A review of the diseases and contaminant related mortalities of tench (*Tinca tinca* L.)

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ABSTRACT: The paper provides a review of the current state of knowledge of parasites, diseases and poisonings of tench (*Tinca tinca* L.) based on the literature and on the authors own findings. Information on the viruses, bacteria, fungi and parasites reported from tench are provided along with deaths resulting from alterations in environmental quality. Finally, a list of the current known species of parasites and diseases reported in the Czech Republic are provided based on our own investigations carried out at the Research Institute of Fish Culture and Hydrobiology at Vodňany (University of South Bohemia Ceske Budejovice, Czech Republic) between 1984 and 2002.

Keywords: viral diseases; bacterial diseases; fungal diseases; parasitic diseases; environmental effects; poisonings; monitoring of tench health in Czech Republic (1984–2002)

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1. Introduction

Tench (*Tinca tinca* L.) is generally considered to be one of the original European cyprinid species. It is most likely to have evolved from primitive Tertiary *Paleoleuciscus* in large lake systems of Central Europe. There are no extant cyprinids that are directly related to tench and whilst it is clearly classified within the Cyprinidae, its taxonomic affinities remain unresolved. In Europe, tench are utilised as food, for leisure purposes such as angling and as ornamental fish and have been used as an indicator of water quality in the context of fish assemblage (Flajshans and Billard, 1995). Tench numbers and abundance have declined markedly in open waters in the Czech Republic, and it is possible that tench may become an endangered species not only in the Czech Republic but throughout Europe, as exemplified by its almost total disappreance from the Danube delta. The reasons for the declines are not clearly understood. In several European countries, tench has been reared in farm ponds, either in monoculture or alongside common carp (*Cyprinus carpio* L.). Within the last twenty years, tench have undergone the process of intensive domestication, similar to that of common carp centuries ago. The domestication and selective breeding of tench was begun in the former Czechoslovakia and in addition to the five original strains, new strains from Hungary, France and Romania have been introduced (Rab *et al*., 2002).

The production of tench for human consumption, as with common carp, is mainly restricted to Central and Eastern Europe. In 2001, 182 t of tench were produced for human consumption in the Czech Republic, of which 24 t were derived from catches in open waters. Tench is used as a model species for studies of performance traits enhancement by means of chromosomal manipulations or, more precisely, by means of triploidy induction (Flajshans *et al*., 1993a,b; Flajshans, 1996; Buchtova *et al*., 2003a,b) and for studies of biological and physiological differences among genome manipulated populations and those obtained by classical breeding techniques (Svobodova *et al*., 1998, 2001a; Svoboda *et al*., 2001).

Compared to other fish species, the occurrence of diseases in tench is lower, and prevalence and intensity of infections tends to be relatively low as well. This is true of tench from pond culture and from open waters. However, losses of tench due to diseases are greater than other species when they are maintained for long periods of time in pond culture. The recent upsurge in the use of warmwater recirculating aquaculture facilities for the rearing of tench fry is likely to lead to an increase in the severity and prevalence of a number of diseases in these systems unless adequate control methods are used.

Tench are considered to be susceptible to similar diseases as those reported for common carp (Schaperclaus, 1979; Bauer *et al*., 1981; Stoskopf, 1993; Citek *et al*., 1998).

2. Viral diseases

There are limited reports of viral infections in tench. However, it is recognised that they are susceptible to similar, if not identical viral diseases of cyprinids, albeit with an atypical picture.

2.1. Rhabdoviruses

Prost (1980) reported the occurrence of spring viraemia (Spring viremia of carp, SVC) caused by *Rhabdovirus carpio* agent in tench and stated that tench co-habited with common carp were likely to succumb to SVC. It is an acute disease occurring in spring months generally when water temperatures exceed 15°C. Typical clinical signs include lethargy, enteritis, peritonitis, oedema of abdominal cavity, exophthalmia, opacity of the swim bladder and petechial haemorrhages in viscera, skin and muscles (Hoole *et al*., 2001). Initial mortality rates are low and increasing later in the course of the infection. Mortality rates can be dependant on a number of factors including the quality of aquatic environment, water temperature and secondary infections such as bacteria. Although SVC can transmit directly between fish, the fish louse *Arguls foliaceus* has been shown to act as a host for the virus.

Ahne *et al*. (1982) isolated rhabdoviruses from moribund tench collected in Germany in 1980 and 1981 which was diagnosed as pike fry rhabdovirus disease (PFRD). One- to two-year-old tench kept in pond culture showed clinical haemorrhages in the skin and at the bases of the scales. No lesions were found on the viscera. Wolf (1988) also reported the isolation of PFRD in tench and two other cyprinids although the importance of these viruses in cyprinids was unclear. The antigenic relationships between PFR rhabdovirus (agent of pike fry rhabdovirus disease) and SVC rhabdoviruses (spring viraemia of cyprinides) are unclear as it is recognised that the indirect fluorescent antibody test (IFAT) does not distinguish between the two viruses (Hoole *et al*., 2001). Additionally, the clinical signs and disease manifestation for SVC and PFR appear to be very similar.

2.2. Reoviruses

Ahne and Kolbl (1987) reported in a brief communication, the occurrence of reoviruses in European tench and chub (*Leuciscus cephalus*). Serologically identical viruses, belonging to a new group of reoviruses, were isolated from both fish species. Isolated reoviruses were serologically close to reoviruses as golden shiner virus (GSV) and chum salmon virus (CSV). It is possible tench may be susceptible to grass carp reovirus disease (GCRD), responsible for high mortalities in cultured grass carp (*Ctenopharyngodon idella*), since other similar reoviruses have been shown to have a low host specificity (Chen and Jiang, 1984). Indeed, Hoole *et al*. (2001) reported that tench are amongst a limited number of cyprinids which are susceptible to the related infection of grass carp, grass carp haemorrhagic disease (GCHD). Clinical symptoms of the disease are atypical, with 1- to 2-year old fish being highly susceptible and mortality rates up to 80% in some cultures in China. Whilst the taxonomic affinities of GCHD are currently unknown, it is possible that it belongs within the picornaviruses.

2.3. Herpesviruses

Citek *et al*. (1998) and Navratil *et al*. (2000) state that tench are susceptible to herpesvirus infection of common carp causing a disease called pox disease of fish or carp verrucous disease (*Epithelioma piscium* – EPa). It is known from pond systems, dam reservoirs and running waters of the Czech Republic and of the entire Europe. Whilst direct losses of fish due to this disease are not high, the external appearance of the fish as a result of the infection can make the fish unmarketable. Tench are also susceptible to fish pox (Hoole *et al*., 2001) which is caused by a virus believed to belong to the herpesvirus group. This disease occurs during the winter period when water temperatures fall below 14°C and it is manifested with smooth, opaque, white to greyish-white areas on fish skin. Initially the skin lesions are small (1–2 mm) and focal which may eventually fuse into larger areas and can even cover the majority of fish body surface. Pathologically, it is a hyperplasia of epithelial cells of epidermis and as with EPa, affected fish are rendered aesthetically unpleasant and are unmarketable. There are currently no known therapeutants for the condition although the severity of the disease can be alleviated by improving general husbandry and altering oxygen levels, organic pollution and water pH. The use of lime has been recommended as a preventive measure.

Clinically atypical viral infections may also weaken fish resistance to other pathological agents such as parasitic infections or unfavourable environmental conditions. The continued monitoring for viral diseases in tench is therefore important, although no viral disease is "typical" for this species.

3. Bacterial diseases

Zmyslowska *et al*. (2000) compared the presence of bacteria in gut of tench with presence of indicator bacteria in water from tanks where the fish have been kept. In addition to finding fungi, the authors reported the presence of the bacterial genera *Pseudomonas*, *Aeromonas* and *Acinetobacter*. It was concluded that the gut flora of tench was identical with that found in the surrounding water and concluded that the sampling of water in which tench were maintained provided a suitable method for the determination of the bacterial fauna of tench.

3.1. Flexibacter

The occurrence and description of bacterial diseases in tench is very sporadic, with the exception of bacterial disease of skin and gills of tench fry (causal agent *Flexibacter* sp.), kept in warmed water fish farming facilities. This disease causes high losses of the fry reared. By altering and/or monitoring environmental conditions such as enhanced oxygenation, checking the organic loading and water temperature reduction mortalities due to the bacteria may be reduced (Roberts, 1989). For therapy, a bath in Chloramin B (20–30% content of active chlorine) at a concentration of 20 mg/l water for 1 hour was found to be the most effective treatment which needs to be repeated daily within a 5-day-period. Prior to using chloramine, a tolerance test on limited number of fish will need to be performed since the active chlorine content is very variable in individual batches of the product. Chloramin bath can be applied also as a preventive treatment every second day, 2–3 times in total.

Tench are susceptible to columnarosis, caused by *Flexibacter columnaris* (Inglis *et al*., 1993). The disease occurs at water temperature of 15°C and higher. White spots on head, gills, fins and body, lined with a red hyperaemic zone are the first clinical signs. During the next phase, lesions are covered with yellow-whitish exudate and show signs of necrotic alterations. The affected fins are lacerated.

3.2. Aeromonas

In the Czech Republic, occasional samples of tench are found with signs of haemorrhagic septicaemia on skin. Prost (1980) described the aetiological agent as *Purpura cyprinorum*. The causative agent of this disease is bacteria *Aeromonas hydrophila* or *Aeromonas sobria*. A part from typical signs on skin, typical changes on viscera may be found in some specimens with mainly strong hyperaemia of intestine mucosa, as well as of other organs in abdominal cavity. Both Noga (1995) and Hoole *et al*. (2001) consider that tench are susceptible to infections of *Aeromonas salmonicida*, the bacteria responsible for furunculosis in salmonids. The infection clinically appears as skin petechia and ulcerous changes in skin. It is known as "summer ulcerous disease" in Europe.

In June 1986 we had the opportunity to diagnoste clinically the erythrodermatitis of tench in 3-year-old tench which had been overwintered and further kept in storage ponds in spring. These fish were generally in very poor condition with superficial haemorrhagic ulcerations on skin. There were solitary fish deaths and thus, antibiotics-containing medicated feed was applied. Chloramfenicol was the antibiotics used at that time although it is no longer recommended for fish therapy. Health of fish was improved and fish were stocked into a pond. Dubois-Dernaudpeys and Tuffery (1979) report tench as a fish substantially more resistant to this bacterial disease compared to common carp (*Cyprinus carpio*) and Lucky (1986) showed by experimental infection that tench was resistant to the causal agent of erythrodermatitis.

3.3. *Sporozoon tincae*

There is a disease of tenchwhich is historically associated with South Bohemian ponds. Volf and Dvorak (1928) described the disease agent as *Sporozoon tincae* that they considered to be a unicellular parasite which caused very extensive and severe disease of tench at one South Bohemian fish farm. Blood infiltrates appeared on various sites of tench skin which then enlarged and became tumors. Scales fell off the affected sites and deep penetrating, open ulcers were formed and in some cases, perforation of the body wall into the abdominal cavity occurred. Periphery of the ulcers was infiltrated with blood and a there was a sanguineous pyorrhoea. Slight hyperaemia of the viscera was noted at the beginning and a total anemia later on. The gills were pale and mortality was high. Approximately 90% of tench showing clinical signs died consequently. The disease was manifested mostly during warm months and ceased in winter. The course of the disease was always chronic, there were 3–9 months elapsed between the first clinical signs and the fish deaths. Other than a further report of the disease by Jirovec *et al*. (1946), there have been few reports on the occurrence of this disease.

Lom *et al*. (1989) included in *S. tincae* among microorganisms traditionally reported among protozoa parasiting on fish whose taxonomic status was unclear. The authors consider tench to be the main host, findings on the common carp are very rare. They point out the high pathogenity for tench, as well as high mortality (90%) during epizootics and the importance of assessing sporadic findings on the common carp and other cyprinids.

A clinical picture similar to that of Volf and Dvorak (1928) during the infection with *S. tincae* was reported in tench from northern Germany in 1980 (Hermanns and Korting, 1985). Fish showed changes of ulcerous character on fin bases, on the body wall and on the tail. Based upon electron-microscopic studies, Kaup and Korting in 1994 classified *S. tincae* as a bacterium. Whilst this bacterium is localized in histiocytes of the subcutis, it can also be found in the spleen and liver of affected fish. It is an encapsulating bacterium. The bacteria is considered problematic in tench farms, mainly in northern Germany, although in contrast to Volf and Dvorak (1928), Hermanns and Korting (1985) mortality rates are usually low at less than 1%.

4. Fungal diseases

4.1. Saprolegnia

Saprolegniosis and branchiomycosis belong to the most serious fungal diseases of tench. Saprolegniosis is one of the most frequent diseases of tench although the exact species involved has not yet been determined. Whilst some authors consider that the disease agent isidentical to pathogenic strains isolated from salmonid fish, Roberts (1989) suggested that *Saprolegnia parasitica* – diclina complex was the agent. Starvation, poor water quality and high stocking density etc. increase the risk of infection and pathogenicity of the fungus. More importantly, the mechanical and chemical damage of the protective mucous layer of skin or injuries to the skin and gills will greatly increase the chances of infection. Tench belong to a group of fish which are extraordinarily sensitive to this disease. Skin lesions covered with saprolegnia hyphae have erythematous margins and during the advanced stage of the disease the areas on skin and gills under fungal growth are necrotic. If signs of saprolegniosis appear in tench culture, external dissinfection is to be applied in a form of therapeutic bath. A bath of malachite green was formerly used. However, nowadays it can be neither recommended, nor permitted. Recommended therapeutic baths include NaCl (salt), formaldehyde or kaliumpermanganate. The use of a bath treatment with blue vitriol ($CuSO_4.5H_2O$), as recommended for other fish species, cannot be recommended for tench due to surprisingly high sensitivity of tench to substances and preparations containing copper.

4.2. Branchiomyces

Many reports suggest that *Branchiomyces demigrans* is the causative agent of branchiomycosis in tench. However, Roberts (1989) reported that two species, *B. demigrans* and *B. sanguinis* were identified from branchiomycosis of tench. Neish and Hughes (1980) and Willoughby (1994) also consider *B. demigrans* and *B. sanguinis* to be the agents of tench branchiomycosis. The onset and course of the disease is dependendant on conditioning factors in which the organic pollution of water plays an important role. Rehulka and Tesarcik (1972) diagnosed branchiomycosis of tench in a duck pond in which common carp and tench were cohabited. Basic histological and pathological alterations considered by the authors were growth of the fungal hyphae in strongly dilatated vessels of secondary lamellae of gills and gathering the fungal spores in their lumina. Gill epithelium reacted to these changes sequentially by intensive hyperplasia followed by local necrosis.

4.3. Other

Pokorny and Cervinka (1974) reported on the occurrence of the fungal disease, *Ichthyochytrium vulgare*, in tench fry cohabited with two-year-old common carp and Neish and Hughes (1980) reported the occurrence of *Cryptococcus* sp. (Blastomycetes) in tench, as well as an experimentally induced infection *Ichthyophonus hoferi*.

5. Mycoplasmoses

Infections caused by mycoplasmas are of current interest although the types, distribution and pathogenicity in fish have not yet been fully elucidated. Kirchhoff *et al*. (1987) isolated a new species of mycoplasma *Mycoplasma mobile* from gills of tench suffering from "red disease". Noga (1995) also reported on *M. mobile* as on a sole representative of mycoplasms isolated from fish and causing skin and gill lesions.

6. Parasitic diseases

Parasitic diseases are the most frequent diseases diagnosed in tench. They are found mainly in tench from warmwater fish farming facilities and from ponds in spring after wintering. Bychowski (1962) listed a total of 65 parasite species known to occur in tench in the former USSR. Although it is possible that some of these may be synonyms, it is clear that tench contain a large number of species. Indeed, Wierzbicka *et al*. (1998) reported 20 parasite species from only three lakes in Poland, including at least one species not reported by Bychowski (1962), strongly suggesting that the list provided by Bychowski (1962) is limited.

6.1. Protista

Although Lom and Dykova (1992) listed 18 species of protistans occurring in tench, the current review is limited to those which either commonly occur on or in tench or those that are recognised as serious pathogens of tench.

6.1.1. Trypanoplasma

Trypansomes of the blood are generally rare in fish, although under certain conditions may be pathogenic. They are transmitted via a leech vector. *Trypanosoma carassii* (formerly *T. danilewskyi*) and *Trypanoplasma borelli*, have been reported from tench. Although *Trypanoplasma* has previously been considered as a trypanosome, there is recent molecular evidence that suggests that it may in fact be a blood stage of the skin parasite *Cryptobia*. Trypansomes are mostly found on weakened tench from pond culture after overwintering and/or starvation. Pokorny and Cervinka (1974) diagnosed haemoflagellates of *Trypanoplasma* sp. in tench fry at one out of seven pond localities. The disease proceeded at low intensity during August. Steinhagen *et al*. (1999) reported histological changes in common carp and tench infected with *Trypanoplasma borelli*. Apart from high number of parasites in peripheral blood, the authors reported anemia of gills, enlarged spleen, enlarged kidney with petechial haemorrhages, local haemorrhages and necroses in liver, spleen and kidney.

6.1.2. Amoebae

Diseases caused by amoebae occur in cyprinid fish and they are clinically manifested by abdominal distention, lethargy and loss of appetite. Pathological examination shows in the affected fish small white nodules on kidney and on other organs in the abdominal cavity. Hoole *et al*. (2001) reported on genus *Acanthamoeba* being pathogenic for cyprinids. No finding of amoebas has been yet registered in tench so far but based on data obtained for other cultured fish species, it is likely that these parasites may become problematic.

6.1.3. Cryptobia and Ichthyobodo

Cryptobia branchialis is observed in higher incidence on skin and gills of early stages of tench fry kept in warmwater fish farming facilities and is usually a parasite of weakened or debilitated fry (worsened condition, organic pollution of water, etc.). Ichhtyobodosis is considered one of the most important protozoal diseases of tench fry. The agent *Ichthyobodo necator* (formerly *Costia*) is found on the skin and gills andmassive infection cause nearly 100% mortality of fry, mainly in the early stages. Solitary occurrence of this parasite on tench in good condition is frequent, especially on older fish, but it does not induce any important pathological changes. Pokorny and Cervinka (1974) reported the occurrence of *I. necator* in tench fry in August.

6.1.4. *Ichthyophthirius multifiliis*

Ichthyophtiriosis is one of the most serious parasitic diseases of freshwater fish. It can cause large losses of tench as well. The agent *Ichthyophthirius multifiliis* parasites between epidermis and cutis and in gill epithelium. Higher temperature of water, dense stock of fish for several weeks and total weakening of the fish by malnutrition or starvation are important conditioning factors affecting the outbreak of ichthyophtiriosis.

6.1.5. Chilodonella

In the Czech Republic, the disease affects tench mostly in spring after overwintering and when rearing the early fry stage in warm water. *Chilodonella hexasticha* is found on skin and gills of tench of all ages. The disease chilodonellosis and consequent losses found above all in tench yearlings in spring after wintering. Weakening of the fish by malnutrition, long wintering and unfavourable oxygen conditions are conditioning factors for outbreak of the disease.

6.1.6. Trichodina and Trichodinella

Representatives of the genera *Trichodina (T. acuta, T. fultoni, T. mutabilis, T. nemachili, T. nigra, T. pediculus, T. rectangli)* and *Trichodinella (T. epizootica)* (Lom and Dykova, 1992) belong to other frequent protozoa occurring in weakened tench. Their rapid development and direct lifecycle can be problematic in both recirculating systems and in systems with poor water quality. They never occur in big quantities in fish in good condition. Although a natural component of an ecosystem, the presence of these ectocommensal parasites in debilitated fish can be idicative of deteriorated culture conditions. Prevention and therapy is the same as for chilodonellosis. Pokorny a Cervinka (1974) reported that *Trichodina* spp. were one one of the most frequent parasites of skin and gills in tench fry from the seven ponds studied.

6.1.7. Coccidiae

Molnar (1982) described a finding of nodular coccidiosis in intestine of 3- to 5-year-old tench. Although the macroscopic finding in intestine was the same as in nodular coccidiosis of common carp (agent: *Goussia subepithealis*), the causal agent in tench was not the same one. The agent of tench coccidiosis was never determined precisely although it was recognised as a *Goussia* sp. Hoole *et al*. (2001) also mentioned the presence of *Goussia* sp. (*G. aurata* and *G. subepithelialis*) in tench, apart from other cyprinids. Although coccidians can transmit directly, it has been shown that it can also be transmitted via oligochaetes.

6.2. Myxozoa

Whilst traditionally classified with the protozoa due to their small size, it is now recognised that myxozoans are degenrate metazoans. Around 1 350 species have been described worldwide in marine and freshwater fish hosts and in at least 20 species of myxozoans, transmission is via an oligochaete alternate host (Kent *et al*., 2001).

Several species of Myxosporea have been reported in tench, similarly to other fish species. The most frequent ones reported are *Myxidium rhodei* from the kidney of tench and *Thelohanellus pyriformis* in its gills. Plasmodia *M. rhodei* develop in renal corpuscles and cause compression of kidney tissue followed by atrophy of the peripheral renal corpuscles whilst the plasmodia of *T. pyriformis* are localised in vessels of gills. Whitish nodules usually 0.5 mm in size appear on gills. Dykova and Lom (1987) describe hypertrophy of endothelial cells when in contact with *T. pyriformis*. No cases of serious damage in tench by Myxosporea have been reported although it is recognised that myxosporea in othe rfish genera, including cyprinids can be pathogenic.

Molnar and Kovacs-Gayer (1986) reported that the myxosporean *Sphaerosphora renicola* from the kidney (developmental stages in gas bladder) of common carp is not contagious to other cyprinids and thus also to tench. However, two *Sphaerospora* species are known to occur in tench, namely *Sphaerospora galinae* in the renal tubule lumens and *S. tincae* in the anterior kidney (Lom *et al*., 1985; Lom and Dykova, 1992). *Zschokkella nova* is a parasite of the gall bladder of cyprinids, including tench (Lom and Dykova, 1992). Among species of Myxobolidae, the following ones are described in tench: *M. baueri*, *M. bramae* (gills), *M. crassus*, *M. cyprini* (muscle), *M. cycloides* (gills, skin and other organs), *M. dispar* (gills, skin and other organs), *M. dogieli*, *M. donesae*, *M. dujardini*, *M. ellipsoides* (connective tissue cells of gas bladder and gills), *M. gigans*, *M. karelicus*, *M. muelleri* (gills and fins), *M. musculi*, *M. oviformis* and *M. shulmani* (Lom and Dykova, 1992).

6.3. Metazoa

Apart from protistan parasites, many metazoan parasites are found in or on tench. As far as the number of species in concerned the metazoan parasites predominate but their occurrence, prevalence and invasion intensity is relatively low. Moravec (1985) reports 13 species of metazoan endoparasites (3 Trematoda, 3 Cestoda, 5 Nematoda and 2 Acanthocephala) in tench from Macha Lake. Losses due to Metazoa are rare.

6.3.1. Monogenea

Of the Monogenea, representatives of genera *Dactylogyrus* and *Gyrodactylus* are most frequently diagnosed in tench and due to their direct lifecycle can be problematic.

Both *Dactylogyrus macracanthus* and *Dactylogyrus tincae,* parasitic on the gills are specific parasites of tench (Ergens *et al*., 1987). Additionally, Wierzbicka *et al.* (1997) described *Dactylogyrus triappendixis* from the gills of tench in Poland, which may also be specific to tench. No serious infections no significant losses due to damage caused by these parasites have been reported in tench. In severe infections, this parasite may induce large necroses of gills and haemorrhages which may cause deaths of the infected fish. *Gyrodactylus tincae* (Ergens *et al*., 1988) is a specific parasite of tench from the genus *Gyrodactylus.* It parasites on skin, fins and in strong invasions also on gills, in all types of water. One- to two-year-old fish are infected most frequently.

In addition to the above named species, other representatives of the genera *Dactylogyrus* and

Gyrodactylus normally found on common carp, can be found on tench kept in ponds with common carp.

6.3.2. Digenea

Digenea or trematodes occur in a number of fish hosts and posses a complex lifecycle involving a number of hosts. In general, the lifecycle involves a first intermediate host such as a snail, a secondary intermediate host like a fish and a final vertebrate host. A specific parasite of tench is *Asymphylodora tincae* parasiting in intestine and belonging to the group of trematodes or Digenea. Its body length is 0.5–1.5 mm. It is relatively widespread in pond culture of tench and its pathogenity is not yet completely understood. No reports are yet known on losses due to infection with this parasite. Nasincova *et al*. (1990) and Nasincova and Scholz (1994) dealt with developmental cycle of *A. tincae.* Moravec (1985) also described an occurrence of this trematode in tench from Macha Lake. Zietse *et al*. (1981) mentioned 57% incidence of *A. tincae* infection in tench from a small lake near Amsterdam during summer.

Moravec (1985) reported the occurrence of the digenetic trematode *Phyllodistomum elongatum* in the urinary system (ureters and urinary bladder) of tench from Macha Lake although no details of the pathogenicity were stated.

Kirk and Lewis (1992) listed tench as susceptible to infections with trematode *Sanguinicola inermis,* in the heart and in blood vessels. Experimental transmission of the parasite was successful and whilst large numbers of cercaria penetrated tench, few developed within the fish, suggesting that tench may be partially refractory to the parasite.

Amongst the Digenea, metacercaria of *Diplostomum spathaceum* are frequently reported in cyprinids and other fish hosts. In a survey of ponds containing mixed stocks of common carp and tench fry and herbivorous fish by the current authors, *D. spathaceum* were frequent and of high intensity in herbivorous fish, solitary to medium strong intensity in common carp and absent in eye leness of tench. In a survey of commercially important fish species in the Czech Republic, Svobodova and Faina (1992) reported the lowest infection intensity of *D. spathaceum* in tench. On contrary, Adamek and Jirasek (1989) found metacercaria of *D. spathaceum* in eye lens of tench fry (prevalence 10–30% and intensity of 1–3 specimens) from a mixed stock of herbivorous fish fry under nearly the same conditions as above. However, the infection was very low. Pokorny and Cervinka (1974) also diagnosed metacercaria of *D. spathaceum* in fry of tench kept in Mlazov nursery pond. The majority of the stock was infected and in some specimens, the number of metacercaria in eye lens reached even several tens. Moravec (1985) reported a prevalence of 5.3% and infection intensity 1–3 metacercaria for *D. spathaceum* in tench from Macha Lake. At the same locality, prevalence of *D. spathaceum* in bream (*Abramis brama*) was 90% and infection intensity was 5–120 metacercaria per fish; in roach (*Rutilus rutilus*) prevalence was 60% and intensity 1–210; for gudgeon (*Gobio gobio*) prevalence was 88% and intensity was 2–30. Most of the other literature relating to *D. spathaceum* in tench related to the prevention of this parasitosis (e.g. Bohm, 1978). Adult tench is able to eradicate great pond snails, the intermediate hosts, and thus it becomes an important factor for interruption of the developmental cycle of *D. spathaceum*.

Hoole *et al*. (2001) reported on a developmental stage of trematode *Apophallus muehlingi* as an agent of "blackpot disease", in which tench and other cyprinid fish are intermediate hosts.

6.3.3 Cestoda

Tapeworms (Cestoda) found in tench are *Khawia baltica*, *Monobothrium wagneri* and *Proteocephalus percae. K. baltica* (body length 23–55 mm) parasites in intestine of tench and occassionally in other cyprinids (Scholz *et al*., 1989). In the Czech Republic, this tapeworm was found in tench from Macha Lake (Moravec, 1985) and from ponds in the region of Jindrichuv Hradec. Therapy of the infected tench has not been carroied out, due to the relatively rare occurrence and low intensity of invasion (mostly 1–2 cestodes in a fish). A finding of *M. wageneri* (body length ca. 30 mm), found in the intestine of tench is even more rare. In the Czech Republic, it was described by Gelnar *et al*. (1994) in tench from Morava River and was reported for the first time in tench in England by Gibson (1993). Moravec (1985) diagnosed *P. percae* in the intestine of tench from Macha Lake. Hoole *et al*. (2001) reported on *Caryophyllaeus fimbriceps* as a tapeworm occurring in the intestine of tench.

Moravec (1985) observed the occurrence of plerocercoids of the tapeworm *Neogryporhynchus chei-*

lancristrotus in the intestine of tench from Macha Lake. The findings were from winter period (November to February) while in other fish this parasite could be found through the whole year.

Schaperclaus (1979) ranks tench in the first place as an intermediate host of larval stage of a tapeworm *Valipora cympylacristrota.* Adult tapeworm parasites in waterfowl, plerocercoid in the intestine and mainly in the gall bladder of tench. In this developmental cycle, tench is intermediate host of the tapeworm.

Whilst there have been relatively few records of deaths due to cestodes, Studnicka *et al*. (1983) reported a mortality event of tench, which they attributed to developmental stages (plerocercoids) of the tapeworm *V. cympylacristrota.* A high prevalence and intensity of infection of tench was found in northwest Poland during the early 1980's which decresed fish growth and led to mortality rates of up to 60%.

6.3.4. Acanthocephala

From the Acanthocephala group, *Acanthocephalus anguillae*, *Acanthocephalus lucii* and *Neoechinorhynchus rutili* have been reported in tench (Moravec, 1985; Tarachewski, 1988). *N. rutili* occurred in lower prevalence (14%) and intensity (1–5 acanthocephalans per fish) in tench from Macha Lake than in common carp (prevalence 48%, intensity 1–60 pcs acanthocephalans per fish) from the same locality (Moravec, 1985).

6.3.5. Nematoda

Skrjabillanus tincae represents endoparasitic roundworm of tench. It parasites in the serous tunica of the anterior part of gas bladder, in urinary system (mesonefros, ureters, urinary bladder) and rarely also on the surface of the heart and the intestine. Moravec (1985) reported a lower occurrence of *S. tincae* in males than in females (1 : 4) of tench investigated in Macha Lake, prevalence being 15%, intensity 1–16 roundworms per fish. Fish-louse, *Argulus foliaceus,* has been implicated as an intermediate host. In the serous tunica of gas bladder of tench from Macha Lake, Moravec (1985) also found roundworms *Philometra ovata* (prevalence 14%, intensity 1–36 roundworms per fish). Larval stages of *Raphidascaris acus* were found by Moravec (1985) in liver, in body cavity and in intestine of tench from Macha Lake. An occurrence of encysted larva of *Agamospirura* sp. in intestine mucous membrane of one tench specimen only was noted in the same locality by the same author. Roundworms of this species parasitic more frequently in intestines of birds; larval stage occurrs in fish (Moravec, 1998). *Pseudocapillaria brevispicula* was found in intestine of tench from Macha Lake (Moravec, 1985) in 21% prevalence and infection intensity 1–11 roundworms per fish.

6.3.6. Hirudinea

Similarly to all other fish species, infection with leech *Pisciola geometra* (Hirudinea) can be found on weakened tench as well. These findings are most frequent in tench from pond culture in spring after wintering. Pokorny and Cervinka (1974) reported the occurrence of *P. geometra* in a solitary intensity in fry of tench from seven observed ponds. Apart from their own pathogenic effect, another serious effect of infection with leeches is that they transmit haemoflagellates of genera *Trypanosoma* and *Trypanoplasma*, which reproduce in the digestive tract of leeches.

6.3.7. Arthropoda

Considering the group of *Arthropoda,* infection with fish-louse, *Argulus foliaceus* is often diagnosed in weakened tench (Gelnar *et al*., 1988). *Argulus* is a temporary parasite of fish and can leave the fish host and move freely for short periods of time. Female *Argulus* spp. leave the host to lay eggs on a suitable host, before returning to the fish. It is generally found on fins and on body surface. *A. foliaceus* punctures the skin with its proboscis and sucks the blood. Evert (1974) says that only an infection with *Argulus* sp. was observed in tench fry reared without an application of any prophylactic bath.

Another arthropod occurring in tench is *Ergasilus sieboldi.* Ergasilosis is a relatively frequent arthropodosis in fish from open waters and some ponds. It is found on the gills of nearly all fish species with the highest invasion intensity in tench and coregonids from all pond fish species. The disease is manifested clinically only during massive infections and leads to fish suffocation. Heavily infected fish grow poorly. The gills surrounding the fixed

Ergasilus are light pink to greyish, isolated haemorrhages can be found. The occurrence of ergasilosis is associated with certain localities (e.g. with the ponds in region of Jindrichuv Hradec in the Czech Republic) and in contrary, it does not occur at all on other localities. Lucky and Kral (1982), in their report on health monitoring of fish from 9 reservoirs in Morava River drainage, mentioned tench and silver bream (*Blicca bjoerkna*) as the fish species where there was diagnosed slight damage caused by *E. sieboldi.* Bocklisch *et al*. (1987) described a mortality event in tench on Hohenfelden dam reservoir due to a severe infection with *E. sieboldi.* Extremely high intensities of infection were found in this reservoir, with up to 3 000 parasites per fish. The affected tench were emaciated, had sunken ocular bulbs, breathed labouriously, lost their escaping reflex and died.

In addition to listing *E. sieboldi* as a parasite of tench, Hoole *et al*. (2001) listed *E. briani* as occurring in between the gill rakers of tench.

7. Fish pests

Predatory copepods, mainly representatives of the genus *Acanthocyclops*, are very dangerous for sac fry of fish. They attack the fry, injure it mechanically, bite it and cause the death of fry. They cause large losses just on sac fry of tench and of herbivorous fish. Fry of these species, spawning later in the season, are stocked into nursery ponds just during a period of the highest occurrence of predacious copepods. Large losses of fish fry due to damage caused by predatory copepods also arise when the early fry of tench is fed with plankton with the predatory copepods, their nauplii or copepodite stages.

8. Neoplastic diseases (tumors)

Prost (1977) classified neoplastic diseases of fish. Apart from 5 groups of benign and malignant tumors (1 – of epithelial cells, 2 – of mesenchymal cells, 3 – of pigment cells, 4 – of neural cells, 5 – teratogenic), she included a 6th group – tumors of viral origin. She focused her attention salmonids but, apart from other fish, she also mentioned tenchwhich were affected by tumor disease. Hoole *et al*. (2001) mentioned an occurrence of rhabdomyoma type tumor (tumor of skeletal muscle) in tench as the only cyprinid fish species affected.

9. Environmental effects and contaminant related mortalities

From the point of view of aquatic toxicology, tench is a very interesting fish, which is worth paying an increased attention. Similarly to other fish species, tench is a sensitive indicator of the environment where it lives. Assessing the cumulation of pollutants in tissues, tench from pond culture tends to be a more sensitive indicator than common carp. Since tench are known to bioaccumulate contaminants they may be useful as bioindicators of environmental conditions in running waters or from dam reservoirs. Tench are usually stocked into open waters as 2- to 3-year old fish but since these fish are derived from naturally reproducing stocks in river systems, they have limited value as a bioindicator in open waters (Svobodova *et al*., 1994). Despite these limitations analysis of tench tissues by the current authors has been used to discriminate localities with differing levels of mercury (Hg) on the Elbe River.

9.1. Mercury (Hg)

Svobodova *et al*. (1994) compared the total mercury content (Hg) in muscle of marketable common carp and tench from selected ponds of South Bohemia. In all cases, the authors reported on higher total mercury content in muscle of tench than of common carp. Contrary to common carp, values measured in muscle of tench were in the area of 0.1 mg/kg (hygienic limit) and in many cases they exceeded this value. According to the authors, this was a consequence of the food intake. Compared to common carp, tench in a pond feed predominately on benthic organisms which tend to bioaccumulate mercury. It should also be noted that the tench studied were about 1 year older than the common carp. The authors further studied the content of organic pollutants (PCBs expressed as a sum of technical mixtures D103 + D106) in muscle of tench and common carp. Differences in values measured for both species were insignificant, ranging from 0.005 to 0.05 mg/kg.

9.2. Copper (Cu)

There is a whole series of papers dealing with the effect of temperature, varying oxygen concentration and effects of various toxic substances on tench (Alabaster and Lloyd, 1980). In most cases, the sensitivity of tench is comparable to common carp. There is a surprisingly high sensitivity of tench to substances and preparations containing copper (Cu). Svobodova *et al*. (1985) reported the acute toxicity of Kuprikol 50 preparation (containing 47.5% copper oxychloride) used in the past for preventive and therapeutic baths of fish and as a molluscicide preparation for eradication of aquatic snails. Within a 48-hour duration, the LC_{50} for tench was determined as 0.5–2.0 mg/l and the preparation was assessed as highly toxic for tench. Sensitivity of tench to copper and its compounds is comparable to rainbow trout (*Oncorhynchus mykiss*), which is considered highly sensitive to copper. Application of the Kuprikol 50 preparation was not recommended for culture of salmonids and of tench. Vykusova and Svobodova (1986) compared the acute toxicity of Kuprikol 50 preparation for various fish species and determined the LC_{50} within 48-hour of its exposure to it. The authors reported a strong toxicity of the preparation tested for rainbow trout – LC_{50} 0.78 mg/l, tench – LC_{50} 2.46 mg/l and for silver carp (*Hypophthalmichthys molitrix*) – LC_{50} 2.97 mg/l.

Svobodova *et al*. (1996) reported the acute 48-hour effect of $CuSO_4.5H_2O$ on hematological values of tench. Compared to the control group of fish, significant differences were found in erythrocyte profile, regarding increased values of erythrocyte count (Er), haemoglobin content (Hb) and haematocrit value (PCV). These changes demonstrated a release of erythrocytes from blood depots and they were of a similar character in tench as in common carp.

9.3. NaCl and formaldehyde

Kouril and Prikryl (1988) carried out toxicity tests on early fry of tench kept in warm water (25°C) using substances for therapeutical baths of fish (NaCl and 40% formaldehyde). With the 15 min exposure, the LC_{50} for NaCl was 18.4 g/l and for 40% formaldehyde it was 1.20 ml/l. The LC_{50} values were lower with longer exposures (1 h, 4 h).

9.4. Nitrites

Problems of toxic effect of nitrites have also been studied in tench. Under normal circumstances, ammonia in the aquatic environment is oxidized to nitrites and these are oxidized to nitrates. Nitrates, contrary to nitrites, are very slightly toxic for fish. Incomplete oxidation of ammonia may happen in recirculating systems of fish culture. Nitrites then penetrate through gills to the blood, bind to haemoglobin and form methaemoglobin. This decreases the transporting capacity of the blood for oxygen. Structural changes of hepatic cells also occur. Decreased nitrification effect in a recirculation system may also happen after application of some antibacterial (e.g. erythromycin) and antiparasitic drugs (e.g. methylene blue) (Collins *et al*., 1975). Acute toxicity of nitrites (NO_2-N) for 20-day-old fry of tench was studied by Korwin-Kossakowski *et al*. (1995) who reported various body deformities of the fry during the test. Decreased activity occurred at higher concentrations of nitrites with fish remaining on the aquarium bottom. This was due to the lack of oxygen in the swim bladder, the size of which was greatly reduced in the affected fish. The authors reported that these changes were reversible. Lethal concentration of nitrites were as followed: 24h LC_{50} = 41.20 mg/l; 48h LC_{50} = 26.08 mg/l; 96h LC_{50} = 19.60 mg/l.

Svobodova *et al*. (2001b) described a mortality event of four-year-old tench of 400–1 000 g body weight that were transported from storage ponds with a water temperature of 4°C to experimental tanks with gradually increasing water temperature up to 19.6–20.0°C. As the experimental tanks were not equipped with a recirculation system partial water changes were carried out. Clinical signs reported by the authors included lassitude and twitches to cramps of muscle after catching the fish. *Post mortem* examination revealed dark dirty brown colouration of gills, body cavity of light colour, liver, kidney and leaking blood of dirty brown colour. The blood was not haemolytic and spleen was enlarged. Methaemoglobin concentration was determined in the blood samples of tench with clinical signs of poisoning. Haemoglobin in the form of methaemoglobin (73.8%) was found predominating in the affected fish. Comparing the methaemoglobin concentration with a control group of fish (from the storage pond), a significant difference ($P \geq 0.001$) was found. At the time of fish deaths, concentration of nitrites (NO_2^-) in water of the experimental tank was 1.95 mg/l and that of nitrates (NO_3^-) was 10.41 mg/l . Concentration of chlorides (Cl^-) was 7 mg/l . Weight ratio of Cl^- : N-NO_2^- was 11.78. This ratio evidenced favourable conditions for absorption of NO_2^- through chloride cells of gills.

9.5. Insecticides

Histopathological changes in adult tench caused by chlorpyrifos insecticide were observed by Gomez *et al*. (1998). Chlorpyrifos was applied in the dose of 181 mg/dm^3, i.e. half of the 96h LC_{50} dose. Fish were exposed to the effect of chlorpyrifos for 12 days. On the day 1, 2, 5, 8 and 12, histopathological and haematological examination (haematocrit and haemoglobin) were carried out and concentration of cholinesterase was determined. The authors recorded clinically uncoordinated movements when swimming, asphyxia (fish were near the water surface), haemorrhages at fin roots and in the anal region. Histological changes were registered in kidney parenchyma (mesangialni proliferative glomerulonefritis, tubular nefrosisa and degenerative alterations together with necrotic alterations of homeopatic kidney cells). Haematological examination confirmed the damage of haematopoietic cells and concentration of cholinesterase confirmed a connection with a damage to the central nervous system.

9.6. pH

Hamackova *et al*. (1998) dealt with effects of different pH of water on survival and growth of tench fry. The authors report pH 7–9 to be optimal. At pH 5 and 10, worsened growth was registered, as well as higher mortality. The pH 4 and 11 were lethal for the tench fry.

10. Results of health examination of tench in the Czech Republic

According to the examination records, the Department of Aquatic Toxicology and Fish Diseases of the Research Institute of Fish Culture and Hydrobiology, University of South Bohemia Ceske Budejovice examined the health status of 56 groups of tench in 1984–2002. The majority of fish examined were obtained form from pond culture or from tank facilities. Fish were subjected to *post mortem* and full parasitological examination. Bacteriological examination was carried out in case suspicion of bacterial infection in the Veterinary Diagnostic Institute in Ceske Budejovice. Nine groups investigated of tench did not show any pathological changes and their parasitological examination was negative as well. No suspicion of viral infection was pronounced in any case, bacterial infections were diagnosed in 4 groups of tench, no mycotic infection was recorded. The majority of diagnoses were of parasitic diseases. Protistan infection were diagnosed most frequently: *Trichodina epizootica* in 14 groups of tench; *Trichodinella* in 7 groups, *Chilodonella piscicola* in 7 groups; *Ichthyobodo necator* in 9 groups; *Ichthyophthirius multifiliis* in 4 groups; *Apiosoma* sp. in 5 groups; *Ambiphrya* sp. in 2 groups; *Trichophrya* sp. in 1 group; *Cryptobia branchialis* in 2 groups. From, Monogenea, *Dactylogyrus* sp. was diagnosed in 2 groups of tench and *Gyrodactylus* sp. in 1 group. Metacercaria of *Diplostomum spathaceum* were found in small numbers in the eye lens of 3 groups of tench. Only one case of occurrence of a tapeworm (Cestoda) was registered and this was *Khawia sinensis*. Leech, *Piscicola geometra* was diagnosed in 3 groups of tench examined. No nematodes were forund during the post mortem examinations. Regarding the arthropods, fish-louse, *Argulus foliaceus* was the only found in 1 group of tench.

The above mentioned examinations were also used to examine health of diploid, gynogenic and triploid tench. Polyparasitic infection of skin and gills, caused by *Dactylogyrus* sp., *Trichodina epizootica* and *Chilodonella piscicola* was of weak intensity and 30–40% incidence in diploids and triploids, while gynogens were infected with medium strong to strong intensity and 100% incidence, causing fish kills in this group. Gynogenic tench showed higher sensitivity and lower resistance to parasitic infections (Flajshans *et al*., 2002).

Lucky, Navratil and Palikova (University of Veterinary and Pharmaceutical Sciences, Brno) examined 43 specimes of tench (*T. tinca*) from water reservoirs of Morava River basin in years 1994–2002. Autors report the following findings of parasites: *Epistylis lwoffi* (on skin of 1 fish), *Gryporhynchus* sp. (in gullet of 2 fish), *Asymphylodora tincae* (in gullet and gut of 5 fish), *Tylodelphys clavata* (in corpus vitreum of 1 fish), *Nematoda* gen. larvae (on skin of 1 fish), *Ergasilus sieboldi* (on gills of 30 fish), *Argulus foliaceus* (on skin of 2 fish) and *Hydrozoetes lacustris* (on gills of 1 fish).

11. Conclusions

The occurrence of diseases in tench (*Tinca tinca* L.) is less frequent in comparison with other fish species and also the prevalence and intensity of infection are usually rather low. This is however valid only for tench from pond culture and open waters. On the contrary, higher losses are registered during long-term keeping of tench in storage ponds. In comparison with other fishes (cyprinids in particular), tench prove high sensitivity to the injury of mucous layer and gills.

The occurrence and descriptions of **viral and bacterial diseases** in tench (*T. tinca*) are very sporadic.

Among **fungal diseases**, saprolegniosis (*Saprolegnia parasitica*) is one of the most frequent tench diseases. High sensitivity of tench to mechanical and chemical injuries of mucous skin layer and gills is their predispose factor.

Parasitic diseases are the most frequent diseases diagnosed in tench. The spectrum of occurrence of all parasite categories is almost identical with the spectrum of parasite occurrence in common carp (*C. carpio*). The specific tench parasites are the fluke *Asymphylodora tincae* (Metazoa – Trematoda), parasitizing in the gut and the nematode *Skrjabillanus tincae* (Metazoa – Nematoda), parasitizing in the serous cover of the gas bladder and in the urinary system.

Concerning the **environmental impacts and poisonings**, tench are classified as a sensitive indicator of the status of water environment, where they live. From the point of view of pollutant accumulation in tissues, tench seem to be even more sensitive than common carp (*C. carpio*). High susceptibility to copper (Cu) compounds and preparations, comparable to rainbow trout (*Oncorhynchus mykiss)* response, is a specific trait of tench.

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