Damage Through Division of Labour: Termites as Social Pests

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Termites are a relatively small but ancient group of insects that radiated from a cockroach-like ancestor roughly 200 millions years ago (Eggleton 2011). This evolutionary persistence appears at odds however with the frailty of an individual termite. Termites are soft-bodied, mostly blind, short-lived insects that are prone to desiccation and disease. They make easy prey for ants and other insectivores. Moreover, individual termites require constant contact and communication with their colony mates for survival. This collective persistence of the termite lineage despite their individual fragility can be explained by two key elements of their biology – namely, a social lifestyle and a propensity to eat wood. These very qualities predispose some species to invade urban, industrial or agricultural habitats as structural pests (Rust and Su 2012).

As social insects, termites live in kin-based colonies in which individuals are specialized for different roles and depend on each other for survival. The principle division within termite societies is between reproductive and non-reproductive castes, whereby the king and queen are specialized for sex and reproduction, while the soldier and worker castes selflessly labor on behalf of their reproducing relatives. This division in colony labor affords termite colonies an economy of scale that is not available to solitary insects, and it factors into their voraciousness as pests (Wu et al. 2015). For termite societies, the colony collective is therefore more resilient and consuming than the sum of its parts, an element of their social biology that is not lost on pest control companies that seek to systematically control the expansiveness and persistence of invasive colonies (Chouvenc et al. 2011).

In Canada, termite diversity is low but there is one invasion with Toronto as the epicenter. The Eastern subterranean termite *Reticulitermes flavipes* (Kollar) likely invaded Ontario via Toronto in the 1930s from contaminated material shipped from the United States across Lake Ontario (Kirby 1965). From this point of entry subterranean termites have spread to a vast region that engulfs this Metropolitan city and its provincial surrounds (Raffoul et al. 2011). Moreover, genetic analysis reveals a number of subsequent invasions into Canada, including to Kincardine, Guelph, Leamington and Windsor, among other Ontario municipalities (Scaduto et al. 2012). Finally, unpublished reports suggest new populations have sprung up in other parts of Canada, including Winnipeg (Manitoba) and the Okanagan (British Columbia).

Our lab at Western University is studying the invasive biology of the Eastern subterranean termite. We ask two principle questions. First, *how* does this species repeatedly invade and persist within Canada, which is just north of its native range. To answer this question, we use behavioral genetic assays on field-caught termites to test how invasive populations differ from their native counterparts. One principle finding is that invasive populations have very subtle kin recognition (Simkovic et al. 2018), which may explain why colonies invasive to Ontario tend not to assort by kin-colony and instead form massive underground super-colonies that become firmly entrenched and difficult to eradicate.

Second, we ask, *why* upon invasion do termites abandon their discrete colonies in favor of far-reaching super-colonies? To answer this question, we have sequenced the termite transcriptome (all of the protein-encoding regions of the termite genome) from both native and invasive populations (Wu et al. 2018), and are using this newly-assembled data set to test a possible genetic explanation (Wu and Thompson 2015).

We believe it is possible that termite invasions typically involve genetic 'bottlenecks' that strip founding populations of alleles (variants of a gene) that they require to accurately distinguish kin from non-kin. If this reasoning proves correct for termites invasive to Ontario, then we expect low levels of allelic diversity from invasive populations relative to native populations. In the near future, our research could position our lab to isolate the very genes involved in colony formation. We could potentially target them for 'knock down' via genomic technologies emerging from the pest control sector (Scharf 2015). Given the negative impact that termites continue to bore on wood and wood preservation industries, we see our socio-genetic research on termites at Western University as highly relevant to the Canadian Wood Preservation Association.

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