

## PROTOZOA TRANSMITTED VIA FOOD

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Life cycles — lifestyles of the small and furtive

- Trophozoites (merozoites, tachyzoites) — active, feeding, dividing (+ bradyzoites)
- Cysts — inert transmission form (exception: *Toxoplasma*)
- Gamonts → zygote → oöcyst (sporozoites)

*Giardia lamblia* (= *duodenalis* = *intestinalis*)

- A leading protozoan cause of foodborne (CDC, '98-'02: 3 outbreaks, 119 cases; CAST report has 7000 cases/year, no deaths, & a cost of \$5140/case) and waterborne (CDC, '03-'04: 2 outbreaks, 14 cases) disease in the U.S. Not in FoodNet.
- Transmitted as spheroid cysts 9–12  $\mu\text{m}$  long; incubation period usually 7–10 days; characteristic diarrhea is caused by noninvasive colonization of the upper small intestine may persist for weeks if untreated, but asymptomatic infections are very common.
- Reservoirs are humans, beavers, cattle, and other animals.
- Vehicles are unfiltered surface water (*Giardia* is fairly resistant to chlorine), drinking water recontaminated with sewage, fruits, vegetables, salads, and other foods subject to direct or indirect fecal contamination.

*Cryptosporidium hominis* and *parvum*

- Caused the largest outbreak of waterborne disease in history (Milwaukee, 1993, ca. 403,000 cases, but only one, with  $\geq 1$  case, in '03-'04). Named (*C. parvum*) cause of 4 outbreaks with 130 cases of foodborne disease during '98-'02; outbreaks from apple juice (cider) were recorded in 1993 & 1996, and raw milk and a few other food vehicles have been implicated. FoodNet had about 8850 cases during 2005.
- Oöcysts from humans (*C. hominis* only), cattle, other domestic and wild species — small (4–6  $\mu\text{m}$ ), tough, chlorine-resistant; after incubation averaging 1 week, profuse diarrhea is common and usually lasts less than 30 days (with shedding continuing for 2–6 months); intracellular parasitism; treatment is rehydration. *C. meleagridis* also infects humans.
- Cryptosporidiosis is diagnostic of AIDS in HIV-positive persons and will generally persist (with intermittent symptoms) for life.
- Concern for cryptosporidiosis (especially waterborne) is evoking stringent measures in the U.S. and will inevitably have a significant impact on agriculture involving ruminants.

*Entamoeba histolytica*

- Once a frequent cause of waterborne disease in the U.S., the agent is now fairly rarely heard from here, but continues a very significant threat in the poorer countries.
- Causes amebic dysentery, sometimes abscesses of the liver or other organs (trophozoites are invasive).
- Human-specific; transmitted via fecally contaminated water or food.

*Toxoplasma gondii*

- Toxoplasmosis outbreaks (acute, foodborne) are rare, so not recorded by CDC; CAST: most expensive foodborne disease in the U.S., est. 2090 cases with 42 deaths, \$2.6 billion/yr ( $\times 1/2$ ?) from congenital blindness, hydrocephalus, retardation.
- Tissue cysts (bag of “bradyzoites”) in pork, mutton, beef — killed by cooking or irradiation, but freezing does not eliminate them completely.
- Tachyzoites travel around the body, may encyst in various tissues (often CNS in humans); host’s cellular immune response causes encystation as bradyzoites; tissue cysts are well tolerated in humans but may be reactivated if immunity is later impaired.
- Cats are definitive hosts, usually become infected by eating infected birds or rodents; oöcysts (not immediately infective) in cat feces for up to 3 weeks contaminate animal feed, garden vegetables, other foods, **water**.

*Cyclospora cayetanensis*

- Human-specific; delayed maturation (days to weeks under favorable conditions) of oöcysts in feces makes person-to-person transmission unlikely.
- Fairly common in parts of Latin America and Asia
- Rare in U.S., but caused an extensive (nationwide) outbreak in May–June of 1996, eventually attributed to raspberries imported from Guatemala; again in 1997; embargoed in U.S. (but not Canada) in 1998; back in 1999?
- Presently, there are just four Guatemalan farms that may be permitted to export raspberries to the U.S., contingent on fecal testing of the farm workers. No positive fecal tests had resulted, at last report.
- Nine outbreaks with 325 cases of foodborne disease were recorded during '98-'02.
- FoodNet had ~450 cases in 2005.

## Summary

- This was not an exhaustive look at protozoa that may be foodborne anywhere in the world.
- Of five agents discussed, three species (*Cryptosporidium hominis*, *Cyclospora cayetanensis*, and *Entamoeba histolytica*) are human-specific and are transmitted by a fecal-oral route.
- The remaining agents are all transmitted zoonotically at least some of the time, either via infected animal feces or tissue, but human feces are also important sources of *Cryptosporidium parvum* oöcysts and *Giardia lamblia* cysts that may be transmitted to humans via water or food. Only *Toxoplasma gondii* is apparently not transmitted from person to person, either by contact or via food.

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