CLASSICAL BIOLOGICAL CONTROL IN NEW ZEALAND: AN OVERVIEW OF THE HISTORY, ITS REGULATORY SYSTEM, AND FUTURE PROSPECTS

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ABSTRACT

The threat of non-native invasive species poses a significant risk to global biodiversity and food security, resulting in substantial economic losses every year. This risk has been exacerbated by the growth of global trade, tourism, and climate change. In recent years, there has been a notable rise in the invasion of countries by insect pest species. Many of these insect pests (e.g., brown marmorated stink bug, spotted wing drosophila, spotted lanternfly) are highly polyphagous and pose significant biosecurity risks to agricultural and horticultural industries worldwide. Classical biological control is a recognized and commonly used strategy for managing populations of invasive insect pests and has often proved highly cost effective. It involves introducing a non-native biological control agent to permanently control the target pest. However, the deliberate introduction of an exotic biological control agent is subject to regulatory measures, including a rigorous risk assessment and review process. This process is often time-consuming and may take several years to complete. New Zealand has a long history of classical biological control programs, with more than 750 introductions of biological control agents conducted to date against several invasive insect pests. In New Zealand, the Environmental Protection Authority (EPA) is the regulatory agency responsible for regulating, under the Hazardous Substances and New Organisms Act 1996, the importation and development in containment and release of new organisms (incl. biological control agents). A recent notable example of an EPA release approval was the conditional release approval of a pre-emptive application for the release of the *Trissolcus japonicus* (samurai wasp) in the event of a brown marmorated stink bug (BMSB) incursion. This contribution will provide a quick overview of classical biological control in New Zealand, explain how its regulatory system works, and highlight a recently adopted novel approach to classical biological control (i.e., pre-emptive biocontrol) to enhance current and future preparedness efforts against high-risk insect pests.

Key words: Biological control, regulation, EPA New Zealand, biocontrol preparedness, pre-emptive biocontrol risk assessment

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IZVLEČEK

KLASIČNO BIOTIČNO VARSTVO NA NOVI ZELANDIJI: PREGLED ZGODOVINE, ZAKONODAJE IN OBETI ZA PRIHODNOST

Tujerodne invazivne vrste predstavljajo veliko tveganje za svetovno biotsko raznovrstnost in prehransko varnost, kar vsako leto povzroči znatne gospodarske izgube. To tveganje se je povečalo zaradi rasti svetovne trgovine, turizma in podnebnih sprememb. V zadnjih letih je prišlo do opaznega porasta vdorov škodljivih vrst žuželk v države. Mnoge od teh žuželk (npr. marmorirana smrdljivka, plodova vinska mušica, *Lycorma deliculata*) so zelo polifagne in predstavljajo veliko tveganje za biološko varnost poljedelske in hortikulturne industrije po vsem svetu. Klasično biolotično varstvo je priznana in pogosto uporabljena strategija za obvladovanje populacij invazivnih škodljivih žuželk in se je pogosto izkazala za zelo stroškovno učinkovito. Vključuje uvedbo tujerodnega koristnega organizma za trajno zatiranje ciljnega škodljivca. Vendar pa je namerna uvedba tujerodnega koristnega organizma za zatiranje škodljivega organizma predmet regulativnih ukrepov, vključno s strogim postopkom ocene tveganja in pregleda. Ta postopek je pogosto dolgotrajen in lahko traja več let. Nova Zelandija ima dolgo zgodovino klasičnih programov biotičnega varstva, z več kot 750 vnosi koristnih organizmov, izvedenih do danes proti več invazivnim škodljivim žuželkam. Na Novi Zelandiji je Agencija za varstvo okolja (ang.: Environmental Protection Authority (EPA)) regulativna agencija, ki je v skladu z Zakonom o nevarnih snoveh in novih organizmih iz leta 1996 odgovorna za urejanje uvoza in razvoja pri zadrževanju in izpustu novih organizmov (vključno s koristnimi organizmi). Nedavni pomemben zgled odobritve Agencije za varstvo okolja za sprostitev koristnega organizma je bila pogojna odobritev preventivne (predhodne) vloge za izpustitev jajčnega parazitoida *Trissolcus japonicus* v primeru pojava marmorirane smrdljivke (BMSB). Ta predstavitev bo zagotovila pregled klasičnega biotičnega varstva na Novi Zelandiji, razložila, kako deluje njen regulativni sistem, in poudarila nedavno sprejet nov pristop k klasičnemu biotičnemu varstvu (tj. preventivno biotično varstvo), da bi izboljšali sedanja in prihodnja prizadevanja za pripravljenost na visoke na visoko tvegane škodljivce.

Ključne besede: biotično varstvo rastlin, zakonodaja, Uprava za varstvo okolja, pripravljenost na biotično varstvo rastlin, ocena tveganja za preventivno biotično varstvo rastlin

1. Overview of classical biological control in New Zealand

Non-native invasive insect species pose a significant risk to global biodiversity and food security, resulting in substantial economic, environmental, social and cultural costs (Sunny and Sanchirico, 2018). Recent years have seen a substantial increase in invasive insect species worldwide, where approximately 480,000 non-native species have been introduced into different ecosystems, mostly due to the globalisation of trade, tourism and climate change (CABI 2019; Paini et al. 2016). Many invasive insect species (e.g. brown marmorated stink bug, fall armyworm) are highly polyphagous and present an imminent threat to agriculture and native ecosystems worldwide. For example, in New Zealand, invasive species such the brown marmorated stink bug

(BMSB), *Halyomorpha halys* (Hemiptera: Pentatomidae), are expected to result result in multi-billion-dollar losses to agricultural and horticultural industries (e.g. kiwifruit, pipfruit) (Charles et al. 2019).
Traditionally, after the arrival of a pest into a new environment, the first management practices usually aim to eradicate, but if this is unsuccessful, strategies change to long-term management aiming to attempt population suppression and slowing the spread of the invasive pest (Fleming et al. 2017; Robertson et al. 2020). Classical biological control (CBC), which involves introducing a non-native biological control agent to permanently control the target pest, is frequently adopted as a cost-effective component of integrated pest management programs for sustainable management of invasive arthropod pests (De Clercq et al. 2011, Hajek 2004; Van Driesche et al. 2008).
CBC has been used to fight invasive pests for centuries, and since the late 1800s there has been over 6000 introductions of more than 2000 insect biological control agents (BCAs) world-wide to control insect pests (Kenis et al. 2017). New Zealand has a long history of CBC programs, with the earliest biological control agent introduction was *Coccinella undecimpunctata* (Coleoptera: Coccinellidae), a coccinellid predator released in 1874 to attack aphids (Cameron et al. 1993). CBC expanded in the 1920's and then peaked in the 60's, when most of the introductions of BCAs were made (i.e., 55 importations for release) (Cameron et al. 1993). Introductions have decreased steadily subsequently, partially because of growing awareness of risks to non-target organisms and the introduction of Hazardous Substances and New Organisms (HSNO) Act 1996. To date, over more than 750 introductions of BCAs have been conducted in New Zealand against over 126 invasive insect pests (Ferguson et al., 2007).

2. New Zealand´s regulatory system for the introduction of new organisms

The deliberate introduction of an exotic BCA to enable CBC against invasive pests is subject to regulatory measures, including a rigorous risk assessment and review process (Castella et al. 2022; Ehlers et al. 2020; Barratt and Ehlers 2017; Barratt et al. 2018). This process is often time-consuming and conducting all research needed to approve the introduction of a BCA may take several years to complete (Avila et al. 2023). In New Zealand, the Environmental Protection Authority (EPA, formerly the Environmental Risk Management Authority) is the regulatory agency responsible for regulating, under the HSNO Act 1996, the importation and development in containment and release of new organisms (incl. biological control agents). Under this regulatory regime, a new organism is, in part, defined as an organism belonging to a species that was not present in New Zealand immediately before 29 July 1998 (Ehlers et al. 2020). The HSNO Act requires that new organism introductions, including biological control agents must be compatible with safeguarding the life-supporting capacity of air, water and ecosystems, the sustainability of flora and fauna, and the intrinsic value of ecosystems (ERMA New Zealand 1998). Biocontrol practitioners must submit an application for evaluation to the EPA before the importation or release of any new organism intended to be introduced into the New Zealand environment. Such

applications must demonstrate that the proposed BCA poses a minimal risk and that it can be imported into quarantine. Then, to get approval for the release of the proposed BCA, additional evidence must be provided to show that specific native and beneficial organisms will not be at risk (Barratt & Moeed 2005).

2.1 Overview of the application process

In New Zealand, applicants are required to compile a comprehensive dossier of information that substantiates why they believe a proposal to release a new organism complies with regulatory standards (Ehlers et al. 2020). This information aims to inform the EPA about both the potential risks (adverse effects) and benefits associated with the proposed biocontrol agent. These evaluations enable a comparative assessment according to the stipulations outlined in the HSNO Act.

Risks, costs and benefits to the environment may arise both directly from the introduction of individuals of a new organism and indirectly from their effects on ecosystem relationships (including human activities) (Barratt et al, 2007). The benefits of the new biocontrol agent are evaluated based on its potential positive impacts on the environment, market economy, public health, and its significance to Maōri culture and well-being (Barratt et al, 2007; Ehlers et al. 2020). Assessments of benefits and risks are made based on the current situation and future pest management strategies other than biological control. Applications may be declined by the EPA if the adverse effects are deemed to outweigh the benefits. In addition, the EPA must ascertain whether the proposed biocontrol agent meets a defined set of minimum standards established in the HSNO Act (Ehlers et al. 2020). These standards establish a baseline that all new biocontrol organisms must satisfy, alongside presenting a robust case for their benefits, before they can be considered for release in New Zealand.

Once an application is formally received, the EPA is required to publicly announce its decision on whether to approve the release of a new biocontrol agent within 100 business days of receiving the application (Barratt et al, 2007; Ehlers et al. 2020). During this timeframe, the EPA publicly notifies the application to invite comments from the New Zealand public regarding the proposed release of the new organism, conducts both scientific and cultural assessments of the application, and convenes a public hearing and consideration meeting (Barratt et al, 2007; Ehlers et al. 2020). The purpose of a public hearing and consideration meeting is to enable submitters to present relevant information directly to an independent decision-making committee, by speaking to their submission. At this meeting, the independent committee deliberates and decides whether to approve or reject the application (Barratt et al, 2007; Ehlers et al. 2020).

Once EPA approval for release is granted, biological control agents must first spend time in a containment facility until permission to remove them is granted by the Ministry for Primary Industries, pending evidence of their correct identity and lack of disease or other unwanted organisms. In the last ten years the EPA has approved 18 biocontrol agents to combat invasive weeds and insect pests in New Zealand (EPA 2023).

3. Pre-emptive biological control: an innovative tool to manage high-risk pests

Classical biological control is commonly adopted as a cost-effective component of integrated pest management programs for sustainable management of invasive insect pests (De Clercq et al. 2011, Hajek 2004; Van Driesche et al. 2008). However, CBC programs are traditionally conducted once a pest has established, and invariably take several years to achieve BCA approval and implementation, during which time pest impacts accelerate. A pre-emptive biocontrol approach provides an opportunity to develop CBC for invasive pests prior to their arrival into NZ, and a critical aspect of this is risk assessment carried out in advance (Avila et al. 2023, Hoddle, 2023). Implementing pre-emptive biosafety testing, means that natural enemies can be selected, screened in containment or overseas, and potentially pre-approved by regulators prior to a pest establishment, thus, improving CBC efficiency (Avila et al. 2023, Hoddle, 2023). Therefore, such a pre-emptive biocontrol approach would greatly contribute reducing pest densities and rates of spread early in the invasion phase, ultimately reducing the economic or environmental damage associated with the pest (Avila et al. 2023).

In New Zealand, BMSB poses a significant threat to food production sustainability and conservation due to its biology and broad host range (Duthie, 2012; Lee et al., 2013). While BMSB has not yet been detected in New Zealand, the risk of its entry and establishment is high. Therefore, the severity and imminent nature of a BMSB incursion has prompted the development of a pre-emptive CBC approach in the anticipated arrival of this high-risk pest in New Zealand (Avila et al. 2023; Charles et al. 2019). As a result, a pre-emptive CBC program using the egg parasitoid *Trissolcus japonicus* (Hymenoptera: Scelionidae), the most promising BCA of BMSB, was initiated in December 2015. The objective of this program was to assess the biosafety of *T. japonicus* for non-target species in New Zealand, so it could be pre-approved for release in the event of a BMSB incursion (Charles et al. 2019). In March 2018, following the completion of the risk assessment, an application was submitted to the EPA seeking pre-approval to import and release *T. japonicus* into New Zealand. The EPA's final decision, announced in August 2018, granted conditional approval for the release of *T. japonicus* in the event of a BMSB incursion, contingent upon the development of a suitable release plan (EPA, 2018). This marks the first time a BCA has been granted pre-approval to import for release into New Zealand prior to the arrival of its target pest, and the first worldwide example to approve the future release of *T. japonicus* in the event of a BMSB incursion. Successfully implementing this pre-emptive biocontrol strategy will enable an immediate biocontrol response to a BMSB invasion in New Zealand which will improve the chances of eradication or implementing an area-wide pest management program early in the invasion phase. This novel approach to classical biological control may encourage other biocontrol practitioners to adopt a pre-emptive biocontrol strategy for managing exotic pest incursions in the future and, therefore, enhance biocontrol preparedness against high-risk pests.

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