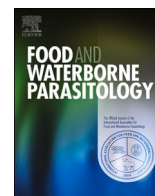


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Foodborne and waterborne parasites at the 2020/2021 European Multicolloquium of Parasitology (EMOP)

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ABSTRACT

This Special Issue in Food and Waterborne Parasitology consists of six articles derived from presentations at the 13th European Multicolloquium of Parasitology (EMOP), that was held in Belgrade, Serbia in October 2021. Within the broad scope of parasitology presented at EMOP 2020/2021, the focus of several sessions, seminars, and presentations was on foodborne and waterborne parasites, with different aspects concerned with *Cryptosporidium*, *Toxoplasma*, *Trichinella*, and *Opisthorchis* all featuring. Although only a few manuscripts on foodborne and waterborne parasites are presented in this SI, the wide-ranging scope of the articles and, more broadly, of the presentations at EMOP 2020/2021, suggests that the topic of parasites transmitted by food and/or water remains of interest in the European parasitology community. We believe this is likely to be the case for years to come, and the topic is likely to feature prominently in the next (14th) EMOP, scheduled to be held in Poland in 2024. This interest, along with some obvious gaps in the articles on foodborne and waterborne parasites of both European and global importance (such as tapeworms, particularly *Echinococcus* spp. and *Taenia solium*), suggests to us that another SI on the subject could be of value as an outcome of the 14th EMOP.

The European Multicolloquium of Parasitology (EMOP), the official conference of the European Federation of Parasitologists (EFP), is an international broad-scope parasitology meeting that takes place every 4-years. Historically, the EFP is a product of the Cold War. Founded in 1966, it was a response by European parasitologists from both sides of the ‘iron curtain’ to the division of Europe that had severely restricted scientific exchange. Consequently, the main purpose of EFP has been, and still is, to bring parasitologists from different political blocks together by promoting personnel exchange and, above all, to hold a common conference – EMOP – where all could meet. In the age of the internet, email, and unrestricted travel this initial purpose had gathered some layers of dust which, sadly, have all of a sudden been blown away by the recent developments that we are all witnessing – not only in Europe. Again, we face travel restrictions and de-funding of scientific cooperation with the ‘wrong’ countries, even bans on sample exchange. In a way it is discouraging to see that the initial purpose of EMOPs may, in the immediate future, be more relevant than ever. Although not anticipating the recent scope of trouble, EFP had already focussed its attention on countries where free scientific life is not taken as granted, opening the possibility of membership to parasitology societies from non-European countries with a strong link to European institutions. In the spirit of scientific cooperation across borders, most of EFP’s modest funds are used to facilitate travel and EMOP attendance of parasitologists from disadvantaged scientific communities.

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EMOPs are timed to occur midway between the 4-year cycle of the International Congress of Parasitology (ICOPA), the official conference of the World Federation of Parasitologists. The 13th EMOP was thus initially scheduled to take place in 2020, two years before ICOPA, which took place in August 2022 in Copenhagen, Denmark.

However, like so many other things, EMOP-2020 was impacted by the COVID-19 pandemic and, after considerable uncertainty and rescheduling, the 13th EMOP became EMOP 2020/2021 and was held in Belgrade, Serbia in October 2021. Due to the pandemic, the meeting organizers arranged a hybrid event. For those able to attend physically in person, which included not only Serbian scientists and those from nearby countries, but also a substantial number from further away, this was probably the first chance to travel and interact face-to-face with fellow parasitologists for months and months. This was an enormous pleasure for many. However, those unable to attend in person were also welcomed, and there was the option for both presenters and audience to participate remotely.

The focus of EMOP 2020/2021 was “changing climate, changing parasites” – but the scope was nevertheless broad, with 4 parallel sessions running over 4-days, not including the opening day with a plenary lecture. There was also a plenary lecture on each of the four conference days, with one of these, the closing presentation on the last day of the conference, being the basis for the article by [Petersen et al. \(2022; in this SI\)](#). In addition to the symposia, associated meetings, workshops, and different society meetings were also held, and, for physical attendees, it became a challenge to decide where to be and when with the various options available simultaneously. One positive feature of remote attendance is the possibility to “leap” between rooms with minimal physical exertion – just the click of a button.

Many of the sessions included aspects associated with foodborne and waterborne parasites, including a seminar with presentations of the different regional OIE Collaborative Centres on foodborne zoonotic parasites. In addition, there was a triple-session symposium entitled “Foodborne and waterborne parasites: changing climate, changing trends, changing parasites”. The latter not only included traditional oral presentations, but also a moderated panel discussion in which the oral presenters, as well as other invited speakers, participated.

These sessions, as well as many others, some focussing on specific parasites and others on particular methods, tools, or aspects, were the inspiration for this Special Issue.

Based on submitted abstracts, prior to the meeting a list of researchers registered to be presenting work at EMOP concerned with food and waterborne parasites were contacted and asked if they would be interested in preparing a manuscript on their planned presentation within the scope of this journal. Based on feedback received, interested researchers were contacted following the meeting with information about how to submit their work to this Special Issue.

The completed SI consists of six research publications: one on *Toxoplasma gondii*, three on *Cryptosporidium*, one concerned with *Opisthorchis felineus*, and one focussing on *Trichinella*.

The *Toxoplasma* publication ([Petersen et al., 2022; in this SI](#)) provides a narrative review from scientists who have been investigating prenatal screening for toxoplasmosis for many years. Starting from the pre-screening era, from around the 1940s to 1960s, to the screening programmes introduced in the 1980s and 1990s in both Europe and elsewhere, to the multicentre studies at the turn of the century, to the situation today, this article provides an authoritative overview of what has happened and why, and considers the case going forward and in the light of newer knowledge.

The three *Cryptosporidium* papers focus on highly different aspects of investigation on this important parasite. The article by [Robinson et al. \(2022; in this SI\)](#) describes validation of a multilocus genotyping scheme for subtyping *C. parvum* isolates for use, in particular, in investigating outbreaks, but with application also for other epidemiological investigations of transmission of this zoonotic parasite. Although investigation of variations in the sequence of a gene coding for a 60 kDa glycoprotein (*gp60*) is currently the most commonly used approach for genotyping, other markers are available, and here the authors provide the validation (reproducibility between three different laboratories) for an apparently much more discriminatory approach using a panel of variable-number tandem-repeat (VNTR) markers. The paper by [Certad \(2022; in this SI\)](#) raises the interesting hypothesis of whether *Cryptosporidium* could drive proliferation of cancer cells, potentially increasing its medical importance from that of a gastrointestinal issue to also being of carcinogenic relevance. In particular, results from animal models are described in which the development of digestive adenocarcinoma is investigated, with emphasis on particular pathways and processes, and discussion of whether this parasite might transform host cells by affecting signal transduction. The author opens the door towards further research questions that need to be explored further to understand the process and its importance. The third article focussing on *Cryptosporidium* is basically an overview of outbreaks of cryptosporidiosis occurring in France (and overseas territories) in the four-year period of 2017–2020 ([Costa et al., 2022; in this SI](#)). An unexpectedly high total of eleven outbreaks are mentioned, ranging between those involving just a few patients to those where hundreds, even thousands, of people have been infected. For some outbreaks, the route of infection remains unknown (three outbreaks), whereas for others the route seems to be established, with waterborne transmission predominating (six outbreaks). Of considerable interest is an outbreak in which contaminated curd cheese was associated with an outbreak at a school in which around 180 people were infected. Another unusual outbreak involved firefighters who became infected in association with having to remove dead cattle from a road traffic accident involving a cattle truck. The authors conclude that the number of the outbreaks not only indicates the power of surveillance, but also that data gathered should assist in the development of strategies for monitoring and prevention.

The single paper concentrating on trematodes ([Pakharukova et al., 2022; in this SI](#)) describes how gene expression analysis was used to investigate the effect of infection with the liver fluke *Opisthorchis felineus* on mammalian host response. These transcriptomic experiments were based on infections in hamsters and subsequent investigation either one month or three months post infection, and comparison with controls. In addition to the gene expression analysis and analysis of pathways and gene ontology, other techniques - histopathology/immunohistochemistry and Western blotting - were also conducted. Based on Molecular Signatures Database hallmarks, the process found to be most enriched in infected animals was epithelial-mesenchymal transition. Among the various results

obtained, of particular interest was that different sets of genes seemed to be activated in chronic (3-month) infection compared with acute (1-month) infection. In the Discussion of this article, the authors provide interesting speculations on how the mechanisms and pathogenesis of the carcinogenesis occurring in people infected with this parasite, and also with the related trematodes, *Opisthorchis viverrini* and *Clonorchis sinensis*, could be investigated and elucidated using comparative, high-throughput mRNA sequencing studies.

Finally, the paper by Gherman et al., (2022; in this SI) provides a comprehensive review of what we know about *Trichinella* spp. infections in wild mammals in Romania from surveys that have been conducted over the past 30 years. All studies on wild omnivores and carnivores, their location, sample sizes, detection methods, and results are tabulated and provide an easy overview of the state of the art. Although the number of examined animals per study varies from between one to thousands, study areas and periods differ, and detection methods vary, the collected data clearly suggest that mammals with more strictly carnivorous diets (canids and felids) are more frequently infected than those with more omnivorous habits (e.g., bears and wild boars). The review also makes clear that far more research effort is necessary to unravel the relative contribution of the different host species to the life cycles of the two *Trichinella* species that have been detected in Romanian wildlife, namely *T. britovi* and *T. spiralis*, as well as their possible links with domestic transmission.

It is, perhaps, of concern that the most important foodborne parasite globally (FAO/WHO, 2014; Torgerson et al., 2015) *Taenia solium*, was not addressed by any of the researchers who contributed to this SI. Although this may reflect the European focus of EMOP, the foodborne parasite indicated to be of most foodborne significance in Europe, *Echinococcus multilocularis* (Bouwknegt et al., 2018), was also not included in the SI. Those parasites that were covered by the SI ranked 2nd and 6th (*Toxoplasma* – congenital and acquired, respectively), 3rd and 7th (*Trichinella spiralis* and other *Trichinella* species, respectively), 5th (the 3 papers concerned with *Cryptosporidium*), and 12th (Opisthorchiidae) in the European prioritisation (Bouwknegt et al., 2018). It should, however, be noted that waterborne infection was not included directly (except when in fruit juice or on fresh produce) in the prioritisation exercises of FAO/WHO (2014) or of Bouwknegt et al. (2018). The major transmission route of *Cryptosporidium*, featuring predominantly in this SI, is probably via water.

Although this SI comprises only six research papers, the programme of EMOP 2020/2021 and the number of researchers included in the original outreach indicate that parasites transmitted by either food or water continue to be of importance in Europe and beyond. The next (14th) EMOP is due to be held in Wroclaw, Poland in August/September 2024. It seems to us that foodborne and waterborne parasites are likely to maintain their position of relevance and interest to the parasitology research community and will, again, feature highly in the next EMOP programme. We think that it might be of interest and value to use that occasion to again put together a SI to follow the progress of research efforts on this subject as presented to fellow parasitologists at the 14th EMOP. We put this idea forth already now as a challenge for scientists attending to consider preparing both presentations for the conference and also related articles for another similar SI.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Lucy J Robertson reports a relationship with European Federation of Parasitologists that includes: board membership. Thomas Romig reports a relationship with European Federation of Parasitologists that includes: board membership. Both authors (Lucy Robertson and Thomas Romig) are GE for this SI - the manuscript is basically an editorial. In addition Lucy Robertson is an AE of this journal.

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