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Review paper

Zoonotic potential of *Eustrongylides spp.* in freshwater fish meat

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ABSTRACT

Parasites from the genus *Eustrongylides* spp. are widespread throughout the world in numerous species of freshwater fish and represent a significant hazard for humans. The development cycle of this parasite is complex. Definitive hosts are fish-eating birds while fish are intermediate host or paratenic host. Humans are accidental hosts and some clinical cases requiring surgical intervention have been reported, making eustrongylidosis a serious zoonotic disease. The aim of the paper is to present the most important characteristics of this parasite, previous findings in various fish species around the world, clinical cases in humans, prevention measures, as well as some aspects of current national and European regulations.

1. Introduction

In recent years, a constant trend of increased fish consumption has been noticeable around the world (*Tacon*, 2023). Fish is an important part of a healthy diet due to its nutritional properties (*Ljubojević et al.*, 2017; *Chen et al.*, 2022). However, the fact that fish can be a source of zoonoses must not be ignored (*Ljubojević et al.*, 2016; *Williams et al.*, 2022). Parasites, as well as their larval forms in fish meat, lead to sensory changes in fish meat, and fish that is visibly invaded by parasites is assessed as hygienically unfit for human consumption. In addition, certain parasites that may be present in freshwater fish have significant zoonotic potential, pose a serious risk and can lead to serious disease in humans (*Ljubojević et al.*, 2012). Roundworms are nematodes belonging to the genus *Eustrongylides* in the family *Dioctophymatidae* are present worldwide in many fish species, including species that are commercially important. The aim of the paper is to present the most important features of this parasite, its worldwide distribution, recorded clinical cases in humans, preventive measures, as well as some points of current national and European legislation, as well as various recommendations of relevant bodies.

2. Development cycle of *Eustrongylides* spp.

The development cycle of parasites from the genus *Eustrongylides* is very complex. Adult forms of the parasite are found in fish-eating birds, which are also the main host of this parasite. These birds that live near different water surfaces spread parasite eggs in the aquatic ecosystem with their faeces. *Oligochaeta* eat the eggs that reach the aquatic ecosys-

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tem, and in them, the development cycle continues by releasing the larvae. The next transitional hosts are fish that feed on the oligochaetaes, while the parasitological stage developed in them is infectious for the final host, i.e. for fish-eating birds, but also for predatory fish (*Novakov et al.*, 2013). Predatory fish are paratenic hosts and can transmit the parasite to piscivorous birds. Larvae reach sexual maturity quickly in fish-eating birds, where they lay eggs and complete their life cycle (*Orajić et al.*, 2023). Humans are accidental hosts.

3. Worldwide distribution of *Eustrongylides spp.*

Undoubtedly, anthropogenic influences through environmental pollution, climate change, construction of dams, as well as changes in people's habits when it comes to migration, tourism, and methods

Table 1. Worldwide distribution of Eustrongylides spp. in different fish species

Fish species	Country and/or region	Reference
Perch (*Perca fluviatilis*); largemouth black bass (*Micropterus salmoides*); Big-scale sand smelt (*Atherina boyeri*); eel (*Anguilla anguilla*); black bullhead (*Ictalurus melas*); carp (*Cyprinus carpio*); tench (*Tinca tinca*); pumpkinseed sunfish (*Lepomis gibbosus*)	Central Italy, the Trasimeno Lake	*Franceschini et al*., 2022
Perca fluviatilis, Lepomis gibbosus, Micropterus salmoides	Northern Italy, Lake Garda	*Menconi et al*., 2021
Big-scale sand smelt (*Atherina boyeri*)	Italy, Lake Massaciuccoli	*Guardone et al*., 2021
European perch (*Perca fluviatilis)*, largemouth black bass (*Micropterus salmoides*), sand smelt (*Atherina boyeri)*	Italy, Trasimeno Lake	*Branciari et al*., 2016
Perch (*Perca fluviatilis*, Linnaeus)	Central Italy, Trasimeno Lake (Umbria region)	*Dezfuli et al*., 2015
39 species of prey fish species and piscivorous fish species	USA, Florida	*Coyner et al*., 2002
European catfish (*Siluris glanis*)	Serbia, Danube-Tisa-Danube Canal in the territory of Novi Sad	*Novakov et al*., 2013
Pike-perch (*Sander lucioperca*)	Serbia, Vojvodina, Danube-Tisa-Danube Canal in the city area of Novi Sad	*Bjelić-Čabrilo et al*., 2013
Glossogobius giuris (Ham.)	India	*Kaur et al*., 2013
Odontobutis obscurus, *Silurus asotus*, *Culter mongolicus*, *Acanthogobius flavimanus*, *Monopterus albus*, *Channa argus*, *Channa asiatica*	China, nine localities	*Xiong et al*., 2013
Bigmouth sleeper (*Gobiomorus dormitory*)	Mexico, El Mezquital, Matamoros Tamaulipas,	*Salgado-Maldonado*, 2006
Bigmouth sleeper (*Gobiomorus dormitory*)	Northeastern Mexico, four coastal localities of Tamaulipas	*Garrido-Olvera et al*., 2022
Murray cod and Murray cod-trout cod hybrids	Australia	*Shamsi et al*., 2023
Hoplia malabaricus	Brazil, the Brazilian Amazon	*Correa et al*., 2023

of preparing and eating fish, contribute to changes in the prevalence of fish parasites, and contribute to parasites becoming global, not only health but also a significant economic problem (*Baltić et al*., 2013). Nematode larvae *Eustrongylides* spp. are distributed worldwide in numerous fish species, and some of the findings are shown in Table 1.

Parasites were mostly recorded in fish from wild catch, but some cases were also recorded in farmed fish. *Mitchell et al.* (2009) reported a case of mortality caused by *Eustrongylides ignotus* in commercially farmed sunshine bass, a hybrid cross of female-white bass, and male-striped bass in the USA. *Hernández-Ocampo et al.* (2012) described the occurrence of parasites in farmed fish in Mexico. *Kundu et al.* (2016) reported the presence of parasites in *Channa punctatus* fish (17–21 cm in length) collected from fish farms in Naihati and Kalyani, West Bengal.

4. Public health issues

The importance of parasites from the genus *Eustrongylides* from the aspect of public health is mostly in the fact that the larvae are not only present in the digestive tract but also in the meat of various types of fish (*Ljubojević et al*., 2012; *Novakov et al*., 2013). Findings of *Eustrongylides* larvae and clinical cases of the disease have been described in humans after consumption of raw or insufficiently thermally processed fish carrying third or fourth stage larvae (Table 2). The majority of patients required abdominal surgery.

Diseases caused by fish parasites are most often associated with Asia, but the risk has increased significantly in other parts of the world due to changes in aquaculture, tourism and increased transport and distribution of both fish and people. Additionally, methods of fish meat preparation are one of the most important factors contributing to the appearance

Table 2. Reported clinical cases of eustrongylidosis in humans

Region/Country	Number and age of patients	Symptoms	Reference
California, USA	One adult man	Under the skin granulomas in the chest contained the *Eustrongylides* nematodes	*Beaver and Theis*, 1979
Maryland, USA	Two fishermen	Progressive spastic pains of the stomach area 24 hours after the parasites got into gastrointestinal tract	*Guerin et al*., 1982
Baltimore, USA	Three adult patients	Parasites emerging from a patient's intestinal wall into the abdominal cavity were observed by laparoscopy. Two patients required abdominal surgery while one was treated medically.	*Gunby*, 1982
New York City, USA	A college student	A 10-hour history of pain in stomach	*Wittner et al*., 1989
New Jersey, USA	17-year-old youth	Intense abdominal pain in the right lower quadrant. Two large living nematodes were surgically removed from the peritoneal cavity	*Eberhard et al*., 1989
USA	A 17-year-old white male patient	Right lower quadrant pain, laparotomy for suspected acute appendicitis, a temperature of 38°C	*Narr et al*., 1996
South Sudan	Two women, 23 and 24 years of age	Fourth-stage larvae of *Eustrongylides* emerged from the lower limb of patients	*Eberhard and Ruiz-Tiben*, 2014

of diseases caused by parasites. *Eiras et al.* (2017) reported that people travelling abroad can also transfer parasites. According to the available data, no cases of disease in humans have been recorded in Serbia so far. However, the presence of this parasite in fish caught in rivers or canals in Serbia have been recorded (*Bjelić-Čabrilo et al.*, 2013; *Ćirković et al.*, 2013; *Novakov et al.*, 2013), which is very significant, but more extensive research is necessary in order to get a better picture of the epidemiology of this parasite in our country and to determine adequate measures in the form of monitoring, but also for potential sanitary measures. The big problem is that when it comes to fish-borne parasites there are very little data, many cases are unreported and those that are reported are mostly discovered by chance.

5. Diagnosis

A reliable diagnosis is achieved by visual inspection and dissection of a group of fish, as well as considering the places where parasites appear and the characteristic appearance of the parasites. Parasites of the genus *Eustrongylides* are relatively long, smooth and round in shape, and due to the presence of haemoglobin, they are a red colour (*Oraić et al.*, 2023). Beside visual inspection, candling is also applied. Both methods are highly dependent on the training and skill of the operator, as well as the type of sample being examined. In addition to these methods, other methods are also applied, such as the UV-press method (*ISO 23036-1*, 2021) the digestion method (*ISO 23036-2*, 2021) and the method that involves placing all internal organs in a container filled with water and leaving it to incubate at room temperature overnight (*Shamsi and Suthar*, 2016). These methods are very difficult to apply in routine work by food business operators and are mainly used in laboratories. The importance of fish-borne parasites is recognized, but there is still a problem that there are not enough standardized analytical methods and validated procedures for testing fish for the presence of parasites (*Chalmers et al.*, 2020).

6. Prevention and control

Prevention is possible by interrupting the developmental cycle of the parasite, i.e., by removing one of the transitional hosts or by removing the final host from the parasite's developmental cycle. Sanitation of fish ponds is a preventive solution for farmed fish, and as previously noted, very few cases of eustrongylidosis have been reported in aquacultured fish. The most important measure of prevention is the consumption of thermally well-processed fish. Recommendations are to avoid raw or thermally insufficiently treated fish in the diet. Very little data is available on the impact of different processing technologies on the survival of parasites in fish. Thermal treatment with the correct application of the ratio of time and temperature is one of the safest measures (*Ljubojević et al.*, 2015). In addition, adequate freezing is an adequate measure for parasites from the genus *Eustrongylides*, while fish preservation methods in the form of brining or pickling can reduce but not eliminate or reduce to an acceptable level the hazard for humans from *Eustrongylides* parasites (FDA, 2022). The presence of visible parasites means that the fish is not suitable for human consumption according to both European and Serbian regulations (*EC 178*, 2002; *Official Journal of RS, 41*, 2009 ; *17*, 2019), which causes significant economic consequences. *Franceschini et al.* (2022) reported in details the parasitological risk management carried out by food business operators to detect and remove visible parasites during different fish processing methods in order to prevent the placing on the market of fish contaminated with visible parasites according to *EC 2074* (2005). The larvae, due to their characteristic appearance, are relatively visible both in the organs and in the flesh of the fish, which enables them to be detected and removed by food business operators. Furthermore, in case of heavy infestation, fish could be discarded. Also, there are guides from various relevant organizations when it comes to processing fish in order to eliminate the risk of parasites (*Codex Alimentarius*, 2009; *ESSA*, 2018). The correct application of preventive procedures according to the European legislation for risk management that exists for fish from the sea is very important, i.e., that the same procedures are applied to freshwater fish, especially taking into account the changes in people's behaviour and habits when it comes to food, by which they have impact on the spread of zoonoses through the consumption of infected fish.

7. Conclusion

The best preventive measure when it comes to the risk of *Eustrongylides* spp. from fish to human health is visual inspection of fish by entities in the food business along with proper fish preparation. Continuous veterinary sanitary control of fish and fish products is necessary when placing them on the market, bearing in mind the zoonotic poten-

tial of this parasite, i.e., that it is a danger to human health. Certainly, there is a need for a multidisciplinary approach to the problem in terms of the cooperation of different sectors, i.e., the inclusion of state institutions, scientific institutions, professional organizations of the veterinary and agricultural and biological professions and production entities in order to conduct wider research and establish the real impact of parasites on production in aquaculture, and including losses due to damage caused by parasites. All this should contribute to the adoption of more detailed regulations related to this issue.

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References

Baltić, M., Bošković, M., Djordjević, V., Marković, R., Dimitrijević, M. & Pavličević, N. (2013). Fish-borne parasitic zoonoses with special reference to anthropogenic impact. 6. International Conference "Water & Fish" Faculty of Agriculture, Belgrade-Zemun, Serbia, 129–135.

Beaver, P. C. & Theis J. H. (1979). Dioctophymid larval nematode in a subcutaneous nodule from man in California. *American Journal of Tropical Medicine and Hygiene*, 28, 206–212, https://doi.org/10.4269/ajtmh.1979.28.206

Bjelić-Čabrilo, O., Novakov, N., Ćirković, M., Kostić, D., Popović, E., Aleksić, N. & Lujić, J. (2013). The first determination of *Eustrongylides excisus* Jägerskiöld, 1909: larvae (Nematoda: Dioctophymatidae) in the pike-perch *Sander lucioperca* in Vojvodina (Serbia). *Helminthologia*, 50, 291–294, https://doi.org/10.2478/s11687-013-0143-1

Branciari, R., Ranucci, D., Miraglia, D., Valiani, A., Veronesi, F., Urbani, E., Lo Vaglio, G., Pascucci, L. & Franceschini, R. (2016). Occurrence of parasites of the genus *Eustrongylides* spp. (Nematoda: Dioctophymatidae) in fish caught in Trasimeno lake, Italy. *Italian Journal of Food Safety*, 5, 206–209, https://doi.org/10.4081/ijfs.2016.6130

Chalmers, R., Robertson, L., Dorny, P., Jordan, S., Kärssin, A., Katzer, F., La Carbona, S., Lalle, M., Lassen, B., Mladineo, I., Rozycki, M., Bilska-Zajac, E., Schares, G., Mayer-Scholl, A., Trevisan, C., Tysnes, K., Vasilev, S. & Klotz, C. (2020). Parasite detection in food: Current status and future needs for validation. *Trends in Food Science & Technology*, 99, 337–350, https://doi.org/10.1016/j.tifs.2020.03.011

Chen, J., Jayachandran, M., Bai, W. & Xu, B. (2022). A critical review on the health benefits of fish consumption and its bioactive constituents. *Food Chemistry*, 369, 130874, https://doi.org/10.1016/j.foodchem.2021.130874.

Codex Alimentarius, (2009). Code of Practice for fish and fishery products. First edition World Health Organization Food And Agriculture Organization Of The United Nations Rome, Italy. Retrieved from https://www.fao.org/3/a1553e/a1553e00.pdf, Accessed May 2023.

Correa, L. L., Soares, G. B., Müller, M. I. & Adriano, E. A. (2023). First morphological and molecular characterization of the genus *Eustrongylides* nematode larvae infecting fish in the Brazilian Amazon. *Biologia*, 1–8, https://doi.org/10.1007/s11756-023-01422-6

Coyner, D. F., Spalding, M. G. & Forrester, D. J. (2002). Epizootiology of *Eustrongylides* ignotus in Florida: Distribution, density, and natural infections in intermediate hosts. *Journal of Wildlife Diseases*, 38(3), 483–499, https://doi.org/10.7589/0090-3558- 38.3.483

Ćirković, M., Novakov, N., Petrović, J., Ljubojević, D., Apić, J., Babić, J. & Teodorović, V. (2013). Finding of parasitic nematodes of fishes present in the market. *Archives of Veterinary Medicine*, 6(2), 3–13.

Dezfuli, B. S., Manera, M., Lorenzoni, M., Pironi, F., Shinn, A. P. & Giari, L. (2015). Histopathology and the inflammatory response of European perch, muscle infected with *Eustrongylides* sp. (Nematoda). *Parasites & Ve*ctors, 8, 227, https://doi.org/10.1016/j.foodres.2014.06.038

Eberhard, M. L. & Ruiz-Tiben, E. (2014). Case report: Cutaneous emergence of *Eustrongylides* in two persons from South Sudan. *The American Journal of Tropical Medicine and Hygiene*, 90(2), 315–317, https://doi.org/10.4269/ajtmh.13-0638

Eberhard, M. L., Hurwitz, H., Sun, A. M. & Coletta, D. (1989). Intestinal perforation caused by larval *Eustrongylides* (Nematoda: Dioctophymatoidea) in New Jersey. *The American Journal of Tropical Medicine and Hygiene*, 40, 648–650, https://doi.org/10.4269/ajtmh.1989.40.648

EC, 178/2002 (2002). Commission Regulation (EC) No 178/2002 of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. *Official Journal of the European Union*, 31, 1–24.

EC, 2074/2005 (2005). Commission Regulation (EC) No. 2074/2005 of 5 December 2005 laying down implementing measures for certain products under Regulation (EC) No 853/2004 of the European Parliament and of the Council and for the organisation of official controls under Regulation (EC) No 854/2004 of the European Parliament and of the Council and Regulation (EC) No 882/2004 of the European Parliament and of the Council, derogating from Regulation (EC) No 852/2004 of the European Parliament and of the Council and amending. *Official Journal of the European Union*, 50, 27–59.

Eiras, J. C., Pavanelli, G. C., Takemoto, R. M. & Nawa, Y. (2018). An overview of fish-borne nematodiases among returned travelers for recent 25 years–unexpected diseases sometimes far away from the origin. *The Korean Journal of Parasitology*, 56(3), 215–227, https://doi.org/10.3347/kjp.2018.56.3.215

ESSA, (2018). European guide to good practice for smoked and/or salted and/or marinated fish. Retrieved from https://food.ec.europa.eu/system/files/2018-10/biosafety_fh_guidance_essa_smoked-salted-marinated-fish.pdf. Accessed on April 2023.

FDA, (2022). Fish and fishery products hazards and controls guidance. Retrieved from: https://www.fda.gov/media/80637/download. Accessed 06 May 2022.

Franceschini, R., Guardone, L., Armani, A., Ranucci, D., Roila, R., Valiani, A., Susini, F. & Branciari, R. (2022). Five-years management of an emerging parasite risk (*Eustrongylides* sp., Nematoda) in a fishery supply chain located on Trasimeno Lake (Italy). *Food Control*, 136, 108858, https://doi.org/10.1016/j.foodcont.2022.108858

Garrido-Olvera, L., García-Prieto, L., Osorio-Sarabia, D., Sánchez-Martínez, J. G., Rábago-Castro, J. L., Hernández-Mena, D. I. & de León, G. P. P. (2022). Parasites with zoonotic potential found in commercially important fish in Tamaulipas, Northeastern Mexico. *Parasitology International*, 88, 102550, https://doi.org/10.1016/j.parint.2022.102550

Guardone, L., Ricci, E., Susini, F., Polsinelli, E., Guglielmone, G. & Armani, A. (2021). First detection of *Eustrongylides excisus* (nematoda: Dioctophymatidae) in big-scale sand smelt (*Atherina boyeri*) from the Lake Massaciuccoli (northwest Tuscany, Italy): Implications for public health and seafood quality. *Food Control*, 120, 107517, https://doi.org/10.1016/j.foodcont.2020.107517

Guerin, P. F., Marapendi, S. & Grail, L. (1982). Intestinal perforation caused by larval *Eustrongylides*. *The Morbidity and Mortality Weekly Report*, 31, 383–389.

Gunby, P. (1982). One worm in the minnow equals too many in the gut. *JAMA*, 248(2), 163.

Hernández-Ocampo, D., Pineda-López, R. F., Ponce-Palafox, J. T. & Arredondo-Figueroa, J. L. (2012). Parasitic helminth infection in tropical freshwater fishes of commercial fish farms, in Morelos State, Mexico. *International Journal of Animal and Veterinary Advances*, 4(5), 338–343.

ISO, 23036-1, (2021). Microbiology of the food chain — Methods for the detection of Anisakidae L3 larvae in fish and fishery products — Part 1: UV-press method. Retrieved from https://www.iso.org/standard/74372.html. Accessed May 2023.

ISO, 23036-2, (2021). Microbiology of the food chain — Methods for the detection of Anisakidae L3 larvae in fish and fishery products — Part 2: Artificial digestion method. Retrieved from https://www.iso.org/standard/74373.html. Accessed May 2023.

Kaur, P., Shrivastav, R. & Qureshi, T. A. (2013). Pathological effects of *Eustrongylides* sp. larvae (Dioctophymatidae) infection in freshwater fish, *Glossogobius giuris* (Ham.) with special reference to ovaries. *Journal of Parasitic Diseases*, 37(2), 245–250, https://doi.org/10.1007/s12639-012-0173-5

Kundu, I., Bandyopadhyay, P. K., Mandal, D. R. & Gürelli, G. (2016). Study of pathophysiological effects of the nematode parasite *Eustrongylides* sp. on freshwater fish *Channa punctatus* by hematology, serum biochemical, and histological studies. *Türkiye Parazitolojii Dergisi*, 40(1), 42–47, DOI: 10.5152/tpd.2016.4551

Ljubojevic, D., Novakov, N., Djordjevic, V., Radosavljevic, V., Pelic, M. & Cirkovic, M. (2015). Potential parasitic hazards for humans in fish meat. *Procedia Food Science*, 5, 172–175, https://doi.org/10.1016/j.profoo.2015.09.049

Ljubojevic, D., Pelic, M., Djordjevic, V., Milojevic, L. & Cirkovic, M. (2016). Bacterial hazards in fish meat: The aetiologic agents of foodborne diseases. *Meat Technology*, 57(1), 31–42.

Ljubojević, D., Bjelić-Čabrilo, O., Novakov, N., Ćirković, M., Davidov, I., Jovanović, M. & Aleksić, N. (2012). *Eustrongylides* sp. in freshwater fish species as a potential hazard for humans. In Proceedings of the International Conference Biological Food Safety and Quality. Faculty of Agriculture, Novi Sad , Serbia.

Ljubojević, D., Đorđević, V. & Ćirković, M. (2017). Evaluation of nutritive quality of common carp, *Cyprinus carpio* L. In IOP conference series: Earth and Environmental Science, 85(1), 012013, IOP Publishing, Zlatibor, Serbia.

Menconi, V., Tedesco, P., Pastorino, P., Confortini, I., Esposito, G., Tomasoni, M., Mugetti, D., Gustinelli, A., Dondo, A., Pizzul, E., Fioravanti, M. L. & Prearo, M. (2021). Could fish feeding behaviour and size explain prevalence differences of the nematode *Eustrongylides excisus* among species? The case study of Lake Garda. *Water*, 13(24), 3581, https://doi.org/10.3390/w13243581

Mitchell, A. J. (2009). Eustrongylides ignotus infecting commercial bass, *Morone chrysops* female X *Morone saxatilis* male, and other fish in the southeastern USA. *Journal of Fish Diseases*, 32, 795–799, https://doi.org/10.1111/j.1365-2761.2009.01051.x

Narr, L. L., O'Donnell, J. G., Libster, B., Alessi, P. & Abraham, D. (1996). Eustrongylidiasis: a parasitic infection acquired by eating live minnow. *Journal of Osteopathic Medicine*, 96, 400–402, https://doi.org/10.7556/jaoa.1996.96.7.400

Novakov, N., Bjelic-Cabrilo, O., Cirkovic, M., Ljubojevic, D., Lujic, J., Davidov, I., & Jovanovic, M. (2013). Eustrongylidosis of European catfish (*Siluris glanis*). *Bulgarian Journal of Agricultural Science*, 19(1), 72–76.

Official Journal of RS 41/2009, 17/2019. Food Safety Law.

Oraić, D., Giovanna Zupičić, I. & Zrnčić, S. (2023). Eustrongilidoza riba: Pregledni članak. *Veterinarska Stanica*, 54(1), 107–113, https://doi.org/10.46419/vs.54.1.5

Salgado-Maldonado, G. (2006). Checklist of helminth parasites of freshwater fishes from Mexico. *Zootaxa*, 1324(1), 1–357, https://doi.org/10.11646/zootaxa.1324.1.1

Shamsi, S. & Suthar, J. (2016). A revised method of examining fish for infection with zoonotic nematode larvae. *International Journal of Food Microbiology*, 227, 13‒16, https://doi.org/10.1016/j.ijfoodmicro.2016.03.023

Shamsi, S., Francis, N., Masiga, J., Barton, D. P., Zhu, X., Pearce, L. & McLellan, M. (2023). Occurrence and characterisation of *Eustrongylides* species in Australian native birds and fish. *Food and Waterborne Parasitology*, 30, e00189, https://doi.org/10.1016/j.fawpar.2023.e00189

Tacon, A. G. (2023). Contribution of fish and seafood to global food and feed supply: An analysis of the FAO food balance sheet for 2019. *Reviews in Fisheries Science & Aquaculture*, 31(2), 274–283, https://doi.org/10.1080/23308249.2022.2124364

Williams, M., Hernandez-Jover, M. & Shamsi, S. (2022). Parasites of zoonotic interest in selected edible freshwater fish imported to Australia. *Food and Waterborne Parasitology*, 26, e00138, https://doi.org/10.1016/j.fawpar.2021.e00138

Wittner, M., Turner, J. W., Jacquette, G., Ash, L. R., Salgo, M. P. & Tanowitz, H. B. (1989). Eustrongylidiasis: a parasitic infection acquired by eating sushi. The New England *Journal of Medicine*, 320, 1124–1126, https://www.nejm.org/doi/pdf/10.1056/NEJM198904273201706

Xiong, F., Li, W. X., Wu, S. G., Zou, H. & Wang, G. T. (2013). Molecular phylogeny and host specificity of the larval *Eustrongylides* (Nematoda: Dioctophmidae) from freshwater fish in China. *The Journal of Parasitology*, 99(1), 137–144, https://doi.org/10.1645/GE-3163.1