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BRIEF REPORT

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Field evidence of caddisfly larvae (Trichoptera: Limnephilidae, Leptoceridae) using alien *Crassula helmsii* (Kirk) Cockayne fragments (Saxifragales: Crassulaceae) in case construction

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ABSTRACT

We present the first field observations of caddisfly (Trichoptera) larvae using an invasive alien aquatic plant, *Crassula helmsii* (Kirk) Cockayne, in case construction. In samples from invaded ponds across the UK and Belgium, we have recorded the presence of *C. helmsii* fragments in cases from *Limnephilus lunatus* Curtis, 1834, *Limnephilus marmoratus* Curtis, 1834, *Limnephilus flavicornis* (Fabricius, 1787) (Limnephilidae), *Triaenodes bicolor* (Curtis, 1834), and *Oecetis furva* (Rambur, 1842) (Leptoceridae). Fragmentation of *C. helmsii* in case creation and augmentation may produce vegetative propagules, thus facilitating further dispersal of this invasive macrophyte.

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New Zealand pygmyweed; invasive; aquatic macrophyte; propagules; dispersal

Introduction

Invasive alien aquatic plants are proliferating globally, with far-reaching (and potentially detrimental) consequences for the structure and functioning of recipient ecosystems (Gallardo Clavero, Sánchez, and Vilà 2016; Lobato-de Magalhães et al. 2023; Strayer 2010; Tasker, Foggo, and Bilton 2022). The dispersal and establishment of alien macrophyte species is therefore of great interest to researchers and conservation practitioners. Propagule pressure, including from vegetative fragments, is considered a key factor in the spread of such plants (Lobato-de Magalhães et al. 2023; Louback-Franco, Dainez-Filho, Souza, and Thomaz 2020).

Caddisfly larvae (Trichoptera) are widespread and frequently abundant members of the benthic fauna of freshwaters worldwide (de Moor and Ivanov 2007). Many caddisfly species create protective cases from plant fragments, mollusc shells and/or mineral grains,

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adhered using silk secreted from labial glands. These are made recurrently through each of the five larval instars (Hanna 2009). Crane et al. (2021) hypothesised that the creation and augmentation of caddis cases could facilitate the dispersal of vegetatively propagating alien macrophytes, and demonstrated this potential in the laboratory by assessing the fragmentation of *Elodea canadensis* Michx., *Elodea nuttallii* (Planch.) H. St. John, *Crassula helmsii* (Kirk, 1899) Cockayne and *Lagarosiphon major* (Ridl.) Moss during case-building by *Limnephilus lunatus* Curtis, 1834. Here, we present the first field observations of the invasive alien macrophyte New Zealand pygmyweed (*Crassula helmsii* – see Smith and Buckley 2020) used in case construction by caddisfly larvae.

Material and methods

As part of a field study assessing the impacts of *Crassula helmsii* on benthic macroinvertebrates (unpublished), we collected samples from waterbodies invaded by *C. helmsii* across NW Europe. Samples were taken from dense (>50% cover) *C. helmsii* stands using an FBA net (20 × 25 cm, 1 mm mesh). Samples were transferred to 1 l pots and immediately fixed in either 70% industrial denatured alcohol or 70% propylene glycol.

Observations

In samples from invaded ponds across the United Kingdom (UK) and Belgium, case-building caddisfly larvae frequently used fragments of *Crassula helmsii* for case-building. From invaded ponds in Cornwall, Norfolk and Sussex, UK, we have recorded the presence of *C. helmsii* fragments in cases from *Limnephilus lunatus, Limnephilus marmoratus* Curtis, 1834, *Limnephilus flavicornis* (Fabricius, 1787) (Limnephilidae) and *Triaenodes bicolor* (Curtis, 1834) (Leptoceridae). In Antwerp Province, Belgium, *C. helmsii* fragments were also observed in the case of *Oecetis furva* (Rambur, 1842) (Leptoceridae). *Crassula helmsii* material in the cases we examined varied according to caddisfly species. *Limnephilus marmoratus* and *L. flavicornis* cases consisted of stem fragments, whilst *L. lunatus* and *T. bicolor* tended to use leaves and *O. furva* was observed using a mixture of leaf and stem fragments (Figure 1).

Crassula helmsii has been demonstrated to readily reproduce from single-node stem fragments (Hussner 2009), so their production during case-building is likely to represent a source of viable propagules, as suggested by Crane et al.'s (2021) laboratory studies. Even in caddisfly species using leaves, which for *C. helmsii* are not viable propagules (Hussner 2009), case-building is likely to also generate 'waste' fragments which may themselves be viable. Material in cases tended to be green upon collection, suggesting that the caddisfly larvae had generated these fragments through shredding rather than utilising material already broken down by other processes. In sites where we observed the use of *C. helmsii* fragments in case-building, native aquatic macrophytes were often abundant, but caddisfly larvae did not appear to select these preferentially. Indeed, the recalcitrant (degradation-resistant) nature of *C. helmsii* detritus relative to many native macrophytes (Tasker, personal observations) may promote preferential use of *C. helmsii* fragments as a source of material for case-building.

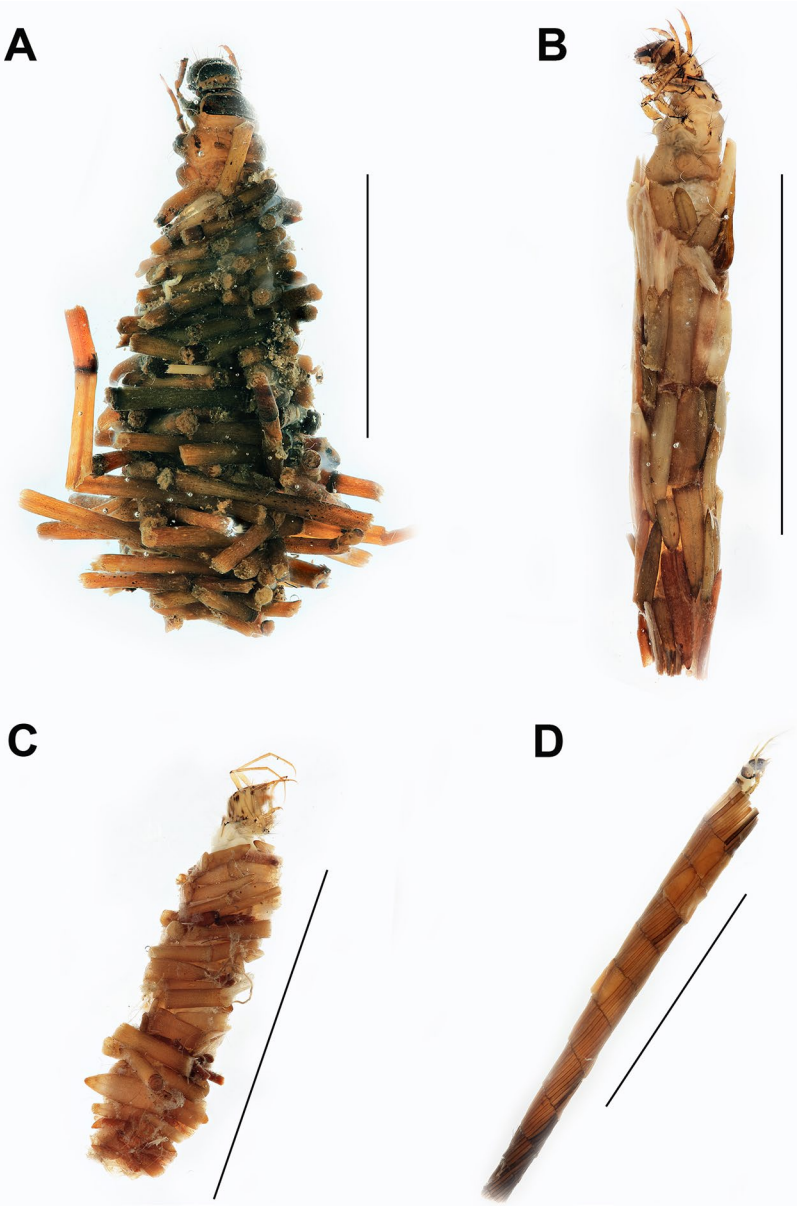

Figure 1. Caddisfly larvae (Trichoptera) with cases containing *Crassula helmsii* (Kirk), 1899, Cockayne fragments: (a) *Limnephilus flavicornis* (Fabricius, 1787), with case composed of stem fragments; (b) *Limnephilus lunatus* Curtis, 1834, with case composed of leaves; (c) *Oecetis furva* (Rambur, 1842), with case comprising a mixture of leaves and stem fragments; (d) *Triaenodes bicolor* (Curtis, 1834), with case containing leaves. Scale bars = 2 cm.

Conclusion

Our observations provide the first field evidence that the creation and augmentation of caddisfly cases may result in the fragmentation of the invasive alien macrophyte

Crassula helmsii, as demonstrated in the laboratory by Crane et al. (2021). Given the near-ubiquity of caddisflies in freshwater systems worldwide, this behaviour could significantly increase the production of *C. helmsii* propagules, and facilitate its further dispersal and establishment. The interactions between caddisfly larvae and *C. helmsii* reported here may also apply to other invasive alien aquatic plants.

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