

Grasman, J.; van Herwaarden, O. A.; Hemerik, L.; van Lenteren, J. C.

A two-component model of host-parasitoid interactions: Determination of the size of inundative releases of parasitoids in biological pest control. (English) Zbl 0966.92026
Math. Biosci. 169, No. 2, 207-216 (2001).

Summary: A two-component differential equation model is formulated for a host-parasitoid interaction. Transient dynamics and population crashes of this system are analysed using differential inequalities. Two different cases can be distinguished: either the intrinsic growth rate of the host population is smaller than the maximum growth rate of the parasitoid or vice versa. In the latter case, the initial ratio of parasitoids to hosts should exceed a given threshold, in order to (temporarily) halt the growth of the host population. When not only oviposition but also host-feeding occurs the dynamics do not change qualitatively. In the case that the maximum growth rate of the parasitoid population is smaller than the intrinsic growth rate of the host, a threshold still exists for the number of parasitoids in an inundative release in order to limit the growth of the host population.

The size of an inundative release of parasitoids, which is necessary to keep the host population below a certain level, can be determined from the two-component model. When parameter values for hosts and parasitoids are known, an effective control of pests can be found. First it is determined whether the parasitoids are able to suppress their hosts fully. Moreover, using our simple rule of thumb it can be assessed whether suppression is also possible when the relative growth rate of the host population exceeds that of the parasitoid population. With a numerical investigation of our simple system the design of parasitoid release strategies for specific situations can be computed.

MSC:

92D40 Ecology
92D30 Epidemiology
93C95 Application models in control theory

Cited in **51** Documents

Keywords:

functional response; exponential growth; biological control; host-parasitoid interaction; differential inequalities

Full Text: [DOI](#)

References:

- [1] J.C. van Lenteren, Measures of success in biological control of arthropods by augmentation of natural enemies, in: S. Wratten, G. Gurr (Eds.), *Measures of Success in Biological Control*, Kluwer Academic Publishers, Dordrecht, 2000, pp. 77-104
- [2] van Lenteren, J.C.; Woets, J., Biological and integrated pest control in greenhouses, *Ann. rev. ent.*, 33, 239, (1988)
- [3] van Lenteren, J.C., Integrated pest management in protected crops, (), 311
- [4] Nicholson, A.J.; Bailey, V.A., The balance of animal populations. part I. *proc. zool. soc. lond.*, 3, 551, (1935)
- [5] Hochberg, M.E.; Holt, R.D., The uniformity and density of pest exploitation as guides to success in biological control, (), 71
- [6] Jones, T.H.; Hassell, M.P.; Godfray, H.C.J., Population dynamics of host – parasitoid interactions, (), 371
- [7] Briggs, C.J.; Nisbet, R.M.; Murdoch, W.W.; Collier, T.R.; Metz, J.A.J., Dynamical effects of host-feeding in parasitoids, *J. anim. ecol.*, 64, 403, (1995)
- [8] Murdoch, W.W.; Briggs, C.J.; Nisbet, R.M., Dynamical effects of host size- and parasitoid state-dependent attacks by parasitoids, *J. anim. ecol.*, 66, 542, (1997)
- [9] H.J.W. van Roermund, Understanding biological control of greenhouse whitefly with parasitoid *Encarsia formosa*, Thesis, Wageningen University, 1995
- [10] van Lenteren, J.C.; van Roermund, H.J.W., Why is the parasitoid *encarsia formosa* so successful in controlling whiteflies?, (), 116
- [11] Drost, Y.C.; Qiu, Y.T.; Posthuma-Doodeman, C.J.A.M.; van Lenteren, J.C., Lifehistory and oviposition behaviour of *amitus bennetti*, a parasitoid of *bemisia argenti foli*, *Ent. exp. et appl.*, 90, 183, (1999)
- [12] Edelstein-Keshet, L., *Mathematical models in biology*, (1988), Random House NewYork · [Zbl 0674.92001](#)

- [13] Holling, C.S., Some characteristics of simple types of predation and parasitism, *Canad. ent.*, 91, 385, (1959)
- [14] Krivan, V., Dynamical consequences of optimal host-feeding on host – parasitoid population dynamics, *Bull. math. biol.*, 59, 809, (1997) · [Zbl 0897.92035](#)
- [15] Ives, A.R.; Settle, W.H., The failure of a parasitoid to persist with a superabundant host: the importance of the numerical response, *Oikos*, 75, 269, (1996)

This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.