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RESEARCH ARTICLE

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Love at first bite? Pre-release surveys reveal a novel association between a native weevil and the invasive *Nymphaea mexicana* Zuccarini (Nymphaeaceae) in South Africa

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Classical biological control aims to suppress alien invasive plant populations by introducing host-specific natural enemies from the native range. This relies on the assumption that invasive plant populations in the invaded range benefit from the release of natural enemies. Pre-release surveys in the invaded range are a useful way to determine if enemy release applies to a particular invasive alien plant, and to determine what other factors may contribute to the invasion. Similarly, pre-release surveys gather information that can be used to compare invaded sites before and after the release of biological control agents and may also identify whether natural enemies have been accidentally introduced into the country. Pre-release surveys were conducted in South Africa on the invasive *Nymphaea mexicana* Zuccarini (Nymphaeaceae) to gather such information about this species, for which a biological control programme is being developed. There was lower diversity and abundance of herbivores in the native range compared to South Africa, suggesting that *N. mexicana* does experience enemy release at most sites in South Africa. This support for the enemy release hypothesis justifies the investment in biological control for its management. However, a native weevil, *Bagous longulus* Gyllenhal (Coleoptera: Curculionidae), was found feeding and reproducing on *N. mexicana* at three sites, resulting in damage to the leaves and suggesting that a novel association has formed between these species. *Bagous longulus* may have potential to be distributed to sites of *N. mexicana* where it is not present, though further investigation is necessary to confirm if its host range is suitable for this to be a safe endeavour. With the exception of sites where *B. longulus* was present, leaf sizes were large and damage was low, and there is no evidence that any natural enemies have been accidentally introduced from the native range. Findings such as these emphasise the importance of conducting thorough surveys during the development of biological control programmes.

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INTRODUCTION

To manage invasive alien plants, classical biological control makes use of host-specific insect herbivores from the native range of the alien plant to suppress populations in the invaded range (Müller-Schärer & Schaffner 2008). Biological control has been successful in controlling many weed species (McFadyen 2000; van Klinken et al. 2003; Herrick & Kok 2010; Coetzee et al. 2011, 2021) and is cost effective and environmentally friendly (de Lange & van Wilgen 2010; van Wilgen et al. 2020). Biological control for weed management relies mostly on invasion hypotheses such as the Enemy Release Hypothesis (ERH), which states that alien plants may become invasive due to reduced herbivory as a result of the lack of natural enemies in the invaded range (Keane and Crawley 2002), and the Evolution of Increased Competitive Ability (EICA) hypothesis. The EICA hypothesis states that invasive alien plants shift resource allocation from defence to growth and reproduction when they experience reduced herbivory (Blossey and Notzold 1995). While there is contrasting evidence for these hypotheses, in which there may be more complex and varied explanations for invasion success in different species (Colautti et al. 2004; Joshi and Vrieling 2005), understanding the drivers for invasions are important to determine the best means of managing problematic populations.

To initiate a biological control programme, a series of research steps should be taken to gather sufficient information about the target plant and maximise the chances that released agents will be effective at suppressing invasive populations (Jacob and Briese 2003; Sheppard et al. 2003; van Klinken and Raghu 2006). One such step is the completion of pre-release surveys, which involves identifying insect fauna associated with an invasive alien plant in its invaded range, before biological control agents are introduced. These surveys are useful to ascertain whether enemy release contributes to the plant's invasiveness (Keane and Crawley 2002; Canavan et al. 2014), and to determine whether potential biological control agents are already established in the invaded range (Dudley et al. 2006). This information is important in making decisions about measures to manage invasive alien plant populations and may save considerable time and money that would otherwise be invested in importing and testing potential biological control agents from the native range. For example, in California, U.S.A., surveys revealed that the potential biological control agent *Tetramesa romana* Walker (Eurytomidae) was already established on the invasive alien *Arundo donax* L. (Poaceae) (Dudley et al. 2008). *Tetramesa romana* was also found on *A. donax*