

Redefining parasite life cycles through epidemiology, pathology and developmental biology

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Traditionally, parasitology curricula have emphasized parasite life-cycle diagrams to teach students about the dynamic and diverse strategies for movement between hosts and through external environments. While useful, such schematics often suggest the presence of developmentally unchangeable discrete stadia of development in many helminth species, and simple static contamination of abiotic environments by helminth eggs and protist cysts/oocysts. For more than 30 years, I have worked with collaborators from many countries, and especially Poland, to explore greater complexities in parasite development and dissemination than these conceptually simplistic models imply. Our work has revealed that protists and microsporidia such as *Cryptosporidium*, *Giardia*, *Encephalitozoon* and *Enterocytozoon* are influenced dynamically by non-host biotic agents in their environment as they move between hosts. Among helminths, we have shown that trematode embryos in digenean genera such as *Brandesia*, *Prosotocus*, *Maritrema*, and *Mediogonimus* vary markedly in timing of miracidial larvigenesis to accommodate diverse interactions with their respective gastropod hosts and environments. Similarly, our work with cestodes has suggested that diverse interactions between adult parental and embryonic or larval structures in cyclophyllidean, proteocephalidean, trypanorhynchan, bothriocephalidean, and gyrocotylidean cestodes may contribute to variations in transmission strategies between hosts. Regarding postlarval development of trematodes, our work has shown that post-cercarial stages of some digeneans, such as species of *Echinostoma* and *Ornithodiplostomum*, use variable developmental strategies as they move through a dynamic series of specific functional-developmental transformations within their hosts. Likewise, variations in postlarval development of cestodes from oncosphere and hexacanth larva to metacestode juvenile, including metamorphosis, may result in a broad range of forms and activity, including asexual proliferation, in the post-metamorphic juvenile stage. In this latter developmental period, we have recently demonstrated malignant neoplastic transformations among *Mesocestoides* tetrathyridia and *Spirometra* plerocercoids (“*Spargana*”), suggesting patterns of juvenile differentiation that may become dysfunctional for the individual metacestode, fatal for the host, but possibly reflective of a retention of developmental plasticity that characterizes cestodes in general.