Taxonomic update and Lucid key for introduced blackberry in Australia

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Summary The common name blackberry refers to an unknown number of species of Rubus in Australia. Many of them were introduced from Europe and America and, to a lesser extent, Asia. Exotic species of Rubus are important weeds of agriculture, forestry and natural ecosystems. The adoption of best-practice management of weedy blackberry is dependent on correct identification for determining biological and chemical control methods optimal for each species and location. Exotic species must also be distinguished from native Rubus spp., to prevent unnecessary removal of the latter.

A taxonomic revision of exotic species of Rubus present in Australia recognised 23 introduced species. In consultation with Rubus specialists from Europe and North America, names are applied for the first time to ten of these. The most commonly encountered blackberries are part of the Rubus fruticosus aggregate, originating from Europe. This aggregate is taxonomically complex due to polyploidy and to reproduction which is predominantly sexual with occasional sexual events. Species are difficult to tell apart, and application of Rubus names has varied between states. A study of morphological and genetic variation within the Rubus fruticosus agg. revealed at least 15 species, the commonest and most widespread of which is R. anglocaudatus, known previously as R. procera or R. discolor. DNA phenotyping was used to confirm identification in doubtful cases and to support taxonomic determination based on morphology.

A summary of species of the R. fruticosus agg. found in Australia, their distribution and DNA phenotypes, and names used previously for these species in Australia, is presented. Based on the taxonomic update, a draft of an interactive, electronic tool for distinguishing the various blackberry species, developed using Lucid software, is now available on CD or online at http://www.flora.sa.gov.au. The necessity for voucher-based observations is emphasised.

Keywords Blackberry, DNA, biological control, chemical control, interactive identification, Lucid, Rubus, taxonomy, voucher.

INTRODUCTION

Rubus is a cosmopolitan genus that includes raspberry, blackberry and numerous 'berry' fruit cultivars important in horticultural production. Exotic species of Rubus have been introduced to Australia from Europe, North America and Asia. European blackberry, comprising closely related species of the Rubus fruticosus L. aggregate, were introduced by early European settlers. The term species, in the sense of the biological species concept, is difficult to apply in classifying much of the variation encountered in Rubus. However, it is used here since this is the level at which the variation is treated in Europe and America and for consistency.

European blackberry is a Weed of National Significance that infests pasture, forests and natural ecosystems (Amor et al. 1998, Thorp and Lynenh 2000). The weed status of species of North American or Asian origin, especially species that have naturalised from cultivation, requires further investigation. Species of Rubus can be found in moist areas from northern tropical Queensland to southern Tasmania and in wetter areas across southern Australia. Species of the R. fruticosus agg. are found mainly in temperate Australia, mostly from the Brisbane region south and where the annual rainfall exceeds 700 mm (Amor et al. 1998). Most species are shrubs with biennial stems. In the first year, a vigorous non-flowering shoot, the primocane, is produced. Floricanes develop in the second season from leaf axils along the primocane.

Rubus is taxonomically complex. The majority of European blackberry species are polyploid, facultatively apomictic and pseudogamous (Nybohn 1988). Seed produced is genetically identical to the mother
plant but a proportion of seed may develop following sexual reproduction. Interspecific hybridisation and phenotypic plasticity make it difficult to distinguish between species. Existing taxonomic treatments for the *R. fruticosus* agg. in Australia are largely based on names determined for collections from Victoria in the 1960s (Amor and Miles 1974). However, there is variation between Australian states in names applied to species, and additional species of the *R. fruticosus* agg. and other exotic species of *Rubus* have been recognised recently (Evans et al. 1998).

The adoption of best-practice management of blackberry is dependent on correct identification for optimising biological and chemical control methods for each species and location. Exotic species must also be distinguished from native *Rubus* spp., to prevent unnecessary removal of the latter. For example, *R. parvifolius* L., a native raspberry, is often found growing with weedy exotic blackberries and has been known to have been removed in error. Identification of species using a dichotomous key presented in the language of systematic botany is a tedious and fraught process for most weed managers. We present a summary of the recent taxonomic update of exotic *Rubus* in Australia and comment on a draft of an interactive, electronic key designed for user-friendly identification of exotic and native species of *Rubus*.

**MATERIALS AND METHODS**

Over 300 voucher collections were made throughout Australia, predominantly of the *Rubus fruticosus* agg., from 1996–2001, either by or under the guidance of D.E. Symon and/or J.R. Hosking. At the same time, fresh leaves were collected and total DNA extracted from 198 collections for M13/HaeIII DNA phenotyping by K. Evans. Processing of leaflet samples and techniques for DNA analysis are described in Evans et al. (1998, 2000) and Evans and Weber (2003).

Voucher collections were integrated into a taxonomic revision of *Rubus* in Australia by D.E. Symon. Taxa of the *R. fruticosus* agg. were named with reference to material in Europe, and in consultation with *Rubus* specialists T.E. Weber (University of Vechta, Germany) and A. Newton (Exmouth, Devon, United Kingdom). *Rubus* spp. of North American origin were named with the assistance of G. Moore (Brooklyn Botanical Gardens, New York) and M. Widrlecher (Iowa State University). Results of DNA analyses were used to assist determinations based on morphology and also to confirm identification in some doubtful cases. Morphometric analyses of variation in the *Rubus fruticosus* agg. were carried by M. Whalen and J. Oliver based on the newly determined collections of the State Herbarium of South Australia.

Based on this taxonomic revision, a draft version of an interactive key, known as Blackberry, has been developed using Lucid software (www.lucidcentral.com) by R.M and W.R. Barker, in collaboration with D.E. Symon and K.J. Evans.

**RESULTS AND DISCUSSION**

The **taxonomic revision** The major focus of the work, the *Rubus fruticosus* aggregate, has been found to consist of at least 15 species in Australia (Table 1). Seven of the names within this aggregate are applied for the first time. Two species that were unable to be named were distinguished by phrase names. Four North American species, *R. laudatus* A.Berger, *R. loganobaccus* L.H.Bailey, *R. philadelphicus* Blanch., and *R. rostellatus* (L.H.Bailey) Rydb., are naturalised in Australia. The names of the first three of these American species are applied in Australia for the first time.

Fifty M13/HaeIII-DNA phenotypes were identified among 198 collections from the *R. fruticosus* L. agg. across Australia. Thirty-four DNA phenotypes were correlated to 15 species of the *R. fruticosus* agg. (Table 1): the remaining 16 DNA types were undetermined or of questionable identity. Exotic *Rubus* spp. have had over 160 years to evolve in Australia, and new biotypes may have arisen by hybridisation and/or somatic mutation. It is also possible that some of these biotypes have not yet been recognised morphologically in Europe or North America.

A large multiple-authored paper describing the outcomes of this study and containing a revised taxonomy of introduced species of *Rubus* is about to be submitted for publication (Evans et al., in preparation).

Blackberry, a ‘user friendly’ interactive key **Blackberry** is a two-level key: the parent key is a key to all species of *Rubus* in Australia and is designed to be used when it is not known if the plant in question is an exotic or a native species. The subkey contains all presently known species of the *R. fruticosus* agg. in Australia and other species with which they might be confused; it can be accessed directly when the user knows they have a weedy species of the *R. fruticosus* agg.

Character states used to separate species are presented as images or line drawings. Once the plant in question is determined, notes about the species, including a list of defining characters, and images, allow comparison to ensure that an accurate determination has been made. Where possible the notes section for each blackberry species provides specific information on ecology and best-practice management. However, this information is still mostly lacking and in need of
### Table 1. Summary of taxa of the *Rubus fruticosus*- agg. in Australia, their distribution, DNA phenotype(s) and names used previously in Australia.

<table>
<thead>
<tr>
<th>Taxon of the <em>Rubus fruticosus</em> agg.</th>
<th>No. of DNA phenotypes identified to date</th>
<th>Distribution by state</th>
<th>Name(s) used previously</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>R. anglocanaliculatus</em> A.Newton<em>4</em></td>
<td>3</td>
<td>WA, SA, Qld, NSW, ACT, Vic., Tas.</td>
<td><em>R. procera</em> or <em>R. discolor</em></td>
</tr>
<tr>
<td><em>R. cissburiensis</em> W.C. Barton &amp; Ridd.</td>
<td>1</td>
<td>Vic.</td>
<td><em>R. cissburiensis</em></td>
</tr>
<tr>
<td><em>R. echinatus</em> Lindl.</td>
<td>2</td>
<td>Vic., Tas.</td>
<td></td>
</tr>
<tr>
<td><em>R. erythrophyllus</em> B. G. Eades &amp; A.Newton</td>
<td>1</td>
<td>SA, Vic., Tas.</td>
<td><em>R. rosaceus</em></td>
</tr>
<tr>
<td><em>R. lacinatus</em> Wild.</td>
<td>1</td>
<td>SA, NSW, Vic., Tas.</td>
<td><em>R. lacinatus</em></td>
</tr>
<tr>
<td><em>R. leightonii</em> Lees ex Leight.</td>
<td>2</td>
<td>NSW</td>
<td><em>R. leightonii</em></td>
</tr>
<tr>
<td><em>R. leucostachyus</em> Schleich. ex Sm.</td>
<td>4 (11)<em>c</em></td>
<td>SA, NSW, Vic., Tas.</td>
<td><em>R. ulmifolius</em> hybrids</td>
</tr>
<tr>
<td><em>R. leucostachyus</em> Foster biotype</td>
<td>3</td>
<td>Vic., Tas.</td>
<td><em>R. ulmifolius</em> hybrids</td>
</tr>
<tr>
<td><em>R. phaeocarpus</em> W.C.R. Watson</td>
<td>1</td>
<td>SA, NSW</td>
<td></td>
</tr>
<tr>
<td><em>R. polyanthemus</em> Lindeb.</td>
<td>1</td>
<td>NSW, Vic.</td>
<td><em>R. polyanthemus</em></td>
</tr>
<tr>
<td><em>R. riddellsii</em> Rilstone</td>
<td>1</td>
<td>SA</td>
<td></td>
</tr>
<tr>
<td><em>R. rubrithorax</em> W.C.R. Watson</td>
<td>1</td>
<td>SA, Tas.</td>
<td></td>
</tr>
<tr>
<td><em>R. sp. Scott Creek</em> (Smyde 16054)</td>
<td>1</td>
<td>SA</td>
<td></td>
</tr>
<tr>
<td><em>R. sp. Tasmania</em> (Hooking 1551)</td>
<td>1 (3)<em>c</em></td>
<td>Tas.</td>
<td></td>
</tr>
<tr>
<td><em>R. ulmifolius</em> Schott</td>
<td>8 (9)<em>c</em></td>
<td>WA, SA, NSW, Vic.</td>
<td><em>R. ulmifolius</em></td>
</tr>
<tr>
<td><em>R. ulmifolius</em> var. opolodiaphorus* Suide</td>
<td>1</td>
<td>WA, SA</td>
<td><em>R. ulmifolius</em> var. inermis</td>
</tr>
<tr>
<td><em>R. vestitus</em> Weibeh</td>
<td>2</td>
<td>SA, NSW, Vic., Tas.</td>
<td><em>R. vestitus</em></td>
</tr>
<tr>
<td><em>R. spp.</em></td>
<td>6</td>
<td>SA, NSW, Vic., Tas.</td>
<td></td>
</tr>
</tbody>
</table>

*4 Refer to Evans and Weber (2003).
*b Taxon name applied for the first time in Australia.
*c Number in parenthesis indicates total DNA phenotypes including unvouchered collections or those of questionable identity.

A compilation from voucher-supported observations by the Australian weed community. Distribution maps can be generated from links to Australia's Virtual Herbarium. Map accuracy will improve as respective herbaria update databases for collections that have been newly determined. A draft of *Blackberry* is available on CD from the State Herbarium of South Australia and on the Web at www.flora.sa.gov.au when the local server or network facilitates delivery. It is the same version as that used at *Blackberry* training workshops in all southern states in late 2003 and early 2004. An example of the electronic interface is presented in Figure 1.
At the 'on ground' level, application of the Lucid tool will alert the weed manager that the blackberry infestation might contain a species that responds differently to herbicides and/or biological control, when compared to other species in the locality. With the release of additional strains of the rust biocontrol agent, *Phragmidium violaceum* (Schultz) Winter, in NSW and WA in 2004, prior knowledge of species in release areas should aid assessment of any differences in rust impact. Regarding chemical control, there is anecdotal evidence to suggest that *R. leucostachys*, formerly known by weed managers in Australia as one of the *R. ulmifolius* hybrids, is a 'hard to kill' blackberry taxon (Amor 1975, Milne and Dellow 1998). This may be attributed to the higher density of canes when compared with other taxa such as *R. anglocandicans* (Amor 1975).

The need for voucher specimens  It is important to note that blackberry collections are not always able to be determined to species level. In all situations where observations about particular species are being recorded, we encourage weed managers to prepare voucher specimens for deposition to a recognised herbarium, preferably with replicate specimens to be forwarded also to the State Herbarium of South Australia.

Instructions on how to prepare voucher specimens are provided in Blackberry. Submission of vouchers will allow: (a) identification of knowledge gaps and further research on the systematics of exotic *Rubus* in Australia; (b) more accurate distribution maps; (c) improvement of the Blackberry data set; and (d) the identification of the material to be checked if questions arise in the future.

The collection of voucher specimens for deposition in herbaria will be an essential component of any new herbicide and/or rust trials. Without voucher specimens, the identity of the blackberry under study cannot be verified.

ACKNOWLEDGMENTS

We thank the Natural Heritage Trust, the CRC for Australian Weed Management, herbaria and numerous co-operators for supporting this work. In particular, we thank Rick Roush, former Director of the Weeds CRC, and Bill Barker, Department of Environment and Heritage, SA, for their roles in project development. We also acknowledge Judith Symon, Beth Chandler, Gilbert Dashorst, Duncan Mackay, Hilda Nybom, Midori Jones, Eligio Bruzzese, Franz Mahr and Katherine Lockwood.

REFERENCES


