

SHORT COMMUNICATIONS

**COMPARATIVE BIOLOGY AND EFFECTS OF CROSSBREEDING
PAREUCHAETES INSULATA (LEPIDOPTERA: ARCTIIDAE),
A BIOLOGICAL CONTROL AGENT OF
CHROMOLAENA ODORATA (ASTERACEAE)**

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Abstract

Although populations of *Pareuchaetes insulata* imported from the USA (Florida) and Jamaica were released separately at several sites each in South Africa, only one Florida and no Jamaica sites were definitely established. It is likely that insects from the established Florida site interbred with insects from the Jamaica population released at nearby sites. This study was aimed at determining possible reasons for the establishment difference between the two populations and to assess outcomes of crossbreeding where sites overlapped. Trials comprised crossbreeding and backcrossing of a Florida population from the only established site in South Africa and a laboratory reared Jamaica population. Population fitness was determined by measuring adult fecundity, egg viability, larval sizes and development and survival rates of the different life stages. Trials were repeated over two successive years. The Florida population was superior to the Jamaica population in most measured parameters, particularly in the second year, and hybridisation reduced the fitness of the Florida population. It is not known whether these differences in fitness were intrinsic to the populations, were laboratory artifacts or were in response to feeding on South African *C. odorata*. The lower fitness of the Jamaica population may have reduced its likelihood of establishing successfully, and reduced the fitness of the established Florida population where they came into contact. These results caution that different populations of a biocontrol agent should be kept separate in culture, and that the possible consequences of mixing genotypes should be investigated before field releases are made.

Keywords: *Pareuchaetes insulata*, population fitness, hybridisation, backcrossing, biological control, *Chromolaena odorata*

Introduction

Under the Conservation of Agricultural Resources Act (43 of 1983), many alien plants are classified as invasive in South Africa (Henderson, 2001). On invasion, alien plants displace indigenous vegetation or occupy fields intended for planted crops, e.g. sugarcane fields (Korsu Kandeh, 2002) and pose threats to the biodiversity of natural environments, human health, water supplies and reduce the economy of the country (Moran *et al.*, 2005). Of the invasive alien plants present in South Africa, *Chromolaena odorata* (L.) King and Robinson (Asteraceae: Eupatorieae), a shrub from the Americas, is rated as one of the most problematic,

and was thus targeted for a number of control measures, including chemical, mechanical and biological control (Goodall and Erasmus, 1996).

Biological control

In 1988, the Plant Protection Research Institute of the Agricultural Research Council (ARC-PPRI) initiated a biological control programme against *C. odorata* in South Africa (Zachariades *et al.*, 1999). Two species of biological control agents that were released in the 1980s and 1990s failed to establish (Zachariades *et al.*, 1999). A culture of *Pareuchaetes insulata* Walker (Lepidoptera: Arctiidae), a moth with defoliating larvae from the Caribbean region, was imported from Florida, USA, and tested for host specificity. *P. insulata* was subsequently released at 17 sites in the KwaZulu-Natal province of South Africa, with the Cannonbrae plantation near Umkomaas receiving the most larvae (387 862). Initial surveys conducted at Cannonbrae showed low numbers of insects persisting at the site. Following this apparent failure to establish, in November 2002, cultures of *P. insulata* were introduced from Cuba and Jamaica (Strathie and Zachariades, 2006). Compared with the Florida sites, initial results at one each of the Cuba and Jamaica sites were promising. From smaller numbers released, damage was proportionally higher, and was recorded further from the release point. Damage also persisted longer after releases had terminated. However, after the first winter, the Cuba population vanished. The Jamaica population, although recovered in extremely low numbers, persisted for several years after releases ended. This appeared to follow a pattern similar to that of the Cannonbrae site (Zachariades and Strathie, 2006).

Establishment

In December 2004, an outbreak of *P. insulata* larvae occurred one kilometre from the Cannonbrae release site, in a stand of young *C. odorata* plants (Zachariades and Strathie, 2006). It is likely that local adaptation of the insect (Hufbauer, 2002) took place in the 15 months between the final releases and the outbreak. Throughout 2005, the density and distribution of *P. insulata* increased. By April 2006, large areas of *C. odorata* within a 4 km radius of the release site had been defoliated and *P. insulata* was distributed over more than 20 km along the coast on either side of the release site, as well as 10 km inland (Zachariades and Strathie, 2006). Release sites for the Jamaica population at both Finningley Estates and Umdoni Forest, 2 km and 20 km respectively from the Cannonbrae site, fell within the radius over which insects from Cannonbrae were found to have spread by April 2006. It is therefore possible that adults from the Jamaica and Florida populations interbred in the field (Zachariades and Strathie, 2006). Because differences in the ability of different genetic populations (biotypes or strains) of an agent species to establish successfully have been recorded in weed biocontrol (Hoffmann *et al.*, 2002), it is possible that interbreeding between Jamaica and Florida *P. insulata* populations may have a deleterious effect on the established population. Differences in the biology of populations of *P. insulata* that possibly respond differently to the South African biotype of *C. odorata*, and the implications of crossbreeding in the field, were major foci of this study.

Biology of pure populations of *P. insulata*

Data collected in 2006 and 2007 showed that the Florida population had higher fitness levels than the Jamaica population in most measured parameters, including egg fecundity and viability and adult longevity. However, the Jamaica population also showed good survival rates, big head capsules and higher host suitability in 2006. At the end of 2006, both *P.*

insulata populations in the laboratory became infected with the fungus *Isaria fumosorosea* Wize (Hypocreales: Cordycipitaceae), necessitating a re-collection of a Florida culture from Cannonbrae. The Jamaica laboratory population recovered from a single egg batch, suggesting that the lower fitness recorded during the 2007 trials was probably due to inbreeding.

Crossbreeding of *P. insulata*

The Florida and Jamaica populations mated successfully and produced normal hybrid progeny. Backcrossing the hybrid progeny with parental populations produced F₂ progeny in all mating combinations. This supports the hypothesis that the two populations may have interbred in the field, and that some of the damage to *C. odorata* in the 'hybrid zone' could be attributed to the hybrid larvae of these populations. In both years, high variability in measured life history parameters was evident among the hybrids and backcrosses. These parameters varied in value between being similar to the two parental populations, intermediate between them and higher or lower than either parental population. In most cases, the hybrid and backcrossed progeny followed the trends of the weaker Jamaica population. Therefore, when two populations of the same agent species have different levels of fitness, for whatever reason, their hybridisation may negatively affect the fitness of the stronger population, to the extent that the fitness of the hybrids is as low as the weaker population, rather than being intermediate between the two (Henig, 2000). The lower fitness of the Jamaica population, particularly in 2007, may thus have reduced the fitness of the established Florida population where the two interbred.

Conclusions

The results of the study caution against the casual mixing of distinct populations or laboratory cultures of a single species of agent, either in the laboratory or in the field in the country of introduction. Whatever the reason, different populations and cultures may have different levels of fitness, and hybridisation may lead to disproportionate loss of fitness for the stronger population. The study also emphasises the importance of maintaining genetic diversity and possibly avoiding the development of laboratory strains by regular re-collection of fresh field material for inclusion in the culture.

It is important to keep colonies being held for mass rearing free of disease. The origin of the fungus that afflicted the cultures is not known, but may have been picked up from the *C. odorata* cuttings brought from the field to the laboratory for larval feeding. If this is the case, changes in this aspect would be desirable. These could include the sterilisation of cuttings prior to feeding (Boughton and Pemberton, 2008) and feeding larvae chromolaena plants grown under hygienic laboratory conditions.

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