A comparison of novel weapons in European and Australian Echium plantagineum populations using metabolic profiling

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Abstract

Native to the Iberian Peninsula, *Echium plantagineum* L. was introduced to Australia in 1800's and is a noxious invasive weed in Australian pastures. Its toxicity to grazing livestock causes > $250 M annual losses to the Australian industries. However, in its native range it is not particularly invasive or toxic. Plants from twelve geographically distinct European and Australian populations of *E. plantagineum* were collected and analyzed for accumulation of allelochemicals including antimicrobial and phytotoxic naphthoquinones (NQs) and shoot toxic pyrrolizidine alkaloids (PAs). NQs were extracted in ethanol from the root periderm, whereas foliage was extracted in methanol for analysis of PAs. Extracts were subjected to metabolic profiling using UHPLC-ESI-QTOF (Agilent, USA) in negative and positive mode. Data was processed using targeted and non-targeted analyses and compared to an in-house

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database of NQs and PAs using Mass Profiler Professional Software (Agilent, USA). Australian populations produced up to 6-fold higher concentrations of NQs and 3-fold reduced concentration of 14 PAs ($P< 0.05$) in comparison to plants collected from the Iberian Peninsula. *Echium plantagineum* plants established more densely across the Australian range, and field stands were also significantly less biodiverse as measured by plant species richness in contrast to stands in the native range. Plants in the native range retained their potent ability to defend against herbivory through the enhanced production of an abundance of PAs, while Australian plants defended through increased production of a diversity of phytotoxic and antimicrobial NQs in root periderm tissues. Our studies suggest that the invasion success of *E. plantagineum* in Australia, in contrast to establishment in the native range, may be related to post-introduction adaptive evolutionary changes in plant metabolism. Upregulation of key metabolites in Australia may be associated with climate-driven natural selection processes and plant's escape from natural enemies, further contributing to successful invasion following introduction.

Keywords: Plant invasion, naphthoquinones, pyrrolizidine alkaloids, UHPLC QTOF, biodiversity