Biological Synopsis of Tench (*Tinca tinca*)

B. Cudmore and N.E. Mandrak

Centre of Expertise for Aquatic Risk Assessment
Fisheries and Oceans Canada
867 Lakeshore Rd., P.O. Box 5050
Burlington, ON
L7R 4A6

2011

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2948

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 901-1425 were issued as Manuscript Reports of the Fisheries Research Board of Canada. Numbers 1426-1550 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministére des Pêches et des Océans, e'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complèrwa. Le titre exact paraît au-dessus du résumés de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques,*et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministére.

Les numéros 1 à 900 de cette série ont été publiés à titre de manuscrits (série biologique) de l'Office de biologie du Canada, et aprés le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports manuscrits sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur don't le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Manuscript Report of
Fisheries and Aquatic Sciences 2948

2011

BIOLOGICAL SYNOPSIS OF TENCH
(*Tinca tinca*)

by

B. Cudmore and N.E. Mandrak

Centre of Expertise for Aquatic Risk Assessment
Fisheries and Oceans Canada
867 Lakeshore Rd., P.O. Box 5050
Burlington ON L7R 4A6 CANADA

Cat. No. Fs 97-4/2948E ISBN 0706-6473

Correct citation for this publication:

Cudmore, B., and N.E. Mandrak. 2011. Biological synopsis of Tench (*Tinca tinca*). Can. MS Rpt. Fish. Aquat. Sci. 2948: v + 20p.

ABSTRACT

Cudmore, B., and N.E. Mandrak. 2011. Biological synopsis of Tench (*Tinca tinca*). Can. MS Rpt. Fish. Aquat. Sci. 2948: v + 20p.

The Tench (*Tinca tinca*) is a large minnow species that has been introduced to Canada and is established in several locations in British Columbia and Quebec. Tench has been identified by Fisheries and Oceans Canada's Centre of Expertise for Aquatic Risk Assessment as being a species that may require a detailed level risk assessment. This biological synopsis, a required component of the risk assessment, includes a description, distribution, biology, natural history, human use, impacts and management practices of the Tench.

The Tench, which is native to Europe, has been introduced into Africa, Asia, Australia, New Zealand and North and South America largely for aquaculture and sport fishing. Although it is established in many countries, its impact is either unknown or considered to be minor. However, when Tench occurs in high densities a cascade effect in the food chain may occur. Tench feeding on browsing gastropods causes an increase in periphyton growth on macrophyte surfaces. This increase reduces light penetration and nutrient supply to macrophytes, resulting in their decline. As Tench survives in degraded environments, it is unclear whether it impacts the water quality or simply inhabits a niche that other species cannot occupy.

RÉSUMÉ

Cudmore, B., and N.E. Mandrak. 2011. Biological synopsis of Tench (*Tinca tinca*). Can. MS Rpt. Fish. Aquat. Sci. 2948: v + 20p.

La tanche (*Tinca tinca*) est une espèce de ménés grande qui a été introduite au Canada et qui s'est établie à plusieurs endroits en Colombie-Britannique et au Québec. La tanche a été identifiée par le Centre d'expertise pour l'évaluation des risques en milieu aquatique de Pêches et Océans Canada en tant qu'espèce pouvant nécessiter une évaluation du risque détaillée. Le présent synopsis des données biologiques, l'un des composants requis pour l'évaluation du risque, donne une description de l'espèce et des renseignements sur sa répartition, sa biologie, son histoire naturelle, son utilisation par l'homme, ses impacts et les pratiques de gestion pertinentes.

La tanche, une espèce indigène d'Europe, a été introduite en Afrique, en Asie, en Australie, en Nouvelle-Zélande et en Amérique du Nord et du Sud en grande partie pour l'aquaculture et la pêche sportive. Bien qu'elle soit établie dans nombreux pays, ses impacts demeurent inconnus ou sont considérés comme mineurs. Cependant, la tanche peut avoir un effet en cascade sur la chaîne alimentaire lorsqu'elle est présente à des densités élevées. La tanche, lorsqu'elle s'alimente de gastéropodes brouteurs, provoque une augmentation de la croissance du périphyton sur la surface des macrophytes. Cela réduit la pénétration de la lumière et l'apport d'éléments nutritifs aux macrophytes, provoquant ainsi leur déclin. Comme la tanche survit dans les environnements dégradés, on ne sait pas précisément si elle a des impacts sur la qualité de l'eau ou si elle occupe simplement une niche qui ne convient pas à d'autres espèces.

1.0. INTRODUCTION

Many non-native species have negatively impacted Canadian freshwater biodiversity (Metcalfe-Smith and Cudmore-Vokey 2003). Assessing the risk of potential aquatic invasive species is one of the mandates for Fisheries and Oceans Canada's Centre of Expertise for Aquatic Risk Assessment (CEARA). Tench (*Tinca tinca*) has been identified by CEARA as a species of potential concern.

Tench has been introduced extensively into most continents around the world from its original distribution in Europe (Kottelat 1997). Between 1886 and 1896, the U. S. Fish Commission introduced more than 138,000 Tench into at least 36 states (Nico and Fuller 2010). This intentional introduction was for Tench to become both a food and sport fish (Baird 1879). From the state of Washington, Tench dispersed through the Columbia River drainage system into British Columbia where it was first recorded in Christina Lake in 1915 (Dymond 1936, McPhail and Carveth 1993). Tench has also become established in Quebec. It was illegally introduced through aquaculture operations in 1986 (Vachon and Dumont 2002), escaped into the Richelieu River in 1992, and has established a reproducing population (Marcogliese *et al.* 2009). Since 2002, The Tench has been angled on several occasions in Lake Champlain, Quebec and may have an established population (Marsden and Hauser 2009).

A biological synopsis, including its description, distribution, biology, natural history, human use, known impacts and management practices, are presented in this report.

1.1. NAME AND CLASSIFICATION

From Froese and Pauly (2009):
Kingdom: Animalia
Phylum: Chordata
Class: Actinoptergii
Order: Cypriniformes
Family: Cyprinidae
Genus and Species: *Tinca tinca* (Linnaeus 1758:321) type locality: Europe
Original Combination: *Cyprinus tinca* – senior synonym
Common English Name: Tench. Other English Names: Doctor Fish, Green Tench
Canada - Quebec French Name: tanche

1.2. DESCRIPTION

Tench (Figure 1) is a large member of the minnow family reaching a maximum total length of 70 cm (28 inches). The body is thickset, heavy, and laterally compressed. The head is triangular; the snout is relatively long; the mouth is terminal, small, and has thick lips with a pair of well-developed barbels, one at each corner of the mouth. The eye is small and orange-red in colour. The pharyngeal tooth count is 0,5-4,0 or 0,5-5,0. Gill rakers are usually 13. All fins are rounded; one dorsal fin with 8-9 rays and no spines; pectoral fins relatively short; adult males with a larger pelvic fin and thickened second ray; anal fin with 7-8 rays and no spines; caudal fin usually square, may be slightly forked with rounded lobes. The caudal peduncle is deep and short. The scales are small and embedded in thick skin with 95-105 in the lateral line; lateral line is complete. The vertebral count is 38 or 39. The maximum published weight of Tench is 7,500 g (Scott and Crossman 1973, Page and Burr 1991, Coad 1995, Freyhof and Kottelat 2008, Froese and Pauly 2009).

Colouration of Tench is olive-green to dark green or almost black on the back with golden reflections on the sides. The belly is dark gold and the fins are dark. Artificially bred Tench, known as Golden Tench or Schlei, are light gold to red with black or red spots on the sides and fins, and are similar in appearance to Goldfish (*Carassius auratus*), particularly as both species have small scales (Scott and Crossman 1973, Coad 1995, Freyhof and Kottelat 2008, Froese and Pauly 2009).

Secondary sexual characteristics of Tench develop on males greater than 12 cm long (Weatherley 1959) and include a larger pelvic fin with a thickened second ray and a large protruberance extending from the flank (Coad 1999).

Although Brylinska *et al.* (1999) indicate that Tench rarely, if ever, naturally hybridize with other cyprinids, Rowe *et al.* (2008) reported that Tench occasionally hybridize with Common Carp (*Cyprinus carpio*), Goldfish and Rudd (*Ctenopharyngodon idella*). Triploid Tench may occur naturally in some populations and may be difficult to distinguish from adult male diploid Tench as they have enlarged pelvic fins (Weatherley 1959). Tench have $2n = 48$ diploid chromosomes made up of 6 metacentric, 8 subtelocentric and 10 acrocentric pairs. The average haploid chromosome length is 2.191 µm (Hamalosmanoglu and Kuru 2004).

Morphological features of juvenile Tench and their hybrids with Common Carp and Bream (*Abramis brama*) are provided in Tables 1 and 2 (Mamcarz *et al.* 2006).

Reciprocal hybrids between Tench and Bream, and Tench and Carp were artificially crossed. Survival rates for Tench and Bream were high (60%) but were low (0.2%) for Tench and Carp (Mamcarz *et al.* 2006).

2.0. DISTRIBUTION

2.1. NATIVE DISTRIBUTION AND ABUNDANCE

Tench is thought to be native throughout most of Europe, but naturally absent from Ireland, Scandinavia north of 61°30'N, the eastern Adriatic basin and western and southern Greece (Freyhof and Kottelat 2008).

In the United Kingdom, abundance of Tench varies with the environment and ranges from 126-530 individuals/hectare depending on the presence of aquatic vegetation (Wright and Giles 1991). Recruitment was variable with strong year classes occurring in years with warm summers (Wright and Giles 1991). In mixed species communities in the United Kingdom, Tench accounted for 8% of all fishes by numbers and 25% of all fishes by biomass (Lusk *et al.* 1998).

2.2. NON-NATIVE DISTRIBUTION AND ABUNDANCE (EXCLUDING CANADA)

Tench has been stocked for centuries throughout Europe and its original distribution is not clearly known. It has been introduced to North and South Africa, Tasmania, Australia, New Zealand, India, North America, and Chile (Freyhof and Kottelat 2008). In Asia, it is found as far east as the Ob and Yenisei rivers. It is also found in Lake Baikal, Russia (Froese and Pauly 2009).

Introduced Tench in five ponds in Waikato, New Zealand was found to be at a maximum density of 250 individuals/hectare (Hicks *et. al.* 2007).

2.3. DISTRIBUTION IN CANADA

Tench occurs in the Canadian provinces of British Columbia and Quebec. It has not been reported for Ontario (Lui *et al.* 2008), although it is considered to be a potential invader (Holm *et al.* 2009).

Populations currently established in British Columbia originated from a series of small lakes near Spokane, Washington, where Tench was first introduced around 1895 (Carl *et al.* 1977). Tench was first recorded in British Columbia in Christina Lake in 1915 (Dymond 1936) and from a lakeside pond near Osoyoos Lake in 1941 (Clifford and Guiguet 1958). All Tench occurrences in British Columbia have entered via the Columbia River system (Scott and Crossman 1973) by way of Washington where it is widespread (Chapman 1942).

Tench was introduced illegally into Quebec via aquaculture operations in 1986 (Vachon and Dumont 2002). The fish escaped into the Richelieu River in 1992 and has established a reproducing population (Marcogliese *et al.* 2009). Tench has been caught periodically by anglers in Lake Champlain, Quebec, since 2002 and is assumed to have migrated there from the Richelieu River (Marsden and Hauser 2009).

3.0 BIOLOGY AND NATURAL HISTORY

3.1. AGE AND GROWTH

Tench reaches maturity between 2-6 years and 70-250 mm standard length. Females often mature one year later than males (Freyhof and Kottelat 2008). Maximum length reached is 70 cm total length and maximum recorded weight in the United Kingdom is 7340 g. Maximum age recorded is 20 years (Froese and Pauly 2009). Table 3 presents mean length at various age groups for Tench from two waterbodies in Tasmania. The length of young-of-the-year Tench ranges from 2-8 cm, depending on the summer temperature. At 10 years, Tench may weigh close to 1500 g. There are clear local variations in growth rate depending on water body size. In small bodies of water, Tench become stunted because of high density, with a maximum weight of 2000-3000 g and living up to 15-20 years (Finnish Game and Fisheries Research Institute 2008, Shelton *et al.* 1981). Females were found to mature earlier, have higher fecundities, and spawn more frequently in a warm pond than in a colder pond (Horoszewicz 1983).

Tench can be aged using annuli on scales, operucla, fin rays or otoliths (Rowe *et al.* 2008). All structures gave similar results up to nine years of age, however, difficulties occurred using scales over nine years (Wright and Giles 1991).

3.2. PHYSIOLOGICAL TOLERANCES

Tench are considered to be a warm water fish with a preferred temperature range of 20-27°C (Perez Regadera *et al.* 1994). Coad (1999) reported a preferred range of 15-23.5°C. In aquaria providing a temperature gradient, Tench preferred waters between 20-24°C, rarely venturing into waters over 25°C (Alabaster and Downing 1966). Tench have been reported to tolerate waters up to 37°C for brief periods (Coad 1999). Juvenile Tench prefer warmer water temperatures than adults. Hamackova *et al.* (1995) determined that temperatures below 22°C increased the mortality rate of 2-4 day old fry, but not 7-10 day old fry. The extent of mortality was directly related to the extent of the temperature drop.

Tench are highly tolerant of low oxygen levels (Coad 1999) and can survive in waters with oxygen levels as low as 0.7 mg/l, where even Common Carp can not survive (BISON 2003). However, in Finland, Tench have died due to oxygen depletion in winter (Finnish Game and Fisheries Research Institute 2008).

Adult and larval Tench are tolerant of pH in the range 6.5-8.0 (BISON 2003). Mortality increased at pH below 5 and above 10.8 (BISON 2003). Hamackova *et al.* (1998) found that larval survival was highest in the pH range 7-9; however, some survival occurred at a pH of 5 and a pH of 10. Values below 5 and above 11 were lethal to all larvae.

Tench can thrive in brackish waters such as estuaries of the Baltic Sea, where salinities can range from 4-10 ppt (Weatherley 1959). A salinity of 15.4 ppt was fatal within 24 hours; however, Tench were able to withstand 13.8 ppt, with greatly reduced motor functions (Weatherley 1959). Coad (1999) reported a tolerance to 12 ppt salinity.

Tench prefer low water velocities and avoid high-gradient reaches of rivers and streams where maximum water velocity exceeds 0.27 m/s (BISON 2003).

Other factors known to limit the size of Tench populations include water level fluctuations, increased exposure to wave action, destruction of fry habitat, and predation (San Juan 1995). Loss of macrophytes may also limit Tench populations in lakes (Wolter *et al.* 2000).

3.3. REPRODUCTION

Tench mature in 3-5 years (Neophitou 1993). In central Europe, spawning occurs in early June in shallow bays of lakes or ponds with dense vegetation. A female is usually accompanied by two or more males (Breder and Rosen 1966). Large numbers of sticky, yellowish-green eggs are scattered on the surface of submerged plants, and are then fertilized by the male (Breder and Rosen 1966). Eggs are 1 mm in diameter (Scott and Crossman 1973). In Finland, spawning begins once the water temperature is at least 20°C, and becomes most intense at 22-24°C. Spawning ceases if the temperature drops below 20°C (Finnish Game and Fisheries Research Institute 2008). The demand for a relatively high spawning temperature restricts the success of Tench reproduction in Finland (Finnish Game and Fisheries Research Institute 2008). Average number of eggs per kilogram of body weight is 300,000-400,000 (Scott and Crossman 1973).

Incubation of eggs occurred in 76 hours at a mean water temperature of 19.6°C (Penaz *et al.* 1981), with the highest incubation rate (89.4%) occurring at 22.9°C and fry hatching after 48 hours (Kouril *et al.* 1988). Once hatched, larvae are about 3.8 mm long (Penaz *et al.* 1981). Larvae have attachment organs allowing them to stick to under-surfaces of plants (Coad 1999). Feeding begins after eleven days, at a length of 5.6 mm, and the larvae are free-swimming beyond this size (Penaz *et al.* 1981). Scott and Crossman (1973) reported that feeding begins within 4-7 days of hatching.

Tench have strong secondary sexual characteristics. The pelvic fins on males are enlarged and a muscular protuberance is visible on each flank during spawning season (Breder and Rosen 1966, Scott and Crossman 1973).

3.4. FEEDING AND DIET

The diet of Tench consists mainly of aquatic insect larvae and molluscs (Scott and Crossman 1973). Tench is a generalized benthophagous species feeding on whatever is most readily available, including zooplankton (cladoceran, copepods and ostracods), benthic crustacea (amphipods and decapods), benthic insecta (chironomids, ephemeroptera, odonata, hemiptera, hirudinea and corixidae) and bivalves (gastopoda and small bivalvia) (Michel and Oberdorff 1995, Rowe *et al.* 2008).

Table 4 presents a gut content analysis of Tench from Lake Tiberias, Tasmania (Weatherley 1959). Foraging most often occurs at dawn and dusk. Young Tench feed mostly on algae. In Finland, larvae and young-of-the-year feed mostly on zooplankton (Finnish Game and Fisheries Research Institute 2008). As yearlings, Tench initially prey on cladocera and copepods, and then begin feeding on chironomid larvae.

Tench are nocturnal foragers and visual cues are less important than olfaction and taste for finding prey species (Rowe *et al.* 2008). In a small eutrophic lake in the United Kingdom, Tench spent a considerable amount of time searching for prey and travelling relatively large distances (Perrow *et al.* 2005). During daylight, Tench were almost completely inactive, displaying a strong association for the littoral emergent vascular plant, *Typha angustifolia* (Perrow *et al.* 2005). Feeding ceased in autumn when the water temperature dropped below 8°C (Finnish Game and Fisheries Research Institute 2008).

In artificial ponds, larvae that feed on a minimum of 50 nauplii larva/day reached highest survival rates (Celada *et al.* 2007). In aquaria, Tench operated string sensor-activated self-feeders and displayed a strictly nocturnal behaviour both indoors and outdoors (Herrero *et al.* 2005).

3.5. HABITAT

Tench is typically found in shallow, densely vegetated waters with low water velocity, and soft substrates of mud, silt or sand (Rowe *et al.* 2008). It is rarely found in clear waters with a stony substrate, and is absent in fast-flowing streams. In aquaria, Rendon *et al.* (2003) found that Tench showed a clear preference for mud over other substrates including sand, artificial vegetation, and concrete. This type of habitat occurs in the lower reaches of rivers, oxbows and river deltas, estuarine areas, wetlands, shallow margins of lakes, drainage canals, and shipping canals. In a small lake in the United Kingdom, Tench were almost completely inactive during the day, resting together in the littoral emergent vascular plant *Typha angustifolia* (Perrow *et al.* 2005). Depth preference is reported to be 1 m (Froese and Pauly 2009), however, larger

Tench have been captured at depths of 7-15 m in several New Zealand lakes (Rowe *et al.* 2008).

In a study of 480 lakes in Poland, Tench were found to be in increasing numbers with increasing proportions of littoral zones in lakes (Mamcarz and Skrzypczak 2006). In Finland, Tench occur in restricted nearshore areas in summer and live passively in deeper waters during winters (Finnish Game and Fisheries Research Institute 2008). In Iran, Tench were largely inactive in winter and buried themselves in shallow muddy habitats Coad (1999).

Juvenile Tench were found to occur in shallow waters with a silty bottom, including off-channel sites found in many English rivers with dense milfoil and pondweed (Copp 1977).

3.6. INTERSPECIFIC INTERACTIONS

Tench fall prey to certain piscivorous fishes. In European waters, the main predator of Tench is the Northern Pike (*Esox lucius*), and it is also vulnerable to predation by Largemouth Bass (*Micropterus salmoides*) (BISON 2003). In a range of Swedish lakes it was determined that those with piscivorous fishes were characterised by having a low Tench population size and a prevalence of large fishes. In lakes with no piscivores, Tench populations were large and the lakes were composed mainly of small fishes (Bronmark *et al.* 1995).

According to Brylinska *et al.* (1999) Tench rarely naturally hybridize with other cyprinids. However, Rowe *et al.* (2008) reported that Tench may occasionally hybridize with Common Carp, Goldfish and Rudd.

According to legend, some species of fish rub their fins and bodies against Tench, as it is thought that the mucous Tench produces has a healing effect (Rowe *et al.* 2008). For this reason it is also called the "doctor fish".

3.7. MOVEMENT AND MIGRATION

In summer, Tench remain in fairly restricted nearshore areas, sometimes moving into shallows and lake margins at dusk to feed. In a small eutrophic lake in the United Kingdom, Tench spent considerable time searching for prey and travelling relatively large distances. During daylight, Tench were almost completely inactive, resting together in locations that had *Typha angustifolia* (Perrow *et al.* 2005).

During winter, Tench live passively in deeper waters with little or no movement (Finnish Game and Fisheries Research Institute 2008). In Iran, Tench were largely inactive in winter, burying themselves in shallow mud Coad (1999).

Light levels influence the movement of juvenile Tench (Gallardo *et al.* 2006). Juveniles always preferred light levels less than 10 lux and moved into areas with the lowest light levels. When vegetation was provided, juvenile Tench remained hidden in the vegetation even at non-optimal light intensities until light levels reached 150 lux; then juvenile Tench moved out of vegetation in favour of low light levels.

3.8. DISEASES AND PARASITES

In Quebec, nine of ten Tench sampled in 2000 were infected with parasites, including *Raphidascaris acus* (80%), *Ergasilus megaceros* (60%), larval *Valipora campylancristrota* (20%) and larval Proteocephalidae (20%). These invasive Tench were found to have fewer parasite species than those in their native range, in accordance with the enemy escape hypothesis (Marcogliese *et al.* 2009). Tench is host to a new parasite for Canada, the copepod *E. megaceros. Valipora campylancristrota*, a potentially pathogenic metacestode, may have been introduced with Tench (Marcogliese *et al.* 2009). The concomittant introduction of Tench and *V. campylancristota* may pose a threat to the Copper Redhorse (*Moxostoma hubbsi*), a species at risk found almost exclusively in the Richelieu River (Dumont *et al.* 2002, Marcogliese *et al.* 2009).

Endoparasites in Tench from Turkey include *Ligula intestinalis, Caryophyllaeus laticeps, Bothriocephalus acheilognathi* and *Proteocephalus torulosus* from Cestoda; *Asymphylodora tincae* from Digenea; and *Acanthocephalus anguillae* from Acanthocephala (Ozan *et al.* 2006). The tapeworm species, *Khawia baltica*, is a specific parasite of Tench. Its distribution is presently limited to central Europe (Scholz 1993).

Reviews of diseases and contaminant related mortalities of Tench were published by Fijan (1999) and Svobodova and Kolarova (2004). The following diseases are mentioned: spring viremia of carp (SVC); Grass Carp reovirus disease (GCRD);

haemorrhagic septicaemia carried by the agent *Purpura cyprinorum*; furunculosis carried by *Aeromonas hydrophila* or *A.sobria*. Parasitic diseases are most common in Tench, the most common being *Sporozoon tincae*. A list of parasite species of Tench from the former USSR can be found in Bychowski (1962). The most serious fungal diseases of Tench include saprolegniosis and branchiomycosis (Svobodova and Kolarova 2004).

4.0. USE BY HUMANS

4.1. USE AS HUMAN FOOD

In Europe, Tench has considerable value because of its highly esteemed flesh, which is considered to be firm, white and tasty when smoked or fried (Scott and Crossman 1973, Finnish Game and Fisheries Research Institute 2008).

4.2. RECREATIONAL, COMMERCIAL AND AQUACULTURAL USES

As Tench had devoted anglers in Europe (Scott and Crossman 1973), it was first imported into the United States from Germany by the U.S. Fish Commission in 1877 for use as a food and sport fish (Nico and Fuller 2010). The Fish Commission stocked more than 138,000 Tench from 1886 to 1896 to at least 36 different states; however, they are presently found in negligible numbers in most states.

Tench is an important but small component of commercial catches in large European lakes (Grosch *et al.* 2000). The aquaculture of Tench is increasing in southern Europe and may replace the commercial harvest (Rowe *et al.* 2008). Golden Tench is used as ornamental fish for pond culture, usually in association with carp (Scott and Crossman 1973).

5.0. IMPACTS ASSOCIATED WITH INTRODUCTIONS

5.0. IMPACTS ASSOCIATED WITH INTRODUCTIONS

Although the impact of Tench is considered to be largely unknown in the United States (Nico and Fuller 2010), it was reported to be a nuisance because of high abundance in certain parts of Maryland and Idaho in the 1940s (Baughman 1947). The diet, which consists mainly of aquatic insect larvae and molluscs (Scott and Crossman

1973), may cause it to be a potential competitor for food with sport fishes and native cyprinids (Moyle 1976).

5.1. IMPACTS ON AQUATIC MACROPHYTES

Tench may affect food webs and change lake ecosystems when they occur in high densities. Tench often feed on browsing gastropods, which stimulates periphyton growth on macrophyte surfaces (Bronmark 1994). An increase in periphyton cover reduces light penetration and nutrient supply to macrophytes, resulting in their decline (Rowe *et al.* 2008). Periphyton growth may also be stimulated from an increase in cycling of inorganic nitrogen through Tench excreta when densities of Tench are high (Williams *et al.* 2002). Tench biomass greater than 200 kg/ha is likely required before there is an adverse effect on macrophytes (Williams *et al.* 2002).

Tench were introduced into experimental enclosures with two density levels of white water lily (*Nymphaea alba*) in Little Mere, United Kingdom. Tench reduced the numbers of gastropods (but not of other macroinvertebrates), which in turn increased the biomass of periphyton growing on artificial substrates within the enclosures (Beklioglu and Moss 1998).

5.2. IMPACTS ON WATER QUALITY

As Tench can survive in degraded environments, it is unclear whether it contributes to the degradation or just inhabits a niche that other species cannot occupy (Global Invasive Species Database 2005). In their discussion of Tench introduced to Africa, de Moor and Bruton (1988) noted that the species is known to stir up bottom sediments, possibly affecting water quality, although not to the same extent as Common Carp. There is good evidence in Europe and New Zealand that Tench in high densities reduce water clarity in shallow lakes (Rowe *et al.* 2008). When introduced into lakes with other invasive cyprinid species, such as Goldfish and carp, there is a combined effect of disturbed sediments, an increase in nutrient cycling and amplified top-down effects on zooplankton. This accelerates eutrophication, degrades water quality and reduces habitat for native fishes (Rowe *et al.* 2008).

5.3. IMPACTS ON FAUNA

The impact of Tench on fauna is related to the wide range of organisms that it consumes. Although there is no evidence that they directly impact other fish species, there is an impact on the aquatic community if Tench are found in high densities (Rowe *et al.* 2008). Non-native fish species, including Tench that were introduced to Chile for aquaculture purposes, have created problems for native fish species (Perez *et al.* 2003). Tench may show selective predation on gastropods, which increases periphyton growth on macrophytes, which in turn causes a decline in macrophyte growth (Bronmark 1994). This trickle-down or cascade effect could have negative effects on the aquatic community (Global Invasive Species Database 2005). Non-molluscan benthic macroinvertebrates were not greatly affected by the presence of Tench in a eutrophic pond in Sweden (Bronmark 1994).

The concomittant introduction of Tench and the parasite *Valipora campylancristota* may pose a threat to the Copper Redhorse, a species at risk species of the sucker family found almost exclusively in the Richelieu River, Quebec (Marcogliese *et al.* 2009).

Impacts of Tench are often lumped together with other cyprinids such as Goldfish and Common Carp and as such are difficult to discern. In California it is thought that Tench may directly compete with trout and other native fishes for food supply (Moyle 1976).

LITERATURE CITED

Alabaster, J. and Downing, A. 1966. A field and laboratory investigation of the effect of heated effluents on fish. Fishery Invest., Lond. (Ser.1) 6(4): 1-42.

Baird, S. F. 1879. Report of the Commissioner of Fish and Fisheries for 1875-1876. Part IV. U.S. Commission of Fish and Fisheries, Washington, D.C..

Baughman, J. L. 1947. The Tench in America. J. Wildl. Manage. 11(3): 197-204.

Beklioglu, M., and Moss, B. 1998. The effects of Tench (*Tinca tinca* L.) and sticklebacks (*Gasterosteus aculeatus* L.) on planktonic and benthic communities in mesocosms in a shallow lake. Aquat. Ecol. 32: 229–240.

BISON (Biota Information System of New Mexico) 2003. [Online Database] http://www.bison-m.org/booklet.aspx?id=010550 (accessed 3 March 2010).

Breder, C., and Rosen, D. 1966. Modes of Reproduction in Fishes. American Museum of Natural History, Natural History Press, Garden City, New York. 941 p.

Bronmark, C. 1994. Effects of Tench and perch on interactions in a freshwater, benthic food chain. Ecology 75(6): 1818-1828.

Bronmark, C., Paszkowski, C., Tonn, W., and Hargeby, A. 1995. Predation as a determinant of size structure in populations of crucian carp (*Carassius carassius*) and Tench (*Tinca tinca*). Ecol. Freshw. Fish 4: 85-92.

Brylinska, M., Brylinski, E., and Bninska, M. 1999. *Tinca tinca* Linnaeus, 1758. *In* The Freshwater Fishes of Europe. Vol. 5/1 (Cyprinidae 2). Edited by P. Banarescu. Aula-Verlag GmbH, Wiebelsheim. pp. 229–302.

Bychowski, B.E.1962. Key for identification of freshwater fish parasites. Akademie ved SSSR, Moskva, Leningrad. 776 p. [Translated from Russian by Google Translate]

Carl, G., Clemens, W.A., and Lindsey, C.C. 1977. The Fresh-water Fishes of British Columbia. British Columbia Provincial Museum Handbook No. 5. 192 p.

Celada, J., Carral, J., Rodríguez, R., Sáez-Royuela, M., Aguilera, A., Melendre, P., and Martín, J. 2007. Tench (*Tinca tinca* L.) larvae rearing under controlled conditions: density and basic supply of *Artemia* nauplii as the sole food. Aquacult. Int. 15(6): 489-495.

Chapman, W. M. 1942. Alien fishes in the waters of the Pacific northwest. Calif. Fish Game 28: 9-15.

Clifford, C., and Guiguet, C. J. 1958. Alien Animals in British Columbia. British Columbia Provincial Museum, Department of Education, Handbook No. 14. Victoria, BC. In: Klinkenberg, Brian. 2010. E-Fauna BC: Electronic Atlas of the Fauna of British Columbia www.efauna.bc.ca Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. [Accessed: March 2010].

Coad, B. 1995. with H. Waszczuk and I. Labignan Encyclopedia of Canadian Fishes. Canadian Museum of Nature, Ottawa and Canadian Sportfishing Productions, Waterdown, Ontario. viii + 928 p.

Coad, B. 1999. Freshwater fishes. *In* Yarshater E. Encyclopædia Iranica (Daneshnameh-ye Iranika). Volume IX, Fascicule 6. Festivals VIII - Fish. Bibliotheca Persica Press, New York. pp. 655-669.

Coad, B. 2011 Freshwater Fishes of Iran [online publication] http://www.briancoad.com/Species%20Accounts/Contents%20new.htm (accessed Mar 2011).
Copp, G.H. 1977. Microhabitat use of fish larvae and 0+ juveniles in a highly regulated section of the River Great Ouse. Regul. Rivers: Res. Manage. 13: 267-276.
de Moor, I.J. and Bruton, M. N. 1988. Atlas of alien and translocated indigenous aquatic animals in southern Africa. South African National Scientific Programme Report No. 144. Council for Scientific and Industrial Research, Pretoria, South Africa. 310 p.
Dumont, P., Vachon, N., Leclerc, J., and Guibert, A. 2002. Intentional Introduction of Tench into Southern Quebec. *In* Alien Invaders in Canada's Waters, Wetlands, and Forests. Edited by R. Claudi, P. Nantel, and E. Muckle-Jeffs. Natural Resources Canada. Ottawa. pp. 169–177.
Dymond, J. R. 1936. Some fresh-water fishes of British Columbia. Report on the Commercial Fisheries of British Columbia. Contribution of the Royal Ontario Museum of Zoology 9: L60-L73.
Fijan, N. 1999. Spring viraemia of carp and other viral diseases and agents of warm-water fish. *In* Fish Diseases and Disorders, Vol. 3: Viral, Bacterial and Fungal Infections. Edited by P.T.K. Woo and D.W. Bruno. CAB International. pp. 177-244.
Finnish Game and Fisheries Research Institute 2008. Commercially exploited fish species in Finland. [Online atlas] http://www.rktl.fi/english/fish/fish_atlas/ (accessed March 2010).
Freyhof, J., and Kottelat, M. 2008. *Tinca tinca*. *In* IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. [Online database] http://www.iucnredlist.org/apps/redlist/details/21912/0 (accessed 04 February 2010).
Froese, R. and Pauly, D. Editors. 2009. FishBase. version (11/2009) [Online database] http://www.fishbase.org/search.php (accessed February 2010).
Gallardo, J., García, J., Ceballos-Zúñiga, E., and Pérez, J. 2006. Selective behaviour of a Tench, *Tinca tinca* (L.), stock in different light–substrate combined conditions. Aquaculture International 14(1-2): 163-170.
Global Invasive Species Database. 2005. *Tinca tinca*. [online database] http://www.issg.org/database/species/ecology.asp?si=618&fr=1&sts=sss&lang=EN (accessed March 2010).
Grosch, U., Rennert, B., and Hilge, V. 2000. Development and use of surface waters, and the fate of the related fisheries in the Berlin area of Germany. Fish. Manage. Ecol. 1: 179-188.
Hamackova, J., Kouril, J., Kamler, E., Szlaminska, M., Vachta, R., Stibranyiova, I., and Asenjo, C. 1995. Influence of short-term temperature decreases on survival, growth and metabolism of Tench (*Tinca tinca* (L.)) larvae. Pol. Arch. Hydrobiol. 42: 109-120.
Hamackova, J., Kouril, J., and Kozak, P. 1998. The effects of pH upon the survival and growth rates in Tench (*Tinca tinca* (L.)) larvae. Pol. Arch. Hydrobiol. 45: 399-405.
Hamalosmanoglu, M., and Kuru, M. 2004. Karyotype analyses of the Tench (*Tinca tinca* L., 1758) living in Lake Mogan (Ankara). Turk. J. Vet. Anim. Sci. 28: 143-147.

Herrero, M., Pascual, M., Madrid, J., and Sánchez-Vázquez, F. 2005. Demand-feeding rhythms and feeding-entrainment of locomotor activity rhythms in Tench (*Tinca tinca*). Physiol. Behav. 84(4): 595-605.
Hicks, B., Brijs, J., Bell, D., and Powrie, W. 2007. Boat electrofishing survey of Waitakere City pond. New Zealand CBER Contract Report 64. 14 p.
Holm, E., Mandrak, N., and Burridge, M. 2009. The ROM field guide to freshwater fishes of Ontario. Royal Ontario Museum. Toronto. 462 p.
Horoszewicz, L. 1983. Reproductive rhythm in Tench, *Tinca tinca* (L.), in fluctuating temperatures. Aquaculture 32: 79-92.
Kottelat, M. 1997. European freshwater fishes. Biologia 52 Suppl. 5: 1-271.
Kouril, J., Penaz, M., Prokes, M., and Hamackova, J. 1988. The Effects of Water Temperature on Egg Incubation and Length of Incubation Time in Tench. Bulletin of the Vyzk. Ustav Ryb. Hydrobiology, Vodnany 24: 3-9.
Linnaeus, C. 1758. Tomus I. Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Editio decima, reformata. Holmiae. (Laurentii Salvii) (1-4): 1-824.
Lui, K., Butler, M., Allen, M., da Silva, J., and Brownson, B. 2008. A field guide to aquatic invasive species. Identification, collection and reporting of aquatic invasive species in Ontario waters. Queen's Printer for Ontario. 188 p.
Lusk, S., Luskova, V., and Halacka, K. 1998. The status of Tench (*Tinca tinca* (L.)) in aquatic habitats of the floodplain along the lower reaches of the River Dyje (Czech Republic). Pol. Arch. Hydrobiol. 45: 407-414.
Mamcarz, A., and Skrzypczak, A. 2006. Changes in commercially exploited populations of Tench, *Tinca tinca* (L.), in littoral zones of lakes of northeastern Poland. Aquacult. Int. 14(1-2): 171-177.
Mamcarz, A., Kucharczyk, D., and Kujawa, R. 2006. Reciprocal hybrids of Tench *Tinca tinca* (L.) - Bream *Abramis brama* (L.), and Tench · Carp *Cyprinus carpio* L., and some characteristics of their early development. Aquacult. Int. 14: 27–33.
Marcogliese, D., Gendron, A., and Dumont, P. 2009. Parasites of illegally introduced Tench (*Tinca tinca*) in the Richelieu River, Quebec, Canada. Comp. Parasitol. 76(2): 222-228.
Marsden, J., and Hauser, M. 2009. Exotic species in Lake Champlain. J. Great Lakes Res. 35: 250–265.
McPhail, J., and Carveth, R. 1993. Field key to the freshwater fishes of British Columbia. Fish Museum, Department of Zoology, University of British Columbia Canada, 239 p.
Metcalfe-Smith, J.L., and Cudmore-Vokey B., 2003. Status of the conservation and protection of freshwater biodiversity in Canada, with emphasis on the Great Lakes. National Water Research Institute Report No. 03-005. Environment Canada.
Michel, P., and Oberdorff, T. 1995. Feeding habits of fourteen European freshwater fish species. Cybium 19(1): 5-46.
Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley.
Neophitou, C.1993. Some biological data on Tench (*Tinca tinca* (L.)) in Lake Pamvotida (Greece). Acta Hydrobiol. 35(4): 367-379.

Nico, L. and Fuller, P. 2010. *Tinca tinca.* USGS Nonindigenous Aquatic Species Database, Gainesville, Florida. RevisionDate: 2/17/2010. [Online database] http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=652 (accessed February 2010).

Ozan, S., Kir., I., Ayvaz, Y., and Barlas, M. 2006. An investigation of parasites of Tench (*Tinca tinca* L., 1758) in Beyşehir Lake. Turkiye Parazitol Derg. 30(4): 333-338. (In Turkish with English abstract).

Page, L., and Burr, B. 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston. 432 p.

Penaz, M., Wohlgemuth, E., Hamackova, J., Kouril, J. 1981. Early ontogeny of the Tench, *Tinca tinca* 1. Embryonic period. Folla Zoologica. 30: 165-176.

Pérez, J., Alfonsi., C., Nirchio., M., Muñoz, C., and Gómez, J. 2003. The introduction of exotic species in aquaculture: a solution or part of the problem? Interciencia 28(4): 234-238.

Perez-Regadera, J., Gallardo, J., Ceballos, E., and Garcia, J. 1994. Model development for the determination of final preferenda in freshwater species application in Tench (*Tinca tinca* L.). Pol. Arch. Hydrobiol. 42: 27-34.

Perrow, M., Jowitt, A., and Johnson, S. 2005. Factors affecting the habitat selection of Tench in a shallow eutrophic lake. J. Fish Biol. 48(5): 859–870.

Rendon, P., Gallardo, J., Ceballos, E., Regardera, J., Garcia, J.2003. Determination of substrate preferences of Tench, *Tinca tinca* (L.), under controlled experimental conditions. J. Appl. Ichthyol. 19: 138-141.

Rowe, D., Moore, A, Giorgetti, A., Maclean, C., Grace, P., Wadhwa, S., and Cooke, J. 2008. Review of the impacts of Gambusia, Redfin Perch, Tench, Roach, Yellowfin Goby and Streaked Goby in Australia. Prepared for the Australian Government Department of the Environment, Water, Heritage and the Arts. 245 p.

San Juan, J. 1995. Limiting factors in the development of natural Tench (*Tinca tinca* (L.)) populations in Spanish reservoirs. Pol. Arch. Hydrobiol. 42: 19-25.

Scholz, T. 1993. On the development of *Khawia baltica* Szidat 1942, (Cestoda; Lytocestidae), a parasite of Tench *Tinca tinca* (L.). Folia Parasitol. 40:99-103.

Scott, W.B., and Crossman, E.J. 1973. Freshwater fishes of Canada. Bulletin of Fisheries Research Board of Canada 184: 1-966.

Shelton, W., Smitherman, R., and Jensen, G. 1981. Density related growth of grass carp, *Ctenopharyngodon idella* (Val.) in managed small impoundments in Alabama. J. Fish Biol. 18: 45-51.

Svobodova, Z., and Kolarova, J. 2004. A review of the diseases and contaminant related mortalities of Tench (*Tinca tinca* L.). Vet. Med.–Czech Republic 49: 19-34.

Vachon, N., and Dumont, P. 2002. Study of the first references to Tench (*Tinca tinca* L.) caught in the upper-Richlelieu River (Quebec). Quebec Society of Wildlife and Parks, Monteregie Directorate of Wildlife Management, Longueuil, Technical Report: 16-07.

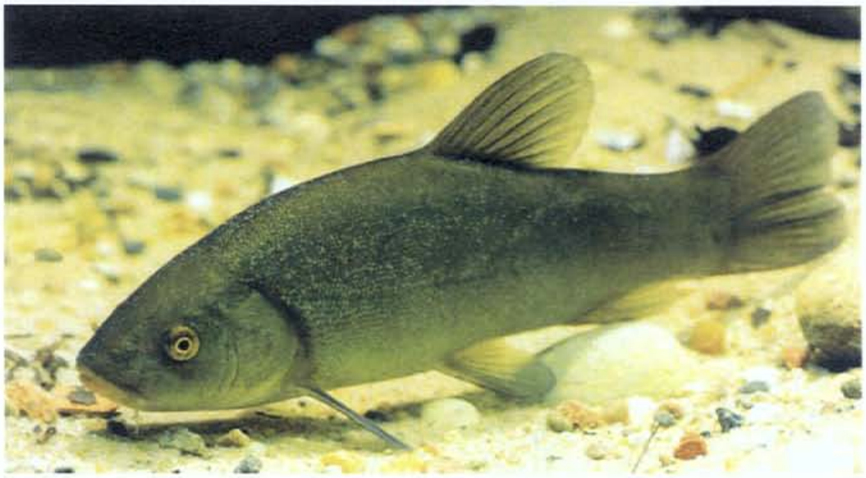
Weatherley, A. 1959. Some Features of the Biology of the Tench *Tinca tinca* (Linnaeus) in Tasmania. J. Anim. Ecol. Vol. 28(1): 73-87.

Williams, A.E., Moss, B., and Eaton, J. 2002. Fish induced macrophyte loss in shallow lakes: top-down and bottom-up processes in mesocosm experiments. Freshwater Biol. 47: 2216-2232.

Wolter, C., Minow, J., Vilcinskas, A., and Grosch, U. 2000. Long term effects of human influence on fish community structure and fisheries in Berlin waters: an urban water system. Fish. Manage. Ecol. 7: 97-104.

Wright, R., and Giles, N. 1991. The population biology of Tench *Tinca tinca* (L) in two gravel pit lakes. J. Fish Biol. 38: 17-28.

a)



b)

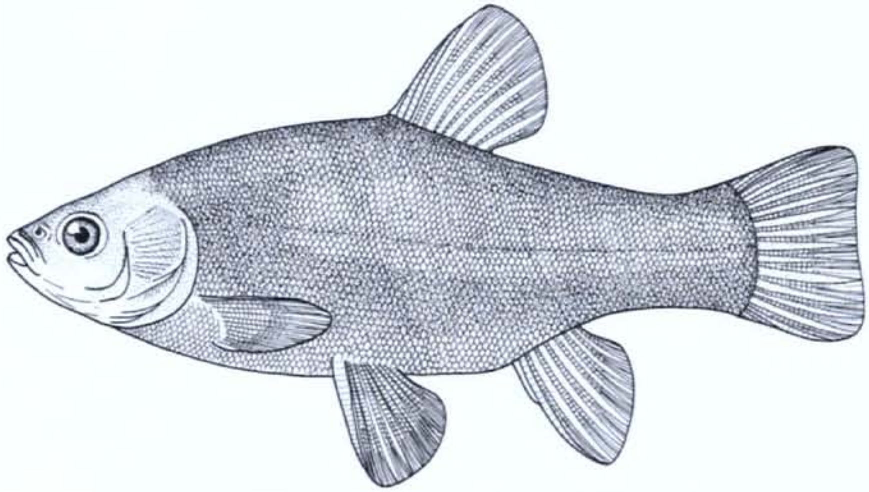


Figure 1. Tench (*Tinca tinca*) a) live specimen (copyright: Steffen Zienert; Froese and Pauly, 2010) and, b) stipple drawing (copyright: Brian W. Coad, Canadian Museum of Nature; Coad, 2011).

Table 1. Morphological features of juveniles in hybrid (Tench x Common Carp) and parental species. All parameters in rows are statistically different ($p<0.05$) (Mamcarz *et al.* 2006).

Feature	Hybrids	Tench	Common Carp
Soft rays in dorsal fin	14.7±0.4	8.5±0.1	20.2±0.3
Soft rays in anal fin	11.2±0.9	7.3±0.3	15.2±0.8
Scales in lateral line	73.3±5.9	103.1±2.3	36.3±1.2
Scales over lateral line	19.8±0.9	31.4±1.2	5.8±0.2
Scales under lateral line	14.9±1.1	22.6±0.6	5.6±0.1

Table 2. Morphological features of juveniles in hybrid (Tench x Bream) and parental species. All parameters are statistically different ($p<0.05$) (Mamcarz *et al.* 2006).

Feature	Hybrids	Tench	Bream
Soft rays in dorsal fin	8.8±0.1	8.5±0.1	9.1±0.1
Soft rays in anal fin	17.1±1.4	7.3±0.3	25.2±1.2
Scales in lateral line	81.3±3.5	103.1±2.3	53.2±1.3
Scales over lateral line	24.2±1.3	31.4±1.2	13.1±0.3
Scales under lateral line	16.8±1.2	22.6±0.6	7.3±0.4

Table 3. Lengths of Tench in Coal River and Lake Tiberias, Tasmania (Weatherley 1959).

Age at capture	**1 +**	**2+**	**3+**	**4+**	**5+**	**6+**	**7+**	**8+**	**9+**
Coal River									
Number of fish	0	2	24	52	59	76	34	10	6
Mean length (cm)	-	7.0	11.5	16.3	20.5	23.3	25.7	29.1	29.6
Lake Tiberias									
Number of fish	26	34	51	75	52	15	2	3	0
Mean length (cm)	3.9	6.9	9.3	11.5	13.4	14.8	20.7	26.5	-

Table 4. Gut contents of Tench from Lake Tiberias, Tasmania. Values given are percentages of total number of fish that contained prey item. (Weatherley 1959).

Fish groups	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Length (cm)	2.3-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	10.1-20.0	20.0+
Number of fish	34	35	25	10	14	12	10	2
Food item								
Copepoda	85	83	64	70	86	42	40	50
Cladocera	94	86	80	70	86	75	70	0
Amphipoda	44	74	88	90	79	42	60	50
Ostracoda	0	6	28	40	29	33	40	50
Chironomidae	26	37	36	20	50	33	30	50
Odonata	0	0	0	0	7	42	50	100
Ephemeroptera	0	0	0	0	14	50	60	0
Hemiptera	0	0	0	0	2	8	10	0
Hydracarina	9	23	0	20	14	8	10	0
Oligochaeta	0	0	0	10	21	0	0	0
Mollusca	0	0	0	0	7	8	10	50
Algae	68	46	48	50	50	25	30	0