FISH-BORNE PARASITIC ZOONOSES WITH SPECIAL REFERENCE TO ANTHROPOGENIC IMPACT

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ZOONOTSKE PARAZITOZE RIBA SA POSEBNIM OSVRTOM NA ANTROPOGENI UTICAJ

Apstrakt

Parazitska oboljenja koja se prenose mesom ribe dugo vremena nisu dobijala zasluženu pažnju, pre svega jer su ove zoonoze bile vezane za zemlje tropskog i suptropskog pojasa, naročito azijske zemlje u kojima riba predstavlja veoma značajan izvor proteina za stanovništvo ruralnih sredina. Međutim, kao posledica globalnog zagrevanja dolazi do promena u ekosistemima voda i širenja geografskih granica u kojima se određeni paraziti pojavljuju. Širenju parazita doprinosi i fenomen globalizacije, razvijene saobraćajne mreže, komercijalni internacionalni hipermarketi, ali i demografske promene stanovništva od kojih najveći značaj imaju migracije. Na povećanje populacije pod rizikom utiču i promene kulturoloških navika i kulinarske prakse, naročito sve češća konzumacija sirove, marinirane, sušene ili na drugi način temperaturno nedovoljno obrađene ribe i proizvoda od ribe. Tokom poslednje decenija zabeležen je progresivan rast broja ljudi koji se hrane u restoranima, kioscima brze hrane ili kod uličnih prodavaca, koji često ne poštuju pravila o bezbednosti hrane. Ovakve navike posledica su brzog tempa života i sve većeg opterećenja današnjeg čoveka, ali i popularizacija raznih kuhinja, naročito azijske kuhinje, u svetu, ali i u našoj zemlji.

Prilagođavajući prirodu svojim potebama, čovek, kako na direktan, tako i na indirektan način, utiče na rasprostranjenost samih parazita. Izmena strujanja vode, koje nastaje pregrađivanjem reka branama prilikom izgradnje hidroelektrana i povišenje temperature vode, usled izgradnje termoelektrana, dovodi do supstitucije jednih vrsta fitoplanktona, zooplanktona i riba drugim vrstama. Promene flore i faune vodenog ekosistema ima direktan uticaj i na ptice koje se njima hrane, a koje su često pravi ili prelazni domaćini parazita. Ne retko, zbog narušavanja ekosistema i introdukcije novih vrsta riba javljaju se novi paraziti koji nisu karakteristični za neko područje. Zagađenje reka teškim meta-

lima je jedan od značajnih antropogenih faktora koji utiču na prisustvo parazita, ali i na stepen akumulacije teških metala u mišićima riba. Naime, paraziti ne naseljavaju vodu zagađenu metil živom, ali istraživanja su pokazala da ukoliko su ribe već invadirane parazitima u trenutku zagađenja, akumuliraju živu u svom organizmu u manjim koncentracijama od one ribe koja nije inficirana.

U epidemiologiji zoonotskih parazitoza koje se prenose mesom riba najveći značaj imaju helminti, pre svega klase *Trematoda* vrste *Clonorchiosis sinensis* i *Opisthorchis spp. C. sinensis* ima izuzetan socialno-ekonomski značaj u određenim delovima Azije i predstavlja veliki zdravstveni problem. Procenjuje se da je oko 35 miliona ljudi u toku poslednje decenije inficirano ovim parazitom na globalnom nivou. *O. felineus* se nalazi u Kazakstanu, Rusiji, Nemačkoj, Italiji, Španiji, Grčkoj, Makedoniji i Albaniji, dok je *O.viverrini* karakteristična za područje Kambodže, Laosa, Vijetnama i Tajlanda. Prema podacima WHO iz 1995. godine preko 18 miliona svetskog stanovništva je obolelo od parazitoza izazvanim trematodama koje su prenete mesom riba, a njihova procena je da je pod rizikom od inficiranja više od pola milijarde stanovnika. Difilobotrijaza je parazitoza izazvana helmintima iz klase *Cestoda*, roda *Diphyllobothrium*, od kojih *Diphyllobothrium latum* predstavlja najčešći uzročnik infekcija ljudi. Ovi paraziti rasprostranjeni su u Evropi, Severnoj i Južnoj Americi i Aziji. U Evropi *D.latum* je rasprostranjen u oblastima oko alpskih jezera, a najveći broj slučajeva prijavljen je u Francuskoj, Švajcarskoj i Italiji. Od nematoda najveći značaj imaju kosmopolitski rasprostranjene *Anisakis simplex* i *Pseudoterranova decipiens*. Visok procenat parazitskih infekcija protiče subklinički ili asimptomatski, a manji broj se manifestuje kroz simptome poremećaja digestivnog trakta, dok se difilobotrijaza manifestuje hipovitaminozom B12 vitamina. Zbog velikog broja neprijavljenih slučajeva, ne uvek jasno izraženih kliničkih simptoma i manjka metoda za otkrivanje uzročnika, ove parazitoze se, uglavnom, ne dijagnostifikuju, naročito u delovima sveta za koji nisu karakteristične.

Ključne reči: helminti, ekosistem, klimatske promene, zagađenje vode
Keywords: helminths, ecosystem, climate changes, water pollution

INTRODUCTION

Compared with other well-studied parasitic diseases, fish-borne parasitic zoonoses have been public health orphans in the world of research funding, especially because these zoonoses have been limited for the most part to populations living in low- and middle-income countries (Chai et al., 2005). Zoonotic parasites are a significant food safety problem, particularly in Asia, because fish are a very important source of protein for people living in rural areas (Thien et al., 2009). In an attempt to change the nature, so they can adjust it for their needs, humans, directly or indirectly, affect parasites occurrence. As a result of global warming it is expected for some species to become locally extirpated and experience range contractions, while introductions of others, including potentially harmful pathogens, will occur in both freshwater and marine systems (Marcogliese, 2001.). Geographical barriers are slowly being breached by international travel developing into a major industry, by improved refrigerated food transport, by growing international markets, by increased tourism and by demographic changes such as migration (Chai et al., 2005; Dorny et al., 2009). Populations at risk are expanding also as a result of changes in cultural habits and culinary practices, such

as the increase of eating raw, marinated, smoked, salted, pickled, airdried or undercooked fish meat and fish products. Eating sushi, sashimi, koi-pla, kinilaw and cevishe is becoming inceasingly fashionable in many countries (Macpherson, 2005). In the last decade it has been noted increasing in the number of people eating meals prepared in restaurants, canteens and fast food outlets as well as from street food vendors who do not always respect food safety (Dorny et al., 2009). All of these has led to a dramatic rise in the incidence of a large number of fish-borne zoonotic parasitic infections in previously uninfected ethnic groups (Macpherson, 2005). The role of some factors like ages, malnutrition, HIV infection and other underlying medical conditions should not be neglected in etiopathogenesis of fish-borne parasitic zoonoses (Dorny et al., 2009).

Fish parasitesTrematodiasis

Trematodiasis is the infection of humans caused by trematode parasites, known also as a liver flukes. The ones that cause the most common infection in humans are *Clonorchis sinensis*, *Opisthorchis viverrini* and *Opisthorchis felineus*. The life cycles of these trematode species are similar. Eggs are shed with the feces of the definitive host (man or other piscivorous animals). If the eggs reach water they develop into miracidia which are ingested by a snail, the first intermediate host, in which they develop and ultimately shed into the water as motile cercariae which penetrate into the muscle tissue of a fish, the second intermediate host. Human infection takes place through the consumption of under-processed fish containing the infective stage of the parasite (Santos and Howgate, 2011). *Clonorchis sinensis* (Chinese liver fluke) is widely distributed in East Asia and in this region present the most important species of fish-borne zoonotic parasite. *Opisthorchis viverrini* is highly prevalent in Southeast Asia including Thailand, Laos, Cambodia and Vietnam, and there are about 9 million people who are infected globally (Chai et al., 2005). *Opisthorchis felineus* is prevalent in Spain, Italy, Albania, Greece, France, Macedonia, Switzerland, Germany, Poland, Russia, Turkey, and in parts of the former Soviet Union (Chai et al., 2005, Macpherson, 2005). The major clinical problems in infected humans are cholangitis, choledocholithiasis, pancreatitis and cholangiocarcinoma and they are associated with the long chronic infections, but severe infections can cause jaundice, portal hypertension, ascites, gastrointestinal bleeding and formation of gallstones (Chai et al., 2005; Dorny et al., 2009).

Cestodiasis

Diphyllobothriasis is the most important fish-borne zoonosis caused by a cestode parasite. At least 13 of about 50 species of *Diphyllobothrium* have been reported from humans, but most important is *Diphyllobothrium latum*. The egg hatches in water, the motile embryo coracidium is ingested by a copepod, and develops to the procercoid. When an infected copepod is ingested by the second intermediate host (freshwater, anadromous or catadromous fish), the larva is released, enters the tissues of the host and develops to the plerocercoid which is infective for the final host (Chai et al., 2005). These parasites are found in Europe, North and South America and Asia. About 20 million people are infected worldwide (Dorny et al., 2009). In Europe, Scandinavian countries present 'hot spot', and Switzerland, Sweden, Finland and Estonia report more than 10 cases per year, while Lithuania, Poland, Hungary, Italy and France average 2–10 cases annually (Chai et al., 2005). Most of the cases in Switzerland, France and Italy occur in the Alpine Lakes region. Diphyllobothriasis in humans may often be asymptomatic,

but in some cases it may cause diarrhea, abdominal pain and megaloblastic anaemia as a result of B12 deficency (Macpherson, 2005; Dorny et al., 2009).

Nematodiasis

Of all nematode parasites most commonly involved in human infections is *Anisakis simplex*, while *Pseudoterranova decipiens* is less frequent. Infections with the *Anisakis physeteris* and *Contracaecum spp*. are sporadic (Dorny et al., 2009). The life cycle of *Anisakidae* involve small crustaceans as the first intermediate host, fishes and cephalopods as the second host, and marine mammals as the definitive host. Humans are accidental hosts that become infected by eating larvae contained within the paratenic host (Lima dos Santos and Howgate, 2011). *A. simplex* and *Pseudoterranova spp.* are found in the northern, north east and north west Atlantic, northern Pacific, in the Mediterranean Sea, Norwegian Sea and Barents Sea. Anisakiasis is prevalent in north Asia and western Europe (Netherlands, Germany, France and Spain) (Chai et al., 2005). *A. simplex* causes an acute or chronic infection followed by abdominal pain, nausea, vomiting, and diarrhea and some patients develop syndromes exhibiting clinical manifestations of allergy (Lima dos Santos and Howgate, 2011).

Gnathostomiasis is primarily a disease of the skin caused by migration of the larvae of a *Gnatostoma* nematode and it is known to occur mainly in South East Asia, but has been reported as a cause of human infection in Peru, Ecuador and Mexico. It is often reported in tourists returning from endemic areas where they have eaten undercooked freshwater fish (Nawa et al., 2005; Dorny et al., 2009).

Anthropogenic impact

Climate change

Climate change can occur as a result of natural and anthropogenic causes. Temperature change, alterations in water levels, stratification, ice cover, acidification, ultraviolet radiation are some of the factors that affect parasits of aquatic organisms, their life cycles and distribution. Climate change has been predicted to be one of the major drivers of biodiversity change, especially in lakes (Marcogliese 2001). Global climate change with rising sea-levels and water temperatures that may result in changes in ocean circulation and a decrease in salinity may also cause measurable effects on fish parasite composition and biogeography. Climate warming affect interactions between host and parasits by increasing pathogen development rates, transmission and number of generation times per year, raising the overwinter survival rate of the pathogen and increasing the host susceptibility to thermal stressors. Also, increasing temperature alter the seasonality and biogeographical range of many species, including the hosts and the parasites (Palm, 2011).

Aquatic ecosystem pollution

Aquatic ecosystems present the most sensitive systems on earth (Palm, 2011).

Pollution can affect parasitism in fish in two different ways. It can increase parasitism if host defence mechanisms are negatively affected by increasing host susceptibility, or by simply increasing the population densities of suitable intermediate or final hosts. Some studies have focused on parasite-induced stress that was measured as an increased stress hormone concentration and it often present the first step in a series of physiological reactions such as a depressed immune response or other fundamental physiological

reactions. Pollution can also decrease parasitism provided that infected hosts suffer more from environmental exposure than do uninfected hosts or pollution drives the necessary intermediate and final hosts to become extinct (Marcogliese, 2001). If the fish is living within a polluted environment where some pollutants also enter the fish, the concentration of these substances in the immediate surroundings of the parasite can also increase and accumulate in the parasite's tissue, proving that fish parasites closely interact with the metabolisms of their host. Parasites are more susceptible to the particular pollutant, sush as haevy metals, than their host and some fish parasites can accumulate pollutants in a much higher concentration (to several thousand-fold higher levels) as their host organisms. That is one of the resons why parasites, especially helminths, can serve as biological indicators of water pollution (Palm, 2011; Marcogliese, 2001).

Industrialisation, technology and transport development

The creation of large freshwater reservoirs for hydroelectrical, irrigation, flood control or drinking water purposes present one of the most dramatic and widespread anthropogenic impacts on the natural environment (Morley, 2007). In Republic of Serbia the biggest hydroelectric power station and the biggest reservoir at the same time is Djerdap, Gate I, on the Danube River. Dams construction destabilizes the aquatic environment for a number of years which has serious implications for the aquatic area. There is a replacement of rheophilic fauna with limnophilic fauna. This changes affect not only phytoplancton and zooplancton but also a fish, especially because the dams make it difficult for migratory fish to enter the reservoir which are reflected to changes in their parasite fauna such as elimination, reduction or emergence of species which are not endemic for that area (Morley, 2007). There are anthropogenic impacts that may directly affect the physical parameters of the water and consequently parasites. For example, thermal power station Nikola Tesla (TENT) on the Sava River near Obrenovac, affect water temperature. As a result of cooling water from TENT A and B water temperature in Sava River is for 2 C° higher then water in Danube River. Because of higher temperatures there is no ice cover on Sava River. Missing of ice cover has a indirect influence on parasitic fish fauna. In these condition fish don't reduce feeding and migratory birds may remain present during all seasons, creating the potential for parasite transmission throughout the year. Also, on the higher temperature duration of parasite life cycle is shorter (Marcogliese, 2001).

Demographic and tourism habits changes

As a result of globalisation, new tehnology and improved transport, in the last few decades it has been noted increasing number of immigrants from developing parts of the world to developed countries in search of opportunities and better life. This mobility implies also importing different cultures, health beliefs, food preferences that can present a risk factors not only for immigrants but for public health (Broglia and Kapel, 2011). An interesting variation on the potential risks associated with the immigration is the report of *O. felineus* infections in a family of Russian immigrants residing in Israel. One of the members of the family brought back from a visit to the family's former home, in an endemic area of Siberia, an infected fishwhich was then consumed locally (Chai et al., 2005).

Some changes of the twentieth century, like tourism and international travel, have a great role in increasing number of not only fish-borne parasitic zoonoses, but of all parasitic diseases. In 2008, the World Tourism Organization reported that international

tourist arrivals reached 924 million, and this number was expected to increase to 1.6 billion by the year 2020. Far and exotic destination that once was availble only for high class of society, nowadays present popular places for vacation. Travellers dining in street restaurants can be expected to have much higher risks of infections with various parasites, especially in Asia (Broglia and Kapel, 2011).

Changes in cultural habits, culinary practices and life style

Human behaviour and changes in live style may affect public health on many ways. Untill recent eating of raw fish was part of traditions, cultural and religious beliefs, but nowadays it presents part of everyday life, not only in Asia but all over the world. Eating sushi, sashimi (traditional Japanese dishes), koi-pla, kinilaw and cevishe is becoming increasingly fashionable in many countries as a result of globalisation and media, which play a significant role in popularisation of exotic foods (Broglia and Kapel, 2011; Macpherson, 2005). People more often consume raw or undercooked foods in the so called street-food restaurants or take-away, that do not always respect food safety standards (WHO, 2002). But it is not always a fast food products that present a risk factor for fish borne parasitic zoonoses. The increased awareness of healthy dietary regimes to prevent cardiovascular disease and cancer has raised fish consumption, including fish oil, omega-3 fatty acids, which has led to more aquaculture products from Asian markets being now globally traded and consumed (Broglia and Kapel, 2011).

Control Measures

A number of control measures are used to protect fish products from parasites (Orlandi et al., 2002). Evisceration of fish soon after catching prevents the larvae from migrating from the intestinal tract to the muscle tissue of the fish (Baltić et al., 2005). Moreover, if there are parasites in fish tissue they can be killed by using physical or chemical treatments. Salting and marinating are the chemical treatments most commonly used to inactivate viable helmints larvae, but their efficiency depends on concentration of salt and duration of treatment period. Vegetable products such as shogaol and gingerol extracted from Zingiber officinale are able to kill A. simplex, but only under specific conditions (EFSA, 2010). Freezing (-35Cº for 15 h or -15C° for at least 96 h) and cooking (60Cº for at least 1 min.-core temperature) remain the reference processes guaranteeing the destruction of larvae. Other physical treatments which can be used for killing helmints larvae are high hydrostatic pressure, irradiation (for some parasites) and hot smoking (EFSA, 2010; Orlandi et al., 2002). Low voltage current is patented in Spain in 2005, but this method is not currently available and requires further research (EFSA, 2010).

CONCLUSIONS

Some natural changes like global warming, but more important anthropogenic impacts such as pollution, dams construction or human behaviour affect parasites life cycles, distribution, and prevalence, making the multiple routes of transmission more complicate and difficult to understand. As a result of these impacts, fish borne parasitic zoonoses present global increasing, not only health but also economic problem.

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