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# Editorial: Parasitism: the good, the bad and the ugly

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## Editorial on the Research Topic

### Parasitism: the good, the bad and the ugly

Parasitism is a tight association between species in which one organism, the parasite, lives on or inside the host, causing it harm, and is structurally adapted to this way of life (1). Until the twenty-first century, parasitism was studied by parasitologists, rather than ecologists or evolutionary biologists. Today, parasitism is a major element of evolutionary ecology, as nearly all free-living animals, are hosts to at least one parasite species (2, 3). Since it is in the parasite's evolutionary interest for its host to flourish, long-term coevolution can lead to a stable relationship bordering on mutualism (1, 4). According to Lynn Margulis, when resources are scarce, natural selection moves relationships from parasitism to mutualism, as was brilliantly illustrated in Margulis' endosymbiosis theory, where eukaryotic mitochondria and chloroplasts descended from formerly free-living prokaryotes (5).

While worm parasitism clearly affects animals, it may also reduce the prevalence and severity of autoimmune diseases in animal hosts, including humans (6). Helminth infections might safeguard hosts from immune-mediated illnesses like allergies and autoimmune disease, as well as suppress detrimental inflammatory host's reaction. In this symbiotic relationship, the helminth, and the host benefit from each other's presence (7–9). The boundary between mutualism, symbiosis, and pathological parasitism is narrow and is frequently overlapping without a theory to clearly explain this relationship between the parasite, host, and ecological niche (10–12). Parasites are frequently seen as dangerous and primarily viewed as harmful to the host (3, 13). However, removing them entirely would be detrimental to the host, the environment, and the parasites themselves (3). Complex natural ecosystems with diverse species and their interactions are the result of a long evolutionary history (12, 14). Parasites make up half of life's diversity and play vital ecological roles (3, 15). Parasites allow for inter-species DNA exchange, allowing for evolutionary change (16). To complete their life cycles, many parasites rely on predator-prey or other stable ecological interactions (12, 17). At individual and species levels, hosts have developed adaptations to their coevolving parasites (10, 11, 15, 18). Often, the expression of normal behavior or the development of a healthy immune system depends on parasite infections (8). In instances where parasites are not present, hosts may occasionally exhibit phenotypes that are less than ideal (14). Conserving parasite species is supported by their evolutionary heritage and potential, their role in ecosystem services, and their value as indicators of ecosystem quality (3, 19). Parasites imply a healthy ecology (20). Researchers have highlighted the functional significance of parasites in preserving the health of individual hosts, host populations,

and entire ecosystems in order to raise awareness of parasite conservation (3, 14). For individual hosts, parasites impose energetic demands that reduce growth, fecundity, and survival (21, 22), but these apparent negative effects on host fitness may be compensated by positive consequences, such as improving normal host immune system function (8, 9, 23), regulating their host's microbiome (7, 8, 24–26), inducing specific interaction between gut microbiota and host immune responses (27–29), and providing protection against pollutants such as heavy metals (20, 30, 31). Even though parasites decrease host fitness, they could potentially maintain host population viability by controlling host population size (18, 32, 33), and increasing genetic variety while avoiding the detrimental effects of inbreeding (21). Parasites can act as keystone species, allowing competing species to coexist while lowering the dominance of superior competitors (17). Parasites may mediate predatory and competitive interactions among free-living species at higher levels of organization, adjusting community structure and diversity, food web complexity, and energy flow throughout the entire ecosystem (20, 34–36). While parasites typically remain absent from food web representations, they consistently hold the top position (15).

With 220 million people affected annually by malaria, measures such as prophylaxis, eradicating mosquito vectors using pesticides, and developing a malaria vaccine, have been attempted to stop malaria transmission (37). Nonetheless, medication resistance, mosquito pesticide resistance, and vaccination failures due to parasite mutations or parasite immune manipulation have all been issues (38–40). Similar problems have been observed with other economically significant groups of parasites that cause disease in livestock, poultry, and domestic animals, such as protozoa, helminths, and ectoparasites (41, 42).

Due to their potential benefits in numerous ecosystems, parasites should not be eliminated from Earth's environments (3). Nonetheless, some parasites do represent a serious threat to human and animal health; therefore, we must find an appropriate equilibrium between parasite burden, human and animal fitness, and ecosystem quality, all while adhering to the current one health concept (14, 27, 33, 43–46). To achieve this equilibrium, parasite managements must rely on suitable treatment, prevention and control strategies, and their appropriate implementation at field (3, 29, 38, 47). Studies on parasites management can serve as a link between health and environmental sciences, enabling accomplish the objective of the one health concept through an interdisciplinary and holistic approach (14, 44, 48).

Several issues regarding holistic approaches to parasite management have aroused the interest of scientific community, with resulting in several investigations and publications to answer if parasites are good, bad, or ugly for human's and animal's health. This Research Topic contains all various initiatives to harness knowledge, such as the following:

1. Genetic studies for both ecto- and endo parasites. Generated mitochondrial genome data provided further flea taxonomic and epidemiological studies (Liu et al.). Genetic analysis of *Fasciola hepatica*, demonstrated population

structure in South America not previously realized using nuclear and mitochondrial markers (Garcia-Corredor et al.).

2. Innovative lab procedures. Currently, it is feasible to use harmless methods for preserving avian *Eimeria* sp. sporulated oocysts for challenge testing or live coccidiosis vaccines (Laverty et al.). Isolates of live-attenuated *Histomonas meleagridis* were successfully obtained by serial passaging in a lab setting (Beer et al.). These attenuated vaccine strains proved to be immunoprotective against challenge with virulent *H. meleagridis*. However, commercial application of these attenuated vaccines is not currently feasible from a production, labor, and economic standpoint. Nowadays, the identification of *E. tenella* antigens through novel immunological approaches is crucial for the development of successful genetically engineered vaccines (Juárez-Estrada et al.). Lab procedures indicates that Ferritin 2 has emerged as a promising antigen for a universal vaccination against avian mites (Win et al.).

3. Bibliometric analysis for screening assistance. Bibliometric data provides insight for the selection and evolution of anticoccidial drugs and, contributes to understand anticoccidial medication utilization trends (Kandee et al.).

4. Experimental infection models are necessary to mimic complex multi-factorial interactions. An experimental mixed avian *Eimeria* sp. challenge model that particularly evaluates performance, intestinal permeability, and dysbiosis is suitable to analyse different strategies for avian coccidiosis control (Graham et al.). An experimental model revealed that horizontal transmission of *H. meleagridis* could vary depending on the pathogenicity of the challenge strain and Turkey diet composition (Barros et al.). Turkeys experimentally vaccinated with a candidate *E. meleagrimitis* strain with or without amprolium intervention showed altered ileal and cecal microbiome (Trujillo-Peralta et al.). In an experimental model of priming/challenge, an *E. meleagrimitis* strain candidate vaccine caused a moderate infection that induced protective immunity (Trujillo-Peralta et al.). Coccidiosis infection in lambs impacts rumen fermentation in a way that is independent of plane nutrition, but this effect does not translate to performance response (Sujani et al.).

5. Alternatives to antibiotics. As demand rises to decrease (eliminate) antibiotic use in poultry; natural resources such as *Yucca schidigera* and *Trigonella foenum* are promising coccidiosis control options (Benarbia et al.). Soybean lecithin has also been linked to increased resilience in several animal species to physical and chemical stressors (Wee et al.).

Novel research on parasitology contributes to identify new prevention and control measures that we need now more than ever front to current climate changing (43, 49, 50).

## Author contributions

MJ-E: Conceptualization, Data curation, Writing—original draft, Writing—review and editing. GT-I: Conceptualization, Data

curation, Funding acquisition, Writing—original draft, Writing—review and editing. DG: Conceptualization, Data curation, Writing—original draft, Writing—review and editing. XH-V: Data curation, Visualization, Writing—review and editing.

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