Parasites are responsible for some truly debilitating conditions, and the impact they have on humans and livestock – particularly in developing countries – is enormous. Here, *International Innovation* looks at the three main parasite groups and the myriad ways they have found to infect their hosts.

**WORMS**

Parasitic worms, or helminths, are a diverse group, ranging from tiny 1 mm-long monogenean trematodes to 10 m beef tapeworms, which inhabit the human gut. Helminths are often characterised by convoluted life history strategies involving multiple hosts – some trematode flatworms make use of three different host species – or else taking unconventional routes, migrating around the host’s body. One example is the widespread human roundworm, *Ascaris lumbricoides*, which relies on its larvae being coughed up – having entered the pulmonary circulation and subsequently the lungs – and then swallowed so that they can mature in the small intestine.

Often, helminths do not cause extensive damage, and many human populations proceed in a state of relatively good health despite underlying worm infections. Some species, however, can cause horrific disabilities and present a great socioeconomic burden to afflicted communities. River blindness is caused by an extreme host immune response to dead filarial nematodes which destroy the optical tissues of the eye, while several other nematode species can infest the human lymph system, resulting in the severe deformities of elephantiasis.

**PROTOZOA**

While single-celled and seemingly innocuous when compared with the large, multicellular helminths, protozoa are responsible for some of the most devastating human diseases, including malaria, sleeping sickness and Chagas disease. Much of their virulence comes from the inventive methods they utilise to spread between hosts, often travelling within insect vectors.

Amoebae and ciliates are common causes of gastrointestinal problems in areas with poor sanitary conditions, as they are transmitted via a faeco-oral route. Leishmaniasis is caused by protozoa transmitted in the bites of sandflies and results in disfiguring sores that erupt on the skin and, in more serious cases, on the surfaces of the infected individual’s vital organs. Similarly, the *Plasmodium* parasites that cause malaria are famously transmitted by the bite of female *Anopheles* mosquitoes. Unlike most worms, protozoa are able to multiply inside their hosts, contributing to their success and allowing life-threatening diseases to develop from initial infection of very few individual cells.

**ECTOPARASITES**

The term ectoparasite is used to describe any parasite that makes a home on the outer surface of its host. In practice, this is generally applied to several families of small, blood-sucking arthropods including lice, mites, ticks and fleas. These organisms are equipped with an array of hooks and claws that allow them to cling to hair follicles and burrow into the skin of their host.

The immediate effects of ectoparasite infestation are undeniably unpleasant, causing discomfort and – in more severe cases – anaemia, but their real harm comes from the infectious diseases they carry. The feeding behaviour of these arthropods, which may involve regurgitation of their last blood meal into the new host, or else their excretions coming into contact with wounds, facilitates the transmission of harmful pathogens between infected and uninfected hosts. Life-threatening conditions, such as Lyme disease and typhus, are among the diseases transmitted by ectoparasites, and the best way to prevent their spread is to control the populations of parasitic arthropod vectors.

The word parasite comes from the ancient Greek word parasitos; literally meaning “one who eats at the table of another”. While the term is used widely to describe an array of organisms – both multi- and unicellular – its broad definition is an organism that lives in or on another organism (the host) and derives nutrients at the expense of the other.