

Parasites and biological invasions: do helminths play a role in facilitating grey squirrel (*Sciurus carolinensis*) settlement and in its competition with native red squirrel (*Sciurus vulgaris*)?

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AIM: Several studies have shown that parasites can play an important role in biological invasions (Dunn AM, 2009, *Adv Parasitol*, 68: 161-184), mainly via two different processes. First, during the invasion process, alien species often lose part of their parasite community with a positive impact on their population growth and consequently on their settlement and spread ("parasite release hypothesis", Torchin ME et al 2003, *Nature*, 421: 628-630). Second, parasites may mediate the impact of invasive species on native taxa ("parasite-mediated competition", Hudson P and Greenman J, 1998, *Trends Ecol Evol*, 13:387-390), introducing in the environment novel parasites to which native species are more susceptible or increasing the abundances of local parasite acting as additional reservoir (Tompkins DM, 2001 *Parasitology*, 1999: 187-193). Since 1948, the Eastern grey squirrel (*Sciurus carolinensis*), a North-American alien species, has been repeatedly introduced in Italy, causing local extinction of the native Eurasian red squirrel (*Sciurus vulgaris*), mainly through exploitation competition for food (Martinoli A et al, 2010, *Hystrix It J Mamm*, 21: 127-136). Our purpose is to explore gastro-intestinal helminth communities of grey and red squirrels in Italy in order to investigate the role of parasites in the settlement of the alien species and in its interaction with native one. In particular, we want to test two independent hypothesis: the parasite release and the parasite-mediated competition.

MATERIAL AND METHODS: We have sampled 8 populations (4 grey-only, 3 red-only and 1 red-grey area) in Piedmont and Lombardy by capturing both species with standard live-trapping techniques. Grey squirrels were euthanized immediately after capture, while red squirrels were marked and released after samples collection. Grey squirrels were then dissected and their intestinal content examined using standard parasitological techniques. For red squirrels, we performed coprological analysis and tape tests to obtain indirect information on their gastro-intestinal parasites. To provide a check-list of red squirrel parasites, we also dissected several roadkills collected from different sites in Northern Italy.

RESULTS: We dissected 142 grey squirrels in which we identified four different species of gastro-intestinal nematodes: *Strongyloides robustus*, *Trichostrongylus calcaratus*, *Trichuris muris* and *Aonchotheca annulosa* (prevalence: 74%, 13%, 6% and 2%, respectively). The species richness we observed is lower compared to what is reported for grey squirrel in their native range (Rausch R and Tiner JD, 1948, *Am Midl Nat*, 39: 728-747). *S. robustus* is a parasite common and abundant in North-American squirrels (Bartlett CM, 1995, *Folia Parasit*, 42:102-114), but never recorded in Europe until now, thus likely brought here by grey squirrels during the invasion process. On the contrary, *T. calcaratus*, *T. muris* and *A. annulosa* should be considered as non-specific or accidental species, the latter two acquired by the grey squirrel here in Europe. As regards red squirrels, coprological analysis, tape tests and 26 roadkills collected in red-only areas have shown the presence of only one nematode, *Rodentoxyuris sciuri* (prevalence: 96%), typical of this species and already recorded in red squirrels in Europe (Hugot JP et al, 1996, *Int J Parasitol*, 26: 147-149). On the other hand, in red-grey areas, coprological analysis and roadkills examination have shown the presence of *S. robustus* in red squirrels, suggesting parasite transmission from the grey squirrel to the native species.

CONCLUSION: Our results lend support to the parasite release hypothesis, as grey squirrels in Italy are missing several helminths species usually present in North-America. Moreover, the lack of species-specific parasites is suggested by the presence of some accidental species, probably exploiting vacant niches. Concerning parasite-mediated competition, we found that *S. robustus* can be transmitted to the red squirrel, but so far we haven't found any evidence of helminths spillover from red to grey squirrel. To confirm that *S. robustus* actually plays a role in grey squirrel impact on the native species, further investigation on the pathogenic effect of this nematode on red squirrels is needed.