

Healthy invaders do it better: loss of parasites in mammals introduced to Italy

Romeo C.¹, Cafiso A.¹, Fesce E.¹, Martinoli A.², Wauters L.A.², Lanfranchi P.¹, Ferrari N.^{1,3}

¹ Department of Veterinary Medicine, Università degli Studi di Milano, Milano, Italy. claudia.romeo@unimi.it

² Department of Theoretical and Applied Sciences, Università degli Studi dell'Insubria, Varese, Italy

³ Centro di Ricerca Coordinata Epidemiologia e Sorveglianza Molecolare delle Infezioni, Università degli Studi di Milano, Milano, Italy

Parasitic infections are ubiquitous in wild animals, with most individuals having to cope with several parasite species. However, alien species often lose part of their parasite community during invasion due to stochastic processes, treatments during captivity or suboptimal environmental conditions. At the individual level, hosts will benefit from a reduced parasite pressure, as they may shift resources away from costly immune functions towards other activities, such as reproduction and growth. Consequently, the loss of parasites observed in many alien species is among the mechanisms that may explain why successful invaders often show improved performances in introduction ranges compared to native ranges (enemy-release hypothesis). We surveyed gastro-intestinal helminths infecting three invasive mammals introduced to Northern Italy (grey squirrels, *Sciurus carolinensis*; Pallas' squirrels, *Callosciurus erythraeus*; raccoons, *Procyon lotor*), to verify whether any loss of parasites that may have facilitated their invasion had occurred.

We examined 504 grey squirrels, 74 Pallas' squirrels and 44 raccoons culled within alien species control programmes. Gastro-intestines were removed from carcasses, dissected and rinsed through a 0.03mm sieve. The obtained material was examined under a microscope and the recovered helminths were identified through a combination of morphology and molecular tools.

In grey squirrels we found 7 gastro-intestinal helminth taxa, most of which were detected only rarely (i.e. prevalence <5%) and had low intensity of infection. Parasite richness ranged from 0 to 3 species/host (mean: 0.77), with 62% of squirrels infected by at least one species. The most represented parasites were *Strongyloides robustus* (prevalence: 57%; mean intensity±SE: 23.1±0.8 worms/infected host). *Trichostrongylus* spp. (8%; 2.9±0.7) and *Rodentoxyuris sciuri* (6%; 18.2±13.5). In Pallas' squirrels we detected 6 parasitic taxa, but only 15% of the examined individuals were infected by gastro-intestinal helminths and we did not detect any coinfection (mean richness: 0.15 species/host). The most abundant parasites were *Rodentoxyuris sciuri* (5%; 2.25±1.5) and *Trichuris muris* (4%; 1±0). Finally, in raccoons we found a total of 11 parasitic taxa, 6 of which had prevalence >5%. Richness ranged from 0 to 6 species/host (mean: 1.25) and 70% of raccoons were infected by at least one species. The most represented parasites were *Strongyloides procyonis* (25%; 17.4±8.1 parasites/infected host), *Capillaria putorii* (23%; 7.9±2.4) and *Porrocaecum* spp. (14%; 24.8±9.7).

Our findings show that grey squirrels, Pallas' squirrels and raccoons introduced to Italy harbour impoverished parasite communities compared to their native ranges. Grey squirrels and raccoons both retained two North American helminths, whereas Pallas' squirrels carried along from SE Asia a single nematode. Local parasites were detected only sporadically and in all the three hosts, especially Pallas' squirrels, we found many individuals that were completely free of gastro-intestinal helminth infections. Raccoons were the most parasitised host species, but considering their omnivorous diet and opportunistic behaviour, their helminth community still appears poor in terms of richness and intensity of infection. The present survey supports the premises for an enemy-release, suggesting that the establishment and spread of these three alien mammals may have been facilitated by a reduced parasite pressure.