Microbial replacement in mutualistic interactions with ticks

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Résumé

Mutualism with microbes is one of the keys to the origins of complex life on Earth. Beneficial
symbionts play functional roles in metabolism, immunity, adaptation, and adaptability of macro-organisms. This is notably the case in arthropods for which many species carry maternally inherited bacteria that are required for diet-niche exploitation through their unique
biochemical capabilities which often involves the provisioning of nutritional supplements. These interactions have led to highly co-evolved relationships that are traditionally envisioned as stable cooperative associations. Among arthropods, ticks (a diversified group of about 900 species, class:Arachnida), are widespread ectoparasites of vertebrates. As other obligate blood-feeders, they are usually found in association with a nutritional symbiont
that provides B vitamins. In ticks, this symbiont generally belongs to the genera *Coxiella* or *Francisella*, and less often to the order *Rickettsiales*. However, recent evidence suggests that the apparent stability of beneficial mutualistic relationships is not a definite outcome, as
recently acquired symbionts can replace ancestral beneficial symbionts and provide similar benefits to the host. Here, we investigate the mechanisms underlying the emergence of mutualism with microbes, their maintenance, their breakdown, and their rebirth. To this aim,
we focus on the evolutionary adaptive dynamics of nutritional mutualism in ticks using a metagenomics approach. An extensive sampling from different geographical locations enabled the retrieval of 38 putative symbiont genome sequences from 15 tick species hosting diverse nutritional symbionts. Our analyses included both published and newly assembled tick mitochondrial and tick-associated bacterial genomes. We conducted comprehensive analyses, encompassing high-throughput comparative genomics of both symbiotic and pathogenic bacteria (*Coxiella*, *Francisella*, *Rickettsiales*), along with targeted investigations into bacterial genomes in coinfection/replacement events that we identified. First results suggest that competition between symbionts with similar metabolic capabilities is a central force underlying dynamic shifts in mutualistic interactions.

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Mots-Clés: symbiosis, nutritional mutualism, genomics, phylogenetics, hematophagy, competition