Parasites as food borne zoonosis pathogens

II Webinar of the WOAH National Focal Points for Aquatic Animals in Europe
December 5th, 2024


From Shinsen Yamaino Soushi, by Daizennosuke Koan (1850).

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Fish-borne parasitic zoonoses

More than 500 M of human estimated at risk

Neglected diseases in Public Health for:

diagnostic difficulties

sanitary, economic and social impact unknown

complex human behaviour

biology, epidemiology and clinical aspects still poorly known

Fish-borne parasitic zoonoses

During last years an increasing interest for fish-borne parasitic zoonoses due to:

- expansion of production and international commercial trade in fishery products
- changing of culinary habits towards an increasing consumption of raw/undercooked/marinated fish
- globalization and migration flows across world

INCREASED RISK OF ACQUIRING FISH-BORNE PARASITIC ZOONOSES

800 million people continue to suffer from chronic malnourishment worldwide
Global population is expected to reach 9.6 billion people by 2050 – with a concentration in coastal urban areas –huge challenge of feeding our planet

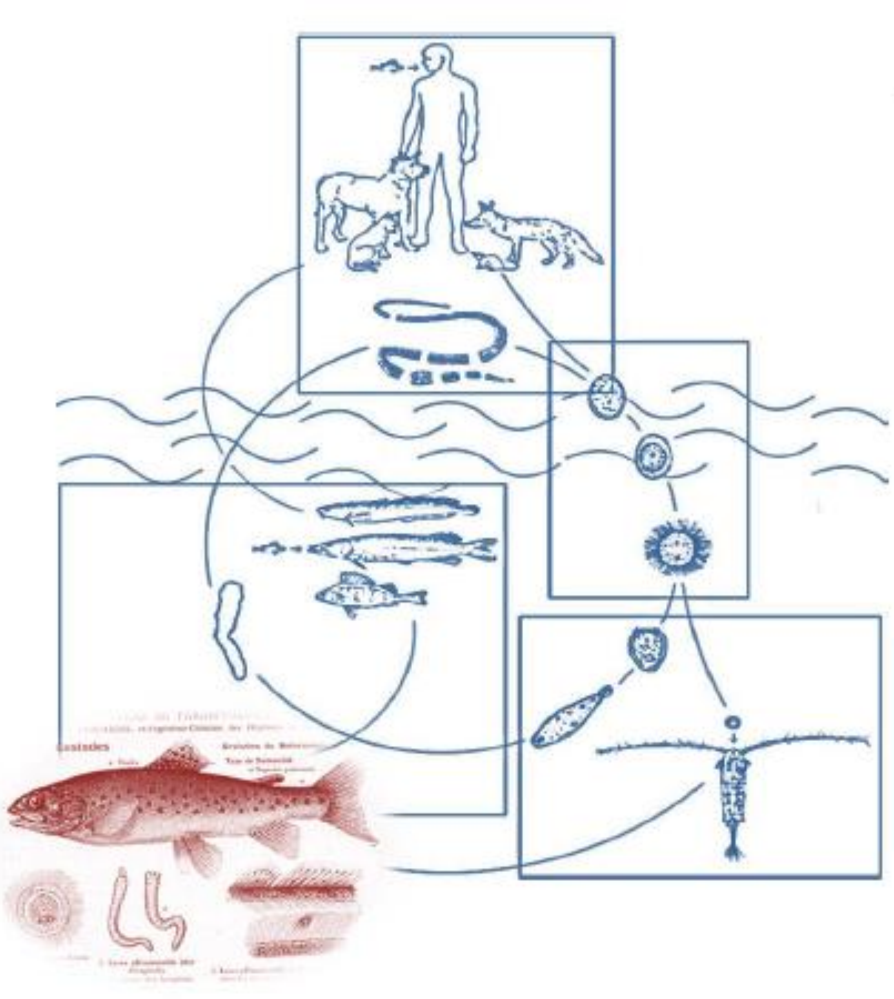
Fisheries and aquaculture could play a significant role in eliminating hunger, promoting health and reducing poverty. Fish continues to be one of the most-traded food commodities worldwide. It is especially important for developing countries, sometimes worth half the total value of their traded commodities (FAO, 2014)

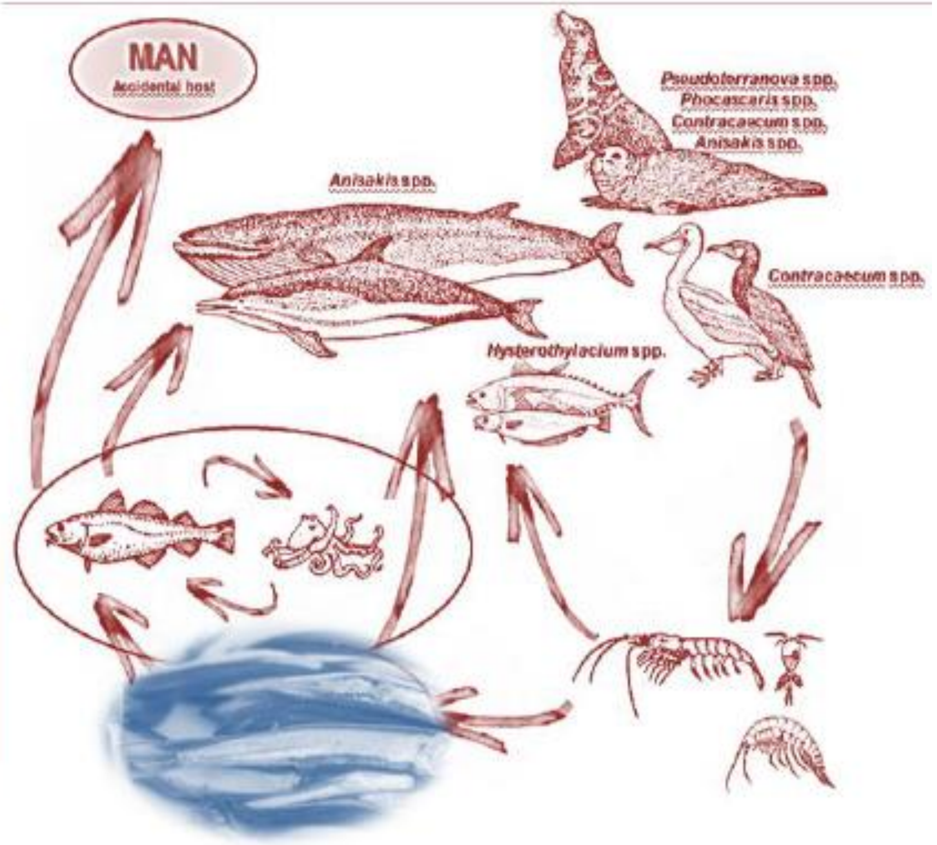
Fish-borne parasitic zoonoses

Although currently WHO includes, with regard to zoonotic fish helminthes, only Opisthorchiidae (namely *Opisthorchis* spp. and *Clonorchis* spp.) in the priority list of the foodborne parasites "that could produce a substantive burden of disease" (Torgerson et al., 2014, Trends Parasitol., 30: 20-26) …it is undeniable that other fish parasites such as Anisakid nematodes and Diphyllobothriid cestodes should be taken into account when considering the zoonotic risks linked to European fish products consumption.

In fact, according to EFSA Scientific Opinion on risk assessment of parasites in fishery products (European Food Safety Authority, 2010, EFSA J., 8, 1543)…
…all wild fish should be considered at risk of containing any viable zoonotic parasites if these products are to be eaten raw or almost raw, pointing out the need to carry out epidemiological surveys on presence/diffusion of zoonotic parasites in all fishery grounds.

Several zoonotic helminths can be transmitted through consumption of raw and/or undercooked fish products to humans, since fish actively participate to biological cycles of heteroxenous parasites which involve man as definitive or accidental host, causing different degrees of pathology.





Parasites in Fishery products

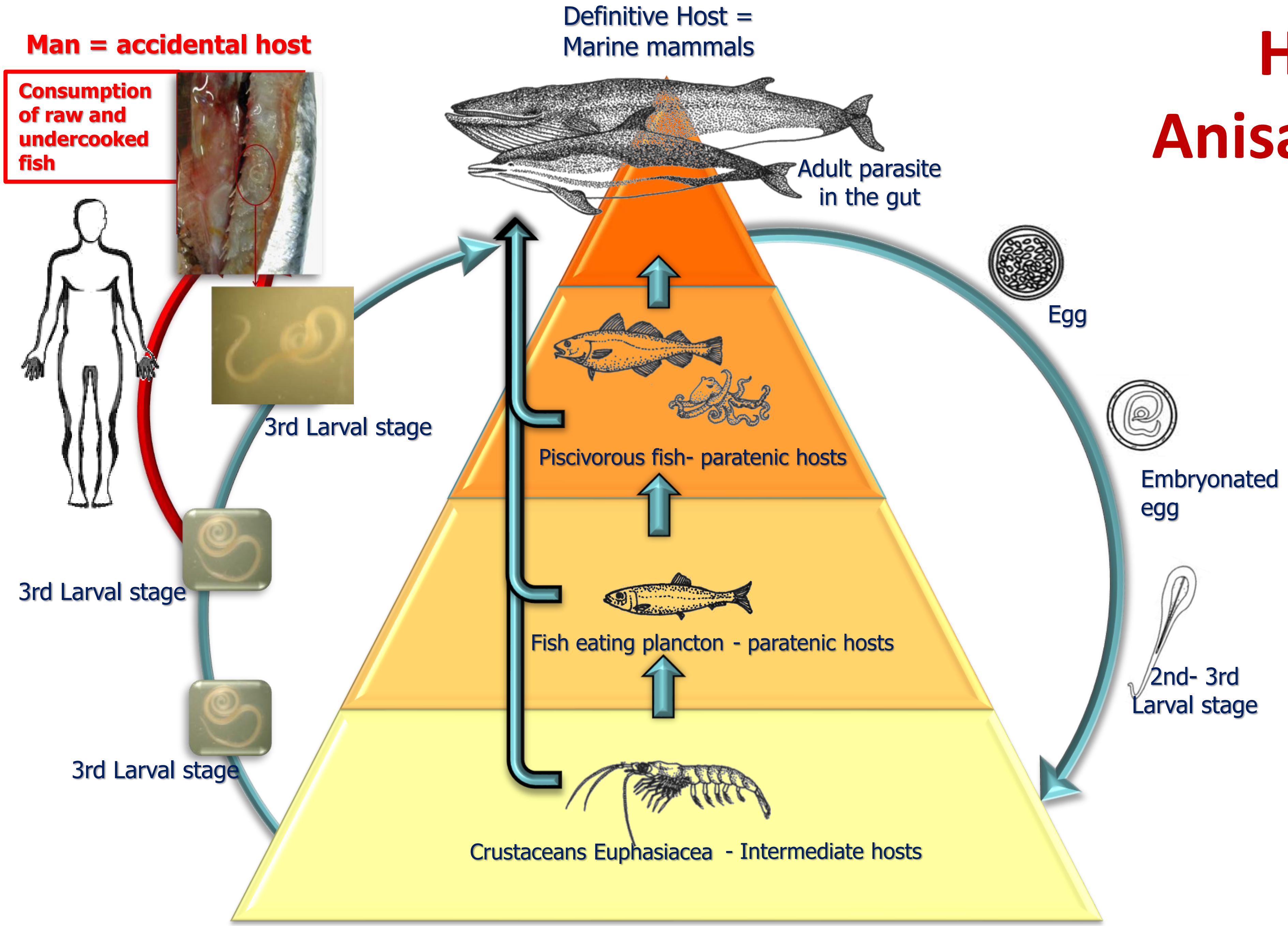
Zoonotic parasites

- Larval stages of Nematodes Anisakidae of the genera *Anisakis* and *Pseudoterranova (Phocanema)*
- Larval stages of Trematoda digenea Opisthorchiidae and Heterophyidae
- Larval stages of Cestoda Diphyllobothriidae

Not zoonotic parasites

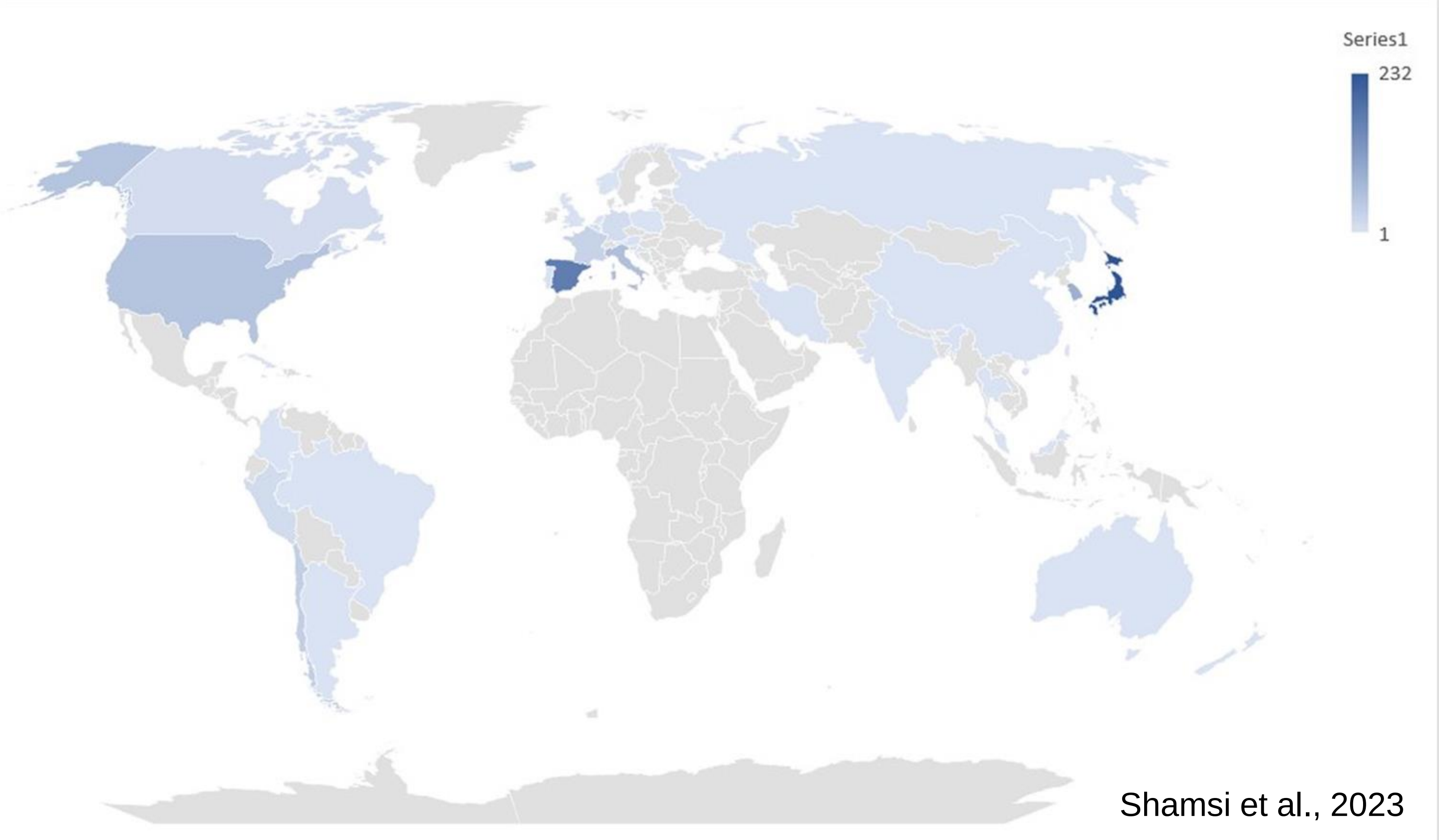
- Larval stages and adults of Nematodes Anisakidae of the genus *Hysterothylacium*
- Larval stages of Trematoda digenea
- Encysting parasites of Microsporidia e Myxozoa
- Parasites causing skeletal and muscular deformities: Myxozoa
- Crustaceans ectoparasites

Human Anisakiasis



Life cycle of *Anisakis* spp. – transmission through the trophic chain

Geographical distribution of human Anisakiasis



Shamsi et al., 2023

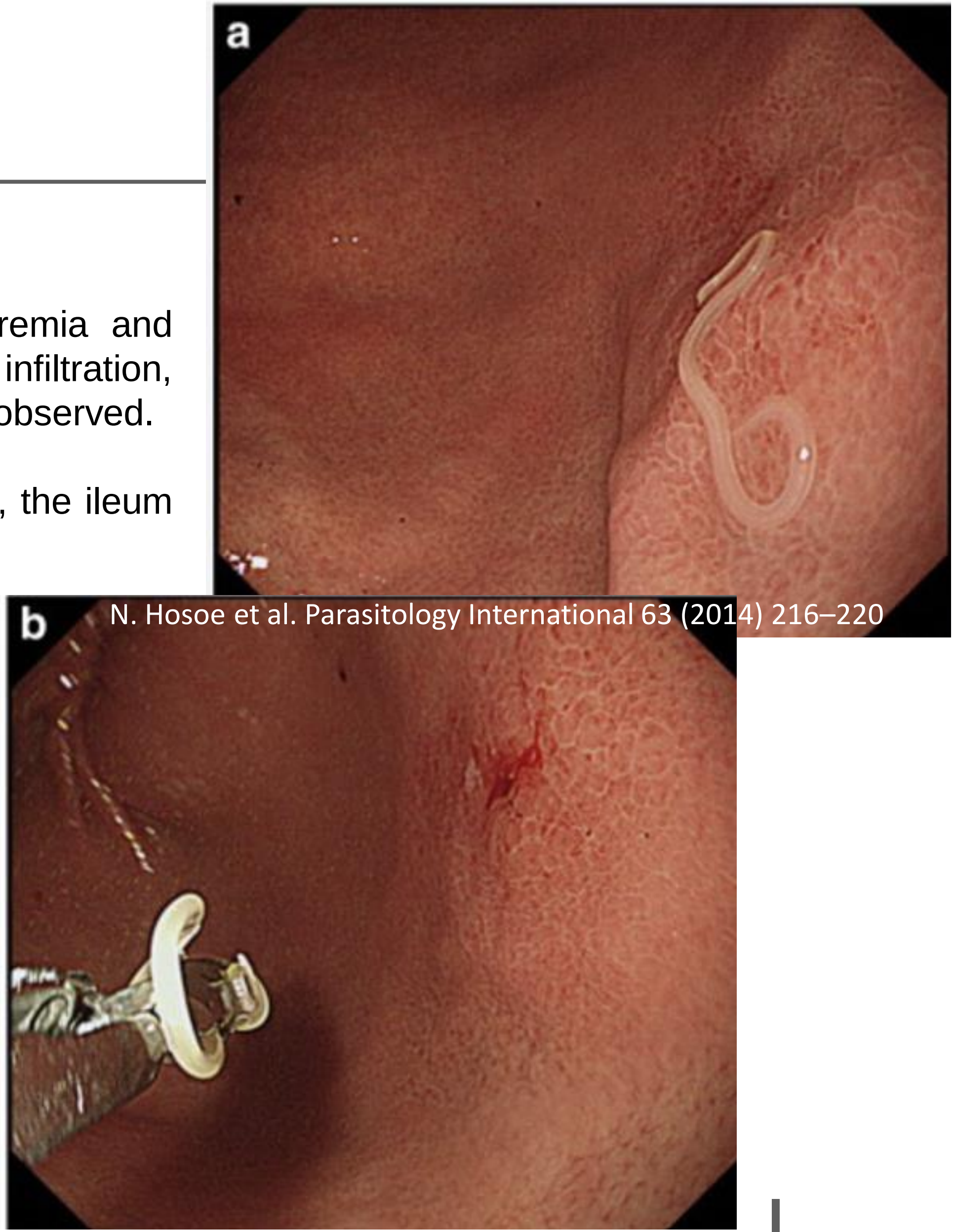
Human Anisakiasis

invading form

After penetration of the larva on the gastric/intestinal wall, causing edema, hyperemia and sometimes bleeding, they an inflammatory reaction with eosinophilic and lymphocytic infiltration, followed by connective tissue proliferation resulting in granuloma formation is frequently observed.

Invasion of the stomach wall is more frequently than the intestinal wall; In the intestine, the ileum seems to be more involved.

Most of them remain in the submucusal layer, but some can reach the abdominal cavity penetrating the entire wall thickness.



N. Hosoe et al. Parasitology International 63 (2014) 216–220

Allergic form

Growing awareness for potentially life-threatening allergic reactions when the parasite penetrate the gastric mucosa.

These reactions are characterized by urticaria, occurring generally on the arms and abdomen, and by angioedema or anaphylaxis.

Anisakis antigens seem resistent to cooking and freezing process.

Probably a previous contact with *Anisakis* allergens is necessary for the allergic reaction

Dibothriocephalosis by *Dibothriocephalus latus* (ex *Diphyllobothrium latum*)

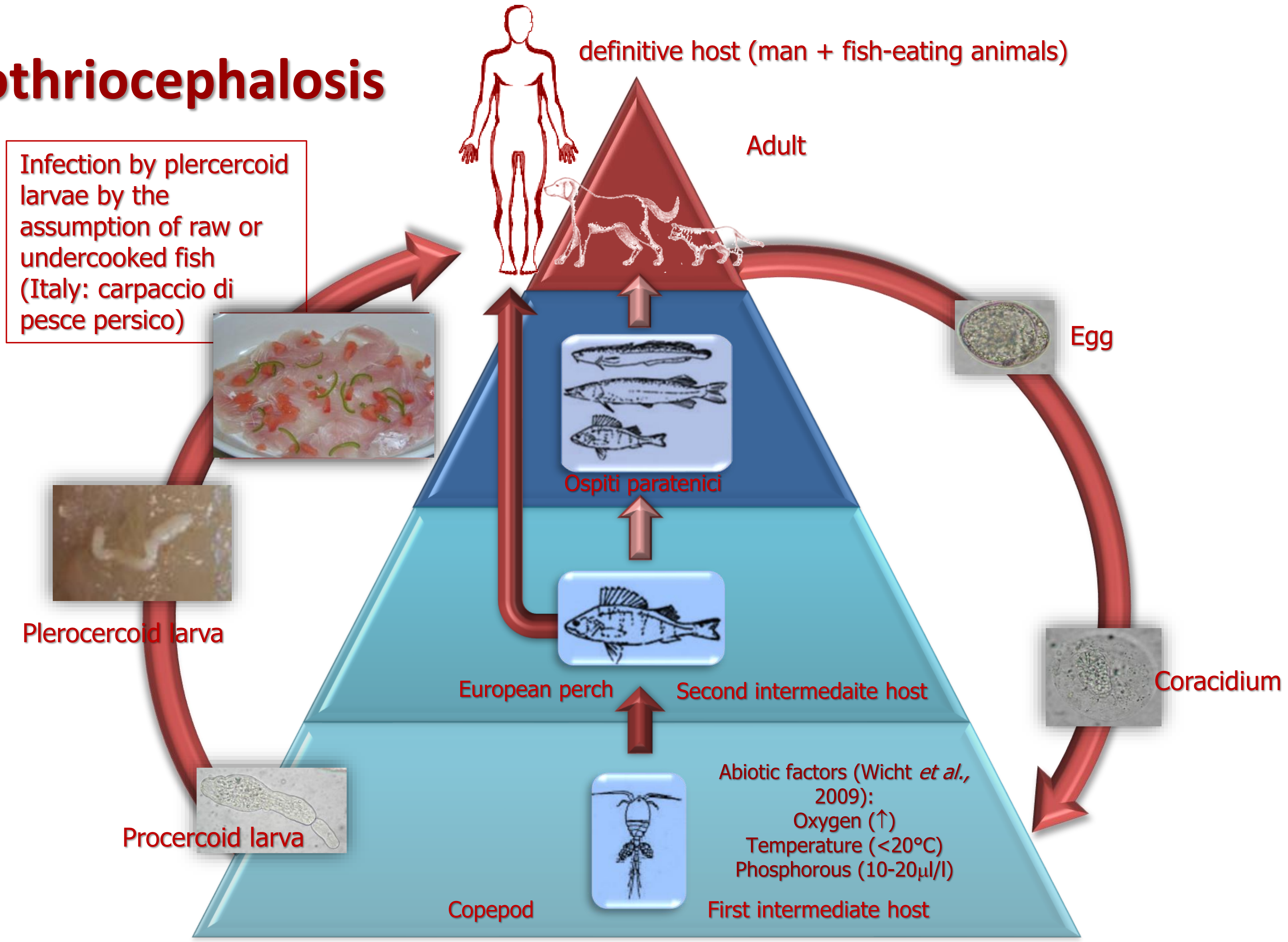
Tapeworms of the genus *Dibothriocephalus*, commonly called “broad tapeworms” or “fish tapeworms,” have been known as intestinal parasites of humans for a long time.

Yr	Event
10000–4000 BC	Earliest evidence of human infection (Peru)
4000 BC	Eggs of *Diphyllobothrium* in France and Germany
1592 AD	First recognizable description (T. Dunus in Locarno, Switzerland)
1747 AD	First recognition of the link between the parasite and fish by H. D. Spöring
1758 AD	The species named as *Taenia lata* by C. Linnaeus
1819 AD	First scientific description of *D. latum* (as *Bothriocephalus latus*)
End of the 19th century	Elucidation of transmission to humans through consumption of infected fish
1917 AD	Elucidation of the role of copepods as first intermediate hosts

In the early 1970s, Dibothriocephalosis was estimated to affect **9 million humans globally, with 5 million in Europe, 4 million in Asia, and the rest in America. More recent data indicate that 20 million people are infected worldwide**, but no recent estimation concerning the global prevalence of this parasitosis has been done

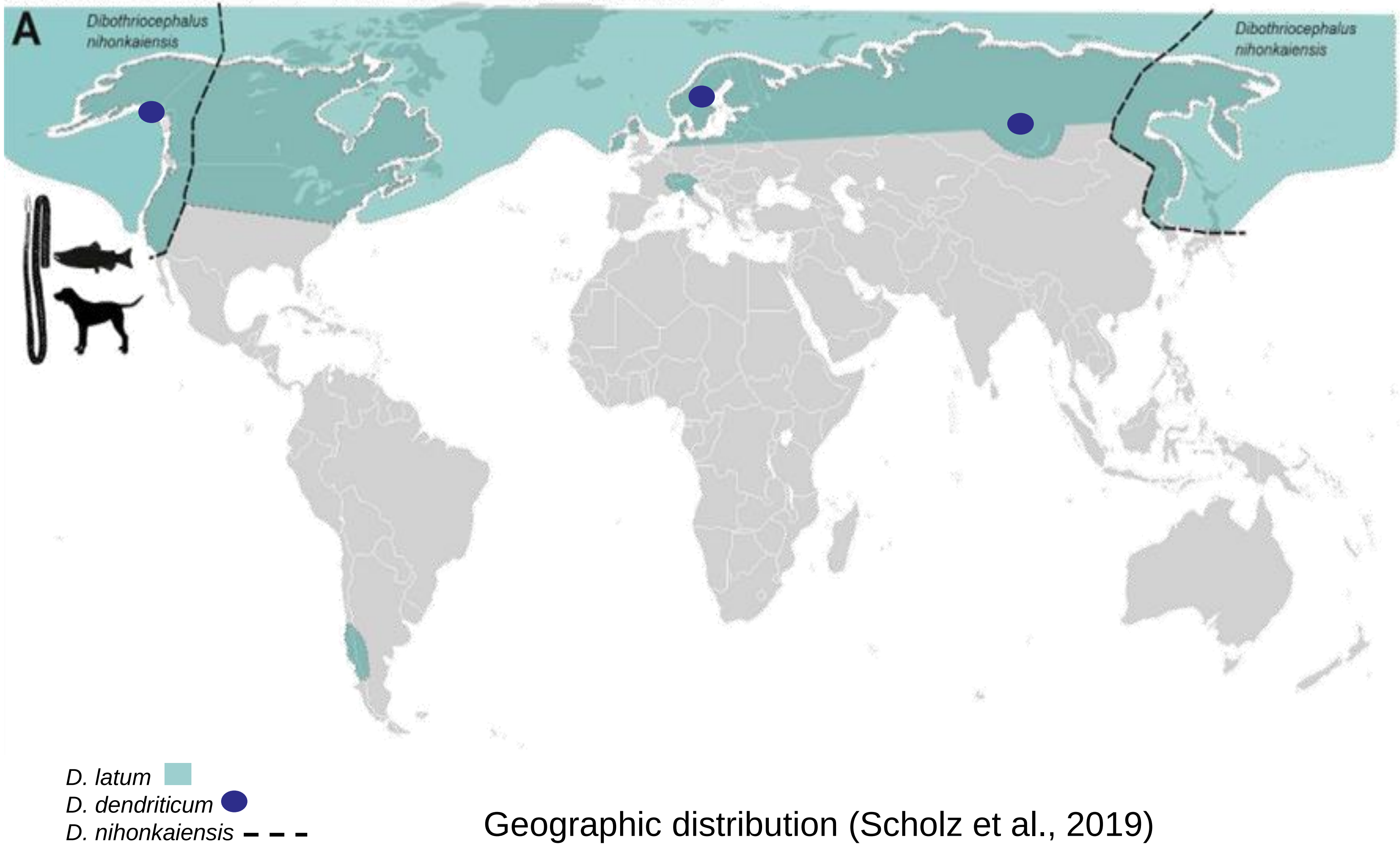
In the last years decline of human Dibothriocephalosis in several countries, particularly in North America, Asia and most of Europe. In contrast, Dibothriocephalosis has shown a re-emergence in some countries such as Russia, South Korea, Japan and South America (Argentina). Several cases have also been recently reported from the regions where a disappearance of the disease had been expected, such as Alpine lakes in Switzerland, northern Italy, and eastern France

Human Dibothriocephalosis



Life cycle of *Dibothriocephalus latus* / transmission through the trophic chain

Dibothriocephalosis by *Dibothriocephalus latus* (ex *Diphyllobothrium latum*)



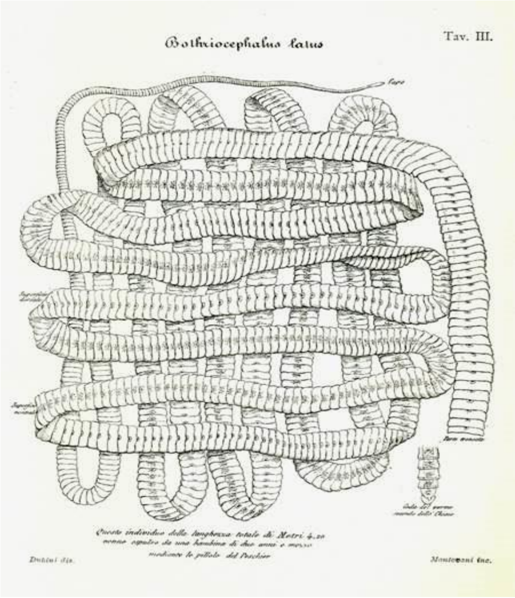
Geographic distribution (Scholz et al., 2019)

HUMAN DIBOTHRIOCEPHALOSIS

Diphyllobothrium tapeworms are among the largest parasites of humans and may grow up to 2 to 15 m in length as adults in the intestine.

The maximum length (up to 25 m) was reported for tapeworms with as many as 4,000 segments.

The growth rate may be as high as 22 cm/day, or almost 1 cm/h. These parasites may live up to 20 years or longer; a patient with an infection more than 25 years old was reported by Dogiel. Species of Diphyllobothrium are characterized by a scolex with a paired slit-like attachment groove (bothrium) on the dorsal and ventral surfaces, dividing it into two lips or leaves



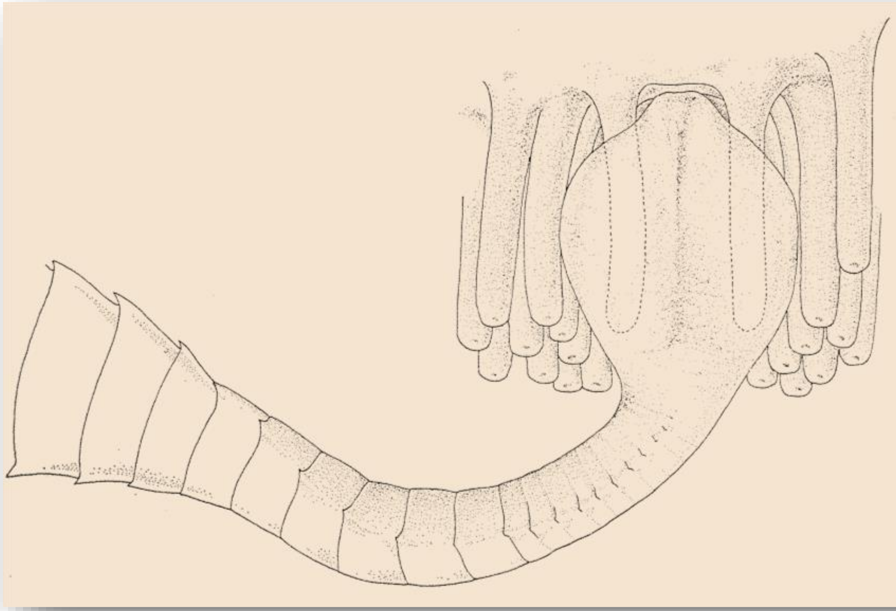
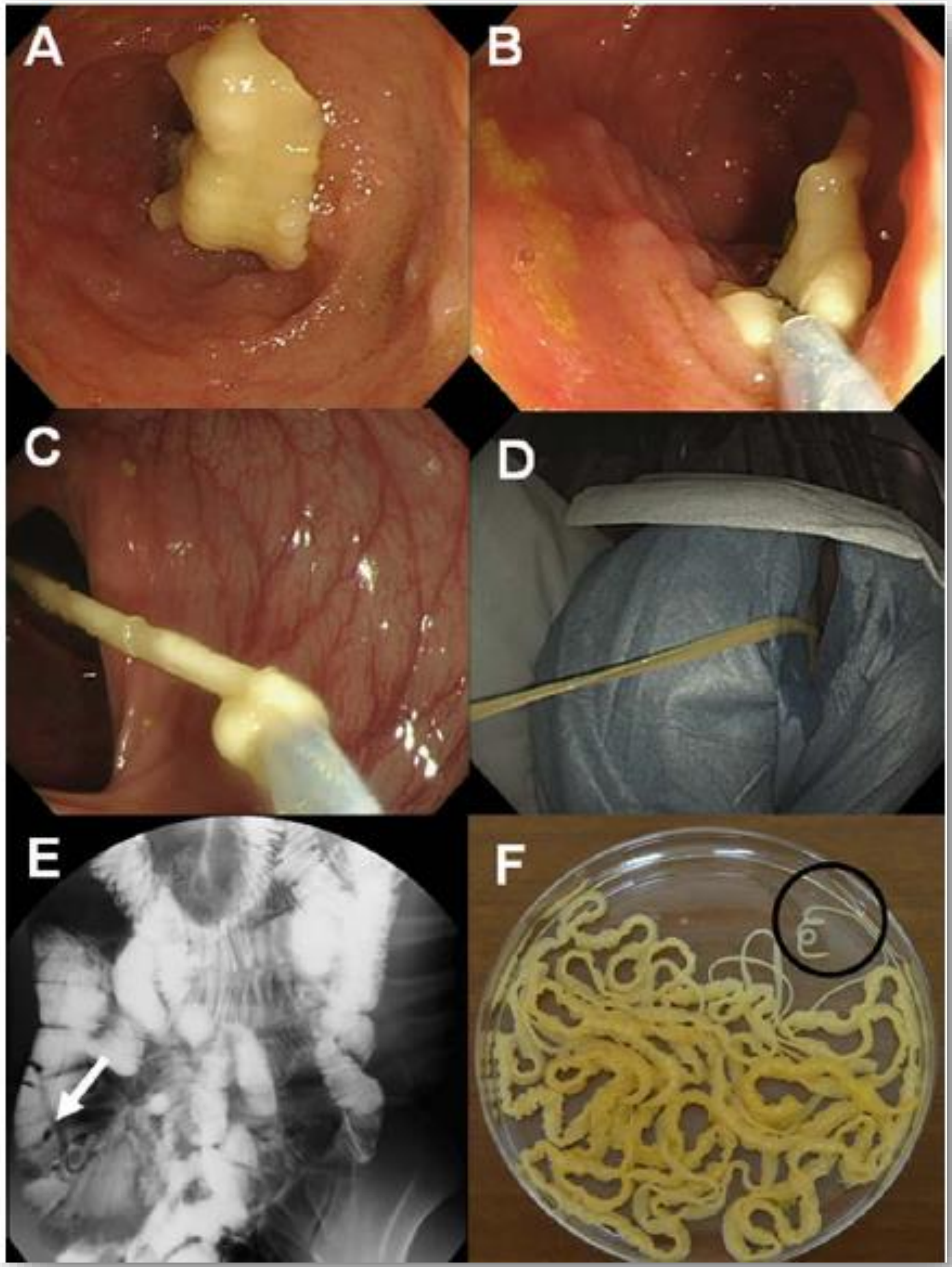


Fig. 4. *Diphyllobothrium* sp. scolex attached to the gut (Andersen, 1975b).

HUMAN DIBOTHRIOCEPHALOSIS

Clinical symptoms:

- Subclinical course
- Catharral inflammation of the intestine (in the anchored areas)
- Abdominal pain, diarrea, vomit, anorexia
- Severe anemia (deficit of vit. B12)
- Symptoms occurrence after many year
- Treatment with Praziquantel very effective (5-10 mg/kg)



Risk factors and intervention strategies

Change of eating habits=

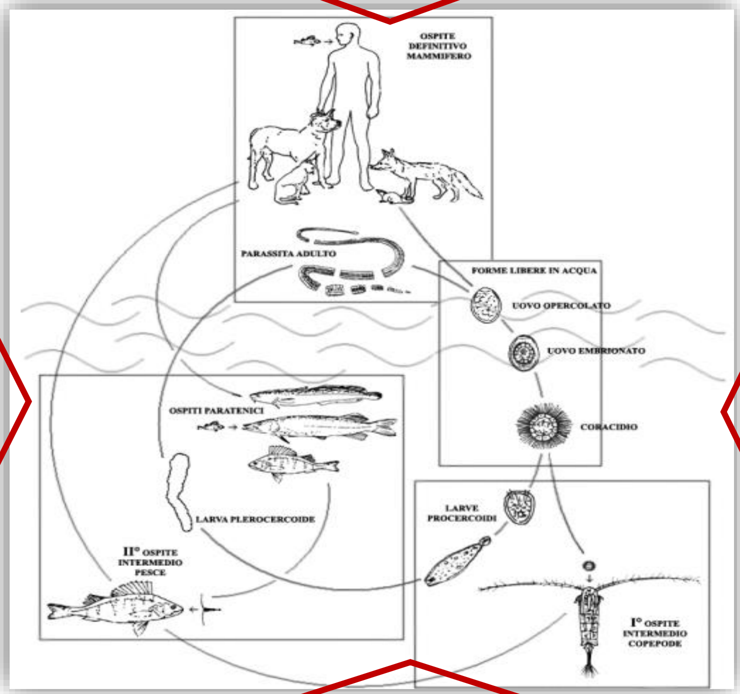
Increasing consumption of raw, undercooked, marinated, cold smoked fish products

RISK FACTOR

Suitable fish hosts

Role of paratenic hosts

CONTROL ON FISH PRODUCTS BY THERMIC TREATMENTS



Man = subclinical disease

DIFFICULT DIAGNOSIS & CONTROL

Lack of sewage depuration

People movement

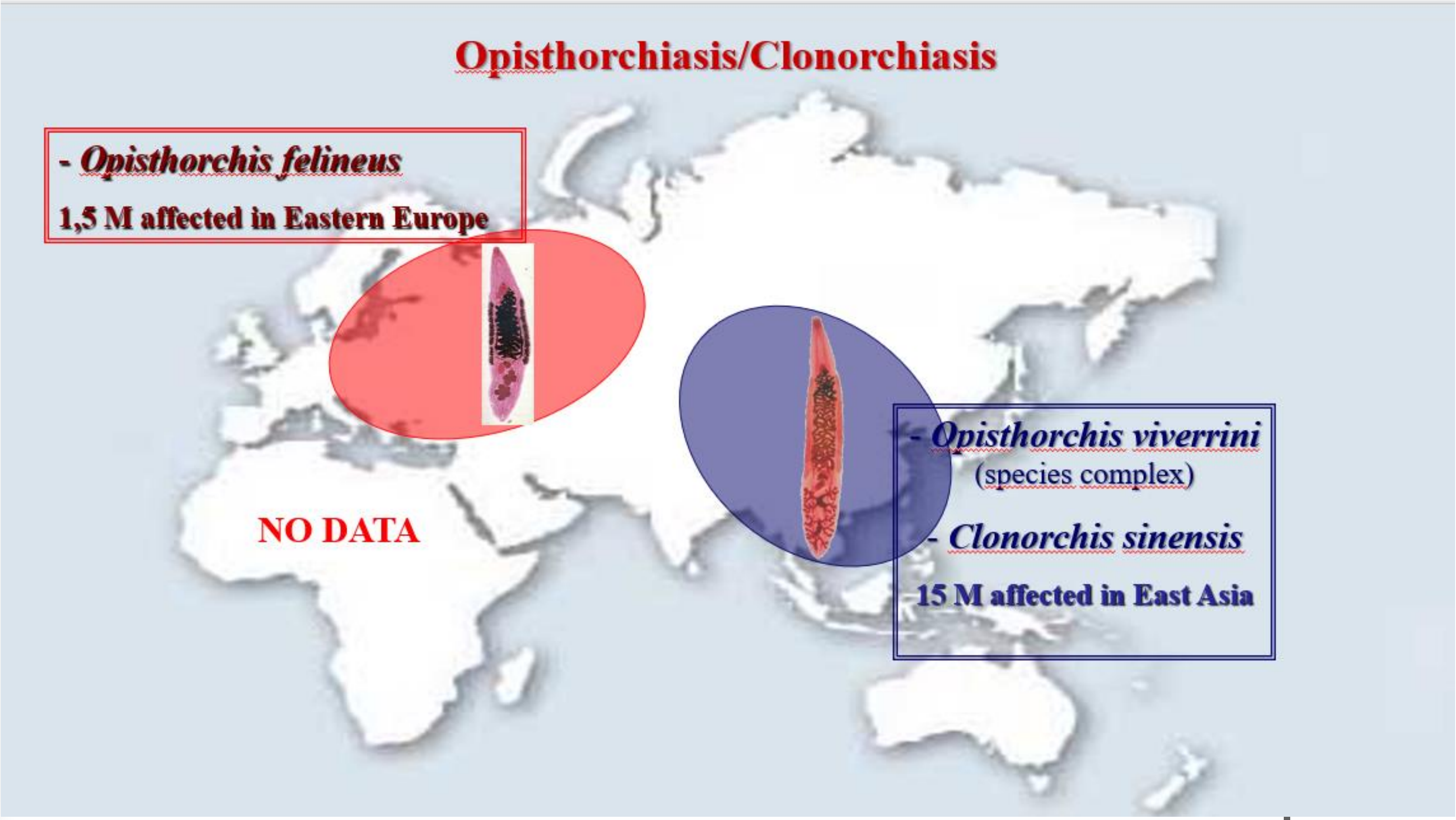
Multiple definive hosts?

Wild reservoirs

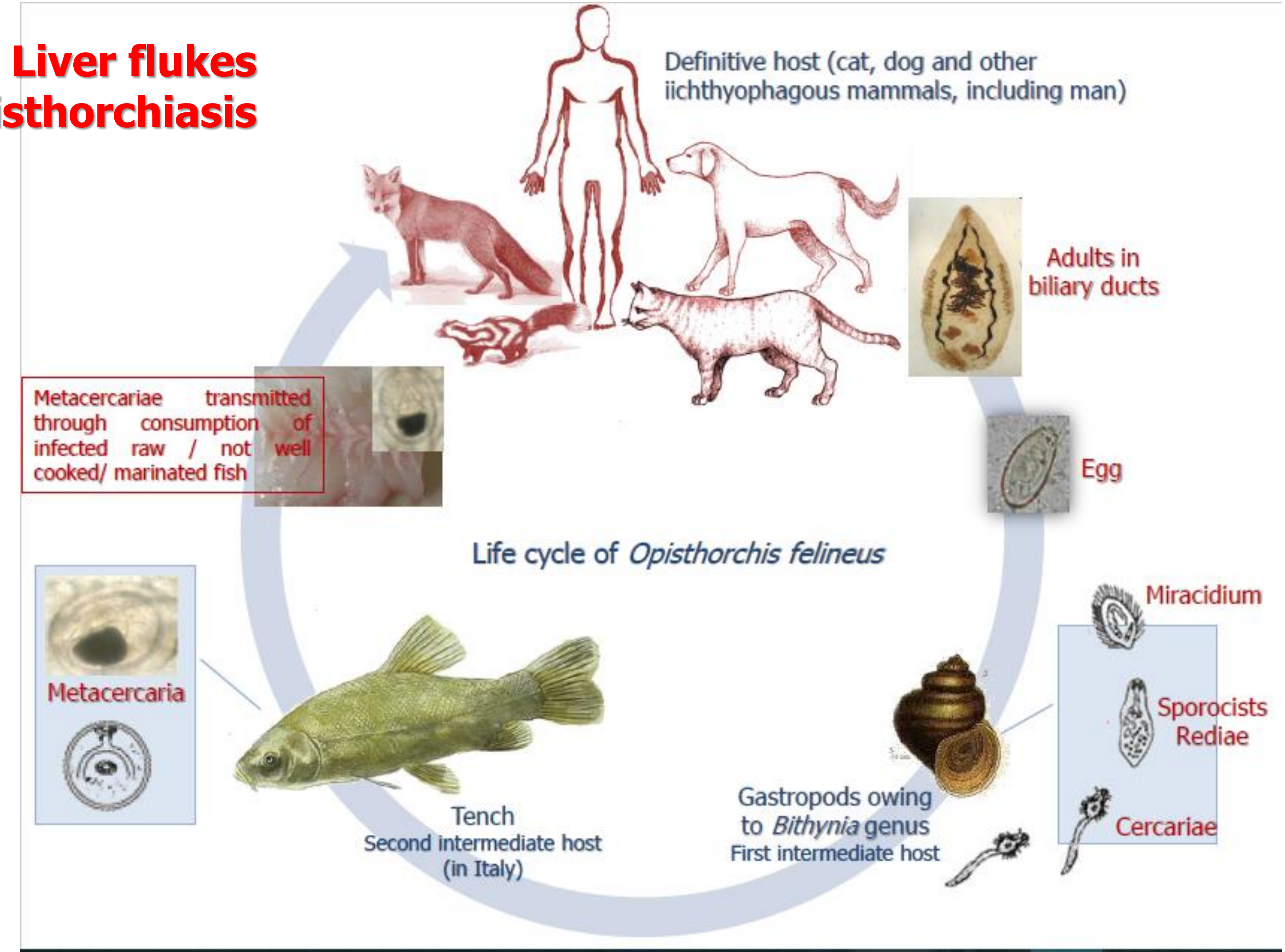
Maintenance of parasitosis

FISH INSPECTION =
Dfficult to apply in freswater fishery and market

Opisthorchiasis by *Opisthorchis felineus, O. viverrini, Clonorchis sinensis*
LIVER FLUKES



Liver flukes
Opisthorchiasis



Human Opisthorchiasis

CLINICAL SYMPTOMS IN MAN

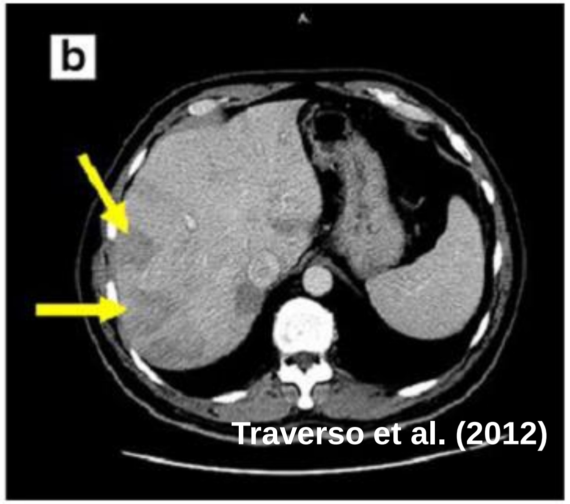
Clinical course typically without specific symptoms, severe in heavy infections.

Acute symptoms: fever, abdominal pain, headache, weakness, gastrointestinal symptoms, eosinophilia

Chronic symptoms: anorexia, nausea, abdominal pain, pancreatitis, colecystitis, phlogosis of duodenum, hepatic abscesses, bile ducts obstruction

Carcinogenetic

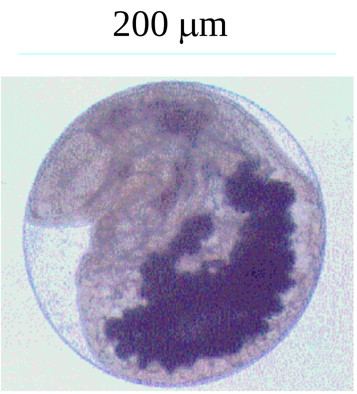
O. felineus causes similar symptoms in dogs and cats

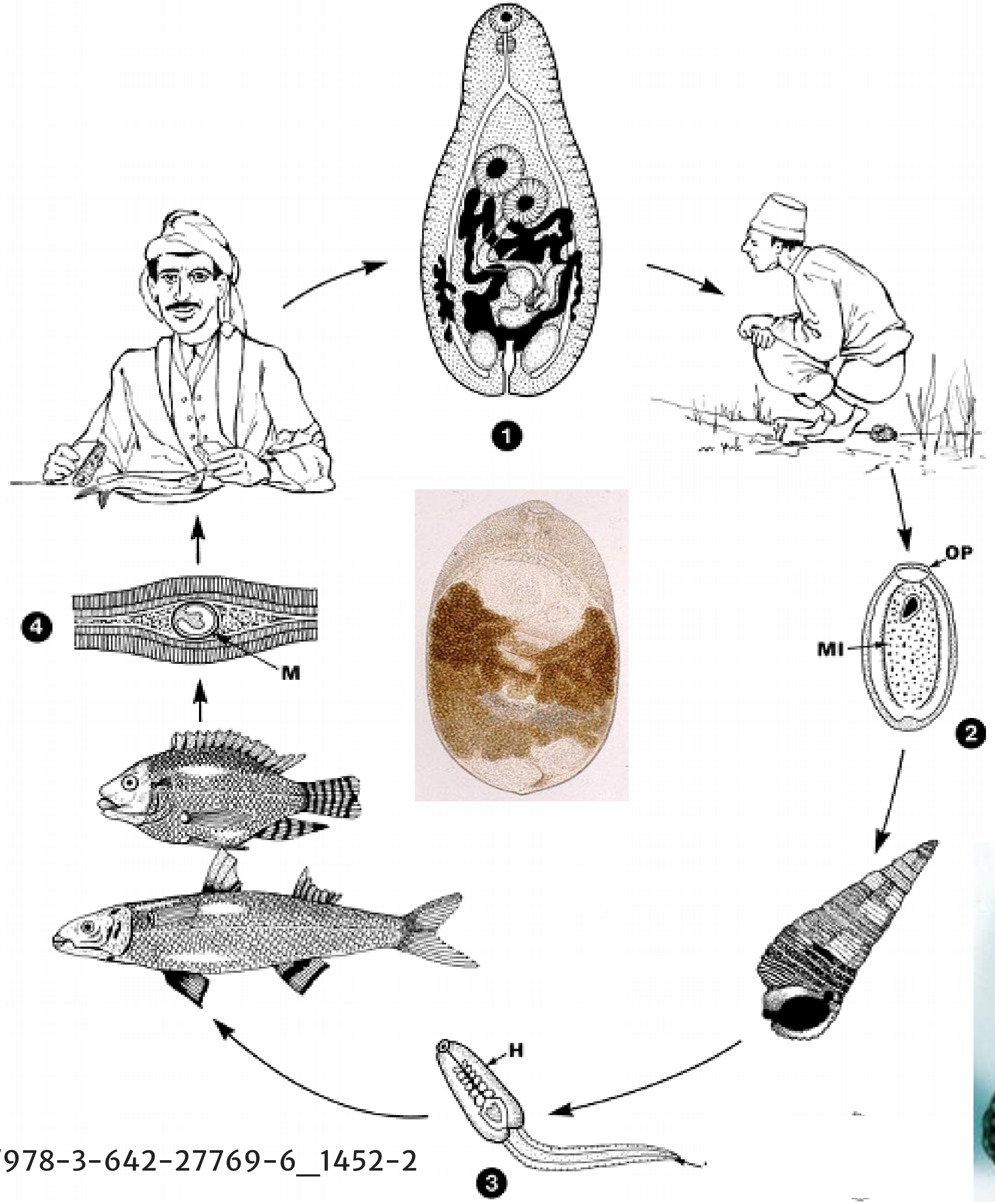


Changing agricultural practices that rely on human feces for fertilization of crops could help reduce infection with Opistorchid digeneans in some agricultural subsistence communities.

Unfortunately this, too, can be a difficult practice to disengage since human feces serves as a very rich fertilizer and, thus, can form a critical component to subsistence farming in many parts of the world where other fertilizers or farming technologies are cost prohibitive.

Intestinal flukes
Heteropyidosis

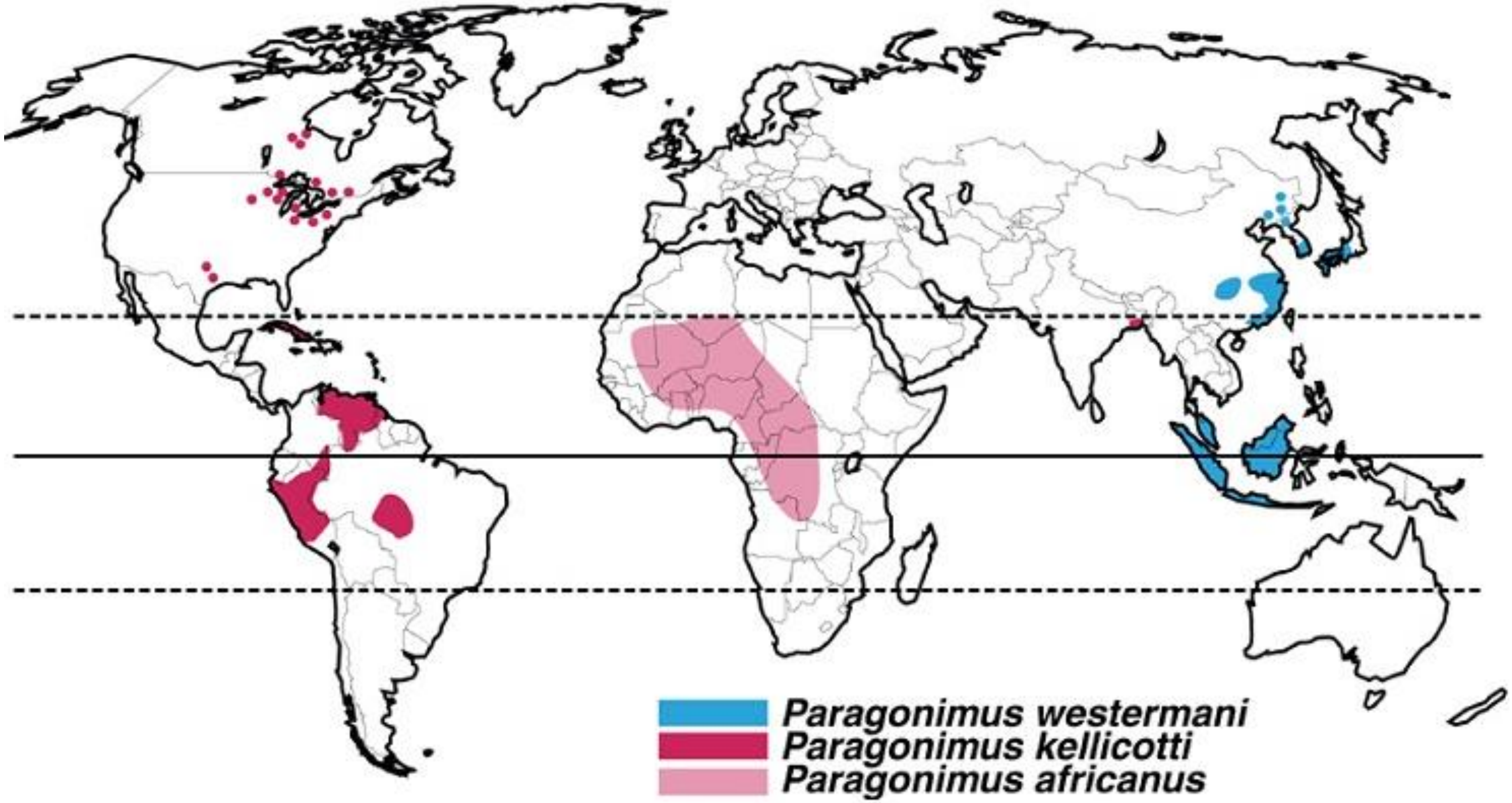




Life cycle of *Heterophyes heterophyes*

Mehlhorn, H. (2015). https://doi.org/10.1007/978-3-642-27769-6_1452-2

Lung Distomatosis by *Paragonimus* spp.



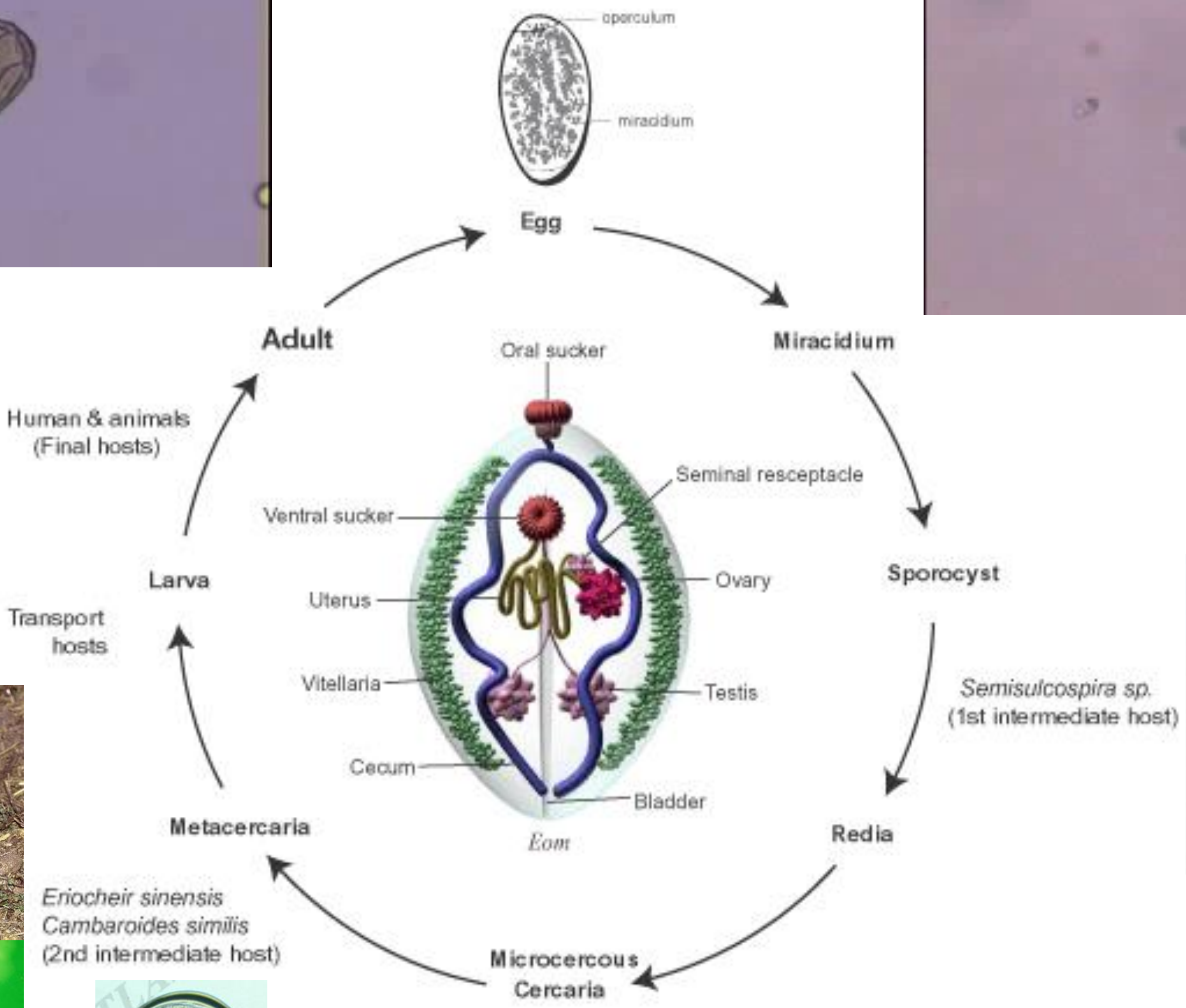
Map showing areas endemic for *Paragonimus westermani*, *P.kellicotti* and *P.africanus*. Copyright ITM

Human cases worldwide by digenean trematodes

• *Schistosoma haematobium*	78 M
• *S. japonicum*	69 M
• *Schistosoma mansoni*	57 M
• ***Paragonimus* spp.***	**21 M**
• *Fasciolopsis buskii*	15 M
• *Opisthorchis* spp.	10 M
• *Clonorchis sinensis*	7 M
• *Fasciola hepatica*	2 M
• *S. mekongi*	Thousands

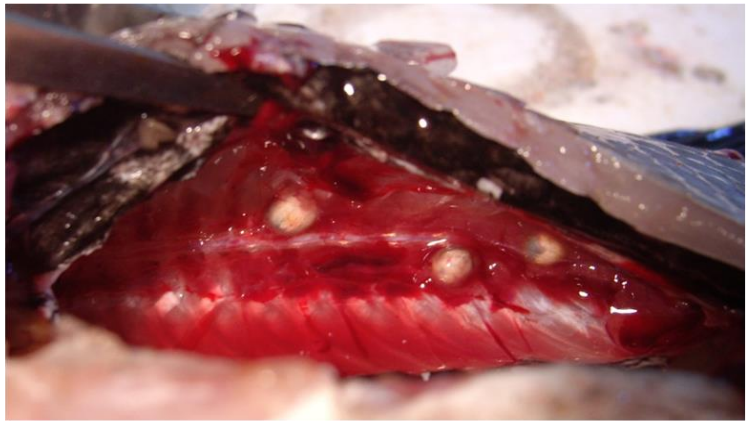
* The spread of human Paragonimiasis globally is only estimated. Annually, for example, in Japan and Korea, 200 and 500 cases are diagnosed.

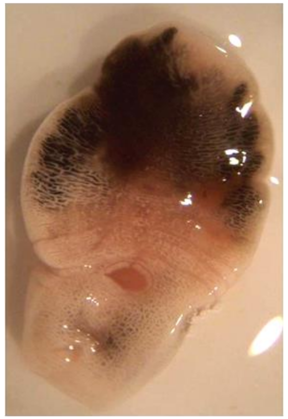
Paragonimus westermani

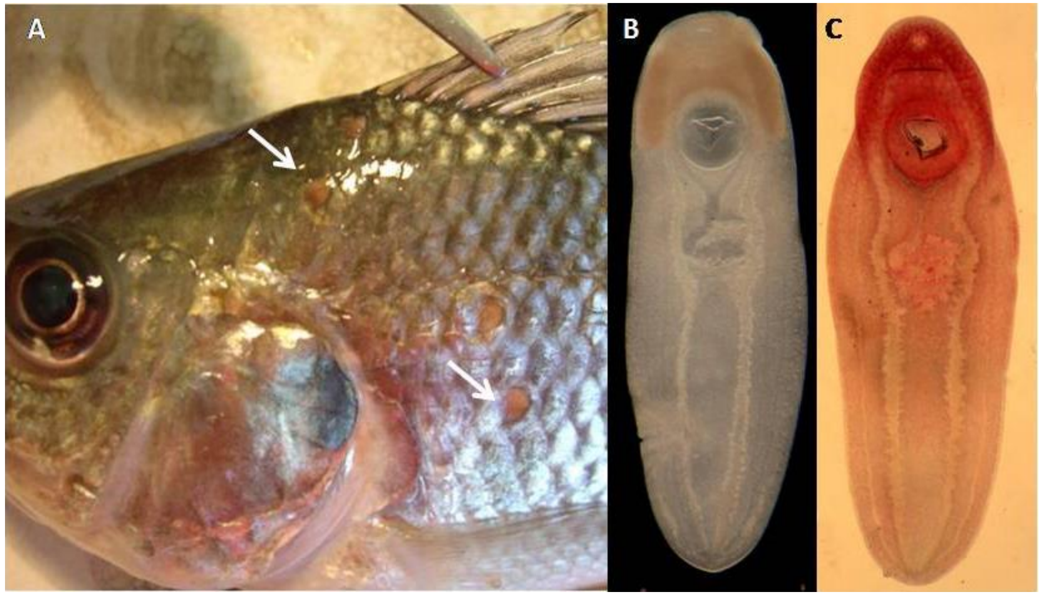


PARASITES WITH ZOONOTIC POTENTIAL

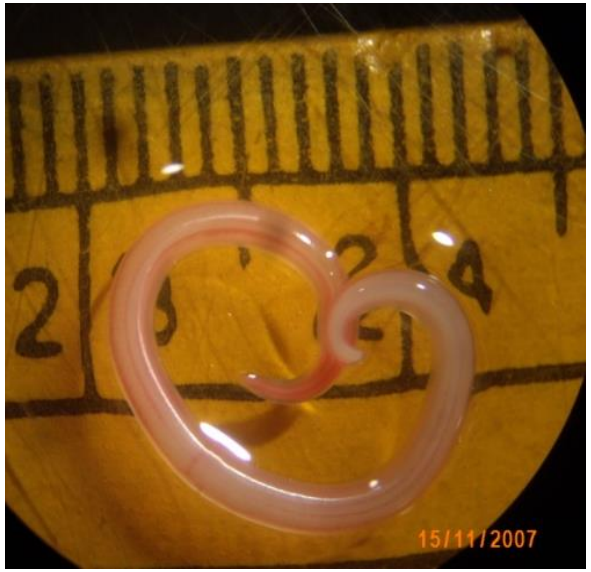
Heteroxenous Parasites - Clinostomidae

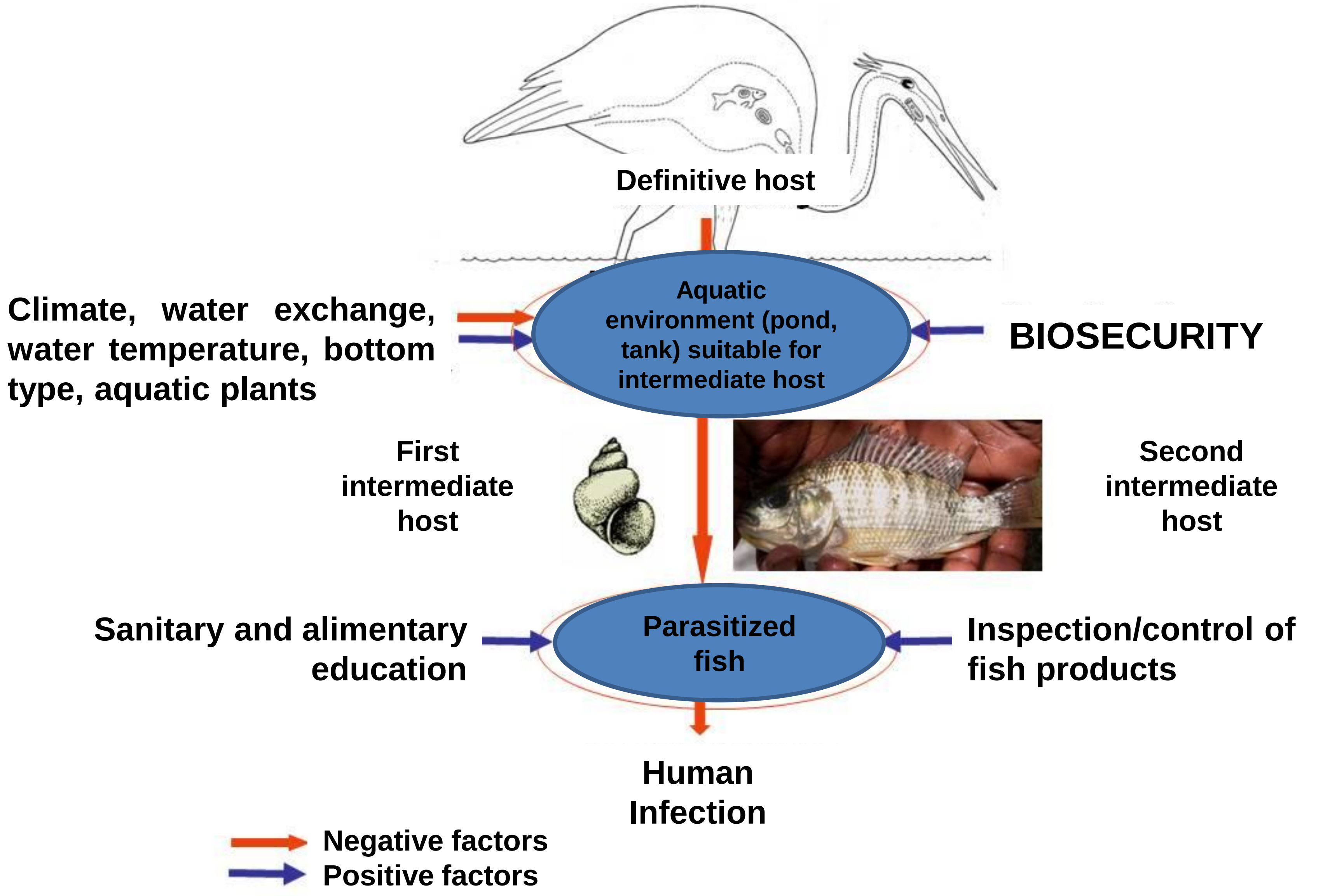






Heteroxenous Parasites - *Contracaecum*




Definitive host
Aquatic environment (pond, tank) suitable for intermediate host
Climate, water exchange, water temperature, bottom type, aquatic plants
BIOSECURITY
First intermediate host
Second intermediate host
Parasitized fish
Sanitary and alimentary education
Inspection/control of fish products
Human Infection
Negative factors
Positive factors

PARASITIC ZOONOSES IN AQUACULTURE

EFSA Panel on Biological Hazards (BIOHAZ)

European Food Safety Authority

EFSA Journal 2010; 8(4):1543

Scientific Opinion on risk assessment of parasites in fishery products

All wild caught seawater and freshwater fish must be considered at risk of containing any viable parasites of human health concern if these products are to be eaten raw or almost raw. For wild catch fish, no sea fishing grounds can be considered free of *A. simplex* larvae. For farmed Atlantic salmon, if reared in floating cages or onshore tanks and fed on compound feedstuffs, which are unlikely to contain live parasites, the risk of infection with larval anisakids is negligible unless changes in farming practices occur. Apart from farmed Atlantic salmon, sufficient monitoring data are not available for any other farmed fish therefore it is not possible to identify which farmed fish species do not present a health hazard with respect to the presence of parasites.

EFSA recommends that co-ordinated studies to improve surveillance and diagnostic awareness of allergic reactions to parasites in fishery products should be implemented, and encourage epidemiological studies on a European scale to assessing the impact of *A. simplex* parasitized fish on human associated disease, including all allergic forms.

EU Regulation 1276/2011

3. Food business operators need not carry out the freezing treatment set out in point 1 for fishery products:

(a) that have undergone, or are intended to undergo before consumption a heat treatment that kills the viable parasite. In the case of parasites other than trematodes the product is heated to a core temperature of 60 °C or more for at least one minute;

(b) that have been preserved as frozen fishery products for a sufficiently long period to kill the viable parasites;

(c) from wild catches, provided that:

(i) there are epidemiological data available indicating that the fishing grounds of origin do not present a health hazard with regard to the presence of parasites; and

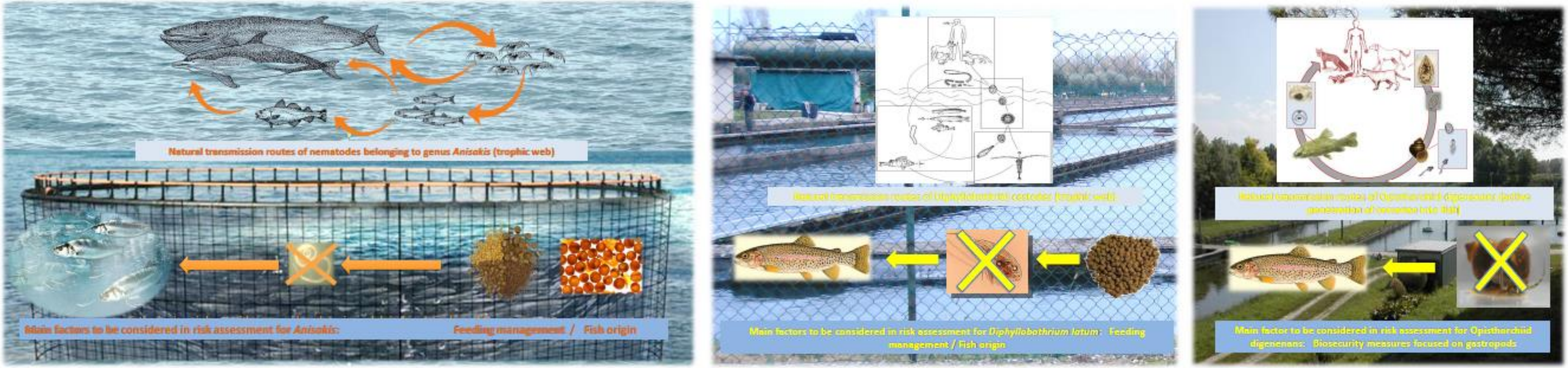
(ii) the competent authority so authorises;

(d) derived from fish farming, cultured from embryos and have been fed exclusively on a diet that cannot contain viable parasites that present a health hazard, and one of the following requirements is complied with:

(i) have been exclusively reared in an environment that is free from viable parasites; or

(ii) the food business operator verifies through procedures, approved by the competent authority, that the fishery products do not represent a health hazard with regard to the presence of viable parasites.

PARASITIC ZOONOSES IN AQUACULTURE



Anisakis and *Diphyllobothrium* life cycles develop through the natural food chains and a correct feeding protocol, besides the exclusive introduction of hatchery produced fry, should minimize the “trophic contact” between fish and invertebrates which are natural intermediate hosts of these parasites. Regarding zoonotic opisthorchiid digeneans, transmitted to fish via active penetration of cercariae developed in snails, biosecurity measures focused on avoiding the presence of gastropods in freshwater farms located in endemic/risky areas should be applied.

Farming systems that by nature exclude any possibility for infection

These are systems where the design of the facilities and the farming system by nature protect against the access of any source of infection.

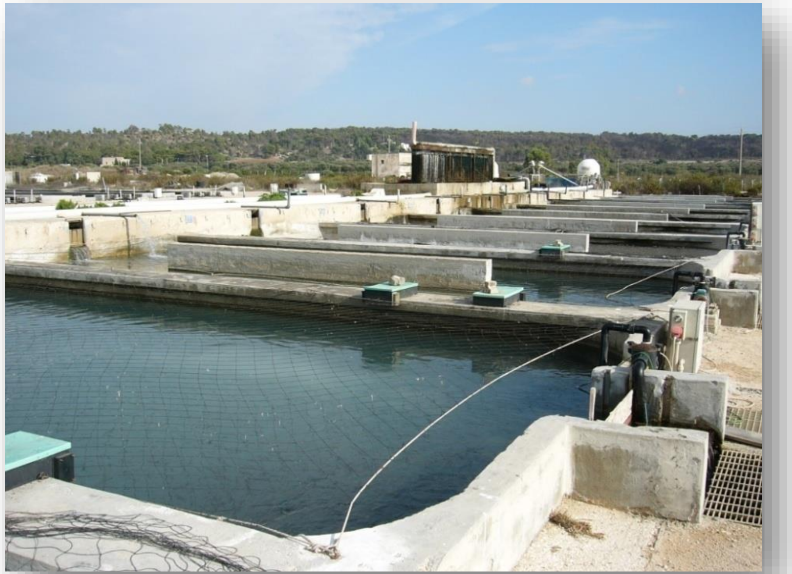
Such systems include on-shore tank systems supplied with water that can be demonstrated to be free from parasites.

Open systems as floating cages, etc. do not belong to this category.

When reared in fresh water, the water should be flowing continuously and should not come from lakes or reservoirs.

When these requirements are not met, or when fish are reared in salt water, water should be filtered in a way that prevents the access of any source of infection.

For farming systems that by nature exclude any possibility for infection of the fishery product it is sufficient to document the compliance with good practices for such farming systems that ensures the absence of parasites that represent a health hazard.



Fish farming with negligible risk for infection

Basic criteria: fish is cultured from embryos and fed their whole life on a diet that cannot contain viable parasites.

However, fish may live at least part of its life in an environment where the presence of parasites cannot be excluded.

According to the scientific opinion of EFSA Atlantic salmon farmed in a specific way represents a negligible risk with regard to parasites of public health importance*.

Practical experience have shown that other fishery products farmed in certain ways and/or in specified areas, both in fresh water and salt water, may be free from parasites that represent a risk to the consumers.

Before food business operators apply the derogation from the freezing treatment for such production it must have been demonstrated that the procedures applied ensure that the production does not represent a health hazard with regard to the presence of live parasites.

The competent authority must approve those procedures.

Fish farming with negligible risk for infection

If the type of production cannot exclude the risk for parasites as a general rule more intensive monitoring of fishery products, at farm level or even at batch level, could be deemed necessary. Methods applied for checking for the absence of parasites should be adjusted to the type of parasites, type of fish species, etc., ranging from plain visual inspection via candling (visual inspection on a light table) to artificial digestion in Pepsin/HCl.

EU REGULATIONS UPDATE

https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2024.8719

Adopted: 13 March 2024

DOI: 10.2903/j.efsa.2024.8719

efsa JOURNAL

SCIENTIFIC OPINION

Re-evaluation of certain aspects of the EFSA Scientific Opinion of April 2010 on risk assessment of parasites in fishery products, based on new scientific data. Part 1: ToRs1–3

EFSA Panel on Biological Hazards (BIOHAZ) | Konstantinos Koutsoumanis | Ana Allende | Avelino Alvarez-Ordóñez | Sara Bover-Cid | Marianne Chemaly | Alessandra De Cesare | Lieve Herman | Friederike Hilbert | Roland Lindqvist | Maarten Nauta | Romolo Nonno | Luisa Peixe | Giuseppe Ru | Marion Simmons | Panagiotis Skandamis | Elisabetta Suffredini | Kurt Buchmann | Mercedes Careche | Arne Levsen | Simonetta Mattiucci | Ivona Mladineo | Maria João Santos | Rubén Barcia-Cruz | Alesandro Broglia | Kateryna Chuzhakina | Sonagnon Martin Goudjihounde | Beatriz Guerra | Winy Messens | Irene Muñoz Guajardo | Declan Bolton

EU REG… PDATE

- The experts consider it to be 9… …culating aquaculture systems (RAS), or indoor or roofed fac… …fed with heat treated feed, are not exposed to zoonotic… …or flow-through freshwater ponds or tanks are exposed… …vidence of infection in market quality Atlantic salmon a… …nce of infection in gilthead seabream, turbot, meagre, A… …ve not been published for brown trout, African catfish, E…
- The published data currently a… …s in sea-caged European seabass (*A. pegreffii*, *A. simplex* (s.s.)… …lantic cod (*C. lingua*, *A. simplex* (s.l.)), as well as tench farmed in o… …*Paracoenogonimus ovatus*).
- Due to the lack of representati… …es of the prevalence or the abundance of those parasites, th… …all fish species, farming systems and production area in the…

Due to the lack of representative data, it is not possible to make informative estimates of the prevalence or the abundance of those parasites, that are considered to be of public health importance, for all fish species, farming systems and production area in the EU/EFTA

Thanks for the kind attention!