently coloured populations co-occur (J. R. Hosking, pers. comm., 2018).

The final hypothesis of hybridisation that should be mentioned is that various cultivars of *X. bracteatum* (with slightly curved phyllaries coloured pink, orange, purple and red) are widely thought to have been developed in Germany in the 1800s and 1900s, from hybridisation with South African species of *Helichrysum* (Rymer 2006; Russell 2015). Evolutionary analyses have suggested that breeding compatibility between *Xerochrysum* and African *Helichrysum* is unlikely because of the large phylogenic distance between them (Galbany-Casals *et al.* 2014; Nie *et al.* 2016). A recent study of gene flow and ancestry analyses showed that some colourful cultivars are hybrids between eastern Australian *X. bracteatum* and Western Australian *X. macranthum* (Collins *et al.* 2021).

Resolution of the longstanding taxonomic uncertainty in *Xerochrysum* will facilitate study of evolutionary relationships and ecology of members of the genus, provide a sound basis for assessment of conservation status, allow accurate curation of herbarium collections and identification within the genus, and highlight taxa with particular horticultural potential. The present study applies molecular and morphological approaches to test species limits and find evidence of common ancestry or recent gene flow among populations of *Xerochrysum* from across Australia. Identification of corresponding molecular and morphological discontinuities would support taxon boundaries indicative of separately evolving lineages, consistent with the unified species concept

(De Queiroz 2007). Specifically, this study aims to test the status of formal and informal (phrase name) taxa and putative hybrids within *Xerochrysum*. Taxa recognised here will be described and diagnosed using morphology, congruent with the molecular data.

Materials and methods

Definition and usage of morphological terms, including those describing stylar appendage shape, leaf shape and indumentum, follow the 'Flora of Australia' glossary (Orchard and Thompson 1999). Trichome terminology draws on Payne (1978).

Study group

The current study uses the species of *Xerochrysum* defined by Wilson (2017) and other formally accepted phrase name and manuscript taxa (Table 1; CHAH 2020*a*), but also includes informal phrase names in use at NE (Table 2; N.C.W. Beadle Herbarium (NE) database, see https://ncw-beadleherbarium.une.edu.au/). This approach ensured testing of the current species limits against multiple hypotheses of putative new entities. During the course of fieldwork, populations in the Sydney Basin and New South Wales South Coast bioregions were seen to have leaf indumentum and habit distinct and different from populations in the New England Tablelands Bioregion, and the former are hereafter being referred to as *X. bracteatum sens. str.*, and the latter as *X.* sp. Northern Tablelands. Populations currently included in the *X. bracteatum* complex and of uncertain grouping are referred to as *X. bracteatum sens. lat.* Additional informal phrase names were used to group populations outside the Sydney Basin and New South Wales South Coast, and they were included in analyses under these informal phrase names (Table 2). Populations similar to *Xerochrysum palustre* but with scabridulous phyllaries were tentatively referred to as *X.* aff. *palustre*.

Field collection

Field collection was essential to gather high-quality specimens, as well as propagules, and tissue for DNA extraction with sufficient sampling density. Many gatherings of *Xerochrysum* in Australian herbaria, including many type specimens, are fragments and comprise just the inflorescence and upper cauline leaves and do not have the base of the plants, lower leaves, root-system, or cypselae (T. L. Collins, pers. obs., 2017–2020). Sites were prioritised to collect topotypes, and other sites known from specimen collections <20 years old (Australia's Virtual Herbarium, see http://avh.chah.org.au) to increase the likelihood of relocating sites. Fieldwork was conducted between November 2017 and March 2019. Owing to record-low rainfall and extreme drought (Bureau of Meteorology 2020), no fieldwork was conducted in western NSW and western Queensland. Descriptions of habit, habitat and associated plants, topography, number of plants in the population, and soil were recorded at each collection site. Herbarium specimens, leaf material for DNA extraction, cypselae and cuttings were collected when found, and when permit conditions allowed. When available, leaf material from at least five plants spaced ~5 m apart was placed immediately in nylon bags and then in sealed containers with silica gel desiccant (Si gel). Herbarium specimens were pressed in the field, and air-dried at ~16°C and 16% relative humidity before freezing

Table 1. Formally accepted Australian Plant Census (CHAH 2020*a*) phrase name taxa of *Xerochrysum*.

X. bracteatum sp. Mount Merino (S.T.Blake 22869) Qld Herbarium
X. bracteatum sp. North Stradbroke Island (L.Durrington 675) Qld Herbarium
X. sp. Blackfellows Gap (N.T.Burbidge 6926) Qld Herbarium
X. sp. Glencoe (M.Gray 4401) NE Herbarium
X. sp. New England (L.M.Copeland 3731) NE Herbarium
X. sp. Point Lookout (I.R.Telford 12830) NE Herbarium

MS, manuscript; Qld, Queensland; NE, N.C.W. Beadle Herbarium.

Table 2. Informal phrase name taxa applied to some *Xerochrysum*.

Informal name	Distribution
X. aff. *palustre*[A]	Eastern Tasmania; South East Forests NP and Kanangra–Boyd NP, NSW
X. sp. Porongurup[A]	Summit of peaks in Stirling and Porungurup ranges, WA
X. sp. Cox Peninsula[A]	Cox Peninsula, Northern Territory
X. sp. Flinders Range[A]	Eyre Peninsula and Flinders Range, SA; Nombinnie NR, NSW
X. sp. Fly Point[A]	Northern Cape York Peninsula, Queensland
X. sp. Forests[A]	Walpole–Nornalup NP, WA
X. sp. Golden[A]	North and east of Perth, WA
X. sp. Limestone[A]	Conspicuous Cliffs in Walpole–Nornalup NP, WA
X. sp. Lofty Ranges[A]	Lofty and Tothill Ranges, SA
X. sp. Mount Kaputar[B]	Nandewar Ranges, NSW
X. sp. North Kennedy[B]	Atherton Tablelands, Queensland
X. sp. Northern Tablelands[A]	Barrington Tops NP, New England Tablelands, NSW, and Bunya Mountains NP, Queensland
X. sp. Walker Point[A]	Annan River NP, Queensland
X. viscosum Torrington[A]	Torrington Conservation Reserve, NSW

[A]Added during the course of this study.
[B]In use at herbarium NE.
NSW, New South Wales; WA, Western Australia; SA, South Australia; NP, National Park; NR, Nature Reserve.

for 1 week at ~ −30°C for herbarium biosecurity. A complete list of gatherings used in the present study can be found in Supplementary Table S1.

To broaden sampling, additional sources were accessed. Small quantities of leaf were taken from Si gel collections at the N.C.W. Beadle Herbarium (NE) or from herbarium specimens. Si gel collections of *X. bracteatum sens. lat.* and *X. subundulatum* were made available for analysis by the Terrestrial Ecosystem Research Network (TERN). Collections of cypselae were accessed from the South Australian Seed Conservation Centre, Australian PlantBank, Royal Tasmanian Botanical Gardens, and the Australian National Botanic Gardens. An extended network of colleagues, friends and volunteers collected material when available and permit conditions allowed.

Collections were made under the following permits and licences: Queensland Government permit number WITK18639817; New South Wales permit number SL100305; Northern Land Council permit number 81511; Northern Territory Government permit number 62139; South Australia permit number G25787-3; Tasmania permit number TFL17334; Western Australia permit number SW019464 and Regulation 4 number CE005748.

Plant propagation and cultivation

Fruits obtained during field collection and from seedbank collections were sown in a commercial seed-raising medium (Searles Seed Raising Mix, JC & AT Searle Pty Ltd, Kilcoy, Qld, Australia) and germinated in a refrigerated incubator (Model: RI250SG, Thermoline Scientific Equipment Pty Ltd, Sydney, NSW, Australia), set at 22°C day, 12°C night and 10-h–14-h day–night with fluorescent lighting. Germinated seedlings were transplanted to a soil-less potting medium (Searles Professional Potting Mix, JC & AT Searle Pty Ltd, Kilcoy, Qld, Australia). Seedlings and plants were grown in an air-conditioned glasshouse maintaining the maximum temperature below 25°C.

Small numbers of seedling transplants were collected when fruits were unavailable. Seedlings were removed from soil, wrapped in damp paper inside a plastic bag and kept cool. On return to the university, seedlings were potted in soil-less potting media and kept under intermittent mist with bottom heat for ~2 weeks before transferring to the air-conditioned glasshouse.

Phenetic analyses of morphology

Fourteen quantitative and two qualitative characters (Table 3) were recorded from 97 herbarium specimens representing all study group taxa (Table 4) except for the '*X. milliganii* group'. The '*X. milliganii* group' was excluded on the basis of the distinctive phyllary morphology, thereby focussing the phenetic analysis on the *X. bracteatum* complex. Live plants were grown to provide fresh material for comparison with dried specimens. Use of herbarium specimens for phenetic analyses gave access to a broader range of populations and putative entities. The choice of characters was based on preliminary examinations of herbarium specimens, cultivated plants, plants in the field, and published characters applied to species of *Xerochrysum* (Flann 1998; Wilson 2017). Quantitative characters were used in preference over qualitative characters, to avoid imposing artificial or arbitrary boundaries on any morphological variability. Means were calculated from at least three measurements per specimen for all characters except length of cauline leaf mucro (Table 3, Character 6). Cypselae length and width, not including pappus, were measured using the eyepiece graticule in a Leica 7.5 stereomicroscope, calibrated using a ruler with a half-millimetre scale. Leaf-width dimensions on mature leaves were measured using a ruler with a half-millimetre scale. Leaf length was not measured because of the imprecision of measuring folded and curved leaf specimens. Phyllary apex angle was measured using the angle tool in ImageJ (ver. 1.52a, see https://imagej.nih.gov/ij/download.html; Schneider *et al.* 2012) on images taken on an iPhone 6 camera (Apple Inc., Cupertino, CA, USA). Stereome and phyllary lamina vascular bundles were

Table 3. Characters used in morphometric analyses of taxa and putative entities of *Xerochrysum*.

Number	Character
1	Length of cypsela (mm)
2	Width of cypsela (mm)
3	Mean apical angle of longest phyllaries (degrees)
4	Ratio of female floret length to bisexual floret length
5	Leaf width (mm)
6	Length of cauline leaf mucro (μm)
7	Septate trichome density on cauline leaf margin (mm^{-1})
8	Glandular trichome density on cauline leaf adaxial lamina ($0.25\ mm^{-2}$)
9	Septate trichome density on cauline leaf adaxial lamina ($0.25\ mm^{-2}$)
10	Glandular trichome density on cauline leaf abaxial lamina ($0.25\ mm^{-2}$)
11	Septate trichome density on cauline leaf abaxial lamina ($0.25\ mm^{-2}$)
12	Septate trichome density on cauline leaf abaxial midvein (mm^{-1})
13	Glandular trichome density on cauline leaf abaxial midvein (mm^{-1})
14	Abaxial glandular trichome apical cell diameter (μm)
15	Taproot or rhizome
16	Phyllary white, or yellow

Units are given for each measurement.

Table 4. Geographic subsets of species and entities of *Xerochrysum* used in phenetic analyses of morphology.

Subset	Entity name	Populations
'northern'	*X. boreale*	Wadeye; Yunupingu Cattle Farm; Mirrnatja; Dundee Beach; Dhupuwamirri
	X. sp. Cox Peninsula	Cox Peninsula.
	X. sp. Fly Point	Fly Point.
	X. sp. Mount Elliott	Mount Elliott.
	X. sp. North Kennedy	Herberton Range NP; Herberton; Wondecla; Blackbraes NP; Eungella; Paluma Range.
	X. sp. North Stradbroke Island	Fraser Island; Moreton Island; Noosa NP; Iluka; Byfield NP; Town of 1770.
	X. sp. Walker Point	Annan River NP.
'southern'	*X. bicolor*	Alum Cliffs; Arthur-Pieman Conservation Area; Temma.
	X. bracteatum sens. str.	The Oaks; Mount Keira; Bulli Lookout; Gulaga NP; Nethercote Falls.
	X. halmaturorum	Cape Saint Albens; Pink Bay; Lesueur Conservation Park.
	X. interiore	Alice Springs; Mereenie Loop Road; Pilbara.
	X. papillosum	Tessellated Pavement; Saint Patricks Head.
	X. sp. Flinders Range	Flinders Ranges.
	X. sp. Lofty Ranges	Newland Head; Hindmarsh Falls; Tothill Range.
	X. viscosum	Warby–Ovens NP; Kaputar Road; Torrington CR; Saint Arnaud; Hobart; Apsley Falls; Mudgee; Lithgow; Black Mountain.
'eastern'	*X. bracteatum sens. str.*	The Oaks; Mount Keira; Bulli Lookout; Gulaga NP; Nethercote Falls.
	X. sp. Barrington Tops (white)	Barrington Tops NP.
	X. sp. Barrington Tops (yellow)	Barrington Tops NP.
	X. sp. Fly Point	Fly Point.
	X. sp. Glencoe	Costellos Road; Barrington Tops NP; Boonoo Boonoo NP. Werrikimbe NP; Ebor.
	X. sp. Mount Kaputar	Mount Kaputar NP.
	X. sp. Mount Merino	The Pinnacle.
	X. sp. New England	Round Waterhole Creek; Henry River Falls; Hillgrove Gorge; Jeogla; Gara Gorge; Saint Helena Creek.
	X. sp. North Kennedy	Herberton Range NP; Herberton; Wondecla; Blackbraes NP; Eungella; Paluma Range.
	X. sp. North Stradbroke Island	Fraser Island; Moreton Island; Noosa NP; Iluka; Byfield NP; Town of 1770.
	X. sp. Northern Tablelands	Armidale; Barrington Tops NP; Nowendoc; Apsley Falls; Bunya Mountains NP.
	X. sp. Point Lookout	New England NP.
	X. sp. Walker Point	Annan River NP.
	X. viscosum	Warby-Ovens NP; Kaputar Road; Torrington CR; Saint Arnaud; Hobart; Apsley Falls; Mudgee; Lithgow; Black Mountain.
'western'	*X. halmaturorum*	Cape Saint Albens; Pink Bay; Lesueur Conservation Park.
	X. interiore	Alice Springs; Mereenie Loop Road; Pilbara.
	X. macranthum	Chidlow Road; Collie; Mount Cooke.
	X. sp. Flinders Range	Flinders Ranges.
	X. sp. Golden	Wannamal; Talbot West Road.
	X. sp. Pilbara	Wanna Munna Road.
	X. sp. Porongurup	Conspicuous Cliffs; Walpole–Nornalup NP; Stirling Range NP; Porungurup NP.

CR, Conservation Reserve; NP, National Park.

observed using a Leica 7.5 stereomicroscope with transmitted light. Scanning electron microscopy (SEM) was used to examine sections of mature leaves mounted onto 12.5-mm aluminium SEM stubs with double-sided carbon tape, and included the margin, apex and midvein for both adaxial and abaxial surfaces. Mounted samples were placed on an angled stage and gold-coated using a JEOL MP-19020NCTR NeoCoater (JEOL Ltd, Tokyo) for 6 min, rotating the stage 60° laterally every 2 min. Specimens were examined and images captured with a JEOL JSM-6010LA Analytical SEM (JEOL Ltd, Tokyo) at 10 kV. A series of images was taken at 75× and 100× magnifications. Trichome density was recorded from SEM using a stencil template representing 0.25-mm^2 leaf area and the cell-counter tool in ImageJ (ver. 1.52a; Schneider *et al.* 2012). Apical-cell diameter and length of cauline leaf-tip mucro were measured on SEM micrographs with a ruler with a half-millimetre scale calibrated against the micrograph scale bar.

Data were entered into PATN (ver. 3.12, see https://patn.org/; Belbin 1993). All characters were weighted equally for cluster and ordination analysis to examine patterns of similarity and difference among individuals. Three-dimensional ordination fusing semi-strong hybrid multi-dimensional scaling (SSH MDS) was conducted using the Gower metric association measure (Gower 1971), a widely used method that involves range-standardisation of data for each character. SSH MDS has a demonstrated effective recovery of phenetic clusters (Faith *et al.* 1987; Holman *et al.* 2003; Plunkett *et al.* 2013). The ordination analyses were produced with 250 random starts and 500 iterations. The principal component correlation (PCC) analysis in PATN uses multiple linear regressions to fit each selected variable independently into the ordination space (1, 2 or 3 dimensions). The result is a set of coordinates that represents the tip of the vector of the variable. An *r*-squared value provides some estimate on how good the fit was. Variables with PCC values >0.7 were considered to contribute strongly. Phenograms were produced from classification analysis using the unweighted pair-group method with arithmetic mean (UPGMA) agglomerative hierarchical fusion ($\beta = -0.1$). Subsets of the morphometric data (Table 4) representing broad distribution patterns of *Xerochrysum* across Australia (i.e. north, south, east and west) were analysed using PATN as above, to assess the extent to which co-located species and putative entities can be distinguished by morphometric analysis. Ordinations were plotted in *R* (ver. 3.6.1, R Foundation for Statistical Computing, Vienna, Austria) through *RStudio* (ver. 1.0.153, RStudio PBC, Boston, MA, USA, see https://rstudio.com/) with species and putative entities being designated unique colours.

Sample selection for molecular analyses

Sampling density was not applied uniformly across all collection sites. For example, the long-standing phrase name entity *X.* sp. Mount Merino, currently included in *X. bracteatum*, has a perennial life form, shrub-like habit, very large capitula, dense tomentose leaf indumentum, and is known only from cliff-edge habitats on the margins of *Nothofagus moorei* closed forests in northern New South Wales and south-eastern Queensland. The distinct morphology and limited distribution of *X.* sp. Mount Merino suggests a rare and restricted 'narrow endemic', and because of finite resources, only two samples were sequenced. The morphologically distinctive Tasmanian alpine endemics *X. collierianum* and *X. milliganii* were limited to three samples each. Greater sampling density was applied to test species limits, shared common ancestry and recent gene flow between populations and putative hybrids with less certain boundaries occurring sym- or parapatrically. Sampling locations for all species and putative entities is shown in Fig. 1. Details of the rationale, used to include the populations representing species and putative entities examined with molecular data, can be found in the Supplementary material under the subheading, 'Rationale for sample selection in molecular analyses'.

DArTseq genotyping, population genetic structure and ordination

DNA extraction and DArTseq reduced representation sequencing were conducted by Diversity Arrays Technology Ltd, using the DArTseq approach with medium marker density and proprietry DNA purification (Kilian *et al.* 2012). This method can be optimised for detecting gene flow in organisms lacking a reference genome (Al-Beyroutiová *et al.* 2016; Egea *et al.* 2017; Alam *et al.* 2018). Details of the DArTseq approach can be found in the Supplementary material under the subheading, 'DArTseq genotyping'.

Exploratory filtering of DArTseq loci at different levels of stringency confirmed only minor effects on the clustering of samples in PCoA. Filtering loci and individual call rate using the function *gl.filter.callrate* (Gruber *et al.* 2018) excluded samples with >20 and >30% missing data respectively, ensuring minimal missing data, inclusion of most samples, and maximal computational efficiency.

Genetic divergence and diversity were estimated for each taxon in *R* (ver. 3.6.1). Expected heterozygosity and inbreeding estimation F_{IS} were estimated using the *adegenet* package H_S function and *inbreeding* function respectively (ver. 0.5-11, see https://cran.r-project.org/package=adegenet; Jombart and Ahmed 2011). Observed heterozygosity was calculated using the *dartR* function *gl.report.heterozygosity* (ver. 2.0.3, see https://CRAN.R-project.org/package=dartR; Gruber *et al.* 2018) and means were calculated. Nei's genetic divergence coefficient G_{ST} is analogous to F_{ST} for bi-allelic loci (Nei 1973, p. 3322). F_{ST} for species and cultivars was calculated using the *hierfstat* package *fstat* function (ver. 0.5-11, J. Goudet and T. Jombart, see https://CRAN.R-project.org/package=hierfstat, accessed 12 May 2022).

Underlying data structure and visualisation of genetic differences for all *Xerochrysum* samples was undertaken by

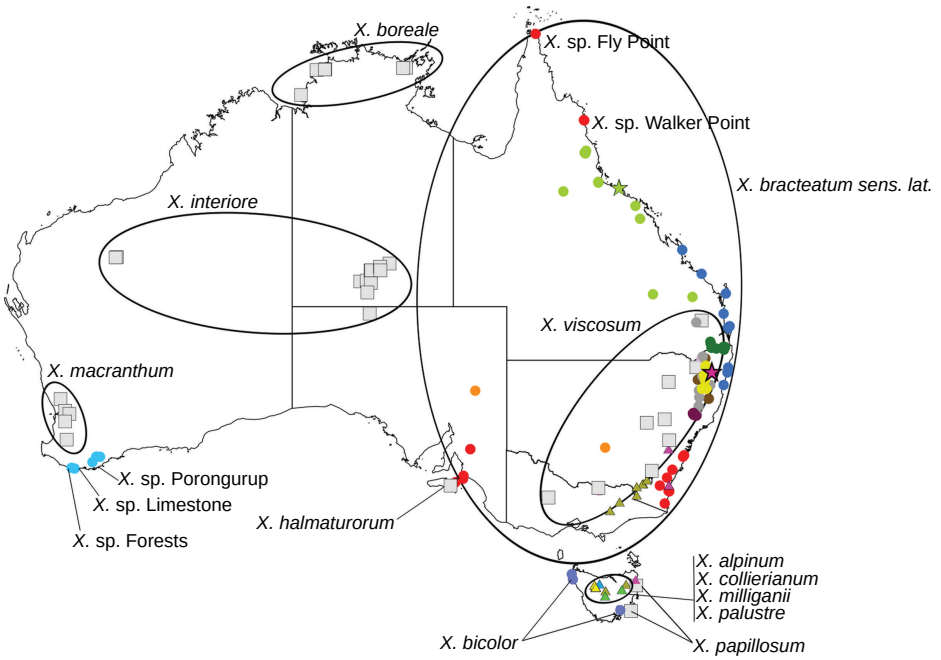

Fig. 1. Sample locations for *Xerochrysum*. Labelled ellipses indicate the distribution of samples included in *X. bracteatum sens. lat.*, *X. viscosum*, *X. macranthum*, *X. interiore* and *X. boreale*. Clockwise, starting at Cape York Peninsula (the north-eastern tip of Australia): *X. bracteatum sens. lat.* (red circles), *X.* sp. North Kennedy (pale green circles), *X.* sp. Mount Elliot (pale green star), *X.* sp. North Stradbroke Island (dark blue circles), *X.* sp. Mount Merino (dark green circles), *X.* sp. Northern Tablelands (grey circles), *X.* sp. New England (yellow circles), *X.* sp. Point Lookout (pink star), *X.* sp. Glencoe (brown circles), *X.* sp. Barrington Tops (purple circles), *X.* aff. *palustre* (pink triangles), *X.* sp. Flinders Range (orange circles), *X. subundulatum* (gold triangles), *X. palustre* (green triangles), *X. collierianum* (blue triangles), *X. milliganii* (yellow triangle), *X. alpinum* (white triangle obscured by *X. milliganii*).

principal coordinate analysis (PCoA) using the function *gl.pcoa* in the *dartR* package (Gruber *et al.* 2018). Principal coordinate analysis (Gower 1966) produces low-dimensional coordinates from a derived distance matrix that summarises as much as possible the variance in the original data (Faraway 2012). Exploratory filtering of DArTseq loci at different levels of stringency confirmed only minor effects on the clustering of samples in PCoA. Filtering loci and individual call rate using the function *gl.filter.callrate* (Gruber *et al.* 2018) excluded samples with >20 and >30% missing data respectively, ensuring minimal missing data, inclusion of most samples, and maximal computational efficiency. Subsets of the DArTseq samples (Table 5) representing large clusters in the PCoA (Fig. 2) were produced from the raw data, filtered to exclude samples with loci call rates missing >40% and individual call rates missing >40%, to allow examination of finer-scale genetic differences (Rutherford *et al.* 2018). Individual samples were identified in each PCoA by using the function *gl.pcoa.plot*, with the label argument set to 'interactive' (Gruber *et al.* 2018).

Bayesian genetic clustering

To assess putative hybridisation and account for fine-scale variation, 'Bracteatum' and 'Boreale' subsets of the sequence data identified using PCoA (Table 5, Fig. 2) were investigated using the Bayesian Monte Carlo Markov-chain (MCMC) procedure implemented in STRUCTURE (ver. 2.3.4, see https://web.stanford.edu/group/pritchardlab/structure_software/release_versions/v2.3.4/html/structure.html; Pritchard *et al.* 2000; Beaumont *et al.* 2001; Falush *et al.* 2003). The program optimises the allele frequencies that characterise K genetic clusters based on a model assuming random mating and linkage disequilibrium within ancestral populations. If a model allowing admixture is used, each individual is assigned a proportion of ancestry derived probabilistically from each ancestral population. This approach is appropriate because it does not assume ancestry *a priori*. We used the default setting for RECESSIVEALLELES = 0, treating all samples as diploid, as diploids comprised the majority of samples (Laport *et al.* 2016). STRUCTURE has previously been tested in several diploid–polyploid species complexes (D'hoop *et al.* 2010; Stöck *et al.* 2010; Moore *et al.* 2014), with little effect of the RECESSIVEALLELES flag observed for codominant markers (Moore *et al.* 2014; Meirmans 2019). Simulations have shown STRUCTURE to be robust in detecting population structure in mixed-ploidy samples (Stift *et al.* 2019). Estimation of ancestry clusters was performed on 10 replications using K = 1–16 for the 'Bracteatum' group, and 10 replications using K = 1–10 for the 'Boreale' group and species and putative entities associated with *X.* sp. Blackfellows Gap. Higher values of K were tested for the 'Bracteatum' group

Table 5. Subsets used to examine large groups within the 'allXerochrysum' PCoA of molecular data for *Xerochrysum*.

Subset	Entity	Population
'Bracteatum' group	*X. bicolor*	Alum Cliffs; Arthur-Pieman CR; Temma.
	X. bracteatum	Cultivars; The Oaks; Bulli Lookout; Mount Keira; Gulaga NP; Nethercote Falls; St Helena; Queenstown, Tasmania.
	X. halmaturorum	Cape St Albans; Lesueur CP; Newland Head; Pink Bay.
	X. interiore	Mereenie Loop Road; Owen Springs NP; Pilbara.
	X. papillosum	St Patricks Head; Tessellated Pavement.
	X. sp. Barrington Tops	Barrington Tops NP.
	X. sp. Flinders Range	Flinders Ranges; Nombinnie NR.
	X. sp. Glencoe	Costello Road; Barrington Tops.
	X. sp. Lofty Ranges	Hindmarsh Falls; Tothill Range.
	X. sp. Mount Kaputar	Lindsay Rock Tops; Mount Coryah; Mount Kaputar summit.
	X. sp. New England	Round Waterhole Creek; Styx River; Henry River Falls.
	X. sp. Point Lookout	New England NP.
	X. viscosum	Apsley Falls; St Arnaud; Black Mountain; Coomba Falls; Coxs River; Green Camp; Hobart; Lithgow; Mudgee; Torrington CR; Wallangarra; Wellington.
'Boreale' group	*X. boreale*	Wadeye; Dundee Beach; Dhupuwamirri; Mirrnatja; Yunupingu Cattle Farm.
	X. bracteatum sens. lat.	Chinchilla; Narrabri; Yeppoon.
	X. sp. Cox Peninsula	Cox Peninsula.
	X. sp. Fly Point	Fly Point.
	X. sp. Mount Elliott	Bowling Green Bay NP.
	X. sp. Mount Merino	The Pinnacle.
	X. sp. North Kennedy	Herberton Range NP; Blackbraes NP; Eungella; Herberton; Paluma Range; Wondecla.
	X. sp. North Stradbroke Island	Town of 1770; Noosa NP; Iluka; Fraser Island NP; Moreton Island NP.
	X. sp. Northern Tablelands	Apsley Falls; Ebor; Costello Road; Barrington Tops NP; The Head; Bunya Mountains NP.
	X. sp. Walker Point	Annan River NP.
Species and putative entities associated with *X.* sp. Blackfellows Gap	*X. subundulatum*	Lake Augusta, Lake Lee Road; Cradle Mountain; Ben Lomond; Mount Buller; Connors Hill; Dead Horse Gap; Wares Yard.
	X. sp. Blackfellows Gap	Namadgi NP.
	X. viscosum	St Arnaud NP; Warby–Ovens NP; Black Mountain; Lithgow.
	X. bracteatum sens. str.	Nethercote Falls; Gulaga NP; The Oaks; Bulli Lookout; Mount Keira.
	X. palustre	Bronte Lagoon; Smiths Lagoon.
	X. aff. *palustre*	Kanangra Boyd NP; Southern Forests NP; Reids Road.

CA, Conservation Area; Ck, Creek; CP, Conservation Park; NP, National Park; NR, Nature Reserve; St, Saint.

because of the greater number of putative entities. Values of K best supported by the data were identified by plotting the natural logarithm of the likelihood and were used to assess the support for each value of K following the reasoning outlined by Pritchard *et al.* (2000). Caution must be taken when interpreting large STRUCTURE barplots because the algorithm parsimoniously explains variation among individuals and does not provide a parametric model of divergence and admixture (Lawson *et al.* 2018). To address this issue, we examined a further four subsets of the data, including (1) *X.* sp. Barrington Tops, *X.* sp. Glencoe, *X.* sp. New England and *X.* sp. Point Lookout, (2) *X. bicolor*, *X. halmaturorum* and *X.* sp. Lofty Ranges, (3) *X. boreale*, *X.* sp. Mount Elliott, *X.* sp. North Kennedy, *X.* sp. Fly Point and *X.* sp. Walker Point, and (4) *X. bracteatum sens. lat.* (putative weedy populations), *X.* sp. Northern Tablelands, *X.* sp. North

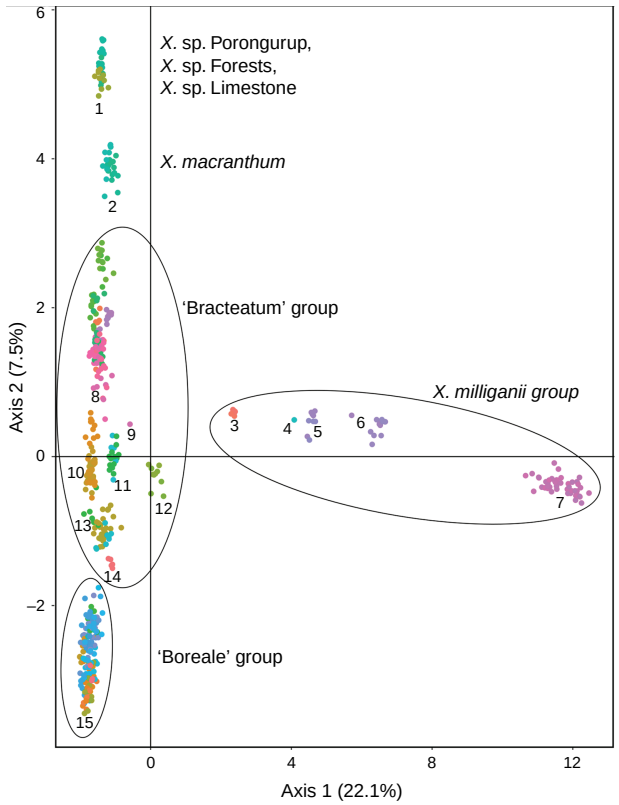

Fig. 2. Principal coordinate analysis Axes 1 and 2 of 2486 single-nucleotide polymorphism loci representing all species of *Xerochrysum* (except *X. collierianum*) and putative entities. Each dot represents an individual sample, coloured by population. Groups are numbered as in Table 9.

Stradbroke, and *X.* sp. Chinchilla. Violations of the model assumptions can occur by inclusion of samples that are close relatives, population divergence owing to isolation-by-distance, subtle subdivisions nested within diverged groups, and recent genetic bottlenecks, potentially leading to misinterpretation of the results (Lawson *et al.* 2018). We also applied an alternative to estimating the optimal number of *K* clusters, by cautiously describing the clustering results over several values of *K* in relation to known natural history data (Funk *et al.* 2020).

Results

Field collections

Collections were made at 116 sites, with 89 vouchers bearing mature cypselae. Photographs of habit and habitat were taken, and notes on associated species and soil substrate were collected.

Phenetic analyses of morphology

Indumentum and trichome length observed on cultivated plants was consistent with that of dried herbarium specimens, although spreading trichomes on live plants became appressed on the dried specimens, an artefact that was likely due to the pressing and drying process. Indumentum on cauline leaves was observed to vary among species and entities, with differing states being described as cobwebby, hispidulous, hispid, hirsute, felted, pilose, tomentose, and woolly, composed of septate trichomes (Fig. 3), sometimes with flagelliform apices (see Fig. 4), or with sessile or stipitate glands. Phenetic analysis of all 97 specimens of *Xerochrysum* using 16 characters produced mixed groups loosely corresponding to named species and putative entities in most cases (Supplementary Fig. S1); *viz*, *X. halmaturorum*, *X. viscosum*, *X.* sp. Glencoe, *X.* sp. North Stradbroke Island, *X. bracteatum*, *X.* sp. Mount Elliott, *X.* sp. North Kennedy, *X. boreale*, *X.* sp. Point Lookout, *X.* sp. New England, and *X.* sp. Northern Tablelands. Entities not forming clusters included *X. bicolor*, *X.* sp. Mount Kaputar, *X.* sp. Lofty Ranges, *X.* sp. Barrington Tops, *X.* sp. Mount Merino, *X. macranthum*, *X.* sp. Porongurup, and *X. papillosum*. Ordinations based on subsets of the data broadly corresponding to northern, southern, eastern and western distribution showed tighter clustering, but again groups were incomplete and somewhat mixed (Fig. 5).

Leaf trichome density, in particular the density of glands on the leaf adaxial surface, had the highest PCC values, indicating that they were the most informative characters in the phenetic analyses (Supplementary Tables S2–S7). Absence or near absence of non-glandular multicellular trichomes on the leaf abaxial surface was recorded on *X. bracteatum sens. str.*, *X.* sp. Barrington Tops with white phyllaries (yellow-phyllaried plants have multicellular trichomes), *X. bicolor*, *X. halmaturorum*, *X.* sp. Lofty Ranges, *X. interiore*, *X. macranthum*, *X.* sp. Walker Point and *X. viscosum* (Tables 6–8). Absence or near absence of glands on the leaf abaxial midvein was recorded on *X. boreale*, *X.* sp. Fly Point, *X.* sp. North Kennedy, and *X.* sp. Walker Point (Tables 6–8). A summary of the morphometric data is available as Supplementary material to this paper (Supplementary Table S8).

Examination of 15 specimens of *X. bracteatum sens. lat.* collected from the eastern and western highlands of Papua New Guinea and held at CANB showed large variations in leaf and stem indumentum, but overall similarity with populations of *X.* sp. North Kennedy and *X.* sp. Mount Elliott. A densely tomentose leaf indumentum, composed of septate trichomes and stipitate glands, was seen on both abaxial and adaxial surfaces. Six collections dating from 1954 to 1968 seemingly have no glands, possibly because of use of EtOH during specimen preservation.

Scanning electron micrographs

Stipitate or sessile glands were seen on most leaves dried for SEM (Fig. 4, S2–S9). Flagelliform trichomes, with filaments extending from the apical cell, were seen on many species

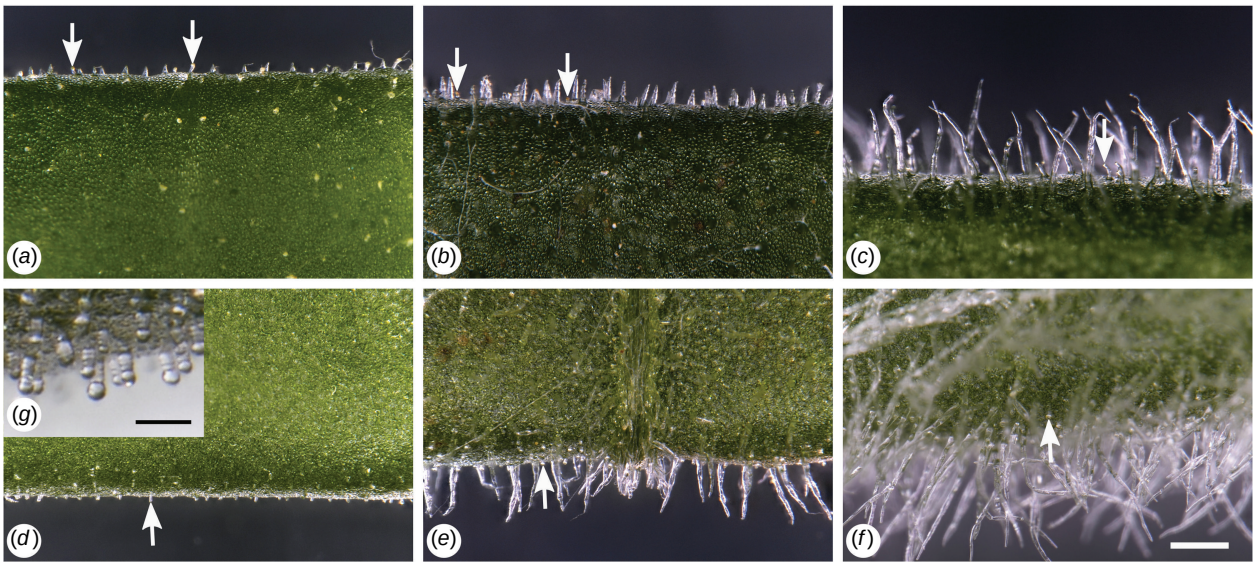

Fig. 3. Indumentum variation among species of *Xerochrysum*. White arrows indicate stipitate glands in *a–g*. Leaf surface: (*a–c*) adaxial; (*d–g*) abaxial. (*a*) Hispidulous and with glands (*X. bracteatum sens. str.*, *T.L.Collins 1005*); (*b*) hispid and with glands (*X.* sp. Barrington Tops, *T.L.Collins 1046*); (*c*) hirsute to pilose, and with glands (*X.* sp. Point Lookout, *T.L.Collins 958*); (*d*) with glands (*X. bracteatum sens. str.*, *T.L.Collins 1005*); (e) hirsute and with glands (*X.* sp. Barrington Tops, *T.L.Collins 1046*); (*f*) pilose and with glands (*X.* sp. Point Lookout, *T.L.Collins 958*); (*g*) stipitate glands on abaxial leaf surface (*X. bracteatum sens. str.*, *T.L.Collins 1005*). Scale bars: 0.5 mm (*a–f*); 100 µm (*g*).

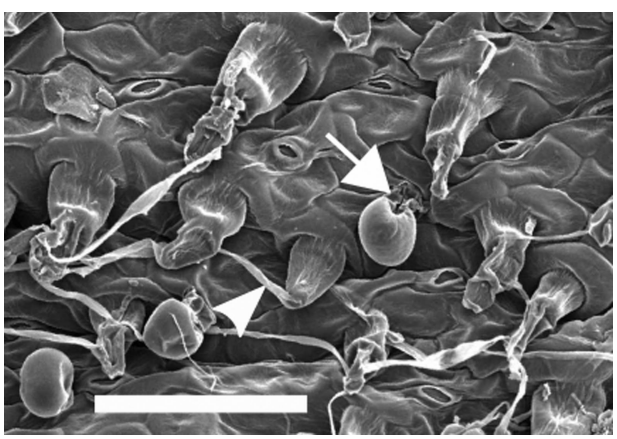

Fig. 4. Flagelliform trichomes and stipitate glands found on some species of *Xerochrysum*. Arrow with tail indicates stipitate gland; arrow without tail indicates septate trichome with flagelliform apex (cauline leaf adaxial surface, *X. macsweeneyorum*, *T.L.Collins 957*). Scale bar: 100 µm.

and putative entities (Fig. 4, S10, S11). The filament, and eventually the trichome, appeared to readily abrade away to retain the trichome base and forming a hispid indumentum. Complete removal of the trichome base was observed on some species (e.g. *X.* sp. North Stradbroke Island, Supplementary Fig. S4b) causing a 'trichome-scar'.

Examination of fresh leaves from cultivated plants confirmed that stipitate or sessile glands occur on all *Xerochrysum* either on adaxial or abaxial surfaces, or on both surfaces. Presence or absence of multicellular trichomes on cauline leaf abaxial surfaces varied between species and putative entities (Tables 7, 8). White phyllary colour seen in some *X.* sp. Barrington Tops populations covaried with the near absence of septate trichomes on the cauline leaf abaxial surface (Fig. 6*e,f*), as well as the much larger cotyledon size than in *X.* sp. Barrington Tops populations with yellow phyllaries.

DArTseq genotyping, population genetic structure and ordination

A total of 555 *Xerochrysum* samples were sequenced using the DArTseq method (Kilian *et al.* 2012). Fourteen of these failed to sequence and provided no data, including all *X. collierianum* samples. The sequence data partition contained 541 samples, with 47 207 loci representing all named species of *Xerochrysum* (except *X. collierianum*) and putative entities (hereafter: 'allXerochrysum'). Filtering 'allXerochrysum' on locus and individual call rate >20 and >30% missing data respectively reduced the dataset to 524 samples and 2486 loci.

Observed heterozygosity was slightly lower than expected for most taxa and populations (Supplementary Table S9). All taxa had a positive F_{IS} indicative of reduced heterozygosity, with less densely sampled populations having both higher expected and observed heterozygosities than did the larger groups. Very high values of F_{ST} (>0.4) were obtained for *X. bicolor*, *X. boreale*, *X. halmaturorum*, *X. palustre*, *X.* aff. *palustre*, *X. papillosum*, *X.* sp. Lofty Ranges, and *X.* sp. New England (Supplementary Table S9). Pairwise F_{ST} comparisons among *X. bicolor*, *X. halmaturorum* and *X.* sp. Lofty

Fig. 5. Semi-strong hybrid multi-dimensional scaling ordinations of morphological characters on subsets of species and putative entities of *Xerochrysum* representing broad distribution patterns across Australia (Table 4). (*a*) Northern; (*b*) southern; (*c*) eastern; (*d*) western. Each ball represents an individual sample, coloured by species or putative entity.

Table 6. Summary of morphological observations seen in species and putative entities of *Xerochrysum* in the *X. milliganii* Group based on herbarium specimens and cultivated plants.

Entity	Outer phyllary abaxial indumentum	Plant base	Adaxial leaf-surface glandular vesicles	Abaxial leaf-surface septate trichomes	Phyllary shape	Foliaceous bracts subtending capitula >10 mm long	Cauline leaves >10 mm wide
X. alpinum	sca	rhi	sti	abs	acu	Yes	No
X. aff. *palustre*	sca	rhi	ses	abs	acu	Yes	No
X. collierianum	gla	fib	sti	abs	acu	Yes	No
X. milliganii	gla	fib	abs	pre	acu	No	No
X. palustre	gla	rhi	abs	abs	acu	No	No
X. subundulatum	sca	rhi	sti	abs	acu	Yes	Yes

gla, glabrous; sca, scabridulous; rhi, rhizomatous; fib, fibrous; ses, sessile; abs, absent; pre, present; acu, acuminate; obt, obtuse.

Table 7. Summary of morphological observations in species and putative entities of *Xerochrysum* included in the 'Bracteatum' group, based on herbarium specimens and cultivated plants.

Entity	Plant base	Life form	Capitula	Abaxial leaf-surface septate trichomes	Medial phyllary shape	Foliaceous bracts subtending capitula >10 mm long	Cauline leaves >10 mm wide
X. sp. Point Lookout	rhi	per	pan	pre	lan	Yes	Yes
X. bicolor	tap	per	pan	abs	lan	No	Yes
X. bracteatum sens. str.	tap	ann	pan	abs	obl	No	Yes
X. sp. New England	rhi	per	pan	pre	lan	No	No
X. sp. Barrington yellow	rhi	per	pan	pre	ova	Yes	Yes
X. sp. Barrington white	rhi	per	pan	rarely	ova	Yes	Yes
X. sp. Blackfellows Gap	rhi	per	sol	abs	ova	Yes	Yes
X. sp. Flinders Range	tap	ann	pan	abs	ova	Yes	Yes
X. halmaturorum	tap	per	pan	abs	lan	Rarely	Yes
X. interiore	tap	ann	pan	abs	ova	No	Yes
X. macranthum	tap	ann	pan	abs	lan	No	Rarely
X. sp. Glencoe	tap	per	sol	pre	obl	Yes	Rarely
X. sp. Lofty Ranges	tap	per	pan	abs	lan	No	Yes
X. papillosum	tap	per	pan	abs	lan	Yes	Rarely
X. sp. Porongurup	tap	per	pan	scattered	ell	Rarely	Yes
X. viscosum	tap	per	pan	rarely	obl	No	No

gla, glabrous; sca, scabridulous; rhi, rhizomatous; tap, taproot; per, perennial; ann, annual or biennial; sol, solitary; pan, in panicles; abs, absent; pre, present; lan, lanceolate; ova, ovate; obl, oblong; ell, elliptic.

Ranges indicated a gradual increase in genetic divergence between populations as distance between populations increased (Supplementary Table S11). Populations of *X. halmaturorum* on Kangaroo Island showed the greatest level of divergence (0.593–0.599) from Tasmanian *X. bicolor* (0.222–0.313). Pairwise F_{ST} comparisons among populations of *X.* sp. North Kennedy, *X.* sp. Mount Elliott, *X.* sp. weedy, and *X.* sp. North Stradbroke Island indicated similar levels of genetic divergence among populations of *X.* sp. North Kennedy on the Atherton Tablelands (0.182–0.201), and between Atherton Tablelands populations and those in the Paluma Ranges and *X.* sp. Mount Elliott at Mount Elliott (0.137–0.214; Supplementary Table S13).

The first two axes in the PCoA of 'allXerochrysum' (Fig. 2, Table 9) explained 29.6% of the genetic variation and showed distinct separation of some taxa. Axis 1 clearly separates *X. subundulatum* (Fig. 2, Cluster 7) and the rest of *X. milliganii* group from all other species and putative entities of *Xerochrysum*. *Xerochrysum* aff. *palustre* (Cluster 6) is disjunct and separate from *X. palustre sens. str.* (Cluster 5), *X. milliganii* (Cluster 4) and *X. alpinum* (Cluster 3). Axis 1 also separates *X.* sp. Glencoe (Cluster 12) from other species and putative entities of *Xerochrysum*. Axis 2 of 'allXerochrysum' (Fig. 2) shows *X.* sp. Porungurup, *X.* sp. Forests and *X.* sp. Limestone as a distinct group (Cluster 1) separated from *X. macranthum* (Cluster 2).

The large subset 'Bracteatum' PCoA Axes 1 and 2 (Fig. 7*a*) showed 23.4% of the genetic variation and all species and putative entities formed distinct clusters except for *X. papillosum* and *X. viscosum*. 'Bracteatum' PCoA Axes 1 and 3 (Fig. 7*b*) showed separation of *X. papillosum* from *X. viscosum* and also separated the *X. interiore* central Australian populations from *X.* sp. Pilbara. Unexpectedly, *X.* sp. New England separated into two clusters, with one representing the Henry River Falls population clustering close to populations of *X. viscosum*, and the other Round Waterhole Creek and Jeogla populations clustering near samples of *X.* sp. Glencoe and *X.* sp. Mount Merino. Also, *X. bracteatum sens. str.* forms three groups, comprising (1) introduced plants on St Helena, (2) naturally occurring populations in New South Wales, and (3) the cultivars (Fig. 7, labelled *a*, *b*, and *c* respectively). Tasmanian and South Australian populations of *X. bicolor*, *X. halmaturorum*, and *X.* sp. Lofty form a single cluster in both Axes 1 and 2, and 1 and 3.

The smaller subset 'Boreale' PCoA Axes 1 and 2 (Fig. 8*a*) explained 30.4% of the genetic variation of these samples, and clearly separated the Gheebulum Kunungai (Moreton Island) National Park population of *X.* sp. North Stradbroke Island from all other samples. Other populations of this putative entity formed separate clusters; the Iluka population was nested within *X.* sp. Northern Tablelands as was the

Table 8. Summary of morphological observations seen in species and putative entities of *Xerochrysum* included in the 'Boreale' group, based on fieldwork, herbarium specimens and cultivated plants.

Entity	Life form	Capitula	Adaxial glands	Abaxial septate trichomes	Medial phyllary shape	Subtending foliaceous bracts >10 mm long	Cauline leaves >10 mm wide
X. sp. Walker Point	per	sol	sti	abs	lan	Yes	Rarely
X. boreale	per	pan	abs	pre	ova	No	Yes
X. sp. Chinchilla	ann	pan	sti	abs	ova	Rarely	Rarely
X. sp. Mount Merino	per	pan	sti	pre	lan	Yes	Yes
X. sp. Mount Elliott	per	pan	sti	pre	lan	Yes	Yes
X. sp. North Kennedy	per	pan	sti	pre	lan	Yes	Yes
X. sp. Fly Point	per	pan	abs	pre	lan	Yes	Yes
X. sp. Northern Tablelands	ann	pan	sti	pre	obl	Rarely	No
X. sp. North Stradbroke Island	per	pan	sti	scattered	ova	Yes	Yes
X. sp. weedy	ann	pan	sti	abs	ova	Yes	Yes

per, perennial; ann, annual or biennial; sol, solitary; pan, in panicles; sti, stipitate; abs, absent; pre, present; lan, lanceolate; ova, ovate; obl, oblong.

naturalised *X. bracteatum sens. lat.* from Tasmania; the Noosa NP, Town of 1770 and K'gari (Fraser Island) populations clustered very close to Gloucester Tops plants of *X.* sp. Northern Tablelands as well as Chinchilla and Narrabri plants of *X. bracteatum sens. lat.*; and the Byfield plants clustered as a distinct group nearby. Samples of *X.* sp. North Kennedy clustered with *X.* sp. Fly Point, *X.* sp. Walker Point and *X.* sp. Mount Elliott, except for the single sample from Eungella, west of Mackay, which was placed either intermediate to the Yeppoon plants (Fig. 8*a*), or the Byfield plants (Fig. 8*b*). All samples of *X. boreale* formed a distinct and well-separated cluster. 'Boreale' group PCoA Axes 1 and 3 (Fig. 8*b*) explained 28.5% of the genetic variation and showed distinct separation of *X.* sp. Fly Point, *X. boreale* and the Gheebulum Kunungai (Moreton Island) National Park population of *X.* sp. North Stradbroke Island from all other samples. Clustering of remaining samples from the 'Boreale' group PCoA Axes 1 and 3 was in accordance with Axes 1 and 2.

PCoA of the *X.* sp. North Kennedy and closely associated entities, Axes 1 and 2 (Fig. 9*a*), contained 29.7% of the genetic variation of these samples. Axes 1 and 3 (Fig. 9*b*) contained 23.7% of the genetic variation. Populations of *X.* sp. North Kennedy formed three clusters congruent with a north–south distribution. Both Axes 1 and 2, and Axes 1 and 3 showed *X.* sp. Fly Point and *X.* sp. Walker Point as separate clusters from *X.* sp. North Kennedy.

Population genetic structure Bayesian genetic clustering

For the 'Bracteatum' group, the log-likelihood of the model suggested K lay in the range $K = 6$–9 (Supplementary Fig. S12). There was very little increase in K from $K = 6$, and, at $K = 7$, large variations in mean log-likelihood made interpretation uncertain. This indicated that the single-nucleotide polymorphism data may represent between six and nine distinct entities. STRUCTURE bar plots in the range $K = 6$–9 suggested that there is no shared ancestry or recent gene flow between *X. bracteatum sens. str.* and all of the putative entities except a small proportion with *X.* sp. Flinders Range populations, which contained a complex mix of allele frequencies (Fig. 10, S13). *Xerochrysum papillosum* was distinct from all other entities $K = 6$–9. The putative entities *Xerochrysum* sp. Mount Merino and *X.* sp. Point Lookout were different mixtures of ancestry clusters. Bar plots between $K = 6$–9 also suggest that *X. viscosum* and *X.* sp. Mount Kaputar share a common ancestry, with only slight variations between populations, as do *X.* sp. Barrington Tops–*X.* sp. Glencoe, and *Xerochrysum interiore*–*X.* sp. Pilbara.

Common ancestry was also suggested among *X. bicolor*, *X. halmaturorum* and *X.* sp. Lofty Ranges (Fig. 10). At $K = 7$–8, different allele frequencies were suggested between *X. bicolor* and *X. halmaturorum*, with *X.* sp. Lofty

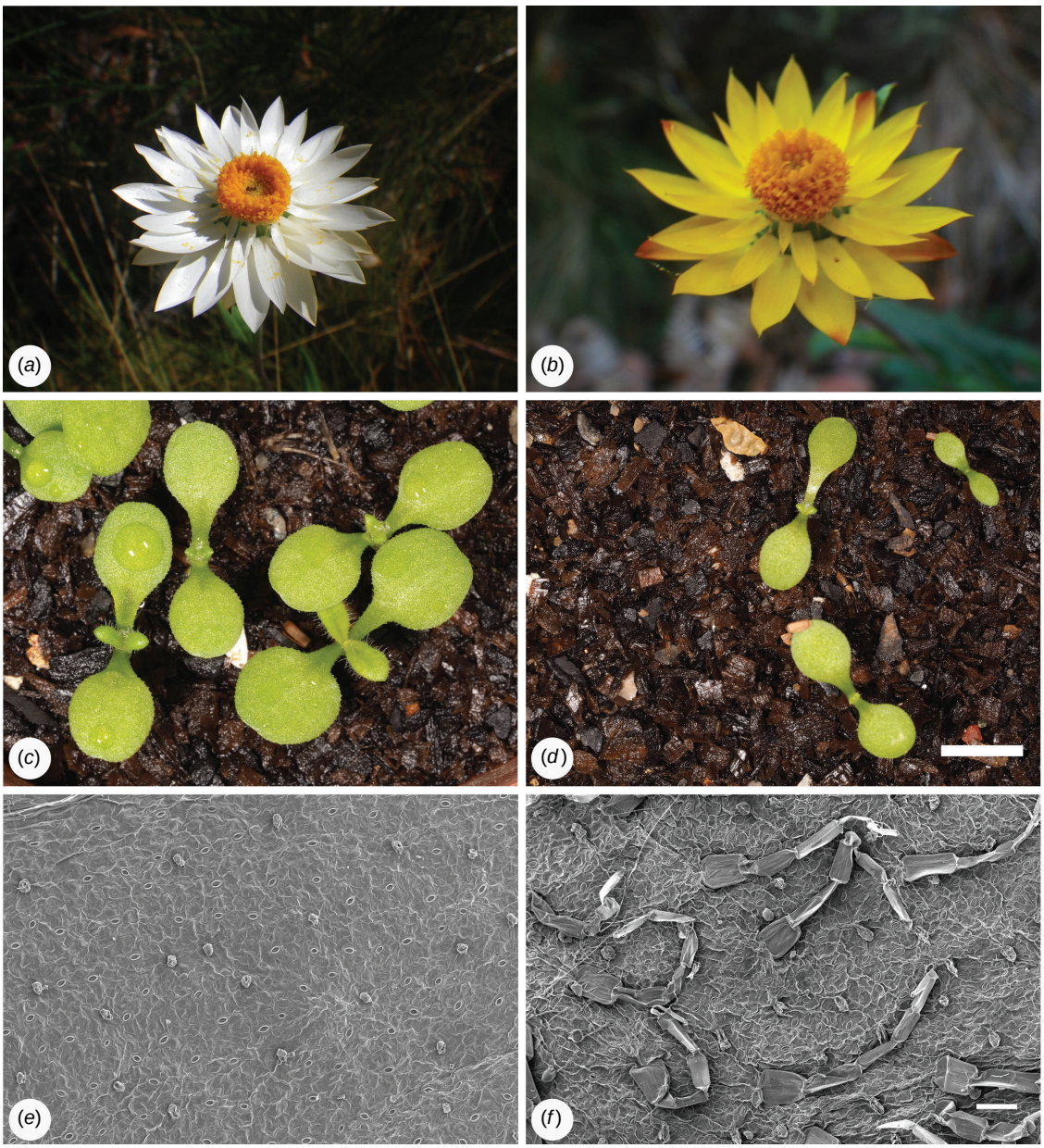

Fig. 6. Comparative morphology of phyllary colour, cotyledon size and cauline leaf abaxial indumentum for *Xerochrysum* sp. Barrington Tops populations. (*a*, *c*, *e*) White phyllaries *T.L.Collins 1043*; (*b*, *d*, *f*) yellow phyllaries *T.L.Collins 1046*. Scale bars: 1 cm (*d*, for *c* and *d*); 100 µm (*f*, for e and *f*).

Ranges sharing proportions of both (Supplementary Fig. S13 and Table S10). At $K = 9$, *X. bicolor* was again similar to *X.* sp. Lofty Ranges, with small differences in ancestry in *X. halmaturorum*.

Bayesian analysis on a subset of the 'Bracteatum' data examining allele frequencies shared among *X.* sp. Barrington Tops, *X.* sp. Glencoe, *X.* sp. New England and *X.* sp. Point Lookout suggested $K = 5$ (Supplementary Fig. S14). Results confirmed separate ancestry of *X.* sp. Barrington Tops, *X.* sp. Glencoe, and *X.* sp. Point Lookout (Fig. 11), with *X.* sp. New England diverged into two lineages, with the population at Round Waterhole Creek being largely distinct from those at Henry River Falls and Jeogla.

A subset containing *Xerochrysum bicolor*, *X. halmaturorum* and *X.* sp. Lofty Ranges suggested $K = 3$ (Supplementary Fig. S15), with *X. bicolor* being distinct from both other entities (Fig. 12). This subset suggested greater genetic complexity than did the analysis of 'Bracteatum'. Populations of *X. halmaturorum* on Kangaroo Island at Cape St Albans, Lesueur and Pink Bay shared ancestry distinct and separate from plants at Newland Head, which had shared ancestry with the Tothill Range populations. Plants of *X.* sp. Lofty

Table 9. Taxon and putative entity clusters from principal coordinate analysis of 2486 single-nucleotide polymorphism loci representing all species of *Xerochrysum* (except *X. collierianum*).

Number	Cluster	Taxon	Scope
1		*X.* sp. Porongurup, *X.* sp. Forests, *X.* sp. Limestone	All populations for these entities
2		*X. macranthum*	All populations for this species
3	*X. milliganii* group	*X. alpinum*	All populations for this species
4		*X. milliganii*	All populations for this species
5		*X. palustre*	All populations for this species
6		*X.* aff. *palustre*	All populations for this entity
7		*X. subundulatum*	All populations for this species
8	'Bracteatum' group	*X. viscosum*, *X.* sp. Mount Kaputar, *X. halmaturorum*, *X.* sp. Lofty Ranges, *X. papillosum*, *X. bicolor*	All populations for these entities
9		*X.* sp. Blackfellows Gap	Namadgi NP
10		*X. bracteatum sens. str.*	All populations for this species
11		*X. interiore*, *X.* sp. New England	All populations for these entities except *X.* sp. New England, Henry River Falls
12		*X.* sp. Glencoe	All populations for this entity
13		*X.* sp. Barrington Tops, *X.* sp. Flinders Range, *X.* sp. New England, *X.* sp. Mount Merino	All populations for these entities
14		*X.* sp. Point Lookout	New England NP
15	'Boreale' group	*X. bracteatum sens. lat.*, *X.* sp. North Stradbroke Island, *X.* sp. Northern Tablelands, *X.* sp. North Kennedy, *X.* sp. Mount Elliott, *X. boreale*, *X. interiore*, *X.* sp. Walker Point, *X.* sp. Fly Point, *X.* sp. weedy	All populations for these entities except *X. bracteatum sens. lat.*, Tasmania, Chinchilla, Narrabri.

NSW, New South Wales; NP, National Park.

Ranges at Hindmarsh Falls were suggested to have ~30% ancestry shared with Kangaroo Island populations and the remainder with plants at Newland Head and Tothill Range (Fig. 12).

Bayesian analysis of a subset containing populations of *X. viscosum* and *X.* sp. Mount Kaputar was largely congruent with 'Bracteatum' data, suggesting *X. viscosum* and *X.* sp. Mount Kaputar to be conspecific (Supplementary Fig. S13, S16, S17). Populations at the northern extent of the distribution of *X. viscosum*, at Torrington, Wallangara and Coomba Falls, were suggested to have different ancestry (Supplementary Fig. S17). The plants at Apsley Falls, previously thought to be a putative new entity conspecific with *X.* sp. Mount Kaputar, share ~36% ancestry with the Torrington plants.

The log-likelihood of the model of the STRUCTURE analysis for the 'Boreale' group (Supplementary Fig. S18), suggested $K = 6$. However, at $K = 7$, large variations in mean log probability scores made assessment of K difficult. The main differences between clusters at $K = 6$ and those at $K = 7$ (Supplementary Fig. S19) were the suggested divergence of *X. bracteatum sens. lat.* populations from *X.* sp. North Stradbroke Island, and the suggested divergence of *X.* sp. Fly point and *X.* sp. Walker Point, both from each other, and from *X.* sp. North Kennedy. These results can also be seen in the major and minor clusters at $K = 6$ (Fig. 13). Ancestry of all populations of *X. boreale*, including *X.* sp. Cox Peninsula, are shared at $K = 6$ (Fig. 13). Most populations of *X.* sp. Northern Tablelands shared a common ancestry with the Iluka population of *X.* sp. North Stradbroke Island. Exceptions were plants in southern Queensland, at The Head and Bunya Mountains NP, which had ~12–23% of *X.* sp. North Stradbroke Island ancestry. At $K = 6$, differences between major and minor clusters suggested varying proportions of shared ancestry among *X.* sp. North Stradbroke Island from Byfield NP, 1770, Noosa National Park and K'gari (Fraser Island) and *X. bracteatum sens. lat.* from Narrabri and Chinchilla. The Gheebulum Kunungai (Moreton Island) National Park population of *X.* sp. North Stradbroke Island was distinct from all other samples in the analysis. Bar plots of major and minor clusters at $K = 6$ showed that all populations sampled of *X.* sp. North Kennedy clustered with *X.* sp. Mount Elliott and suggested similar ancestry to populations at Fly Point and Walker Point, except for differing proportions of a maroon-coloured cluster (Fig. 13).

Bayesian analysis of a subset of the 'Boreale' data examining allele frequencies shared between *X. boreale*, *X.* sp. Fly Point, *X.* sp. Mount Elliott, *X.* sp. North Kennedy and *X.* sp. Walker Point suggested $K = 6$ (Supplementary Fig. S20). Results confirmed the unique ancestry of both *X.* sp. Fly

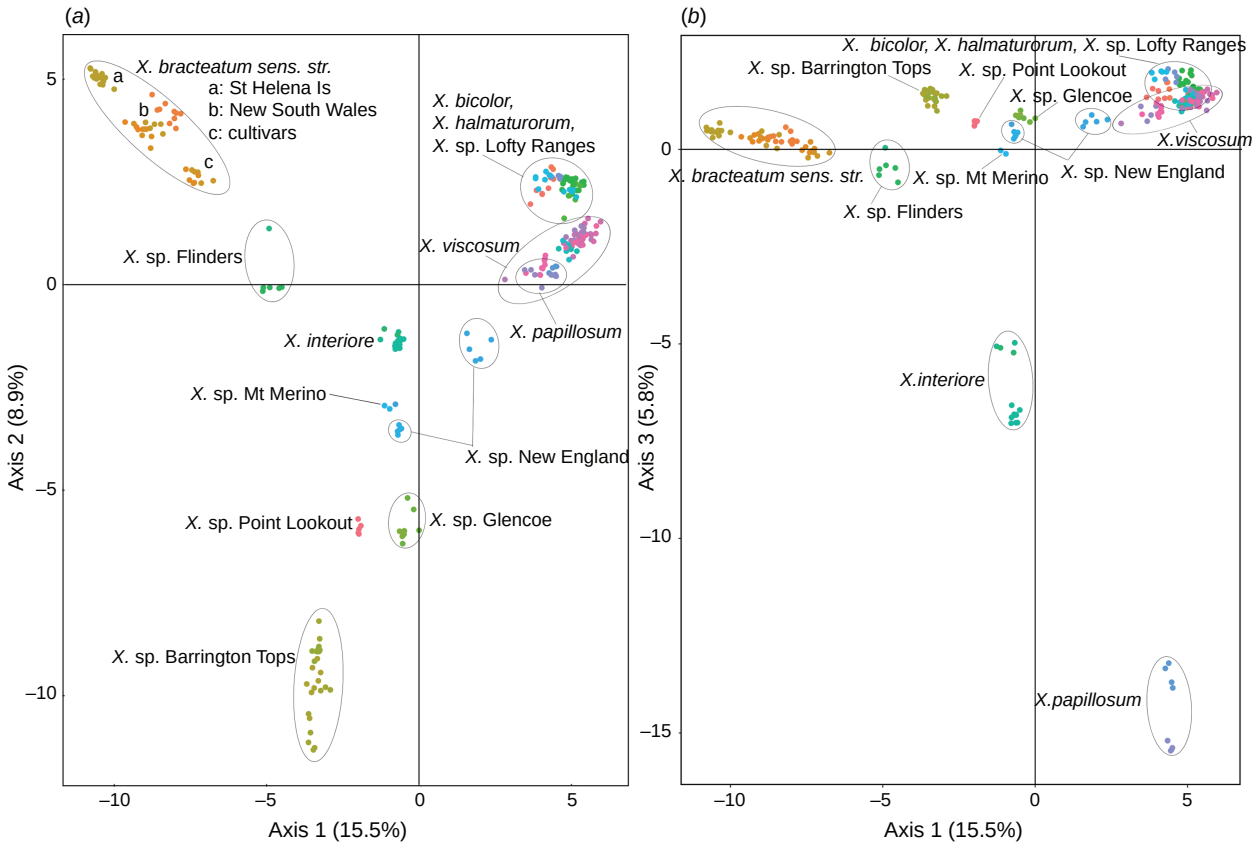

Fig. 7. Principal coordinate analysis of 5637 single-nucleotide polymorphism loci representing species and putative entities of *Xerochrysum* in the 'Bracteatum' group. Each dot represents an individual sample, coloured by population. (*a*) Axes 1 and 2; (*b*) Axes 1 and 3.

Point and *X*. sp. Walker Point, and suggested population genetic structure between eastern and western populations of *X. boreale*, and between northern and southern populations of *X*. sp. North Kennedy, with the southern populations at Paluma and Blackbraes National Park having ancestry similar to that of *X*. sp. Mount Elliott (Fig. 14). Plants at Wondecla were suggested to have ~56% ancestry shared with Herberton and Baldy Mountain, and ~43% with Blackbraes National Park. The Paluma Range and Mount Elliott populations were suggested to have a complex ancestry; however, examination of the raw output showed both clustering with the Blackbraes population in 8 of the 10 runs at $K = 6$. A subset analysing allele frequencies shared between *X*. sp. North Stradbroke Island, *X*. sp. Northern Tablelands, and *X. bracteatum sens. lat.* (including *X*. sp. Chinchilla and *X*. sp. weedy) suggested $K = 4$ (Supplementary Fig. S21), and STRUCTURE bar plots (Supplementary Fig. S22) were congruent with 'Boreale' results (Fig. 13).

For the analysis of putative relatives of *X*. sp. Blackfellows Gap, the log-likelihood of the model suggested $K = 5$ (Supplementary Fig. S23); however, biologically relevant clustering occurred up to $K = 6$. STRUCTURE bar plots at $K = 4$ did not distinguish between *X. bracteatum sens. str.*, *X. viscosum* and *X*. sp. Blackfellows Gap, but did separate *X. subundulatum*, *X. palustre* and *X*. aff. *palustre* (Fig. 15). At $K = 5$, 9 of the 10 runs separated *X. bracteatum sens. str.* and *X. viscosum*, whereas *X*. sp. Blackfellows Gap appeared to share a complex mix of ancestry with both of these species and small proportion of *X. subundulatum*.

Discussion

This study is the first to apply molecular and quantitative morphological approaches to attempt to resolve species limits in *Xerochrysum*. Multiple data sources are critical to delimit species in taxonomically difficult groups (Dayrat 2005; Anderson *et al.* 2017). Although phenetic analysis of morphological characters did not produce distinct clusters corresponding with named species and putative entities, indumentum characters were found to be informative in delimiting the phrase name entities. The differences observed here support most species recognised in past revisions that applied intuitive approaches (i.e. without quantitative analysis) to species delimitation in *Xerochrysum* (e.g. Wilson 2017). Molecular analyses of populations of *X*. aff. *palustre*

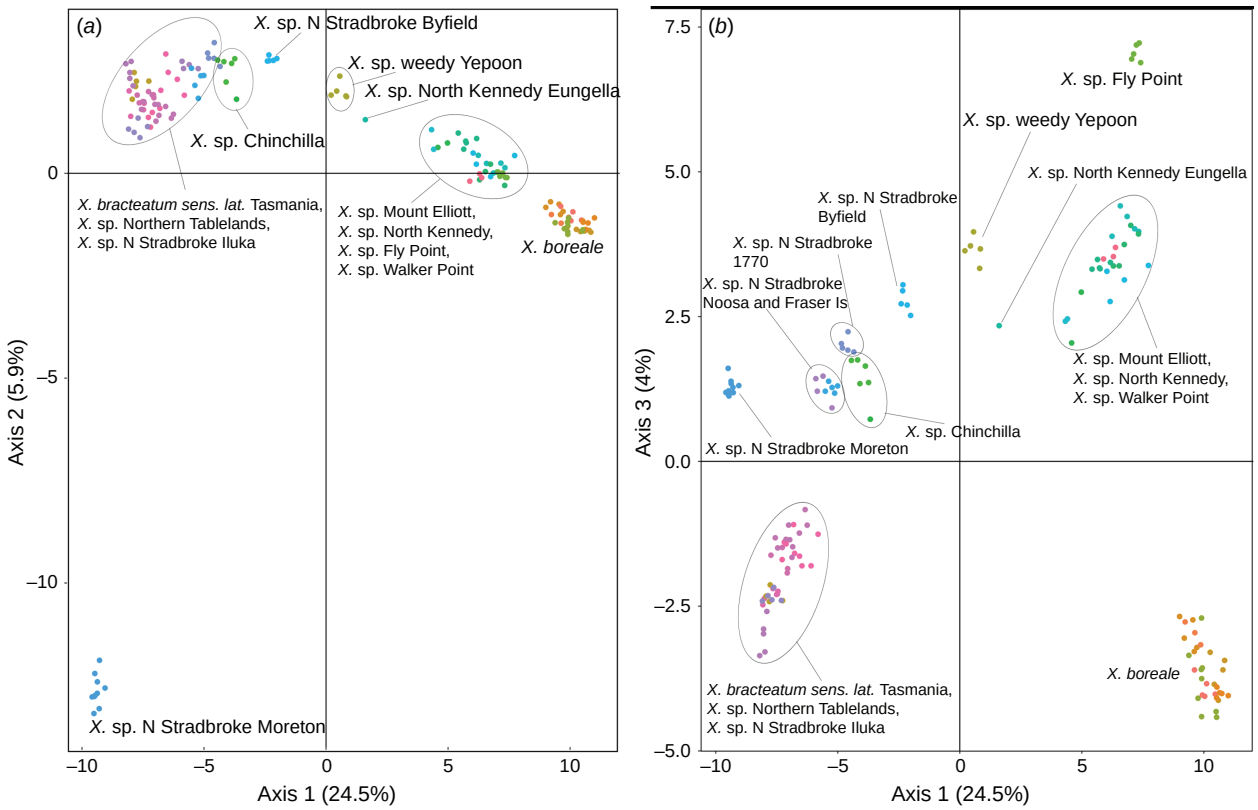

Fig. 8. 'Boreale' principal coordinate analysis of 4637 single-nucleotide polymorphism loci representing some species and putative entities of *Xerochrysum*. Each dot represents an individual sample, coloured by population. (*a*) Axes 1 and 2; (*b*) Axes 1 and 3.

and populations currently included in the *X. bracteatum* complex, indicated genetic disjunctions, and the diagnostic morphology presented here (Tables 6–8) strongly supports the long-standing hypothesis that many of the recognised and putative entities merit consideration as taxonomic groups.

Molecular data indicated that *X.* aff. *palustre* is distinct and separate from both *X. subundulatum* and *X. palustre* (Fig. 2, Table 9). Bayesian clustering clearly distinguished this entity at low values of *K* (Fig. 15). Morphologically *X.* aff. *palustre* is distinguished from *X. subundulatum* by the sessile glands on the adaxial leaf surface (stipitate glands in *X. subundulatum*) and narrower leaves, and from *X. palustre* by the scabridulous outer phyllaries (Table 8). These multiple lines of evidence support the recognition of *X.* aff. *palustre* as a distinct species.

The Western Australian perennial, *X.* sp. Porongurup, clustered in the PCoA (Fig. 2) with *X.* sp. Forests and *X.* sp. Limestone, and morphological comparisons were also unable to find differences to separate these entities. However, these entities are genetically distinct from the annual or occasionally biennial herb *X. macranthum* and all other species and putative entities of *Xerochrysum*. Morphological comparisons from herbarium specimens and field observations indicated that *X.* sp. Porongurup, *X.* sp. Forests and *X.* sp. Limestone comprise a single entity that is a long-lived perennial, with broader, hairier leaves and slightly larger inflorescences than those of the annual *X. macranthum* (Table 7), and should be recognised as a distinct entity.

Analyses of subsets of molecular data (Fig. 7, 8) were able to detect and visualise finer-scale genetic differences. Molecular data supported the hypotheses formed during field work that *X. bracteatum sens. str.* occurs only in the Sydney Basin, and South East Corner bioregions (Fig. 7 and Collins *et al.* 2021). The molecular data also showed distinct clusters corresponding to *X.* sp. Flinders Range, *X.* sp. Mount Merino, *X.* sp. Northern Tablelands, and *X.* sp. Point Lookout, corroborating the morphological differences seen in the field and on herbarium specimens. An unexpected outcome was *X.* sp. New England forming two genetic clusters, with Henry River Falls and Jeogla plants being intermediate between the Round Waterhole Creek samples and the cluster of *X. viscosum* (Fig. 7). Bayesian analysis suggested that the Henry River Falls plants have mixed ancestry and share ~56% of their ancestry with *X. viscosum*, ~31% with *X.* sp. New England, and ~13% with *X.* sp. Northern Tablelands (T. L. Collins, J. J. Bruhl, R. L. Andrew, I. R. H. Telford and A. N. Schmidt-Lebuhn, unpubl. data). This putative hybrid has leaf shape and size

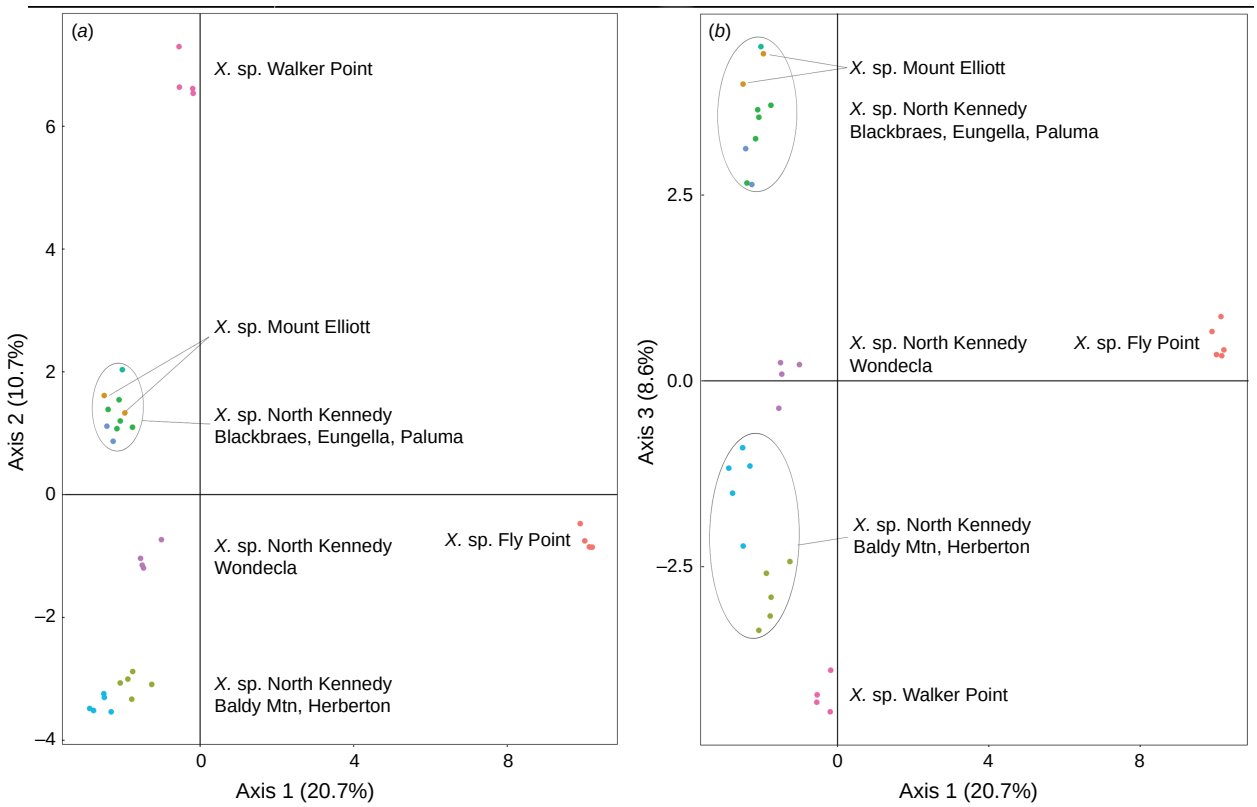

Fig. 9. *Xerochrysum* sp. North Kennedy and genetically similar entities principal coordinate analysis of 1342 single-nucleotide polymorphism loci. Each dot represents an individual sample, coloured by population. (*a*) Axes 1 and 2; (*b*) Axes 1 and 3.

similar to those of *X.* sp. New England; however, cauline leaf abaxial surface and margin indumentum are very similar to *X. viscosum* (Supplementary Table S8). None of the putative parental species has been collected from Henry River Falls, but *X. viscosum* is common at Torrington State Conservation Area (~75 km away), and *X.* sp. New England was collected from Round Waterhole Creek ~30 km away.

Xerochrysum sp. Mount Elliot and *X.* sp. North Kennedy were genetically similar (Fig. 9), with populations of both exhibiting separation along a geographic cline, possibly owing to genetic drift (Mitchell-Olds and Schmitt 2006), although genetic divergence was observed to be small (Supplementary Table S13). Bayesian clustering suggested shared ancestry (Fig. 13) and morphological comparisons (Table 8) were unable to detect distinct characters that separate these entities. Both these lines of evidence supported the conclusion that *X.* sp. Mount Elliot and *X.* sp. North Kennedy are a single entity, hereafter referred to as *X. strictum*, which is formally described in the Taxonomy section (below). Specimens of *Xerochrysum* collected in Papua New Guinea in the eastern and western highlands at altitudes of ~1000 m were morphologically similar to *X. strictum,* supporting the hypothesis that this species also occurs there.

The molecular data showed *X. strictum*, *X.* sp. Fly Point and *X.* sp. Walker Point as having distinct genetic differences (Fig. 9). Comparisons of habit, capitula arrangement, leaf indumentum (on both adaxial and abaxial surfaces), and leaf width showed differences that were maintained in cultivation among the three entities (Table 8, Supplementary Fig. S5, S6). Genetic and morphological differentiation outlined above supported the recognition of *X. strictum*, *X.* sp. Fly Point and *X.* sp. Walker Point as distinct species.

Xerochrysum sp. New England, *X.* sp. Barrington Tops and *X.* sp. Glencoe were genetically and morphologically distinct in multivariate ordinations, and Bayesian clustering did not distinguish between *X.* sp. Barrington Tops populations with white and yellow phyllaries. Most Australian herbaria include these three putative entities in the unpublished subspecies *X. bracteatum* subsp. *barringtonense* Paul G.Wilson MS. At Barrington Tops NP, *X.* sp. Barrington Tops and *X.* sp. Glencoe populations occur sympatrically and have similar flowering phenology (Australia's Virtual Herbarium, see http://avh.chah.org.au; T. L. Collins, pers. obs., 2018). Some plants of *X.* sp. Barrington Tops with intermediate pale yellow phyllary colour were seen at one site where yellow and white phyllary populations co-occurred with *X.* sp. Glencoe (T. L. Collins, pers. obs., 2018). The intermediate plants with pale yellow phyllaries shared similar leaf abaxial indumentum, with plants with white phyllaries, whereas plants with golden yellow phyllaries are hirsute abaxially.

Comparisons of morphology among *X.* sp. Barrington Tops, *X.* sp. New England and *X.* sp. Glencoe (Table 7)

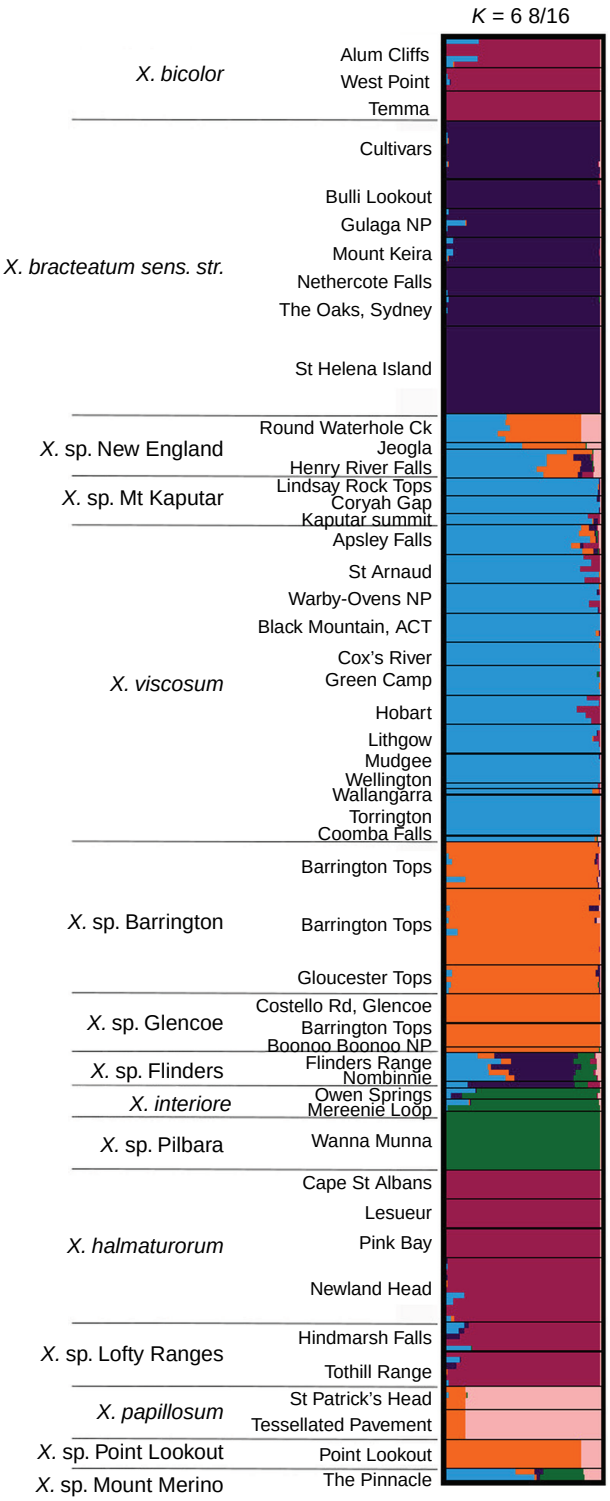

Fig. 10. STRUCTURE bar plots for 'Bracteatum' samples of *Xerochrysum*, major clustering modes $K = 6$. Bar plots show each individual as a horizontal bar divided into segments on the basis of the proportion of ancestry suggested for 1–16 subpopulations across 8 of the 16 runs; $n = 246$. Fine black lines delineate sampling locations.

demonstrated that the crown and root system, arrangement of capitula, and leaf-width characters separate them, both from each other, and from *X. bracteatum sens. str.* Recognising these three putative entities as distinct groups, separate from *X. bracteatum sens. str.* and all other entities studied here, is supported by the genetic differentiation (Fig. 2, 7) and the diagnosable morphological differences (Table 7). The population of putative hybrids between *X.* sp. New England and *X. viscosum* at Henry River Falls can also be distinguished using leaf morphology, from among *X.* sp. Barrington Tops, *X.* sp. Glencoe, and their parents (Table 7).

Wilson's (2017) formal description of *X. halmaturorum* is very similar to his description of *X. bicolor*. The only clear distinguishing character in the descriptions is the presence of 'tuberous roots' on *X. bicolor* (Wilson 2017). We did not observe tuberous roots on any species or putative entities of *Xerochrysum* throughout the fieldwork or on herbarium specimens. Morphological comparisons were unable to find distinct differences to separate the group of *X. bicolor*, *X. halmaturorum* and *X.* sp. Lofty Ranges (Table 7), and the molecular data did not consistently identify distinct ancestry clusters (Fig. 7, 12). Pairwise comparisons of F_{ST} indicated similar genetic divergence between Tasmanian populations of *X. bicolor*, and between *X. bicolor* and *X.* sp. Lofty Ranges (Supplementary Table S11). Populations of *X. halmaturorum* on Kangaroo Island had the greatest level of divergence from both Tasmanian *X. bicolor* and *X.* sp. Lofty Ranges in the Tothill Ranges. This indicated genetic similarity and may reflect continuous gradations or admixture between some populations (Rosenberg *et al.* 2002). These multiple sources of data supported the inclusion of *X. halmaturorum* and *X.* sp. Lofty Ranges in an expanded *X. bicolor*, which has nomenclatural precedence (Lindley 1835).

A long-standing putative natural hybrid between *X. subundulatum* and *X. viscosum* (Burbidge 1970), *X.* sp. Blackfellows Gap, is currently included in *X. subundulatum* (CHAH 2020*a*). First collected in 1961, additional collections were made in 1987 (~10 km south of Blackfellows Gap at Mount Murray, *P. Gilmore 6209*), and in 2007 (3.5 km north-east of Mount Murray at Cotter Hut, *J.J. Bruhl 2596*). *Xerochrysum viscosum* and *X. subundulatum* are both common in Namadgi National Park (Australia's Virtual Herbarium, see http://avh.chah.org.au). Molecular data showed *X.* sp. Blackfellows Gap to be genetically more similar to *X. viscosum* and *X. bracteatum sens. str.* than to *X. subundulatum* (Fig. 2). Bayesian clustering suggested a complex mixture of ancestry, mainly comprising *X. viscosum* but with traces of *X. bracteatum*, *X. subundulatum*, *X. palustre* and *X.* aff. *palustre* (Fig. 15). Confident conclusions cannot be formed (Rosenberg *et al.* 2002); however, the single sample was neither intermediate nor nested in *X. subundulatum* or any of the *X. milliganii* group (Fig. 2). The three disjunct collections made over the past 46 years enclose an area over 1500 ha (Australia's Virtual Herbarium, see http://avh.chah.org.au), indicating a persistent presence.

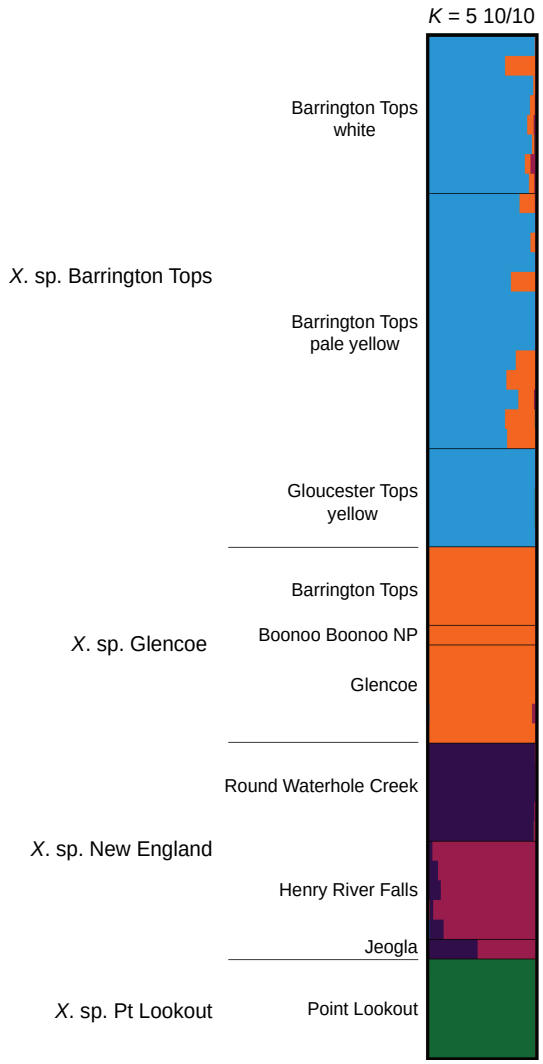

Fig. 11. STRUCTURE bar plots for the putative species *Xerochrysum* sp. Barrington Tops (white, pale yellow and yellow phyllary colours), *X.* sp. Glencoe, *X.* sp. New England, and *X.* sp. Point Lookout, major clustering modes $K = 5$. Bar plots show each individual as a horizontal bar divided into segments on the basis of the proportion of ancestry suggested for 1–10 subpopulations across all of the 10 runs; $n = 52$. Fine black lines delineate sampling locations.

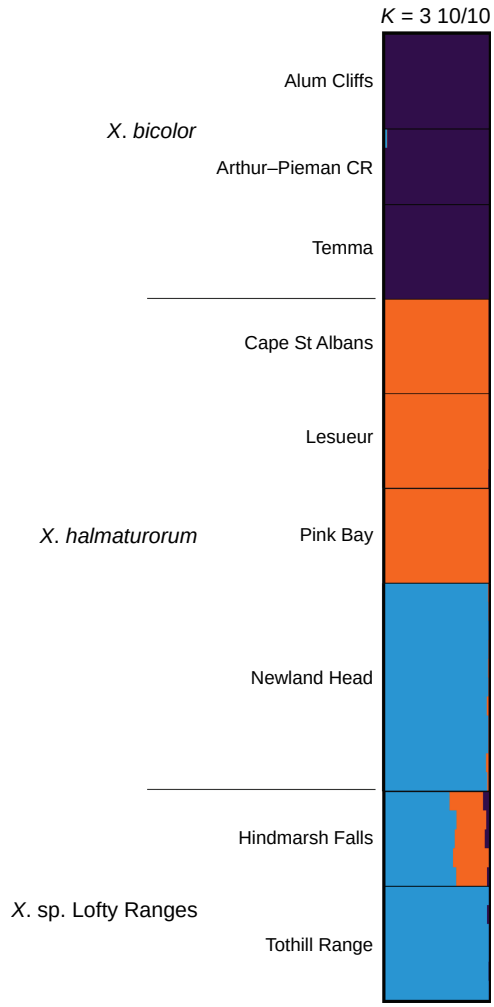

Fig. 12. STRUCTURE bar plots for *Xerochrysum bicolor*, *X. halmaturorum*, and *X.* sp. Lofty Ranges major clustering modes $K = 3$. Bar plots show each individual as a horizontal bar divided into segments on the basis of the proportion of ancestry suggested for 1–10 subpopulations across all of the 10 runs; $n = 51$. Fine black lines delineate sampling locations.

Superficially, *X.* sp. Blackfellows Gap is similar to *X. subundulatum* with a low-growing clonal habit and rhizomatous root system; however, glabrous and obtuse phyllaries (*v.* scabridulous and acuminate), a deciduous pappus (*v.* persistent), and sessile glands on leaf abaxial surfaces (*v.* stipitate glands) distinguish it from that species. Increased sampling would be necessary to confirm that *X.* sp. Blackfellows Gap is of hybrid origin, or a distinct entity.

Samples grouped under the phrase name *X.* sp. North Stradbroke Island were not a single morphological and genotypic entity. The data indicated at least three distinct groups that are not corroborated by variations in morphology. The Iluka population clustered in the PCoA with *X.* sp. Northern Tablelands (Fig. 8), and samples from Byfield National Park formed a distinct cluster separate from all others in the 'Boreale' subset. Populations from Gheebulum Kunungai (Moreton Island) National Park were genetically widely diverged from other populations of *X.* sp. North Stradbroke Island, with little indication of shared common ancestry (Fig. 8, 13). Comparisons of morphology between mainland populations on headlands and the Gheebulum Kunungai (Moreton Island) National Park population showed differences in leaf length and width, and leaf indumentum. Plants on K'gari (Fraser Island; from habitat similar to those on Gheebulum Kunungai) were genetically similar to those on headlands at Noosa National Park and the Town of 1770, and also shared a similar leaf indumentum with headland populations. The failure to clarify the species limits in *X.* sp. North Stradbroke Island populations could

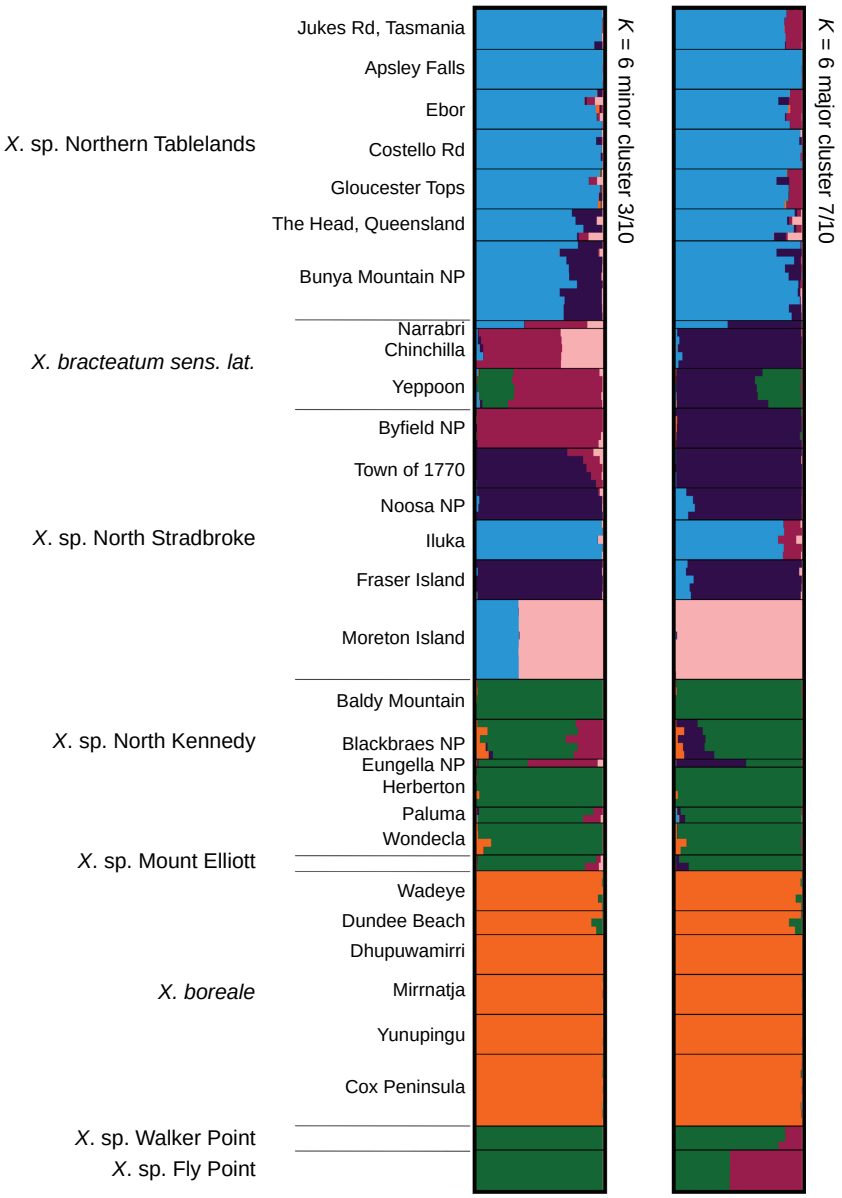

Fig. 13. STRUCTURE bar plots for 'Boreale' samples of *Xerochrysum*, major and minor clustering modes $K = 6$. Bar plots show each individual as a horizontal bar divided into segments on the basis of the proportion of ancestry suggested for 1–10 subpopulations across all of the 10 runs; $n = 148$. Fine black lines delineate sampling locations.

be due to insufficient sampling, or historical and ongoing disturbance.

Naturalised populations of *Xerochrysum* seem to have contributed to the taxonomic confusion in other locations. During fieldwork, several populations of *Xerochrysum bracteatum sens. lat.* appeared to be naturalised or spreading outside their natural distribution, including near Queenstown in Tasmania (cited as *X. bicolor* in Wilson 2017), near Woodford and Yeppoon in Queensland. Molecular data placed the Tasmanian population with *X.* sp. Northern Tablelands (Fig. 8), and examination of morphology supported this finding. *Xerochrysum* sp. Tin Can Bay from Yeppoon was suggested to have ancestry shared with *X. bracteatum sens. lat.* and *X.* sp. North Kennedy (Fig. 13) and could be the product of a recent hybridisation event. All putative naturalised populations of *Xerochrysum* seen during this study were in highly disturbed roadside habitats and had been first recorded in the past 20 years or were new records, and they did not seem to occur in native vegetation nearby.

Conclusions

Multiple lines of evidence, including distinct genotypic differences, common ancestry and distinct morphology, support the recognition of 12 additional species of *Xerochrysum* (Table 10).

In all cases, distinct morphology on herbarium specimens and cultivated plants, corroborated by the molecular data, was observed among these entities, and it is on the combination of morphology and genetic differences that we propose taxonomic recognition at species rank. The parapatric

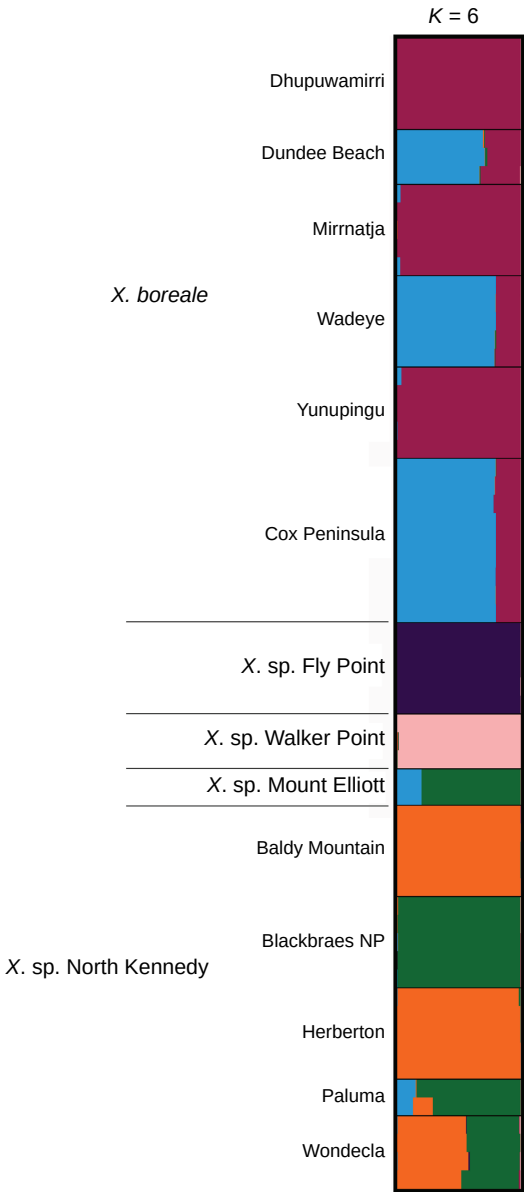

Fig. 14. STRUCTURE bar plots for *Xerochrysum boreale* and genetically similar putative species, major and minor clustering modes $K = 6$. Bar plots show each individual as a horizontal bar divided into segments on the basis of the proportion of ancestry suggested for 1–10 subpopulations across all of the 10 runs; $n = 63$. Fine black lines delineate sampling locations.

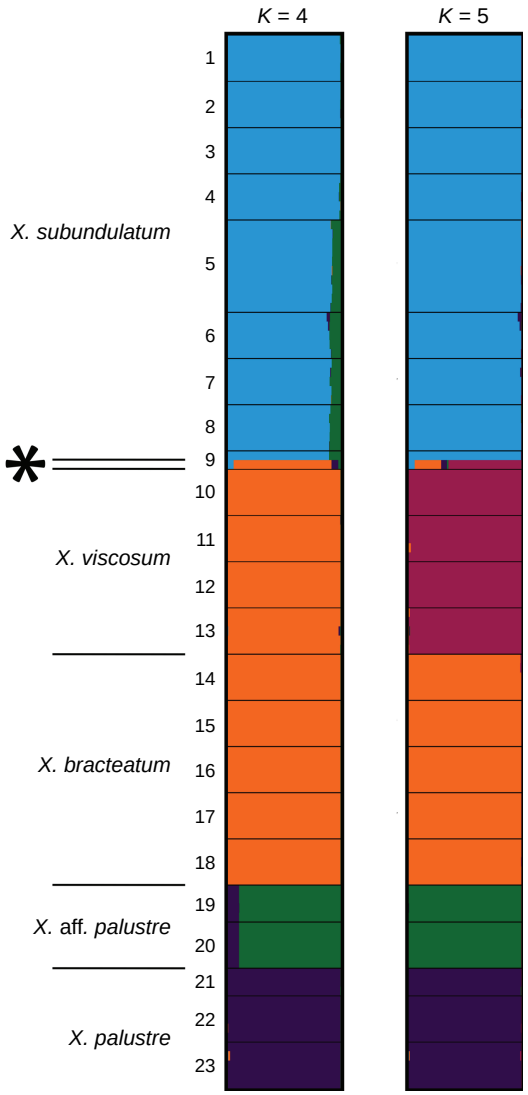

Fig. 15. STRUCTURE bar plots, for species of *Xerochrysum* associated with *X.* sp. Blackfellows Gap (marked with an asterisk, *), for major clustering modes $K = 4$–5. Bar plots show each individual as a horizontal bar divided into segments on the basis of the proportion of ancestry suggested for four or five ancestral populations across all runs at $K = 4$ and 9 of the 10 runs at $K = 5$; $n = 114$. Fine black lines delineate sampling locations, numbered as in Supplementary Table S14. Of the two samples collected from Namadgi National Park (Location 9), morphological characters indicated that one is clearly *X. subundulatum*, and the other is *X.* sp. Blackfellows Gap (N.T.Burbidge 6926).

populations within *X. murapan* that differ in multiple morphological traits were shown to be genetically similar, indicating recent divergence (see De Queiroz 2005, 2007).

Confounding results prevented confident assignment of coastal populations of *Xerochrysum* from Diamond Head, New South Wales, to Mackay, Queensland. They are treated here as either *X.* sp. North Stradbroke Island or *X.* sp. Tin Can Bay (includes *X.* sp. weedy). Limited sampling of populations west of the Great Dividing Range in New South Wales and Queensland prevented confident conclusions on the taxonomy of populations of *Xerochrysum* at Narrabri and Chinchilla. Denser sampling may indicate these populations to be part of *X. hispidum* or another entity. They are treated here as *X.* sp. Chinchilla.

Molecular and morphological data indicated the recently described *X. halmaturorum* to be conspecific with *X. bicolor* and the putative entity *X.* sp. Lofty Ranges. A taxonomic revision of an expanded concept for *X. bicolor* is provided in the following section.

Table 10. New species names of *Xerochrysum* and their corresponding phrase names.

New name	Phrase name
X. andrewiae	*X.* aff. *palustre*
X. banksii	*X.* sp. Walker Point
X. berarngutta	*X.* sp. Point Lookout (I.R.Telford 12830) NE Herbarium
X. copelandii	*X.* sp. New England (L.M.Copeland 3731) NE Herbarium
X. frutescens	*X. bracteatum* sp. Mount Merino (S.T.Blake 22869) Qld Herbarium
X. gudang	*X.* sp. Fly Point
X. hispidum	*X.* sp. Flinders Range
X. macsweeneyorum	*X.* sp. Northern Tablelands
X. murapan	*X.* sp. Barrington Tops
X. neoanglicum	*X.* sp. Glencoe (M.Gray 4401) NE Herbarium
X. strictum	*X. bracteatum* subsp. Mount Elliot (A.R.Bean 3593) Qld Herbarium and *X.* sp. North Kennedy
X. wilsonii	*X.* sp. Porongurup

Recognition and description of these 12 new taxa in *Xerochrysum,* together with basic information on ecology, distribution and conservation status, provide a taxonomic service to conservation and land managers, enabling future detailed assessment of conservation status and facilitating targeted conservation management where required.

This study has shown previously unrecognised species diversity in a much-admired and widely grown genus. Most species of *Xerochrysum* are perennial, with habits varying across shrub-like (e.g. *X. frutescens*), prostrate (e.g. *X. banksii*) and compact growth forms (e.g. *X. neoanglicum*). There are distinctly tropical (e.g. *X. boreale*, *X. strictum*, *X. gudang*), arid zone (e.g. *X. interiore*), coastal (e.g. *X. bicolor*, *X. papillosum*, *X.* sp. North Stradbroke Island), temperate (e.g. *X. bracteatum sens. str.*, *X. macranthum*, *X. macsweeneyorum*), wetland (e.g. *X. palustre*) and alpine species (e.g. *X. subundulatum*, *X. alpinum*, *X. milliganii*, and *X. collierianum*). Application of this knowledge to plant breeding and development could expand the range of ornamental cultivars.

Taxonomy

Arrangement of this section follows that of Wilson (2008, 2017) and recognises the morphologically distinct *X. bracteatum* and *X. milliganii* groups. Characters in species descriptions follows Flann (1998) and Wilson (2017). Taxa are sorted alphabetically within groups. Type specimens for the names treated below have been examined either directly (indicated by '!') or as images from CANB and on JSTOR Global Plants (indicated by '*', see https://plants.jstor.org/). Distribution data are based on selected specimens seen and use IBRA regions (Department of the Environment and Energy 2016). Conservation status is based on International Union for Conservation of Nature Red List Categories and Criteria, Version 3.1. (IUCN 2019).

Xerochrysum Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990)

Type: Xerochrysum bracteatum (Vent.) Tzvelev.

Bracteantha Anderb. & Haegi, *Opera Bot.* 104: 102 (1991), *nom. illeg.* *Type: Bracteantha bracteata* (Vent.) Anderb. & Haegi.

Annual or *perennial herbs*, usually taprooted, sometimes rhizomatous. *Indumentum* cobwebby, felted, hirsute, hispid, pilose, tomentose, villous, or woolly, with septate trichomes, often flagelliform, and with sessile or stipitate glands. *Leaves* alternate; lamina flat or with margin recurved. *Capitula* terminating branches or branchlets, homogamous or heterogamous, disciform. *Phyllaries* multiseriate, medial phyllaries longest; lamina rigidly chartaceous, often spreading at junction with claw when mature; claw coriaceous, broadly oblong, flat; stereome broad, that of inner phyllaries fenestrate, veins numerous and extending into lamina, veins each of equal thickness in the *X. bracteatum* group, or central vein thickest in the *X. milliganii* group. *Receptacle* ± flat or concave, epaleate. *Outermost florets* usually sterile or sometimes female; *corolla* very narrowly tubular, shorter than bisexual florets, 3-, 4- or 5-lobed. *Inner* (or all) *florets* bisexual; *corolla* narrowly tubular, 5-lobed, lobes ovate, yellow to orange; anthers with apical appendage ovate and outwardly concave, tails slender, ± equal to collar, pollen pale yellow; style arms slender, with rounded, clavate, ovate, deltoid, triangular or narrowly triangular stylar appendage, yellow. *Cypsela* cylindrical or oblong, ~2.5–3.5 mm long; pericarp thick, finely striated, glabrous, surface with linear idioblasts, brown or straw- or bronze-coloured; stipe hollow, carpopodium of one row of thickened cells; apex patelliform when mature. *Testa* free from pericarp, cells ± equilateral, without thickening; vein passing to apex. *Pappus* uniseriate; bristles slender, equal to or exceeding corolla, white or yellow, consistent with the colour of the medial phyllaries, barbellate with apical cells acute and occasionally coloured red, bristles very shortly united at base and eventually deciduous as a whole or in pieces in the *X. bracteatum* group, or persistent in the *X. milliganii* group.

Key to species of *Xerochrysum*

1. Herbs, rhizomatous; claw of medial phyllaries with a central vein that passes into the lamina; cypselae with persistent pappus and no pappus–pericarp abscission line.....2

Herbs, or shrub-like, taprooted or sometimes rhizomatous; claw of medial phyllaries with several vascular bundles that terminate at its apex; cypselae with deciduous pappus, or if persisting, then with a distinct pappus–pericarp abscission line.....7
2. Phyllaries white, pale pink or crimson.....3
Phyllaries yellow.....4
3. Stem indumentum densely white-cottony, without glands, becoming glabrescent with age; leaves woolly on margin, otherwise glabrous or cobwebby.....*X. milliganii*
Stem indumentum hirsute with stipitate glands; leaves cobwebby to woolly on margin, adaxially hirsute, otherwise glands both sides.....*X. collierianum*
4. Stem indumentum densely cottony towards apex, glands absent.....5
Stem indumentum cobwebby and glandular with glands towards apex.....*X. alpinum*
5. Outer phyllaries smooth abaxially.....*X. palustre*
Outer phyllaries scabridulous abaxially.....6
6. Cauline leaves 20–60 mm long and 2–10 mm wide, glabrous or with sessile glands adaxially.....*X. andrewiae*
Cauline leaves 25–90 mm long and 5–20 mm wide, hispid or scabrid with stipitate glands adaxially.....*X. subundulatum*
7. Cauline leaves abaxially hirsute to tomentose or with scattered septate trichomes.....8
Cauline leaves abaxially without septate trichomes.....18
8. Most cauline leaves less than 10 mm wide.....9
Most cauline leaves 10 mm wide or greater.....14
9. Cauline leaves abaxially with occasional or scattered septate trichomes.....10
Cauline leaves abaxially hirsute to hispid or tomentose.....12
10. Cauline leaves with persistent stipitate glands on cauline leaf adaxial surface; prostrate habit; far northern Queensland coastal headlands.....*X. banksii*
Cauline leaves with fragile stipitate or sessile glands on cauline leaf adaxial surface; erect habit; not in far northern Queensland....11
11. Cauline leaves with sessile glands breaking and leaving a varnished appearance; Victoria, inland New South Wales, and southern Queensland.....*X. viscosum*
Cauline leaves with stipitate glands, fragile and usually lost but retaining persistent stipes and not appearing varnished; Top End, Northern Territory, and Kimberley, Western Australia.....*X. boreale*
12. Basal rosette usually absent at flowering, flowering stems branched, capitula in open panicles.....13
Basal rosette usually present at flowering, flowering stems unbranched, capitula solitary.....*X. neoanglicum*
13. Annual or biennial; taproot present; basal leaf rosette present or usually marcescent; abaxial leaf lamina densely hispidulous with flagelliform trichomes and minute persistent septate bases up to ~0.02 mm long; widespread on roadsides and grassy woodlands on basaltic and granitic clay soils.....*X. macsweeneyorum*
Perennial; short rhizome or taproot present; basal leaf rosette absent; leaves hirsute abaxially with flagelliform trichomes on septate bases up to 0.1 mm long; restricted to gorge rim habitats on skeletal metasedimentary and granitic soils.....*X. copelandii*
14. Cauline leaf margin hispid with septate trichomes; habitat not on margins of rainforest or *Nothofagus moorei* forest.....15
Cauline leaf margin woolly with septate trichomes; habitat mostly on margins of rainforest or *Nothofagus moorei* forest.....*X. frutescens*
15. Populations restricted to northern New South Wales.....16
Populations restricted to northern Queensland.....17
16. Cauline leaf abaxial lamina glabrous or with scattered septate flagelliform trichomes; ovate stylar appendages; restricted to Barrington Tops National Park, New South Wales.....*X. murapan*
Cauline leaf abaxial lamina pilose with septate flagelliform trichomes; lanceolate stylar appendages; restricted to high-altitude escarpment in New England National Park, New South Wales.....*X. berarngutta*
17. Stylar appendage lanceolate with acute apex; cauline leaf adaxial indumentum hirsute, with slender, lanceoloid septate trichomes, numerous stipitate glands; erect habit.....*X. strictum*
Stylar appendage ovate with obtuse apex; cauline leaf adaxial indumentum hispid, with stout septate trichomes arising from thickened basal cells, stipitate glands few or absent; decumbent habit.....*X. gudang*
18. Most mid-cauline leaves less than 10 mm wide.....19
Most mid-cauline leaves greater than 10 mm wide.....22
19. Phyllaries broad and rounded.....20
Phyllaries narrow and lanceolate.....21
20. Erect open habit; annual, or biennial in wetter years; stylar appendage ovate; inland northern New South Wales and south-western Queensland .....*X.* sp. Chinchilla
Compact habit; perennial; stylar appendage narrow triangular; coastal headlands in New South Wales, and southern and central Queensland .....
X. sp. North Stradbroke Island (L. Durrington 675) Qld Herbarium
21. Annual, or biennial in wetter years; foliaceous bract subtending capitulum less than 10 mm long; south-western Western Australia.....*X. macranthum*
Perennial; foliaceous bract subtending capitulum greater than 10 mm long; Tasmania and Victoria.....*X. papillosum*
22. Tap rooted; not in alpine habitats.....23
Rhizomatous; alpine habitats .....*X.* sp. Blackfellows Gap
23. Stylar appendage narrow triangular.....24
Stylar appendage broad triangular or ovate.....25
24. Foliaceous bract subtending capitulum greater than 10 mm long; cauline leaves hispid adaxially and with large trichomes scattered on leaf lamina and margin; Flinders Ranges and inland areas of southern South Australia, Victoria and New South Wales.....*X. hispidum*
Foliaceous bract subtending capitulum less than 10 mm long; cauline leaves sparsely hirsute adaxially; arid Northern Territory, northern South Australia, and arid Western Australia.....
.....*X. interiore*
25. Stems cottony or woolly below capitulum.....26
Stems hispid or with flagelliform trichomes below capitulum.....
.....*X. bicolor*
26. Phyllaries yellow; Queensland, New South Wales or Victoria.....27
Phyllaries white or pink; Western Australia.....*X. wilsonii*
27. Cauline leaf adaxial indumentum hispid or hirsute with septate trichomes without flagelliform apices, and older leaves not glabrescent; Queensland.....28
Cauline leaf adaxial indumentum hispid with minute flagelliform trichomes, older leaves glabrescent; south-eastern New South Wales and eastern Victoria.....*X. bracteatum*
28. Cauline leaves 15–60 mm wide and 90–150 mm long, cauline leaf adaxial indumentum sparsely hispid with septate trichomes ..... .
X. sp. North Stradbroke Island (L. Durrington 675) Qld Herbarium
Cauline leaves 5–30 mm wide and 15–130 mm long, cauline leaf adaxial indumentum hirsute with septate trichomes .....
.....*X.* sp. Tin Can Bay

Xerochrysum bracteatum group

Xerochrysum banksii (A.Cunn. ex DC.) T.L.Collins & I.Telford, comb. nov.

Helichrysum banksii A.Cunn. ex DC., *Prodr.* 6: 188 (1838); *Gnaphalium banksii* (A.Cunn. ex DC.) Sch.Bip., *Bot. Zeit.* 3: 171 (1845). *Type citation*: 'in Novae-Holl. ora boreali-orient. ad flum. Endeavour in sylvaticus graminosis olim legit cl. Banks et postea A Cunningham jul. flor

(v.s. comm. a cl. A. Cunn.)'. *Type*: Grassy forest-land, Endeavour River, N.E. Australia [Queensland], lat. 15° south, July 1819, *A. Cunningham s.n.* (lecto, here designated: G-DC G00328465*; isolecto: K 000899119*).

[*Helichrysum bracteatum auct. non* (Vent.) Willd.: G.Bentham, *Fl. Austral.* 3: 620 (1867), *p.p.*]

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, populations on coastal headlands between Cooktown and Cairns, Queensland only].

Prostrate, tap-rooted, perennial herb. *Stems* and *branches* hirsute, scabrid, glabrescent and with glands; internode length 5–60 mm. Flowering stems branched or unbranched. *Basal leaf rosette* present at flowering in first year, later absent. *Basal leaves* oblanceolate to spathulate, 50–120 mm long and 10–25 mm wide, base amplexicaul, apex mucronate, margin hirsute; basal leaf abaxial indumentum with glands and occasionally hirsute with septate trichomes, midvein indumentum pilose with septate trichomes; basal leaf adaxial indumentum hirsute with septate trichomes. *Cauline leaves* oblanceolate, 20–50 mm long and 5–10 mm wide, base subauriculate and amplexicaul, apex mucronate, margin hirsute; *abaxial indumentum* with glands, midvein indumentum hirsute with septate trichomes; *adaxial indumentum* hirsute, scabrid and with glands. *Foliaceous bracts subtending capitula* 6–12 mm long, margin hispid. *Capitula* 30–40 mm wide, terminal, solitary. *Outer phyllaries* broad-ovate, brown or straw-coloured, basal margin fimbriate and hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* narrow ovate to lanceolate, abaxially yellow, apex cuspidate. *Stylar appendages* triangular. *Cypsela* oblong, ~2.5 mm long and 0.9 mm wide, cross-section squarish or circular; pericarp straw- or brass-coloured, idioblasts present. *Pappus* deciduous, ~6 mm long.

Distribution

Endemic to Queensland where it occurs in the Wet Tropics Bioregion on the eastern coast between Cairns and Cooktown (Fig. 16).

Phenology

Inflorescences recorded from June–December. Mature cypselae collected in July and October (Fig. 17).

Habitat

The species inhabits grassy herblands on rocky coastal headlands. Associated species include *Heteropogon triticeus*, *Themeda triandra*, *Myoporum boninense* and *Santalum lanceolatum*.

Conservation status

Only two collections are known from the past 15 years from a single population of unknown size in Annan River (Yuku Baja-Muliku) National Park. Populations recorded in the 1800s in Cooktown and Trinity Bay near Cairns may now be extinct because of intense coastal development. On the basis of only one known extant population of unknown size, we suggest that a '*Data Deficient*' status is appropriate under the IUCN (2019). Confirmation of the loss of populations in Cairns, Mossman River and Cooktown may qualify *X. banksii* as '*Endangered*' or '*Critically Endangered*'.

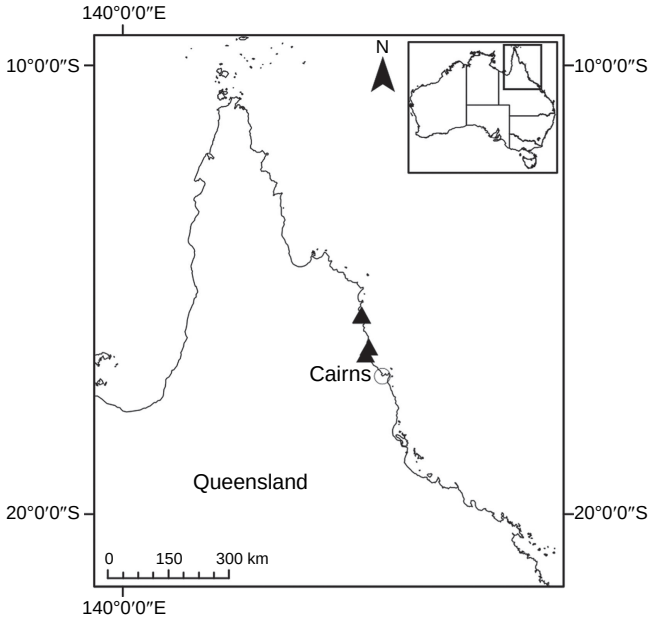

Fig. 16. Distribution of *Xerochrysum banksii*.

Notes

Some variation in leaf indumentum was seen on specimens collected in the 1800s from Trinity Bay (MEL 61211, and MEL 61314), with a hispid to hirsute leaf indumentum both abaxially and adaxially with septate trichomes. Recent collections from Annan River National Park have no septate trichomes abaxially, only sessile glands. A specimen from Mossman's [=Mossman] River (*W.A. Sayer s.n.* MEL 61192) has hispid leaf indumentum with much shorter septate trichomes. *Xerochrysum banksii* retains a prostrate habit in cultivation. The informal phrase name *X.* sp. Walker Point NE Herbarium has been used at NE for curatorial purposes and this study.

Alan Cunningham's specimen at G-DC is here selected as the lectotype, as this specimen would have been used by de Candolle in preparing the protologue.

Selected specimens examined

QUEENSLAND: Cook: Endeavour River, June 1770, *J. Banks & D. Solander s.n.* (MEL 1591810!); Cooktown, 1877, *W. Persieh s.n.* (MEL 0061318A!); Endeavour River, 1882, *W. Persieh s.n.* (MEL 0061336A!); Annan River National Park, Walker Point, 22 Oct. 2018, *A.J. Saunders 1* (BRI!, CANB!, CNS!, NE 110024!); Walker Point, S of Cooktown, 5 Dec. 2005, *B.S. Wannan 4156* (BRI!, BSW, NSW!); Mossman's [=Mossman]

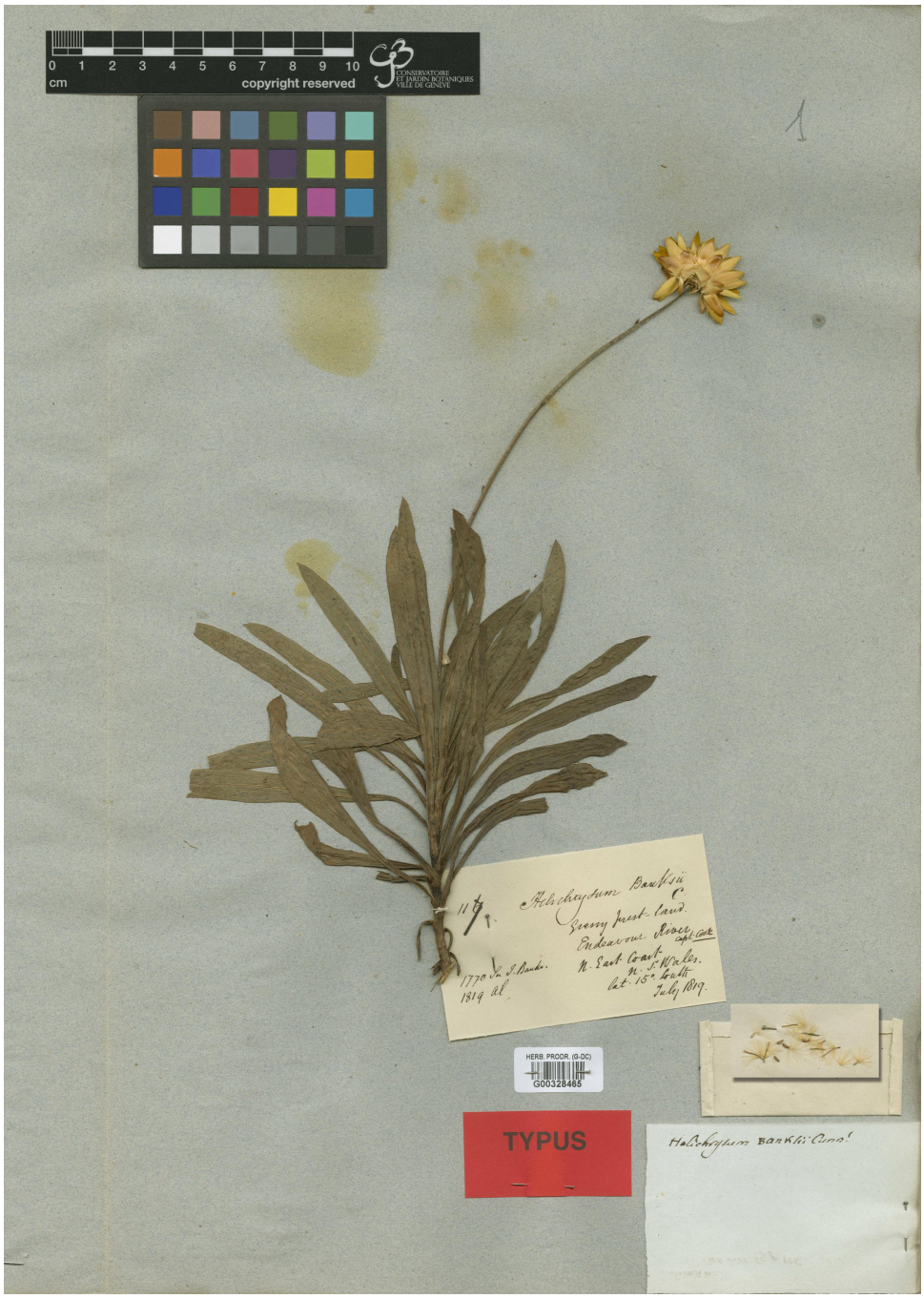

Fig. 17. Lectotype of *Xerochrysum banksii* (G-DC G00328465). Image: © Conservatoire et Jardin botaniques de la Ville de Genève.

River, 1886, *W.A. Sayer s.n.* (MEL 0061192A!); Trinity Bay, 1881, *G. Karsten s.n.* (MEL 0061211A!); Trinity Bay, *E. Fitzalan s.n.* (MEL 0061314A!).

Xerochrysum berarngutta T.L.Collins & I.Telford, sp. nov.

Type: AUSTRALIA: New South Wales: Northern Tablelands: New England National Park, Eagles Nest Lookout, below Point Lookout, 5 Feb. 2005, *I.R. Telford 12830* & *L.M. Copeland*, (holo: NSW!; iso: BRI!, MEL!, NE 83736!, PERTH!).

Xerochrysum sp. Point Lookout (I.R.Telford 12830) NE Herbarium, CHAH, *Austral. Pl. Census* (2020) [accessed 20 February 2020].

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, populations on the high escarpment cliffs at Point Lookout, New England National Park, New South Wales only].

Diagnosis

Distinguished from *X. bracteatum sens. str.* by a perennial life form (annual or biennial in *X. bracteatum*), abaxial leaf surface pilose with septate and glandular trichomes and

glands (only with glands in *X. bracteatum*), cuspidate to apiculate phyllary apices (obtuse in *X. bracteatum*), and foliaceous bracts subtending capitula 10–20 mm long (8–10 mm in *X. bracteatum*); and from all other species in the genus by a long, thick rhizome, a densely pilose leaf indumentum of septate trichomes, and stipitate glands both abaxially and adaxially.

Decumbent, rhizomatous, perennial herb. *Stems* and *branches* with glands and villous with septate trichomes, internode length 40–55 mm. *Basal leaf rosette* absent at flowering. *Basal leaves* spathulate, 70–200 mm long and 15–30 mm wide, base amplexicaul, margin villous with septate trichomes, apex obtuse and mucronate; abaxial indumentum densely pilose with septate trichomes and with glands, midvein indumentum villous with septate trichomes; adaxial indumentum densely pilose with septate trichomes. Radical leaves arising from a rhizome. *Cauline leaves* oblanceolate to obovate, 40–150 mm long and 4–30 mm wide, leaf base attenuate, margin villous with septate trichomes, apex apiculate and mucronate; *abaxial indumentum* densely pilose with septate trichomes and sessile glands, midvein indumentum villous with septate trichomes; *adaxial indumentum* hirsute to densely pilose with septate trichomes, and sessile glands. *Foliaceous bracts subtending capitula* 10–20 mm long, margin villous. *Capitula* 40–60 mm wide, terminal, in panicles or solitary. *Outer phyllaries* broad-ovate, brown or straw-coloured, basal margin fimbriate, apex apiculate, abaxial surface smooth. *Medial phyllaries* ovate to lanceolate, abaxially orange or yellow, apex cuspidate to apiculate. *Stylar appendages* narrowly triangular to ovate. *Cypsela* oblong, ~2.7 mm long and 0.9 mm wide, cross-section squarish or circular; pericarp straw- or brass-coloured, idioblasts present. *Pappus* deciduous, ~7 mm long.

Distribution

Endemic to the high-altitude escarpment on the eastern edge of the New England Tablelands Bioregion, where it is known only from the vicinity of Point Lookout, ~70 km east of Armidale, New South Wales (Fig. 18).

Phenology

Recorded flowering from February–April (Fig. 19). Late-stage infructescence containing small numbers of cypselae collected in April.

Habitat

Occurring in small openings in the canopy at ~1400-m altitude, growing in humic sediments on and between basalt boulders, on steep slopes and broken cliffs. Associated with *Acacia melanoxylon*, *Banksia integrifolia* subsp. *monticola*, *Eucalyptus pauciflora*, *Lomatia fraseri*, *Cassinia telfordii*, *Lomandra longifolia*, *Solanum* and *Plectranthus*.

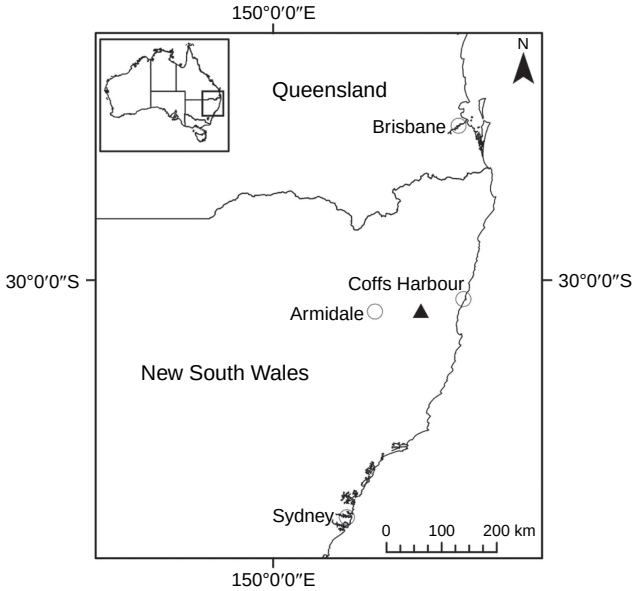

Fig. 18. Distribution of *Xerochrysum berarngutta*.

Other associated species include the localised cliff-line endemics *Coronidium elatum* subsp. *minus*, *Gingidia rupicola*, *Gaultheria viridicarpa* and *Wahlenbergia telfordii*.

Conservation status

Only known from effectively one population in the New England National Park, New South Wales, where 17 plants were recorded scattered along ~170 m of escarpment in 2017. On the basis of only one known extant population of less than 50 individuals, we suggest a '*Critically Endangered*' status is appropriate under the IUCN (2019), fulfilling Criteria C2 and D.

Etymology

The species epithet is the traditional name of the type locality, a place considered sacred to traditional owners (Steven Ahoy, pers. comm., 2020), as a noun in apposition (ICN Art. 23.5, Shenzhen Code, Turland *et al.* 2018).

Selected specimens examined

NEW SOUTH WALES: Northern Tablelands: New England National Park, Point Lookout, 12 Apr. 2017, *T.L. Collins 958* & *J.J. Bruhl* (BRI!, NE!, NSW!); New England National Park, Eagles Nest Lookout, 11 Mar. 2006, *G.P. Duley 69, J.J. Bruhl* & *I.R. Telford* (NE!).

Xerochrysum bicolor (Lindl.) R.J.Bayer, *Kew Bulletin* 56: 1014 (2001)

Helichrysum bicolor Lindl., *Bot. Reg.* 21: t. 1814 (1835); *Gnaphalium bicolor* (Lindl.) Sch.Bip. *Bot. Zeit.* 3: 171 (1845); *Helichrysum bracteatum* var. *bicolor* (Lindl.) L.H.Bailey, *Cycl. Amer. Hort.* 2: 723 (1900); *Bracteantha bicolor* (Lindl.) Anderb. & Haegi, *Op. Bot.* 104: 105 (1991).

Fig. 19. Isotype of *Xerochrysum berarngutta (I.R.Telford 12830 & L.M.Copeland*, NE 83736).

Type citation: 'introduced by Mr. Low of the Clapton Nursery… It is a native of Van Diemen's Land, whence our excellent correspondent Mr. Gunn has sent beautiful specimens (No. 111).' *Type*: in insula van Dieman (Herb. Gunniani No. 111), *s. dat., R.C. Gunn 111*, (lecto: CGE; isolecto: MEL 61303!; possible isolecto: NSW 122366, *fide* P. G. Wilson, *Nuytsia* 28: 14 (2017)).

Xerochrysum halmaturorum Paul G.Wilson, *Nuytsia* 28: 15 (2017). *Type*: Cape St Albans, Kangaroo Island, South Australia, 24 Nov. 1994, *B.M. Overton 2513* (holo: AD 99610190!; iso: MEL 2048046!).

Erect, perennial, taprooted herb. *Stems* and *branches* with glands, and scabrid or hispid (prominent raised ridges along stems), internode length 10–35 mm. *Basal leaf rosette* absent at flowering. *Basal leaves* obovate or spathulate, 50–150 mm long and 10–30 mm wide, base auriculate or attenuate and amplexicaul, margin hirsute, pilose or hispid with septate trichomes, apex obtuse to apiculate and mucronate; abaxial indumentum with glands, midvein indumentum hirsute to hispid with septate trichomes and with glands; adaxial indumentum scabrid or hispid with septate trichomes, and with glands. *Cauline leaves* obovate, 40–120 mm long and 10–35 mm wide, base auriculate and amplexicaul, margin hispid or scabrid with dense, shorter septate trichomes as well as scattered septate trichomes, 2–4 times longer, and with stipitate glands; apex acuminate to apiculate and mucronate; *abaxial indumentum* with glands, midvein indumentum hispid and scabrid with septate trichomes; *adaxial indumentum* hispid or scabrid with septate trichomes, and with glands. *Foliaceous bracts subtending capitula* 5–15 mm long, margin hispid with stipitate glands. *Capitula* 30–60 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate, brown or straw-coloured, basal margin fimbriate or hispid, abaxial surface smooth, apex acuminate. *Medial phyllaries* narrow ovate to lanceolate, abaxially brown, white or yellow, apex acuminate to cuspidate. *Stylar appendages* deltoid to ovate. *Cypsela* oblong, ~2.5 mm long and 0.75 mm wide, cross-section squarish; pericarp brown, idioblasts present. *Pappus* deciduous ~4–8 mm long.

Distribution

Occurs sporadically over a broad area in southern South Australia in the Flinders Lofty Block and Kanmantoo bioregions, in south-western Victoria in the Victorian Midlands Bioregion, and coastal Tasmania in the King, Tasmanian West, and Tasmanian South East bioregions (Fig. 20).

Phenology

Flowers recorded from November–January, and mature cypselae in February.

Habitat

Coastal heath, low shrubland grassland mosaic and *Allocasuarina–Eucalyptus* woodland, on sandy or skeletal gravelly loam soils, among low rock outcrops or on cliffs.

Conservation status

Occurs over a large area, including public and private conservation reserves. Populations on Kangaroo Island and in the Tothill Ranges estimated in the hundreds and thousands of plants respectively. Listed as 'rare' under the Tasmanian *Threatened Species Protection Act* 1995. Not listed under the Commonwealth of Australia *Environment Protection and Biodiversity Conservation Act* 1999. Monitoring and assessment of response and recovery after the 2019–2020 bushfires would inform conservation status (Keelty *et al.* 2020). With the inclusion of populations in South Australia and Victoria, we recommend a status of '*Least Concern*' (IUCN 2019).

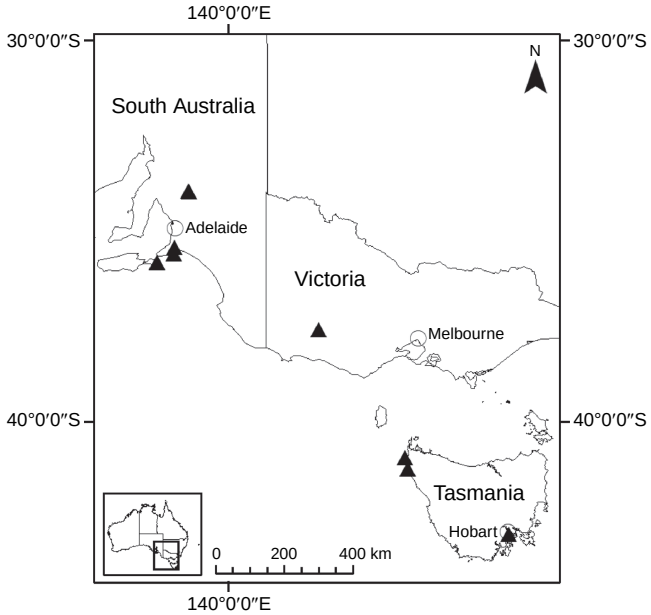

Fig. 20. Distribution of *Xerochrysum bicolor*.

Notes

The majority of collections are from populations with yellow phyllaries; however, a population with white phyllaries from the western coast of Tasmania near Temma was found during fieldwork and in the analyses.

'Eastcoast paperdaisy' is used in Tasmania for *X. bicolor* (State of Tasmania, 'Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au, accessed 22 March 2020).

Selected specimens examined

SOUTH AUSTRALIA: Goyder: Tothill Range, Mollers Gap Road, 26 Nov. 2017, *T.L. Collins 988 & A.N. Schmidt-Lebuhn* (AD!, CANB!, NE!). Adelaide Hills: South Australia, 10 Nov. 1879, *R. Tate s.n.* (AD!). Victor Harbor: South Australia, 1 Dec. 1909, *E.H. Ising s.n.* (AD!); Hindmarsh Falls, 23 Nov. 2017, *T.L. Collins 982 & A.N. Schmidt-Lebuhn* (AD!, CANB!, NE!); Newland Head Conservation Park, 23 Nov. 2017, *T.L. Collins 981 & A.N. Schmidt-Lebuhn* (AD!, CANB!, NE!). Yankalilla: South Australia, Jan. 1926, *J.B. Cleland s.n.* (AD!). Kangaroo Island: Cape St Albans, 20 Nov. 2017, *T.L. Collins 973 & A.N. Schmidt-Lebuhn* (AD!, CANB!, NE!). VICTORIA: Southern Grampians: Victorian Midlands, 29 Dec. 1988, *R.M. King 9703 & F.E. Heinz* (MEL!). Horsham: Victorian Midlands, 8 Nov. 1987, *S.T.W. Parfett 134* (MEL!). TASMANIA: Little Badger Island, *s. dat., J.S. Whinray 8605* (CANB, HO, MEL!); Alum Cliffs, S of Taroona, Hobart, 28 Feb. 2018, *T.L. Collins 1016 & R.L. Andrew* (NE!, HO!, CANB!); Arthur Pieman Conservation Reserve, 4 Mar. 2018, *T.L. Collins*

1033 & R.L. Andrew (NE!, HO!, CANB!); S of Temma on coastal track, 4 Mar. 2018, *T.L. Collins 1034 & R.L. Andrew* (NE!, HO!, CANB!).

Xerochrysum boreale Paul G.Wilson, *Nuytsia* 28: 17 (2017)

Type: Port Keats opposite Dorcherty Island, Northern Territory, 9 Aug. 1983, *C.R. Dunlop 6459 & G. Wightman* (holo: DNA D0021944!; iso: AD 98419226, BRI, CANB 345434*, MEL 0291510, NSW 518497!).

Xerochrysum bracteatum subsp. (Port Keats C. Dunlop + 6459), A. E. Holland in P. D. Bostock and A. E. Holland (eds), *Census Queensl. Fl.* 32 (2007).

Xerochrysum bracteatum subsp. Port Keats (C. Dunlop + 6459) Qld Herbarium, CHAH, *Austral. Pl. Census* (2020) [accessed 20 February 2020].

Erect, annual or perennial, taprooted herb. *Stems* and *branches* cobwebby or pilose, internode length 5–30 mm. *Basal leaf rosette* present in first year at flowering, later absent. *Basal leaves* oblanceolate to obovate, 30–70 mm long and 5–12 mm wide, base amplexicaul, margin cobwebby or pilose with septate trichomes, apex mucronate; abaxial indumentum hirsute with septate trichomes and with glands, midvein indumentum cobwebby or hirsute with septate trichomes; adaxial indumentum hirsute with septate trichomes. *Cauline leaves* oblanceolate, 20–80 mm long and 4–9 mm wide, base amplexicaul, margin cobwebby or hirsute with septate trichomes, apex mucronate; *abaxial indumentum* hirsute with septate trichomes, and with glands, midvein indumentum cobwebby to hirsute; *adaxial indumentum* cobwebby to hirsute with septate trichomes. *Foliaceous bracts subtending capitula* 5–8 mm long, margin cobwebby. *Capitula* 25–35 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate, brown or straw-coloured, basal margin hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* ovate to narrow ovate, abaxially yellow, apex cuspidate. Stylar appendages narrowly triangular. *Cypsela* oblong, ~2.3 mm long and 0.75 mm wide, cross-section circular; pericarp grey–brown, idioblasts present. *Pappus* deciduous, ~6–7 mm long.

Distribution

Endemic to the northern end ('Top End') of the Northern Territory in the Darwin Coastal and Arnhem Coast bioregions (Fig. 21).

Phenology

Recorded flowering August–October, with cypselae being recorded in October.

Habitat

Populations in the Darwin Coastal Bioregion commonly occur in eucalypt and *Pandanus* woodlands on sandy coastal plains with rare occurrences further inland on sandstone plateaux in the Mount Tolmer and Bundy Station areas, and on sandy clay seasonal swamps on the Cox Peninsula. Occurs on clay soils on the margins of the Arafura Swamp and gravelly loams in eastern Arnhem Land.

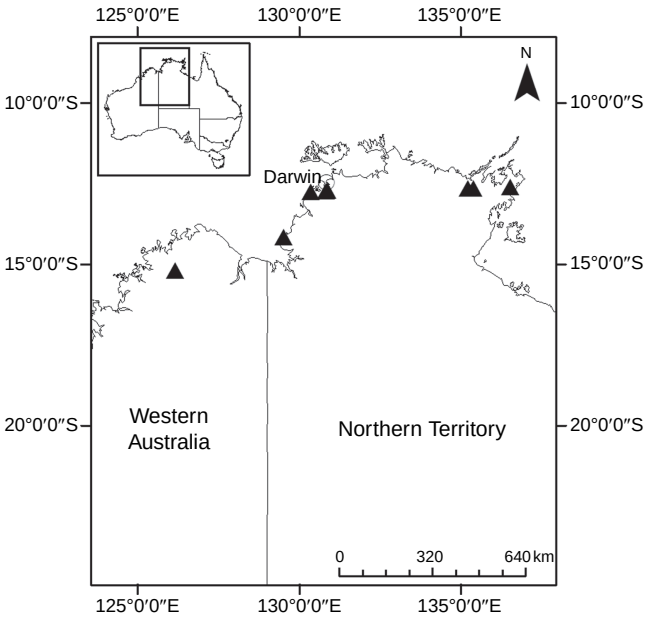

Fig. 21. Distribution of *Xerochrysum boreale*.

Notes

The largest populations seen during the course of this study were in areas that were patchily burnt as part of traditional land management practices in the early dry season (June–July) near the communities of Wadeye (U. Crocombe, pers. comm., 2018) and Mirrnatja (S. Guyula, pers. comm., 2018). Two populations from sandy clay seasonal swamps on Cox Peninsula have some individuals appearing to have rhizomatous stems, possibly adventitious roots in response to partial burial, and some with taproots. Molecular data indicated no genotypic differences within or between any *X. boreale* populations included in this study, and for this reason, we are not recognising rhizomatous plants as a different taxon.

Conservation status

Occurs over a large area, with some populations in the thousands recorded in 2018. Changes to land management and absence of traditional early dry season burning may be affecting some populations that could not be located in 2018 (T. L. Collins and J. J. Bruhl, unpubl. data). Plants at Dundee Beach in the Darwin Coastal Bioregion were affected by habitat loss as a result of coastal development and grassland mowing. We recommend a status of '*Least Concern*' (IUCN 2019).

Selected specimens examined

NORTHERN TERRITORY: Darwin and Gulf: Dundee Beach, S of Dunheved Road, 2 Oct. 2018, *T.L. Collins 1088 & J.J. Bruhl* (CANB!, DNA!, NE!); Dhupuwamirri Road, on road to Mirrnatja, 9 Oct. 2018,

T.L. Collins 1091 & J.J. Bruhl (CANB!, DNA!, NE!); Mirrnatja, ~2.2 km N of village, 10 Oct. 2018, *T.L. Collins 1092 & J.J. Bruhl* (CANB!, DNA!, NE!); Central Arnhem Road, Yunupingu Cattle Farm, 10 Oct. 2018, *T.L. Collins 1093 & J.J. Bruhl* (CANB!, DNA!, NE!); Wadeye, Old Mission Road, 5 Oct. 2018, *T.L. Collins 1089 & J.J. Bruhl* (CANB!, DNA!, NE!); Wadeye, on unnamed coast track, 5 Oct. 2018, *T.L. Collins 1090 & J.J. Bruhl* (CANB!, DNA!, NE!). WESTERN AUSTRALIA: West Kimberley: West Kimberley, 1901, *F.M. House s.n.* (PERTH!). Wyndham–East Kimberley: Head of King Edward River, 7 Sep. 1921, *C.A. Gardner 1565* (PERTH!).

Xerochrysum bracteatum (Vent.) Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990)

Xeranthemum bracteatum Vent., *Jard. Malmaison* 1: 2, t. 2 (1803); *Helichrysum bracteatum* (Vent.) Andrews, *Bot. Repos.* 6: ad t. 428 (1805); *Helichrysum chrysanthum* Pers., *Syn. Plant.* 2(2): 414 (1807), *nom. illeg., nom. superfl.; Helichrysum bracteatum* (Vent.) Willd., *Enum. Pl.* 2: 869 (1809), isonym; *Xeranthemum lucidum* Maund, *Bot. Gard.* 2: 135 (1828), *nom. illeg., nom. superfl.; Helichrysum bracteatum* (Vent.) Andrews var. *bracteatum*, A.P. de Candolle, *Prodr.* 6: 189 (1838); *Gnaphalium chrysanthum* Sch.Bip., *Bot. Zeitung* 3: 171 (1845); *Bracteantha bracteata* (Vent.) Anderb. & Haegi, *Op. Bot.* 104: 102 (1991). *Type citation*: 'originaire de la Nouvelle Hollande' [Port Jackson, Australia]. *Type*: ex H. Malmaison, *s. dat., E.-P.Ventenat s.n.* (holo: G-DC G00341478*).

Helichrysum bracteatum var. *chrysanthum* DC., A.P. de Candolle, *Prodr.* 6: 189 (1838), *nom. inval.*

Argyrocome bracteata B.D.Jacks., *Index Kew.* 1(1): 184 (1893) nom. inval., pro syn.

Helichrysum lucidum var. *normalis* F.Muell., *Fragm.* 11(89): 48 (1878) *nom. inval.*

Erect, annual or sometimes short-lived perennial (dependant on season), tap-rooted herb, 0.5–1.8 m tall. *Stems* and *branches* cobwebby, hirsute to pilose with septate trichomes, or glabrescent, and with glands; internode length 10–35 mm. Flowering stems branched, or unbranched (becoming branched with maturity, occasionally single-stemmed). *Basal leaf rosette* usually absent at flowering. *Basal leaves* elliptic to spathulate, 50–150 mm long, and 10–30 mm wide, base amplexicaul and attenuate, margin woolly to hirsute with septate trichomes, apex obtuse to apiculate; abaxial indumentum hispidulous with septate trichomes, and with glands; adaxial indumentum hispidulous with septate trichomes. *Cauline leaves* oblanceolate, 50–180 mm long, 5–25 mm wide, base attenuate and subamplexicaul, margin hispid with septate trichomes, apex acuminate to acute; *abaxial indumentum* with glands, midvein indumentum hispid with septate trichomes; *adaxial indumentum* hispidulous with septate trichomes and with glands. *Foliaceous bracts subtending capitula* ~8–10 mm long, margin hispid with septate trichomes. *Capitula* terminal, 30–50 mm wide, in panicles; *outer phyllaries* broad-ovate, yellow or brown, basal margin hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* oblong, narrow ovate or lanceolate, abaxially brown or yellow, apex cuspidate. *Stylar appendages* deltoid to acute. *Cypsela* oblong, ~2.2 mm long and 0.75 mm wide, cross-section squarish; pericarp grey–brown, idioblasts present. *Pappus* deciduous 5–6 mm long.

Distribution

Endemic to south-eastern New South Wales and far-eastern Victoria in the Sydney Basin, South East Corner, and South East Coastal Plain bioregions (Fig. 22). Naturalised in Saint Helena and many countries owing to widespread cultivation (Missouri Botanical Garden 2020).

Phenology

Recorded flowering in Australia August–February and fruiting December–February.

Habitat

Most commonly recorded from eucalypt woodland and forest on a wide variety of soils including ones derived from granite and basalt, from sea level to ~1000-m altitude. Common on roadsides where disturbance and water shed from the road may favour dispersal, germination and establishment.

Conservation status

Although there have been relatively few collections in the past few decades in the Hawkesbury–Nepean region, *X. bracteatum* has been collected from ~20 populations on the New South Wales South Coast in the past 30 years, including in conservation reserves. We recommend a status of '*Least Concern*' (IUCN 2019).

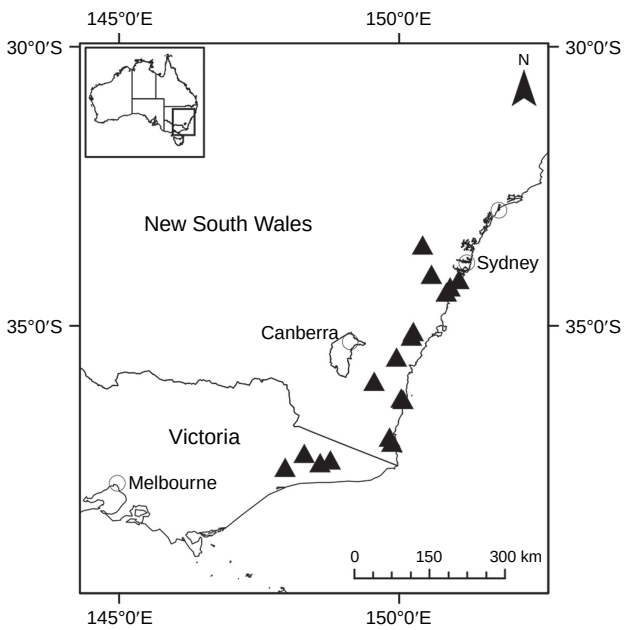

Fig. 22. Distribution of *Xerochrysum bracteatum*.

Notes

Xerochrysum bracteatum is illustrated in Fairley and Moore (1989), plate 1158 on page 317, as *Helichrysum bracteatum*, yellow paper daisy or golden everlasting.

Selected specimens examined

NEW SOUTH WALES: Central Tablelands: Mount Tomah, Lithgow Road, 25 Jan. 1959, *B.R. Paterson s.n.* (CANB*). Central Coast: The Oaks, on road to Penrith (Silverdale Road), 15 Dec. 2018, *T.L. Collins 1005* (CANB!, NE!, NSW!); Hopetoun Park, Panorama House Motel, Bulli Lookout, 7 Jan. 2019, *T.L. Collins 1168* (CANB!, NE!, NSW!); Mount Keira Road, 7 Jan. 2019, *T.L. Collins 1169* (CANB!, NE!, NSW!). South Coast: Nowra Road ~4 km E of intersection with Gretas Road, 26 Jan. 2019, *T.L. Collins 1174* (CANB!, NE!, NSW!); Central Tilba, Paradise Hill, 27 Jan. 2019, *T.L. Collins 1175* (CANB!, NE!, NSW!); Gulaga National Park, Mount Dromedary Trail, 27 Jan. 2019, *T.L. Collins 1177* (CANB!, NE!, NSW!); Nullica State Forest, track to Nethercote Falls, 3 Feb. 2019, *T.L. Collins 1181* (CANB!, NE!, NSW!). VICTORIA: East Gippsland: on track to summit of Mount Ellery, 22 Feb. 1984, *D.E. Albrecht 212* (AD, MEL!); Mount Elizabeth Nature Conservation Reserve, 26 Oct. 2019, *J.J. Bruhl 3643, S. Dema, & H.T. Kennedy* (CANB!, MEL!, NE 109790!, NSW!).

Xerochrysum copelandii J.J.Bruhl & I.Telford, sp. nov.

Type: AUSTRALIA: New South Wales: Northern Tablelands: Styx River, 50 m NW of bridge SW of Jeogla on road to Kempsey, 1 Apr. 2007, *J.J. Bruhl 2649 & O.D.Q. Bruhl* (holo: NSW!; iso: BRI!, CANB!, K!, MEL!, MO!, NE 90257!).

Xerochrysum sp. New England (L.M.Copeland 3731) NE Herbarium, CHAH, *Austral. Pl. Census* (2020) [accessed 20 February 2020].

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, populations in gorge-rim habitat in the New England Tablelands Bioregion only, but excluding the population at Henry River Falls thought to be a hybrid with *X. viscosum*].

Diagnosis

Distinguished from *X. bracteatum* by a perennial life form (*v.* annual or sometimes short-lived perennial), septate trichomes on leaf abaxial surface (*v.* with glands), and acuminate phyllary apices (*v.* apiculate). Distinguished from *X. murapan* by foliaceous bracts subtending capitula 8–10 mm long (*v.* 10–25 mm long in *X. murapan*), acuminate to cuspidate phyllary apex (*v.* apiculate), and cauline leaves 5–10 mm wide (*v.* 10–25 mm wide in *X. murapan*).

Erect, shortly rhizomatous or taprooted, perennial herb, up to ~1 m tall. *Stems* and *branches* cobwebby, hirsute, or glabrescent, and with glands; internode length 15–30 mm. *Basal leaf rosette* absent at flowering. *Basal leaves* spathulate, 80–130 mm long and 20–35 mm wide, base subamplexicaul, margin hirsute with septate trichomes, apex apiculate; abaxial indumentum hirsute to hispid with septate trichomes, and with glands; abaxial midvein indumentum villous with septate trichomes; adaxial indumentum hispid with septate trichomes, and with glands. *Cauline leaves* oblanceolate or lanceolate, 20–90 mm long and 5–10 mm wide, base subauriculate and amplexicaul, margin hispid and scabrid with septate trichomes, apex mucronate; *abaxial indumentum* hirsute with septate trichomes, to glabrous, and with glands; abaxial midvein indumentum cobwebby and hispid with septate trichomes, and with glands; *adaxial indumentum* cobwebby and hispid with septate trichomes, and with glands. *Foliaceous bracts subtending capitula* 8–10 mm long or sometimes absent, margin glabrous or hispid. *Capitula* 25–50 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate, brown or straw-coloured, basal margin fimbriate and hispid, abaxial surface smooth, apex acuminate. *Medial phyllaries* narrow ovate to lanceolate, abaxially yellow, apex acuminate to cuspidate. *Stylar appendages* deltoid to ovate (female florets have clavate to rounded stylar appendages). *Cypsela* oblong, ~2.3 mm long and 0.75 mm wide, cross-section squarish to circular; pericarp brown to brass- or straw-coloured, idioblasts present. *Pappus* deciduous, ~6 mm long.

Distribution

Endemic to north-eastern New South Wales where it is known only from the New England Tablelands Bioregion (Fig. 23). Mostly occurring along the eastern escarpment of the plateau from the Great Dividing Range south-east of Tenterfield, New South Wales, south to the gorges of the Macleay River catchment east of Armidale.

Phenology

Recorded flowering January–February and fruiting in February (Fig. 24).

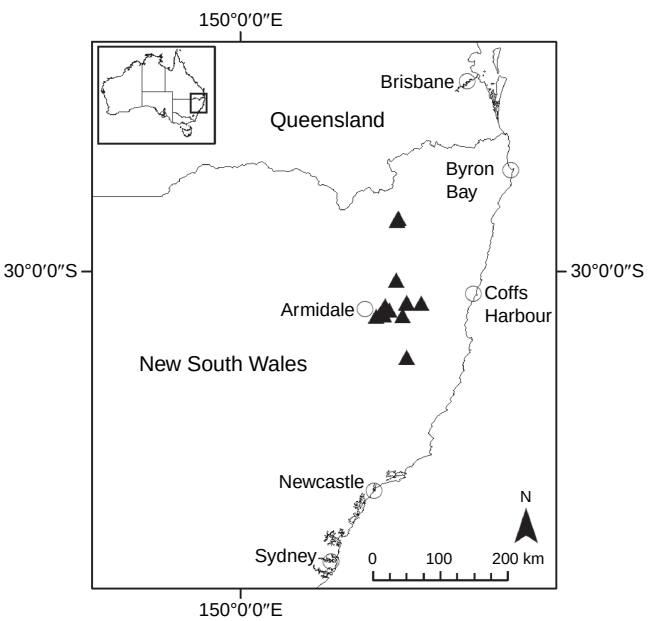

Fig. 23. Distribution of *Xerochrysum copelandii*.

Fig. 24. Isotype of *Xerochrysum copelandii* (*J.J.Bruhl 2649* & *O.D.Q.Bruhl*, NE 90257).

Habitat

The species inhabits ridge tops and gorge rims, often in rocky sites, at 900–1500-m altitude on skeletal or gravelly soils derived mostly from metasediments or basalt, rarely from granite. The species grows in grassy open forest or woodland with *Eucalyptus laevopinea*, *E. nobilis*, *E. obliqua*, *E. pauciflora*, *E. retinens* or *E. caliginosa* recorded as dominants. Other associated species include *Acacia melanoxylon*,

Allocasuarina torulosa, *Coprosma quadrifida*, *Pimelea neoanglica* and *Poa sieberiana*.

Conservation status

Recorded as common, although localised at most sites. We recommend a status of '*Least Concern*' (IUCN 2019).

Notes

Cauline leaf lamina abaxial indumentum is variable: populations at Round Waterhole Creek, Metz Gorge, Werrikimbe National Park, Cathedral Rock National Park, and New England National Park, have an hirsute indumentum of scattered septate trichomes; populations at Washpool National Park, Styx River, Round Mountain, and the putative hybrid *X. copelandii* x *viscosum* at Henry River Falls have sessile glands.

Etymology

The species epithet recognises the work of outstanding field-botanist and taxonomist Lachlan Mackenzie Copeland (1973–) of Coffs Harbour.

Selected specimens examined

NEW SOUTH WALES: Northern Tablelands: Guy Fawkes River National Park, Henry River Falls, 24 Aug. 2017, *T.L. Collins 969, R.L. Andrew, J.J. Bruhl & J.K. Janes* (NE!); Round Waterhole Creek, 11 Feb 2018, *T.L. Collins 1013 & B. Wright* (CANB!, BRI!, NE!, NSW!); Hillgrove Gorge, 28 Feb. 1999, *J.J. Bruhl 1840 & I.R. Telford* (NE!); Washpool National Park, S of summit of Mount Bajimba, 25 Feb. 2011, *L.M. Copeland 4502* (BRI, NE!, NSW); Great Dividing Range, Washpool National Park, 25 Jan. 2014, *I.R. Telford 13440 & T. Vollbon* (NE!).

Xerochrysum frutescens J.J.Bruhl & I.Telford, sp. nov.

Type: AUSTRALIA: Queensland: Moreton: Main Range, Mount Cordeaux, summit ridge, 1 Nov. 2005, *I.R. Telford 12874, J.J. Bruhl & L.M. Copeland* (holo: BRI!; iso: NE 85983!, CANB!, K!, NSW!).

Helichrysum sp. 1 (McPherson Range), J.D. Briggs and J.H. Leigh, *Rare or Threatened Austral. Pl.* 24 (1988).

Helichrysum sp. (Mt Merino S.T.Blake 21554), A.E. Holland in R.J.F. Henderson (ed.), *Queensl. Vasc. Pl.: Names and Distrib.* 39 (1994).

Xerochrysum bracteatum subsp. Mount Merino (S.T.Blake 22869) Qld Herbarium, A.E. Holland in P.D. Bostock and A.E. Holland (eds), *Census Queensl. Fl.* 32 (2007).

Xerochrysum sp. Mount Merino (S.T.Blake 22869) NE Herbarium, CHAH, *Austral. Pl. Census* (2020) [accessed 20 February 2020].

Xerochrysum 'Dargan Hill Monarch', Australian Cultivar Registration Authority 1977.

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, only populations in the Main, McPherson and Tweed Ranges, Queensland and New South Wales].

Diagnosis

Distinguished from *X. bracteatum* by the perennial life form and shrub-like habit (*v.* annual or sometimes short-lived perennial, and erect habit), acuminate to cuspidate phyllary apices (*v.* apiculate), and foliaceous bracts subtending capitula 10–40 mm long (8–10 mm long in *X. bracteatum*). Distinguished from *X. berarngutta* by the taproot (*v.* rhizome), and the hispid leaf lamina adaxial indumentum (*v.* hirsute to pilose).

Erect, taprooted, perennial shrub-like herb, up to ~80 cm tall. *Stems* and *branches* cobwebby, to felted, tomentose, villous, or woolly with septate trichomes, and with glands; internode length 5–40 mm. *Basal leaf rosette* absent at flowering. *Basal leaves* oblanceolate to obovate or spathulate; 40–100 mm long and 10–25 mm wide, base amplexicaul and attenuate, margin cobwebby to villous with septate trichomes, apex obtuse and mucronate; abaxial indumentum cobwebby to tomentose or villous with septate trichomes, and with glands; abaxial midvein indumentum cobwebby and villous with septate trichomes, or glabrous; adaxial indumentum cobwebby to hirsute with septate trichomes, and with glands. *Cauline leaves* oblanceolate to lanceolate, 50–200 mm long and 5–20 mm wide, leaf base amplexicaul and attenuate, margin cobwebby, hispid, or woolly with septate trichomes, apex acute and mucronate; *abaxial indumentum* cobwebby to villous or tomentose with septate trichomes, and with glands; abaxial midvein indumentum cobwebby, hirsute or woolly with septate trichomes, and with glands; *adaxial indumentum* cobwebby to hirsute or hispid with septate trichomes, and with glands. *Foliaceous bracts subtending capitula* 10–40 mm long, margin felted to woolly. *Capitula* 50–90 mm wide, terminal, in panicles or solitary. *Outer phyllaries* ovate to broad-ovate, brown, basal margin fimbriate and hispid, abaxial surface smooth, apex cuspidate, or acute to acuminate. *Medial phyllaries* lanceolate, abaxially yellow, apex acuminate to cuspidate. *Stylar appendages* deltoid to ovate. *Cypsela* oblong, ~2.5 mm long and 0.9 mm wide, cross-section squarish to circular; pericarp straw- or brass-coloured, idioblasts present. *Pappus* deciduous, ~8 mm long.

Distribution

Restricted to South Eastern Queensland, and New South Wales North Coast bioregions along the Main Range (Great Dividing Range) from Cunninghams Gap, Queensland, south to *Acacia* Plateau, eastward along the McPherson Range to Springbrook and southward along the Tweed Range, New South Wales (Fig. 25).

Phenology

Recorded flowering November–March (Fig. 26) with mature cypselae collected in May.

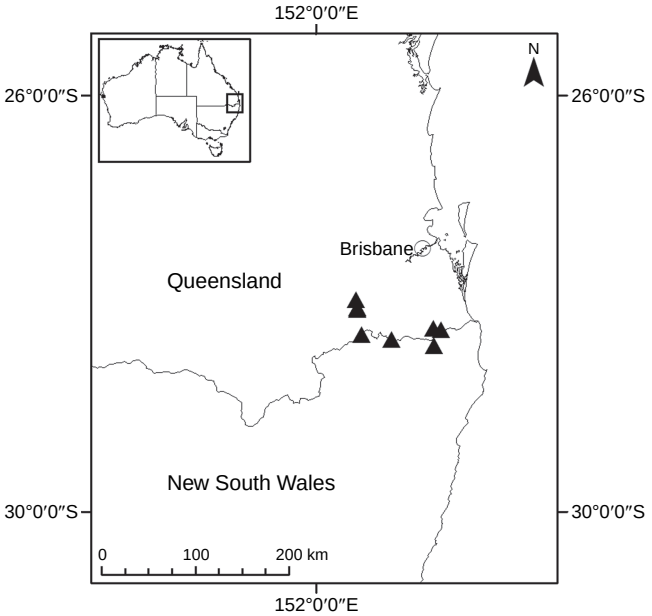

Fig. 25. Distribution of *Xerochrysum frutescens*.

Habitat

Xerochrysum frutescens inhabits rocky slopes and cliff tops at 1000–1150-m altitude in skeletal loamy soils mostly on trachyte and basalt cliff edges of the Main Range and Tweed volcanoes. The species grows in open forest or shrub communities, mostly adjacent to rainforest including *Nothofagus moorei* closed forest. Associated taxa at Main Range sites include *Leptospermum polygalifolium* subsp. *montanum*, *Cuttsia viburnea*, *Pimelea umbratica*, *Doryanthes palmeri* and at McPherson Range sites, *Cassinia straminea*, *Coronidium telfordii*, *Podolepis monticola*, *Prostanthera lanceolata* and *Leucopogon* sp. Lamington (G. Leiper AQ633386).

Conservation status

Most populations occur in conservation reserves but there are no precise data on population sizes. Specimen label data indicate fewer than 10 known populations that are localised or restricted in extent, and most occur at altitudes of >1000 m. Without population data it is not possible to confidently evaluate conservation status. Ongoing threats associated with anthropogenic climate change including heatwaves, extreme drought and intense fires potentially threaten *X. frutescens* and the associated vegetation. Given the very limited geographic range and estimated small population sizes, we suggest a '*Vulnerable*' status is appropriate under the IUCN (2019) because it fulfils the criteria of D1 and D2. A precise assessment of population size and estimated stability would clarify whether *X. frutescens* should be listed as '*Vulnerable*', '*Endangered*' or '*Critically Endangered*'.

Notes

The two collections from Mount Merino Lookout (*I.R. Telford 12886* and *I.R. Telford 2632*) have relatively long, scattered septate trichomes compared with the shorter, closely spaced septate trichomes seen on specimens from other populations.

Etymology

The specific epithet is from the Latin *frutex* (a bush or shrub) and refers to the shrub-like habit of this species.

Selected specimens examined

QUEENSLAND: Moreton: Main Range National Park, ~200 m S of summit of Mount Cordeaux, 11 Mar. 2005, *L.M. Copeland 3904 & A.J. Lynch* (NE!, PERTH); Main Range National Park, Goomburra Section, 28 Oct. 2015, *P.I. Forster 43151* (BRI!); Mount Mitchell, Cunninghams Gap, 18 Aug. 1992, *P.I. Forster 11105* (BRI!); Mount Lindesay, base of trachyte cliffline, 15 Nov. 1990, *P.I. Forster 7562* (BRI!). NEW SOUTH WALES: North Coast: McPherson Range, Limpinwood Nature Reserve, Mount Merino, 6 Nov. 2005, *I.R. Telford 12886* (NE!); Koreelah National Park, 28 Mar. 2009, *L.M. Copeland 4353* (CANB, NE!, NSW); Lamington Plateau, Hunter's Lookout, 12 Mar. 2014, *P.I. Forster 40802* (BRI!).

Xerochrysum gudang T.L.Collins & J.J.Bruhl, sp. nov.

Type: AUSTRALIA: Queensland: Cook: Somerset Lookout, Fly Point, ~350 m SW of lookout parking area, 50 m from rocky coast, 28 June 2018, *T.L. Collins 1061 & J.J. Bruhl*, (holo: BRI!; iso: CANB!, CNS!, NE 107429!).

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, populations in the Torres Strait and on the northern tip of Cape York Peninsula, Queensland only].

Diagnosis

Distinguished from *X. bracteatum* by a perennial life form (*v.* annual or sometimes short-lived perennial), the presence of septate trichomes on leaf lamina abaxial surface (*v.* with glands), and the absence of glands on stems and leaf lamina adaxial surface (*v.* with glands). Distinguished from *X. strictum*, *X. banksii* and *X. boreale* by the absence of glands on stems and leaf adaxial surfaces (present on *X. strictum*, *X. banksii* and *X. boreale*).

Decumbent to erect, taprooted, perennial herb. *Stems* and *branches* up to 70 cm long, cobwebby, hirsute, scabrid, or woolly, to glabrescent; internode length 10–20 mm. Previous season's flowering stems marcescent. *Basal leaf rosette* absent at flowering. *Basal leaves* oblanceolate to spathulate, 70–120 mm long and 5–15 mm wide, base subamplexicaul, margin villous with septate trichomes, apex mucronate; abaxial indumentum villous with septate trichomes, and with glands, midvein indumentum pilose with septate trichomes; adaxial

Fig. 26. Isotype of *Xerochrysum frutescens (I.R.Telford 12874, J.J.Bruhl & L.M.Copeland* NE 85983).

indumentum villous with septate trichomes. *Cauline leaves* oblanceolate to lanceolate, 50–100 mm long and 6–15 mm wide, base auriculate and amplexicaul, margin cobwebby and hirsute with septate trichomes, apex mucronate; *abaxial indumentum* hispid with septate trichomes and with glands, midvein indumentum cobwebby and hispid with septate trichomes; *adaxial indumentum* cobwebby and hirsute with septate trichomes. *Foliaceous bracts subtending capitula* 6–8 mm

long, margin woolly to cobwebby, and hispid. *Capitula* 30–40 mm wide, terminal, in panicles. *Outer phyllaries* ovate to broad-ovate, brown or straw-coloured, basal margin fimbriate and hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* narrow ovate to lanceolate, abaxially yellow, apex cuspidate. *Stylar appendages* deltoid. *Cypsela* oblong, ~2.7 mm long and 0.75 mm wide, cross-section circular; pericarp straw- or brass-coloured, idioblasts present. *Pappus* deciduous, ~8–9 mm long.

Distribution

Known only from the Somerset area of northern Cape York and nearby islands in the Cape York Peninsula Bioregion (Fig. 27). Extensive survey of similar habitat on Cape York Peninsula has not recorded populations of *Xerochrysum* between Jardine River National Park and Cooktown, except for *X. strictum* near Coen (J. R. Clarkson, pers. comm., 2018).

Phenology

Recorded in flower June–October and fruiting in June (Fig. 28).

Habitat

Windswept grassy herbfields among shrubland on low rocky headlands.

Conservation status

Population-size data are scant, with 50–100 plants being estimated at Somerset Lookout in 2018, and other specimen label data describing populations as 'sporadic' (*L.J. Brass 18778*), and 'infrequent' (*K.R. Thiele 905*). Given the very limited geographic range and estimated small population sizes, we suggest a '*Vulnerable*' status is appropriate under the IUCN (2019) because it fulfils the criteria of D1 and D2. A precise assessment of population size and estimated stability would clarify whether *X. gudang* should be listed as '*Endangered*' or '*Critically Endangered*'.

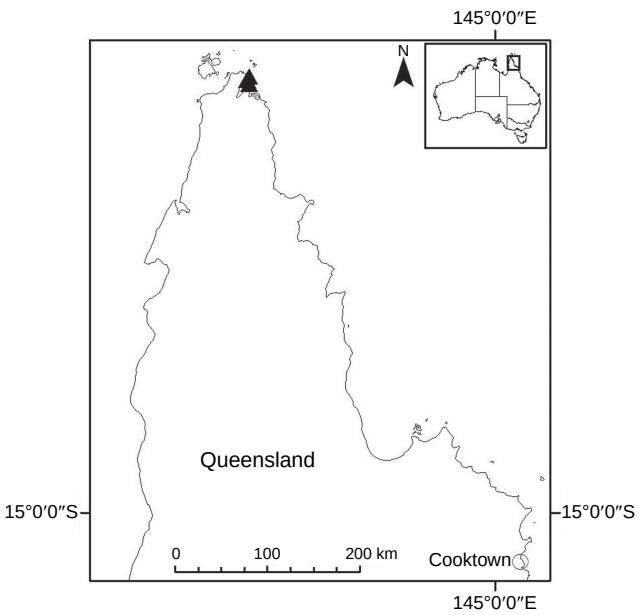

Fig. 27. Distribution of *Xerochrysum gudang*.

Notes

The decumbent habit observed in the field was retained on glasshouse-grown plants. The informal phrase name *X.* sp. Fly Point NE Herbarium has been used at NE for curatorial purposes and this study.

Etymology

The species epithet is the traditional name of the type locality, a place important to traditional owners (Christo Lifu, pers. comm., 2020), as a noun in apposition (Shenzhen Code art. 23.5; Turland *et al.* 2018).

Selected specimens examined

QUEENSLAND: Cook: Albany Island, *s.dat.*, *W. Hill 71* (K000899118*); Fly Point, near Albany Pass, Cape York Peninsula, 25 June 1973, *S. Powell 9* (CANB!); Fly Point, ~11 km SE of Cape York, 30 Oct. 1965, *L.S. Smith 12636* (BRI!); Newcastle Bay, Cape York Peninsula, 15 Feb. 1986, *D.L. Jones s.n.* (BRI!); Newcastle Bay, 2.5 miles S of Somerset, 2 May 1948, *L.J. Brass 18778* (A, CANB!); Headland above Nanthau Beach, 4.5 km direct line SSW of Somerset, 30 June 1985, *K.R. Thiele 905* (CANB!).

Xerochrysum hispidum T.L.Collins & I.Telford, sp. nov.

Type: AUSTRALIA: New South Wales: South Western Plains: Mid Western Highway, 21 km from Rankins Springs towards West Wyalong, 12 Oct. 2019, *I.R. Telford 13546, J.J. Bruhl & S. Dema*, (holo: NSW!; iso: BRI!, CANB!, MEL!, NE 109359!, US!).

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.* populations in south-western New South Wales, inland South Australia and inland Victoria with prominent, robust, hispid septate trichomes scattered on the leaf lamina adaxial surface, leaf margin and abaxial midvein only].

Diagnosis

Distinguished from *X. bracteatum* and *X. bicolor* by the presence of foliaceous bracts subtending capitula 15–35 mm long (8–10 mm long in *X. bracteatum*; 5–6 mm long in *X. bicolor*), and the prominent, robust, hispid septate trichomes scattered on the leaf lamina adaxial surface, leaf margin and abaxial midvein. Further distinguished from *X. bicolor* by a strictly annual life form (*v.* perennial), and the attenuate leaf base (*v.* auriculate).

Erect, taprooted, annual herb, 10–80 cm tall, depending on rainfall. *Stems* and *branches* cobwebby and hispid with

Fig. 28. Isotype of *Xerochrysum gudang* (*T.L.Collins 1061* & *J.J.Bruhl*, NE 107429).

septate trichomes, and with glands; internode length 15–30 mm. *Basal leaf rosette* may be present or absent at flowering. *Basal leaves* obovate to spathulate, 50–150 mm long and 10–40 mm wide, base amplexicaul, margin hispid and pilose with septate trichomes, apex mucronate and apiculate; abaxial indumentum with glands, midvein indumentum pilose with septate trichomes; adaxial leaf surface glabrous (with scattered septate trichomes). *Cauline leaves*

oblanceolate to obovate, 60–160 mm long and 10–30 mm wide, base amplexicaul and attenuate, margin cobwebby and hispid with septate trichomes, apex acute and mucronate; *abaxial indumentum* with glands, midvein indumentum hispid or pilose with septate trichomes; *adaxial indumentum* hispid with septate trichomes, and with additional scattered large septate trichomes, and with glands. *Foliaceous bracts subtending capitula* 15–35 mm long, margin hispid. *Capitula* 35–50 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate, brown or straw-coloured, basal margin fimbriate and hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* oblong to ovate, abaxially yellow, apex acuminate to cuspidate, or apiculate. *Stylar appendages* narrowly triangular to deltoid. *Cypsela* oblong, ~3.3 mm long and 1 mm wide, cross-section squarish; pericarp brown, idioblasts present. *Pappus* deciduous, ~8.5 mm long.

Distribution

Occurs sporadically following winter rainfall over a broad area of South Australia, Victoria and New South Wales, in the Eyre Yorke Block, Gawler, Flinders Lofty Block, Murray–Darling Depression, and Riverina bioregions (Fig. 29).

Phenology

Recorded flowering August–October (Fig. 30).

Habitat

Shrubby and grassy eucalypt woodlands and *Acacia* shrublands, on orange–red sandy loams and red, gravelly, clay soils.

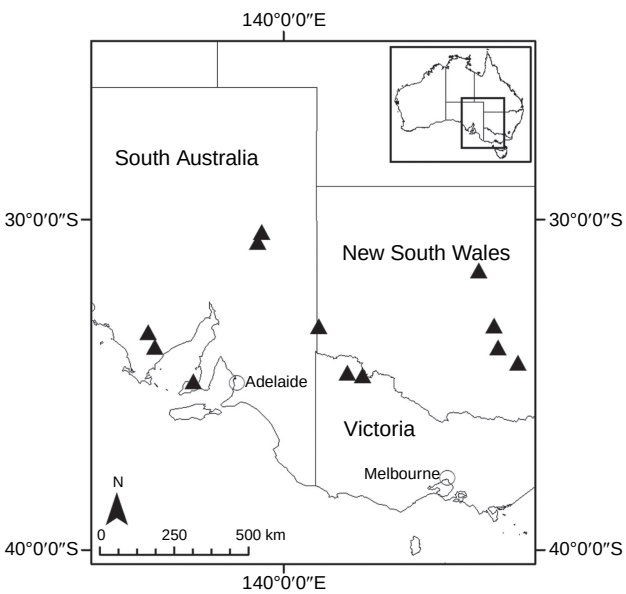

Fig. 29. Distribution of *Xerochrysum hispidum*.

Conservation status

Occurs over a wide geographical area, including in several conservation reserves and is not considered to be rare or threatened. We recommend a status of '*Least Concern*' (IUCN 2019).

Notes

The informal phrase name *Xerochrysum* sp. Flinders Range NE Herbarium has been used at NE for curatorial purposes and this study.

Etymology

The specific epithet is from the Latin, *hispidus* (rough, shaggy, hairy), in reference to the indumentum, comprising scattered, large, spreading septate trichomes, occurring abaxially along the leaf midrib and adaxially over the lamina, which are particularly helpful in identifying specimens.

Selected specimens examined

SOUTH AUSTRALIA: unincorporated: Balcanoona, near Nudlamutana Well, 26 Oct. 1967, *H. Eichler 19646* (AD!). Elliston: Hambidge Flora and Fauna Reserve, 18 Sep. 1966, *C.R. Alcock 1023* (AD!). Cleve: Hincks National Park, summit of Verran Hill, 6 Oct. 1968, *J.R. Wheeler 733* (AD!). NEW SOUTH WALES: unincorporated: Scotia Sanctuary, 22 May 2011, *D. Wood 240* (CANB!). Lachlan: 2.5 miles [~4 km] E from Euabalong turn-off from Lake Cargelligo, 23 May 1969, *P.N. Martensz 178* (CANB*). Cobar: 10.5 miles [~16.8 km] S of Cobar on Nymagee road, 30 Sep. 1966, *C.W.E. Moore 4487* (CANB*). Coolamon: Near Ariah Park, ~40 km WNW of Temora, 28 Oct. 1978, *C.J. Shepherd 870* (CANB*). VICTORIA: Mildura: Murray-Sunset National Park, 10 Oct. 2014, *V. Stajsic 7611* (MEL!); Hattah Lakes National Park, 1 Oct. 1948, *A.C. Beauglehole 1101* (MEL!); ~10.5 miles [~16.8 km] NW of Warooka, 25 Oct. 1967, *T. Smith 774* (AD!).

Xerochrysum interiore Paul G.Wilson, *Nuytsia* 28: 19 (2017)

Type: 4 miles [~6.4 km] east of *Acacia* Well, Undoolya, Northern Territory, 9 Nov. 1954, *G. Chippendale 450* (holo: AD 95805047; iso: BRI, CANB 37993, DNA A0000450, NSW 518728, PERTH 00423815*).

Erect, annual (never biennial), taprooted herb. *Stems* and *branches* hispid with septate trichomes, or glabrescent, and with glands; internode length 15–20 mm. *Basal leaf rosette* often present at flowering, or absent (will flower with loose basal rosette in drier seasons). *Basal leaves* obovate to spathulate, 70–110 mm long and 15–35 mm wide, base auriculate and attenuate, apex apiculate; abaxial indumentum with glands, midvein indumentum pilose with septate trichomes; adaxial indumentum with scattered septate trichomes. *Cauline leaves* spathulate to obovate, 50–200 mm long and 10–30 mm wide, leaf base attenuate and auriculate, margin hirsute with septate trichomes, apex mucronate; *abaxial indumentum* with glands, midvein indumentum hispid with

Fig. 30. Isotype of *Xerochrysum hispidum (I.R.Telford 13546, J.J.Bruhl & S.Dema*, NE 109359).

septate trichomes, and with glands; *adaxial indumentum* hirsute with septate trichomes, and with glands. *Foliaceous bracts subtending capitula* ~2–4 mm long or absent, margin fimbriate or hispid. *Capitula* 25–40 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate, straw-coloured, basal margin fimbriate, abaxial surface smooth, apex obtuse or apiculate. *Medial phyllaries* ovate to narrow ovate, abaxially yellow, apex cuspidate. *Stylar appendages* narrowly triangular

or rounded. *Cypsela* ~3.5 mm long and 0.9 mm wide, cross-section squarish or circular; pericarp grey–brown, idioblasts present. *Pappus* deciduous, ~10–11 mm long.

Distribution

Occurs sporadically following winter rainfall over a broad area in central Australia, including the Finke, MacDonnell Ranges, Great Sandy Desert, and Central Ranges bioregions, with a disjunct distribution in the Pilbara Bioregion (Fig. 31).

Phenology

Recorded flowering July–September and fruiting September–December.

Habitat

Acacia shrublands on red–orange sandy loam and gravelly loam soils.

Notes

A specimen from Balladonia, Western Australia (*B.L.Turner 5251*, MEL 602769!) is noteworthy in that it has cobwebby trichomes below the capitulum (*v.* short, stiff, septate trichomes) and immediately noticeable, much shorter (15–30 mm long) obovate cauline leaves (*v.* spathulate to obovate cauline leaves, 50–200 mm long). The area in which this collection was made is markedly disjunct from all other populations of *X. interiore* and other species of *Xerochrysum* in Western Australia

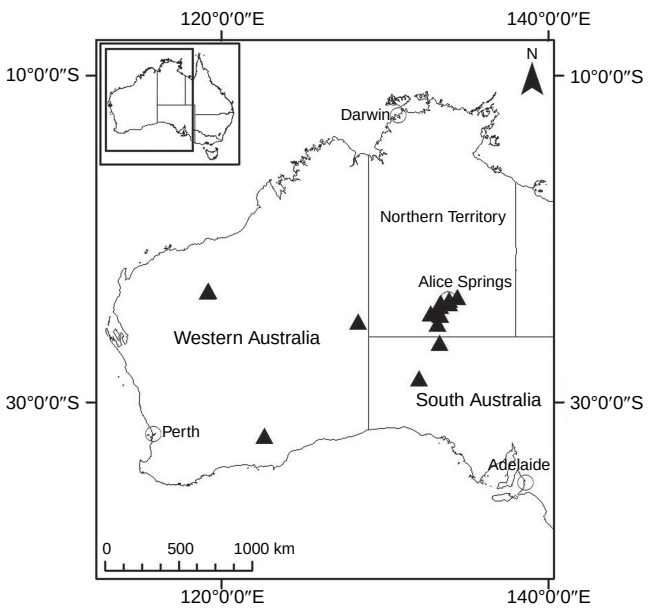

Fig. 31. Distribution of *Xerochrysum interiore*.

Conservation status

Occurs over a wide geographical area, including in several conservation reserves and is not considered to be rare or threatened. We recommend a status of '*Least Concern*' (IUCN 2019).

Selected specimens examined

NORTHERN TERRITORY: MacDonnell: 1.4 km N of Erldunda Roadhouse, ~50 m E of Stuart Highway, 25 Sep. 2016, *J.J. Bruhl 3446* (NE!, NT!); Alice Springs, 500 m NE of the end of Baldissera Drive, 19 Oct. 2014, *T.L. Collins 713* (NT!, NE!); S of Alice Springs, 17 km along Maryvale Road, 2 Jul. 2014, *T.L. Collins 706* (NT!, NE!). SOUTH AUSTRALIA: unincorporated: De Rose Hill Station ~9 km NE of Homestead, 31 Aug. 1989, *H.P. Vonow 1288* (AD!). WESTERN AUSTRALIA: Fortescue: Wanna Munna Road, Pilbara, 22 Aug. 2018, *T.L. Collins 1073 & J.J. Bruhl* (CANB!, NE!, NT!, PERTH!). Ngaanyatjarraku: ~49 km N of Mount Fanny on Giles–Mount Davies road, 11 May 1977, *M. Lazarides 8341* (CANB, NSW, PERTH!). Dundas: 87.7 km E of Norseman on Eyre Highway, 16 Aug. 1995, *R.J. Cranfield 10058* (PERTH!).

Xerochrysum macranthum (Benth.) Paul G.Wilson, *Taxon* 64(1): 105 (2015)

Helichrysum macranthum Benth. in S.L. Endlicher *et al.*, *Enum. Pl.* 65 (1837); *Gnaphalium macranthum* (Benth.) Sch.Bip., *Bot. Zeit.* 3: 171 (1845); *Aphelexis macrantha* (Benth.) Hereman *Paxton's Bot. Dict.* 41 (1868). *Type citation*: 'Swan River (Hügel).' *Type*: Freemant. [Freemantle, Western Australia], *s. dat.*, *K.A. Huegel s.n.* (holo: W 0047162*).

Helichrysum bracteatum var. *albidum* DC., A.P. de Candolle, *Prodr.* 6: 189 (1838). *Type citation*: 'Rarius in hortis colitur.' *Type*: Hort. Genev., 15 Oct. 1834, *leg. ign. s.n.* (syn: G-DC G 00470178; G-DC G 00470552, *n.v.*, *fide* P. G. Wilson, *Nuytsia* 28: 23 (2017)).

Helichrysum glabratum DC., A.P. de Candolle, *Prodr.* 6: 189 (1838); *Gnaphalium glabratum* (DC.) Sch.Bip., *Bot. Zeit.* 3: 171 (1845). *Type citation*: 'in Nova Hollandia merid. et orientali.' *Type*: Nouvelle Hollande, côte oriente, *s. dat., leg. ign., s.n.* (syn: G-DC G00470680*); Nouvelle Hollande, côte merid., *s. dat., leg. ign., s.n.* (syn: G-DC G00470565*).

Helichrysum robustum Paxton, *Paxton's Mag. Bot.* 7: 188 (1840). *Type citation*: 'Among the plants raised from the Swan River seeds… It has been raised both in the Clapton and Epsom nurseries.' *Type: n.v.*, *fide* P.G. Wilson, *Nuytsia* 28: 23 (2017).

Helichrysum niveum Graham, *Bot. Mag.* 67: t. 3857 (1841), *nom. illeg., non* (L.) Less. (1832); *Helichrysum nervosum* Don, *Hort. Cantab.* 13th edn, 567 (1845), *nom. nov*. *Type citation*: 'raised by Mr. Low of Clapton, from seed sent from Swan River by Mr. Drummond, late of Cork, and seedlings, sent to the garden of the Caledonian Horticultural Society in October, 1839.' *Type*: Gard. of Caledon. Hort Soc, 1840, *leg. ign.* (syn: FI 006313*); Hort. Rollison, 1838, Botanist T (syn: K 000899127*).

Erect, taprooted, annual to short-lived perennial herb up to ~70 cm. *Stems* and *branches* cobwebby to hirsute and hispid with septate trichomes, or glabrescent, and with glands; internode length 20–40 mm. *Basal leaf rosette* usually absent at flowering. *Basal leaves* spathulate, 70–150 mm long and 15–25 mm wide, base amplexicaul, margin cobwebby to hirsute with septate trichomes, apex apiculate; abaxial indumentum with glands, midvein indumentum pilose with

septate trichomes and with glands; adaxial indumentum with scattered septate trichomes. *Cauline leaves* oblanceolate to elliptic, 30–100 mm long and 5–12 mm wide, base subauriculate and amplexicaul, margin hispid with septate trichomes, apex acute; *abaxial indumentum* with glands, midvein indumentum hirsute with septate trichomes and with glands; *adaxial indumentum* hispid with septate trichomes, and with glands. *Foliaceous bracts subtending capitula* 5–7 mm long, margin hispid. *Capitula* 30–50 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate, straw-coloured, pink, white, or occasionally yellow or brown; basal margin fimbriate and hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* narrow ovate to lanceolate, abaxially white or yellow, apex cuspidate. *Stylar appendages* deltoid. *Cypsela* oblong, ~2.6 mm long and 0.8 mm wide, cross-section squarish; pericarp brown, idioblasts present. *Pappus* deciduous, ~7–8 mm long.

Distribution

Endemic to south-western Western Australia in the Geraldton Sandplains, Jarrah Forest, and Swan Coastal Plain bioregions (Fig. 32).

Phenology

Recorded flowering September–December and fruiting in November–December.

Habitat

Shrubby and grassy eucalypt woodland on gravelly sandy loam soils.

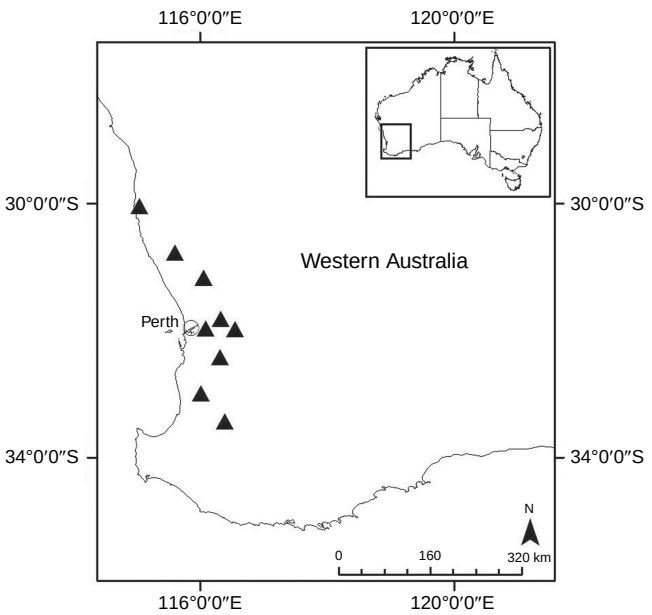

Fig. 32. Distribution of *Xerochrysum macranthum*.

Conservation status

Occurs over a wide geographical area, including in several conservation reserves and is not considered to be rare or threatened. We recommend a status of '*Least Concern*' (IUCN 2019).

Notes

Some populations to the north and east of Perth consist entirely of plants with golden-yellow phyllaries. Molecular data confirmed that these are genetically similar to *X. macranthum* plants with white phyllaries. The informal phrase name *X.* sp. Golden was applied to populations with yellow phyllaries in the analyses.

Selected specimens examined

WESTERN AUSTRALIA: Coorow: north heading track 7.0 km E of intersection of Coastal Road [Indian Ocean Drive] and Eneabba–Coolimba road, 20 Sep. 1994, *E.D. Kabay 655* (PERTH!). Chittering: Wannamal (127 km N of Perth), 13 Dec. 2018, *T.L. Collins 1148* (CANB!, K!, NE!, PERTH!). Mundaring: Government Road (Chidlow Road), ~1.9 km S of Wooroloo, 13 Dec. 2018, *T.L. Collins 1150* (CANB!, NE!, PERTH!, US!); junction Turkey Farm track and York–Chidlow road, 2 Nov. 1996, *B.J. Lepschi 3164* & *T.R. Lally* (AD, CANB, MEL, PERTH!); Wandoo National Park, Talbot West Road, 13 Dec. 2018, *T.L. Collins 1153* (CANB!, NE!, PERTH!). Kalamunda: Kalamunda National Park, 1 Nov. 2000, *K. Macey 258* (PERTH!); Lesmurdie Falls National Park, 14 Sep. 1992, *S. Patrick 1213* (PERTH!). West Arthur: ~23.5 km E of Collie, 19 Dec. 2018, *T.L. Collins 1164* (CANB!, NE!, NSW!, PERTH!). Boyup Brook: Donnybrook–Boyup Brook road and intersection with Camballan Road, 19 Dec. 2018, *T.L. Collins 1163* (CANB!, MO!, NE!, PERTH!).

Xerochrysum macsweeneyorum T.L.Collins, sp. nov.

Type: AUSTRALIA: New South Wales: Northern Tablelands: Roadside reserve, Old Gostwyck Road, ~180 m S of intersection with Bellandean Road, 11 Apr. 2017, *T.L. Collins 957* & *J.J. Bruhl*, (holo: NSW!; iso: BRI!, CANB!, NE 104743!, K!).

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, populations of annual or occasionally biennial plants with very small septate flagelliform trichomes on leaf abaxial surface naturally occurring on the Northern Tablelands, New South Wales, and in southern Queensland only].

Diagnosis

Distinguished from *X. bracteatum* by presence of a dense covering of very small septate flagelliform trichomes on leaf abaxial surface (*X. bracteatum* has no septate trichomes abaxially), cauline leaves 3–10 mm wide (5–25 mm wide in *X. bracteatum*); and from other similar species by the annual or biennial life form (*v.* perennial life form in *X. copelandii* and *X. murapan*), cauline leaf width (10–25 mm wide in *X. murapan*), foliaceous bracts subtending capitula 4–9 mm long (10–25 mm long in *X. murapan*), obtuse phyllary apices (acuminate in *X. copelandii*).

Erect, taprooted, annual to short-lived perennial herb, up to ~1.3 m tall. *Stems* and *branches* cobwebby or glabrescent,

and with glands; internode length 10–40 mm. *Basal leaf rosette* may be present but usually marcescent at flowering. *Basal leaves* spathulate, 80–150 mm long and 15–30 mm wide, base subamplexicaul, margin pilose with septate trichomes, apex mucronate; abaxial indumentum hirsute to hispidulous with septate trichomes, and with glands; abaxial midvein indumentum pilose with septate trichomes; adaxial indumentum hirsute with septate trichomes. *Cauline leaves* oblanceolate to lanceolate, 30–110 mm long and 3–10 mm wide, leaf base subauriculate, margin hispid with septate trichomes, apex mucronate; *abaxial indumentum* cobwebby and hispid with septate trichomes, and with glands; abaxial midvein indumentum cobwebby and hispid with septate trichomes, and with glands; *adaxial indumentum* hispid with septate trichomes, and with glands. *Foliaceous bracts subtending capitula* 4–9 mm long or absent, margin with glands, cobwebby, fimbriate, and hispid. *Capitula* 30–45 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate to rounded, brown or straw-coloured, basal margin fimbriate to hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* oblong, narrow ovate or elliptic, abaxially yellow, apex acuminate to apiculate. *Stylar appendages* narrowly triangular to triangular. *Cypsela* oblong, ~2 mm long and 0.7 mm wide, cross-section squarish to circular; pericarp straw- or brass-coloured, idioblasts present. *Pappus* ~6–8 mm long.

Distribution

Occurs in the New England Tablelands and South Eastern Queensland bioregions, with disjunct populations on grassy balds at Bunya Mountains National Park in Queensland, and at Copeland Tops and in Barrington Tops National Park in New South Wales (Fig. 33).

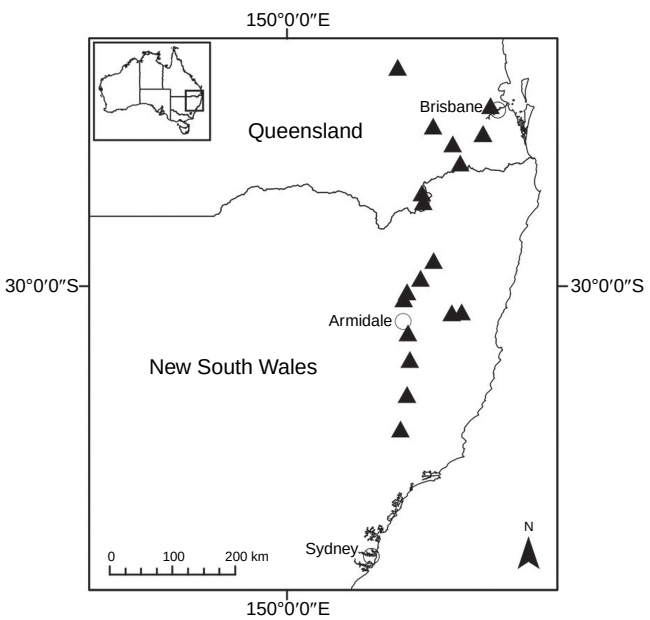

Fig. 33. Distribution of *Xerochrysum macsweeneyorum*.

Phenology

Recorded flowering November–May and fruiting December–May (Fig. 34).

Habitat

Grassy herblands and woodlands, often on basalt-derived clay soils, usually at altitudes of >450 m.

Conservation status

Occurs over a wide geographical area, including in several conservation reserves and is not considered to be rare or threatened. We recommend a status of '*Least Concern*' (IUCN 2019).

Notes

Often with persistent, desiccated (marcescent) basal rosette leaves or leaf bases. A population introduced to Jukes Road, Queenstown, Tasmania, has become naturalised there (M. Baker, pers. comm., 2018). The informal phrase name *Xerochrysum* sp. Northern Tablelands NE Herbarium has been used at NE for curatorial purposes and this study.

Etymology

Honouring my partner's grandfather and mother, Eddie and Geraldine (Gerry) McSweeney of Dublin and Randwick respectively, both growers and lovers of plants. Orthography follows ICN Rec. 60C.4(a) (Shenzhen Code, Turland *et al.* 2018).

Selected specimens examined

QUEENSLAND: Darling Downs: Bunya Mountains National Park, track to Barker Creek Lookout from Paradise, 21 Nov. 2018, *T.L. Collins 1141* (BRI!, CANB!, NE!); Spring Creek Road, W of Condamine River, 20 Mar. 2018, *T.L. Collins 1039 & B. Wright* (BRI!, CANB!, NE!); Eukey, Anderson Lane, 21 Nov. 2018, *I.R. Telford 13531* (BRI!, CANB!, NE!, NSW!); Stanthorpe, 5 Nov. 1963, *W.T. Jones s.n.* (CANB 266087.1*). NEW SOUTH WALES: Northern Tablelands: E of Glencoe, Costello Road, 8 Dec. 2018, *T.L. Collins 1147* (CANB!, NE!, NSW!); Ben Lomond Range, N of Guyra, 24 Feb. 1970, *I.R. Telford 1415* (CANB*); ~20 miles [~32 km] from Guyra towards Glen Innes on New England Highway, 23 Feb. 1961, *M.E. Phillips s.n.* (CANB 14159.1*, NSW 518529!); junction to New England National Park, 4 Feb. 1996, *M. Ito 96011, T. Nishino & Y. Kita* (AD, CANB*, NSW, TI); Waterfall Way, ~1.5 km E of Ebor, 22 Apr. 2018, *T.L. Collins 1049 & D.T. Collins* (AD!, CANB!, NE!, NSW!); near Meldrum between Dorrigo and Ebor, 16 May 1978, *B. Barnsley 191* (CANB*); Oxley Wild Rivers National Park, Apsley Falls, 17 Feb. 2018, *T.L. Collins 1015* (BRI!, CANB!, HO!, NE!, NSW!); Thunderbolts Way, ~4.96 km S of Nowendoc Road intersection, 22 Dec. 2017, *T.L. Collins 1009 & P.L. Collins* (BRI!, CANB!, E!, NE!, NSW!); Barrington Tops National Park, Gloucester Tops, 9 Apr. 2018, *T.L. Collins 1042* (CANB!, MO!, NE!, NSW!, PERTH!). TASMANIA: Mount Jukes Road, 4.9 km from King River crossing, 20 Feb. 2005, *M.L. Baker 1539* (CANB!, HO!, PERTH!); Mount Jukes Road, 21.4 km SSE of Queenstown, 23 Jan. 2018, *J.R. Nevin 154* (NE!); Queenstown area, Mount Jukes Road, 4.85 km after the King River bridge, 1 Mar. 2018, *T.L. Collins 1023 & R.L. Andrew* (CANB!, HO!, NE!).

Fig. 34. Isotype of *Xerochrysum macsweeneyorum* (*T.L.Collins 957 & J.J.Bruhl*, NE 104743).

Xerochrysum murapan T.L.Collins & I.Telford, sp. nov.

Type: AUSTRALIA: New South Wales: Northern Tablelands: Barrington Trail 0.6 km S of the Barrington Tops Forest Road, Barrington Tops State Conservation Area, 27 Feb. 2009, *J. R. Hosking 3201* (holo: NSW!; iso: CANB, MEL, NE 95474!, PERTH).

Xerochrysum bracteatum subsp. *barringtonense* MS, G.J. Harden, *New South Wales Fl. Online* (see http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm, accessed 21 May 2018).

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, populations of perennial, shortly rhizomatous plants with branching habit restricted to Barrington Tops National Park, New South Wales only].

Diagnosis

Distinguished from other species, with which it has been confused in the past, by the perennial life form (*v. X. bracteatum* and *X. macsweeneyorum* annual to biennial), foliaceous bracts subtending capitula 10–25 mm long (*v.* 8–10 mm long on *X. bracteatum* and *X. copelandii*), inflorescences in panicles (*v. X. neoanglicum* inflorescence solitary), cuspidate to apiculate medial phyllary apices (*v. X. neoanglicum* obtuse), and cauline leaves 10–25 mm wide (*v. X. neoanglicum* leaves 2–12 mm wide; *X. copelandii* leaves 5–10 mm wide).

Erect, rhizomatous or taprooted, perennial herb up to ~70 cm tall. *Stems* and *branches* becoming purple–red with age, cobwebby and hirsute with septate trichomes, or glabrescent, and with glands; internode length 10–75 mm. Basal leaf rosette present or absent at flowering. *Basal leaves* spathulate, 60–180 mm long and 15–35 mm wide, base amplexicaul, margin hirsute with septate trichomes, apex apiculate; abaxial indumentum hirsute with septate trichomes, midvein with scattered septate trichomes; adaxial indumentum hirsute with septate trichomes. *Cauline leaves* oblanceolate to obovate, 30–200 mm long and 10–25 mm wide, base subauriculate and amplexicaul, margin cobwebby and hirsute with septate trichomes; apex mucronate; *abaxial indumentum* cobwebby and hirsute with septate trichomes, and with glands; midvein indumentum hirsute with septate trichomes or hispid with scattered glands; *adaxial indumentum* hispid with septate trichomes, and with glands. *Foliaceous bracts subtending capitula* 10–25 mm long, margin woolly, or cobwebby, and hispid. *Capitula* 30–45 mm wide, terminal, in panicles or occasionally solitary. *Outer phyllaries* broad-ovate, brown, basal margin fimbriate or hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* ovate to lanceolate, abaxially yellow, apex cuspidate to apiculate. *Stylar appendages* ovate. *Cypsela* oblong, ~2.3 mm long and 1 mm wide, cross-section squarish to circular; pericarp brown, idioblasts present. *Pappus* deciduous, ~8 mm long.

Distribution

Restricted to the Barrington Tops National Park in the New England Tablelands Bioregion, with known occurrences restricted to Barrington Tops itself and Gloucester Tops, ~22 km to the south-east, in New South Wales (Fig. 35).

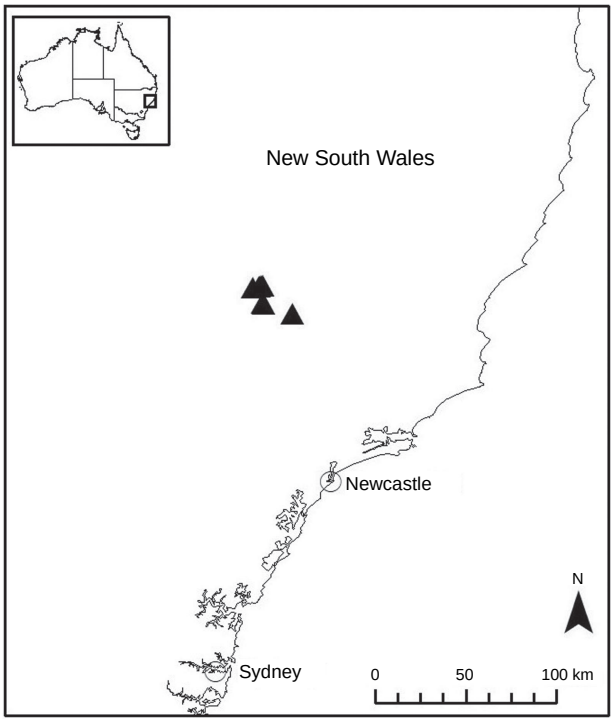

Fig. 35. Distribution of *Xerochrysum murapan*.

Phenology

Recorded flowering February–April with mature cypselae recorded in February and April (Fig. 36).

Habitat

Occurs in eucalypt forest and woodland at altitudes of >1000 m.

Conservation status

All existing collections come from either Barrington Tops National Park, including the Gloucester Tops area, or the adjoining Barrington Tops State Forest, with specimen label data estimating some populations comprising thousands of plants. Issues associated with anthropogenic climate change including heatwaves, extreme drought and intense fires are likely to present a threat to *X. murapan* and the associated vegetation in the future. We recommend a status of '*Least Concern*' (IUCN 2019), with the need for reassessment in the future if climate changes rapidly.

Notes

The informal phrase name *Xerochrysum* sp. Barrington Tops has been used at NE for curatorial purposes and this study.

Fig. 36. Isotype of *Xerochrysum murapan* (*J.R.Hosking 3201*, NE 95474).

Etymology

The specific epithet, in reference to the phyllary colour on the type specimen, is the colour yellow in the Gathang and Wonaruah languages of the traditional owners of Barrington Tops (Stephen Brereton, pers. comm., 2020), and is used as a noun in apposition.

Selected specimens examined

NEW SOUTH WALES: Northern Tablelands: Moonan State Park [Barrington Tops State Forest], Cobark Lookout, 5 Feb. 1996, *M. Ito 96029, T. Nishino & Y. Kita* (CANB, MEL!, NSW, TI); Barrington Trail, 0.6 km south of the Barrington Tops Forest Road, 27 Feb. 2009, *J.R. Hosking 3204* (CANB, MEL, NE!, NSW, PERTH); Barrington Tops National Park, Gloucester Tops, 9 Apr. 2018, *T.L. Collins 1041* (CANB!, BRI!, NE!, NSW!); Barrington Tops National Park, Polblue Swamp, 10 Apr. 2018, *T.L. Collins 1044* (CANB!, BRI!, NE!, NSW!); Barrington Tops National Park, Bull Ridge Road, 10 Apr. 2018, *T.L. Collins 1046* (CANB!, BRI!, NE!, NSW!); Careys Peak, Barrington Tops, 12 Feb. 1971, *I.R. Telford 2729* (CANB!).

Xerochrysum neoanglicum J.J.Bruhl & I.Telford, sp. nov.

Type: AUSTRALIA: New South Wales: Northern Tablelands: 400 m N of Glencoe along New England Highway, E side of road, 8 Nov. 2002, *L.M. Copeland 3468, J.J. Bruhl & I.R. Telford*, (holo: NSW!; iso: BRI!, CANB!, K!, MEL!, NE 80118!, PERTH!, US!).

Xerochrysum bracteatum subsp. *barringtonense* MS, G.J. Harden, *New South Wales Fl. Online* (see http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm, accessed 21 May 2018).

Xerochrysum sp. Glencoe (M.Gray 4401) NE Herbarium, CHAH, *Austral. Pl. Census* (2020) [accessed 20 February 2020].

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, populations with a solitary inflorescence, annually arising from a perennial crown and restricted to the New England Tablelands Bioregion and Barrington Tops, New South Wales only].

Diagnosis

Distinguished from other species, with which it has been confused in the past, by the perennial life form (*v.* annual or biennial in *X. bracteatum*), solitary inflorescence (*v.* paniculate in *X. bracteatum*, *X. copelandii*, and *X. murapan*), presence of septate trichomes on leaf abaxial surface (*v.* absent in *X. bracteatum*), leaves 2–12 mm wide (5–25 mm wide in *X. bracteatum* and 10–25 mm wide in *X. murapan*, and 5–10 mm wide in *X. copelandii*), and foliaceous bracts subtending capitula 10–20 mm long (8–10 mm long in *X. bracteatum* and 8–10 mm long or sometimes absent in *X. copelandii*).

Erect, taprooted, perennial herb annually reshooting from a crown, up to ~50 cm tall. *Stems* and *branches* becoming reddish with age, cobwebby, hirsute to woolly with septate trichomes, and with glands; internode length 15–30 mm. *Basal leaf rosette* usually present at flowering. *Basal leaves* oblong to obovate, 30–100 mm long and 10–20 mm wide, base amplexicaul, margin cobwebby to villous with septate trichomes, apex mucronate and apiculate; abaxial indumentum with glands, midvein indumentum cobwebby or villous with septate trichomes, and with glands; adaxial indumentum hirsute to villous with septate trichomes, and with glands. *Cauline leaves* lanceolate, 25–100 mm long and 2–12 mm wide, base attenuate, margin cobwebby or villous with septate trichomes, and hispid, apex mucronate; *abaxial indumentum* hirsute with septate trichomes, and with glands, midvein indumentum cobwebby with septate trichomes, and with glands; *adaxial indumentum* hispid to pilose with septate trichomes, and with glands. *Foliaceous bracts subtending capitula* 10–20 mm long, margin woolly or cobwebby. *Capitula* 35–60 mm wide, terminal, solitary (never branched). *Outer phyllaries* broad-ovate to ovate, brown or straw-coloured, basal margin fimbriate and hispid (extending to the apex), abaxial surface smooth, apex apiculate. *Medial phyllaries* oblong to narrow ovate, abaxially yellow, apex apiculate. *Stylar appendages* clavate to ovate. *Cypsela* oblong, ~2.2 mm long and ~1 mm wide, cross-section squarish to circular; pericarp straw- or brass-coloured, idioblasts absent. *Pappus* deciduous, ~8 mm long, apical cells often tinted red.

Distribution

Xerochrysum neoanglicum is widespread through the New England Tablelands Bioregion (NETB) from the eastern edge of the Granite Belt near Wallangarra, Queensland, south through the higher eastern edge of the NETB to Werrikimbe National Park, New South Wales, and in the New South Wales North Coast Bioregion at Barrington Tops National Park (Fig. 37).

Phenology

Recorded flowering November–February (Fig. 38).

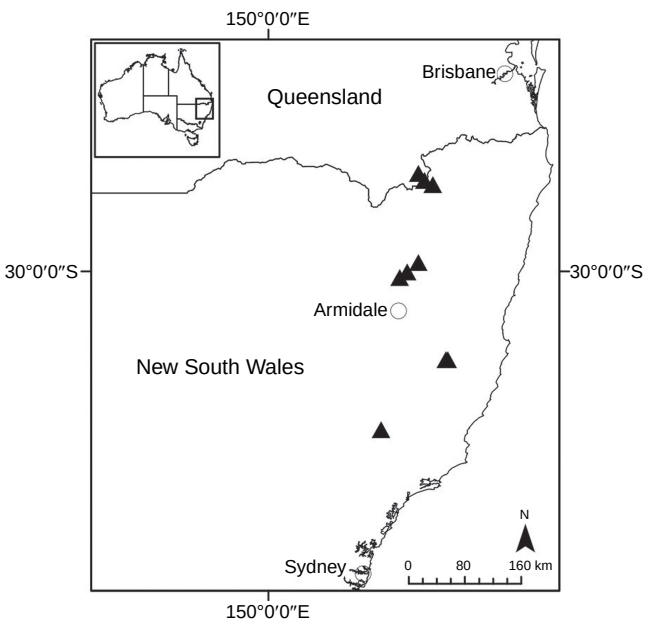

Fig. 37. Distribution of *Xerochrysum neoanglicum*.

Fig. 38. Isotype of *Xerochrysum neoanglicum* (*L.M. Copeland 3468, J.J. Bruhl & I.R. Telford*, NE 80118).

Habitat

Xerochrysum neoanglicum grows in frost hollows, gullies and on swamp margins at 850–1350-m altitude. The vegetation is usually herbfield or *Eucalyptus pauciflora* grassy woodland, soils are mostly clay loam on basalt, occasionally on humic silt on granite (Granite Belt and Boonoo Boonoo). Other taxa

recorded at sites include *Eucalyptus acaciiformis*, *Poa sieberiana* and *Carex* sp. Majors Point (*L.M. Copeland 1812*).

Conservation status

Invasive grass species and their management on road reserves, land clearing and improved pastures, small population sizes and potential in-breeding depression, and issues associated with anthropogenic climate change, in particular extreme drought, present threats to *X. neoanglicum*. Unregulated seed collection and over-grazing could also threaten populations by depleting seedbanks, trampling habitat, and introducing invasive species and pathogens. We recommend a status of '*Vulnerable*' under the (IUCN 2019), as it fulfils the criteria for VU D1.

Notes

This species has horticultural potential with large inflorescences borne on single-stems and a naturally compact habit. Native plant nurseries and societies on the Northern Tablelands have been growing and selling this species for several years; however, plants can be difficult to maintain because they appear to be drought sensitive (T. L. Collins, pers. obs., 2016 and 2021; J. Nevin, pers. comm., 2020). The unpublished name *X. bracteatum* subsp. *barringtonense* Paul G.Wilson MS has been applied to this species.

Etymology

The specific epithet recognises the New England Tablelands from where this species is mostly found.

Selected specimens examined

QUEENSLAND: Darling Downs: Mount Norman, Wallangarra, 3 Oct. 1998, *D. Hockings s.n.* (BRI-AQ 663705!); Racecourse Creek Swamp, 25 km E of Mount Norman picnic area, 24 Dec. 1999, *F.D. Hockings 1003* (BRI!). NEW SOUTH WALES: Northern Tablelands: Boonoo Boonoo, Resurrection Creek, at Mount Lindesay Road crossing, 8 Nov. 2010, *I.R. Telford 13334 & T. Vollbon* (BRI!, CANB!, K!, MEL!, MO!, NE!, NSW!, NY!, US!); E of Glencoe, Costello Road, 8 Dec. 2018, *T.L. Collins 1146* (CANB!, NE!, NSW); 5.4 km N of Llangothlin along road to Ben Lomond, 12 Nov. 2005, *L.M. Copeland 4006* (CANB, NE!, NSW, US); Little Llangothlin Nature Reserve, Billy Bung Lagoon, 20 Nov. 2005, *I.R. Telford 12914* (CANB!, CHR!, MEL!, NE!, NSW!, US!); NE of Ebor along Waterfall Way, 17 Dec. 2016, *J.J. Bruhl 3511 & I.R. Telford* (NE!); Werrikimbe National Park, SW side of Racecourse Swamp, 13 Feb. 2003, *L.M. Copeland 3561, J. Hodgon & I.R. Telford* (CANB!, MEL!, NE!, NSW!, PERTH!); alongside Edwards Swamp Trail, north of Barrington River, 23 Feb. 2005, *J.R. Hosking 2586* (CANB, MEL, NE!, NSW).

Xerochrysum papillosum (Labill.) R.J.Bayer, *Kew Bull.* 56(4): 1015 (2001)

Helichrysum papillosum Labill., *Nov. Holl. pl.* 2: 46 t. 192 (1806); *Bracteantha papillosa* (Labill.) Anderb. & Haegi, *Opera Bot.* 104: 105 (1991). *Type citation*: 'in capite Van-Diemen.' *Type*: In capite Van-Diemen [Tasmania], *s. dat.*, *J.J.H. de Labillardière s.n.* (lecto, here designated: FI 006315*; probable isolecto: FI 006314*, MEL 61392*, G-DC G00470570*).

Erect, taprooted, perennial herb. *Stems and branches* cobwebby, hirsute, hispid, or glabrescent, and with glands; internode length 1–40 mm. *Basal leaf rosette* absent at flowering. *Basal leaves* spathulate, 50–120 mm long and 10–20 mm wide, base amplexicaul, margin cobwebby or hispid, apex apiculate and mucronate; basal leaf abaxial indumentum with glands, midvein glabrous (occasionally with scattered septate trichomes); adaxial indumentum hispid and with glands. *Cauline leaves* oblanceolate to lanceolate, 35–150 mm long and 3–10 mm wide, base subauriculate, margin cobwebby, hispid, scabrid, and with glands, apex apiculate and mucronate; *abaxial indumentum* with scattered septate trichomes and glands, midvein indumentum cobwebby, hispid, and with glands; *adaxial indumentum* hispid and with glands. *Foliaceous bracts subtending capitula* 10–35 mm long, margin cobwebby, hispid and with glands. *Capitula* 35–55 mm wide, terminal, in panicles or solitary. *Outer phyllaries* broad-ovate, pink, brown, or straw-coloured, basal margin fimbriate and hispid, abaxial surface smooth, apex acuminate to apiculate. *Medial phyllaries* narrow ovate to lanceolate, abaxially white or yellow, apex cuspidate or apiculate. *Stylar appendages* clavate to ovate. *Cypsela* ~2.8 mm long and 1 mm wide, cross-section squarish or circular; pericarp brown, idioblasts present. *Pappus* deciduous, ~7 mm long.

Distribution

Occurs sporadically in Tasmania, the Bass Strait islands and on Wilsons Promontory, Victoria, in the Tasmanian South East, Furneaux and South East Coastal Plain bioregions (Fig. 39).

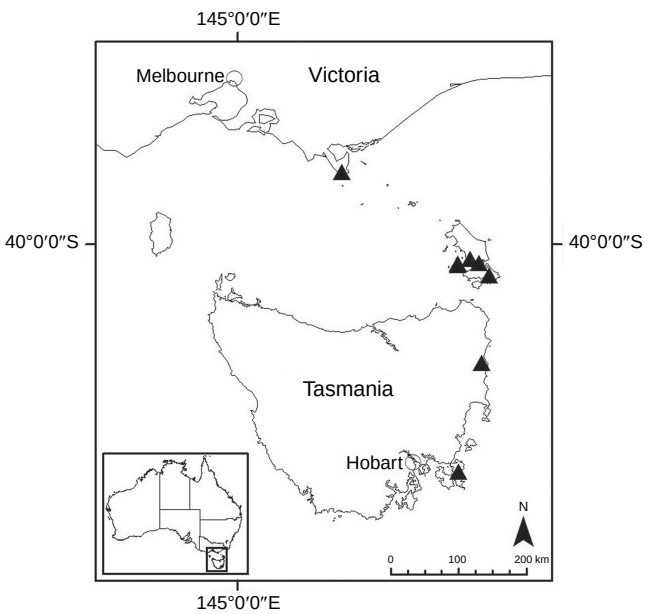

Fig. 39. Distribution of *Xerochrysum papillosum*.

Phenology

Flowering recorded August–March.

Habitat

Occurs in coastal heath and margins of eucalypt forests on sandy soils from sea level to ~650-m altitude.

Conservation status

Many populations occur in conservation reserves; however, there are no data on population sizes. Currently considered '*Not Threatened*' ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au). We recommend a status of '*Least Concern*' (IUCN 2019).

Notes

Labillardière's specimen at FI (006315) is here selected as the lectotype, because it is the most complete of the available specimens here considered to comprise original material, and has been extensively annotated by Labillardière. Material at FI, G-DC and MEL, here treated as probable isolectotypes, appear to have been collected on the same voyage as the isolectotype to judge from annotations on the specimens.

The common names 'cliff paperdaisy' and 'cliff everlasting' are used for *X. papillosum* in Tasmania ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au).

Selected specimens examined

VICTORIA: South Gippsland: Wilsons Promontory National Park, 10 Nov. 1983, *A.C. Beauglehole 75352* (MEL!); South Cape Bay, 6 Apr. 1930, *H.F. Comber 2278* (E 00231983!, HO). TASMANIA: Little Dog Island, Furneaux Group, 28 Aug. 1973, *J.S. Whinray 186* (CANB!); Mount Chappell Island, Furneaux Group, 8 Feb. 1972, *J.S. Whinray 222* (CANB!); Sea Lion Island, near its centre, 29 Aug. 1985, *J.S. Whinray 8758* (CANB!); Flinders Island, slopes of Strzelecki Peaks, 28 Feb. 1977, *B.C. Crisp 460* (CANB!); Mount Chappell Island, S end, 1 Nov. 1992, *R. Burns 444* (CANB!); Mount Chappell Island, Mount Chappell, N face, 1 Nov. 1992, *R. Burns 436* (CANB!); St Patricks Head State Reserve, upper slopes and summit, 6 Mar. 2018, *T.L. Collins 1037 & R.L. Andrew* (CANB!, HO!, NE!); Eaglehawk Neck, Tessellated Pavement, 28 Feb. 2018, *T.L. Collins 1018 & R.L. Andrew* (CANB!, HO!, NE!).

Xerochrysum strictum T.L.Collins & J.J.Bruhl, sp. nov.

Type: AUSTRALIA: Queensland: Atherton Tableland: Herberton – Irvinebank Road, ~6.2 km W of Atherton – Herberton road, 27 June 2018, *T.L. Collins 1058 & J.J. Bruhl*, (holo: BRI!; iso: CANB!, CNS!, NE 107426!).

Xerochrysum bracteatum subsp. (Mount Elliot A.R. Bean 3593), A.E. Holland in P.D. Bostock and A.E. Holland (eds), *Census Queensl. Fl.* 32 (2007); CHAH, *Austral. Pl. Census* (2020) [accessed 20 February 2020].

Xerochrysum sp. 'Cockatoo Creek', P.G. Wilson, *Nuytsia* 28: 13 (2017).

[*Xerochrysum bracteatum auct. non* (Vent.) Tzvelev: N.N. Tzvelev, *Novosti Sist. Vyssh. Rast.* 27: 151 (1990), *p.p.*, populations of erect, perennial plants with hirsute cauline leaves with septate trichomes and stipitate glands on both abaxial and adaxial surfaces, in central and northern Queensland only].

Diagnosis

Distinguished from other species growing in northern Queensland or those with which it has been confused in the past, by the perennial life form (*v. X. bracteatum* annual or biennial), presence of septate trichomes and stipitate glands on leaf abaxial surface (*v. X. bracteatum* and *X. banksii* with glands only), hirsute leaf indumentum adaxially (*v. X. bracteatum* hispid), erect habit (*v. X. banksii* prostrate; *X. gudang* decumbent to erect), acuminate medial phyllary apices (*v. X. bracteatum* and *X. banksii* obtuse, *X. boreale* cuspidate), leaves 5–25 mm wide (leaves 5–10 mm wide in *X. banksii*, 4–9 mm wide in *X. boreale*, and 6–15 mm wide in *X. gudang*), and presence of persistent glands on leaf adaxial surface (*v.* fragile and readily lost in *X. boreale* and *X. gudang*).

Erect, taprooted, perennial herb, up to ~1.3 m tall, readily resprouting from taproot. *Stems* and *branches* cobwebby or woolly, hirsute, and with glands; internode length 15–25 mm. *Basal leaf rosette* absent at flowering unless resprouting. *Basal leaves* obovate, 80–120 mm long and 20–50 mm wide, base subauriculate and amplexicaul, margin woolly, apex mucronate; abaxial indumentum villous with septate hairs and stipitate glands, midvein indumentum hirsute; adaxial indumentum villous. *Cauline leaves* oblanceolate to obovate, 50–200 mm long and 5–25 mm wide, base subauriculate and amplexicaul, margin cobwebby to cottony, or hirsute, apex mucronate; *abaxial indumentum* cobwebby to hirsute, and with glands; abaxial midvein indumentum cobwebby to hirsute; *adaxial indumentum* hirsute and with glands. *Foliaceous bracts subtending capitula* 5–10 mm long, margin with glands,

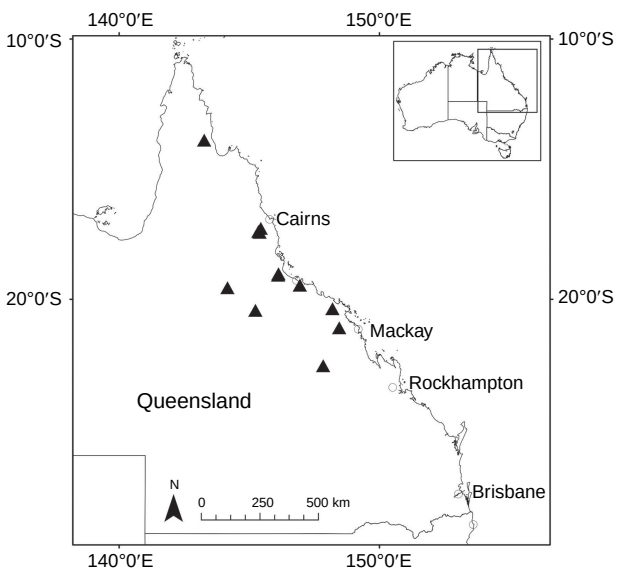

Fig. 40. Distribution of *Xerochrysum strictum*.

Fig. 41. Isotype of *Xerochrysum strictum* (*T.L. Collins 1058 & J.J. Bruhl*, NE 107426).

cobwebby, and hispid. *Capitula* 30–40 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate, yellow, brown, or straw-coloured; basal margin fimbriate and hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* narrow ovate to lanceolate, abaxially yellow, apex acuminate. *Stylar appendages* narrowly triangular to obovate. *Cypsela* oblong, ~2.2 mm long and ~0.7 mm wide, cross-section circular; pericarp straw- or brass-coloured, idioblasts present. *Pappus* deciduous, ~8 mm long.

Distribution

Endemic to Queensland, occurring in the Brigalow Belt North, Einasleigh Uplands and Cape York Peninsula Bioregions and as disjunct populations in the Brigalow Belt South Bioregion (Fig. 40).

Phenology

Recorded flowering June–November and fruiting recorded in July (Fig. 41).

Habitat

Grassy eucalypt woodland at altitudes of >500 m in the northern distribution and >300-m altitude in the Brigalow Belt South Bioregion.

Conservation status

Occurs over a wide geographical area, including in several conservation reserves and is not considered to be rare or threatened. We recommend a status of '*Least Concern*' (IUCN 2019).

Notes

Xerochrysum strictum is a morphologically variable species distributed along a geographic cline, with some populations having distinctly narrow leaves, such as, for example, *S.A. Morain 197* and *R.J. Fensham 253*, similar to a population included in this study from Blackbraes National Park (*T.L. Collins 1067*) in the western part of the distribution. Specimens from Mount Fox seemingly have no glands on the uppermost cauline leaf margins, and no glands on the stems, for example, *M.S. Clemens s.n.* (BRI 248110!), *M.S. Clemens s.n.* (BRI 362638!). The informal phrase name *Xerochrysum* sp. North Kennedy has been used at NE for curatorial purposes and this study.

Etymology

The specific epithet is from the Latin, *strictus* (tight, close, straight, drawn together), and refers to the erect habit seen in the field and in cultivation.

Selected specimens examined

QUEENSLAND: Cook: McIlwraith Range, edge of scrub, north-west of campsite, 25 May 2003, *D.L. Jones 18897* (CANB!); Herberton Range Ridge Road, 27 June 2018, *T.L. Collins 1051 & J.J. Bruhl* (BRI!, CANB!, CNS!, NE!); Herberton–Irvinebank road, 27 June 2018, *T.L. Collins 1058 & J.J. Bruhl* (BRI!, CANB!, CNS!, NE!); SSW of Wondecla, 1 July 2018, *T.L. Collins 1063 & J.J. Bruhl* (BRI!, CANB!, CNS!, NE!); Blackbraes National Park, 2 July 2018, *T.L. Collins 1067 & J.J. Bruhl* (BRI!, CANB!, CNS!, NE!). North Kennedy: ~17 km W of Paluma along road to Hidden Valley, 11 Nov. 2006, *J.J. Bruhl 2473* (BRI!, NE!); ~700 m SSE of Mount Zero along high-tension power-line access track, 11 Nov. 2006, *J.J. Bruhl 2477 & I.R. Telford* (BRI!, NE!, NSW!); base of Roma Peak, ~40 km S of Bowen, 30 June 1991, *A.R. Bean 3347* (BRI!); 21 km NW of Pentland on road to Lolworth Station, Hughenden, 24 July 1975, *A.D. Chapman 1355* (BRI!, CANB). South Kennedy: Clarke Range, ~8 km NW of Eungella, 24 June 2014, *I.R. Telford 13489, J.J. Bruhl & C.J. Prychid* (BRI!, CANB!, NE!, US!). Leichardt: W lower slopes of Wolgang [Wolfgang] Peak, 17 Oct. 1983, *R.J. Henderson H2912 & G.P. Guymer* (CANB!).

Xerochrysum viscosum (Sieber ex DC.) R.J.Bayer, *Kew Bull.* 56(4): 1015 (2001)

Helichrysum viscosum Sieber ex Spreng., *Syst. Veg.* 3: 484 (1826); *Helichrysum bracteatum* var. *viscosum* Sieber ex DC., *Prodr.* 6: 189 (1838); *Bracteantha viscosa* (Sieber ex DC.) Anderb. & Haegi, *Op. Bot.* 104: 105 (1991). *Type*: Novae Holl. [New South Wales], *Sieber 345* (lecto, *fide* P.G. Wilson, *Nuytsia* 28: 29 (2017): G-DC G00470540*, isolecto: HAL 0111515, MEL 604820, NY 00179176*, W 18890232748).

Erect, taprooted, perennial herb, up to ~60 cm tall. *Stems* and *branches* scabrid and with glands, internode length 5–20 mm. *Basal leaf rosette* absent at flowering. *Basal leaves* oblanceolate to spathulate, 50–120 mm long and 3–15 mm wide, base amplexicaul, margin hispid and with glands, apex apiculate; abaxial indumentum with glands, midvein glabrous (occasionally with scattered septate trichomes); adaxial indumentum pilose. *Cauline leaves* linear to oblanceolate, 20–80 mm long and 1–5 mm wide, base truncate, apex acute or apiculate and mucronate, margin hispid and with glands; *abaxial indumentum* with glands, midvein indumentum with glands (occasionally with scattered septate trichomes); *adaxial indumentum* hispid and with glands. *Foliaceous bracts subtending capitula* 4–8 mm long, margin with glands. *Capitula* 20–30 mm wide, terminal, in panicles or solitary. *Outer phyllaries* broad-ovate, brown or straw-coloured, basal margin fimbriate and hispid, abaxial surface smooth, apex acuminate or apiculate. *Medial phyllaries* oblong, ovate or narrow ovate, abaxially yellow, apex cuspidate or apiculate. *Stylar appendages* narrowly triangular or deltoid. *Cypsela* ~2.2 mm long and 0.7 mm wide, cross-section squarish or circular; pericarp brown, idioblasts present. *Pappus* deciduous, ~7–8 mm long.

Distribution

Occurs over a broad area from Victoria to south-eastern Queensland. Recorded in the Murray–Darling Depression, Riverina, New South Wales South Western Slopes, South Eastern Highlands, Brigalow Belt South, Nandewar, New England Tablelands, and South Eastern Queensland bioregions (Fig. 42).

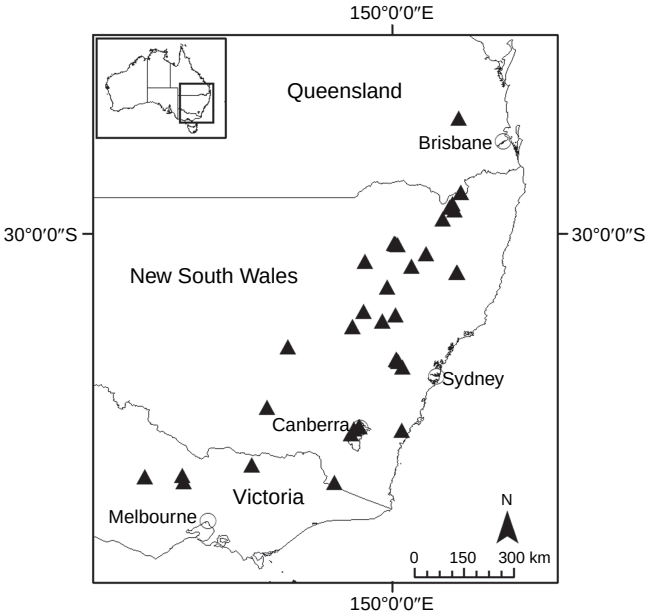

Fig. 42. Distribution of *Xerochrysum viscosum*.

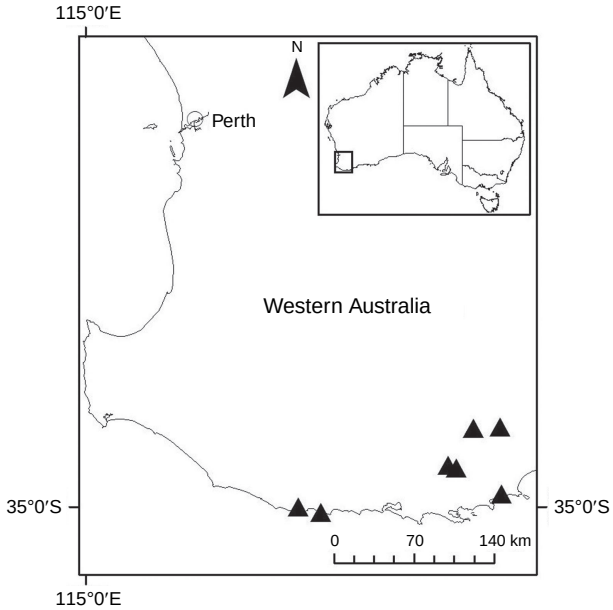

Fig. 43. Distribution of *Xerochrysum wilsonii*.

Phenology

Recorded flowering October–March.

Habitat

Occurs in woodlands and open forests on gravelly and sandy soils.

Notes

Lower cauline leaves on primary shoots are longer and broader than those higher and on axillary branches. Glands on leaves and stems are fragile and commonly leak resin, coating leaves and stems and leaving a shiny or varnished appearance. Populations in the Torrington State Conservation Area have slightly broader and more scabrid leaves, for example, *P.J. Clarke s.n.* (NE 85889!), *C.E. Nano 48* (NE 66184!).

'Sticky everlasting' is in use in New South Wales (New South Wales Flora Online, see http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm) and Victoria (Royal Botanic Gardens Victoria, VicFlora, see https://vicflora.rbg.vic.gov.au/, accessed 22 March 2020).

Conservation status

Recorded over a wide geographical area, including in several conservation reserves and is not considered to be rare or threatened. We recommend a status of '*Least Concern*' (IUCN 2019).

Selected specimens examined

QUEENSLAND: Burnett: Coomba Falls, near Maidenwell, 25 Mar. 1997, *P.I. Forster 20583* (BRI!). Darling Downs: 5 km from Wallangarra along New England Highway towards Stanthorpe, 21 Jan. 2009, *I.R. Telford 13281 & J.J. Bruhl* (BRI, CANB, NE!). NEW SOUTH WALES: Northern Tablelands: Torrington SRA, 16 Jan. 1997, *C.E. Nano 48* (NE!); Oxley Wild Rivers National Park, Apsley Falls, 17 Feb. 2018, *T.L. Collins 1014* (CANB!, NE!, NSW!). Central Western Slopes: Mudgee–Muswellbrook road, 16 Dec. 2017, *T.L. Collins 1008* (CANB!, NE!, NSW!); Wellington, 2 km NE from summit of Mount Arthur, 10 May 2017, *M.R. Thomas 28* (NE!). Central Tablelands: Western Highway, W of Lithgow, 16 Dec. 2017, *T.L. Collins 1007* (CANB!, NE!, NSW!, US!). AUSTRALIAN CAPITAL TERRITORY: Black Mountain ACT, lower slope, 6 Dec. 2017, *T.L. Collins 991* (CANB!, NE!, NSW!). VICTORIA: St Arnaud, 2 km SW of T-junction of Wimmera Highway with Dundas Street, 22 Oct. 2018, *J.R. Nevin 164* (BRI!, CANB!, CHR!, MEL!, NE!, NSW!, US!); Warby-Ovens National Park, below road to Pine Gully Walk, 20 Dec. 2018, *J.R. Hosking 4060* (AD!, CANB!, MEL!, NE!, NSW!).

Xerochrysum wilsonii T.L.Collins, sp. nov.

Type: AUSTRALIA: Western Australia: Darling: Porongurup National Park, upper slopes and summit of Devils Slide, 17 Dec. 2018, *T.L. Collins 1160* (holo: PERTH!; iso: CANB!, NSW!, NE 108019!).

[*Xerochrysum macranthum auct. non* (Benth.) Paul G.Wilson: A.N. Schmidt-Lebuhn *et al.*, *Taxon* 64(1): 105 (2015), *p.p.*, populations of perennial plants in the Esperance, Jarrah Forest and Warren bioregions with mid-cauline leaves ≥12 mm wide only].

Diagnosis

Distinguished from *X. macranthum* by a perennial life form (*v.* annual or biennial), cauline leaves 10–20 mm wide (*v.* 5–12 mm), capitula 40–60 mm wide (*v.* 30–50 mm wide).

Erect or occasionally decumbent, taprooted, perennial shrub-like herb, 30–180 cm in length. *Stems* and *branches* cobwebby to hispid, scabrid, and with glands; internode length 15–50 mm. *Basal leaf rosette* absent at flowering.

Fig. 44. Isotype of *Xerochrysum wilsonii* (*T.L.Collins 1160*, NE 108019).

Basal leaves spathulate, 80–160 mm long and 20–30 mm wide, base amplexicaul, margin cobwebby to pilose, and hispid; apex apiculate; abaxial indumentum pilose and with glands, midvein indumentum pilose and with glands; adaxial indumentum hispid, pilose, and with glands. *Cauline leaves* oblanceolate, 60–110 mm long and 10–20 mm wide, base

amplexicaul, margin cobwebby, hispid, and scabrid, apex mucronate; *abaxial indumentum* with sessile glands and scattered septate trichomes; midvein indumentum hispid, scabrid, and with glands; *adaxial indumentum* hispid, scabrid, and with glands. *Foliaceous bracts subtending capitula* ~10 mm long, margin cobwebby and hispid. *Capitula* 40–60 mm wide, terminal, in panicles. *Outer phyllaries* broad-ovate, pink, white, or straw-coloured; basal margin fimbriate and hispid, abaxial surface smooth, apex apiculate. *Medial phyllaries* narrow ovate to elliptic, abaxially white, apex cuspidate. *Stylar appendages* ovate. *Cypsela* oblong, ~2.1 mm long and 0.9 mm wide, cross-section squarish or circular; pericarp brown, idioblasts present. *Pappus* deciduous, ~7–8 mm long.

Distribution

Endemic to the far south-west of Western Australia and recorded in the Esperance, Jarrah Forest and Warren bioregions (Fig. 43).

Phenology

Recorded flowering November–January and fruiting December–February (Fig. 44).

Habitat

Occurring in diverse habitats from montane heath and scree slopes at ~1000-m altitude to coastal heath near sea level, on skeletal sandy soils.

Conservation status

All known populations occur in conservation reserves, but appear to be restricted to specific habitats. We recommend a status of '*Data Deficient*' (IUCN 2019) and suggest that a detailed analysis of the area of extent be conducted to determine appropriate conservation status.

Notes

At Toolbrunup in Stirling Range National Park, large plants up to 1.8 m in length were seen decumbent across the scree-slope below the summit, with stem diameters up to ~100 mm. Occasional plants have been recorded at lower elevations (e.g. *J.R. Wheeler 4022* (PERTH!)), possibly owing to flower picking and subsequent discarding by bushwalkers; however, these lowland populations in Stirling Range National Park do not appear to persist (T. L. Collins, pers. obs., 2018). The informal phrase-names *X.* sp. Porongurup, *X.* sp. Limestone and *X.* sp. Forests have been used at NE for curatorial purposes and this study.

Etymology

The specific epithet honours the work of botanist Paul Graham Wilson (1928–), of the Western Australian Herbarium (PERTH), who has contributed greatly to Australian daisy taxonomy.

Selected specimens examined

WESTERN AUSTRALIA: Darling: Stirling Range National Park, summit of Bluff Knoll, 16 Dec. 2018, *T.L. Collins 1157* (CANB!, K!, NE!, PERTH!, US!); Stirling Range National Park, summit of Toolbrunup, 16 Dec. 2018, *T.L. Collins 1158* (CANB!, NE!, PERTH!); Walpole–Nornalup National Park, Conspicuous Cliffs, 18 Dec. 2018, *T.L. Collins 1161* (CANB!, K!, NE!, NSW!, PERTH!, US!); Walpole–Nornalup National Park, Delta Road, 18 Dec. 2018, *T.L. Collins 1162* (CANB!, NE!, PERTH!); Collier Peak, Porongurup Range, 20 Nov. 1987, *G.J. Keighery 8722* (PERTH!); Yallerungup Peak, Porongurup Range, 15 Dec. 1986, *G.J. Keighery 8419* (PERTH!); Mount Many Peaks, 4 Oct. 1994, *S. Barrett 24* (PERTH!).

Xerochrysum milliganii group

Xerochrysum alpinum Paul G.Wilson, *Nuytsia* 28: 36 (2017)

Type: Lake Lea Road, Tasmania, 17 Feb. 1998, *A.M. Buchanan 15101* (holo: HO 324393).

Erect, perennial, rhizomatous herb up to 20 cm. *Stems* and *branches* cobwebby and with glands, internode length 10–35 mm. *Basal leaf rosette* present at flowering. *Basal leaves* obovate, 20–60 mm long and 10–25 mm wide, base attenuate, margin cottony and with glands, apex apiculate; abaxial indumentum with glands, midvein glabrous; adaxial indumentum hispid and with glands (hispid indumentum on midvein basally). *Cauline leaves* obovate, 20–50 mm long and 1–3 mm wide, base attenuate, margin cobwebby or cottony, apex apiculate; *abaxial indumentum* with glands, midvein indumentum with glands; *adaxial indumentum* with glands. *Foliaceous bracts subtending capitula* 10–12 mm long (with fimbriate apical hairs), margin cobwebby and with glands. *Capitula* 30–45 mm wide, terminal, solitary. *Outer phyllaries* ovate, straw-coloured, basal margin fimbriate, extending to apex, abaxial surface scabridulous towards apex, apex fimbriate. *Medial phyllaries* lanceolate, abaxially yellow, apex cuspidate. *Stylar appendages* clavate. *Cypsela* 2.3 mm long and 0.75–1 mm wide, cross-section with oblique angles; pericarp grey–brown, idioblasts absent. *Pappus* persistent, ~5–6 mm long.

Distribution

Occurring in the Tasmanian Central Highlands and Ben Lomond bioregions (Fig. 45).

Phenology

Recorded flowering February–March and fruiting in March.

Habitat

Alpine herbfields and shrublands at >900-m altitude.

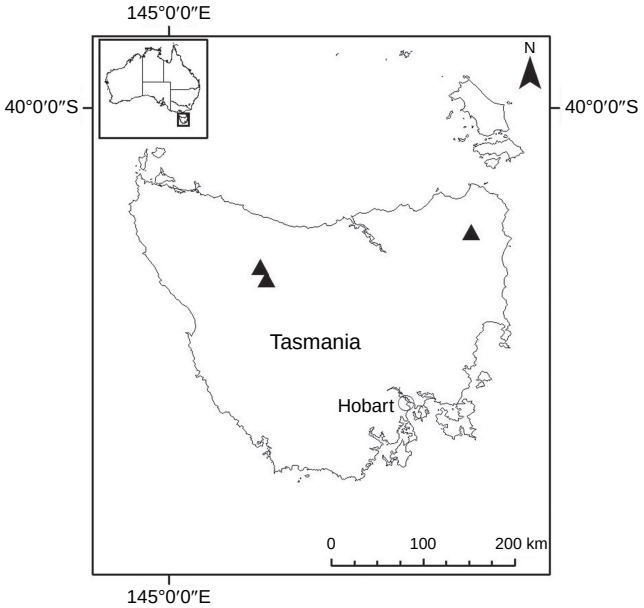

Fig. 45. Distribution of *Xerochrysum alpinum*.

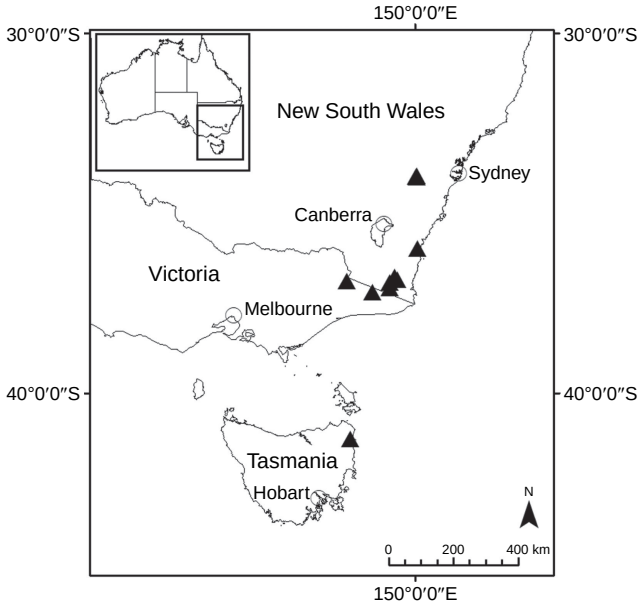

Fig. 46. Distribution of *Xerochrysum andrewiae*.

Conservation status

Considered widespread (Wilson 2017), and recorded in several conservation reserves, currently listed as '*Data Deficient*' in Tasmania ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au). We recommend a status of '*Data Deficient*' (IUCN 2019) and suggest that a detailed analysis of area of extent, population sizes and health be conducted to determine appropriate conservation status.

Selected specimens examined

TASMANIA: Vale of Belvoir Conservation Reserve, Lake Lee Road, 2 Mar. 2018, *T.L.*ttp://anpsa.org.au/APOL2006/ju *Collins 1024 & R.L. Andrew* (CANB!, HO!, NE!); Cradle Mountain National Park, Face Track, 3 Mar. 2018, *T.L. Collins 1030 & R.L. Andrew* (CANB!, HO!, NE!), summit of Blue Tier, 23 Feb. 1878, *A. Simson 1101* (MEL 0061148A).

Xerochrysum andrewiae T.L.Collins & J.J.Bruhl, sp. nov.

Type: AUSTRALIA: Tasmania: Ansons Bay Road, ~4.5 km N of Reids Road, SW side of road, ~70 m from road edge, 6 Mar. 2018, *T.L. Collins 1036 & R.L. Andrew*, (holo: HO!; iso: CANB!, NE 106812!).

[*Xerochrysum subundulatum auct. non* (Sch.Bip.) R.J.Bayer: R.J. Bayer, *Kew Bull.* 56(4): 1015 (2001) *p.p.*, only populations with stipitate glands on cauline leaves adaxially].

[*Bracteantha palustris auct. non* Flann: C. Flann, *Muelleria* 11: 97 (1998), *p.p.*, populations with smooth outer phyllaries only; *Xerochrysum palustre auct. non* (Flann) R.J.Bayer: R.J. Bayer, *Kew Bulletin* 56(4): 1014 (2001), *p.p.*, populations with smooth outer phyllaries only].

Diagnosis

Distinguished by the sessile glands on the adaxial leaf surface (*v.* stipitate glands in *X. subundulatum*; absent in *X. palustre*), foliaceous bracts subtending capitula up to 15 mm long (*v.* 5–10 mm long on *X. palustre*), leaves 2–10 mm wide (*v.* 5–20 mm in *X. subundulatum*), outer phyllary abaxial surface scabridulous (*v.* smooth in *X. palustre*).

Erect, rhizomatous, perennial herb, 30–60 cm tall. *Stems* and *branches* cobwebby to glabrescent, internode length 10–20 mm. *Basal leaf rosette* absent at flowering. Seedling and basal leaves not seen. *Cauline leaves* oblanceolate to lanceolate, 20–60 mm long and 2–10 mm wide, base attenuate, margin cobwebby, hispid, or glabrous, apex acute and apiculate; *abaxial indumentum* with glands, midvein glabrous or indumentum hispid; *adaxial indumentum* cobwebby, scattered hispid, and with glands. *Foliaceous bracts subtending capitula* 15 mm long, margin cobwebby. *Capitula* 35–40 mm wide, terminal, solitary. *Outer phyllaries* ovate, orange, brown, or straw-coloured; basal margin fimbriate and hispid, abaxial surface scabridulous, apex acuminate to apiculate. *Medial phyllaries* narrow ovate to lanceolate, abaxially yellow, apex cuspidate or apiculate. *Stylar appendages* ovate. *Cypsela* oblong, 2.3 mm long and 0.8 mm wide, cross-section squarish to circular; pericarp brass-coloured, idioblasts present. *Pappus* persistent.

Distribution

Recorded from New South Wales, Victoria and Tasmania, occurring in the Sydney Basin, South East Corner, Australian Alps, and Ben Lomond bioregions (Fig. 46).

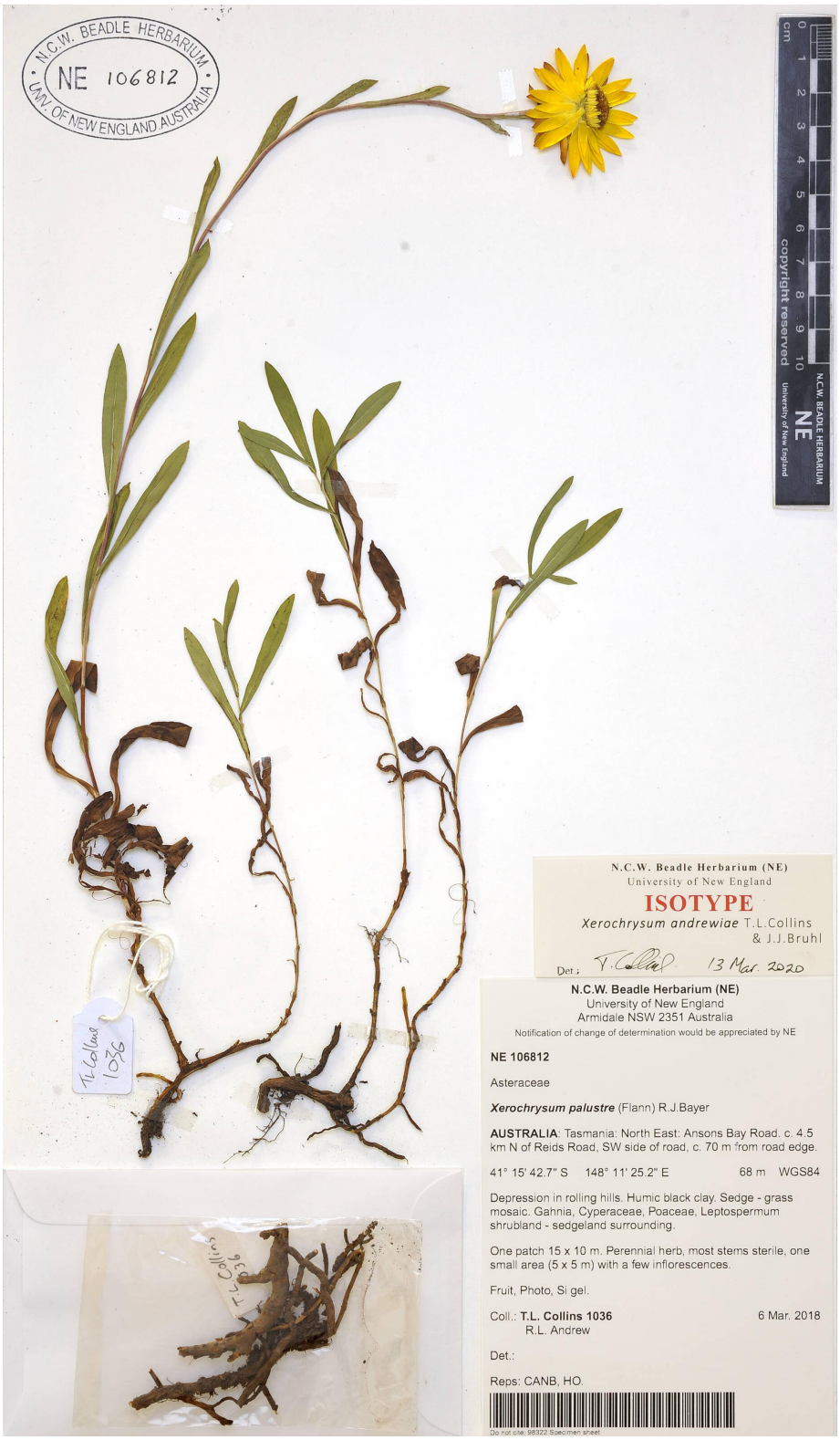

Fig. 47. Isotype of *Xerochrysum andrewiae* (*T.L.Collins 1036 & R.L.Andrew*, NE 106812).

Phenology

Flowering February–April and fruiting March (Fig. 47).

Habitat

Lowland wetlands in Tasmania to wetlands up to ~1400-m altitude on the mainland in New South Wales and Victoria.

Conservation status

Population sizes in Tasmania have been estimated in the hundreds to thousands. Ongoing threats associated with anthropogenic climate change; in particular, extreme drought, and intense wildfire, potentially threaten *X. andrewiae* across the distribution. Given the past taxonomic confusion, we recommend a status of '*Data Deficient*' (IUCN 2019) and suggest that a detailed analysis of the area of extent, population sizes and health be conducted to determine appropriate conservation status.

Notes

At Tantawangalo State Forest populations of *X. palustre sens. str.* and *X. andrewiae* are sympatric and mixed collections have been made (e.g.: *D.L. Jones 17164*, MEL 2101319!, CANB 616790). The informal phrase name *Xerochrysum* aff. *palustre* has been used at NE for curatorial purposes and this study.

Etymology

The specific epithet recognises the significant contributions of botanist, supervisor and co-collector of the type, Rose Lorien Andrew (1978–), of the University of New England Armidale, New South Wales.

Selected specimens examined

NEW SOUTH WALES: Central Tablelands: Kanangra Walls, 22 Mar. 2011, *R. Johnstone 2906* (BRI, CANB, MEL!, NSW!); Kanangra Boyd National Park, 19 Apr. 2015, *J. Miles 15–50* (NSW!); Kanangra Walls Road, 12 Jan. 2001, *D.L. Jones 17798* (CANB*, MEL, NSW); Jensens Swamp, 1 Mar. 1985, *D.H. Benson 2330* (NSW!). South Coast: Coolumbooka Nature Reserve, 30 Apr. 2002, *I. Crawford 7018* (CANB!); on Outskirt Creek tributary arm in NW corner of Bondi or Mountain Top Travelling Stock Reserve, 16 Feb. 2015, *J. Miles 15–27* (NSW!); Bega Swamp at the head of Brogo River, 6 May 1976, *R. Pullen 10268* (CANB!, NSW); ~9.8 km E of Cathcart towards Pambula, 8 Feb. 2000, *D.L. Jones 17157* (MEL!); Badja State Forest, 12 Feb. 2004, *N.G. Walsh 6006* (MEL!); 17.8 km E of Braidwood–Clyde Mountain, 19 Mar. 2006, *D.L. Jones 19352* (CANB, MEL!). VICTORIA: East Gippsland: Alpine National Park, Playgrounds, 10 Feb. 2005, *N.G. Walsh 6260* (MEL!); Alpine National Park, Cowombat Flat Track, 10 Feb. 2005, *N.G. Walsh 6258* (MEL!); Snowy River National Park, 11 Jan. 1993, *I.R. Telford 11782* (CANB*, MEL); Bidwell, Upper Delegate River, 19 Jan. 1953, *R. Melville 2959* (MEL!, NSW). TASMANIA: North East: Break O'Day: Bells Marsh, 13 Apr. 2009, *M. Wapstra 714* (HO!); Powers Rivulet Marsh, 12 May 2009, *M. Wapstra 717* (HO!); unnamed marsh, W of Ansons Bay Road, 13 Apr. 2009, *M. Wapstra 715* (HO!).

Xerochrysum collierianum A.M.Buchanan, *Muelleria* 20: 49 (2004)

Type: St Valentines Peak, Tasmania, 13 Jan. 1986, *P. Collier 1206* (holo: HO 116970).

Erect, perennial, fibrous-rooted herb up to ~25 cm. *Stems* and *branches* hirsute or glabrescent, and with glands; internode length 10–35 mm. *Basal leaf rosette* present or absent at flowering. *Basal leaves* obovate to spathulate, 20–80 mm long and 5–10 mm wide, base amplexicaul, margin cobwebby or hirsute, apex mucronate or apiculate; abaxial indumentum with glands, midvein indumentum with glands; adaxial indumentum hirsute and with glands. *Cauline leaves* oblanceolate, 20–40 mm long and 3–7 mm wide, leaf base attenuate, margin cobwebby or woolly, and hispid; apex mucronate; *abaxial indumentum* with glands, midvein indumentum with glands; *adaxial indumentum* hirsute and with glands. *Foliaceous bracts subtending capitula* 7–12 mm long, margin cobwebby or hispid. *Capitula* 30–40 mm wide, terminal, solitary. *Outer phyllaries* ovate, white, basal margin fimbriate or hispid, abaxial surface smooth, apex acute. *Medial phyllaries* narrow ovate to lanceolate, abaxially white, apex apiculate. *Stylar appendages* ovate. *Cypsela* ~2.5 mm long and 0.75 mm wide, cross-section with oblique angles; pericarp brown, idioblasts indistinct. *Pappus* persistent, ~6 mm long.

Distribution

Endemic to Tasmania in the Central Highlands Bioregion (Fig. 48).

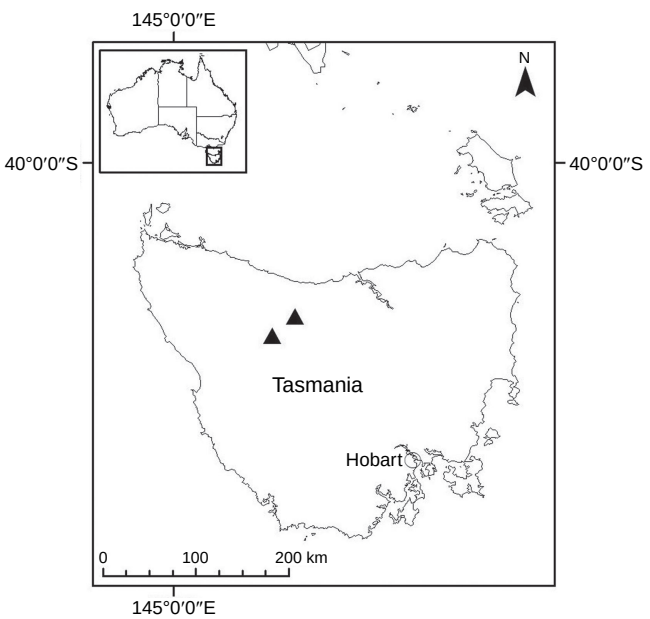

Fig. 48. Distribution of *Xerochrysum collierianum*.

Phenology

Fruiting recorded in March.

Habitat

Steep rocky ridges and outcrops on mountain sides, growing in skeletal gravelly soils and cracks in rocks.

Conservation status

Listed as of conservation significance in Tasmania because of occurrence in only one bioregion and being endemic to Tasmania ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au). We recommend a status of '*Data Deficient*' (IUCN 2019) and suggest that a detailed analysis of the area of extent, population sizes and health be conducted to determine appropriate conservation status.

Notes

The common name 'quartzite paperdaisy' is in use in Tasmania ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au).

Selected specimens examined

TASMANIA: Central Highlands: Mount Claude Lookout track from Olivers Road, 2 Mar. 2018, *T.L. Collins 1026 & R.L. Andrew* (CANB!, HO!, NE!); on rocky outcrop at intersection of Mount Claude Lookout track and Olivers Road, 2 Mar. 2018, *T.L. Collins 1027 & R.L. Andrew* (CANB!, HO!, NE!); Cradle Mountain National Park, 3 Mar. 2018, *T.L. Collins 1032 & R.L. Andrew* (CANB!, HO!, NE!).

Xerochrysum milliganii (Hook.f.) Paul G.Wilson, in A.N.Schmidt-Lebuhn *et al.*, *Taxon* 64: 106 (2015)

Helichrysum milliganii Hook.f., *Fl. Tasman.* 1: 214 t. LX. B. (1856). *Type*: Mount Sorell [*sic*], Macquarie Harbour [Tasmania], 15 Jan. 1847, *J. Milligan 755* (lecto, designated by A.N. Schmidt-Lebuhn *et al.*, *Taxon* 64: 106 (2015): K 000928522*; isolecto: K 000928518, K 000928519, K 000928520, MEL 1585997; residual syntype: Mount Pearse, Surrey Hills, Tasmania, *s. dat.*, *R.C. Gunn* 1169 (K)).

Erect, fibrous-rooted, perennial herb, up to 20 cm. *Stems* and *branches* cobwebby, or woolly, or glabrescent; internode length 5–20 mm. Flowering stems unbranched. *Basal leaf rosette* present at flowering. *Basal leaves* obovate, 10–15 mm long and 3–6 mm wide, base amplexicaul, apex acute, margin cobwebby and with glands; abaxial leaf surface glabrous, midvein glabrous; adaxial indumentum with scattered glands. Leaf arrangement cauline or radical. *Cauline leaves* oblanceolate or lanceolate, 15–25 mm long and 3–5 mm wide, base truncate, apex acute, margin cobwebby, or glabrous, or woolly; *abaxial indumentum* cobwebby, midvein indumentum cobwebby; *adaxial indumentum* with scattered glands. *Foliaceous bracts subtending capitula* 5–7 mm long, margin cobwebby or fimbriate. *Capitula* 30–40 mm wide, terminal, solitary. *Outer phyllaries* white, basal margin cobwebby or fimbriate, abaxial surface smooth, apex acute. *Medial phyllaries* abaxially white, apex cuspidate or apiculate. Stylar appendages clavate. *Cypsela* ~3 mm long and ~0.75 mm wide, cross-section squarish; pericarp grey–brown, idioblasts absent. *Pappus* persistent, ~6 mm long.

Distribution

Endemic to Tasmania in the Central Highlands Bioregion (Fig. 49).

Phenology

Recorded flowering January–March and fruiting in March.

Habitat

Alpine herbfields and shrublands at >900-m altitude.

Conservation status

Listed as of conservation significance in Tasmania and endemic to Tasmania ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au). We recommend a status of '*Data Deficient*' (IUCN 2019) and suggest that a detailed analysis of the area of extent, population sizes and health be conducted to determine appropriate conservation status.

Notes

The common name 'snow paperdaisy' is a name in use in Tasmania ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au).

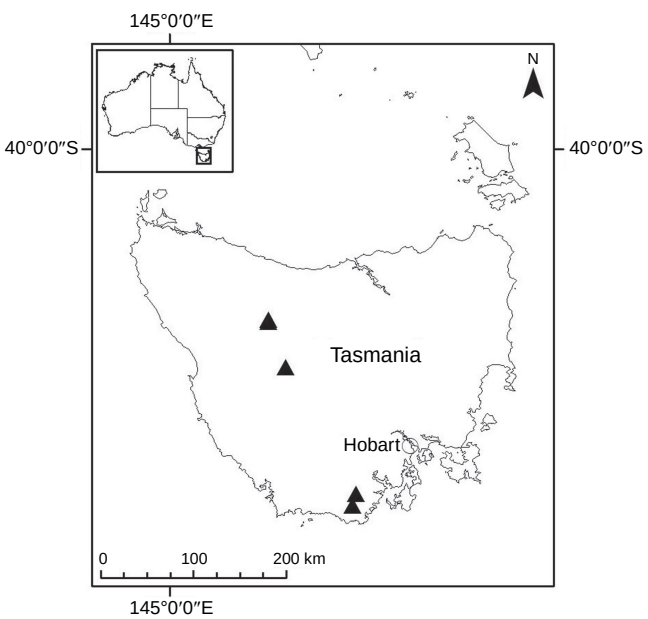

Fig. 49. Distribution of *Xerochrysum milliganii*.

Selected specimens examined

TASMANIA: Central Highlands: Cradle Mountain National Park, upper slope of Marions Lookout, 3 Mar. 2018, *T.L. Collins 1028 & R.L. Andrew* (CANB!, HO!, NE!); Cradle Mountain National Park, Face Track, 3 Mar. 2018, *T.L. Collins 1029 & R.L. Andrew* (CANB!, HO!, NE!); Mount Rufus, 25 Jan. 1949, *N.T. Burbidge 3341* (CANB*). Huon Valley: Moonlight Ridge, hill one, 31 Jan. 1983, *P.S. Short 1873* (CANB*, MEL); Adamsons Peak, 7 Feb. 1969, *I.R. Telford EMC2480* (CANB!, PERTH).

Xerochrysum palustre (Flann) R.J.Bayer, *Kew Bull.* 56(4): 1014 (2001)

Bracteantha palustris Flann, *Muelleria* 11: 97 (1998). *Type*: Saplings Morass Flora and Fauna Reserve, Victoria, 11 Dec. 1996, *C. Flann 1 & N.G. Walsh* (holo: MEL 2036150*; iso: CANB 528907*, NSW 458152).

Helichrysum acuminatum var. *angustifolium* DC., *Prodr.* 6: 188 (1838). *Type citation*: 'in terra Van-Diemen legit cl. Gunn.' *Type*: van Diemen, *s. dat.*, *Gunn 247* (syn: G-DC G00470645*); In insula Van Diemen, *s. dat.*, ?*Gunn s.n.* (possible syn: MEL 61301*).

Erect, rhizomatous, perennial herb, ~30–60 cm tall. *Stems* and *branches* cobwebby or woolly to glabrescent, and with glands; internode length 15–35 mm. *Basal leaf rosette* absent at flowering. Seedling and basal leaves not seen. *Cauline leaves* lanceolate, 20–120 mm long and 2–10 mm wide, base attenuate, margin cobwebby, hispid, and scabrid, apex acute and apiculate; *abaxial indumentum* with glands, midvein glabrous (occasionally with scattered septate trichomes and glands); *adaxial indumentum* cobwebby or glabrous, and with glands. *Foliaceous bracts subtending capitula* 5–10 mm long, margin cobwebby and fimbriate. *Capitula* 35–45 mm wide, terminal, solitary. *Outer phyllaries* ovate, brown or straw-coloured, basal margin fimbriate and hispid, abaxial surface smooth, apex acute to apiculate. *Medial phyllaries* lanceolate, abaxially brown or yellow, apex apiculate to acute. *Stylar appendages* clavate to ovate. *Cypsela* oblong, ~3 mm long and ~0.75 mm wide, in cross-section with oblique angles to circular; pericarp brass-coloured, idioblasts present. *Pappus* persistent, ~8 mm long.

Distribution

Occurring in New South Wales, Victoria and Tasmania in the South East Corner, South East Coastal Plain and Tasmanian Southern Ranges bioregions (Fig. 50).

Phenology

Recorded flowering December–January and fruiting in February.

Habitat

Swamps typically below 500-m altitude.

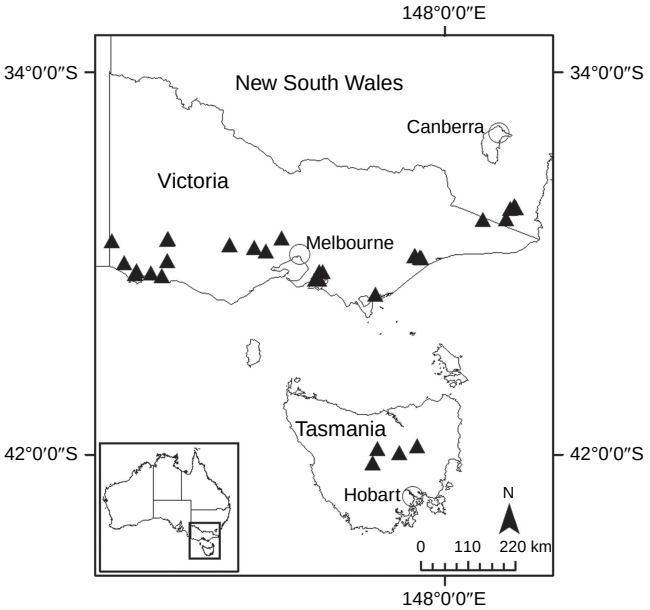

Fig. 50. Distribution of *Xerochrysum palustre*.

Conservation status

Listed as '*Vulnerable*' under the *Tasmanian Threatened Species Protection Act* 1995, the *Victorian Flora and Fauna Guarantee Act* 1988, and under the Commonwealth of Australia *Environment Protection and Biodiversity Conservation Act* 1999.

Notes

At Tantawangalo State Forest populations of *X. palustre* and *X. andrewiae* are sympatric and mixed collections have been made (e.g. *D.L. Jones 17164* MEL 2101319!, CANB 616790).

The common name 'swamp paperdaisy' is in use in Tasmania ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au), and 'swamp everlasting' in New South Wales and Victoria (New South Wales Flora Online, see http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm; VicFlora, see https://vicflora.rbg.vic.gov.au/).

Selected specimens examined

NEW SOUTH WALES: South Coast: corner Tin Mine Road and Tantawangalo Mountain Road, 17 Jan. 2000, *D.L. Jones 17111* (CANB, NE!); ~9.8 km E of Cathcart towards Pambula, 8 Feb. 2000, *D.L. Jones 17157* (CANB, MEL!). VICTORIA: East Gippsland: Gisborne Racecourse Marshlands Reserve, 12 Dec. 1996, *C. Flann 5 & N.G. Walsh* (MEL!). Western Plains: Lower Glenelg River area, Red Gum Flat, 25 Jan. 1970, *A.C. Beauglehole 33395* (MEL!). TASMANIA: Central Highlands: Bronte Lagoon, 1 Mar. 2018, *T.L. Collins 1019 & R.L. Andrew* (CANB!, HO!, NE!). Northern Midlands: Smiths Lagoon, 7 Mar. 2018, *T.L. Collins 1038 & R.L. Andrew* (CANB!, HO!, NE!).

Xerochrysum subundulatum (Sch.Bip.) R.J.Bayer, *Kew Bull.* 56(4): 1015 (2001)

Helichrysum acuminatum DC., *Prodr.* 6: 188 (1838), *nom. illeg., non* (Link) Sweet (1826); *Gnaphalium subundulatum* Sch.Bip., *Bot. Zeitung* 3: 171 (1845), *nom. nov.*; *Bracteantha acuminata* Anderb. & Haegi, *Op. Bot.* 104: 105 (1991), *nom. illeg., nom. superfl.*; *Bracteantha subundulata* (Sch.Bip.) Paul G.Wilson, *Muelleria* 7(4): 519 (1992). *Type citation*: 'ad terram Van-Diemen legit cl. Gunn'. *Type*: Van-diemen [Tasmania], *R.C. Gunn* 244 (syn: G-DC G00470677*); Van Diemensland, *leg. ign., s.* dat. (possible syn: MEL 61149*).

Procumbent or erect, rhizomatous, perennial herb. *Stems* and *branches* cobwebby, woolly, or glabrescent, and with glands; internode length 10–30 mm. *Basal leaf rosette* present or absent at flowering. *Basal leaves* obovate to spathulate, 20–60 mm long and 6–20 mm wide, base amplexicaul, margin cobwebby or villous, apex apiculate; abaxial indumentum with glands, midvein indumentum cobwebby or villous; adaxial indumentum cobwebby, hispid, and with glands. *Cauline leaves* oblanceolate to obovate, 25–90 mm long and 5–20 mm wide, base attenuate and amplexicaul, margin cobwebby or hispid, apex apiculate and mucronate; *abaxial indumentum* hirsute, glabrescent and with glands; abaxial midvein indumentum cobwebby, hispid, and with glands; *adaxial indumentum* hispid, scabrid, and with glands. *Foliaceous bracts subtending capitula* 12–15 mm long, margin cobwebby, hispid and with glands. *Capitula* 35–50 mm wide, terminal, solitary. *Outer phyllaries* ovate to broad-ovate, orange, brown, or straw-coloured; basal margin hispid, abaxial surface scabridulous, apex acute. *Medial phyllaries* narrow ovate to lanceolate, abaxially yellow, apex acute. *Stylar appendages* ovate. *Cypsela* ~3 mm long and 1 mm wide, cross-section with oblique angles; pericarp brown, idioblasts present. *Pappus* persistent, ~7.5 mm long.

Distribution

Occurs in New South Wales, Victoria and Tasmania, in the South Eastern Highlands, Australian Alps, and Central Highlands and Ben Lomond bioregions respectively (Fig. 51).

Phenology

Recorded flowering January–March and fruiting in March.

Habitat

Alpine and subalpine herblands, shrublands and woodlands with good moisture availability.

Notes

See notes above for *X.* sp. Blackfellows Gap collections from Namadgi National Park and Kosciuszko National Park that may represent hybrids between *X. subundulatum* and *X. viscosum*.

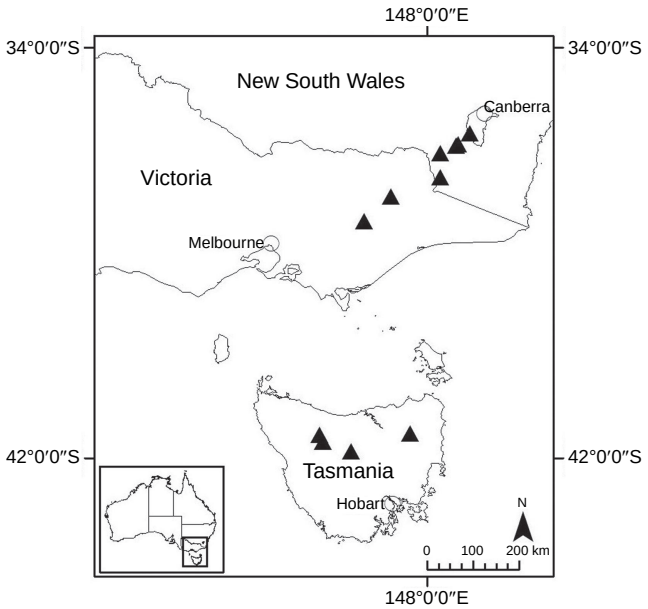

Fig. 51. Distribution of *Xerochrysum subundulatum*.

Conservation status

Occurs over a wide geographical area, including in several conservation reserves, and is not considered to be rare or threatened. We recommend a status of '*Least Concern*' (IUCN 2019).

Notes

The common names 'orange paperdaisy' or 'orange everlasting' are in use in Tasmania ('Natural Values Atlas', see www.naturalvaluesatlas.tas.gov.au) and 'alpine everlasting' is in use in New South Wales and Victoria (New South Wales Flora Online, see http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm; VicFlora, see https://vicflora.rbg.vic.gov.au/).

Selected specimens examined

AUSTRALIAN CAPITAL TERRITORY: Namadgi National Park, Cotter Hut Road, 3 Jan. 2007, *J.J. Bruhl 2595 & I.L. Crawford* (CANB!, NE!, NSW!). NEW SOUTH WALES: Southern Tablelands: Kosciuszko National Park, alongside Tooma Road, 25 Mar. 2014, *J.R. Hosking 3746* (CANB, MEL, NE!, NSW, US). VICTORIA: unincorporated: Panorama Hill, Falls Creek, near the top of the Panorama Poma, 11 Mar. 1984, *D.E. Albrecht 263* (MEL!). Alpine: Mount Buffalo National Park, 19 Jan. 1988, *A.C. Beauglehole 92582* (MEL!). East Gippsland: Bogong High Plains, Buckety Plain, 20 Jan. 1988, *N.G. Walsh 2021* (MEL!). TASMANIA: Ben Lomond: Ben Lomond National Park, 5 Mar. 2018, *T.L. Collins 1035 & R.L. Andrew* (CANB!, HO!, NE!). Central Highlands: Central Highlands Highway, Little Pine Lagoon, 1 Mar. 2018, *T.L. Collins 1020 & R.L. Andrew* (CANB!, HO!,

NE!); Liaweeni, 1 Mar. 2018, *T.L. Collins 1021 & R.L. Andrew* (CANB!, HO!, NE!); Lake Augusta, 1 Mar. 2018, *T.L. Collins 1022 & R.L. Andrew* (CANB!, HO!, NE!); Cradle Mountain National Park, Face Track, 3 Mar. 2018, *T.L. Collins 1031 & R.L. Andrew* (CANB!, HO!, NE!).

Entities of the *Xerochrysum bracteatum* group requiring further study

Xerochrysum sp. Blackfellows Gap (*N.T.Burbidge 6926*) Qld Herbarium

Low-growing, rhizomatous, perennial herb. Cauline leaves lanceolate, margin revolute and hispid with stipitate glands, apex acuminate to acute, and mucronate. Abaxial lamina indumentum with sessile glands, midvein indumentum hispid; adaxial lamina indumentum hispid and with glands. Outer phyllaries smooth, medial phyllaries oblong to ovate, abaxially yellow. Cypsela ~3 mm long and 1 mm wide; pericarp brown, idioblasts absent. Pappus deciduous, ~9 mm long.

Habitat and distribution

Collections from open grassy herbfields and woodlands in the Namadgi and Kosciuszko national parks, in the Australian Capital Territory and adjacent New South Wales in the Australian Alps Bioregion, are tentatively assigned to this entity.

Notes

Collections referred to *Xerochrysum* sp. Blackfellows Gap from Namadgi National Park and Kosciuszko National Park, labelled by herbaria as *X. subundulatum* (e.g.: *J.J. Bruhl 2596*, *L.A. Craven 10074*) have broad-ovate, smooth, outer phyllaries with apiculate apices, and broad medial phyllaries with acuminate apices. These collections also have sessile glands on cauline leaves abaxially and cypsela with a deciduous pappus, whereas typical *X. subundulatum* has narrow acute phyllaries, cauline leaves abaxially bearing glands on stalks, scattered septate trichomes, and the cypsela with a persistent pappus.

Species limits among *X.* sp. Blackfellows Gap, *X. viscosum* and *X. subundulatum* are uncertain because limited sampling and molecular data were unable to resolve genetically distinct entities or confirm hybrid ancestry; however, informative morphological characters separating these entities deserve further study. The historical legacy of colonialisation and dispossession of the Ngunnawal, Ngunawal and Ngambri people in Namadgi National Park is reflected in the phrase name derived from the location of the first herbarium collection.

Xerochrysum sp. Chinchilla (*A.N.Schmidt-Lebuhn 1745*) NE Herbarium

Erect, annual or biennial, taprooted herb. Cauline leaves oblanceolate, margin cobwebby and hispid, apex acute and mucronate. Abaxial indumentum with glands, midvein indumentum hispid and with glands; adaxial indumentum cobwebby, hispidulous and with glands. Medial phyllaries oblong to ovate, abaxially yellow.

Habitat and distribution

Collections from open grassy woodlands from central western Queensland to Narrabri, New South Wales in the Brigalow Belt South Bioregion are tentatively assigned to this entity.

Notes

Usually a short-lived annual following winter rainfall. Species limits between *X.* sp. Chinchilla and *X. hispidum* remain uncertain, despite the limited molecular data suggesting genetically distinct entities. Informative morphological characters distinguishing these entities could not be defined and require further study.

Xerochrysum sp. North Stradbroke Island (*L.Durrington 675*) Qld Herbarium

Helichrysum macrocephalum A.Cunn ex DC., *Prodr.* 6: 188 (1838). *Gnaphalium macrocephalum* (A.Cunn. ex DC.) Sch.Bip., *Bot. Zeit.* 3: 17 (1845). *Type*: Sandy shores of Moreton Bay, N.S. Wales [Queensland] lat. 27.5 S, Oct. 1824, *A. Cunningham 121* (holo: G-DC G00328540*).

Xerochrysum bracteatum subsp. (North Stradbroke Island L.Durrington 675), A. E. Holland in P.D. Bostock and A.E. Holland (eds), *Census Queensl. Fl.* 32 (2007).

Erect, perennial, tap-rooted herb. Cauline leaves obovate, margin cobwebby, hispid and scabrid, apex obtuse and mucronate. Abaxial indumentum with glands, midvein indumentum hispid with scattered glands; adaxial indumentum hispid and scabrid. Medial phyllaries ovate to narrow ovate, abaxially yellow.

Habitat and distribution

Collections from coastal sand dunes and dune swales on Minjerribah (North Stradbroke Island), K'gari (Fraser Island) and Mulgumpin (Moreton Island), and from coastal headlands from the Whitsunday Islands south to Diamond Head, in the Central Mackay Coast, South Eastern Queensland and New South Wales North Coast bioregions are tentatively assigned to this entity.

Notes

Seedling leaves seen on Mulgumpin (Moreton Island) can be up to 35 cm long and 8 cm wide, the largest in the genus. *Xerochrysum* sp. North Stradbroke Island may be conspecific with *H. macrocephalum* but molecular and morphological data were inconclusive. Further research is underway at the University of New England.

Xerochrysum sp. Tin Can Bay (*T.L.Collins 1116*) NE Herbarium

Erect, perennial, tap-rooted herb. Cauline leaves oblanceolate to lanceolate, margin cobwebby and hispid, apex acuminate to acute, and mucronate. Abaxial indumentum with glands, midvein indumentum hispid with scattered glands; adaxial indumentum cobwebby, hispid, and with glands. Medial phyllaries ovate to narrow ovate, abaxially orange, brown, or yellow.

Distribution and habitat

Collections in woodlands on sandy soils east of the Great Dividing Range in Queensland, from Mackay to Tin Can Bay in the Central Mackay Coast, South Eastern Queensland bioregions are tentatively assigned to this entity.

Notes

Requires further sampling to test species limits. Treated in the analyses as *X*. sp. weedy.

Supplementary material

Supplementary material is available online.

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