# A REVIEW OF DIPHYLLOBOTHRIASIS: AN EMERGING AND RE-EMERGING PARASITC ZOONOSIS

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**Abstract**

Diphyllobothriasis also called "fish tapeworm, the broad tapeworm, Jewish House wife's disease and Scandinavian House wife's disease" is an intestinal parasitic zoonotic infection caused by the cestode *Diphyllobothrium*. 14 species of *Diphyllobothrium* have been described but only four species *D. latum, D. pacificum, D.denderiticum, D. nihonkaiense*are commonly known to infect human, fish eating mammals(Dogs, Cats, Foxes, Bears) and fish eating birds. *D. latum* is the most common cause of diphyllobothriasis. It is transmitted to humans by the ingestion of fish that harbor infectious larvae of the genus *Diphyllobothrium* causing a wide-ranging spectrum of diseases and severity. More than 20 million humans are estimated to be infected worldwide.The second intermediate hosts include both freshwater and marine fish. At the beginning of the past century, diphyllobothriasis was widespread in endemic areas with lakes and Rivers, but it apparently disappeared since the early 1980s. In the early 2000, it has re-emerged. The increasing popularity of cold, smoked, marinated or raw fish products seems to be the main reason for the return of diphyllobothriasis. Although *D. latum* has long been studied, many aspect of its biology, epidemiology, distribution, clinical manifestation, diagnosis and control remain patchy and require intensive research. However, it is hoped that warning of the potential risk of re-emergence of diphyllobothriosis due to changing eating habits, globalization of the food market and climatic change will help in a more effective control of this parasitic disease on the global scale.

**Keywords:** *Diphyllobothrium*, Zoonosis, Fish, Intermediate host, Epidemiology

## Introduction

Diphyllobothriasis also called "fish tapeworm, the broad tapeworm, is an intestinal parasitic zoonotic infection caused by the cestode*Diphyllobothrium*(Yoneva*et al.,* 2014; An *et al.,* 2017).This infection has started gaining more attention due to a recent surge in human cases, but reports of diphyllobothriasis date as far back as the prehistoric period and *Diphyllobothrium*eggs have been identified as far back as 3917 B.C. in Germany (Colak, 2017). Freshwater fish serve as the primary epidemiological reservoir for *D. latum*, while other *Diphyllobothrium* species originate from marine fishes (Kuchta*et al.,* 2007). Thus, the fundamental risk factor is the consumption of raw freshwater or marine fish with human disease occurring after maturation of larval stages of the tapeworm in the hosts (Durrani*et al.,* 2020)Health authorities are aware that fish borne parasitic diseases reduce the commercial value of fish and fish products and also affect the economy of the seafood trade. In response to these issues, health authoritieshave enacted measures to reduce food borne illnesses (Kuchta*et al.,* 2007) Although *D. latum* has long been studied, many aspect its biology, epidemiology and distribution remain poorly understood.

## Review

### Epidemiology

The distribution of *Diphyllobohrium* in human and non human hosts are presented in Table 1. It shows that *D. latum* infects humans of any age group and gender and are reported all over the worldwith fresh water fish, marine and Anadromous fishes as definitive intermediate hosts (Table 2). Some species of *D. latum* have also been reported in some parts of Nigerian water fishes (Table 3).

**Table 1: Distribution of *Diphyllobothrium* seen in Human and other hosts**

| Species | Major Final hosts | Occurrence |
|---|---|---|
| *D. latum* | Humans, Dogs, Cats, Foxes, Bears | Europe, North America |
| *D. dendriticum* | Humans, fishing, eating birds | Northern Europe, Asia |
| *D.dallinae* | Humans, Dogs, Foxes | North America, Europe |
| *D. alascense* | Humans, Dogs, Orcas | North America, Asia |
| *D. nihonkaiense* | Humans, Bears, Foxes | North America, Europe |

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|---|---|---|
| *D. pacificum* | Humans, sea lion | South America, Asia |
| *D.stemnacephalum* | Humans, Dolphins and Whales | South America, Asia |

Bauerfeind*et al*. 2016

**Table 2: Global distribution of *Diphyllobothrium***

| Continent | Countries | Species | 2nd Intermediate hosts | Refences |
|---|---|---|---|---|
| Europe | France | *D. latum* | Fresh water fish | Margino*et al*. 2007. |
| | Germany | *D. latum* | Fresh water fish | Wicht*et al.* 2008. |
| | Italy | *D. latum* | Fresh water fish | Nakao *et al.* 2007. |
| | Portugal | *D. nihonkaiense* | Anadromous fish | Nawa*et al*. 2005. |
| | Spain | *D. latum* | Fresh water fish | Esteban *et al.* 2014. |
| | Switzerland | *D. pacificum* | Marine fish | Pangan*et al*.2009. |
| | Finland | *D. latum* | Fresh water fish | Kyronpa*et al*. 2003. |
| | Belgium | *D. allomae* | Fresh water fish | JogisteBaratov, 2001. |
| | Cyprus | *D. latum* | Fresh water fish | Reperant*et al*. 2007. |
| Asia | Japan | *D. nihonkaiense* | Anadromous fish | Yamasaki *et al*. 2001. |
| | China | *D. nihonkaiense* | Anadromous fish | Chen *et al*. 2014. |
| | Indonesia | *D. latum* | Fresh water fish | Fuchizaki*et al.* 2003. |
| | India | *D. nihonkaiense* | Anadromous fish | Devi *et al*. 2007. |
| | Korea | *D. pacificum* | Marine fish | Park *et al*. 2015. |
| | Russia | *D. nihonkaiense* | Anadromous fish | Cai*et al*. 2017. |
| | Taiwan | *D. nihonkaiense* | Anadromous fish | Rohela*et al.* 2006. |
| | Mongolia | *D. nihonkaiense* | Anadromous fish | Myadagre*et al*. 2007. |
| | Okinawa | *D. nihonkaiense* | Anadromous fish | Arizona *et al*. 2009. |
| North America | Bahamas | *D. latum* | Fresh water fish | Scholz and Kutcha, 2016. |
| | Columbia | *D. latum* | Fresh water fish | Fang *et al*. 2015. |
| | Canada | *D. dendriticum* | Fresh water fish | Raus and Adams, 2000. |
| | Greek | *D. dallinae* | Fresh water fish | Rauch, 1956 |
| | Dominica | *D. alascense* | Marine fish | Rauch & Adams, 2000 |
| | Jamaica | *D. latum* | Fresh water fish | Dick, 2008 |
| | Mexico | *D. nihonkaiense* | Anadromous fish | Chou *et al*. 2006 |
| | Alaska | *D. latum* | Fresh water fish | Donoso, 1986 |
| | Costa Rica | *D. latum* | Fresh water fish | Kutcha *et al*. 2013. |
| South America | Argentina | *D. latum* | Fresh water fish | Semenas, 2014. |
| | Peru | *D. dendriticum* | Fresh water fish | Reinhard and Urban, 2003. |
| | Brazil | *D. pacificum* | Marine fish | Knoff*et al*. 2011. |
| | Bolivia | *D. pacificum* | Marine fish | Park *et al*. 2007. |
| | Nicaragua | *D.pacificum.* | Marine fish | Chai *et al*. 2005. |
| | Ecuador | *D.pacificum* | Marine fish | Sagua*et al*. 2001. |
| | Chile | *D. latum* | Marine fish | Marcado*et al.* 2010. |
| | Venezuela | *D. pacificum* | Fresh water fish | Reagua*et al*. 2002. |
| | Uruguay | *D. pacificum* | Marine fish | Nicolande*t al*. 2003 |
| Oceania | Australia | *D. pacificum* | Marine fish | Yamasaki *et al*. 2000. |
| | N. Zealand | Unknown | Unknown | Not reported |
| | New Guinea | Unknown | Unknown | Not reported |
| | Fiji | Unknown | Unknown | Not reported |
| | Marshal Islands | Unknown | Unknown | Not reported |
| | Samao | Unknown | Unknown | Not reported |
| Africa | South Africa | Unknown | Unknown | Not reported |

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|---|---|---|---|---|
| | Botswana | Unknown | Unknown | Not reported |
| | Guinea | Unknown | Unknown | Not reported |
| | Ethiopia | Unknown | Unknown | Not reported |
| | Angola | Unknown | Unknown | Not reported |
| | Tanzania | Unknown | Unknown | Not reported |
| | Uganda | Unknown | Unknown | Not reported |
| | Nigeria | *D. latum* | Unknown | Ihesiulor*et al*. 2013. |
| | Madagascar | Unknown | Unknown | Not reported |

**Table 3: Distribution of cestodes in the geopolitical zones of Nigeria**

| Zones | States | Cestodes | References |
|---|---|---|---|
| North Central | Niger | *Polyonchobothniumspp* | Owolabi, 2008. |
| | Abuja | *Monobothriumspp* | Dankishiya*et al*. 2013. |
| | Benue | *D. latum* | Omeji*et al*. 2014. |
| | Kwara | *Monobothriumspp* | Urukwu and Adikwu, 2017. |
| | Kogi | *Polyonchobothriumspp* | Amaechi, 2014. |
| | Plateau | *Monobothriumspp* | Anosike*et al*. 1992. |
| | Nasarawa | *D. latum* | Absalom *et al.* 2018 |
| North East | Gombe | *Monobothriumspp* | Dauda*et al*. 2016. |
| | Borno | *D. latum* | Biu and Akorede, 2013. |
| | Bauchi | *D. latum* | Udechukwu*et al*. 2018. |
| | Taraba | *D. latum*, | Mathias, 2014. |
| North West | Kano | *Proteocephalusspp* | Bichi and Ibrahim, 2009. |
| | Kaduna | *Monobothriumspp* | Oniye*et al.* 2004. |
| | Sokoto | *D. latum* | Magami*et al*. 2016. |
| | Katsina | *Polyonchobothniumspp* | Yuguda*et al*. 2017. |
| | Jigawa | *Amonotaenia* | Danyaro*et al.* 2018. |
| South South | Cross River | *D. latum* | Ekanem*et al*. 2011. |
| | Delta | *Monobothriumspp* | Vincent *et al*. 2014. |
| | Edo | *D. latum* | Onyedineke*et al*. 2010. |
| | AkwaIbom | *Amonotaenia* | Edema *et al.* 2008. |
| | Rivers | *Monobothriumspp* | Cletus *et al*. 2016. |
| South East | Anambra | *Monobothriumspp* | Ezenwaji*et al.* 2005. |
| | Enugu | *D. latum* | Ugbor*et al*. 2014. |
| | Imo | *Polyonchobothriumspp* | Ugwuzor, 1987. |
| | Ebonyi | *Monobothriumspp* | Azubuike*et al.* 2015 |
| | Abia | *Polyonchobothriumspp* | Uchechukwu, 2014 |
| South West | Oyo | *D. latum* | Abidemi-Iromini, 2019. |
| | Ogun | *Proteocephalus* | Fafioye*et al*. 2017. |
| | Osun | *Monobothriumspp* | Olurin*et al*. 2012. |
| | Ekiti | *Polyonchobotothrium* | Olofintoye, 2006. |
| | Lagos | *D. latum* | Hassan *et al.* 2010. |

**Pathophysiology**

Immature eggs are passed in feces, eggs mature (18 to 20 days) and yield oncospheres which develop into a coracidia. Coracidia ingested by a suitable first intermediate host (freshwater crustacean, e.g. a copepod) Coracidia develops into procercoid larvae and copepod ingested by a suitable second intermediate host, procercoid larvae migrate into the fish flesh, there they develop into a plerocercoid larvae, the infective stage for humans. Humans can acquire the disease by eating infected host fish raw or undercooked. In humans the plerocercoid develops into adults residing in the small intestine (Choi *et al.*, 2012).Once established, the tapeworm induces changes in the concentration of several

neuromodulators in the host tissue and serum (Yoneva*et al.,* 2014). Additionally, *D. latum* infection has been shown to cause structural changes leading to altered gastrointestinal tract functioning by modulating theNeuroendocrine response and causing enhanced secretion as well as changing gut motility (Arizono*et al.,* 2009).Despite the large size of most *Diphyllobothrium* species and, thus, their mechanical effect on the host, many infections with this parasite are reported to be asymptomatic (Ikuno *et al.,* 2018).

**Clinical manifestations**

Can be a long-lasting infection (decades). Most infections are asymptomatic. However affected individual may havecentral nervous system manifestation, ocular manifestations,gastrointestinal manifestation, hematological manifestations, respiratory manifestations and dermatological manifestations(Scholz*et al.,* 2009).

**Diagnosis**

Identification of eggs in the stool by microscopy. High sensitivity (95%) due to high no. of excreted eggs Idendification of proglottids passed in the stool and staining can also be of diagnostic value (Radacovska*et al.,* 2019)

**Prevention and control**

Ingestion of raw freshwater fish should be avoided. Adequate cooking of freshwater fish at 55$^{o}$C will destroy the encysted fish tapeworm larvae. Freezing at -10°C kill the larvae within for 24–48 hours (Sharma *et al.,* 2018).Public health information campaigns may be employed to educate the public about the risks of consuming improperly prepared fish. Proper disposal of sewage can reduce fish (and therefore human) infections(Scholz*et al.,* 2009). Prevention of water contamination from defecating may be achieved. Basic sanitation measures and screening and successful treatment of people infected with the parasite. Food safety control can also be of value in the control (Ito and Budke, 2014).

**Treatment**

Praziquantel is a drug of choice. Adults: 5-10 mg/kg orally in a single dose. Children: dosage is the same as for adults. Praziquantel should be taken with liquids during a meal. Alternatively Niclosamide (Yomesan® 500mg ) can be used. Adults: niclosamide 2 g orally once. Children: 50 mg/kg (max. 2 g) orally once. Niclosamide must be chewed thoroughly or crushed and swallowed with a small amount of water

**Conclusion**

This parasitic disease should not be regarded as neglected, because new foci and human infections with exotic species have recently appeared, even in countries with a high standard of medical care.

Better education of all population segments, such as consumers, health professionals, fishermen, and sellers, particularly in endemic areas, is necessary.A multidisciplinary approach could provide a better way to fill the current knowledge gaps. Public health education, food safety control, and consumer education on the risks of raw fish consumption are fundamental to control and prevent diphyllobothriasis.

However, it is hoped that warning of the potential risk of reemergence of diphyllobothriosis due to changing eating habits, globalization of the food market and climatic change will help in a more effective control of this parasitic disease on the global scale.

**Recommendations**

Given the effect of globalization and the prevalent habit of consuming raw or undercooked fish, clinicians, nurse practitioners, nurses with specialty training in infectious diseases, pharmacists, and public health officials should be aware of the re-emergence of diphyllobothriasis, as part of an inter-professional healthcare team approach. There should be a periodic monitoring of the infection in man and fishes with regular prevalence surveys to study the evolutive nature of diphyllobothriasis.

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