Conceptual Overview of Evolution of Parasitism

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ABSTRACT

As the name suggests, parasitism is a close relationship between species in which one organism, the parasite, lives inside another organism, the host, causing harm to the latter, and the host is structurally tailored to the parasite. Essentially, parasitism describes the relationship between two species where one organism lives on or inside another and benefits from it by harming the other. Furthermore, parasites affect host behavior, fitness, and population size, often affecting trophic interactions, food chains, competition, biodiversity, and keystone species. It is evident from these interactions that parasites shape communities and ecosystems. In addition, parasites can greatly influence host behavior and fitness, regulate host populations, influence trophic interactions, food webs, competition, biodiversity, and keystone species. Community- and ecosystem structures are shaped by parasite interactions.

Introduction

An organism, the parasite, lives inside another organism, the host, causing harm to it, and is structurally tailored to meet its needs. Parasite relationships, as defined by the definition of parasitism, exist between two species when one organism lives on or inside another organism and benefits from it by harming it. It is possible to classify parasites into two types: ectoparasites, which live on the surface of the host and do not themselves cause disease; or endoparasites, which are either intercellular (inhabiting spaces in the host's body) or intracellular (inhabiting cells). It is common for intracellular parasites, such as bacteria or viruses, to be transmitted by a third organism known as a carrier, or vector. An example of this interaction is malaria, which is caused by a protozoan of the genus Plasmodium transmitted to humans by an anopheline mosquito bite. An elm bark beetle can spread Dutch elm disease (caused by the fungus Ceratocystis ulmi).1

Moreover, parasites affect host behavior and fitness, as well as host population size, often with profound effects on trophic interactions, food chains, competition, biodiversity, and keystone species. As a result of these interactions, parasites influence communities and ecosystems. Moreover, parasites can influence host behavior and fitness, regulate host populations, and influence trophic interactions, food webs, competition, biodiversity, and keystone species profoundly. It is likely that parasite interactions shape ecosystems and community structures.

Observing parasite ecological interactions can be difficult. Many parasites live in secret, intimately connected to their hosts, but invisible to the outside world. They are also typically very small, with some notable exceptions. Therefore, parasites might be assumed to play a smaller role in community ecology than free-living organisms since they are generally inconspicuous.2

Advances in the field of disease ecology have uncovered remarkable facts about parasites, they are not only ecologically important, but sometimes their power equals or exceeds even free-living species in terms of structure. In truth, parasitism is more common than other consumer strategies, being arguably the most widespread life-history strategy found in nature. Furthermore, its influence on host behavior and fitness is undeniable, playing a role in population sizes and having far reaching implications for trophic interactions, food webs, competition and biodiversity as well as keystone species. It is therefore evident that parasites are major players when it comes to structuring communities and ecosystems alike.3

Evolution of Parasitism

In addition to serving as predators, parasites can also serve as important sources of prey. Parasites that feed on hosts are a special kind of predation. On islands with sea bird colonies in the Gulf of California, predators such as lizards, scorpions, and spiders are one to two orders of magnitude more abundant because they eat bird ectoparasites. During the consumption of infected hosts, predators also consume parasites accidentally. The contribution of macroparasites to the diet of predators can be significant when macroparasites are

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large, such as nematodes found in the guts of vertebrate hosts. The role of parasites as predators and prey suggests that considerable amounts of energy may directly flow through parasites in food webs, despite their small size and cryptic nature.4

The oligochaete worm eats trematode parasites that live in freshwater snails. Cleaner wrasse and cleaner shrimp remove ectoparasites from coral trouts. In ecosystems where parasites are highly productive, parasites may be a valuable food source for predators. It is possible for parasites with complex life cycles to move from one host to another through predation in some cases. As parasites infect new hosts through trophic transmission, they often alter the host's behavior or morphology in a way that increases predation risk, thereby aiding the parasite in reaching its next host.

An example of how parasites can influence predator-prey interactions is seen in estuarine killifish infected by the trematode Euhaplorchis californiensis. Erratic swimming behavior caused by this parasite renders them up to 30 times more vulnerable to bird definitive hosts. Another trematode, Ribeiroia ondatrae, causes amphibians to develop limb deformities including extra or missing limbs, thus hampering their ability to move and making them more prone to predation. Although seldom obvious, such parasites may have an effect on trophic dynamics on a larger scale.5

Limb deformities reduce the frog's ability to evade predators, potentially making it more susceptible to being eaten by the definitive host of the trematode parasite.

Considering the prominent role played by parasites in trophic interactions, we might expect parasites to strongly influence food web characteristics. In recent years, parasite inclusion has resulted in dramatic changes in the topology of food webs, including species richness, number of links, length, and connectance.

Approximately 78% of all links in a salt marsh food web in California were parasitized, and estimates of connectance increased by 93%, which may impact web stability. It is also evident that mid-trophic levels, rather than the lowest trophic levels, are vulnerable to natural enemies because they are at risk from predators as well as parasites transmitted trophically.

Incorporating parasites into food webs also implies that the classical Eltonian pyramid may need to be revised: parasites would occupy the pinnacle of this new pyramid if parasites feed at a trophic level above their hosts. This would be a departure from the traditional position of top predators at the top. It was assumed that parasites contributed negligible biomass to ecosystems for decades. By measuring biomass, or productivity, we can quantify the contributions of organisms to ecosystem energy.6

However, when parasite biomass was actually measured on an ecosystem scale, the results challenged the notion that parasites are unimportant in ecosystem energy flow. In some estuarine systems, parasite biomass is comparable to that of top predators. Trematode parasites, for example, have a higher annual biomass than birds do. A similar estimate for plant fungal pathogen biomass was observed in experimental grassland plots in Minnesota.7

Fungal pathogens had a greater impact on grass biomass prediction than herbivory. According to these studies, parasites can significantly influence ecosystem energy and primary producer biomass. The classical approach of omitting parasites from considerations of food web ecology could result in serious errors in our understanding of parasites in food webs, despite the fact that much remains to be learned about their roles in food webs. In some grasslands, fungal pathogens can control productivity and biomass more strongly than herbivorous insects, suggesting parasites play an important role in ecosystem energy.

A phenomenon called parasite-mediated competition is a phenomenon where parasites alter the outcome of competitive interactions between host species. When tolerant host species increase parasite abundance, an indirect negative effect occurs on a second, less tolerant host species. The removal of red squirrels by grey squirrels in Britain may have been facilitated by a parapoxvirus, for instance. Both species are infected by the virus, but native red squirrels are highly susceptible, while invasive grey squirrels suffer relatively minor consequences. By eliminating the populations of one host species, a microparasite has likely facilitated a biological invasion in this case, reducing local biodiversity.8

A parasite can also contribute to biodiversity by allowing a species that is competitively inferior to coexist with a dominant species. On St. Maarten, for example, Anolis gิงgिनिनus outcompetes Anolis wattsi everywhere except in the

island's interior. The parasites of both lizards, Plasmodium azurophilum, coexist only where A. gingivinus is heavily parasitized. This implies that malaria hinders the competitive capacity of the prevailing lizard, thereby providing an opportunity for the less competitive one to cohabit. A similar outcome can be seen in quite a different system involving the pathogenic soil oomycete Pythium and its plant hosts. The presence of a certain plant can alter the constitution of the neighbourhood's soil community, resulting in reduced development of that species, while other colonizing ones enjoy a competitive edge which further boosts overall plant biodiversity.9

Parasitism Types

Parasites are classified into three categories according to where they live:

- **Ectoparasites**: Fleas, ticks, and other ectoparasites are examples of ectoparasites, which live on the surface of the host's body.10
- **Endoparasites**: The term endoparasite refers to parasites that live inside the body of a host. Examples include roundworms and protozoa found in blood.
- **Meso Parasites**: An example of a mesoparasite is a copepod, which enters the host body through an opening and embeds itself.11

Classification Basis of the Life Cycle

Two categories of parasites can be distinguished based on their life cycles:

- **Obligate Parasite**: Parasites that require the bodies of their hosts to survive are known as obligate parasites.
- **Facultative Parasite**: Parasites that do not require the bodies of their hosts to complete their life cycle are known as facultative parasites.

Classification based on their strategies

There are three categories of parasites based on their strategies:

- **Directly Transmitted Parasites**: A directly transmitted parasite is one that enters a host's body on its own. Examples are fleas and mites.
- **Trophically Transmitted Parasites**: Trematodes and roundworms are examples of trophically transmitted parasites, which are parasites that enter the body of hosts when they eat them.
- **Vector Transmitted Parasites**: Those parasites which require an intermediate host to be transported to their definitive host are known as vector transmitted parasites. An example would be a protozoan that causes sleeping sickness and is transmitted by insect bites.12

Other types are:

- The brood parasitism is a form of parasitism where young parasites are raised by hosts. An example is the cuckoo parasitism.
- The parasitism in which the host's food is stolen by the parasite is known as kleptoparasitism.
- In sexual parasitism, the males are dependent on the females to survive. An example is anglerfish parasitism.

Conclusion

Parasitism is a common relationship in nature, with virtually all species around the world acting as either hosts or parasites. Host populations can be reduced by parasites, while trait diversity may also be impacted by their presence, either through suppression of dominant species or through increased within-host variation. Regardless of their effect, however, there are many animals which are parasites at some point during their life cycle.