*Available online at*
http://currentagriculturetrends.vitalbiotech.org/

**ISSN (E): 2583 – 1933**

*Curr. Agri.Tren.:e- Newsletter*, (2024) *3*(6), 15-17

Current Agriculture Trends: e-Newsletter

Article ID: 320

# Long-Term Impact of the Introduced Parasitoid on Invasive Pests

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Open Access

**Article History**
Received: 13.06.2024
Revised: 16.06.2024
Accepted: 22.06.2024



## INTRODUCTION

The introduction of parasitoids as biological control agents has been a widely used strategy to manage invasive pest populations in agriculture. Parasitoids, which are organisms that lay their eggs in or on other insects, eventually leading to the host's death, offer a sustainable alternative to chemical pesticides (Moriya et al., 2023). Over the years, many studies have explored the long-term effects of introducing parasitoids on invasive pests, with a focus on both the ecological impact and the effectiveness of these interventions (Shiga et al., 2023). This article will discuss the long-term impacts of such introductions, using specific examples from recent studies.

### Overview of Parasitoid-Based Biological Control

Parasitoid-based biological control has been employed in various agricultural systems to reduce the population of invasive pests. This method has proven to be particularly effective when dealing with pests that have developed resistance to traditional chemical pesticides (Tagami et al., 2023). The concept involves introducing a natural enemy of the pest from its native habitat into the area where the pest has become invasive. The goal is to establish a balance where the parasitoid suppresses the pest population to a level that does not cause economic damage.

One of the most well-documented examples of this is the introduction of *Torymus sinensis*, a parasitoid wasp, to control the chestnut gall wasp (*Dryocosmus kuriphilus*) in Japan. This biological control effort began in the 1980s and has shown promising long-term results in reducing the pest population and mitigating its impact on chestnut production (Moriya et al., 2023).

**Long-Term Ecological Impacts**

The long-term ecological impacts of introducing parasitoids are complex and multifaceted. On one hand, successful biological control can lead to a significant reduction in the target pest population, as observed in the case of *Torymus sinensis* and the chestnut gall wasp. Studies have shown that over a period of several decades, the population of the chestnut gall wasp has decreased dramatically, allowing chestnut trees to recover and reducing economic losses for farmers (Shiga et al., 2023).

However, there are concerns about the potential for unintended ecological consequences. The introduction of a non-native species, even for biological control, can disrupt local ecosystems. For example, there is the risk that the introduced parasitoid may shift its host preference to non-target species, leading to a decline in native insect populations. This phenomenon, known as non-target effects, has been documented in some cases, although the long-term impact of such effects remains an area of ongoing research (Tagami et al., 2023).

**Table 1 below summarizes the long-term impacts of various parasitoid introductions on invasive pest populations and their ecosystems.**

| Parasitoid Species | Target Pest | Region | Long-Term Impact |
|---|---|---|---|
| *Torymus sinensis* | Chestnut gall wasp | Japan | Significant reduction in pest population, minimal non-target effects (Moriya et al., 2023) |
| *Encarsia formosa* | Whiteflies | Global | Effective control with some non-target impacts (Tagami et al., 2023) |
| *Cotesia glomerata* | Cabbage white butterfly | North America | Reduced pest population, but competition with native parasitoids (Shiga et al., 2023) |

**Economic and Agricultural Impacts**

The economic benefits of parasitoid introduction are closely tied to their effectiveness in controlling invasive pests. In many cases, successful biological control leads to reduced reliance on chemical pesticides, which can lower costs for farmers and decrease environmental pollution (Moriya et al., 2023). Additionally, by reducing pest populations, parasitoids help prevent crop losses and improve yields, which has a positive impact on food security and farmer income.

For instance, in the chestnut orchards of Japan, the introduction of *Torymus sinensis* has significantly improved the health of chestnut trees, leading to increased production and economic stability for local farmers (Moriya et al., 2023). Similarly, the use of *Encarsia formosa* in greenhouse crops has helped control whitefly populations, reducing the need for chemical interventions and allowing for more sustainable agricultural practices (Tagami et al., 2023).

**Challenges and Considerations**

Despite the success of many parasitoid-based biological control programs, several challenges remain. One of the main issues is the need for careful monitoring to ensure that the introduced parasitoids do not negatively affect non-target species. Additionally, there is the challenge of ensuring that the parasitoid population remains stable and effective over the long term. In some cases, environmental changes or adaptations in the pest population can reduce the effectiveness of the parasitoid, necessitating further interventions (Shiga et al., 2023).

Furthermore, the introduction of parasitoids requires thorough ecological risk assessments to balance the benefits of pest control against the potential risks to native biodiversity. Researchers are increasingly

focusing on developing methods to predict and mitigate non-target effects, such as using more specific parasitoid species or implementing integrated pest management (IPM) strategies that combine biological control with other approaches (Tagami et al., 2023).

## CONCLUSION

The long-term impact of introducing parasitoids to control invasive pests has generally been positive, particularly in agricultural settings where these interventions have led to significant reductions in pest populations and economic benefits. However, it is essential to carefully consider and monitor the potential ecological risks associated with such introductions. Ongoing research into the non-target effects and ecological balance will be crucial in ensuring that parasitoid-based biological control remains a sustainable and effective tool in managing invasive pests (Moriya et al., 2023; Shiga et al., 2023; Tagami et al., 2023).

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