BULLETIN

OF THE SCANDINAVIAN SOCIETY FOR PARASITOLOGY

Vol. 4 No. 1 1994

BULLETIN OF THE SCANDINAVIAN SOCIETY FOR PARASITOLGY

Editor-in-Chief: Jorun Tharaldsen, National Veterinary Institute, P.O. Box 8156 Dep, N-0033 Oslo, NORWAY. Telephone: 22 964617 Fax: 22 468890

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).

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 1994; 4: 1-8

INTERACTION BETWEEN *CAMPYLOBACTER JEJUNI/COLI* AND *SCHISTOSOMA MANSONI*, A HELMINTH PARASITE.

Gun-Britt Lindblom and Lars-Åke Nilsson
Departments of Clinical Bacteriology and Medical Microbiology and Immunology,
University of Göteborg, Guldhedsgatan 10, S-413 46 Göteborg, Sweden.

Abstract

Schistosomiasis is highly endemic in many parts of the world where *Campylobacter jejuni/ coli* is a major cause of diarrhoeal disease. In this study the possible interaction between *Campylobacter jejuni/coli* and *Schistosoma mansoni* adult worms was investigated *in vitro* as well as *in vivo* in experimentally infected mice. *Campylobacter jejuni* and *Campylobacter coli* adhered to a high degree to adult schistosome worms, both in vitro and in vivo. The survival of mice infected with both *Campylobacter* and schistosomes was decreased as compared to mice infected with only one of the pathogens. Seventeen days after intravenous injection of bacteria, they could be isolated from the peritoneal cavity of mice previously infected with schistosomes, but not in mice which had received only bacteria. It is suggested that the teguments and/or the gut of the worms constitute potential niches for colonization and multiplication of *Campylobacter*, from which the bacteria can be seeded into the blood circulation of the host.

Introduction

Reports from endemic areas where infections with *Schistosoma* species and *Salmonella typhi/paratyphi* are occurring, have indicated an interaction between bacteria and parasites. Patients with dual infections have shown atypical symptoms of typhoid fever, characterized by intermittent fever and chills (1, 2, 3). Both stool and urine cultures are often negative with regard to *Salmonella*, while the patients are frequently bacteremic. There is also clinical and experimental evidence that the interaction between schistosomes and *Salmonella* may result in prolongation of the bacterial infection (4, 5) and, furthermore, cure of the salmonellosis is difficult as chemotherapy does not seem to have any effect until the schistosomal infection has been treated (6, 7, 8).

Campylobacter jejuni and *Campylobacter coli* are major bacterial causes of diarrhoeal disease in developing countries (9, 10), and these organisms may also invade the blood (11, 12). A high percentage of patients with *Campylobacter* infections have blood, mucus and epithelial cells in their stools, suggesting an invasive abil-

ity of the bacteria (12, 13, 14). This has been demonstrated both by *in vitro* (15, 16, 17) and *in vivo* studies (18, 19, 20).
We have recently performed an epidemiological study in Mwanza, Tanzania, located on the southern shore of lake Victoria, a region being highly endemic for schistosomiasis. In this study *Campylobacter* was found in up to 20% of patients with acute diarrhoea (Lindblom et al., unpublished). Since *Campylobacter* infections are much more prevalent than infections caused by other bacterial enteropathogens, it was considered of interest to study the possible occurrence of interaction between *Campylobacter* and schistosome worms.

Materials and methods

Bacterial strains

Two *Campylobacter* strains were used, *Campylobacter jejuni* (CCUG 8382) and *Campylobacter coli* (CCUG 27940). These strains were isolated from patients with different clinical pictures, the *C. jejuni* strain from a patient with acute watery diarrhoea, and the *C. coli* strain from the blood of a patient with septicemia. Both strains were enterotoxigenic as measured by the CHO-cell test (21). The strains had been lyophilized before being cultivated on blood free selective agar (BFS-agar) (22) for 24 hours at 42°C in a microaerobic atmosphere as described by Skirrow (23).

In vitro assay

Schistosoma mansoni adult worms, were aseptically removed by perfusion of the hepatic portal system of hamsters infected with cercariae 6 weeks earlier (24), and collected in Iscove's medium supplemented with 10% fetal calf serum. Within 1 hour after perfusion about 100 worms in 10 ml of Iscove's medium were mixed with a suspension of *Campylobacter* to give a final bacterial density of approximately 3×10^7 CFU /ml. Incubation was done in 5% CO2 at 37°C for 2 hours, after which extensive washing was performed 20 times in 5 ml PBS with vortexing for 5 seconds between each wash. Control samples (0,1 ml), taken from the first and the last wash solutions, were cultivated on BFS-agar for demonstration of *Campylobacter*. The worms were mounted on BFS-agar, 10-15 worms per plate, and incubated at 42°C for 48-96 hours in a microaerobic atmosphere. A worm was considered to be associated with *Campylobacter* if there was growth of one or more colonies of bacteria immediately around it. Results were expressed as per cent of the number of worms with associated bacteria in relation to the total number of worms plated.

In vivo assay

Swiss mice, bred for many generations at the animal facilities of the departments, were used. All mice were checked by cultivation of rectal swabs for the occurrence of *Campylobacter* spp and found to be negative. Five groups, each consisting of 15 mice were used (see table II). Five weeks after percutaneous infection of mice with 150 cercariae of *S.mansoni*, 4×10^9 CFU of *Campylobacter jejuni* or *coli* suspended in PBS were injected into the

tail vein. For comparison of survival, groups of mice which had only been infected with *Campylobacter* were included. The survival of mice was checked daily. After observation for 17 days the surviving mice were sacrificed. Growth of *Campylobacter* was recorded for all mice. A sample taken with a cotton swab from the peritoneum, was cultivated directly at autopsy. Worms were aseptically removed by perfusion from the hepatic portal system, washed and mounted on BFS-agar plates as described for the *in vitro* assay. Finally, a sample from caecum was cultured. All cultivations were done as mentioned above. The *Campylobacter* isolates from mice were identified with regard to subspecies by the Hippurate hydrolysis test (25).

Results

In vitro experiments

After incubation of *C. jejuni* and *C. coli* with adult schistosome worms, a high degree of adherence was noted, about 90% of the worms having adherent bacteria (table I). The rather firm binding of the bacteria was suggested by the fact that no bacterial growth was recorded when samples from the last wash solution were cultured.

In vivo experiments

Table II summarizes results obtained after intravenous injection of *Campylobacter* into mice infected with *S. mansoni*. The survival was decreased in mice infected with both schistosomes and *Campylobacter* as compared to mice which

Table I. Adherence of ***Campylobacter jejuni*** *and* ***Campylobacter coli*** *to* ***Schistosoma mansoni*** *adult worms after incubation in vitro. After incubation for 2 h the worms were extensively washed. Samples were collected from wash fluids no 1 and 20, cultured and recorded for growth of bacteria. The relative frequency of worms with adherent bacteria is given.*

Strain	Growth of bacteria (CFU/ml) Wash no 1	no 20	Adherence (%)	No of worms tested
C. jejuni	$>10^6$	0	86	169
C. coli	$>10^6$	0	96	216

*Table II. **Schistosoma mansoni** and/or **Campylobacter jejuni/coli** (C. j., C. c.) infected mice (15 mice/group) challenged iv with 4 x 109 CFU of the bacteria, registered with regard to survival of mice (17 days), growth of **Campylobacter** in peritoneum and caecum and relative frequency of worms with adherent bacteria.*

Group	Survival	Growth of *Campylobacter*			
		Peritoneum	Caecum	Adherence	No of worms tested
	n	n	n	%	
S.m.	15/15	0/15	0/15	0	70
S.m.+C.j.	12/15	1/15	15/15	78	99
C.j.	15/15	0/15	9/15	-	-
S.m.+C.c.	14/15	6/15	13/15	68	108
C.c.	15/15	0/15	13/15	-	-

were infected with only one of the pathogens. Three mice died one day after the bacterial infection and one mouse died after 16 days.

Seventeen days after bacterial challenge, *Campylobacter* could be isolated from the peritoneal cavity in 7% (*C. jejuni*) and 40% (*C. coli*) of the double infected mice but not in mice which had received only bacteria. Bacterial colonization of caecum was also evident in a majority of mice infected with *Campylobacter*. When schistosome worms obtained by perfusion at the same time were cultured on BFS-agar, a high prevalence of *Campylobacter*-positive worms was registered, 78% (*C.jejuni*) and 68% (*C.coli*) respectively (Table II).

Discussion

The results of this study show that *Campylobacter jejuni/coli* adhere strongly to schistosome worms, both in vitro and in vivo. This is in accordance with the findings of e.g. Ottens and Dickerson (8), that various other Gram-negative rods are able to colonize schistosomes. The strength of the *Campylobacter*-schistosome binding is illustrated by the fact that extensive washing of the schistosome worms did not remove the bacteria. Although the nature of this interaction was not studied in detail, the occurrence of bacteria randomly distributed around the whole circumference of the worms, indicated that adherence to the schistosome surface tegument is an important adhesion mechanism. This find-

ing does not exclude, however, that bacteria may also be present in the gut of the worms as has been shown for other intestinal pathogens, such as *Salmonella typhimurium* (26, 27).

Clinical characteristics of *Campylobacter jejuni/coli* enteritis and the occurrence of bacteraemia (11, 12, 28) suggest that tissue invasion is one of the mechanisms by which this species causes disease. Systemic infection is probably more frequent than has been clinically reported since it occurs in an early stage of the disease (13). In previous studies we have shown that all of 200 analyzed strains of *Campylobacter jejuni /coli* adhered to human epithelial cells. Forty per cent of the studied strains were also invasive (17).

The significance of the presently described interaction is unclear. It may, however, be speculated that the coexistence of two parasitic infections might modify the clinical course of either infection. The in vivo experiments performed in this study show that *Campylobacter* was found in the peritoneal cavity of schistosome infected mice, especially those infected with the *Campylobacter coli* strain, an invasive strain isolated from a patient with septicaemia, but not in mice infected with *Campylobacter* only. The probable significance of the described interaction is also emphasized by the finding that the survival at 17 days after intravenous injection of bacteria was somewhat decreased in mice infected with both schistosomes and *Campylobacter* as compared to mice infected with only one of the species. This finding is in accordance with similar studies performed with *Salmonella typhi/ paratyphi* (29, 30).

Patients with concomitant occurrence of schistosomiasis and chronic salmonellosis have been reported to display an atypical course of the disease with intermittent fever and chills, and they are frequently found to be bacteriemic (1). This atypical course has been attributed to the intermittent release into the blood stream of bacteria colonizing the intravascularly located worms. Whether or not the interaction between schistosomes and *Campylobacter* described in the present report are of similar clinical significance remains to be studied. Our findings that *Campylobacter* infections may be shown in up to 20% of children under the age of 5 years in Mwanza, Tanzania, an area heavily endemic for schistosomiasis, suggests that double infection with the two parasite species should not be uncommon and that therefor studies on the significance for the morbidity of intestinal diarrhoea caused by *Campylobacter* species as well as schistosomiasis are indicated.

Acknowledgements

This work was supported by grants from the Swedish Agency for Research Cooperation with Developing Countries (SAREC) and the Swedish Council for Forestry and Agricultural Research.

References

1. Tai TY, Hsu CY, Chang HC, Liu YK. Typhoid and paratyphoid fevers occurring in cases of schistosomiasis. Chin Med J (Engl) 1958; 76: 426-35

2. Hathout S.E.-D, El-Ghaffar YA, Awny AY. Salmonellosis complicating schistosomiasis in Egypt. Amer J Trop Med Hyg 1967; 16: 462-72

3. Young SW, Higashi G, Kamel R, El-Abdin AZ, Mikhail IA. Interaction of Salmonellae and Schistosomes in host-parasite relations. Trans Roy Soc Trop Med Hyg 1973; 67: 797-802

4. Neves J, Lobo-Martins NRL. Long duration of septicaemic salmonellosis: 35 cases with 12 implicated species of *Salmonella*. Trans Roy Soc Trop Med Hyg 1967; 61:541-52

5. Melham RF, LoVerde PT. Mechanism of interaction of *Salmonella* and *Schistosoma* species. Infect Immun 1984; 44: 274-81

6. Neves J, Marinho P, Lobo-Martins NRL, DeAraujo PK, Lucciola J. Prolonged septicaemic salmonellosis: treatment of intercurrent schistosomiasis with nitridazole. Trans Roy Soc Trop Med Hyg 1969; 63: 79-84

7. Rocha, H., Kirk JW, Hearey Jr CD. Prolonged *Salmonella* bacteremia in patients with *Schistosoma mansoni* infection. Arch Int Med 1971; 128: 254-57

8. Ottens H, Dickerson G. Studies on the effects of bacteria on experimental schistosome infections in animals. Trans Roy Soc Trop Med Hyg 1972; 66: 85-107

9. Blaser MJ, Duncan DJ, Warren GH, Wang WL-L. Experimental *Campylobacter jejuni* infection of adult mice. Infect Immun 1983; 39: 908-16

10. Kaijser B. *Campylobacter jejuni/coli.* Acta Path Microbiol Scand 1988; 96: 283-88

11. Guerrant RL, Lahita RG, Winn WC, Roberts RB. Campylobacteriosis in man: Pathogenic mechanisms and review of 91 bloodstream infections. Amer J Med 1978; 65: 584-92

12. Blaser MJ, Berkowitz ID, LaForce FM, Cravens J et al. *Campylobacter* enteritis: clinical and epidemiological features. Ann Int Med 1979; 91: 179-85

13. Butzler JP, Skirrow MB. *Campylobacter* enteritis. Clin Gastroenterol 1979; 18: 737-65

14. Drake AA, Gilchrist MJR, Washington JA, Huizenga KA, Van Scoy RE. Diarrhea due to *Campylobacter fetus* subspecies *jejuni.* A clinical review of 63 cases. Mayo Clin Proc 1986; 56: 414-23

15. Newell D G, Pearson A. The invasion of epithelial cell lines and the intestinal epithelium of infant mice by *Campylobacter jejuni/coli.* J Diarrh Dis Res 1984; 2: 19-26

16. Bukholm G, Kapperud G. Expression of *Campylobacter jejuni* invasiveness in

cell cultures coinfected with other bacteria. Infect Immun 1987; 55: 2816-21

17. Lindblom G-B, Cervantes L-E, Sjögren E, Kaijser B, Ruiz-Palacios GM. Adherence, enterotoxigenicity, invasiveness and serogroups in *Campylobacter jejuni* and *Campylobacter coli* strains from adult humans with acute enterocolitis. Acta Path Microbiol Scand 1990; 98: 179-84
18. Blaser MJ, Taylor DN, Ekeman RE, Butzler JP. Epidemiology of *Campylobacter jejuni* infections. Epidemiol Rev 1983; 5:157-76
19. Caldwell MB, Walker RI, Stewart SD, Rogers J-E. Simple adult rabbit model for *Campylobacter jejuni* enteritis. Infect Immun 1983; 42: 1176-82
20. Fauchère JL, Veron M, Lellouch-Tubiana A, Pfister A. Experimental infection of gnotobiotic mice with *Campylobacter jejuni:* Colonisation of intestine and spread to lymphoid and reticuloendothelial organs. J Med Microbiol 1985; 20: 215-24
21. Lindblom G-B, Kaijser B, Sjögren E. Enterotoxin production and serogroups of *Campylobacter jejuni* and *C. coli* from patients with diarrhea and healthy laying hens. J Clin Microbiol 1989; 27: 1272-76
22. Chan FTH, MacKenzie AMR, Fuite LA. Modified blood-free selective and enrichment media for the isolation of thermophilic Campylobacters. In *Campylobacter* IV, B. Kaijser & E. Falsen, (eds.). Göteborg, Sweden. 1987; p. 83
23. Skirrow MB. *Campylobacter* enteritis: a "new" disease. Brit Med J 1977; 2: 9-11
24. Smithers SR, Terry RJ. The infection of laboratory hosts with cercariae of *Schistosoma mansoni* and the recovery of adult worms. Parasitology 1965; 55: 695-700
25. Harvey SM. Hippurate hydrolysis by *Campylobacter fetus.* J Clin Microbiol 1980; 11: 435-37
26. Lo Verde PT, Amento C, Higashi GI. Parasite-parasite interaction of *Salmonella typhimurium* and *Schistosoma.* J Infect Dis 1980; 141: 177-85
27. Tuazon CU, Nash T, Cheever A, Neva F. Interaction of *Schistosoma japonicum* with *Salmonella* and other Gramnegative bacteria. J Infect Dis 1985; 152: 722-26
28. Blaser MJ, Reller LB. *Campylobacter* enteritis. New Engl J Med 1981; 305: 1444-51
29. Mikhail IA, Higashi GI, Mansour NS, Edman DC, Elwan SH. *Salmonella paratyphi* A in hamsters concurrently infected with *Schistosoma mansoni.* Amer J Trop Med Hyg 1981; 30: 385-93
30. Tuazon CU, Nash T, Cheever A, Neva F, Lininger L. Influence of *Salmonella* bacteremia on the survival of mice infected with *Schistosoma mansoni.* J Inf Dis 1985; 151: 1166-67

NEWS FROM THE SECRETARY

The Scandinavian Society for Parasitology is involved in organizing various symposia. A special symposium on *Parasites of Biological and Economical Significance in the Aquatic Environment* will be held at Heimaey, Westman Islands, Iceland, July 2 - 6, 1994. The deadline for abstracts is April 15, but if you have missed the final announcement, please contact Hans-Peter Fagerholm (Finland), fax: +358 21 654748. The number of participants is limited, but you may be lucky.

In Vilnius, Lithuania, a joint symposium will be held Sept. 7 - 8, 1994. The second announcement with all information for this symposium on *Parasitic Zoonoses and ecology of Parasites* is found in the middle section of this Bulletin.

We have also started to prepare the 17th Symposium of the Scandinavian Society for Parasitology, to be held in June 1995, in Jyväskylä, Finland. The members of the organizing committee are:

E. Tellervo Valtonen (chairman), Univ. of Jyväskylä	Fax: +358 41 602321
Jouni Taskinen, Univ. of Jyväskylä	Fax: +358 41 602321
Hans-Peter Fagerholm, Åbo Akademi	Fax: +358 21 654748
Voitto Haukisalmi, Univ. of Helsinki	Fax: +358 0 1917429
Sven Nikander, Coll. Vet. Med., Helsinki	Fax: +358 0 3931977
Antti Oksanen, National Vet. and Food Res. Inst. Oulu,	Fax: +358 0 3931977
Inger Ljungström, Swedish Inst. for Inf. Dis. Control, Stockholm	Fax: +46 8 735 1162
Mats Wahlgren, Parasit. Lab., MTC, KI, Stockholm	Fax: +46 8 33 15 47

The organizing committee wants to present an interesting and attractive programme for SSP XVII, so please, you are welcome with suggestions for various topics. Some topics may be suitable as a minisymposium or a round table discussion, please, let us know your ideas.

Membership fee:

At the last General Meeting, in Norway, Oct. 1993, it was decided that the membership fee (SEK 100, SEK 50 for students per year) should be paid biennially, to save expenses for both the society and the members. Please use enclosed postal giro cards, if applicable in your country.

Sven Nikander, Secretary of SSP

Bull Scand Soc Parasitol 1994; 4: 9-13

TRICHOSTRONGYLUS TENUIS FROM WILLOW GROUSE *(LAGOPUS LAGOPUS)* AND PTARMIGAN *(LAGOPUS MUTUS)* IN NORTHERN NORWAY

Ørjan Holstad, Geir Karbøl and Arne Skorping*
Department of Ecology/Zoology, IBG, University of Tromsø, N-9037, Tromsø, Norway

* *Author names are in alphabetical order*

Summary

The caecal nematode, *Trichostrongylus tenuis*, is described from willow grouse *(Lagopus lagopus)* and ptarmigan *(Lagopus mutus)* in Northern Norway. This is the first observation of this parasite in Norwegian grouse. The mean intensity was significantly higher in willow grouse as compared to ptarmigan. Grouse from eight different localities were examined, but *T. tenuis* was only found in typical island and coastal areas.

Introduction

The caecal nematode, *Trichostrongylus tenuis*, is regarded as one of the most serious pathogens in red grouse *(Lagopus lagopus scoticus)* (1). This parasite may affect both mortality and breeding success (1,2), and is thought to be a key factor generating the cyclic population densities of grouse in Scotland and Northern England (3). In addition to its direct effect on winter survival and chick mortality, the parasite can also increase mortality due to predation, probably because it interferes with the birds' ability to control scent emission (1).

Although highly prevalent in the British Islands, *T. tenuis* has been thought to be absent in Norwegian grouse populations (4,5,6). Here we report, for the first time, the finding of *T. tenuis* in both willow grouse *(Lagopus lagopus)* and ptarmigan *(Lagopus mutus)* in Troms county, Northern Norway.

Material and methods

A total number of 159 willow grouse *(Lagopus lagopus)* and 132 ptarmigan *(Lagopus mutus)* were shot in the period 10 Sept. - 10 Oct. 1992 from eight different areas in Troms county (Fig. 1). They were frozen to minus 20 ^{0}C within a 48 hour period. In the laboratory the birds were thawed at room temperature. The whole gastrointestinal system was removed, and the caecal contents were filtered through a 200 mm mesh. The filtrate was then washed into a counting chamber, and examined in a stereo microscope. The nematodes were stored in 70 % ethanol, and some were mounted in polyvinyl lactophenol for identification.

Fig.1 Location of examined areas.

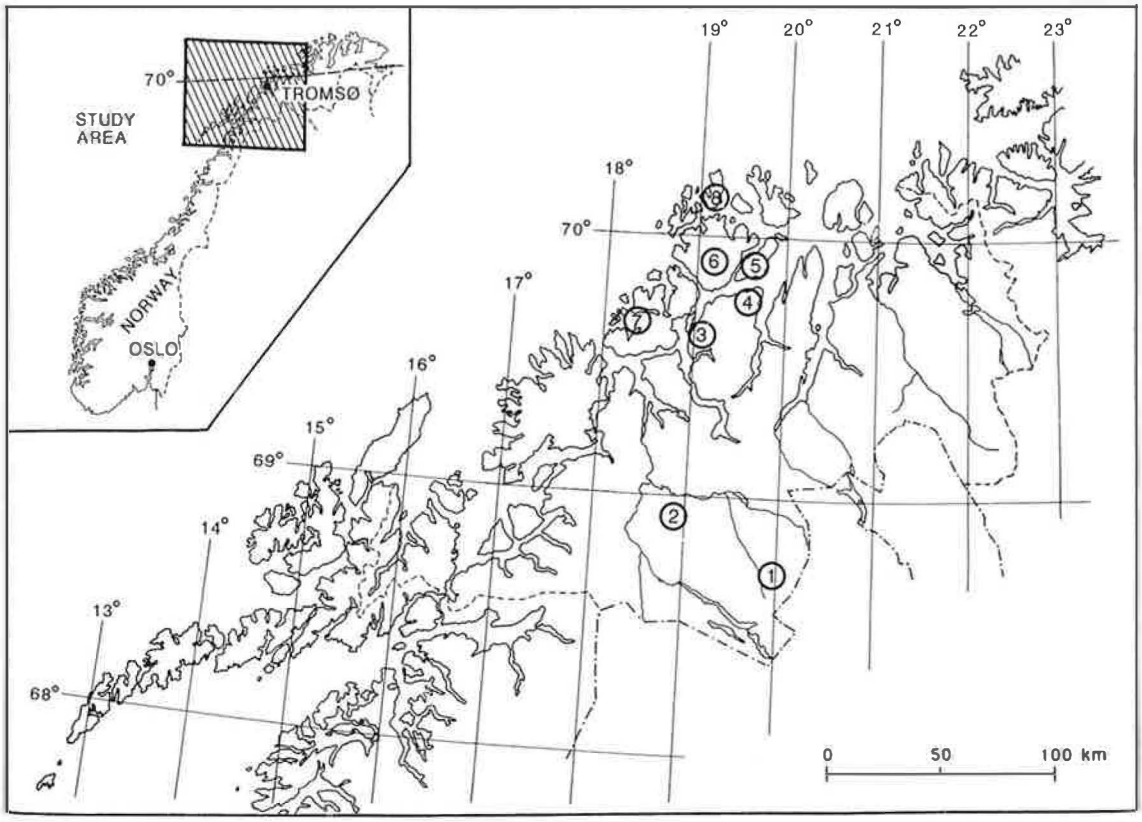


Table 1. Prevalence, mean intensity and the range of infection of Trichostrongylus tenuis in willow grouse, Lagopus lagopus, from eight different areas in Troms county, Norway.

Area	No. examined	Prevalence	Mean intensity	Range
Devdis-Dividalen (1)	24	0		
Kirkesdalen (2)	32	0		
Tromsdalen (3)	0			
Oldervika (4)	23	4.4	7.0	7
Reinøya (5)	21	0		
Ringvassøy (6)	2	50	131.0	131
Kattfjord (7)	35	51.4	68.4	1 - 560
Nordkvaløya (8)	22	100	67.1	4 - 151
Total	159	25.8	60.9	1 - 560

Results.

The number of willow grouse and ptarmigan examined from each area and the prevalence and intensity of *T. tenuis* is shown in Tables 1 and 2. *T. tenuis* was found in both ptarmigan and willow grouse, but both prevalence and mean intensity were markedly higher in the latter. The highest number of nematodes found in a single bird was 560. The difference in intensity between ptarmigan and willow grouse was highly significant (Kruskal-Wallis ANOVA, $\chi^2 = 24.02$, $p < 0.0001$).

All infected birds came from typical island and coastal areas. In the inland areas no infection was found, neither in willow grouse nor in ptarmigan.

Prevalence and intensity tended to be higher in adult birds as compared to yearlings in willow grouse. However, in ptarmigan, the opposite trend was found (Table 3). None of the differences were statistically significant (Kruskal-Wallis ANOVA).

Table 2. Prevalence, mean intensity and the range of infection of Trichostrongylus tenuis in ptarmigan, Lagopus mutus, from eight different areas in Troms county, Norway.

Area	No. examined	Prevalence	Mean intensity	Range
Devdis-Dividalen (1)	30	0		
Kirkesdalen (2)	19	0		
Tromsdalen (3)	3	0		
Oldervika (4)	24	0		7
Reinøya (5)	19	0		
Ringvassøy (6)	10	10	1.0	131
Kattfjord (7)	24	12.5	1.7	1 - 2
Nordkvaløya (8)	3	66.7	38.5	4 - 151
Total	132	4.6	13.8	1 - 65

Discussion

Although *T. tenuis* was found in both willow grouse and ptarmigan, there was a significant difference in the mean intensity between the two species. There was also a marked pattern in the occurrence of *T. tenuis* in grouse populations from different areas. Island and coastal populations had a relatively high prevalence, while the parasite was absent from inland populations.This regional pattern was observed in both host species.

Table 3. Prevalence and mean intensity of infection of Trichostrongylus tenuis in different age groups of willow grouse and in ptarmigan. Only birds from area 7 and 8 are compared (cf. Tab. 1).

Host species	Age group	No. examined	Prevalence	Mean intensity
Willow grouse	Yearlings	26	65.38	58.24
	Adults	28	78.57	75.0
Ptarmigan	Yearlings	14	21.43	26.33
	Adults	13	15.38	1.5

T. tenuis has a direct life cycle with three free-living larval stages. Survival of larvae on the ground is markedly affected by temperature and humidity (1). Humidity appears to be the most important factor. Laboratory experiments has shown that even small reductions in relative humidity can reduce larval life expectancy dramatically (1). A distribution limited to the coastal areas, with a relatively high precipitation, is therefore not unexpected. Since summer precipitation and temperature appears to be the main factors determining the distribution and the infection levels of *T. tenuis*, it is surprising that this species has not been found in more southerly coastal regions of Norway.

Compared to the intensities of *T. tenuis* observed in red grouse (several thousand worms per bird), the willow grouse observed in the present study had relatively low worm burdens. However, all birds in our study were sampled within a short time interval. The number of adult worms are known to fluctuate throughout the year, both due to seasonal recruitment, and seasonal emergence of arrested larvae in the gut wall (1).

In the red grouse, infections appear to build up very rapidly with age, and intensities may reach an asymptote at a very early age (3 -5 months in North Yorkshire), (1). If the same situation prevails in Northern Norway, it is not surprising that we found no marked difference among yearlings and adult willow grouse. In ptarmigan, however, the opposite trend was found, with young birds having higher prevalence and intensity than adults. The low infection level found in ptarmigan may suggest that *T. tenuis* is predominantly a willow grouse parasite, and that ptarmigan only acts as an accidental host. The question of whether the low infection level in adult ptarmigan as compared to young ones is due to age resistance or an age related change in habitat, is an interesting one, but can only be resolved by experimental infections.

Because of its potential as a serious pathogen, a larger study over a longer period and from a wider selection of geographical areas should be conducted.

References

1. Hudson, PJ. Grouse in time and space. The population biology of a managed gamebird. Hampshire, U.K.: Game Conservancy Ltd., 1992

2. Hudson, PJ. The effect of a parasitic nematode on the breeding production of red grouse. J Anim Ecol 1986; 55: 85-92

3. Hudson, PJ, Dobson, AP. Red grouse population cycles and the population dynamics of the caecal nematode, *Trichostrongylus tenuis*. J Anim Ecol 1990; 61: 477-86

4. Lien L. Lirypas endoparasitter. Fauna 1975; 28: 216-21

5. Sonin MD, Barus V. A survey of nematodes and acanthocephalans parasitizing the genus *Lagopus* (Galliformes) in the palaearctic region. Helminthologia 1981; 18: 145-57

6. Steen JB. Ryper. Oslo: Gyldendal, 1989

NORDISK FÖRENING FÖR PARASITOLOGI
SCANDINAVIAN SOCIETY FOR PARASITOLOGY

HAVE YOU CHANGED YOUR ADDRESS LATELY? The mail to several of our members is being returned because they have moved without informing us. If you have a new address, please fill in this slip and return it to the secretary:

Sven Nikander
College of Veterinary Medicine
Box 6
SF-00581 Helsinki FINLAND

Name: .....
Address: .....
.....
.....
.....

Phone: ..... **Fax:** .....
E-Mail address: .....
(if you have)

NEWS Baltic Section

THE BALTIC SOCIETY FOR PARASITOLOGY

At the 12th Baltic Conference on Parasitology, which was held at the end of 1992, the idea to found a Baltic Society for Parasitology was raised. This idea was supported by the majority of the participants. An organizing committee was formed who prepared the statutes and called a first general meeting.

The First General Meeting of the Baltic Society for Parasitology was held on October 12, 1993 in Vilnius. A total of 35 persons from Lithuania, Latvia and Kaliningrad participated. These were scientists from various research institutes, professors from universities, physicians, veterinaries etc.

The statutes of the Society were discussed and adopted. The aim of the society is to develop research and heighten the knowledge of parasitology in the Baltic countries. The Society should become the uniting centre for all parasitologists from the Baltic countries. Any person interested in parasitology, irrespective of nationality, is eligible for membership.

The First General Meeting elected a board of seven members. Dr. V. Kontrimavičius (Lithuania) was elected President and Professor L. Viksna (Latvia) Vice-President. The address of the society is: 3 Gedimino Ave., Vilnius, Lithuania; Tel +370-2-61 40 11.

About 60 persons have expressed their wish to join the Society, i.e. 45 applications from Lithuania, 7 from Latvia, 8 from Kaliningrad and 3 from Belorussia. We hope that the Baltic Society for Parasitology will help develop the field of parasitology and strengthen the contacts between scientists from the Baltic countries.

The first conference on parasitology, organized by the Baltic and Scandinavian societies for parasitology, is going to be The Baltic-Scandinavian Symposium on Parasitic Zoonoses and Ecology of Parasites to be held 7-8 September 1994 in Vilnius, Lithuania.

Dr. T. Arnastauskienė
Secretary
The Baltic Society for Parasitology

THE BALTIC SOCIETY FOR PARASITOLOGY
THE SCANDINAVIAN SOCIETY FOR PARASITOLOGY
THE LITHUANIAN ACADEMY OF SCIENCES
THE LITHUANIAN INSTITUTE OF ECOLOGY
DANISH SOCIETY FOR PARASITOLOGY
THE DANISH CENTRE FOR EXPERIMENTAL PARASITOLOGY
DANISH CENTRE FOR PARASITIC ZOONOSES

BALTIC-SCANDINAVIAN SYMPOSIUM

ON

PARASITIC ZOONOSES AND ECOLOGY OF PARASITES

7-8 September 1994, Vilnius, Lithuania

SECOND ANNOUNCEMENT

Call for papers

DEADLINES:

Registration	1 June 1994
Booking of accommodation	1 June 1994
Payment of registration fee	1 August 1994
Submission of abstracts	1 August 1994

BALTIC-SCANDINAVIAN SYMPOSIUM ON PARASITIC ZOONOSES AND THE ECOLOGY OF PARASITES

Organizing Board:
V. Kontrimavičius, The Baltic Society for Parasitology (Chairman)
L. Viksna, The Baltic Society for Parasitology
V. Paulikas, The Baltic Society for Parasitology
B. Juodka, Lithuanian Academy of Sciences
I. Ljungström, Scandinavian Society for Parasitology
B. Vennervald, Danish Society for Parasitology
E. Petersen, Danish Centre for Parasitic Zoonoses
P. Nansen, Danish Centre for Experimental Parasitology

Organizing Committee in Lithuania:
V. Kontrimavičius (Chairman)
V. Paulikas
G. Valkiūnas
B. Vosylytė
S. Petkevičius

Organizing Committee in Scandinavia (Denmark):
P. Nansen (Chairman)
Chr. Kapel
H. Kürstein

ORGANIZING COMMITTEE ADDRESSES:

For participants from Baltic countries:
Professor V. Kontrimavičius
Lithuanian Academy of Sciences
Gedimino pr. 3 - 2600 Vilnius - Lithuania
Telephone: +370 2 61-40-11 - Telefax: +370 2 61-84-64

For participants from other countries:
Professor Peter Nansen
Centre for Experimental Parasitology
The Royal Veterinary and Agricultural University
Bülowsvej 13 - DK-1870 Frederiksberg C - Denmark
Telephone: +45 35 28 27 75 - Telefax: +45 35 28 27 74

PRELIMINARY PROGRAMME

(The final programme will be defined by the type and number of submitted papers)

Lithuanian Inservice Teachers Training Institute, Vilnius

TUESDAY, 6 SEPTEMBER 1994
Registration: 10.00 a.m. to 6.00 p.m.
Afternoon tour of the University of Vilnius and the old city centre

WEDNESDAY, 7 SEPTEMBER 1994
Opening Session
Welcome
Professor V. Kontrimavičius and Professor B. Juodka, President of the Lithuanian Academy of Sciences

Introduction to The Baltic Society for Parasitology
Professor V. Kontrimavičius

The Baltic-Scandinavian Scope
Professor Peter Nansen

Invited Speakers
Director K.D. Murrell, USA: Foodborne helminth zoonoses

Professor F. van Knapen, The Netherlands: Toxoplasmosis - the animal reservoir

E. Pozio, Italy: Trichinella systematics and speciation and their practical importance in the epidemiology and pathology

Professor A. Alekseev, Russia: Agents of diseases and vectors of zooantropozoonoses as a system with new features

Director J.W. Hansen, FAO, Italy: The role of FAO in controlling parasitic zoonoses and other parasitic infections

Oral Presentations and Posters

THURSDAY, 8 SEPTEMBER 1994
Oral Presentations and Posters

Workshops
Workshops on selected areas of parasitic zoonoses and ecology of parasites will be organized.

Closing Session

Symposium Dinner

FRIDAY, 9 SEPTEMBER 1994
Trip to Kaunas and the Open Air Museum of Lithuania, including lunch

Symposium Language
The language of the symposium will be English. No translation facilities will be available.

Contributed Papers
All participants are invited to submit abstracts. The accepted abstracts will be published in The Bulletin of the Scandinavian Society for Parasitology as soon as possible after the symposium. Participants are encouraged to make their contributions as oral presentations (10 mins. plus 5 of discussion). There will be only limited facilities for poster presentation (70 cm wide x 100 cm high). The Organizing Committee will decide which contributions will be presented. Standard facilities for projecting slides and overhead transparencies will be available. Posters will be displayed throughout the symposium.

Abstracts
No later than 1 August 1994 abstracts (original plus 2 copies) of oral presentations or posters should be mailed to the organizing committee in Copenhagen.

Abstracts must be in English. We advise that the abstract be very carefully prepared as they will be reproduced by camera-ready process exactly as submitted. See enclosed "Instructions for the Preparation of Abstracts for the Baltic-Scandinavian Symposium on Parasitic Zoonoses and Ecology of Parasites".

Registration Fee
No later than 1 August 1994 a registration fee of US$ 75.00 for participants and US$ 50.00 for accompanying persons should be paid. The registration fee includes: Transport from and to airport/railway station, conference kit, final programme, afternoon tour, symposium dinner, coffee breaks, trip to Kaunas and Open Air Museum including lunch.

Pay by bank transfer to: The Baltic Society for Parasitology
Acc.no. 57080252
Vilniaus Bankas
SWIFT: CBVI LT 2X

Social Programme
Open to all registered participants and registered accompanying persons:

Tuesday, 6 September
Tour of the University of Vilnius and the old city centre (3.00 p.m.)

Wednesday, 7 September
Symposium dinner (7.00 p.m.)

Friday, 9 September
Full day tour to Kaunas and the Open Air Museum of Lithuania, including bus and lunch (9.00 a.m. to 7.00 p.m.)

Cancellation of Registration
By letter or telefax only (not by telephone) to the Local Organizing Committee in Copenhagen. For cancellations before 1 August 1994, 100% of the registration fee will be refunded, for cancellation between 1 August and 15 August 1994, 50% of the registration fee will be refunded. No refund can be made for cancellations received after 15 August 1994. All refunds will be processed after the symposium.

Venue
The Symposium will be held at:
Lietuvos Mokytoju Kvalifikacijos Institutas
(Lithuanian Inservice Teachers Training Institute)
Didlaukio 82
2057 Vilnius
Lithuania

Telephone: +370-2-763 831 - Telefax: +370-2-764 435
(open during the Symposium only)

Transport
Tuesday 6 September a shuttle arranged by the Local Organizing Committee will collect participants from the airport and from the railway station and will return participants to the airport and railway station for departure on 9 and 10 September.

Insurance
The Local Organizing Committee does not accept any responsibility for individual medical, travel, or personal insurance. Participants are advised to arrange their own personal insurance.

Climate
In the beginning of September, the average temperature during the day is about 16°C and usually pleasant. You are advised to take along summer suits for the day and some warm clothes for the evening. An umbrella may come in handy.

Electricity Supply
General household electric power is 220 volts/50 cycles A.C.

Accommodation
A number of rooms have been reserved. The rooms are double rooms and the price per room is approximately equivalent to US$ 10.00 per night. Thus approximately US$ 10.00 for single occupancy and US$ 5.00 per person for double occupancy. Please indicate your preference on the accommodation form. Payment for rooms and meals are to be made directly to the Teacher Training Institute. The approximate equivalent of US$ 7.00 should be sufficient for breakfast, lunch, and dinner for one day at the Institute.

Visa Regulations
Citizens of some countries (e.g. Great Britain, Estonia, Iceland, Italy, Denmark, Latvia, Norway) do not need visa. Citizens of other countries: Visas may be obtained on entry at the airport of Vilnius (US$ 20). As visa regulations may change during the period between the printing of this announcement and the Symposium, the Organizing Committee cannot accept any responsibility for information on this matter.

Currency
In general credit cards are not accepted. It is advisable to change currency at the airport on arrival.

INSTRUCTIONS FOR THE PREPARATION OF ABSTRACTS FOR THE BALTIC-SCANDINAVIAN SYMPOSIUM ON PARASITIC ZOONOSES AND ECOLOGY OF PARASITES

Helle Kürstein, Peter Nansen, and Christian Kapel
Danish Centre for Experimental Parasitology, The Royal Veterinary and Agricultural University, Copenhagen, Denmark

If you wish to be considered for an oral or a poster presentation at the Symposium, you must submit an abstract. The abstract must be written in English. Please follow these instructions carefully. Seek linguistic assistance if necessary. The abstract should consist of about 150-200 words. The entire abstract (including both text, tables and figures) should have a maximum width of 135 mm and a maximum height of 205 mm. A strict adherence to these requirements is necessary to ensure that the entire abstract will be reproduced in the Proceedings from the Symposium, which will be printed in the Bulletin of the Scandinavian Society for Parasitology as soon as possible after the Symposium.

We advise that the abstract be very carefully prepared as it will be reproduced by camera-ready process exactly as submitted. Thus, the original print should be of a very good quality. The letter size is 10 points (i.e. 12 characters per inch). If you use and ordinary typewriter, use a fresh ribbon and a clean type face. Use capital letters in the title, which must not exceed three lines in length. Use no more than three lines to present the authors and their affiliation(s). Do not write the full address(es) of the place(s) where the work has been carried out. The full name and mailing address, including telephone and telefax numbers, of the presenting author should be written in an accompanying letter. In this letter also please state whether you wish to present your abstract orally (as is recommended by the Organizing Committee) or as a poster.

Leave at least one line open between the authors' names and the text proper of the abstract. Then type the abstract with single spacing throughout. The abstract should contain a concise statement of the significance of the problem investigated, hypotheses tested, methods used, and the essential results in summary form. Indent the first line of all paragraphs in the text.

Latin genus and species names should be *italicized* or underlined. The full binominal Latin name should be given for all parasites and hosts (except common domestic and laboratory animals) when first mentioned in the text. On later use, species names may be abbreviated. Standard abbreviations may be used without explanation. Other abbreviations must be defined on first use. Abbreviations such as ELISA, DNA and SEM should be in capitals with no full stops.

When references are given, the name of the journals should be abbreviated according to the list of journals indexed in *Index medicus*.

Tables and figures may be typed, drawn in ink, or pasted on the paper. They must be an integral part of the abstract and placed within the boundaries given by the total size of the abstract (135 x 205 mm).

Mail the unfolded original and 2 copies of the abstract with cardboard backing, or other support, to prevent damage no later than 1 August 1994.

Conclusion: Do remember to submit your contribution in an acceptable format, i.e. with a maximum width of 135 mm and a maximum height of 205 mm as shown in this abstract. No extra space is available for figures and tables. Mail to Organizing Committee in Copenhagen before 1 August 1994.

REGISTRATION FORM

Baltic-Scandinavian Symposium on Parasitic Zoonoses and Ecology of Parasites

7-8 September 1994, Vilnius, Lithuania

Please complete and mail to the Organizing Committee (address below) **before 1 June 1994**.

Surname: _____

Name: _____ Title: _____

Institution: _____

Mailing address: _____

City: _____ Country: _____

Telephone: _____ Telefax: _____

Name(s) of accompanying person(s) (not attending lectures): _____

_____

I will participate in the Symposium and would like to present my contribution as an:

Oral presentation ☐ Poster ☐

Title(s): _____

_____

_____

Registration fee

I am aware that registration fee of US$ 75.00 for participants and US$ 50.00 for accompanying persons must be paid to: The Baltic Society for Parasitology
Acc.no. 57080252
Vilniaus Bankas
SWIFT: CBVI LT 2X

no later than 1 August 1994.

Signature: _____ Date: _____

Before 1 June 1994 please mail to:

Professor Peter Nansen
Centre for Experimental Parasitology
The Royal Veterinary and Agricultural University
Bülowsvej 13, 1870 Frederiksberg C, Denmark
Phone: +45-3528 2775 - Fax: +45-3528 2774

ACCOMMODATION FORM

Before 1 June 1994, mail to:
Professor Peter Nansen
Danish Centre of Experimental Parasitology
The Royal Veterinary and Agricultural University
Bülowsvej 13 - 1870 Frederiksberg C, Denmark
Telephone: +45 35 28 27 75 - Telefax: +45 35 28 27 74

Please type or print.

Surname: _____

Name: _____ Title: _____

Institution: _____

Mailing address: _____

_____

City: _____ Country: _____

Telephone: _____ Telefax: _____

I require the following accommodation:

Double room single occupancy ☐ Price per night equivalent to approximately US$ 10.00

Double room double occupancy ☐ Price per person/night equivalent to approx. US$ 5.00

Double room to be shared with: _____

I will arrive: Date: Time: Airport ☐ Railway station ☐

I will leave: Date: Time: Airport ☐ Railway station ☐

Payment for accommodation is to be settled directly with the Teacher Training Institute on location.

Cancellations
Only written cancellations to above address will be accepted. The Organizing Committee may have to request payment for accommodation, if cancellation is received later than 1 September 1994.

Signature: _____ Date: _____

Bull Scand Soc Parasitol 1994; 4: 23-32

GYRODACTYLUS (PLATYHELMINTHES: MONOGENEA) INFESTING ATLANTIC COD, *GADUS MORHUA* L.

Chris Appleby, Dept. of Fish Health, Central Veterinary Laboratory
P. O. Box 8156 Dep., 0033 Oslo, Norway

Abstract

A review of the *Gyrodactylus* species infesting Atlantic cod, *Gadus morhua* L. in Scandinavian and Russian waters is given. Six species are known to infest cod: *G. callariatis, G. pterygialis, G. pharyngicus, G. marinus, G. cryptarum* and *G. emembranatus. G. callariatis* and *G. marinus* have caused disease in caged cod in Norway. The examination technique used for finding *Gyrodactylus* on cod, and the preparation of whole-mounts of *Gyrodactylus* species is also presented.

Introduction

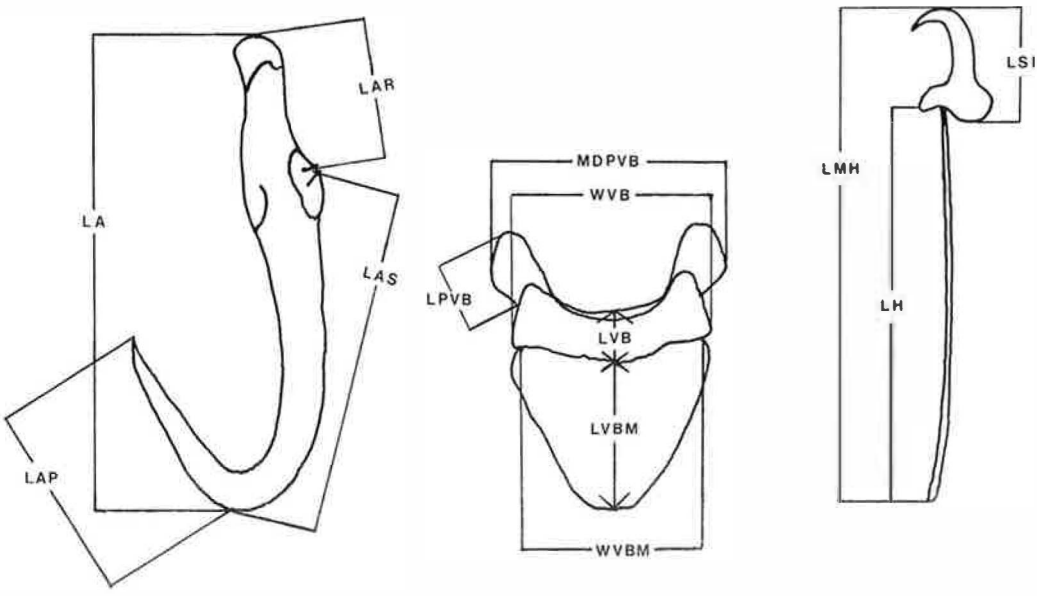
The Atlantic cod, *Gadus morhua* L., is host to a number of protozoan and metazoan parasites. According to Hemmingsen and MacKenzie (1), some 130 parasites have been reported from cod. Their list contains three *Gyrodactylus* species; however, at least six species of this viviparous monogenean genus are reported from cod (2, 3). Most of these species are rather poorly known, but two species are quite common, and may cause disease and mortality in caged cod (4, T. A. Mo, pers. comm.). In spite of our poor knowledge of these species, and their potential economical importance, no proper studies of the *Gyrodactylus* species infesting cod have been carried out.

This article presents a review of the *Gyrodactylus* species of Atlantic cod in Scandinavian and Russian waters. As our knowledge of these species is so poor, it seems appropriate to include some unpublished data from the files at the Central Veterinary Laboratory, Oslo, and a few of the present authors preliminary findings. Included is also a brief outline of the methods used when examining cod and preparing whole-mounts of *Gyrodactylus* specimens.

Examination of cod, and the preparation of whole-mounts of *Gyrodactylus*

Because of minute size and their being easily destroyed, *Gyrodactylus* may be very difficult to find, especially on large host individuals. This is probably the reason for the scarcity of reports of *Gyrodactylus* on cod and other marine fish. Some authors report findings of *Gyrodactylus* spp. on cod, without determining the species. This is probably due to a certain anxiety among biologists and veterinarians when dealing with this taxonomically rather complicated genus.

Fig. 1. Taxonomical characters of the opisthaptor of **Gyrodactylus.** *LA: Total length of anchor; LAR: length of anchor root; LAS: length of anchor shaft; LAP: length of anchor point; LMH: total length of marginal hook; LH: length of marginal hook handle; LSI: length of marginal hook sickle; MDPVB: maximal distance between processes of ventral bar; WVB: width of ventral bar; LVB: length of ventral bar; LVBM: length of ventral bar membrane; WVBM: width of ventral bar membrane; LVPVB: length of processes of ventral bar.*



It is important to use the right technique when examining hosts and preparing *Gyrodactylus* specimens. Cod are often examined for *Gyrodactylus* by casual scrapings of the skin and gills of dead fish. This might reveal parasites if the host is heavily infested. However, as many of the *Gyrodactylus* species infesting cod often infest cryptic sites (e. g. oral cavity, pharynx), a more thorough examination must be carried out. When the purpose simply is to detect and count *Gyrodactylus* specimens, the superior method is to examine whole fish, or parts of fish that have been fixed in formaldehyde (or ethanol) immediately after capture. After rinsing, the host, or host parts, should be examined submerged in water by low magnification under a dissecting microscope. The fixed *Gyrodactylus* specimens will be opaque, and can easily be counted.

When making whole-mounts of *Gyrodactylus* specimens for species determination, the best results are obtained with living parasites [this procedure basically follows Malmberg (2), but will briefly be mentioned here]. Small hosts should be

examined as above immediately after they have been killed. If the host is too large, parts may be cut off, and examined the same way. When examining cod, special attention must be given to all parts of the head, pharynx and gills. Living *Gyrodactylus* specimens should be carefully teased off with pointed watchmakers tweezers and placed in a drop of water on a slide. The excretory system and pharyngeal processes must be studied on living specimens in positive phase contrast under high magnification. The required pressure can be obtained by carefully drawing out water with filtration paper.

For studying the hard parts of the opisthaptor, the parasites must be flattened and fixed. After placing the coverslip, water must be drawn out using filtration paper, and pressure carefully applied to the coverslip with a pair of tweezers.

Table 1. Measurements of the most important taxonomical characters of ***Gyrodactylus*** *spp. on Atlantic cod,* ***Gadus morhua*** *L. All measurements in µm; only ranges are given. Abbreviations as in fig. 1. [Data for* ***G. pterygialis*** *from Hodneland (9); data for* ***G. pharyngicus, G. cryptarum*** *and* ***G. emembranatus*** *from Malmberg (2); other data unpubl.].*

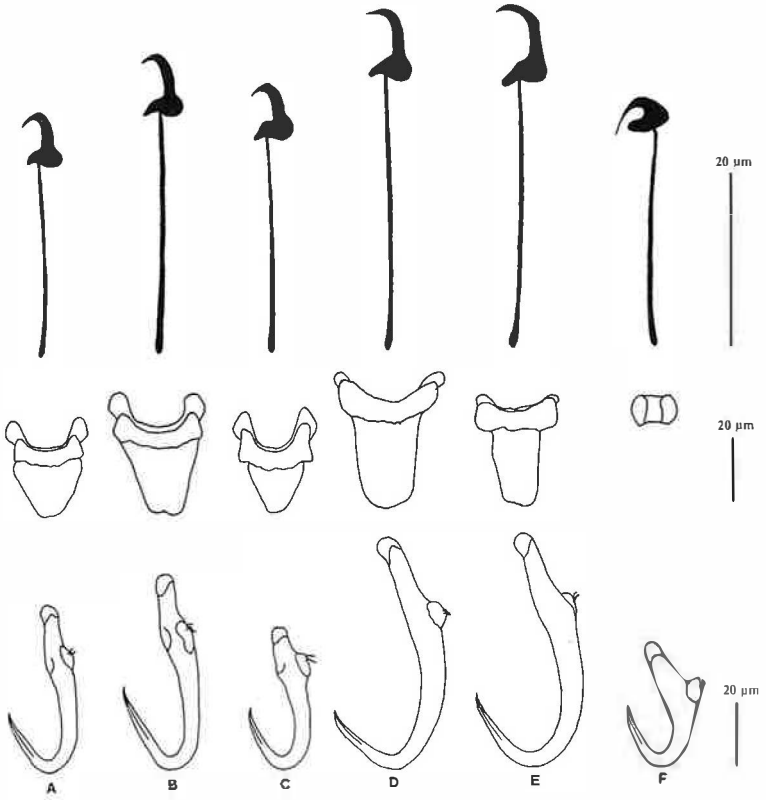
	G. callariatis	*G. pterygialis*	*G. pharyngicus*	*G. marinus*	*G. cryptarum*	*G. emembranatus*
Subgenus	*Mesonephrotus*	*Mesonephrotus*	*Mesonephrotus*	*Metanephrotus*	*Metanephrotus*	*Metanephrotus*
Body length	420 - 700	296 - 535	436 - 700	400 - 620	528 - 760	312 - 496
Pharyngeal processes	short	short	long	long ?	long	short
No. of small penis spines	4 - 7 (1 row)	5 - 6 (1 row)	4 - 8 (1 row)	4 - 5 (1 row)	3 (1 row)	9 - 13 (2-4 rows)
LA	44,5 - 65,0	55,7 - 69,7	44,0 - 49,3	58,0 - 72,0	67,3 - 73,9	37,8 - 40,9
LAR	13,0 - 20,5	16,0 - 22,1	10,6 - 16,7	25,0 - 29,0	23,3 - 27,7	20,2 - 23,8
LAS	34,0 - 48,5	36,0 - 50,4	33,4 - 37,4	44,0 - 53,5	49,7 - 55,9	26,8 - 29,5
LAP	21,0 - 30,5	27,0 - 32,8	20,2 - 22,9	26,0 - 30,5	27,3 - 30,4	20,2 - 22,4
LMH	28,0 - 36,0	31,2 - 41,6	27,7 - 34,3	36,0 - 40,5	39,6 - 42,7	26,4 - 29,9
LH	22,5 - 30,0	24,0 - 33,4	22,0 - 27,7	28,0 - 33,0	30,8 - 33,9	22,0 - 25,5
LSI	6,5 - 7,5	6,7 - 8,3	6,6 - 7,5	8,0 - 9,5	9,2 - 9,7	4,4
MDPVB	26,0 - 34,0	28,2 - 36,0	25,5 - 31,2	31,0 - 35,0	24,2 - 28,6	-
WVB	22,5 - 27,0	23,9 - 38,4	22,9 - 26,8	28,5 - 31,0	23,8 - 26,4	13,2 - 18,5
LVB	5,0 - 8,0	6,1 - 8,0	5,7 - 7,9	6,5 - 10,0	4,8 - 7,9	7,9 - 9,7
LVBM	15,0 - 21,0	19,2 - 26,9	11,4 - 17,2	24,0 - 27,5	21,1 - 26,4	-
WVBM	21,0 - 24,0	-	-	19,0 - 24,0	-	-
LPVB	5,0 - 8,5	6,4 - 9,2	7,9 - 10,6	1,5 - 4,0	0,9 - 3,5	-

To fix the specimen, a small drop of ammoniumpicrate-glycerine is applied to one side of the coverslip. This quickly mixes with the water under the coverslip, and will fix the parasite. Excess water and ammoniumpicrate-glycerine is removed with filtration paper at the other end. The specimens can now be examined under high magnification in positive phase contrast, and drawings and measurements of the penis and hard parts can be made. However, it is often best to leave the whole-mounts a few days before studying them.

The *Gyrodactylus* species infesting Atlantic cod

The most important features used for species determination in *Gyrodactylus* are the hard parts of the posterior holdfast organ (opisthaptor). Fig. 1 shows the most important taxonomical characters of

Fig. 2. The hard parts of the opisthaptor of ***Gyrodactylus*** *spp. from Atlantic cod,* ***Gadus morhua*** *L. (From top to bottom: marginal hooks, ventral bars, anchors)* ***A: G. callariatis, B: G. pterygialis, C: G. pharyngicus, D: G. marinus, E: G. cryptarum, F: G. emembranatus.*** *[Redrawn from Malmberg (2), except* ***G. pterygialis,*** *redrawn from Hodneland (9)].*

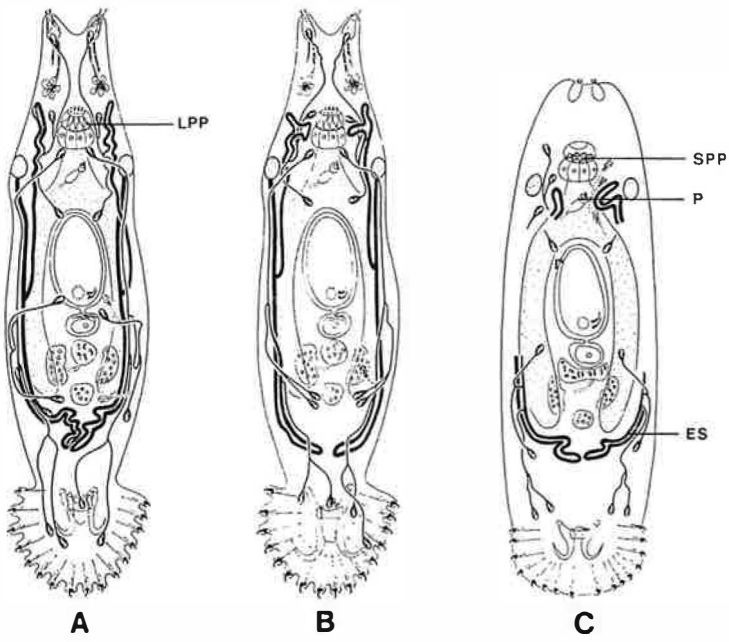


these parts, and how they are measured [Terminology follows Malmberg (2)]. The hard parts of the opisthaptor of the six *Gyrodactylus* species infesting cod are shown in fig. 2. Table 1 gives the measurements of these parts and other selected morphological characters useful for species determination. Ecological terms follow Margolis *et al.* (5).

Gyrodactylus callariatis Malmberg, 1957

This species was first described from Baltic cod from the coast of Stockholm. It is also found on the west coast of Sweden (6), several places in the Oslo Fiord, and as far north as Hordaland county on the west coast of Norway, where it has caused disease on caged cod (unpubl. data). It is a euryhaline species that tolerates salinities from 0.5 % to pure sea water.Sites most commonly infested are the gill arches/rakers, oral cavity and pharynx (the gill filaments are only rarely infested). Fins, body and head are occasionally infested, although heavily infested cod in summer also have large amounts of parasites on these parts. Prevalence on yearlings in one locality in the Oslo Fiord varied from 27 to 84 % throughout the year, being highest in summer (unpubl. data).

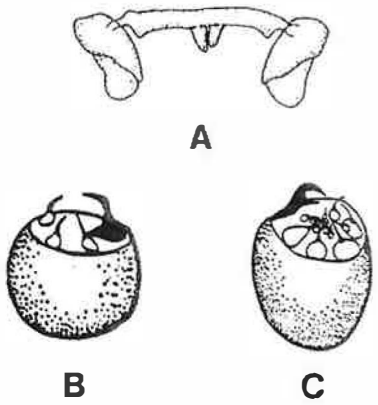
Fig. 3. Three species of ***Gyrodactylus*** *from Atlantic cod,* ***Gadus morhua*** *L.* ***A: G. (Mesonephrotus) pharyngicus, B: G. (Metanephrotus) cryptarum, C: G. (Metanephrotus) emembranatus.*** *LPP: long pharyngeal processes; SPP: short pharyngeal processes; P: penis; ES: Excretory system [From Malmberg (2)].*



G. callariatis has, to my knowledge, only been found on cod.

Malmberg (2) believes *G. callariatis* to be closely related to *G. pterygialis*, and puts the two species in the *callariatis*-group.This species-group is distinguished by having short pharyngeal processes (fig. 3 C), and a dorsal bar (a bar connecting the two anchors on the dorsal side, and is usually seen above the ventral bar in mounts of *Gyrodactylus* specimens) with a characteristic posteriad median process (fig. 4 A).

Fig. 4. A: Dorsal bar of ***G. pterygialis****, showing posteriad median process typical of the* ***callariatis****-group. [From Hodneland (9)]. B: Penis of* ***G. cryptarum****. C: Penis of* ***G. emembranatus****. [From Malmberg (2)].*



This process is lacking in all the other *Gyrodactylus* species infesting cod. *G. callariatis* is, however, quite easy to distinguish from *G. pterygialis*, in that the hard parts of the latter species generally are larger. The anchors of *G. ptery-gialis* are particularly long and slender compared to those of *G. callariatis* (fig. 2 A and 2 B). *G. callariatis* may also be confused with *G. pharyngicus* which occupies a similar site (pharynx). The hard parts of the opisthaptors of the two species are also similar (fig. 2 A and 2 C). The anchor root is the most distinguishing part: it is relatively long and slender in *G. callariatis*, but shorter and somewhat knob-like in *G. pharyngicus*. The latter also has long pharyngeal processes (fig. 3 A), whereas *G. callariatis* has short (most easily seen on live specimens in a microscope with positive phase-contrast).

Gyrodactylus pterygialis Bychowsky & Poljansky, 1953

First described from the Barents Sea on coalfish, *Pollachius virens*, which is the primary host. Fins and body are the sites usually infested. Karasev *et al.* (3) also found it on fins, body and gills of 1-5 year old cod in the Barents Sea; 24 % of the cod were infected, with up to 53 specimens per host. *G. pterygialis* has also been found on coastal cod in the white sea (7), and relict cod from Lake Mogilnoje (8). Prevalence on the relict cod was high (93 %), with up to 200 parasites per host. Malmberg (2) claims to have found this species on members of the Gadidae off the coast of North Norway, but does not specify the host species. Recently, Hodneland (9) found this species on fins and body of *P. virens* on the west coast of Norway, and gives an account of its biology and morphology.

G. pterygialis has also been found on *Eleginus gracilis* from the Barents Sea (7), and *Clupea harengus pallasi* from the White Sea (10). I have also found this species on the gills of whiting, *Merlangius*

merlangus, from the Oslo Fiord. This is obviously a rather widespread species, with an ability to withstand a variety of ecological conditions (e. g. different hosts and salinities) (3).The hard parts of the opisthaptor are somewhat similar to those of *G. callariatis* (see above).

Gyrodactylus pharyngicus Malmberg, 1964

Malmberg (2) found this species in the pharynx of cod from Tromsø, Norway. He also found it sporadically in the pharynx, but also on the gills, of haddock, *Melanogrammus aeglefinus*. The strict site specificity and higher infestation intensities on cod, led Malmberg to the conclusion that cod probably was the primary host, and haddock was accidentally infested. *G. pharyngicus* was also found in the pharynx, but also in the oral cavity and on the gills of 2-4 year old cod in the Barents sea; prevalence was only 3.6 %, with an infestation range of 1 to 68 parasites (3). Vismanis (11, cited in 3) apparently found this species on cod in the Riga Bay in the Baltic. This is the only report of this species outside the Norwegian and the Barents sea, and it is possible that Vismanis confused *G. pharyngicus* with the somewhat similar *G. callariatis*, which is a common species in the Baltic.

Karasev *et al.* (3) characterize *G. pharyngicus* as a euryhaline species that can tolerate the low salinity in some areas of the Barents Sea (and possibly the Baltic), and the higher salinity in other areas of the Barents Sea and the Norwegian Sea.

Malmberg (2) places this species in the subgenus *Mesonephrotus*. This subgenus is diagnosed by having flame cells in the main canals of the excretory system. However, some specimens seem to lack flame cells in the main canals in the posterior part of the excretory system, and in this regard resembling species in the subgenus *Metanephrotus*. Fig. 3 A shows a *G. pharyngicus* specimen with flame cells in the main canals of the anterior and the posterior parts of the excretory system typical of the subgenus *Mesonephrotus*.

Malmberg (2) places *G. pharyngicus* in the *G. arcuatus*-group. The hard parts of the opisthaptor of *G. pharyngicus* resemble the hard parts of the species in this group. The hard parts of *G. pharyngicus* (especially the anchors and ventral bar), however, are somewhat larger and stouter (see 2). Of the *Gyrodactylus* species infesting cod, *G. pharyngicus* can only be confused with *G. callariatis* (see above).

Gyrodactylus marinus Bychowsky & Poljansky, 1953

This species was originally described from specimens parasitizing Atlantic cod, *Gadus morhua morhua* from the Barents Sea. The authors also found it on cod from the Norwegian Sea and on Pacific cod, *G. morhua macrocephalus* and *Theragra chalcogramma* from the Sea of Japan. It is quite common several places on the west coast of Norway and in the Oslo Fiord. *G. marinus* is restricted to the gill filaments in all host species. According to Bychowsky (12, p. 139), this species is most prevalent on older hosts.

Bychowsky and Poljansky (13) found differences in the hard parts of the opisthaptor between parasites from *T. chalcogramma* and the two subspecies of cod. Malmberg (2) speculated that *T. chalcogramma* was infested by a different species, but lacked material to draw any conclusions.

Bychowsky and Poljansky (13) also described the subspecies *G. marinus aeglefinus* from the gill filaments of haddock, *Melanogrammus aeglefinus* from the Barents Sea. Malmberg (2) also found this parasite on haddock from Tromsø, northern Norway. He found that the hard parts of the opisthaptor of *G. marinus* from haddock were markedly different from those of parasites from cod (e. g. anchors and ventral bar smaller; roots of anchors more diverging) and raised *G. marinus aeglefinus* to full species, thus naming it *Gyrodactylus aeglefinus*.

Apart from the very similar *G. aeglefinus*, *G. marinus* could easily be confused with *G. cryptarum* which infests cod (see below). The anchors are similar, but there are slight differences between the marginal hooks and ventral bars of the two species (fig. 2 D and 2 E). The two species also infest different parts of the host.

Lately, *G. marinus* has caused disease and mortality of caged cod along the Norwegian coast (e. g. Tromsø and Sortland, Northern Norway; Bergen, on the west coast). In one occasion, large cod (1-4 k) kept for breeding purposes were infested with more than 50 specimens per gill arch, causing mortality (4). Heavy infestations have also been found on large, wild cod. The fish were emaciated and in a poor condition (unpubl. data).

Gyrodactylus cryptarum Malmberg, 1970

This poorly known species was first collected from 7 specimens of cod from Tromsø. The parasites were found in the preopercular sensory canals and on the skin around them. This is so far the only *Gyrodactylus* species that occupies this peculiar site. However, Karasev *et al.* (3) state that they found a few *G. cryptarum* specimens on the skin of 2-3 year old cod from the Barents Sea, but did not specify on what part of the skin the parasites were found. This might imply that *G. cryptarum* is not so site specific as Malmberg (2) originally thought. However, it is likely that *G. cryptarum* migrates onto the skin before transmission to other host individuals can occur (14).

This species is probably restricted to cold water with high salinity (3).

G. cryptarum is very similar to *G. marinus*, and could easily be confused with it (see above).

Gyrodactylus emembranatus Malmberg, 1970

Malmberg described this species on the basis of 7 specimens found in the pharynx of one cod taken off the coast of Tromsø. Karasev *et al.* (3) also found it on 2-4 year old cod in the Barents Sea. Here also, the prevalence was very low, only 2.4 %, with a maximum of 11 parasites per host. They were found in the pharynx, oral cavity and on the gills.

Because of the very low prevalence and

intensity of infection, Malmberg (2) was not sure if cod was the primary host of *G. emembranatus*. He examined several other likely host species, but did not find the parasite. The finding of this parasite on cod in the Barents Sea may indicate that cod in fact is the primary host. However, this species, or a very closely related one, has been found on the gills of tusk, *Brosme brosme* from Vefsnfjorden in North Norway. The fish had been dead for 24 hours before they were examined, and only 4 specimens were recovered (T. A. Mo, pers. comm.).

G. emembranatus is a remarkable species, and can be confused with no other species of *Gyrodactylus*. As the scientific name implies, it lacks the membrane of the ventral bar, and the processes of the ventral bar are also completely reduced. The characteristic anchors are short and broad, with relatively long roots. The point of the distal part of the marginal hook sickle is extremely curved, almost touching the toe of the sickle (fig. 2 F). *G. emembranatus* also differs from most other *Gyrodactylus* species in having no distinction between body and opisthaptor. The two lobes at the anterior end, typical of most *Gyrodactylus* species, are also greatly reduced (fig. 3 C). The penis has a large number of small spines situated in several rows (fig. 4 C). (A penis typical of the other *Gyrodactylus* species infesting cod is shown in fig. 4 B.).

Karasev *et al.* (3) state that *G. emembranatus* probably has ecological requirements similar to *G. cryptarum*.

Acknowledgements

I thank Roar Gudding, Tore Håstein, Tor Atle Mo and Janneche Utne Skåre for making valuable comments on the manuscript. This work was funded by the "Frisk Fisk" research programme of the Norwegian Fisheries Research Council (NFFR).

References

1. Hemmingsen W, MacKenzie K. A checklist of the protozoan and metazoan parasites reported from the Atlantic cod *Gadus morhua* L. Bull Eur Ass Fish Pathol 1993; 13: 134-37

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

3. Karasev AB, Mitenev VK, Shulman BS. Monogenean genus *Gyrodactylus* parasitizing cod *Gadus morhua* L. in the Barents sea coastal areas. ICES C M 1991; F:8: 1-6

4. Svendsen YS. *Gyrodactylus* på torsk. Norsk Fiskeoppdrett 1991; 16: 26-27

5. Margolis L, Esch GW, Holmes JC *et al.* The use of ecological terms in parasitology. J Parasitol 1982; 68: 131-33

6. Malmberg G. Om förekomsten av *Gyrodactylus* på svenska fiskar. Skr söd Sver Fiskför årsskr 1956: 19-76

7. Timofeeva SV, Marasaeva EF. Parasite fauna of coastal cod and navaga from the White Sea. Modern problems of hydrobiology of the Barents Sea. Apatity USSR A S Kola Branch 1987: 55-65

8. Kulachkova VG, Timofeeva TA. *Gyrodactylus pterygialis* Bych. et Poljan. 1953 from the relict cod of the Mogilnoe Lake. Investigations of Monogenea in the USSR. Proc of All-Union Symposium 1977; L ZIN USSR A S: 47-54

9. Hodneland K. Ectoparasitic helminths from saithe, *Pollachius virens* L., with special emphasis on the reproductive biology of *Diclidophora denticulata* Olsson 1875. Thesis Candidatus scientarium, University of Bergen, 1993

10. Kulachkova VG. Monogenea in the White Sea herring. In: Biology of the White Sea herring. L Nauka 1975; 134-68

11. Vismanis KO. Distribution of *Gyrodactylus* (Monogenea, Gyrodactylidae) in fishes from the Riga Bay. 10 conference of the Ukrainian Society of Parasitologists, proceedings part 1, Kiev Naukova Dumka 1986: 116

12. Bychowsky BE. Monogenetic trematodes, their classification and phylogeny (1957). Transl WJ Hargis, Am Inst Biol Sci, Washington, 1961; 626 pp

13. Bychowsky BE, Poljansky YI. Contribution towards the knowledge of marine monogenetic trematodes of the family Gyrodactylidae Cobb. Trudy Zool Inst Leningr 1953; 13: 91-126

14. Bakke TA, Harris P, Jansen PA, Hansen, LP. Host specificity and dispersal strategy in gyrodactylid monogeneans, with particular reference to *Gyrodactylus salaris* (Platyhelminthes, Monogenea). Dis Aquat Org 1992; 13: 63-74

NORDISK FÖRENING FÖR PARASITOLOGI
SCANDINAVIAN SOCIETY FOR PARASITOLOGY

Please return to the secretary:
Sven Nikander
College of Veterinary Medicine
Box 6
SF-00581 Helsinki FINLAND

APPLICATION FOR MEMBERSHIP

Name: .....

Academic degree: .....

Present position: .....

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 100 (Bona fide students 50), which should be paid to:

Birgitte Vennervald, treasurer, NFP
Dansk Bilharziose Laboratorium
Jægersborg Allé 1D
DK-2920 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.

NORDISK FÖRENING FÖR PARASITOLOGI
SCANDINAVIAN SOCIETY FOR PARASITOLOGY

Protokoll fra generalforsamlingen fredag 1 oktober 1993, kl. 17.30, Vettre Hotel, Asker, Norge. Ca 35 av foreningens medlemmer var til stede.

§ 1

Generalforsamlingen ble åpnet av formannen, Hans-Peter Fagerholm. Innkalling og dagsorden ble godkjent, og Jørn Andreassen ble valgt til ordstyrer.

§ 2

Som referent for møtet ble Jorun Tharaldsen valgt.

§ 3

Til å underskrive protokollen ble Oddvar Helle valgt.

§ 4a

Styrets beretning for virksomhetsperioden ble gjennomgått av formannen og godkjent uten kommentarer.

§ 4b

Kassereren gikk igjennom regnskapet, som var revidert og funnet i orden. Det ble anbefalt at medlemmene betaler kontingenten for flere år ad gangen for å redusere utgiftene ved valutaoverføringene. Kassereren ba dessuten om tillatelse til å sende purrebrev til de som ikke har betalt kontingent i en årrekke, og deretter slette disse fra medlemskartoteket ved fortsatt manglende betaling.

§ 4c

Styret ble innvilget ansvarsfrihet for den avsluttede virksomhetsperioden.

§ 5

Kassereren, Birgitte Vennervald, var ikke på valg. For de øvrige postene hadde styret følgende forslag, som ble vedatt med akklamasjon:

Leder:	Inger Ljungström, Sverige
Nestleder:	Tellervo Valtonen, Finland
Sekretær:	Sven Nikander, Finland
Styremedlem:	Jan Thulin, Sverige

Det ble dessuten anbefalt overfor det nye styret at redaktøren for Bull SSP deltar ved styremøtene.

§ 6

Som suppleanter til styret ble Tor Atle Mo, Norge og Catarina Svensson, Sverige valgt.

§ 7

Til revisorer ble Flemming Frandsen, Danmark og Mathias Eydal, Island valgt. Lars Åke Nilsson, Sverige ble valgt til revisorsuppleant.

§ 8

Hans Peter Fagerholm redegjorde for Bull SSPs status. Det har vært god respons på bladet, men medlemmene ble oppfordret til å komme med mere stoff. I tillegg til å fungere som et medlemsblad der en også kan presentere materiale for rask publisering, er det viktig å bruke tidsskriftet for å informere om alt som skjer av parasittologisk aktivitet innen Norden, herunder omtale av prosjekter og avlagte dr.grader. Det ble anbefalt å holde tidsskriftet på dagens nivå inntil videre, og ikke satse på sterk opptrapping foreløpig.

§ 9

Styret hadde forslag til to nye æresmedlemmer, Bjørn Berland, Norge og Göran Malmberg, Sverige. Begge har vært meget aktive, både innen parasittologisk forskning, og ikke minst innen Nordisk förening för Parasitologi. Forslaget ble enstemmig vedtatt av generalforsamlingen, og æresmedlemmene ble overrakt blomster. Göran Malmberg har vært en flittig fotograf på alle foreningens symposier helt fra starten av, og han lovet å ordne en samling av lysbilder, som skal overrekkes foreningen og presenteres ved det neste symposiet.

§ 10

Medlemsavgiften er fortsatt SEK 100 pr år (SEK 50 for studenter). Om mulig betales for minst 2 år ad gangen.

§ 11

Neste symposium skal holdes i Finland, og Universitetet i Jyväskylä v. Tellervo Valtonen sa seg villig til å stå for arrangementet, hvilket ble akseptert av forsamlingen. Tidspunktet for symposiet ble diskutert, og de siste dagene før midtsommer ble forslått.

Oslo den 12. oktober 1993

Jorun Tharaldsen
referent

Oddvar Helle
protokolluskr.

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 or 5¼ inch disk in MS-DOS or MS-DOS compatible format. The text should be written in WordPerfect or other word processing programs convertible to WordPerfect. **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.

Short articles/communications should 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 shold be numbered consecutively in the order in which they are first mentioned in the text by arabic numerals within parenthesis marks.

The reference list should follow the style set forth in *Uniform Requirements to Manuscripts Submitted to Biomedical Journals,* Br Med J 1988; 296: 401-05. 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:

1. 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
2. Horsberg TE, Berge GN, Høy T et al. Diklorvos som avlusningsmiddel for fisk: klinisk utprøving og toksisitetstesting. Nor Vet Tidsskr 1987; 99: 611-15
3. Anonymous. Some facts on small animal practice. Vet Rec 1987; 120: 73

Books and other monographs:

4. Austin B, Austin DA. Bacterial fish pathogens: disease in farmed and wild fish. Chichester: Ellis Horwood, 1987
5. 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)
6. Sosialdepartementet. Tsjernobyl-ulykken: Rapport fra Helsedirektoratets rådgivende faggruppe. Oslo: Universitetsforlaget, 1987 (Norges offentlige utredninger NOU 1987: 1)
7. 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 National 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.

BULLETIN OF THE SCANDINAVIAN
SOCIETY FOR PARASITOLOGY

VOL. 4 No. 1 CONTENTS APRIL 1993