Bulletin

of the

# SCANDINAVIAN SOCIETY FOR PARASITOLOGY

Vol. 6 No. 1 1996

# BULLETIN OF THE SCANDINAVIAN SOCIETY FOR PARASITOLGY

The Bulletin is a membership journal of the Scandinavian Society for Parasitology. Besides membership information, it also presents articles on all aspects of parasitology, with priority given to contributors from the Nordic countries and other members of the Society. It will include review articles, short articles/communications. Comments on any topic within the field of parasitology may be presented as Letters to the Editor. The Bulletin is also open for a short presentation of new projects. All contributions should be written in English. Review articles are commissioned by the editor, however, suggestions for reviews are welcomed.

Subscriptions are available to non-members upon request from the Publisher. The subscription rate is SEK 300 per year (two issues annually). Subscriptions should be paid to the treasurer of the SSP:

Birgitte Vennervald
Dansk Bilharziose Laboratorium
Jægersborg Allé 1D
DK-2920 DENMARK, Postal giro account number:128-9934



**Cover:** In Norse mythology, the giant ash tree - Yggdrasill - spreads its limbs over the entire mankind. The ash has three roots, each of them sucking water from its own spring.
The first spring- Hvergelmir - is found in the ice cold North; next to the spring, the serpent Níðhoggr is ceaselessly gnawing at the roots of the ash. The second spring - Mímisbrunnr - is the source of wisdom and is guarded by Mímir. The third spring - Urðarbrunnr - is guarded by three women, the Norns, which mete out man's thread of life.

Printed in Norway by HS-Trykk A/S

ISSN 0803-4907

*Bull Scand Soc Parasitol* 1996; 6 (1): 1-10





# *PROCEEDINGS*

## *of the*

## *Danish Society for Parasitology*
## *&*
## *Danish Society for Tropical Medicine*

### *Joint Spring Symposium March 1996*

### *on*

### *Zoonoses*

**9 March 1996**

August Krogh Instituttet, Auditorium.
Universitetsparken 13, 2100 København Ø.

# CONTENTS

# A GLOBAL PERSPECTIVE ON FOOD-BORNE ZOONOSES

K.D. Murrell
Beltsville Agricultural Research Center, Agricultural Research Service, Maryland, USA

Foodborne parasitic diseases are an important cause of illness and economic loss world-wide. The public health burden imposed by parasitic diseases such as toxoplasmosis, trichinellosis, cysticercosis and trematodosis are substantial even in developed countries. The rising concern generally over safety is causing a reappraisal of the significance of foodborne parasites and the strategies to control them. It. is clear that public trust in food production systems will depend on the development of more effective safeguards, which in turn will require much greater understanding of the nature and epidemiology of these zoonoses. The complexities of these parasites' life histories, and the close association of infection risk with entrenched cultural and agricultural practices make solutions difficult. The application of the Hazard Analysis Critical Control Point (HACCP) approach will require more information on parasite epidemiology, particularly factors which regulate survival and transmission. Control strategies must address the complete sequence of events encompassed by the food production chain. This will also require more effective detection technologies. More concerted efforts to educate consumers, industry, government, and public health workers of the hazards of foodborne parasites is also needed. Coupled with this is the demand for implementation of international guidelines and codes established by WHO and FAO for the production of food, especially fish and fish products. This review will present our current understanding of the biology and epidemiology of the major food-borne parasite zoonoses, the major risk factors, and the influence of demographic and development activities.

# *LEISHMANIA* ZOONOSES

R.W. Ashford
Liverpool School of Tropical Medicine, Liverpool, UK

Thanks to improved taxonomic techniques which have informed field studies, the ecology of the leishmanioses is becoming very well understood and is found to illustrate a wide diversity of zoonotic systems. These range from localised purely zoonotic systems through purely anthroponotic systems to introduced zoonoses in secondary hosts in new areas. To date, however, there has been little attempt to develop generalisations to explain the distribution and persistence of foci.

Using examples from a wide variety of systems we will attempt to investigate the factors required for a *Leishmania* focus to survive and spread. It. seems that the main broad controlling factor is the distribution of appropriate vectors. Unfortunately we are almost completely ignorant of the immediate factors determining sandfly distribution, though

general environmental correlates, with an indirect effect are sometimes well described.

The distribution of appropriate reservoir hosts generally determines the local distribution of the parasite within the range of the vector. Reservoir hosts are taxonomically diverse, though they share behavioural and ecological properties. The features shared include abundance, at least locally, and a close relationship with the vector. There are apparent differences between Old and New World systems, for which explanations will be suggested.

Examples will be given of remaining ecological questions and of how these may be tackled. An appeal will be made for studies on the breeding sites of sandflies and on the taxonomy and natural history of reservoir host species.

## TOXOPLASMOSIS IN EUROPE - THE HUMAN PERSPECTIVE

E. Petersen
Laboratory of Parasitology,
Statens Seruminstitut, Copenhagen, Denmark

In Europe, 3.8 million children were born in 1989. Of these, it is estimated that 7.700 mothers were infected with toxoplasmosis during pregnancy, and 3.100 (approx. 1:1000 new-borns) children were infected before birth (assuming 40% transmission rate). Two hundred and fifteen children will have severe damage like hydrocephalus and mental retardation, and the remaining will have a high risk of presenting with retinochoroiditis within the first 20 years of life.

Congenitally infected children may be permanently disabled and require lifelong care. Up to 85% of patients with latent congenital toxoplasmosis will develop significant sequelae including one or more episodes of active retinochoroiditis with impaired eyesight or blindness as a result, and it is conceivable that all patients with congenital toxoplasmosis eventually will develop retinochoroiditis. It has been estimated that up to 70% of cases of retinochoroiditis can be ascribed to infections with *T. gondii,* and toxoplasmosis is therefore probably the single most important cause of retinochoroiditis in children and adults in Europe.

There is no consensus within Europe on the prevention and management of *Toxoplasma* infection in pregnancy. In some countries, prenatal screening is compulsory by law (France & Austria) and in others, it is explicit public health policy not to offer pre- or neonatal screening. Prenatal screening is offered routinely in 33/54 (61%) centres in 21 European countries.

Screening programmes demand considerable funds, and the value and gains of existing and planned screening programmes need to be carefully documented. Prenatal screening programmes has the advantage of offering treatment before birth preventing or limiting sequelae. The disadvantage is that invasive diagnosis is necessary to establish whether the infection has passed from the mother to the foetus. New technologies for neonatal screening for congenital toxoplasmosis by looking

for IgM antibodies on the filter papers obtained as part of existing neonatal screening programmes will make neonatal screening for toxoplasmosis a cost-effective alternative in the future. Our laboratory has for the past three and a half year been conducting a prospective, neonatal screening programme in Denmark including approximately 22.000 women per year. Details of the programme and some preliminary results will be presented.

## TOXOPLASMOSIS - ANIMAL TRANSMISSION SOURCES

P. Lind
Danish Veterinary Laboratory,
Copenhagen, Denmark

*Toxoplasma gondii* has an extremely broad range of intermediate hosts encompassing most groups of warm-blooded vertebrates, and a cosmopolitan geographic distribution. The cat (and other Felidae) are the final host for *Toxoplasma* and the only hosts in which the intestinal coccidian cycle with final shedding of oocysts takes place. After ingestion of tissue cysts from muscle or nervous tissue of prey animals, the cat will shed oocysts during an approx. 1 week period, following a short prepatency period of approx. 4 days. The total oocyst output may amount to the size order of $10^8$. The infection source for hunting cats is primarily smaller rodents and birds, although cats may also be infected by ingesting oocysts. The shedding phase is followed by a solid immunity to reinfection. Long term (>6 yr.) reinoculation studies have, however, demonstrated that immunity is not necessarily life-long. Faecal examinations of cat populations usually provide estimates of oocyst shedding frequencies at or below 1%.

Experimental inoculation studies have shown that 1 sporulated oocyst is the infective dose for intermediate hosts. Oocysts are highly resistant towards most environmental conditions (including frost) and may survive for more than 1 year in soil and water.

Serological investigations on cat populations in Northern Europe and the US consistently show high levels of seropositivity (30 - 70%). The age-related seroprevalence shows a steep rise in juvenile young cats (< 2 yr.), indicating that most cats are infected (and shed oocysts) early in life. Stray cats and farm cats show higher seroprevalence levels than pet cats kept indoors.

Among meat-producing farm animals, cattle are highly resistant to toxoplasmosis. Meat from cattle is not considered significant in transmission of infection to humans.

Tissue cysts have been found with variable frequency in the meat of chicken. The rate of transmission from infected hen to egg is extremely low (probably below 0.1%).

Seroprevalence estimates of *Toxoplasma* infection in sheep in Northern Europe range from 20 to 70%. Sheep and lamb meat are potentially important transmission sources to humans. The fact that most lamb meat in Northern Europe is distributed frozen

probably serves to limit the extent of transmission.

Besides cats, swine are considered the most important transmission source for human infection. Because infective tissue cysts as well as specific antibodies persist in swine for several years after infection, seroprevalence measurements correlate well with meat infectivity. Northern Europe and US prevalence estimates from the 1990s for *Toxoplasma* antibodies in slaughter pigs agree on values at or below 5%, representing a distinct drop from corresponding estimates of 10-30% in previous decades. Recent risk factor analysis performed on a large number of swine farms in Illinois, US, indicate that presence of *Toxoplasma* infected cats (most notably the number of seropositive juvenile cats on the farm) is a much stronger parameter in determining seropositivity among sows and pigs than farm size *per se* or the access of swine to outdoor facilities.

A vaccine for cats based on the tissue cyst (bradyzoite) stage has recently been developed which is able to induce immunity against the intestinal coccidial cycle leading to oocyst production.

## UPDATE ON *CRYPTOSPORIDIUM* AND CRYPTOSPORIDIOSIS

D.P. Casemore
PHLS *Cryptosporidium* Reference Unit, Public Health Laboratory, Glan Clwyd Hospital, Rhyl, UK

*Cryptosporidium* is now well recognised world-wide as an enteric pathogen although its incidence and significance varies widely with place, with time, and with the age and clinical status of the patient. The problems associated with the diagnosis and surveillance of *Cryptosporidium* can be divided into several areas - methodological, expertise and experience, and political and fiscal issues. Both zoonotic and person-to-person transmission occurs and numerous outbreaks have now been described. Hospitals have to consider the risks of nosocomial transmission.

Diagnostic methods have been developed which should ensure the reliability of microscopic diagnosis providing that care is exercised with the use of adequate controls. Failure to do so may lead to misdiagnosis, to flawed surveillance, and to pseudo-outbreaks and incidents. The public health surveillance of any infection may be patchy and unreliable, depending as it does on so many variables, clinical and epidemiological. Attempts have been made to improve this in the UK for cryptosporidiosis. Waterborne outbreaks of cryptosporidiosis are now well documented, Last year, a waterborne outbreak in the UK, in the South West had more than 500 confirmed cases. The largest outbreak to date, involving an estimated 403,000 people, occurred in Milwaukee, USA. These outbreaks were thought to have been caused, as have many other outbreaks, by agricultural effluent contaminating source water, combined with sub-optimal water treatment. It would appear that several factors need to be in place for an outbreak to occur including the nature of the parasite, water treatment faults, and

the nature of the exposed population, including levels of herd immunity.

The source of outbreaks and of sporadic disease is a matter of ongoing research. Disinfection studies have demonstrated the inadequacy of many disinfectants although a well run multistage barrier system seems to be able to deal with the low numbers of oocysts often present in water. Public health control and the prevention of outbreaks is made increasingly difficult by financial and other constraints and even by the effects of changes in agriculture resulting from EC policies. Thus, in recent years we have seen an increasing number of sporadic cases and outbreaks associated with open farms.

The potential for media and political interest when things go wrong are additional problems to be considered by those involved. The British Government's response was the setting up of a Group of Experts, under the Chairmanship, of Sir John Badenoch, to study the problem and to make recommendations to Government Ministers. These include that water can never be guarantied to be free of *Cryptosporidium*, and that action levels of oocysts in water have little meaning, especially from one area to another. The importance was emphasised of having multi-disciplinary investigation teams with adequate surveillance. Advice has been given to immunocompromised patients not to drink unboiled water. In addition, a research programme was set up to look at various aspects of the problem, including the development of typing schemes.

# TRICHINELLOSIS IN THE NORDIC REGION AND THE BALTIC COUNTRIES

C.M.O. Kapel
Danish Centre for Experimental Parasitology, Frederiksberg, Denmark

The main reservoir hosts of *Trichinella* spp. are wildlife. Prevalence in both domestic and sylvatic life cycles appears closely related to the diversity and size of the carnivore populations, and the transmission is strongly influenced by factors such as hunting and veterinary hygiene (i.e. rat control). In many Eastern European countries increasing prevalence of *Trichinella* has been observed in wildlife, domestic animals and man, These apparent changes in prevalence may be assigned to the political and socio-economic changes that have affected the veterinary control and hunting regulations. Additionally, the vast forests with large populations of wildlife create an optimal biotope for the transmission of *Trichinella.* Both sylvatic and domestic *Trichinella* can infect man, wildlife and domestic animals, but, since infectivity and pathogenicity differs widely according to the species of host and species of *Trichinella,* parasite identification is very central for our knowledge of the epidemiology and the control of the disease.

In Greenland, *Trichinella nativa* is the only *Trichinella* species present. Freezing tolerance of the *T. nativa* muscle larvae allows transmission even at temperatures below -2O°C. The main wildlife reservoirs are polar bears (32%), arctic foxes (6%), and walruses (2%), but prevalence among sled dogs is even

higher (>75%). All diagnosed cases of human trichinellosis in Greenland have occurred from consumption of raw or insufficiently cooked walrus and polar bear meat. In the period 1960-1980, 61 human cases have been registered, but if subclinical cases are included the actual number may be tenfold higher. From a survey on human sera, 22% of the native population in an endemic area had antibodies against *Trichinella,* but only in 13% of the positive cases were clinical symptoms recorded, apparently due to immunity at the intestinal level. The prevalence in wildlife in Greenland is highly variable geographically, with the highest prevalence found in the North. In areas where polar bears are hunted, the prevalence in wildlife is very high. When polar bear carcasses from the hunt are left on the ice, they attract other polar bears, arctic foxes or sled dogs. If dumped into the sea, walruses will eventually have access to the carcass. Since sled dogs are fed all remains of the hunt, they will very often become infected with *Trichinella.* Tradition is to leave dead dogs on the ice or dump them into the ocean.

In Scandinavia, marked differences exist between countries, and the prevalence of the three species found *(T. spiralis, T. britovi,* and *T. nativa)* appears closely related to the presence of carnivorous species. In Denmark, only very low prevalence in wildlife is found. In foxes the prevalence is less than 0.1%, and in other carnivorous species *Trichinella* has not been found. *Trichinella* has been reported from imported wild boars held in game parks, but in domestic pigs it has not been found since the 1930's, although 18 million pigs are examined annually. All human trichinellosis has all been assigned to consumption of infected meat during holidays in endemic areas.

In Sweden, *Trichinella* infections in wildlife are more common than in Denmark with a prevalence of 7-20% found in the fox population, but *Trichinella* is only found rarely in domestic pigs. Only *T. spiralis* is demonstrated in domestic pigs, whereas *T. nativa and T. britovi* are also present in the sylvatic reservoirs.

In Norway, infection in both wildlife and domestic pigs appears more frequent than in Sweden (carnivores: 5-25%, domestic pigs: 13 cases since 1970). Only the sylvatic strain *T. nativa* has been found in Norway. Human cases, which have not been registered since the 1940's, were all assigned to consumption of uncontrolled pork meat products, imported or from outdoor-reared domestic pigs.

Finland has the highest prevalence in wildlife among the Scandinavian countries (carnivores: 1-58%, cats 55%, rats 13%). Recent outbreaks among domestic pigs may be connected to increasing prevalence in wildlife and especially among rats and cats. Thus, in 100 *Trichinella* positive pig farms the prevalence among brown rats and cats in the surroundings were 20% and 48%, respectively. In the same areas prevalence among racoon dogs has increased. Both *T. nativa* and *T. spiralis* are found in Finland, but whereas *T. nativa appe*ars confined to sylvatic animals, both species are found in synanthropic animals. Although, the situation in Finland may pose a serious threat to

human health, no cases have been reported, possibly due to intensive meat inspection employing digestive techniques.

In the three Baltic states (Estonia, Latvia, and Lithuania) human trichinellosis is an increasing problem. The large forests in the Baltic countries permit an extraordinary diverse and numerous wildlife fauna to exist. In the northernmost of the Baltic countries, Estonia, all three species are present, whereas in Latvia and Lithuania only *T. britovi* and *T. spiralis* have been found. Thus, *T. nativa* seems restricted to areas where its ability to tolerate freezing is advantageous for transmission. According to the host species the different *Trichinella* species vary in their infectivity. The occurrence of the different *Trichinella* species in the various host species and the possibility of mixed infections in the same host individual may influence epidemiology. Of the three species found, *T. nativa* appears confined to sylvatic animals, *T. britovi* to both sylvatic and domestic animals and *T. spiralis* to synanthropic and domestic animals.

Although differences exist regarding prevalence in wildlife between the countries, human infection arises primarily from the consumption of insufficiently cooked wild boar meat, but domestic pigs increasingly are sources of infection. Infections among domestic pigs are rare, but the few findings could possibly be a result of using non-digestive diagnostic methods for routine control. Socio-economic changes in the Baltic countries have also led to more frequent poaching on wild boars and home slaughtering of outdoor reared pigs from both of which uncontrolled meat has been sold. In Estonia, the prevalence has been rising in sylvatic and domestic animals during the last two decades. The prevalence is high especially among racoon dogs (71%), rats (11%), and cats (4%). Also among farmed carnivorous animals, in the rat populations and among domestic cats, the prevalence has recently increased dramatically. Human trichinellosis occurs more frequently than earlier and, although the size of the problem is not known, consumption of meat from wild boars as well as from domestic pigs appears to be the source of infection. As in Finland, the high prevalence of *Trichinella* in wildlife may pose a serious threat to meat production, although trichinellosis among domestic pigs is as yet rarely detected in Estonia. In Lithuania, the threat of trichinellosis to human health has been underlined by an increasing number of severe and also fatal cases during the 1990's. Meat from wild boars and domestic pigs are both frequent sources of infection. Prevalence in wildlife and synanthropic animals is high (Lynx 24%, fox 18%, racoon dog 18%, wild boar 1%, rat 9%, cat 6%, dog 9%), and among domestic pigs it has been increasing from 0.0015% in the 1930's to 0.03% in 1993. In Latvia, epidemiological data on trichinellosis have not been published since 1980. The latest data on prevalence in wildlife is comparable to those found in the other Baltic countries, and it is likely that trichinellosis is a growing problem both among human and domestic animals in Latvia as well.

Trichinellosis in domestic pigs and humans appears closely associated to prevalence in wildlife, veterinary

hygiene, hunting traditions and diagnostic method employed in meat inspection. To reduce the prevalence in wildlife, one must prevent transmission due to human. Thus, preventing hunters from discarding carcass remnants which could be scavenged by wild and synanthropic animals has been shown to decimate trichinellosis in wildlife populations in the US. Efficient barriers preventing transmission by synanthropic animals (cats and rats) appears very important preventing trichinellosis in production animals. A central issue is to have veterinary regulations prohibiting feeding of improperly heated food to production animals especially waste meat from slaughtering and hunting.

In arctic areas, human trichinellosis arises from consumption of wildlife. In Europe, usually often smoked meat, sausages or other fresh meat products from wild boars, as well as domestic pigs raised under poor sanitary conditions, are sources of infection. Since trichinellosis is relatively rare in most parts of Europe, infection in humans will often be primary infections with expressed clinical symptoms. In the hunting cultures in the arctic areas, gradual immunisation of the local population may be obtained, through tradition bound ingestion of small pieces of raw meat from newly-shot animals. Visitors, tourists, expedition members, etc. from non-endemic areas participating in these hunting rituals may show severe clinical symptoms if infected.

When estimating the prevalence of trichinellosis, it is very important to take into account the diagnostic method. Clearly, the digestive techniques are much more sensitive than the compressorium technique, with 0.1 larvae per gram detected compared with 3 l/g. In most West European slaughter houses digestive techniques are used for routine examination of domestic pigs, but in the Baltic countries compressorium is still the approved method. Thus, light infections may not be detected and the prevalence among domestic pigs in the Baltic region is most likely underestimated.

All species of *Trichinella* can infect humans, domestic animals, and wildlife, but infectivity and pathogenicity varies. For humans, *T. spiralis and T. nativa* have high pathogenicity while T. *britovi* produces fewer severe symptoms. The same three *Trichinella* species all show a high infectivity in carnivores, but appear to have no influence on the health and fitness of the infected animals. Only *T. spiralis* has high infectivity in domestic pigs. As the composition of the *Trichinella* population differs geographically, parasitic identification appears to be of central importance in epidemiological studies and thereby in controlling trichinellosis.

*Bull Scand Soc Parasitol* 1996; 6 (1): 11-17

# ANTIBODIES TO *TOXOPLASMA GONDII* IN NORWEGIAN SLAUGHTERED SHEEP, PIGS AND CATTLE

[1]Eystein Skjerve, [3]Jorun Tharaldsen, [2]Harald Waldeland, Georg Kapperud[1,4], Truls Nesbakken[5]

[1]Norwegian College of Veterinary Medicine; Department of Pharmacology, Microbiology and Food Hygiene; [2]Department of Sheep and Goat Research; [3]Central Veterinary Laboratory, Oslo, Norway; [4]National Institute of Public Health, Oslo, Norway; [5]Norwegian Meat Cooperative, Department of Research and Development, Oslo, Norway

## Abstract

Serum samples from slaughtered pigs, lambs and cattle were analysed for antibodies to the protozoon *Toxoplasma gondii.* Out of the 207 sheep flocks, 91 (44%) were defined as *Toxoplasma* positive, while 18% of the 2070 individual samples were positive. Of the 321 pig herds, 17 (5.3%) were defined as *Toxoplasma* positive, while 2.6% of the 1605 individual samples were seropositive. In cattle, 55 (5.1%) of 1053 individual samples were seropositive. A considerable geographical variation in the incidences of antibodies was observed in all three species. The epidemiological importance of meat as a source of infection for humans is discussed.

## Introduction

Infection with *Toxoplasma gondii* is recognised as a substantial problem in sheep and goat husbandry, causing abortion and reproductive failure of ewes. Recent reports also indicate that the parasite might be a problem in pig husbandry (Dubey *et al.*, 1988; Dubey *et al.*, 1990). Furthermore, transmission of this parasite from animals to man through meat is generally accepted as a health problem in areas where meat is eaten raw or undercooked. The seriousness of congenital toxoplasmosis of man has drawn attention to the epidemiology of *T. gondii,* with the domestic cat and meat-producing animals as important vehicles for transmission to man (Dubey *et al.*, 1989).

Several studies on the prevalence of the infection in different animals have been conducted in Scandinavia. Kapperud (1978) found 21 of 87 (24%) domestic cats with positive dye-test titers, also demonstrating antibodies in a wide range of wild mammals as red foxes, arctic foxes, red deer, roe deer and wild rabbits. Borgen and Berg (1957) found 45% seropositive Norwegian dogs. In a Swedish study, 42% of cats and 23% of dogs were positive (Uggla *et al.*, 1990). Studies have

differed in their design and methods, and can not be directly compared. For dogs and cats, most of the published studies, including the Scandinavian ones, have been on cases presented at veterinary clinics. These animals are not necessarily representative of the general population. It can, however, be concluded that there is a considerable rate of infection among dogs and cats as well as and wild mammals in Scandinavia.

Waldeland (1976a; 1976b; 1977) published a number of studies on *T. gondii* infections in Norwegian sheep. These studies indicated that 42-50% of ewes and 20-39% of slaughtered lambs were seropositive using the dye-test, and that 25-37% of ewes and 10-15% of lamb carcasses contained *T. gondii cysts.* Recent studies indicated that than 60% in sheep in different areas of Sweden are seropositive (Lundén, 1994; Uggla *et al.*, 1983; Uggla *et al.*, 1984). No study has been published on the occurrence of *T. gondii* in goats in Scandinavia, but the importance of the infection as cause of abortion is considerably less than in sheep. Uggla *et al.* (1990) found that 1% of horses in Sweden were seropositive, while the occurrence of antibodies to *T.* gondii in Norwegian horses is unknown. Hellesnes *et al.* (1978) found 16% seropositive slaughtered pigs from south-eastern Norway, while a Swedish study reported 9%, 2.5% and 37% seropositive respectively in different districts (Uggla *et al.*, 1984). The latter study also reported many seropositive cattle, varying from 6% to 35% in different districts. There has been no publication on the occurrence of antibodies to *T. gondii* in Norwegian cattle.

The aim of the present work was to examine the present occurrence of antibodies to *T.* gondii in meat-producing animals in Norway. Also, the survey was intended as a base for further studies on the association between management and hygiene and infection with *T. gondii.* This paper presents the results from the serological surveys, focusing on the geographical differences in the occurrence of seropositive slaughtered lambs, pigs and cattle.

## Materials and methods

### *Sheep*

From each of the 4 most densely populated sheep districts in Norway, the two largest slaughterhouses were selected for sampling. All samples were taken during the autumn slaughtering (September to November 1993). Each slaughterhouse was visited twice - early and late during the sheep slaughtering period. From each of 207 randomly selected flocks, blood samples were collected from 10 animals at bleeding. Samples were transported to the Norwegian College of Veterinary Medicine the same or the following day. The serum was collected and stored at -20 °C. The sera were analysed at the Department of Sheep and Goat Research, Norwegian College of Veterinary Medicine, by an ELISA technique mainly as described by Uggla *et al.* (1990) and Lundén *et al.* (1992). An antigen dilution containing 0.5 mg protein/ml and a dilution of 1:1500 of horse radish conjugated rabbit anti-sheep globulin (Dakopatts, Denmark) was found to give the most reliable result in chessboard titration with sheep sera either positive

or negative in the Sabin Feldman dye test. A sheep flock was defined as *Toxoplasma* positive if at least two of the 10 animals sampled were seropositive.

*Pigs*

Blood samples from pigs were collected from five of the largest pig slaughterhouses in Norway during the period from November 1993 to October 1994. Samples were taken from 5 animals in 321 randomly selected herds and shipped to the Norwegian College of Veterinary Medicine, where serum was collected and stored at -20 °C until sent to the laboratory for analysis. Sera were analysed at the National Veterinary Laboratory in Denmark, by an ELISA method described by Dubey *et al.* (1995). Herds were defined as *Toxoplasma* positive if there was at least one animal with a high titre, or two or more seropositive animals out of five.

*Cattle*

Blood samples from 1053 randomly selected cattle were collected at 9 different slaughterhouses in 1989. Serum was collected by the local meat inspection, stored at - 20 °C and sent to the Norwegian College of Veterinary Medicine for further storage before analysis. Sera were analysed at the Central Veterinary Laboratory, Oslo, Norway using an ELISA method. Briefly, microtiter plates were coated with a *Toxoplasma* antigen (RIVM, Bilthoven, The Netherlands) diluted 1:200 in 0.1 M sodium carbonate buffer, pH 9.6, 0.1 ml antigen dilution per well, and incubated for 1 hour at 37 °C. After washing with 0.05% Tween 20, 0.1 ml of the diluted sera (diluted 1:200 in PBS with 0.05% Tween 20 and 1% horse serum) was added to each well, and the plates were incubated for 1 hour at 37 °C. The sera were tested in duplicate. After repeated washing, 0.1 ml of an anti-bovine HRP conjugate (Sigma A-5295) diluted 1:5000 in PBS/Tween with 2% horse serum was added to each well, and incubation was performed at 37 °C for one hour. After a final washing, 0.1 ml of the enzyme substrate (OPD, Sigma P8412) was added to each well and left at room temperature for 15-20 minutes, when 0.1 ml 1M $H_2SO_4$ was added to stop the reaction, and the optical density was read at 492 nm.

Cumulative incidences (fraction of animals seroconverting before slaughtering) and the 95% exact confidence intervals were calculated using Epi-Info version 6 (CDC/WHO, Atlanta/ Geneva).

## Results

*Sheep*

A high incidence of antibodies to *T. gondii* was found in sheep from all regions in Norway (Table 1). Of a total of 207 herds, 91 (44.0%) were defined as positive. Of the individual samples, 368 (17.8%) revealed antibodies to *T. gondii*. In the whole material, 75 herds (36.2%) had no animal with antibodies, 41 (19.8%) had only one positive animal, 77 (37.2%) had 3-5 positive animals, while only 14 (6.7%) had >5 animals with antibodies. The results are similar to those reported by Waldeland (1976; 1976; 1977). He found a 20-39% incidence of lambs, which is slightly higher than the 18% found in this study. As different methods (ELISA vs. dye-test) were used in the studies and

Table 1. Herd cumulative incidences of antibodies to *Toxoplasma gondii* in Norwegian slaughtered lambs and slaughtered pigs from different counties. Results given as number of positive herds/ number of herds sampled (**Cumulative incidence**, 95% confidence interval)

| COUNTY | SLAUGHTERED LAMBS | SLAUGHTERED PIGS |
|---|---|---|
| Østfold | no data | 2/24 (**8.3%**, 1.0-27%) |
| Akershus | no data | 3/15 (**20%**, 4.3-48%) |
| Hedmark | 18/31 (**58%**, 39-75%) | 2/70 (**2.9%**, 0.3-9.9%) |
| Oppland | 14/20 (**70%**, 46-88%) | 2/30 (**6.7%**, 0.8-22%) |
| Aust-Agder | 3/10 (**30%**, 6.7-65%) | no data |
| Vest-Agder | 5/10 (**44%**, 18-81%) | no data |
| Rogaland | 20/32 (**63%**, 44-79%) | 6/88 (**6.8%**, 2.5-14%) |
| Sogn & Fjordane | 15/52 (**29%**, 17-43%) | no data |
| Møre & Romsdal | no data | 0/8 (**0.00%**, 0.00-37%) |
| Sør-Trøndelag | 1/1 (**100%**, 2.5-100%) | 1/17 (**5.9%**, 0.15-29%) |
| Nord-Trøndelag | no data | 1/69 (**1.4%**, 0.04-7.8%) |
| Nordland | 6/29 (**19%**, 8.0-40%) | no data |
| Troms | 9/22 (**45%**, 21-64%) | no data |
| TOTAL | 91/207 (**44%**, 37-51%) | 17/321 (**5.3%**, 3.1-8.3%) |

different areas were investigated in a different design, results can not be directly compared. The counties with the highest incidences were in Central Norway (Hedmark and Oppland) and South-western Norway (Rogaland). The observed variation may be related to climate, survival of cysts, density of cats and sheep or other factors. This issue will be discussed in a later paper, where results from this study will be linked to information about herd hygiene and management practices.

*Pigs*

A much lower incidence was found in slaughtered pigs, where only 17 (5.3%) of the 321 sampled herds were defined as positive, while 42 (2.6%) of the individual samples were serpositive. Table 1 shows the results countywise. Of the herds defined as positive, 8 were defined as case herds based on one

animal with a high titre, one herd had 2 positive animals, 2 herds had 3 positive, 5 herds had 4 positive and 1 herd had 5 positive animals. In pigs there seems to have been a decrease in the incidence of *T. gondii* during the last 25 years, from the 16 % reported by Hellesnes *et al.* (1978) to 2.6% found in this study. The results are in accordance with studies from other countries, where a lower frequency has been found in modern, commercial pig husbandry than in traditional, small scale farming (Knapen *et al.*, 1982). Although the pig production in Norway still consist of small units, the hygiene and management, as well as the housing, has changed dramatically during the last decades.

*Cattle*

Of the 1053 slaughtered cattle, 54 (5.1%) were positive (Table 2). These results are not easy to interpret. First of all, the lack of specificity of the ELISA test may overestimate the incidence if only results from individual animals are considered. Secondly, cattle do not carry the parasite for a long time, and there is no indication that cattle constitute an important reservoir for *T. gondii* (Dubey *et al.*, 1988). The results do not indicate that there is any health hazard for consumers eating raw or undercooked beef, although some cattle may have been exposed to cysts of *T. gondii*. Cattle have other grazing areas and strategies than sheep, and this may explain the lower incidencein cattle than in lambs.

Table 2. Cumulative incidences of antibodies to *Toxoplasma gondii* in Norwegian slaughtered cattle from 9 different slaughterhouses in Norway. Figures given as number of positive animals/ total number of animals (**Cumulative incidence**, 95% confidence interval).

| Slaughterhouse (County) | Toxoplasma positive |
|---|---|
| Oslo (Oslo) | 1/35 (**2.9%**, 0.07-15%) |
| Rudshøgda (Hedmark) | 8/154 (**5.2%**, 2.3-10.0%) |
| Egersund (Rogaland) | 0/64 (**0.0**, 0.0-5.6%) |
| Forus (Rogaland) | 20/288 (**6.9%**, 4.3-10.5%) |
| Førde (Sogn & Fjordane) | 9/82 (**11.0%**, 5.1-20%) |
| Fosen (Sør-Trøndelag) | 12/177 (**6.8%**, 3.6-11.5%) |
| Namsos (Nord-Trøndelag) | 2/177 (**1.1%**, 0.13-4.0%) |
| Sortland (Nordland) | 2/28 (**7.1%**, 0.88-24%) |
| Brønnøysund (Nordland) | 1/48 (**2.1%**, 0.05-11.1%) |
| TOTAL | 55/1053 (**5.2%**, 4.0-6.7%) |

High incidences of antibodies to *Toxoplasma* in one species in an area did not correspond to high incidences in the other species. The reason for this is unclear, but may indicate that local management factors are more important than are geographical and climatic factors.

The results from the study indicate that meat from lambs, and to a certain extent pigs, may harbour *T. gondii* and may thus constitute a potential health hazard for consumers. If mutton or pork is eaten raw or undercooked without prior freezing, the risk of becoming infected might be considerable. A recent case-control study of pregnant women in Norway confirms this, as consumption of undercooked mutton and to some extent pork was found among important risk factors for getting a primary infection during pregnancy (Kapperud, not published). The possibility of reducing the incidence of *T. gondii* infection in sheep and pig husbandry will discussed in later papers.

**Acknowledgements**

Financial support from the Norwegian Research Council and Omsetningsrådet is acknowledged.

**References**

A Berdal BP, Olsen, Almlid T, Larsen HJ, Lorentzen-Styr AM. Comparison between ELISA and dye-test for detection of naturally acquired *Toxoplasma* antibodies in the goat. Acta Vet Scand 1983; 24: 65-73

Borgen PHF, Berg OA. *Toxoplasma* dye test in dogs in Norway. Acta Pathol Microbiol Immunol Scand 1957; 41: 353-7

Dubey JP, Beattie CP. Toxoplasmosis of animals and man. Boca Raton, Fla.: CRC Press., 1988

Dubey JP, Kirkbride CA. Economic and public health considerations of congenital toxoplasmosis in lambs. JAVMA 1989; 195: 1715-6

Dubey JP, Kirkbride CA. Toxoplasmosis and other causes of abortions in sheep from north central United States. JAMVA 1990; 196: 287-90

Dubey JP, Thulliez P, Weigerl RM, Andrews BS, Lind P, Powell EC. Sensitivity and specificity of various serologic tests for the detection of *Toxoplasma gondii* infection in naturally infected sows. Am J Vet Res 1995; 56: 1030-6

Hellesnes I, Mohn SF, Melhuus B. *Toxoplasma gondii* in swine in south-eastern Norway. Acta Vet Scand 1978; 19: 574-87

Kapperud G. Survey for toxoplasmosis in wild and domestic animals from Norway and Sweden. J Wildlife Dis 1978; 14: 157-62

Knapen F van, Franchimont JH, Lugt G van der. Prevalence of antibodies to *Toxoplasma* in farm animals in the Netherlands and its implications for meat inspection. Vet Quart 1982; 4: 101-5

Lundén A, Carlsson U, Näslund K. Toxoplasmosis and Border disease in 54 Swedish sheep flocks. Seroprevalence

and incidence during one gestation period. Acta Vet Scand 1992; 33: 175-84

Lundén A. *Toxoplasma gondii* infection in sheep; Studies on epidemiology, food hygiene and vaccination. Swedish University of Agricultural Sciences, Uppsala, Sweden, 1994

Uggla A, Beskow P, Schwan O, Bergquist NR, Waller T. Ovine toxoplasmosis in Sweden. Acta Vet Scand 1983; 24: 113-9

Uggla A, Hjort M. A serological study on the prevalence of *Toxoplasma gondii* in meat-producing animals in Sweden. Acta Vet Scand 1984; 25: 567-76

Uggla A, Mattson S, Juntti N. Prevalence of antibodies to *Toxoplasma gondii* in cats, dogs and horses in Sweden. Acta Vet Scand 1990; 31: 219-22

Waldeland H. The geographical distribution of *Toxoplasma gondii* in Norway. Nor J Zool 1976a; 24: 459

Waldeland H. Toxoplasmosis in sheep. The prevalence of *Toxoplasma* antibodies in lambs and mature sheep from different parts of Norway. Acta Vet Scand 1976b; 17: 432-40

Waldeland H. Toxoplasmosis in sheep. I. Long-term epidemiological studies in four breeding flocks. II. Influence of various factors on the antibody contents. III. Haematological, serological and parasitological studies. Acta Vet Scand 1977; 18: 227-56

*Bull Scand Soc Parasitol* 1996; 6 (1): 18-24

# PARASITES OF WHITE BREAM (*BLICCA BJOERKNA*), BURBOT (*LOTA LOTA*) AND RUFFE (*GYMNOCEPHALUS CERNUA*) FROM THE RIVER GLOMMA, SOUTH-EASTERN NORWAY

C. Appleby[1] and E. Sterud[2]
[1]Central Veterinary Laboratory, P. O. Box 8156 Dep., N-0033 Oslo, Norway,
[2]Norwegian College of Veterinary Medicine, P. O. Box 8146 Dep., N-0033 Oslo, Norway

## Abstract

The parasite fauna of white bream (*Blicca bjoerkna*), burbot (*Lota lota*) and ruffe (*Gymnocephalus cernua*) has been studied from the river Glomma in south-eastern Norway. A total of 36 parasite species were found, 11 of which are new records for Norway.

## Introduction

Comparatively little is known about the species diversity of parasites in freshwater fish in Norway. This is especially true for most of the economically unimportant non salmonid species. Vik (1984) reviewed the occurrence of parasites from freshwater fish in Norway. An up to date list is in press, and will appear shortly in Limnofauna Norvegica (Aagaard & Dolmen, 1996). Protozoans are omitted in this list, and what little is known about these organisms in Norwegian freshwater fish is mentioned by Vik (1984).

Halvorsen (1971) investigated the helminth fauna of coarse fish in the river Glomma. This study however, did not include protozoans and nematodes. The present study is a survey of the protozoan and metazoan parasites of white bream, *Blicca bjoerkna* (L.), burbot, *Lota lota* (L.) and ruffe, *Gymnocephalus cernua* (L.) from the river Glomma. The latter species was not examined by Halvorsen (1971), and its parasite fauna has, as far as we know, not previously been studied in Norway.

## Materials and methods

The fish were caught March 7, 1996, by angling through the ice on the river Glomma, (Grønsund, Eidsberg municipality in Østfold county). All fish were kept alive until examination. They were killed by a sharp blow to the head (large fish) or by cutting through the spinal cord behind the brain. Total length, weight and sex were determined for all hosts. Parasites were found by routine parasitological examination by the aid of a dissecting microscope and a microscope equipped with phase contrast. All external and internal organs were examined. If possible, the number of each parasite species was determined, and is presented as intensity range in

Table 1. Ecological terms follow Margolis *et al.*, (1982).

If the parasite species could not be identified immediately, the following references were used for species determination: Bykhovskaya-Pavlovskaya *et al.* (1962) (protozoans, *Dactylogyrus*, cestodes, trematodes, acanthocephalans, molluscs); Lom & Dykova (1992) (protozoans); Moravec (1994) (nematodes); Malmberg (1957, 1970) (*Gyrodactylus*). Other references used for species identification are mentioned below.

## Results and discussion

The results are summarised in Table I, and discussed below for each host species.

White bream, *Blicca bjoerkna*:

There are no previous published accounts of *Trypanoplasma* from Norwegian freshwater fish. Due to the confused systematics of the genus, and difficulties involved in identifying the different species (Lom & Dykova, 1992), we have not attempted to identify the species found in this host. Neither Bykhovskaya-Pavlovskaya *et al.* (1962) nor Lom & Dykova (1992) report findings of *Trypanoplasma* in *Blicca bjoerkna*. The present species is possibly *T. borreli* Laveran & Mesnil, 1902, a common species in the blood of several cyprinids throughout Europe (see Lom & Dykova, 1992).

We are not aware of any previous reports of *Myxobolus* from white bream in Norway. Several *Myxobolus* species are known from this host (Bykhovskaya-Pavlovskaya, 1962). The spores of the species in question are slightly different than those found in burbot, which we have tentatively identified as *M. muelleri* (see below). According to Lom & Dykova (1992), however, the spore morphology of this species may be dependent on the host species. Thus, in the present study, it is possible that white bream and burbot both are infected with *M. muelleri*.

The two monogeneans *Dactylogyrus cornu* and *Paradiplozoon homoion* (Bychowsky & Nagibina, 1959) were found in low numbers. This is the first report of the former from Norway. The latter species was reported from white bream by Halvorsen (1971) as *Diplozoon paradoxum* Nordmann, 1832. The size of the opisthaptoral anchors of the present material (two specimens) shows that they are not identical to *D. paradoxum*, which, according to Khotenovsky (1985), has very large anchors. This species is also considered to be host specific to *Abramis brama* L. *Paradiplozoon bliccae* (Reichenbach-Klinke, 1961), described from *Blicca bjoerkna*, appears to be a valid species (D. I. Gibson, pers. comm.). Our material also fits the description of *P. bliccae*, but at present little is known about this species. Thus, until further work is done on this taxonomically difficult group, we refer to the present species (more or less by convention) as *P. homoion*.

One mature specimen of the cestode *Caryophyllaeides fennica* was found in the present study. This species was not registered in white bream by Halvorsen (1971), but has been found in other cyprinids in Norway (Borgstrøm & Halvorsen, 1968; Halvorsen, 1971).

Table 1. List of parasites found on *Blicca bjoerkna*, *Lota lota* and *Gymnocephalus cernua* from the river Glomma.

Prevalence=%, intensity=range (+= prevalence and intensity not calculated). Abbreviations: ia=immature adult, m=metacercariae, pc=plerocercoid, B=blood, F=fins, H=head, I=intestine, K=kidney, L=lens, S=skin, BC=body cavity, GA=gill arches, GB=gall bladder, GF=gill filaments, LI=liver, OC=oral cavity, PC= pyloric cecae, SB=swim bladder, ST=stomach, UB=urinary bladder.

| Host (number of specimens examined) | *Blicca bjoerkna* (27) | | | *Lota lota* (19) | | | *Gymnocephalus cernua* (23) | | |
|---|---|---|---|---|---|---|---|---|---|
| Length (range): | 115 - 255 mm | | | 360 - 850 mm | | | 85 - 127 mm | | |
| Weight (range): | 14 - 180 g | | | 215 - 3462 g | | | 6 - 29 g | | |
| Parasite species: | Prev. | Int. | Site | Prev. | Int. | Site | Prev. | Int. | Site |
| Bodonidae | | | | + | + | S | | | |
| *Trypanoplasma* sp. | 14.8 | + | B | | | | | | |
| Hexamitidae | | | | 5.3 | + | I | | | |
| *Trypanosoma* sp. | | | | | | | 45 | + | B |
| *Apiosoma* sp. | | | | + | + | S | | | |
| *Trichodina* sp. | | | | | | | + | + | GF |
| *Goussia* sp. | | | | 21.0 | + | GB | | | |
| *Henneguya creplini* (Gurley, 1894) | | | | | | | 34.8 | + | GF |
| *Myxobolus muelleri* Bütschli, 1882 | | | | 26.3 | + | GF | | | |
| *Myxobolus* sp. | 44.4 | + | GF,K | | | | | | |
| *Gyrodactylus lotae* Gussev, 1953 | | | | 68.4 | + | GF,OC,F,S | | | |
| *Gyrodactylus longiradix* Malmberg, 1957 | | | | | | | + | + | F |
| *Dactylogyrus amphibothrium* Wagener, 1857 | | | | | | | 65.2 | 1-30 | GF,OC |
| *Dactylogyrus cornu* Linstow, 1878 | 7.4 | + | GF | | | | | | |
| *Paradiplozoon homoion* (Bych. & Nag., 1959)* | 7.4 | 1 | GF | | | | | | |
| *Caryophyllaeides fennica* (Schneider, 1902) | 3.7 | 1 | I | | | | | | |
| *Caryophyllaeus laticeps* (Pallas, 1781) | 14.8 | 1 | I | | | | | | |
| *Ligula intestinalis* (L., 1758) | 40.7 | 1-12 | BC | | | | | | |
| *Proteocephalus percae* (Müller, 1780) | | | | | | | 39.1 | 1-5 | I,PC |
| *Proteocephalus* sp. | | | | 15.8 | 1-2 | I,PC | | | |
| *Triaenophorus nodulosus* (Pallas, 1781) (pc, ia) | | | | 63.1 | + | LI,I | | | |
| *Azygia lucii* (Müller, 1776) | | | | 5.3 | 3 | I | | | |
| *Bunodera lucioperca* (Müller, 1776) | | | | 15.8 | 1 | I,PC | 56.5 | 1-13 | I,PC |
| *Ichthyocotylurus variegatus* (Creplin, 1825) (m) | 14.8 | + | BC | | | | 86.9 | + | SB,BC |
| *Diplostomum* sp. (m) | 100 | 4-65 | L | 42.1 | 1-20 | L | 34.8 | 1-6 | L |
| *Phyllodistomum folium* (Olfers, 1816) | | | | | | | + | 1-5 | UB |
| *Phyllodistomum macrocotyle* (Lühe, 1909) | 22.2 | 1-5 | UB | | | | | | |
| *Rhipidocotyle fennica* (Gibson *et al.*, 1992)* (m) | 66.7 | <400 | F,H | | | | | | |
| *Camallanus lacustris* (Zoega, 1776) | | | | 78.9 | 1-25 | I,PC,ST | 21.7 | 1-3 | I |
| *Ichthyobronema hamulatum* (Moulton, 1931) | | | | 100 | <100 | I,PC,ST | 4.3 | 1 | I |
| *Philometra ovata* (Zeder, 1803) | 14.8 | 1 | BC | | | | | | |
| *Acanthocephalus lucii* (Müller, 1776) | | | | 26.3 | 1-3 | I,PC | | | |
| *Pseudoechinorhynchus clavula* (Dujardin, 1845) | | | | 57.9 | <30 | I,PC,ST | | | |
| *Anodonta anatina* (L., 1758) | 3.7 | 1 | GA | 89.5 | + | F,GF,GA | 73.9 | + | F,GF,GA,OC |
| *Cystobranchus mammillatus* (Malm, 1863) | | | | 57.9 | 1-5 | GF,GA,OC | | | |
| *Piscicola geometra* (L., 1761) | + | + | S | | | | | | |
| *Ergasilus sieboldi* Nordmann, 1832 | 3.7 | 1 | GF | | | | | | |
| Number of species | 15 | | | 17 | | | 13 | | |

* Full reference to authors in discussion

Metacercariae of a *Rhipidocotyle* species were common and abundant in the fins (especially the caudal fin) of white bream. Metacercariae of this genus are hard to distinguish, but based on the posterior position of the pharynx and the site preferences (see Gibson *et al.*, 1992), they were identified as the newly described species *R. fennica* Gibson, Taskinen & Valtonen, 1992. The final host of this digenean is pike, *Esox lucius* L., and it is probably identical to the species Halvorsen (1971) found in pike, and identified as *R. illense* (Ziegler, 1883).

In the urinary bladder we found a small, delicate, nearly transparent trematode belonging to the genus *Phyllodistomum*. The body size, proportions and size of the large ventral sucker (twice the size of the anterior sucker) suggest that this worm is *P. macrocotyle*, which was originally described from *Blicca bjoerkna* and other cyprinids. As Lühe's (1909) description is not very precise, and lacks an illustration, many authors question the validity of this species (e. g. Nybelin, 1926; Lewis, 1935). Our specimens, however, best fit the description of *P. macrocotyle*, and we tentatively assign them to this species. (Clearly, a lot of work remains to be done on the systematics of *Phyllodistomum*). Apart from Hartvigsen's (1996) report of *Phyllodistomum* sp. from *Abramis brama* L., this is the first published account of this genus from cyprinids in Norway.

Burbot, *Lota lota*:

Five species of protozoans infected burbot in the present study, three of which deserve further comments. The hexamitid flagellate found in the intestine probably belongs to the genus *Hexamita* or *Spironucleus*. Correct determination of these parasites requires the use of an electron microscope, which was not possible in the present study, due to the low intensity of this organism. Thus, at present nothing further can be said about the specific status of this flagellate. Spores of a myxosporean species, which agreed with the description of *Myxobolus muelleri*, were common in the gill filaments. However, this is a variable species which infects several freshwater fish species and a number of different organs (Lom & Dykova, 1992). Our identification must therefore be regarded as tentative. This species has previously not been reported from Norway. Oocysts of an unidentified *Goussia* species was found in the gall bladder. As far as we know, this is the first report of a coccidian from burbot.

*Gyrodactylus lotae* has not been found in Norway before, but turned out to be the most common platyhelminth infecting burbot. Halvorsen (1971) found six mature helminth species in the alimentary canal of burbot. *Rhipidocotyle illense* and *Neoechinorhynchus rutili* (Müller, 1780), which were found at low prevalence in Halvorsen's (1971) study, were not found by us. However, a few fish in the present study harboured *Bunodera lucioperca* and immature specimens of a *Proteocephalus* species (possibly *P. perca*, which we also found in ruffe), two species not recorded from burbot by Halvorsen (1971).

Of the two nematode species infecting burbot, *Ichthyobronema hamulatum* was the most common and abundant, being present in all the

examined fish. Burbot is the only known final host for this nematode, but other fish species may be accidentally infected or act as paratenic hosts (Moravec, 1994), which probably explains the single occurrence in ruffe in this study. The parasite is common throughout its hosts range, but in Europe it has previously only been reported from the former USSR (see Moravec, 1994) and Finland (Fagerholm, 1982).

Ruffe, *Gymnocephalus cernua*:

The present study is the first survey of the parasite fauna of this host in Norway. Low intensities of *Trypanosoma* sp. were found in the blood. Due to the difficulties involved in identifying *Trypanosoma* species, we have not attempted this. According to Lom & Dykova (1992), *T. acerinae* Brumpt, 1906 is common in ruffe, and may be identical to the present species. However, contrary to earlier beliefs, trypanosomes are not strictly host specific (Lom & Dykova, 1992), thus a species determination based only on host species might be misleading. As far as we know, this is the first published report of a trypanosome from freshwater fish in Norway.

An additional four parasites found by us have not previously been reported from Norway: *Henneguya creplini*, *Gyrodactylus longiradix*, *Dactylogyrus amphibothrium* and *Phyllodistomum folium*. *Dactylogyrus amphibothrium* has, however, previously been found by Mo in the river Drammenselva in 1990 (not published, T. A. Mo, pers. comm.). In the same river, he also found *Gyrodactylus cernua* Malmberg, 1957 on the gills and in the oral cavity of ruffe (T. A. Mo, pers. comm.). The latter species was not present in our material.

The common, and extremely abundant, metacercariae of *Ichthyocotylurus variegatus* has previously been reported from Norway by Bakke (1979) as *Cotylurus variegatus,* now placed in the genus *Ichthyocotylurus* (A. Bell, pers. comm.). The *Phyllodistomum* species from the urinary bladder of ruffe we identified as *P. folium.* Apart from this species, another *Phyllodistomum* species, *P. pseudofolium* Nybelin, 1926, described from ruffe, is accepted by some authors (e.g. Bykhovskaya-Pavlovskaya, 1962). However, we agree with Lewis (1935) and Dawes (1968), who regard this species as identical to *P. folium.*

Thirty-six parasite species were found in the present survey of white bream, burbot and ruffe. Eleven (nearly one third) of the species are reported for the first time from Norway. We do not know whether this reflects the current lack of knowledge about the occurrence of freshwater fish parasites in Norway, or is a result of under-reporting (probably a combination of both). Nevetheless, it clearly points out the need for basic studies of the parasite fauna of Norwegian freshwater fish.

## Acknowledgements

We thank Thrond Haugen and Trygve Poppe for assistance during the field work, and Tor Atle Mo for information about monogeneans from ruffe. We also appreciate the comments on *Paradiplozoon* and *Ichthyocotylurus* given by

David I. Gibson and Andy Bell, respectively.

**References**

A Aagaard K, Dolmen D. (eds.) Limnofauna Norvegica. Katalog over norsk ferskvannsfauna. Trondheim: Tapir Forlag, 1996

Bakke TA. Iktene *Cotylurus platycephalus* og *C. variegatus* funnet i Norge. Fauna 1979; 32: 23-6

Borgstrøm R, Halvorsen O. Studies of the helminth fauna of Norway: XI. *Caryophyllaeides fennica* (Schneider) (Cestoda: Caryophyllidea) in Lake Bogstad. Nytt Mag Zool 1968; 16: 20-3

Bykhovskaya-Pavlovskaya IE, Gusev AV, Dubinina MN, *et al.* Key to parasites of freshwater fish of the U.S.S.R.. Akad Nauk SSSR. Zool Inst, No. 80, Leningrad, 1962. (Translated from Russian by the Israel Progr Scien Transl, Jerusalem, 1964)

Dawes B. The Trematoda with special reference to British and other European forms. Cambridge: University Press, 1968

Fagerholm H-P. Parasites of fish in Finland. VI. Nematodes. Acta Acad Åboensis, Ser B 1982; 40: 5-128

Gibson DI, Taskinen J, Valtonen ET. Studies on bucephalid digeneans parasitising molluscs and fishes in Finland. II. The description of *Rhipidocotyle fennica* n. sp. and its discrimination by principal component analysis. Syst Parasitol 1992; 23: 67-79

Halvorsen O. Studies on the helminth fauna of Norway XVIII: On the composition of the parasite fauna of coarse fish in the River Glomma, south-eastern Norway. Norw J Zool 1972; 19: 181-92

Hartvigsen R. Spatial patterns in the occurrence of freshwater fish parasites. Dr. Scient thesis, University of Oslo, 1996

Khotenovsky IA. Suborder Octomacrinae Khotenovsky. Fauna of the USSR Monogenea. Akad Nauk SSSR. Zool Inst, New Series No. 132, Leningrad, 1985 (In Russian)

Lewis FG. The trematode genus *Phyllodistomum* Braun. Trans Am Microscop Soc 1935; 54: 103-17

Lom J, Dykova I. Protozoan parasites of fishes. Amsterdam: Elsevier, 1992

Lühe M. Parasitische plattwurmer. I. Trematoden. Süsswasserfauna Deutschlands 1909, heft 17, Jena: Fischer Verlag

Malmberg G. Om förekomsten av *Gyrodactylus* på svenska fiskar. Skr söd Sver Fiskför (Årsskr 1956) 1957; 19-76

Malmberg G. The excretory systems and the marginal hooks as a basis for the systematics of *Gyrodactylus* (Trematoda, Monogenea). Ark Zool, Ser 2 1970; 23: 1-235

Margolis L, Esch GW, Holmes JC, Kuris AM, Schad GA. The use of ecological terms in parasitology. J Parasitol 1982; 68: 131-3

Moravec F. Parasitic nematodes of freshwater fishes of Europe. Dordrecht: Kluwer Academic Publishers, 1994

Nybelin O. Zur Helminthenfauna der Süsswasserfische Schwedens. I. Phyllodistomen. Göteborg Kungl Vetenskapsamh Handl 1926; 31: 1-29

Vik R. Parasittiske dyr hos våre ferskvannsfisker. In: Sportsfiskerens leksikon. Oslo: Kunnskapsforlaget, 1984: 173-95

*Bull Scand Soc Parasitol* 1996; 6 (1): 25-32

# SOME PARASITES OF MARINE SALMONIDS FROM TANAFJORDEN, FINNMARK, NORWAY.

Glenn A. Bristow, Tor Alvik, Helge Bohne
Parasite Section, Zoological Institute, University of Bergen, Bergen, Norway

## Abstract

21 salmon (*Salmo salar* L.) and 31 sea trout (*Salmo trutta* L.) were taken from Tanafjord; Norway and examined for total parasite burden by the Dogiel complete technique. Two protozoan and 17 metazoan species were found in salmon. Two protozoan and 10 metazoan species in sea trout. 8 species were common to both. Of the protozoans, *Dermocystidium truttae*, is reported here for the first time in a wild Norwegian marine salmonid. A comparison with similar work from western Norway is presented with particular reference to the salmon lice, *Lepeophtheirus salmonis*, and *Caligus elongatus*. Two parasite species infecting freshwater salmonids which survive the journey of their hosts in the sea are considered as potential biological tags.

## Introduction

Our lack of understanding the biology of, and, role played by, parasites in salmonid biology has led to a number of epizootological problems. One recent example is the spread of the freshwater monogenean *Gyrodactylus salaris* (Dolmen 1987, Heggberget & Johnsen 1982, Johnsen, & Jensen 1988, 1992) to Norwegian, Finnish and Karelian (Bristow *et al.* 1994, Ieshko *et al.* 1995) water bodies and the resultant loss of wild stocks. A second example is the salmon louse, *Lepeophtheirus salmonis*, whose epidemiology and pathogenicity are described in Boxshall & Defaye (1993). Other problems have been demonstrated with the tapeworm, *Eubothrium* sp. (Bristow & Berland 1991a), the ciliate *Ichthyobodo necator* (Bristow 1990), and, the myxosporidians *Myxobolus cerebralis* (Håstein 1971) and *Sphaerospora* spp. (Kent & Hendrick 1985). Besides the clear role of induced mortalities by such parasites lie the more general questions of what role the parasites of salmonids play in the normal regulation of their population densities, reproductive potential, and behavior under normal conditions, and, especially when the host populations are under stress.

Older works, such as Pippy (1969, 1980) do not cover the area geographic area of inquiry. Shulman &Shulman-Albova (1953) examined salmonids in

the White Sea basin, however, in many instances the sample sizes reported preclude modern statistical interpretation, and, while valuable for noting the presence of some parasite species, are inadequate.

Berland & Bristow (1992, 1993a,b,) and Bristow & Berland (1991b, 1994) have demonstrated the presence of at least 4 parasite species previously unknown from marine salmonids in west coast of Norway. It is expected that further species remain to be discovered. Berland (1993), based upon the collection of hosts from weirs, presents the only adequate description of salmon lice infection on wild salmon from the Norwegian coast. Almost nothing is known of the impact of these parasite on the wild hosts, the interactions between parasite species, or the parasite populations fluctuate through time. All of this information is critical to an understanding of the host population dynamics and is one of several important areas of study necessary to understand the forces at work regulating host populations. Only when we begin to adequately understand these processes can we talk about protecting our stocks of native salmonids.

Finally, the Tana River (originating in Finland) and Tana Fjord (Fig. 1) represent the only large wild salmon reservoir in Norway that is currently relatively unaffected by anthropogenic influences such as major industrial or agricultural pollution and aquaculture. Thus it represents one of the last chances to examine a relatively natural wild anadromous salmonid population, and, its natural parasite fauna in Norway.

The main objective of this study is to present a preliminary, epidemiological picture of the parasites of marine salmonids returning to the Tana system prior to entering their spawning rivers. Secondary objectives are: 1) to present a

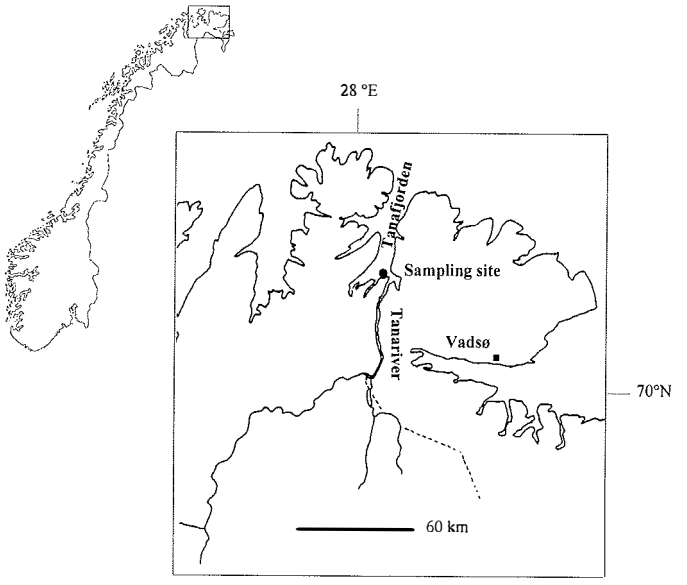


Figure 1. The Tana River and Tanafjorden in northern Norway and Finland.

comparative study of salmonid parasite population dynamics from northern and western Norway; and, 2) to place special emphasis on those parasites associated with losses in aquaculture, and, those reported to affect behaviour and reproductive potential in wild fish.

## Materials and methods

Examination was by the methods are of Berland (1993), Berland & Bristow (1992, 1993a,b) and Bristow & Berland (1994). Salmon were taken from marine weirs, sea trout by rod and reel. The fish were taken individually and examined by the Dogiel complete technique as modified by Bristow (Bristow *et al.* 1994) to include sampling for blood parasites. In order to search the fish for parasites while still fresh, only enough fish to be immediately investigated on return to shore were taken at a given time (generally 4 fish per sampling period).

## Results

During a three week period in June and July 1995, 21 salmon and 31 sea trout from Tana Fjord were examined for parasites. General fish statistics are given in Table 1. Four of the salmon had spent three winters at sea, while the remainder had spent one winter at sea.

Two protozoan, two monogenean, eight digenean, three cestode, two nematode, one acanthocephalan, and, two copepod parasite species were recorded from salmon (Table 2). Two protozan, five trematode, two cestode, two nematode and one copepod parasite species were recorded from sea trout (Table 2). At most, one protozoan, 4 trematode, two cestode and one nematode species were shared by the two salmonids.

The salmon lice *Lepeophtheirus salmonis* and *Caligus elongatus* were found only on salmon. *C. elongatus* was observed only once. Detailed results are presented in Table 3.

Although the number of hosts was too small to subdivide the samples statistically, there is a clear trend in both species toward the larger fish (i.e. those having spent more time at sea) to harbor both a higher number of marine parasite species and higher numbers of individual parasites. Standard parasitic parameters

| Species | n | Average length | Average weight | Con.factor | Sex | |
|---|---|---|---|---|---|---|
| | | cm | g | | Female | Male |
| *Salmo trutta* | 31 | 30,3 (±6,3) | 288,5 (±171,7) | 0,96 (±0,32) | 23 | 8 |
| *Salmo salar* 1 year | 17 | 47,0 (±3,8) | 1194,1 (±224,9) | 1,15 (±0,17) | 9 | 8 |
| *Salmo salar* 3 years | 4 | 96,6 (±4,3) | 10225 (±195,5) | 1,13 (±0,08) | 3 | 1 |

Table 1. General fish statistics for *Salmo salar* and *S. trutta* taken from Tanafjorden during June and July 1995. Con. = condition factor. Figures in parantheses are standard deviations.

| Spices | site | S.salar | S.trutta |
|---|---|---|---|
| PROTOZOA | | | |
| *Dermocystidium trutta* | gills | | * |
| *Chloromyxum sp.* | kidny / urinary bladder | * | |
| *Myxobolus sp.* | spinal cord | * | * |
| MONOGENA | | | |
| *Discocotyle sagittata* | gills | * | |
| *Gyrodactyloides bychowskii* | gills | | |
| TREMATODA | | | |
| *Hemiurus levinseni* | stomach | * | |
| *Hemiurus luehei* | stomach | | * |
| *Brachyphallus crenatus* | stomach | * | |
| *Derogens varicus* | stomach | * | * |
| *Lecithaster gibbosus* | intestine | * | |
| *Crepidostomum farionis* | intestine | * | * |
| *Crepidostomum metoecus* | intestine | * | * |
| *Diplostomum sp.* | eye | * | * |
| CESTODA | | | |
| *Eubothrium sp.* | intestine | * | * |
| *Proteocephalus sp.* | intestine | * | * |
| *Scolex pleuronectis* | intestine | * | |
| NEMATODA | | | |
| *Pseudocapillaria salvelini* | intestine | | * |
| *Hysterothylacium aduncum* | stomach intestine | * | * |
| *Anisakis simplex - larva* | mesenteries | * | |
| ACANTHOCEPHALA | | | |
| *Echinorhynchus gadi* | intestine | * | |
| CRUSTASEA | | | |
| *Lepeophtheirus salmonis* | Integument | * | |
| *Caligus elongatus* | Integument | * | |
| *Salmincola sp.* | gills | | * |

Table 2. Parasite species recorded from *Salmo salar* and *S. trutta* taken from Tanafjorden during June and July 1995.

| | prevalence | intensity | |
|---|---|---|---|
| Group | % | mean | range |
| Total | 90 | 6,9 | 1-29 |
| Female with eggstrings | 81 | 5,1 | 1-27 |
| Female without eggstrings | 19 | 1,3 | 1-2 |
| Male | 19 | 2 | 1-2 |
| juvenile | 43 | 2,3 | 1-7 |
| chaimus | 29 | 1,7 | 1-3 |

Table 3. Prevalence and intensity of infection *Lepeophtheirus salmonis* on *Salmo salar* taken from Tanafjorden from June to July 1995.

for salmon parasites are given in Table 4, those for sea trout in Table 5.

## Discussion

In general the fish host/parasite relationship seems to be well balanced in the marine salmonids of the Tana Fjord system. While it is difficult to asses the effect of the parasites on their hosts in natural systems, no gross pathogenic reactions were recorded. It should be noted, however, that the migration of the salmon itself is a selective process that probably removes any overly weak returnees.

| Species | Prevalence % | intensity Mean | Range |
|---|---|---|---|
| *Chloromyxum sp.* | 5 | - | - |
| *Myxobolus sp.* | 19 | - | - |
| *Discocotyle sagittata* | 5 | 1 | 1 |
| *Gyrodactyloides bychowskii* | 62 | - | - |
| *Hemiurus levinseni* | 29 | 31,5 | 1-76 |
| *Brachyphallus crenatus* | 19 | 21,5 | 2-43 |
| *Derogenes varicus* | 52 | 75 | 1-284 |
| *Lecithaster gibbosus* | 38 | 14,5 | 1-80 |
| *Crepidostomum farionis* | 19 | 6,3 | 2-16 |
| *Crepidostomum metoecus* | 10 | 1,5 | 1-2 |
| *Diplostomum sp.* | 19 | 2,5 | 1-5 |
| *Eubothrium sp.* | 38 | 7,8 | 1-21 |
| *Proteocephalus sp.* | 5 | 1 | 1 |
| *Scolex pleuronectis* | 24 | 19,2 | 3-71 |
| *Hysterothylacium aduncum* | 95 | 40,3 | 2-230 |
| *Anisakis simplex* - larva | 38 | 2,0 | 1-6 |
| *Echinorhynchus gadi* | 14 | 3 | 1-5 |
| *Lepeophtheirus salmonis* | 90 | 6,9 | 1-29 |
| *Caligus elongatus* | 5 | 1 | 1 |

Table 4. Prevalence and intensity of parasites taken from *Salmo salar* from Tanafjorden, June to July 1995.

The infection with the two salmon lice *Lepeophtheirus salmonis* and *Caligus elongatus*, was far below that recorded by Berland (1993) and Bristow & Berland (1994) from wild marine salmon from the coast of western Norway. This may be due to climatic conditions, which, may or may not, be aggravated by the heavy aquaculture in the region of Bergen, where the cited works were performed. No lice were found on the sea trout in Tana Fjorden. This is probably due to the fact that these sea trout had not wandered very far out into the marine areas of the fjord, as evidenced by the relatively high number of freshwater parasite species found in them. Anecdotal evidence indicates that sea trout that wander further out to sea return in August/September may be expected to harbor more marine parasites species, with a significant number of salmon lice among them.

| Species | prevalence % | intensity mean | Range |
|---|---|---|---|
| *Dermocystidium trutta* | 6 | - | - |
| *Myxobolus sp* | 48 | - | - |
| *Hemiurus luehei* | 6 | 12 | 10-14 |
| *Derogens varicus* | 10 | 9,7 | 2-23 |
| *Crepidostomum farionis* | 48 | 12,4 | 1-54 |
| *Crepidostomum metoecus* | 17 | 9 | 1-21 |
| *Diplostomum sp.* | 58 | 16 | 1-83 |
| *Eubothrium sp.* | 6 | 2 | 2 |
| *Proteocephalus sp.* | 6 | 2,5 | 1-4 |
| *Pseudocapillaria salvelini* | 3,2 | 1 | 1 |
| *Hysterothylacium aduncum* | 39 | 3,7 | 1-23 |
| *Salmincola sp.* | 3,2 | 3 | 3 |

Table 5. Prevalence and intensity of parasites taken from *Salmo trutta* from Tanafjorden, June to July 1995.

The presence of the monogenean *Gyrodactyloides bychowskii* is not unexpected as it is normally accepted as a northern species (Albova 1948, Bychowskaya-Palovskaya 1964). This species was recorded in the Bergen area (western Norway) by Bristow & Berland (1994) and has been associated with mortalities in the grow-out phase of salmonid aquaculture (Mo & MacKenzie 1991).

It is clear that some of the freshwater parasites survive long migrations at sea. This is particularly true of the protozoan *Myxobolus sp*, the trematode *Diplostomum* sp. (both parasites found in both hosts species) and the monogenean *Discocotyle sagitatta* (only found in *S. salar* here) in the present case. *Myxobolus* sp. and *Diplostomum* sp. have both been reported from salmon returning to the west coast of Norway (Bristow & Berland 1994), as well as smolt taken at sea (Holst *et al.* 1993). The case of *Myxobolus* is very interesting as this species has been used to identify populations of salmonids in British Columbia to a high degree of accuracy by Quinn *et al.* (1987). The degree of population definition has been so high as to be used as evidence in cases regarding salmon poaching in Canada (Margolis 1993).

Because of the low catch of returning salmon by weir fishermen in 1995 our sample size is insufficient to extend the data statistically. Also, it is inadvisable to base an overall picture of salmonid parasites on one year's data. However, three interesting points may be drawn. First, because of the rather low total sample size, it can be expected that a number of salmonid parasites have yet to be detected. This is particularly true for the 3-winter-at-sea salmon. Secondly, at least 2 potential biological tags, *Myxobolus* sp and *Diplostomum* sp., have been found. Third, the overall condition of the returning fish suggests that the fish host/parasite dynamics are currently in good balance in the Tana Fjord system.

**Acknowledgements**

We would like to thank Fylkesmannen i Finnmark, Miljøvernavdelingen, Damsvn. 1, 9800 Vadsø, Norway, and, Norges forskningsråd, Stensberggt. 26, St. Hanshaugen 0131 Oslo, Norway, (NFR project number 109537/110) for their financial support for this project. We thank, also, Mr. Kjell Moen and Mr. Dag Oppen-Berntsen of those organizations, respectively, for their individual help in organizing and supporting this work.

**References**

Albova RE. A new mongenean fish trematode species of the family *Gyrodactyloides* Bychowsky, 1947. Dokl Akad Nauk SSSR 1948; 60: 615-6

Berland B. Salmon lice on wild salmon (*Salmo salar* L.) in western Norway. In: Boxshall, GA, Defaye D, eds. Pathogens of wild and farmed fish: Sea lice. New York: Ellis Horwood, 1993: 179-87

Berland B, Bristow GA. Rapport fra Prosjekt "Parasittundersøkelser på villaks i Hordaland 1992". Unpubl report to Direktoratet for Naturforvaltning (Norwegian Directorate for Nature Management), Trondheim, Norway. 1993

Berland B, Bristow GA. Some parasites of wild Atlantic salmon (*Salmo salar* L.) returning to the west coast of Norway with comments on their interactions with aquacultured salmon. Proc XVI Symp Scand Soc Parasitol, Oslo, Norway, 1-3 Sept. 1993). Bull Scand Soc Parasitol 1993: 3: 9

Boxshall GA, Defaye D, eds. Pathogens of wild and farmed fish: Sea lice. New York: Ellis Horwood, 1993

Bristow GA. Parasites of Norwegian freshwater salmonids and interactions with farmed salmon - a review. Fish Res 1993; 17: 219-27

Bristow GA. Costiose: En oversikt og resultater av en undersøkelse gjort i Hordaland. Bulletinen (Norsk Foren Akvakulturforsk) 1990; (3): 8-10

Bristow GA, Berland B. The effect of long term, low level *Eubothrium* sp. (Cestoda: Pseudophyllidea) infection on growth in farmed salmon (*Salmo salar* L.). Aquaculture 1991; 98: 325-30

Bristow GA, Berland B. A report on some metazoan parasites of wild marine salmon (*Salmo salar* L.) from the west coast of Norway with comments on their actual or potential interactions with farmed salmon. Aquaculture 1991; 98: 311-8

Bristow GA, Berland B. Parasites of mature *Salmo salar* returning to western Norway. The Eighth Int Congr Parasitol, Izmir, Turkey. Oct 10-14, 1994. Abstr, Vol 1. 1994: 54

Bristow GA, Ieshko E, Shulman B *et al.* Salmon parr parasites from rivers entering the southern White Sea. The Eighth Int Congr Parasitol, Izmir, Turkey. Oct 10-14, 1994. Abstr, Vol 1. 1994: 54

Bykhovskaya-Pavlovskaya IE, Gusev AV, Dubinina MN *et al.* Key to parasites of freshwater fish of the U.S.S.R. Akad

Nauk SSSR. Zool Inst, No. 80, Leningrad 1962. (Translated from Russian by the Israel Progr Scien Transl, Jerusalem, 1964)

Dolmen D. *Gyrodactylus salaris* (Monogenea) in Norway; infestations and management. In: Stenmark A, Malmberg G, eds. Parasites and diseases in natural waters and aquaculture in Nordic countries. Stockholm: Zoo-tax, 1987: 63-9

Håstein T. The occurrence of whirling disease (Myxosomiasis) in Norway. Acta Vet Scand 1971; 12: 297-9

Heggberget GT, Johnsen OB. Infestations by *Gyrodactylus* sp. of Atlantic salmon, *Salmo salar* L., in Norwegian rivers. J Fish Biol 1982; 21: 15-26

Holst JC, Nilsen F, Hodneland K *et al.* Observations of the biology and parasites of postsmolt Atlantic salmon, Salmo salar, from the Norwegian Sea. J Fish Dis 1993; 42: 962-6

Ieshko EP, Berland B, Bristow GA *et al.* Parasites of Atlantic salmon parr in some Karelian rivers flowing into the White Sea. Proc IVth Int Symp Fish Parasitol (Munich 3-7 Oct 1995). 1995; 100

Johnsen PO, Jensen AJ. Infection of Atlantic salmon, *Salmo salar* L., by *Gyrodactylus salaris*, Malmberg 1957, in the River Lakselva, Misvær in northern Norway. J Fish Biol 1992; 40: 433-44

Johnsen BO, Jensen AJ. Introduction and establishment of *Gyrodactylus salaris* Malmberg, 1957, on Atlantic salmon, *Salmo salar* L., fry and parr in the river Vefsna, northern Norway. J Fish Dis 1988; 11: 35-45

Kent ML, Hendrick RP. PKX, the causative agent of Proliferative Kidney Disease (PKD) in Pacific salmonid fishes and its affinities with the Myxozoa. J Protozool 1985; 32: 254-60

Margolis L. A case for forensic parasitology. J Parasitol 1993; 79: 461-2

Mo TA, MacKenzie KA. Occurrence of *Gyrodactyloides bychowskii* Albova, 1948 on gills of sea-caged Atlantic salmon (*Salmo salar* L.). Bull Eur Assoc Fish Pathol 1991; 11: 156-8

Pippy JHC. Preliminary report on parasites as biological tags in Atlantic salmon (*Salmo salar*).- Invest 1966 to 1968. Fish Res Board Can Techn Rep 134, 1969

Pippy JHC. The value of parasites as biological tags in the Atlantic salmon at west Greenland. Rapp P-V Reun Cons Int Explor Mèr 1980; 176: 76-81

Quinn TP, Wood CC, Margolis L. *et al.* Homing in wild sockeye salmon (*Oncorhynchus nerka*) populations as inferred from differences in parasite prevalance and allozyme allele frequencies. Can J Fish Aquat Sci 1987; 44: 1963-71

Shulman SS, Shulman-Albova RE. Parazity ryb Belogo morya (Fish Parasites of the White Sea). Izd AAN SSSR Moskva-Leningrad, 1953

*Bull Scand Soc Parasitol* 1996; 6 (1): 33

# NEWS

## WAAVP WORLD CONFERENCE IN COPENHAGEN IN 1999

The Danish Centre for Experimental Parasitology has been selected by the World Association for the Advancement of Veterinary Parasitology (WAAVP) to organize the World Conference in 1999. The conference will be held at the Royal Veterinary and Agricultural University in Copenhagen.

Organization of the conference will be in the hands of staff-members of the Danish Centre for Experimental Parasitology, which is headed by Professor Peter Nansen.

Support and advice will be given from the Danish Society for Parasitology, the Danish Society for Tropical Medicine, and the Scandinavian Society for Parasitology.

It is an honour to be selected among the five nominated countries, and also a great challenge, being the first time that such a conference will be held in Scandinavia, and in the smallest country hitherto.

# GUIDELINES FOR CONTRIBUTORS

All contributions should be submitted as word-processed manuscripts on floppy disk, accompanied by two exactly matching print-outs of good reading-quality. The preferred storage medium is a 3½ inch disk in MS-DOS or MS-DOS compatible format. The text should be written in Words or WordPerfect or other word processing programs convertible to these. **With a Macintosh computer, save the file in the MS-DOS compatible option.** Please indicate the word processor (and version) used to generate the file, the type of computer, the operating system, and the formatted capacity of the diskette.

The articles/communications should normally not exceed 4 printed pages, including tables, figures, and references, and may contain a maximum of 2000 words if there are no figures or tables. The first page should show the title of the article, and the name(s) of the author(s). The authors' addresses should be given, and the complete correspondence address with telephone and telefax number (if available). The text should follow, without subheadings, but a short summary, maximum 100 words, may be included.

The text should be typed unjustified (unaligned right margins), without hyphenation (except for compound words), and at 1 ½ line spacing. Do not type page numbers. Label the hard copies by hand at the bottom of the page. Please ensure that the digit 1 and the letter 'l' have been used properly, likewise with the digit 0 and the letter 'O'. Do not use decorative formatting, such as boldface and centred headings, or underlining of titles or subheads.

Authors are obliged to follow the rules governing biological nomenclatures, as laid down in e.g. the *International Code of Zoological Nomenclature.* Disease names should follow the principles of *Standardized Nomenclature of Parasitic Diseases* (SNOPAD).

Figure legends must be included on the diskette, but the **figures will be handled conventionally.** They should be marked on the back with the title of the article and name of the (first) author.

Line drawings should be provided as good quality hard copies suitable for reproduction as submitted.

Photographs must be provided as glossy prints, and be of sufficiently high quality to allow reproduction on standard (not glossy) paper. Colour plates will not be printed.

References in the text shold be stated by giving in brackets the name of the author and the year of publication, e.g. (Thornhill, 1987) or (Austin & Austin, 1987). If there are more than two authors, only the first name plus *et al.* is given (Lund-Larsen *et al,* 1977). The reference list should be in alphabetical order, and follow the style set forth in *Uniform Requirements to Manuscripts Submitted to Biomedical Journals,* Br

Med J 1988; 296: 401-5. References to journals should contain names and initials of the authors, article title, the abbreviated name of the journal, year of publication, volume, and first and last page numbers of the paper. Journals should be abbreviated according to the "List of journals indexed in *Index Medicus*". Authors without access to this list may type the full name of the journal, and the Editor will take care of the abbreviations. If there are more than six authors, list only the first three and add *'et al'*. Personal communications and unpublished data should not be used as references, but may be inserted in the text (within parenthesis marks).

Examples of correct forms of references are given below:

*Standard journal article:*

Anonymous. Some facts on small animal practice. Vet Rec 1987; 120: 73

Horsberg TE, Berge GN, Høy T et al. Diklorvos som avlusningsmiddel for fisk: klinisk utprøving og toksisitetstesting. Nor Vet Tidsskr 1987; 99: 611-15

Lund-Larsen TR, Sundby A, Kruse V, Velle W. Relation between growth rate, serum somatomedin and plasma testosterone in young bulls. J Anim Sci 1977; 44: 189-94

*Books and other monographs:*

Austin B, Austin DA. Bacterial fish pathogens: disease in farmed and wild fish. Chichester: Ellis Horwood, 1987

McFerran JB, McNulty MS, eds. Acute virus infections of poultry: a seminar in the CEC programme, Brussels 1985. Dordrecht: Martinus Nijhoff, 1986. (Current topics in veterinary medicine and animal science 37)

Sosialdepartementet. Tsjernobyl-ulykken: Rapport fra Helsedirektoratets rådgivende faggruppe. Oslo: Universitetsforlaget, 1987 (Norges offentlige utredninger NOU 1987: 1)

Thornhill JA. Renal endocrinology. In: Drazner FH, ed. Small animal endocrinology. New York: Churchill Livingstone, 1987: 315-39

The manuscript (diskette and paper copies) should be sent to the editor in your country, see inside of front cover. Label the diskette with the name of the (first) author. Manuscripts are accepted for publication after review and recommendation by the Editorial Board. Authors will be notified by the Editor-in-Chief about final acceptance and expected time of publication.

**REPRINTS WILL NOT BE AVAILABLE.**

**In the interest of speed, no proofs will be sent to authors. It is therefore of vital importance that the manuscripts are carefully checked before submission.**

# NORDISK FÖRENING FÖR PARASITOLOGI

## SCANDINAVIAN SOCIETY FOR PARASITOLOGY

**Please return to the secretary:**
**Sven Nikander**
**Helsinki University**
**Faculty of Veterinary Medicine**
**Tavastvägen 57**
**FIN-0014 Helsinki FINLAND**

### APPLICATION FOR MEMBERSHIP

**Name:** .....

**Academic degree:** .....

**Present position:** .....

**Date/Year of Birth:** .....**Nationality:** .....

**Institution:**.....

.....

.....

.....

**Phone:** .....**Fax:** .....

**E-Mail address:**.....

**Correspondence address (if different):**.....

.....

.....

**Field of research/interest in parasitology:**.....

.....

.....

**Date** .....

**Signature**.....

**The annual membership fee is SEK 150 (Bona fide students 75), which should be paid to:**

**Birgitte Vennervald, treasurer, NFP**
**Dansk Bilharziose Laboratorium**
**Jægersborg Allé 1D**
**DK-2920 Charlottenlund, DENMARK,**
**Postal giro account number: 128-9934**

**Please observe that the membership fee should be prepaid biennially. The fee includes the Bulletin of the Scandinavian Society for Parasitology, two issues per year.**

**BULLETIN OF THE SCANDINAVIAN SOCIETY FOR PARASITOLGY**
**Editor**: Jorun Tharaldsen, Central Veterinary Laboratory, P.O. Box 8156 Dep, N-0033 Oslo, NORWAY.
Telephone: +47 22964617 Fax: +47 22600981 e-mail Jorun.Tharaldsen@vetinst.no

**BULLETIN OF THE SCANDINAVIAN SOCIETY FOR PARASITOLOGY**

**VOL. 6 No. 1** **CONTENTS** **APRIL 1996**