Ecology of Parasites

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The word ecology was first coined by German zoologist Ernst Haeckel. It is composed of two words 'Oikos' (residence) and 'logos' (study). Scientist Tansley first introduced the word ecology. Ecology is the study of relationships among the organisms and their biotic and abiotic environment.

The ecology of parasites is the habitat of a parasite where the parasite interacts and spends a part or whole of its life. The host is the parasites environment. The study of ecology of parasites, therefore, is the study of the infective forms of the parasite from the point of taxonomy, transmission, population dynamics and evolutionary history.

The local environment influences the parasitic transmission directly or through vector. The transmission is the infection capability of the parasite which depends upon its environment and interaction with the different hosts which leads to ecological relationship.

Parasitism is an age old relation. Host–parasite conflict depends upon the habitat of the parasite like ectoparasite, staying on the surface of the body of the host permanently or visits occasionally for food only, while the endoparasites reside throughout their life within the body of the host in any organ, they may be termed coeloparasite, histoparasite, intestinal parasite, blood or tissue parasite, intestinal-tissue parasite, intracellular parasite, etc., these terms are given according to their address of the residence.

Though the environment of a parasite is the host, different stages of transmission like spores, eggs, cysts, larva must survive outside in the abiotic condition during their life outside the hosts.

For a parasite primary need is the food or nutrients which parasite easily finds in the body fluids of the host having dissolved proteins, amino acids, carbohydrates and nucleic acid precursors. In the intestine of a host digested food material is at hand. Parasites exploit such living environment.

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We find that with the evolutionary changes in hosts parallel changes have occurred in their parasites also. The transmission stages also changed to resistant cysts for the survival in the outside abiotic environment.

Besides there are some freak of nature, in birds, females of certain social parasites lay their eggs in the nest of host species, thereby parasitizing the parental care of the host. Certain Dipteran and Hymenopteran insects like females of some flies and wasps deposit their eggs upon the larvae of other insects. The eggs hatch and larvae feed on the host, pupate and then come out as adults. This relationship is termed parasitoidism and they regulate or control the population of the hosts in nature.

The ecological niche of parasite is the nutrients provided by the living body of another species and outside environment confronted by the transmission stages like eggs, cysts, spores, larvae. So, most of the parasites have to face a wide range of micro- and macro-environmental conditions during their life cycles.

A journey through the alimentary canal of host may be described in terms of different symbionts confronted along the way starting from *Entamoeba gingivalis* in the mouth, fourth stage larvae of *Ascaris lumbricoides* in the stomach to Taenia and other helminthes in the small intestine to *Dientamoeba fragilis, Entamoeba coli, Endolimax nana* and *Trichuris trichiura* in the large intestine and ultimately to pinworms (*Enterobius vermicularis*) crawling around the anus. Sometimes the site specific parasites may be found not in the main route but into the lungs, in the bile ducts, etc.

Intensive research gives us the idea of distribution of different parasitic amoebae, parasitic nematodes, parasitic helminthes within the entire length of the intestine. The distribution is motivated by the diet of host, physiological condition and the presence of other parasites. Furthermore fine difference occurs in oxygen, carbon dioxide tension, pH and other chemical and physical factors from the intestinal wall to the centre of the lumen of intestine. Because of such differences different habitats are present for the parasites to colonize.

The population biology of the parasites indicates the phenomenon of 'r'-selection and 'k'-selection strategies. 'r'-selection occurs when selective forces upon organisms are unstable and environmental conditions are variable. Conversely, 'k'--selection prevails when environmental condition is more stable over a period of time. 'r'-strategies create high fecundity, high density-independent mortality, short lifespan, effective dispersal mechanism and size of the population vary over time and always remain below the level of carrying capacity of the habitat. 'k'-strategies usually have low fecundity, density dependent mortality, longer lifespan and population size is more stable. Digenetic trematodes are considered 'r'-strategists. Their biotic potentials for increase in population and high mortality rate put selective pressure on the organisms.

Parasites may exert strong control over the population of their hosts over a period of time. That is why the parasitic pathogens are used to control the population of pests.

Besides, the geographical distribution of parasites is controlled by the presence or absence of certain biological factors, chemicals, weather, physical factors, availability of hosts, vector and stress created by the manmade eradication programme.

Epidemiology is the study of factors responsible for the transmission and distribution of the disease causing organisms. The distribution of hosts, vectors, host specificity and density of hosts directly influences the epidemiology of the pathogenic parasites.

The population dynamics of the disease causing parasites affect the population dynamics of hosts as the parasites depend on the hosts for their life and sustenance.

When one species is dependent on the other for food and shelter, the relationship may be controlled by making the host resistant or by destroying the parasites and for that their population, immunization is necessary to check the reproductive rate of infection. Two pronged attacks: one by immunizing unaffected individual by administrating vaccine and other by destroying parasites by chemotherapy in the affected person will control the diseases and parasites with different reproductive rates of infection.

A complete understanding of host–parasite relationship needs a careful consideration of the ecological context of the relationship. This will ultimately provide us an idea of host–parasite interactions in nature which will lead to a better management of parasite infection in human population.

10.1 Evolution of Parasitism

Evolution of parasitism is the pattern of association among parasites, hosts and the ecological and geographical distribution. The main factors are descent and colonization. Descent is the association of a parasite with a host for a long evolutionary period. Colonization is the association of host and parasite and has undergone evolutionary change together and parasite has colonized the host like the people make colony in a new country or inland far from his own settled place. The host–parasite association may be the product of descent, colonization physical separation of population and extinction. Any of the four factors or all of them may induce parasitism and parasites may be specific to their hosts due to evolution. The high degree of host specificity suggests association by descent.

Evolution of virulence of any parasite depends on pathogenesis and transmission dynamics. Parasites are transmitted horizontally and vertically. Vertical transmission means transmission between generations and horizontal transmission means between the members of same generation. The research work suggests that less virulent strains transmit vertically, while more virulent strains transmit horizontally with high transmission rate.

It can be said that parasitism is a secondarily adapted relation. It may be that some free living organisms accidentally or casually became associated with another organism. This temporary association or accidental association due to pre-adaption found a place suitable to reside as the environment of their old home became hostile. Then one of the associates developed increasing dependency on the other slowly and gradually.

The pre-adaption, in this context, may be said that potential capability of a free living organism for adaptation in a parasitic lifestyle.

This accidental association at initial period remains free living and just an association at one point of time. This association became very necessary for one to survive for some reason. Now this association with a potential host became very important for their survival because of hostile environment.

It is believed that parasites of intestine probably got entrance having been swallowed accidentally by the host. If they were pre-adapted they became gradually more and more dependent upon the new associate and environment. If not might have been migrated to find a more suitable site such as lungs or liver.

It is quite evident that multihost parasites developed their life cycle by trial and error method and this was possible due to their high fecundity and high rate of reproduction.

The blood parasites at first instance entered into the alimentary canal of insects and during the feeding of vertebrates and adapted to that environment secondarily. The present intermediate host may be definitive host but due to increasing number, adaptability reaches the highest point and so elimination started. Elimination of certain hosts proves the natural selection and a more successful life cycle enhances the chance of reaching definitive host.

An example may be cited for evolution of parasites in numerous animal groups. In nematodes there are two such related groups free living *Caenorhabditis elegans* and parasitic *Pristionchus pacificus*. In the free living nematode, Caenorhabditis, certain larvae are produced which are called diapauses (dauer) larvae. This can be explained as arrested developmental stages of a free living nematode which is the result of hostile environmental conditions. Pheromones signal these adverse changes in the environment and compelled the worm to stop development and produce dauer larvae. These larvae attach themselves with other animals and are dispersed to a new environment. This existence of such dauer larvae may be an instance of parasitic nematode life cycle evolved from free living ones.

It is seen that L3 larvae of many parasite nematodes which are infective may have many similarities with dauer larvae of free living nematode. Both are in arrested stage of development, both are in dispersive stage and both will emerge from their arrested condition under congenial environmental condition. There is another example, *Strongyloides stercoralis* having both free living and parasitic life cycle.

The virulence of parasitic infections is the result of evolutionary changes. The parasitologists are trying to have answer why some parasites are so much virulent and others not.

The answer is parasites over a long period evolve into less virulent forms because the death of a host due to virulence of the parasite will ultimately have a negative effect on them for their survival. So a median path is chosen by the parasite being optimum virulent.

Several studies have been made on the evolution of virulence of the parasites. These studies support the idea that genetic diversity of both host and parasite, difference of time period of transmission and individual host-parasite interactions influence the evolution of virulence.