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The effect of temperature on biological control of water hyacinth, *Eichhornia crassipes* (Pontederiaceae) in South Africa

Anthony King

ABSTRACT

The behaviour and physiology of every insect, during all developmental stages, is largely determined by temperature. Metabolic rate, flight activity, nutrition, growth rate, oviposition and longevity can all be correlated to temperature. Consequently, insect development occurs within a definite temperature range which can be experimentally determined. This serves as a basis from which models that estimate insect growth, development and reproduction can be formulated. Such studies on temperature-dependent development are therefore important for understanding predator-prey relationships and insect population dynamics relevant in epidemiology, pest management and biological control of weeds and insect pests.

The biological control of water hyacinth, *Eichhornia crassipes* (Pontederiaceae), in South Africa currently relies on six established agents. However, the results of this programme do not compare well with the achievements made elsewhere. This has been attributed to a number of constraining factors, chief among which is a wide variety of climatic regions, low minimum temperatures and a high incidence of frosting which slows the build-up of natural enemy populations. This research verified and augmented the thermal tolerance data available for three of South Africa's more efficacious agents used against water hyacinth, namely *Neochetina eichhorniae, N. bruchi* (Curculionidae) and *Eccritotarsus catarinensis* (Miridae). Using these data, plant productivity and insect activity was modelled against fine-scale temperature data incorporating three distinct microclimates from 14 field sites distributed throughout South Africa's climatic regions.

Water hyacinth and its natural enemies were found to be negatively affected by low average temperatures. However, the relative consequences for each species at a population level were quite different. Similar thresholds for development, close to 10°C, meant that periods available for growth in areas where temperature is limiting were roughly the same for both plant and insects. Nevertheless, although plant growth largely ceased each winter and aerial parts were often extensively damaged from frost, low temperatures rarely led to significant plant mortality. By contrast, reduced insect recruitment coupled with a high susceptibility to cold- and frost-induced mortality of all life-history stages, pushed insect

populations into winter bottlenecks and even caused local extinctions. The ability to overwinter effectively appears to the primary cause for limited control in colder regions.

Surviving post-winter insect populations were therefore small, inflicted minimal damage due to reduced feeding rates, and were generally asynchronous with the recovery of water hyacinth. This asynchronous development translated into a lag period of roughly 42 days between the onset of water hyacinth growth and the time at which the plant was subjected to meaningful herbivory. Free from early season herbivory, coupled with the fact that vegetative reproduction continued through winter, water hyacinth populations were able to quickly recover and outpaced the detrimental affects caused by insect feeding well into the growth season. The implications for supplementary management strategies are also discussed in light of these outcomes.

Keywords: Biological control; *Eichhornia crassipes*; thermal tolerance; phenological asynchrony.