学 位 論 文 内 容 の 要 旨

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Ecological study of the micropredator, *Taimenobdella amurensis*, a piscivorous leech: filling the gap between predation and parasitism

（魚類捕食性エゾビルの生態学的研究：捕食と寄生の間を埋めるマイクロプレデーション）

Predator-prey and parasite-host relationships are ubiquitous in nature and have been extensively studied in the fields of ecology and evolution. The main difference between predators and parasites are the number of victims: individual predators kill many prey throughout their life, while parasites usually spend their entire or each stage of their life within a single host, which does not necessarily result with host death. However, there is another trophic strategy in between, which has been neglected. These are "micropredators", animals such as mosquitoes and vampire bats, that consume only a part of the prey's body without killing it, but requires multiple prey throughout their life. Some studies have clearly separated micropredation from other trophic strategies and pointed out the importance of treating them separately, but the concept of micropredation has been underappreciated or even misused. Studies on micropredator-prey relationships from different aspects are certainly needed.

In this PhD thesis, I firstly conducted a literature review focusing on how the term and concept have been used since its first appearance in the 1970's. The original term used for this trophic category is as mentioned above, but later it has also been used for small (i.e. micro) predators, like bacteria eating other bacteria. The terminology has been greatly underused even after a seminal review paper in 2002 that clearly categorized different trophic strategies. I listed a variety of taxa that fall into the category of micropredator based on the defined criteria, and found that micropredators exist within diverse animal groups, such as Ixodida, Siphonaptera, Diptera, Lepidoptera, Piscicolidae, lampreys, vertebrate fishes, birds, and mammals, suggesting the parallel evolution or convergence of the strategy. In the literature they were rarely referred to as micropredators: rather, some of them (e.g. lampreys and leeches) were often called "parasites", while the most representative groups (i.e. mosquitos and ticks) were called "vectors". In fact, many micropredators are haematophagous (blood-sucking) and have significant impacts on ecosystems through the transmission of diseases. Their co-evolutionary history is weak compared to parasite-host relationships, but seems to be stronger than predator-prey relationships. I noted that the reason for the relative ignorance of micropredators is partly due to the lack of clear examples, especially model systems.

I then provide a case study of the micropredatatory leech, *Taimenobdella amurensis*, and their main prey fish, *Salvelinus curilus*, in the Sorachi River, Hokkaido, Japan. Since the metapopulation dynamics and genetics of the prey fish have been studied for more than 20 years, it is ideal for investigating micropredator-prey relationships. Here, I specifically focused on the genetic structure of the leech, testing if they mirror parasite-host co-structures or show independent structure from their prey, despite depending on dispersal via prey fish. Thirteen microsatellite primers were designed specifically for this leech. Population genetic analysis showed extremely high genetic divergence even among neighboring streams, without any pattern of isolation-by-distance. This contrasted with the genetic structure of the prey fish and suggested that the functional dispersal by attaching to their prey is minimal. This also indicates that these leeches can form independent local populations even with very small population sizes. Thus, even with the seemingly long periods of attachment and prey specificity, this micropredatory leech does not form a parasite-host like relationship with prey fish: rather, a predator-prey like free-living model is more suitable.

Finally, I examined the generality of micropredator-prey genetic structure by systematic review. No clear effect of trophic strategy (i.e. micropredators, parasites, and free-living animals) on genetic divergence was detected. This was partly due to large variations within trophic strategies: for example, some terrestrial micropredatory leeches showed very strong genetic divergence, which is consistent with my study, but another species that attaches to the eyes of seabirds was genetically homogenous, because of long-distance dispersal via avian migration. The taxonomic differences between species used to represent different trophic strategies was likely also a confounding variable. More critically, there were too few case studies to confirm the general patterns. Despite this setback, based on the data I have collected so far a general pattern supporting my predictions was still possible, as parasites appear to have less structuring than micropredators or free-living animals.

Overall, I concluded that micropredators are relatively common, though not as common as predators and parasites, in many ecosystems. They have unique ecological characteristics, sometimes shared with either parasites or predators. We should incorporate and distinguish them as a legitimate ecological strategy and I hope this case study of the leech-fish system inspires studies on other micropredator-prey systems.