

Biological invasions: personality, parasite infections and their influence on host reproductive success/investment

Santicchia F.¹ Romeo C.², Ferrari N.², Grilli G.², Matthysen E.³, Martinoli A.¹, Wauters L.A.^{1,3}

Corresponding author: f.santicchia@uninsubria.it

¹Environment Analysis and Management Unit - *Guido Tosi Research Group* - Department of Theoretical and Applied Sciences, Università degli Studi dell'Insubria, Varese, Italy

²Department of Veterinary Medicine, Università degli Studi di Milano, Milan, Italy

³Department of Biology, Evolutionary Ecology Group, University of Antwerp, Wilrijk, Belgium

Introduction - Invasive alien species (IAS) are identified as a worldwide threat to biodiversity through different ecological processes, such as interspecific competition, predation, transmission of infectious diseases. Biological invasion success and impact can be determined, positively and negatively, by parasitic infections known to have an important, but often unclear, role over a range of biological scales. Recent studies showed how parasites and animal behaviour are inextricably linked; indeed, risk-taking behaviour, exploration tendency, activity and sociality are all traits that may affect hosts' exposure to parasites by altering contact rates among individuals and/or increasing chances of encountering infective stages in the environment. Furthermore, it has been frequently suggested that personality may play a role in natural invasions with successful invaders being characterised as bolder, more aggressive or more prone to dispersal. Moreover, some studies documented how invasive propensity and, consequently, successful invasion are favoured in (host) species that preferentially allocate resources to growth and reproductive effort over costly immune defence mechanisms against pathogens. On the other hand, the increase in parasite infection is likely to reduce resources that could be used for maintaining homeostasis, body condition, survival and/or reproduction.

We investigated if variation in personality traits of invasive Eastern grey squirrels (*Sciurus carolinensis*) introduced to Italy could affect abundance, infection status and/or intensity of infection of the dominant gastrointestinal nematode (*Strongyloides robustus*) and its potential influence on host reproductive success/investment.

Methods – We determined individual personality through indirect indices (trappability and trap-diversity), calculated using capture-mark-recapture data of invasive grey squirrel, and direct measurements obtained from arena tests. *S. robustus* abundance (n. worms/host), infection status (presence/absence) and intensity of infection (n. worms/infected host) were determined by post-mortem examination of the gastro-intestine from grey squirrel carcasses. Female reproductive success was measured by uterine scars count and male reproductive investment was determined using testes mass as a proxy variable.

Results – Indirect indices and direct measurements of personality produced consistent measures of the personality trait activity-exploration. Furthermore, bolder-explorative grey squirrels were more heavily infected by *Strongyloides robustus* (abundance) than shy ones. However, we also found that host personality mainly influences the probability of acquiring *S. robustus*, whereas it has no effect on parasite intensity in already infected hosts.

Female grey squirrels annual fecundity was affected only by body mass. Conversely, male testes mass was positively related to body mass but negatively to parasite infection (*S. robustus* abundance and intensity).

Discussion – Overall, this study showed that body mass is a prominent factor that drives reproductive output of the invasive grey squirrel, in both sexes. In particular, reaching a good body mass allows female grey squirrels to enter in oestrus and guarantees support throughout pregnancy and lactation of the young. However, male reproductive investment can be influenced by parasites maybe through a more pronounced immune response in more heavily infected individuals, resulting in less energy available to invest in reproduction. Finally, the body mass – parasite load interactions can be mediated by differences in host personality.