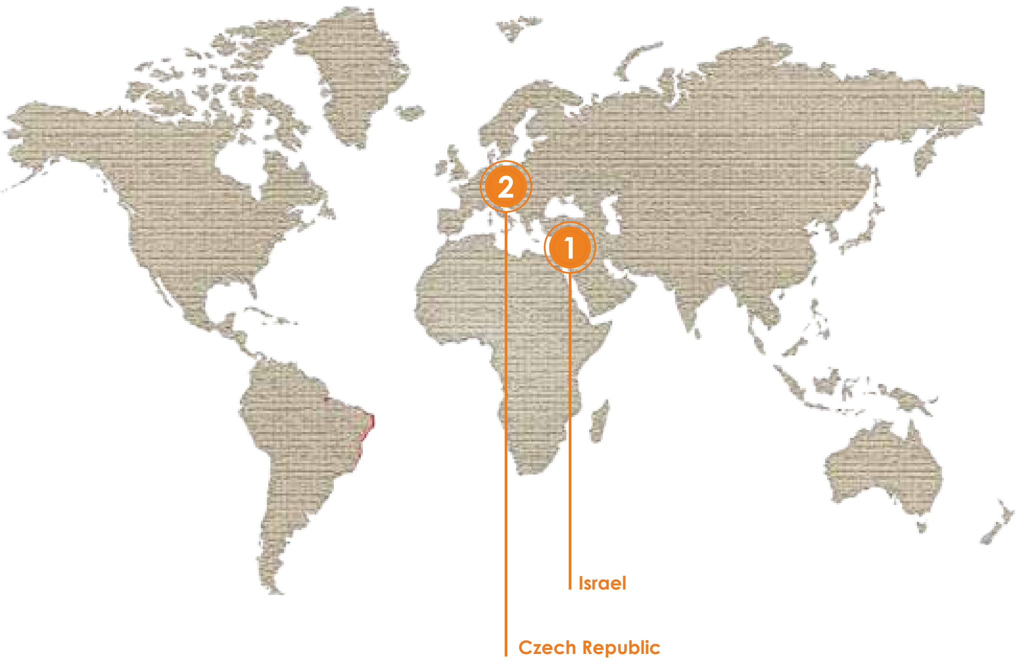
EXPERT TOPIC

COMMON CARP

Welcome to Expert Topic. Each issue will take an in-depth look at a particular species and how its feed is managed.



1 No stomach for it:
why carp don't share our culinary tastes

When farming animals and fish, there is often a danger that we may assume that their dietary requirements match our own. However, those of the common carp, Cyprinus carpio, certainly do not.

For one thing, carp have no stomach. Food passes directly from mouth to intestine, without the acidic conditions of a stomach to quickly break meat down and maximise protein extraction. As a result, the length of the intestine will actually be partly determined by what they are fed during early life. In other words, what is fed to them as juveniles really will affect what you can or can't feed them as adults.

Each day, your average common carp needs about 1g protein per kg bodyweight to maintain itself. As much as 12g per kg will give maximum protein retention, but nitrogen use for growth is actually most efficient at a much lower rate: seven or eight grams per kilo per day. In various eastern European countries and in Israel, crossbreeding programmes are also employed to speed growth.

Extruded feeds are generally more popular for carp than pellets as they float and last longer in the water. However, the extrusion process involves cooking, and this tends to destroy vitamins, so recipes for such feeds tend to have a vitamin level two to five times that actually required by the fish. Not vitamin C though - from the fingerling stage onwards, they make their own from D-glucose.

But the surprises don't end there. It also appears that a substantial amount of magnesium is obtained by the fish, not from food taken in through the mouth, but rather is absorbed from the surroundings via other parts of the body; this may be an important factor to consider in pond aquaculture.

Source: FAO

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COMMON CARP

Myxozoan parasites in common carp – Importance for aquaculture, ongoing research and future perspectives

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Common carp, Cyprinus carpio is one of the oldest domesticated species of fish for food production. Carp culture in China dates back to the 5th century BC, while the earliest attempts in Europe were made during the Roman Empire. Considered a delicacy by the Romans, modern carp has lost some of its exquisiteness but has acquired outstanding importance in freshwater aquaculture, with currently about 14 percent of total global production, over 7.1 million tonnes per year.

Asia is the largest producer with China claiming 60 percent of the world's production while the European market is much smaller. Seven out of the top ten species of farmed fish species are carp and Common carp production continues to increase by an average global rate of over 10 percent per year. Benefits of carp aquaculture include minimal feed requirements, hardy species able to survive a variety of temperatures and water conditions, high cost-benefit ratio as intensive culture year round is not a problem with minimal labor.

In Central Europe, carp ponds are the center of attention at the end of the year, when the season for fallowing the ponds and marketing their meaty carp (Fig 1) arrives so that a favourite Christmas dish lands on the plate in time. But not every carp makes it to the harvest date. In fact, the largest losses in carp pond cultures occur in juvenile carp in their first summer, when temperatures are high, oxygen levels are low and fingerlings receive a bombardment with a wide range of pathogens in the ponds, while they have not yet developed full immunocompetence. Koi Herpes Virus (KHV) is presently the most serious threat to carp farming in Europe and Asia,

Figure 1: Carp Festival in Trebon, Czech Republic

Saprolegnia is the major fungal pathogen and a number of parasites are of great importance.

Myxozoans are morphologically extremely reduced cnidarians, with jellyfish (Medusozoa) as their closest free-living relatives. Interestingly, to the present knowledge, myxozoans have their highest diversification rate in cyprinid hosts, with common carp being host to more than 50 species around the world. Many of these species are only distinguishable by molecular methods as they share morphologically similar spores leading to misconceptions about the number of species found in a host and pathogen identification. This also creates problems for diagnostic and quarantine screening of imported carp stocks for either food/

Figure 2: General life cycle of myxozoan parasite

fish oil production or with ornamental koi carp from Asia for the pet trade in Europe.

Myxozoans infect two types of hosts within their life cycle, a vertebrate and an invertebrate; species known from carp use freshwater oligochaetes or bryozoans to complete their development and transmission between hosts occurs via spore stages (Figure 2). Some infections are innocuous, and others have been linked to significant disease in carp; for many of the known Myxozoa from cyprinid species the invertebrate host is unknown. This and the fact that it is close to impossible to eradicate oligochaetes from pond sediments makes disruption of the life cycle almost impossible. Only management strategies are possible, such as fallowing ponds and adjusting stocking dates to periods of low infective spore concentrations in the water column.

The features of carp aquaculture that make it a profitable industry i.e. intensive stocking in non-flowing, organically enriched waters with minimal/low cost feed input, expose carp to a high risk of myxozoan infections and disease. Crowded, low-oxygen conditions create stressed populations which are more susceptible to disease, carp feed on aquatic invertebrates and burrow into the mud where they are easily exposed to infectious spore stages from invertebrate hosts and stagnant ponds also concentrate infectious stages.

Several myxozoans are known to be highly pathogenic to carp species around the globe, and the importance of some species to the aquaculture industry has led to the inclusion of myxozoans in carp into a European Union funded Research and Innovation program (ParaFishControl, www.parafishcontrol.eu), targeting the development of tools to control or prevent diseases in European farms. In this project, we are responsible for the coordination of research on myxozoans in carp, some of the most significant are shown in Figure 3.

An important research target is Thelohanellus kitauei, the agent of Intestinal Giant Cystic Disease in Asian carp. This myxozoan produces tumor-like cysts in the intestinal wall that block the intestinal lumen, leading to starvation of the host, with important mortality rates reported. T. kitauei invasion of European ponds from the East has been predicted, in relation to trade and movement of fish, especially commercially valuable Koi carp. The parasite was recently detected in Hungarian waters, and we are currently determining its spread in European carp production sites by analysis of water samples from a number of sites in Czech Republic, Hungary, Germany and Austria, with quantification of infective stages in the water column.

The second species of major importance is Sphaerospora molnari, the agent of gill and skin sphaerosporosis in carp, which has been reported as an emerging pathogen in Europe, which additionally functions as a co-factor in Swim Bladder Inflammation of carp. We are establishing the first myxozoan in vitro model using proliferative blood stages of S. molnari. This model can be used in the future e.g. for testing potentially myxoicidal substances for in-feed treatments. Such applied studies are of particular importance as a legalised treatment against myxozoans for fish destined to human consumption does not presently exist.

On the host side, we investigate S. molnari proliferation in carp by quantitative PCR at different temperatures and study the transcriptomic characteristics of the highly proliferative blood stages. According to the International Panel on Climate Change's Fifth Assessment Report, climate change will have an overall negative impact on the world's fisheries and aquaculture through increased water temperatures, acidification and oxygen depletion.

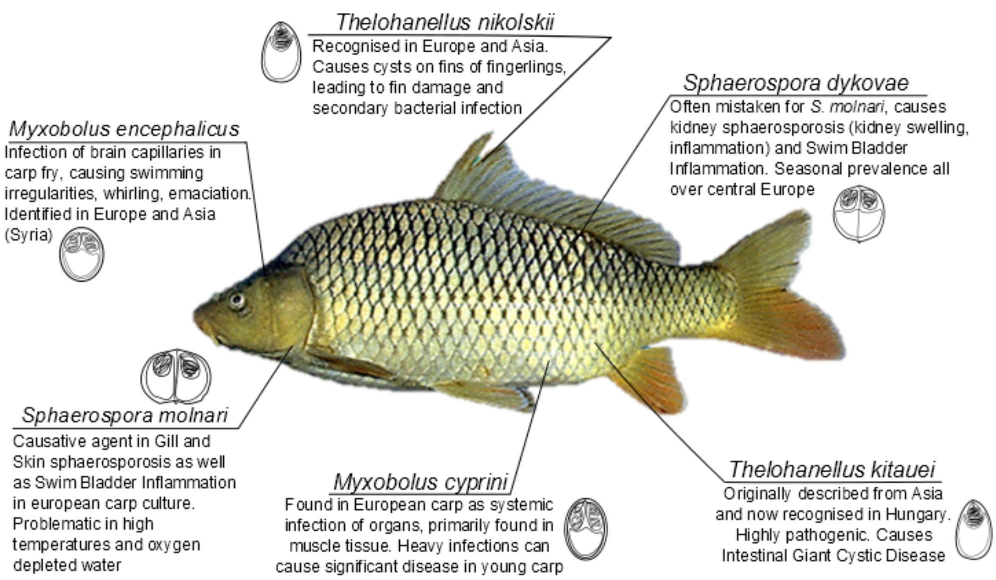
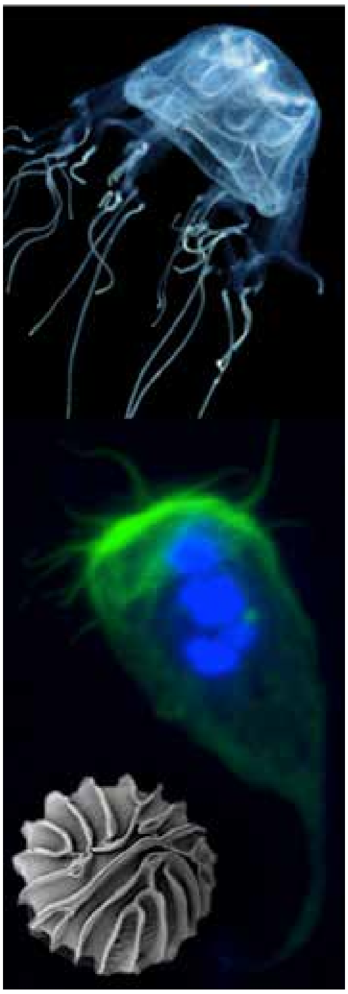


Figure 3: Myxozoan parasites important to carp aquaculture

The European Environmental Agency states that water temperatures in European freshwater habitats have increased by 1-3°C over the last century. At higher temperatures and subsequent lower oxygen levels in stagnant ponds fish may receive a higher dose of infective spores due to increased ventilation volumes passing through the gills, apart from increased proliferation rates in the fish host. Increased severity of myxozoan related diseases at higher temperatures has been shown e.g. in Enteromyxum species causing inflammatory enteritis in pufferfish and Mediterranean sea bream or in Tetracapsuloides bryosalmonae causing Proliferative Kidney Disease in salmonids. Furthermore, it is likely that temperature impacts on the density and number of annual cohorts produced by the invertebrate hosts. Overall, emerging or increasing severity of myxozoan diseases can be predicted for the future.

Research on myxozoans has traditionally been of taxonomic focus, resulting in the description of just under 3000 species. The first life cycle was described only in 1984, and at present, invertebrate and vertebrate hosts are known for only about 50 species, an indication for the fact that our knowledge of this parasite group is still marginal. However, for the species of importance to fisheries and aquaculture, research has gone beyond taxonomy and life cycle investigations. For example we now have extensive seasonal and flow-related monitoring data for Ceratonova shasta, a species that causes mortality in salmonids in the Klamath river basin (Western USA) through intestinal perforations and co-occurring bacterial infections.



Functional approaches were hindered greatly by the lack of genomic and transcriptomic data which have only very recently become available. The final breakthrough was the publication of the genome of T. kitauei, the first genome sequenced for myxozoans, which, at the end of 2014, provided us with a basic idea of the molecular and physiological changes that happened in this diverse group of cnidarians that became parasitic to fish. Genomic and transcriptomic data offer incomparable opportunities for research into molecules that are of particular importance for host-parasite interaction, since the proteins active on this interface are likely good future drug targets to disrupt the parasite's development or the disease process.

Considering that emerging diseases are anticipated as a major limiting factor for future carp aquaculture, support for such targeted anti-myxozoan strategies is now needed now from industry and governments to be ahead of the problems we will face in providing carp in the future and to ensure the production of Christmas carp in Central Europe also in the future.