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## NOTE

### Some observations on *Salsola* L. (Chenopodiaceae) in Australia

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#### Abstract

In recent years there has been much confusion as to the correct name application for the Australian species of *Salsola* L. Prior to the late 1990's *S. kali* L. was universally applied throughout Australia but Rilke (1999) adopted the name *S. tragus* L. and more recently some authors have taken up the name *S. australis* R.Br.

Molecular studies by Hrusa & Gaskin (2008), Borger et al. (2008) and Ayers et al. (2008) confirm that *Salsola australis* is distinct from both *S. tragus* and *S. kali* so this name has been adopted for the forthcoming 5th edition of the *Flora of South Australia*.

Observation of *Salsola* populations in Western Australia and South Australia suggest that *Salsola australis* is a complex of at least six forms which require an Australian-wide molecular/systematic study to determine their status.

**Keywords:** Chenopodiaceae, *Salsola*, *S. australis*, *S. austroafricanus*, *S. tragus*, *S. kali*, molecular studies, observations of populations in Western Australia and South Australia

#### Introduction

When preparing the genera of Chenopodiaceae for the fifth edition of the *Flora of South Australia* (in prep.) a problem arose over the application of the species name for the Australian *Salsola* L. Until recently the name *S. kali* L. had been universally misapplied in state and commonwealth floras to the Australian species but when Rilke (1999) revised *Salsola* sect. *Salsola* she referred all Australian populations to *S. tragus* L., a widespread species in Eurasia and the Mediterranean regions and introduced into other areas including South Africa and North America. Furthermore, she recognised a number of subspecies in Australia applying the names subsp. *tragus*, subsp. *pontica* (Pall.) Rilke and described a new subspecies from Western Australia namely subsp. *grandiflora* Rilke. The former two subspecies occur in Eurasia and the Mediterranean respectively and the latter restricted to Australia.

In a recent study of the *S. tragus* complex in California, Hrusa & Gaskin (2008) recognised three entities in the complex, namely: *S. tragus sens. str.*, *Salsola* 'type B' and in an effort to characterise 'type B' a third entity 'type C' was also identified. Using discriminant analysis with molecular genotype sequencing, *S. tragus* and *Salsola* 'type B' were found to be morphologically distinct species and *Salsola* 'type C' was morphologically intermediate between them. Furthermore *Salsola* 'type C' contained DNA sequence genotypes that were an additive mixture of

haplotypes mostly exclusive to the tetraploid *S. tragus* and the diploid *Salsola* 'type B'. *Salsola* 'type C' was determined to be a fertile allohexaploid resulting from hybridisation between *S. tragus* and *Salsola* 'type B'.

Hrusa & Gaskin found two pre-existing names were available for their *Salsola* 'type B'. The holotype specimen of *S. kali* subsp. *austroafricanus* Aellen (1938) held at Munich (M) and the lectotype (BM) of *Salsola australis* R.Br (1810) matched 'type B' closely. The fertile allohexaploid ('type C') was described as a new species, *S. ryanii* Hrusa & Gaskin. Interestingly,



Fig. 1. *Salsola australis* subsp. *Coastal*, habit — R.J.Chinnock 10246.

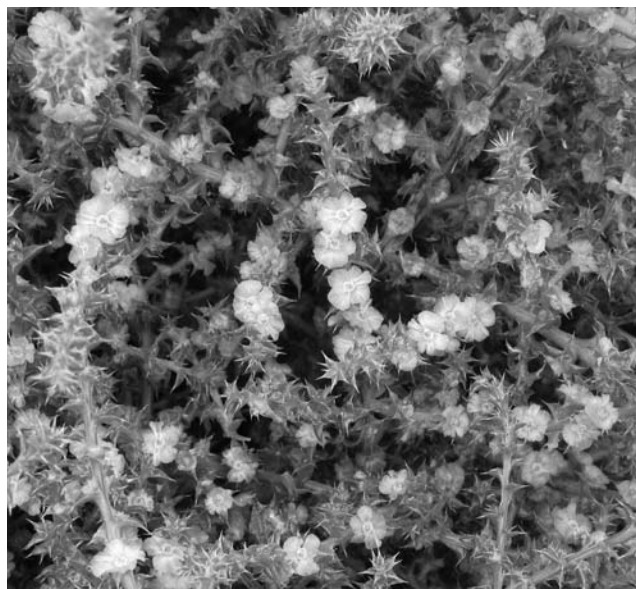


Fig. 2. *Salsola australis* subsp. *Coastal*, fruiting branches — R.J. Chinnock 10246.

another paper on the Californian tumbleweed (*Salsola* sect. *Kali*) by Ayers et al. (2009) refers to *S. kali* subsp. *austroriparianica* but makes no reference to either *S. australis* or the paper by Hrusa & Gaskin (2008). Presumably this was the result of a longer delay before publication, as the Ayers paper was submitted in late 2007.

A molecular and cytological study was recently undertaken by Borger et al. (2008) on populations of *Salsola* found in the south-west of Western Australia. They studied 22 populations and recognised four genetically distinct groups that were not closely related to the *S. tragus* out-group sourced from the USA. Furthermore these groups, together with a *S. australis* sample obtained from Santa Nella, California were found to be diploid whereas *S. tragus* subsp. *tragus* was tetraploid.

Group A was identified as *S. australis* and Groups B, C and D were not classified further and could not be matched up with the descriptions of either *S. tragus* subsp. *pontica* or *S. tragus* subsp. *grandiflora* recorded for Australia by Rilke (1999). According to Borger et al. (2008) their Group D matched Robert Brown's description of *Salsola macrophylla* (collected at Thirsty Sound, Qld) This species was characterised by Brown as being an erect shrub with succulent leaves and is described as an erect woody plant.

Walsh (1996) in his discussion of *S. kali* in the *Flora of Victoria* recognised three entities in that State and although he suggested possible names that could be applied he wisely made no formal recognition of those names. According to Mr Val Stajsic, National Herbarium of Victoria (pers. comm.), two Victorian forms of *Salsola* currently filed in the National Herbarium of Victoria's collections under subsp. *tragus* and subsp. *pontica* are well defined and have different habitat



Fig. 3. *Salsola australis* subsp. *Strobilifera*, showing the fruits aggregated into cones on short lateral branches — R.J. Chinnock 10020.

preferences with one restricted to coastal or near coastal places and the other widespread in the State. The two differ significantly in colour, stem thickness and fruit structure.

I have taken the opportunity recently, since preparing the treatment of *Salsola* for the *Flora of South Australia*, of noting some of the variation seen in populations in Western Australia and South Australia and, although this is in no way intended to be a taxonomic account, my observations do support the work of Borger et al. (2008), Walsh (1996) and Stajsic (pers. comm.) in suggesting that there are a number of well defined taxa within *Salsola australis*. Although I do not know at what level these forms should be formally recognised, I have for consistency referred to them as subspecies in this paper. I have neither examined collections in other Australian herbaria nor have I consulted any type specimens so the observations given below are merely a guide to some of the variation observed.

### Observations & Discussion

At least three forms of *Salsola* are known to occur in South Australia and one of these appears to be restricted to coastal or near coastal areas and may possibly be equivalent to the coastal Victorian form found in similar situations. This form, *Salsola australis* subsp. *Coastal* (R.J. Chinnock 10246), is a very dense, rigid, spinescent, fleshy shrub (Figs 1 & 2) and most probably is the typical form of *S. australis*. Robert Brown collected *S. australis* in the Nuyts Archipelago most likely on St Francis Island and all the collections from the St Francis Isles (St Francis, Dog and Fenelon Islands) held in the State Herbarium (AD) represent this form.

The recent studies by both Hrusa & Gaskin (2008) and Borger et al. (2008) suggest that the Australian populations of *Salsola* are probably endemic and not



Fig. 4. *Salsola* population on the Landor Road, WA.

referrable to *S. tragus* as was done by Rilke in 1999. The study undertaken by Borger et al., was very parochial and only covered a small area of the south west of the continent so there is a need for a detailed Australia-wide study of *Salsola* to be undertaken, combining morphology, ecology, cytology and molecular analyses, before any meaningful taxonomic sense of the genus in Australia can be achieved.

The molecular analysis of the Old World *Salsoleae* sens. lat., undertaken by Akhiani et. al (2007), found that the Australian species fell within the 'Kali Clade' along with *S. kali* and *S. tragus*, and furthermore they resurrected the generic name *Kali* Miller making the combination *Kali australis* (R.Br.) Akhiani & E.H.Roalson although they incorrectly cited the basionym. However the generic name *Kali* as pointed out by Paul G. Wilson is illegitimate (pers.comm., email 31 Mar. 2010), and if this group is treated as distinct from *Salsola* then a new name will be required.

On a recent visit to Western Australia covering areas from Newman southwards to Kalgoorlie, I made observations on various populations of *Salsola* and collected specimens representing five distinct forms. For the purpose of this discussion, I have given these forms phrase names to distinguish the various herbarium collections deposited in AD and PERTH.

At Gwalia near Leonora, two forms occurred sympatrically on rocky slopes, *S. australis subsp. Compact* (R.J.Chinnock 10176) formed a rounded glabrous shrub to 0.8 m tall. *Salsola australis subsp. Compact* is a very common taxon and has been observed in various parts of Western Australia, Northern Territory and South Australia. The other form, *S. australis subsp. Strobilifera* (R.J.Chinnock 10177), was a low irregularly shaped glabrous shrub to 30 cm tall with well defined clusters of fruits forming 'cones' on short



Fig. 5. Forms of *Salsola australis* growing sympatrically on the Landor Road: *S. australis subsp. Compact* (left), *subsp. Glaucous* (right) and small plants of *subsp. Pubescent* (top centre).

lateral branches. This is the form that has commonly been referred to in the past as *S. kali* var. *strobilifera* (Fig. 3). It is very widespread in Australia, well-defined and probably requires specific status. Unlike *S. australis subsp. Compact* this form does not appear to become a tumbleweed.

At one site south of Mt Augustus on the Landor Road, a large population of *Salsola* occurred on disturbed areas adjacent to the road (Fig. 4). Three distinct forms were found growing sympatrically with no suggestion of hybridism (Fig. 5). One form, *S. australis subsp. Glaucous* (R.J.Chinnock 10206) formed an open shrub to 0.8 m tall. The branches and leaves were glabrous, bluish grey green and fruits were just starting to develop. The second was *S. australis subsp. Compact* (R.J.Chinnock 10205), the form found much further south at Gwalia. The third form *S. australis subsp. Pubescent* (R.J.Chinnock 10207) was a very compact low shrub to about 40 cm tall with densely pubescent branches, leaves and flowers. Unlike *S. australis subsp. Compact* which was fruiting, the two other forms at this location were flowering.

In the Newman area, another very distinct form occurs. *Salsola australis subsp. Lucid* (R.J.Chinnock 10212) is a dense rounded glabrous (or occasional scattered hairs on branch) shrub with shiny branches and leaves. It is commonly 40 to 80 cm tall but very large plants to 1.6 m tall and 3.2 m across were also observed (Fig. 6). It is characterised by having very shiny leaves and branches and in addition, the developing fruits, unlike other forms of *S. australis* observed, were coloured deep rose in the lower halves of wings (Fig. 7). The size dimensions of these larger plants greatly exceed those given by Wilson (1984) and, Borger & Scott (2009) for the species.

For the *Flora of South Australia*, I am following Borger & Scott (2009) in adopting the name *S. australis*.



Fig. 6. *Salsola australis* subsp. *Lucid*, near Newman, habit. — R.J.Chinnock 10212.

This species was first collected by Robert Brown at the beginning of the 19th century in the southern part of the continent so it is unlikely that at that time it had been introduced from elsewhere and likewise the diversity observed in populations within Australia would indicate that the species has had a considerably longer history in Australia than a mere few hundred years. The names *S. kali* and *S. tragus* are considered misapplied to Australian populations although the relationship between *S. tragus* and Australian populations still needs to be resolved.

There are at least 6 well-defined taxa represented in Western Australia, South Australia and Victoria of which at least three occur in South Australia namely, *S. australis* subsp. *Compact*, *S. australis* subsp. *Coastal* and *S. australis* subsp. *Strobilifera* — although I make no attempt to apply any infraspecific names. The forms of *S. australis* vary greatly and until there is a detailed Australia-wide molecular/taxonomic study of the complex undertaken I consider it foolhardy to try and apply any of the infraspecific names that have been previously proposed under the misapplied names like *S. kali* or *S. tragus*

### Nomenclature

#### *Salsola australis* R.Br.

Prodr. 411 (1810). — *Kali australis* (R.Br.) Akhani & E.H.Roalson, Int. J. Pl. Sci. 168: 946 (2007) [based on *S. australis* R.Br. not "*Salsola kali* R.Br." as cited].

*Salsola kali* var. *pontica* Pall., Ill. Pl. 37 (1803), pro parte. — *Salsola tragus* subsp. *pontica* (Pall.) Rilke, Biblioth. Bot. 149: 133 (1999), pro parte.

?*Salsola macrophylla* R.Br., Prodr. 411 (1810).

*Salsola brachypteris* Moq., Chenop. Monogr. Enum 147 (1840). — *Salsola kali* var. *brachypteris* (Moq.) Benth., Fl. Austral. 5: 208 (1870).

*Salsola kali* var. *leptophylla* Benth., Fl. Austral. 5: 207 (1870).



Fig. 7. *Salsola australis* subsp. *Lucid*, fruiting branch showing the well-defined rose coloured band at the base of wings of the fruit. — R.J.Chinnock 10212

*Salsola kali* var. *strobilifera* Benth, Fl. Austral. 5: 207 (1870). — *S. australis* var. *strobilifera* (Benth.) Domin, Biblioth. Bot. 89: 628 (1921).

*Salsola kali* subsp. *austroriparica* Aellen, Mitt. Bot. Staatssamml. München 4 : 27 (1961).

*Salsola tragus* subsp. *grandiflora* Rilke, Biblioth. Bot. 149: 135 (1999).

*Salsola kali* auct. non L: P.G.Wilson in A.S.George, Fl. Austral. 4: 314 (1984); P.G.Wilson in Jessop & Toelken, Fl. S. Austral. 1: 291 (1986); N.G.Walsh in N.G.Walsh & Entwisle, Fl. Victoria 3: 197 (1996); S.W.L.Jacobs in Harden, Fl. New South Wales 1: 238 (2000).

*Salsola tragus* auct. non L: Rilke, Biblioth. Bot. 149: 111 (1999), pro parte.

### Conclusions

*Salsola*, widespread and common throughout most of Australia, is not likely to be confused with any other Chenopod genus. *Salsola australis* belongs to *Salsola* sect. *Kali* and is similar to other species of weedy tumbleweed in the section, like *S. kali* and *S. tragus*, widespread in Europe and Asia and introduced into many countries. As such the distinctiveness from these Eurasian species needs to be clarified. There are certainly very distinct forms included under the name *S. australis* but the relationships between these forms and at what level of classification they should be recognised must await until a comprehensive Australia-wide revision is undertaken.

#### Cited Specimens:

*S. australis* subsp. *Coastal*. R.J.Chinnock 10246, Pelican Point road, 0.6 km from T/O off Victoria Road, S.A., 3 Feb. 2010 (AD).

*S. australis* subsp. *Compact*. R.J.Chinnock 10176, Gwalia, just south of Leonora, northern slopes below Gwalia Museum, 11 June 2009 (AD, PERTH); R.J.Chinnock 10205, 4.3 km N of the Burringurrah Aboriginal Community on the Landor-Mt Augustus Road, 20 June 2009 (AD, PERTH).

*S. australis* subsp. *Glaucous*. R.J.Chinnock 10206, 4.3 km N of the Burringurrah Aboriginal Community on the Landor-Mt Augustus Road, 20 June 2009 (AD, PERTH).

*S. australis* subsp. *Lucid*. R.J.Chinnock 10212, Near Newman Racecourse, 2.4 km N of Kalgan Drive T/O on the Great Northern Highway, 22 June 2009 (AD, PERTH).

*S. australis* subsp. *Pubescent*. R.J.Chinnock 10207, 4.3 km N of the Burringurrah Aboriginal Community on the Landor-Mt Augustus Road, 20 June 2009 (AD, PERTH).

*S. australis* subsp. *Strobilifera*. R.J.Chinnock 10020, 3.2 km SW of the Munjini-Nanutarra Road junction with the Tom Price Road, 5 June 2006 (AD, PERTH); R.J.Chinnock 10177, Gwalia, just south of Leonora, northern slopes below Gwalia Museum, 11 June 2009 (AD, PERTH).

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