PAST, PRESENT AND FUTURE OF FOOD-BORNE PARASITE RESEARCH

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The far past

• over millions of years, parasites have adapted to their hosts by escaping immune responses through different evolutionary choices:
  • development of the parasite in young hosts whose immune system is not yet well developed (e.g., Cryptosporidium, Hymenolepis nana)
  • development of the parasite faster than the host's immune response (e.g., Toxoplasma)
  • reduction of the exposure time to the final host’s immune system due to developmental stages spent in intermediate hosts (e.g., Fasciola, Opisthorchis)
  • anatomical seizure of the parasite that does not come into contact with the host's immune system (e.g., Echinococcus, Toxoplasma, Trichinella)
  • settlement in organs or tissues of the host where the defense mechanisms are less efficient (e.g., Fasciola and Opisthorchis in bile ducts)
The recent past of FBP research

• Studies of genomes
• Phylogeny of taxa
• Identification of sibling species
• Improvement of serological tests
• Antigen purification
• Investigation on humoral and cell-mediated immune responses against FBP
• Deep investigations on epidemiological patterns
Present research on FBP

• First NGS approaches to FBP (e.g., Cryptosporidium, Giardia, Cyclospora, Trichinella)

• Metagenomics (e.g., to trace parasites in environmental samples)

• Investigations on the impact of parasites on the human gut microbiome

• Proteomics
What we should keep in mind

- Most foodborne parasites are linked with old and poor farming practices and/or to wildlife
- Poor farming practices are linked with uneducated farmers who, through their incorrect behavior, can favor transmission of *Echinococcus*, *Toxoplasma* and *Trichinella*
- Uneducated hunters and fishermen can favor transmission of meat- and fish-borne parasites
- The increase of the human population density in megacities results in a high environmental and water contamination with, e.g., *Cryptosporidium* and *Giardia*
- The increased temperature could favour the establishment in Europe of foodborne parasites currently circulating in tropical areas (e.g. *Cyclospora*)
Parasites and the food supply system

- Food passes through various phases of a food supply system (farm to fork)
- Farmers, hunters, fishermen, globalization and climate change can impact on foodborne parasites at each phase of this system

Infection of animal hosts
Contamination of crops

Production
Harvest
Inspection
Processing
Distribution
Retailing
Preparation/consumption

Human factors
- Education
- Awareness
- Health and wellbeing
- Hygiene
- Vigilance

Where can we go in?

Parasite loss can be obtained by:
- killing the parasite
- detect and remove

the parasite burden can be minimized by prevention and amelioration management
Possible links between climate change, hosts, parasites and ecosystems

• Globalization and climate change:
  • cause epochal migration of human populations
  • cause a reduction of animal species and habitat variability
  • have different impacts on foodborne parasites

Direct effects of the climate change on parasites

Indirect effects of the climate change on parasites

Parasites in endothermic hosts

Parasites in ectothermic hosts

Ecosystem

Parasite free-living stages

from Polley L.R., 2015
Change of biomasses
The environmental impact of food animals

1 billion heads in 2015

**Animal species** | Water consumption (L) for 1 kg meat production | The future of meat and fish consumption
--- | --- | ---
Chicken | 1,000 | ↑
Pig | 6,000 | ↑
Cattle | 16,000 | ↓
Fish |  | ↑

Kg CO₂ per kg of meat

- Lamb
- Beef
- Pork
- Farmed salmon
- Turkey
- Chicken
- Canned tuna
Introduction of alien host species

• In the last century, 44 alien mammalian species reached Europe, including several carnivores, such as the American mink, the raccoon, the raccoon dog, and the jackal

*1927*

Echinococcus multilocularis
Trichinella spp.

Baylisascaris procyonis

Echinococcus spp.
Trichinella spp.

Trichinella spp.
Foodborne parasites and immigrants

• Intestinal parasite burden (e.g., *Ascaris, Trichuris, Entamoeba, Cyclospora, Cryptosporidium, Giardia, Taenia*) reduces in few months due to the lack of reinfection, however:
  • Most European physicians are not aware of the epidemiology, clinical patterns, diagnosis and treatment of these infections
  • There is a strong reduction of the availability of anti-parasitic drugs on the EU market
  • No new anti-parasite drugs are being developed

• Cultural practices of immigrants can favor the transmission of foodborne parasites
  • *Taenia saginata* (field defecation of shepherds and farmers)
  • *Echinococcus granulosus* (dogs feed with offal and scraps of animals illegally slaughtered at the farm)
  • Education
The present

• Technologies strongly bias the research investigation, but not always research succeed to answer the questions

• We often use very powerful investigative tools, but we lack original ideas
Translational parasitology
Translational parasitology

• 17 year innovation adoption curve from discovery into accepted standards of practice
• Lack of innovation adoption planning in the discovery process
• Even if an innovation is accepted as a standard of practice, patients have a 50/50 chance of receiving appropriate care
What we need in the field of food-borne parasites

• Basic research
  • NGS of FBP

• New drugs
  • No effective drug available for cryptosporidiosis
  • Anti-Toxoplasma drugs are not active against tissue cysts
  • The drugs used today for the treatment of alveolar and cystic echinococcosis are only parasitostatic and not parasitocidal

• New diagnostic tools
  • to identify animals with active tissue cysts of *Toxoplasma gondii*
  • to unequivocally diagnose cystic and alveolar echinococcosis
  • to trace FBP from fork to farm

• New educational tools
  • to train farmers, hunters, fishermen, consumers to veterinary and public health in the field of FBPs and their risks

15-20 years
Thank you for your attention