



Creating the Nation's first BioPark

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Letter From the Desk of David Challinor  
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I originally planned to write this letter during the Zoo Council's Australian tour, which occurred during the first two weeks of November. I had looked forward to this trip with relish for over a year and anticipated the interesting time we would all have together, but alas I was laid low by a parasite and was unable to lead the tour. However, Kathy and George Didden, Malan and Hank Strong, and Jeannine and Charlie Clark, who are all interested in the flora and fauna of the land, had an unbelievable opportunity to savor the wildlife riches of Australia. These six friends are colleagues who showed remarkable flexibility, resourcefulness, and competence in taking their leaderless tour. They reported by fax that everything was fine, and found my Australian friends whom I had arranged to accompany some of their excursions to be informative, supportive, and interesting natural history experts.

Here in Washington I have been recovering from toxoplasmosis and in the process have learned much about this parasite, information which I would like to share with you.

Even the most fastidious person is not immune to all parasites. The late Lewis Thomas, MD wrote a fascinating book called Life on Man wherein he pointed out how crucial most of these one-celled creatures are to our health. Without a balanced population of E. coli in our digestive organs, we would not digest our food properly. We all have normal bacteria in our mouth, which helps start the digestive process. Unfortunately, hostile organisms can also invade our bodies, such as the amoebas that cause dysentery or even the fungi that cause athlete's foot.

Among the protozoans (microscopic, single-cell animals) that can enter humans as well as most other mammals and birds is Toxoplasma gondii. This is an intracellular parasite that is spread in three different ways: 1) to a fetus by an infected mother through her placenta; 2) to most warm-blooded animals by eating meat, vegetable or water contaminated by infective cat feces; or 3) by direct consumption of infective meat. Cats, wild and domestic, are the alternate and obligate hosts, i.e. the life cycle of T. gondii must pass through a cat.



The life cycle of this parasite is relatively simple and starts when a cat (leopard, tiger, ocelot, or domestic cat, etc.) consumes fresh, contaminated (infective) muscle tissue from a bird or mammal. To be infective the meat must contain microscopic cysts of the protozoan. When a cat excretes its meal it releases unsporulated (non-infective) oocysts, but because the cysts in the cat's initial meal went through its gut, a subtle change will take place in the excreted oocyst.

Once the unsporulated oocyst is outside the cat, depending on environmental conditions sporulation occurs within one to five days. At that time infective sporozoites develop inside the oocyst; at this stage they can survive for up to a year and a half, waiting to be eaten by a new, warm-blooded host. When this happens, the sporulated oocysts rupture and each releases eight sporozoites, which multiply in intestinal cells and spread rapidly through the host's body via blood and lymph. Eventually these sporozoites become encysted and remain in the host's tissues for life. The cycle is completed when the infected meat of the host is eaten by any member of the cat family.

Because cats in general spend so much time grooming themselves, the possibility of getting toxoplasmosis (the name for this infection) by touching or caring for a cat is minimal. In my case I may have become infected by working with bare hands in my garden. Five neighborhood cats -- I do not have one -- often use freshly turned garden soil as a latrine and free-ranging cats often catch and eat birds or small rodents infected with T. gondii. Cats kept indoors and fed clean pet food from their kittenhood are not likely to be infected.

I should point out that epidemiologic studies have not shown positively that human infection is linked to a cat in the house, nor even linked to infection from soil contaminated with oocysts. In fact this particular protozoan hides so well that even blood samples from a pet cat will not necessarily show antibodies to T. gondii because cats do not develop antibodies to this protozoan when shedding oocysts. However, if antibodies are found in the cat's blood, it would only indicate that it has shed oocysts sometime in the past; cats rarely shed a second time. The odds of finding oocysts in cat feces are minute because they are shed for only one to two weeks during the life of the cat. It is therefore almost impossible to determine if your pet is infected.

I have gone into great detail to illustrate how a one-cell animal as simple as a protozoan can evolve a multi-step life cycle with an obligate alternate host (cat family) and still thwart the efforts of humans to fight it. As evidence of its ubiquity, an estimated 30-40% of adults in the US have antibodies to T. gondii; most of these people were probably infected by eating raw or undercooked meat. Meat that is processed, salted, frozen or

well-cooked will not retain viable oocysts. Among meat sources, pork is probably the most heavily contaminated, followed by lamb and poultry. Cattle, for some reason, have a strong resistance to T. gondii infection. Game animals such as deer, moose and elk are also carriers, but the highest incidence of contaminated game meat is from black bears. Over a three-year period in Pennsylvania, 80% or more of black bears tested were seropositive for antibodies to T. gondii.

An estimated 30% of reproductive women have antibodies against T. gondii and are therefore protected from toxoplasmosis. All other females are at risk of getting this parasite during pregnancy. Should this happen, the chances are 20-50% that the fetus will be infected by transmission of the protozoans through the placenta. Although most infected children show no obvious evidence of infection at birth, it can erupt later in life (in my case it is possible that the infection stayed dormant for 75 years) and can cause eventual blindness and mental retardation if not treated.

How do you know you have toxoplasmosis? If infected as an adult, symptoms include swollen lymph nodes, aching muscles, fever and headaches. In my case there were no such symptoms; I discovered I had it when I casually covered my right eye while scratching my forehead. I then realized that my left eye had a horizontal fuzzy dark bar across the center of my field of vision. Peripheral sight remained. My good right eye had masked the bar, which means the fuzzy opaque line could have been there for several days. The small blood vessels in the retina are favorite places for this protozoan to lodge and form an occlusion or blockage of the blood. This blocked area causes the blind spot.

The diagnosis of toxoplasmosis was made by the doctors at Georgetown Hospital and was confirmed by the specialists at The Wilmer Eye Institute at Johns Hopkins. The swollen infection (rather like a small boil) on the retina is a typical symptom and a blood titer indicated that in the past I had developed antibodies to this protozoan. A small retinal scar, barely visible, was found at Hopkins in my right eye, which might indicate that years ago I had this disease without even knowing it.

The disease is so rare that ophthalmologists do not know whether any treatment is better than no treatment at all. I take steroids via eye drops every two hours to reduce inflammation, plus a battery of pills daily to attack the protozoans. If everything works as hoped, within the next six to eight weeks the bar should shrink; the residual damage would be a small scar on the retina around which I would have to look.

Control of the disease is the use of common sense. Be sanitary and wash thoroughly hands and tools that handled raw meat. Plain water will kill the stages of T. gondii in raw meat. Pregnant women are often advised to avoid cats and undercooked meat. Wear gloves when gardening and wash vegetables to get rid of contaminated soil particles. And finally, feed pet cats only dry, canned or cooked food. Do not give them raw liver for Vitamin A.

I would like to acknowledge the help of Dr. Richard Cambre, the Zoo's chief veterinarian, with this letter. He kindly called my attention to a seminal paper on toxoplasmosis by J.P. Dubey, who has devoted his research to this disease (J Am Vet Med Assn 1994; 205:1593-1598). As you might expect, zoos must be particularly careful to control toxoplasmosis. No wild cats are exhibited in the same building as New World primates and/or marsupials (kangaroos, etc.) because these two mammal groups are very susceptible to lethal infection. By cleaning cat enclosures daily, shed oocysts do not have time to form the infective sporozoite stage and the cycle can be broken.

As we learn more about the micro-organisms in our bodies, we are better able to keep them properly balanced or dormant. Under normal conditions our immune systems work incredibly efficiently to keep us healthy. Periodically the micro-organisms find a weak link to exploit their host by multiplying rapidly. In-depth knowledge of life cycles provides the best defense against such assaults and I, as an unwilling host, am particularly grateful to Dr. Dubey for his years of research on T. gondii.

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