Regional Invasive Species & Climate Change Management Challenge: Out of Control? The Effects of Climate Change on Biological Control Agents and their Target Hosts

Out of Control? The Effects of Climate Change on Biological Control Agents and their Target Hosts

Biocontrol is an important management tool that utilizes one species (a biocontrol agent) to control another (a target host) and can be an effective approach for controlling populations of invasive species across broad spatial scales. Most strategies of biocontrol involve introducing or supplementing natural predator, herbivore, parasitoid, or pathogen populations to reduce populations of target hosts[1]. A successful biocontrol program results in the suppression (but not eradication) of target host populations across the landscape by reducing host abundance, reproductive output, or vigor[2].

Climate change is complicating biocontrol. Biocontrol agents must have a clear ecological and/or evolutionary relationship with their target host in order to control populations effectively and avoid impacting non-target species[1]. Climate-induced changes in phenology (timing of life events), morphology (form/structure), movement/behavior, physiology, and reproduction/development may differently affect the survival, reproduction, and performance/efficacy of both biocontrol agents and their hosts. There are growing concerns that mismatches between how biocontrol agents and their hosts respond to climate change could alter the efficacy of current and future biocontrol programs.

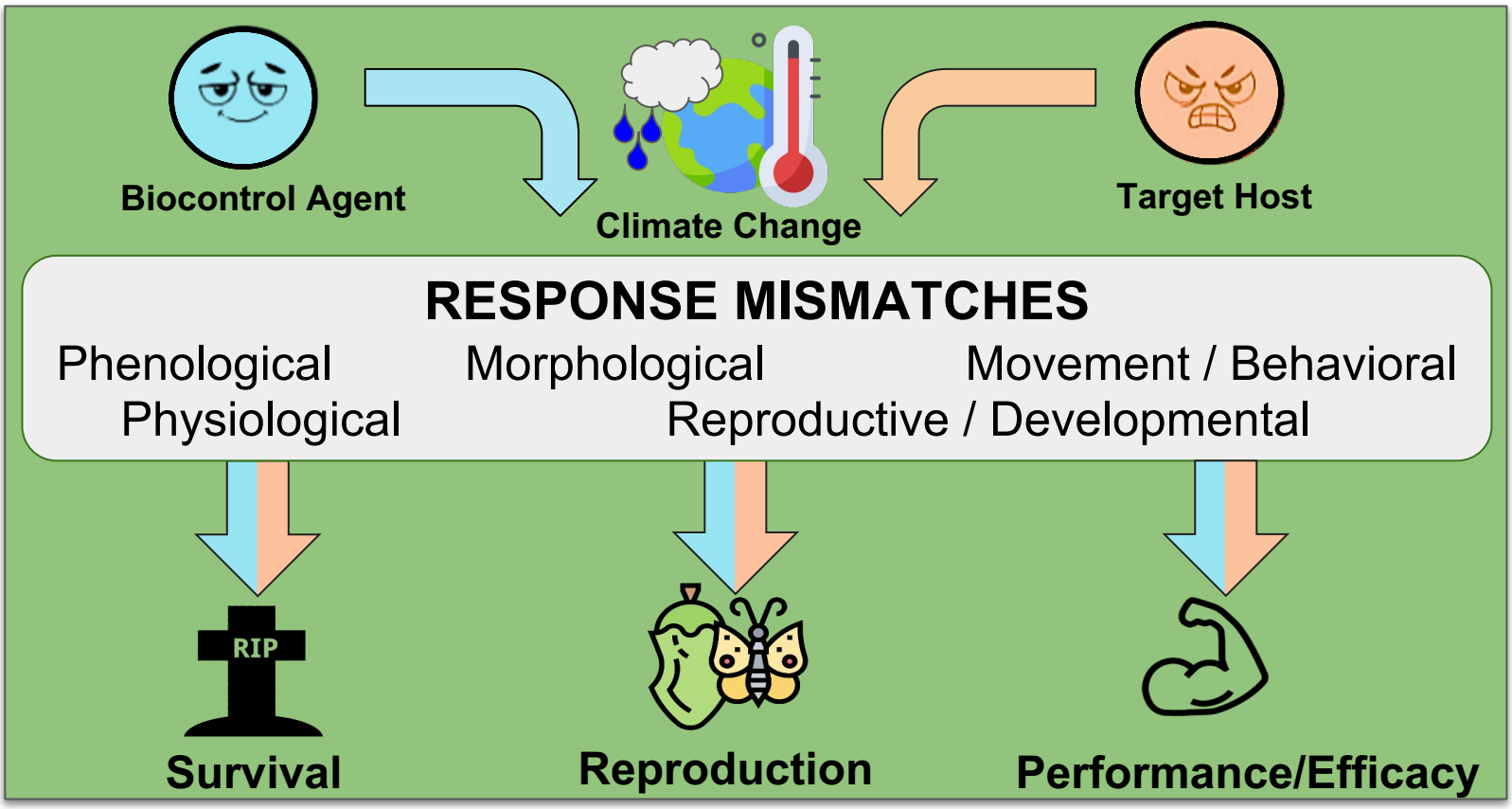


Figure 1 Climate change may create mismatches in the responses of biocontrol agents compared to their target hosts. For example, a potential movement/behavior mismatch could occur if climatic changes such as warmer winter temperatures result in greater range expansion of a target host compared to its biocontrol agent. The resulting mismatch in range extent may reduce range overlap between these two species, potentially increasing the survival/reproduction/performance of the target host where it occurs without its biocontrol agent. Climate change may result in multiple response mismatches and such changes may affect the overall efficacy of biocontrol programs.

Biocontrol Agent	Case studies of responses	Target Host

SURVIVAL

Alligator weed flea beetle (*A. hygrophila*)

Adults and larvae of the alligator weed flea beetle (*Agasicles hygrophila*) are biocontrol agents that feed on leaves and stems of plants in the genus *Alternanthera*.

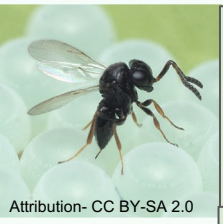
Alligator weed (*Alternanthera philoxeroides*) is a noxious aquatic plant. It forms dense mats that can impede water flow, crowd out native taxa, and hinder recreation activities.

Alligator weed (*A. philoxeroides*)

Warming in field experiments increased overwintering survival of beetles. Higher survival increased overall abundance and may allow beetle range expansion.[4]

Warming increases survival of alligator weed, but beetle herbivory also increased. This suggests warming may improve biocontrol where beetles occur.[4]

REPRODUCTION



Samurai wasp (*T. japonicus*))

The parasitic wasp *Trissolcus japonicus* has been used to control several stink bug species, including *H. halys*.

The brown marmorated stink bug (*Halyomorpha halys)* is a pest that feeds on economically important crops like peaches and apples.

Brown marmorated stink bug (*H. halys*)

Heatwaves lower adult emergence and delay parasitoid development, but do not affect parasitism rates. Wasps may be less affected by heatwaves than hosts.[5]

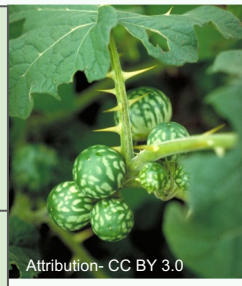
Target hosts were sensitive to heatwaves, with lower hatching success of both parasitized and unparasitized eggs under heatwave conditions.[5]

PERFORMANCE / EFFICACY

Biocontrol beetle (*G. boliviana*)

Gratiana boliviana is a biocontrol beetle that is highly host-specific, only feeding and reproducing on tropical soda apple.

Tropical soda apple (*Solanum viarum*) is a noxious weed with agriculture impacts including lower forage production for grazing livestock.



Tropical soda apple (*S. viarum*)

Beetles ate less leaf area at high CO_2 levels. Lower feeding and higher plant growth suggest lower biocontrol efficacy at high CO_2 levels.[6]

Tropical soda apple plants grew taller and had greater biomass at high CO_2 levels based on a growth chamber experiment.[6]

Management Implications

- Incorporating climate change explicitly into the biocontrol agent testing and approval process, including how biocontrol agents and target hosts survive, reproduce, and perform with warming, drought, and higher CO_2 may help prepare biocontrol programs for future conditions.
- Adjusting the timing, source populations, and frequency of biocontrol releases may be necessary given climate change responses.
- Continuing to explore treatment options for problematic invasive species may yield additional management strategies to supplement biocontrol.
- By collaborating with researchers, more effective monitoring of biocontrol releases may result by gathering baseline data on survival, reproduction, and efficacy of both biocontrol agents and target hosts as well as identifying priority taxa to study.

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NYISRI New York Invasive Species Research Institute

NECASC Northeast Climate Adaptation Science Center

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Learn more at: risccnetwork.org/northeast

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