Super-colonies of the Invasive European Fire Ant

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The European fire ant, *Myrmica rubra*, arrived in southwestern British Columbia approximately 20 years ago, probably hitchhiking in infested horticultural materials.

Recently-established populations of *M. rubra*, in southwestern British Columbia have dramatically decreased the biodiversity of native ants[1] but these invaders mostly come to the attention of the public because of unusually high population densities and a painful sting. Their stinging can make yard and garden work difficult and cause distress for pets. There is also concern that they may be interfering with the successful nesting of some birds[2]. It is estimated that the economic cost of *M. rubra* in British Columbia could reach $100 million/year if they spread across their potential range in the province[3].

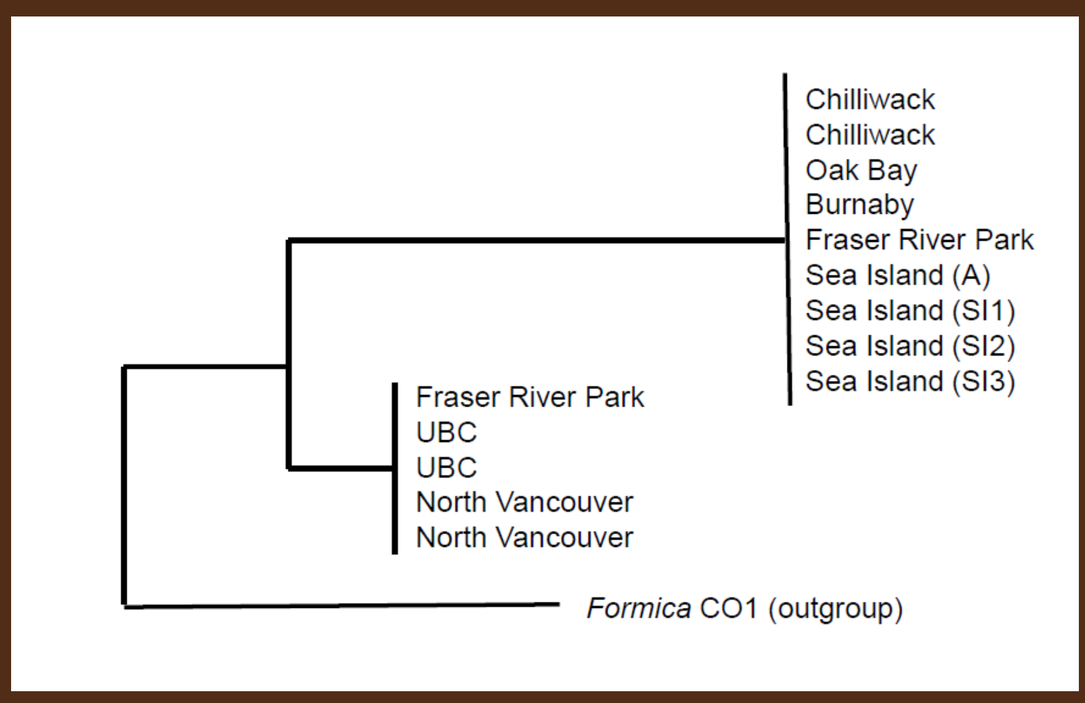
What causes some ants to become so 'invasive', i.e. unusually successful competitors, when they are introduced into new areas? One possibility is aggression towards other species at food items but another is the formation of super-colonies. Super-colonies are typically seen only in a few introduced ant species and are characterized by being formed of multiple nests, with multiple queens, and lack of territorial fighting between workers from neighbouring nests. The resulting large population sizes allow for a larger force of workers, i.e., more scouts and more foragers to recruit, and the lack of intraspecific aggression may free up time and energy for other uses.

Question

Are varying levels of aggression between workers from different nests reflected in the degree of genetic (DNA) difference?

Methods

- We quantified mitochondrial DNA differences between workers from the different outbreak areas.
- DNA was extracted from individual workers from the nests used in the aggression bioassays
- Polymerase chain reaction was used to amplify a 710 base pair partial coding sequence of mitochondrial cytochrome oxidase subunit 1 (COX I) using two 26 base pair primers.
- The resulting fragments were sequenced using the Sanger method.
- Phylogenetic trees (which show the degree of relatedness) were generated using the Maximum Likelihood Estimation technique[4,5,6]



Nucleotide sequences of the COX I gene from ants in different infestations fell into two groups

Conclusions

Nucleotide differences in this one section of DNA are not enough to distinguish ants from different super-colonies but do confirm that the UBC and North Vancouver ants, which do not fight with each other, are genetically similar. The two groupings hint that there may have been either two *M. rubra* introductions into BC, or one (perhaps in the area of Fraser River Park) that was followed by divergence into two main groups.

References

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[2] Higgins, R. 2013. European Fire Ant (*Myrmica rubra*) Project: Confirming Current Distribution in BC and Development of Effective Control Methods Final Report. BC Inter-Ministry Invasive Species Working Group.

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[4] Tamura, K. 1992. Estimation of the number of nucleotide substitutions when there are strong transition-transversion and G + C-content biases. Molecular Biol & Evol. 9:678-687.

[5] Kumar, S, Sletcher, G & Tamura K. 2016. MEGA7: Molecular Evolutionary Genetics Analysis 7.0 for bigger data sets. Molecular Biol & Evol. 33:1870-1874.

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Ant Colonies in the Lab

Ants Fighting

Ants Getting Along

How is *M. rubra* able to displace local ant species?

Ants of the same species can typically recognize, by odours, if they are from different colonies, and will fight. If the *M. rubra* in southwestern BC are derived from a single introduction, a high degree of genetic similarity might cause them to recognize each other as nestmates, even from widely separated areas. This would lead to little ant-ant aggression, leaving more time and energy for tasks such as foraging.

Question

Do *M. rubra* workers from different areas of infestation in southwestern BC recognize each other as nest mates or do they fight?

Methods

- Nests of several hundred workers and at least two queens were collected from 7 different areas of infestation.
- Maintained in the lab for at least two weeks prior to testing.
- 5 workers from each of two different colonies placed into arenas, and the number of ants engaged in fights measured over 10 minutes.
- All possible pairing of locations were tested, with 8 -12 replicates of each pairing.

Results and Conclusions

Workers from *almost* all of the 7 localities fought each other, suggesting that they are genetically different enough that they did not recognize each other as nest mates.

However, workers from colonies at UBC and North Vancouver did not fight, suggesting that those two infestations have a common origin.

Question

Do all the workers from *within* an infestation area treat each other as nest mates?

Methods

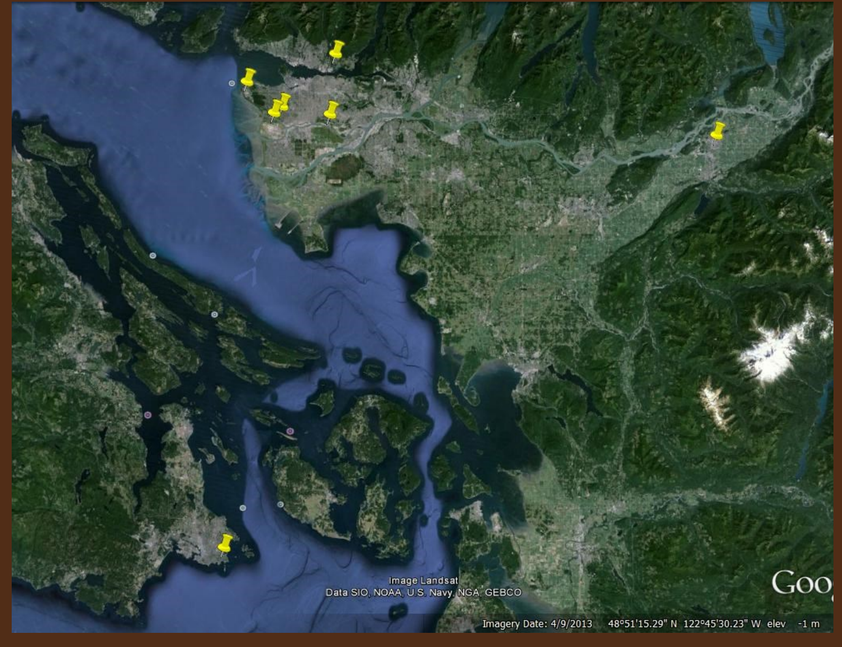
- Nests were collected along transect lines within two of the larger infestations, on Sea Island and in south Vancouver.
- Nests were at least 300 m apart.
- Maintained in the lab as before.
- Frequency of fighting scored as before.

Results

There was little to no fighting between workers within either of the two infestation areas.

Conclusions

- The two areas of infestation each represent a single super-colony of *M. rubra*.
- On Sea Island this single colony is several km across and will contain many millions of individual ants.
- The ability of such a colony to find and monopolize food resources may help to explain how the smaller colonies of native ants are outcompeted.



7 Areas of infestation

Mean percentage of ants participating in fights:

	G	F	E	D	C	B	A
A	75	51	72	79	44	62	0
B	87	81	83	84	80	0	
C	78	52	80	0	0		
D	92	54	90	0			
E	55	83	0				
F	79	0					
G	0						

Letters represent different infestation areas

Mean percentage of ants from different nests *within* the Sea Island outbreak that engaged in fights

	SI1	SI2	SI3	SI4
SI4	2	3	0	0
SI3	3	2	0	
SI2	13	0		
SI1	0			

Nest collection sites *within* the Sea Island infestation area (left side of river)