BULLETIN

OF THE SCANDINAVIAN SOCIETY FOR PARASITOLOGY

Vol. 2 No. 2 1992

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: (02) 96 45 00 ext. 4226/4204, Fax: (02) 46 00 34

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

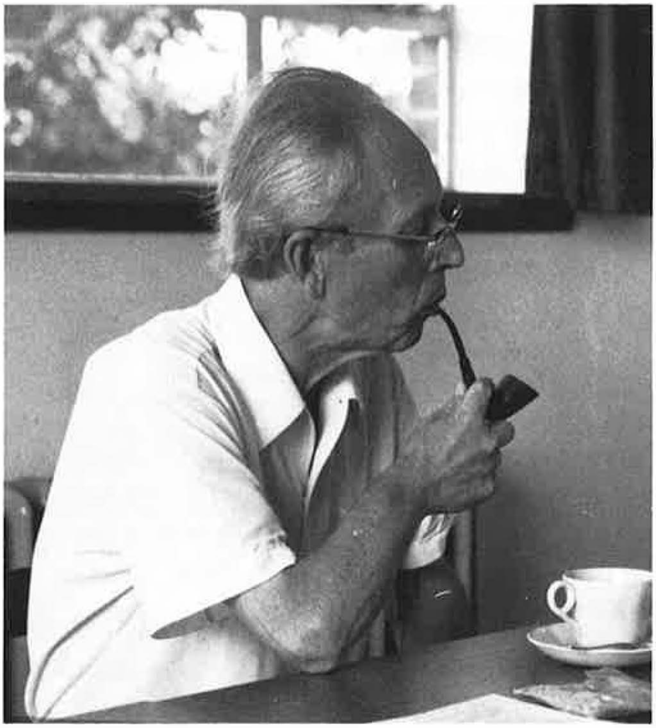
ISSN 0803-4907

BULLETIN OF THE SCANDINAVIAN SOCIETY FOR PARASITOLOGY

VOL. 2 No. 2 **OCTOBER 1992**

Bull Scand Soc Parasitol 1992; 2: 47-57

HOLGER A.E. MADSEN



May 26th. 1909 - December 7th. 1991

Ole Hindsbo
Institute of Population Biology, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark

Holger Madsen was an enthusiastic debater. He sought the truth behind what seemed obvious and he loved to uncover weaknesses in arguments. "Misunderstand me correctly", was a favourite opening comment of his. His characteristic figure made him known by his contemporaries in both Danish and international parasitology.

Holger Emil Madsen was born in Poland, in the town Stettin, as the son of Danish parents originally from Copenhagen. Because of the war the father, naval architect Emil Madsen and the mother, Anna, née Lassen,

returned to Denmark in 1914, where Holger Madsen attended his first school in Elsinore.

In 1920 the family moved to Copenhagen, where, after completing primary school, Holger Madsen went on to Østre Borgerdydskole, graduating in 1927 with a diploma in classics and languages. The same year he started studying biology with the intention of becoming a teacher, but after a couple of years decided to concentrate on zoology, and graduated as MSc in 1935. He was awarded a Masters of Science degree in 1935 specializing in protozoology.

Already in 1931 he had published a paper on ciliates found in the intestine of sea urchins, the body cavity of sea cucumbers and in infusions of rotten grass wrack with purple sulphur bacteria which stank of hydrogen sulphide. He named a new genus and species of trichostome ciliates, *Entodiscus indomitus* and a new species of holostome ciliates, *Cristigera constricta*. In the choice of biotopes and the smell one can clearly detect a trace of his later main area of interest, the endoparasites.

While an undergraduate he took part in the Danish Three Year Expedition to East Greenland (1931-1934) led by Lauge Koch. Here his interests went in two directions: 1) investigations of the arctic beach fauna, where he corroborated that the lack of specific tidal zone fauna in the high arctic littoral areas was not due to the climate, but to differences in food production in the surrounding sea currents. 2) investigations of parasites, particularly in the East Greenland hare.

In contemporary diary notes by Henning Nyholm-Poulsen, a trapper in Greenland, one reads the following characterization (translated): "Student Madsen, zoologist, searched diligently for parasites in the intestines of all sorts of animals and otherwise occupied himself with plankton. Small and crippled, presumably after infantile paralysis. Nice too. Winters on Eskimonæs". Holger Madsens disease, however, was the incurable hereditary disease called "Exostosis cartilaginea multiplex", which is a cartilaginous tumour emerging from the surface of the bones. The most noticeable manifestation the disease was shortened and crooked forearms. In spite of this, he later learned to play the piano and the cross flute.

His interest in coastal fauna continued shortly after his dissertation in work with micro assessment of the productive capacity of the sea bottom. Through this he discovered *Protohydra leuckarti* as a new species for Denmark.

In 1934 after his return from Greenland, and before he had completed his studies, he married Christa Maria Severinsen, a colleague of his sister's.

From 1936 his main occupation was parasitological research projects under the auspices of the newly launched Danish Game Research financed by the Game Foundation. But in the financially difficult time around the Second World War, he taught himself sign language and had supplementary work with schoolteaching deaf and hard-of-hearing. He also wrote about parasites in Sal-

monsen Encyclopedia Magazine (1944-48).

During the war he lived in Kgs. Lyngby, at 43, Haraldslundvej. Here he had contact with the resistance movement - his eldest sons remember a gun and a helmet and, for a time, English pilots. He had three sons, but the marriage did not last, they were divorced in 1947, and he attained custody of the children.

In 1950 he married an acquaintance from Zurich, Elisabeth Maria Naef, who was then working at the International High School in Denmark. They settled far from Copenhagen, in Nødebo, in rural surroundings, and had a daughter in 1951.

The following year he received a Doctor of science degree from the University of Copenhagen and thereafter had the opportunity of two long tours of study:

In 1955-56, he spent two years in the United States; one year in Kansas on a Fulbright--scholarship, and one year with Whitlock at the New York State Veterinary College. Unfortunately, the luggage containing all his scientific notes was stolen on his journey back.

In Kansas, with Merle F, Hansen, Holger Madsen worked with experimental infections with the round worms *Heterakis gallinarum* and *Ascaridia galli* in chickens. The ensuing statistical treatment (1962) of the material bears the imprint of M.F. Hansen's inspiring pioneer work with overdispersed frequency distribution of parasites in host populations. I remember the electric-mechanical calculator Holger Madsen used in the 60's as a true wonder of unending noise, hopping and coughing before it could finally spit out a standard deviation.

The second study tour went to England in 1961-62, where at the Houghton Poultry Research Station, under Horton-Smith, Holger Madsen studied a protozoan disease, Blackhead, whose debatable nematode-borne transport to fowl became one of his later passions.
With his great knowledge of the intestinal worms of fowl he helped a young Ph.D. student, Derek Wakelin, who later in return named a roundworm from Corvidae (ravens) *Capillaria madseni.*

In 1962, simultaneously with his employment at the Game Biological Investigations of the Hunt Fund, he became an external lecturer in parasitology at the University of Copenhagen and started colloquies in parasitology at the Zoological Laboratory.

On an excursion to England and Scotland in 1969 (in Holger Madsen's private car), his first three Ph.D. students in parasitology (Jørn Andreassen, Ole Hindsbo and Ole Rasmussen) benefited from his contacts with the English scientific institutions. On the tour, I took this photo of Holger Madsen.

Holger Madsen was active from the very beginning of the history of the Scandinavian Society for Parasitology. In 1966, at the 1st. Nordic Symposium in Parasitology in Åbo, Finland, in his presentation "about the inter-

action between host and parasite" Holger Madsen critically treated a series of dogmas as he used to call them. The paper has been published in full. Here he shows his ability in using the available literature and his common sense with the view of creating clarity and foresight. He took part in most of the symposia until 1981. From this period we have abstracts from 6 symposia. Strangely enough, the two papers from the symposium in Åbo in 1979 are just a rehash of the two papers from Bergen in 1976 - a fact that might point at an increasing forgetfulness.

The following quotes from the symposia abstracts (translated) reveal attitudes which he found very important:

"Since parasites belong to their hosts, their presence can be no surprise" - "that "pathogenic" organisms can be present without "provoking" and illness equals the fact that one would be astonished at finding anemones in a beech wood." (Symp. VIII and Symp. I (translated) respectively).

"Several --- suggest that host species could be eradicated in a relatively restricted area, but no such cases have ever been demonstrated. One reason why such notions can be formed is that the natures of parasitism and predation (here also parasitoids) are often not kept clearly apart." "It is an invariable part of their life cycle (i.e. the parasitoids, author (O.H.)) that the host is destroyed. This is again the reason why they can have an immediate effect on host populations. They are really a sort of endo-predators." "It lies in the nature of infectious diseases that they cannot possibly have a population-dynamic effect. Even extreme degrees of predation as it takes place with chemical pest control (including parasites') has no such effect. Else it would not be necessary to spray or treat again". (symp. VIII, I (translated) and IX respectively).

Jorun Tharaldsen (pers. comm. 1992) gives the following vivid description of her experience with Holger Madsen during the very early times of the Scandinavian Society for Parasitology (translated): "I remember well when I first met Holger Madsen: I had worked at the parasitological department for only three months when I was asked to give a presentation at the symposium at Voksenåsen, Oslo in 1969. As I felt my parasitological knowledge was minimal, I was scared to death thinking of the intriguing scientific questions that would follow. And rightly so, Holger Madsen raised his hand. I stopped breathing. His question was "Have you really counted all these worms yourself? (and I had). This stopped further questioning.
At the course held in Copenhagen the next summer I brought my three-month-old son (who must be the youngest participant ever). Holger took much care of the baby and inspected both the baby and the room to ensure that everything was in order. That I'll never forget".

The Symposia of the Scandinavian Society for Parasitology were held every year until 1970 when it was decided that the symposia thereafter should be held only every second year. At the same time the increasing activity in Danish parasitology furnished a need for

more interdisciplinary meetings.

In 1972, on the initiative of Holger Madsen's first student, Jørn Andreassen, the Danish Society for Parasitology was started and Holger Madsen became a member of the first board. The collaboration in the society by zoologists, veterinarians and physicians came as a great satisfaction to Holger Madsen and he participated with enthusiasm in the meetings. Holger Madsen became the first honourary member of the Danish Society for Parasitology on March 28, 1985.

Holger Madsen's parasitological work follows three main lines - 1) trichinae, 2) helminths in game fowl and 3) population ecology. These will be discussed in the following sections. In addition he wrote several general articles and had time for a few special research projects.
One example was intracutaneous tests with extracts of *Enterobius vermicularis* on pinworm infected humans. This is a very early work (1946) on one of today's major research areas in parasitology.
His versatility appears in later studies on feather picking in pheasants and on sex determination in day-old pheasant chicks using the feather pattern of the head. Holger Madsen was particularly fond of the publication on the latter work (1969) due to the fine illustrations by his friend, the artist Henning Anton.

In 1933 Holger Madsen became acquainted with the German zoologist Hans Roth, who had fled to Denmark. From 1935, Hans Roth published a series of papers on trichinae which must have inspired Holger Madsen to a study of rats from different parts of the country. "From this material I succeeded in demonstrating in one rat, caught 25. Nov. 1941 in Amager, the presence of trichinae in the masseters. The infection was very light" (Quote H.M. 1943, translated).

Holger Madsen became a prominent agitator against a prevalent theory on the significance of the rat in trichinous infection in swine. "There is innumerable evidence that a rat population is not able to maintain an infection in itself without the introduction of trichinae from outside" - "while the rats are only symptomatic of a trichinous infection of swine offal in the rats environment" (Quote H.M., 1961, translated).

A serious outbreak of trichinosis in Greenland in 1947 made Hans Roth start a large--scale investigation into the occurrence of trichinae in Greenland. More than 10.000 samples from sledge dogs and prey were gathered, but Hans Roth managed to examine only a minor part of the material before his early death in 1951. Holger Madsen completed the work and published it in 1961 together with a reference list in which he surpassed himself with no less than 485 references.

When in 1972 three new species of Trichinella were described, Holger Madsen was careful to point out that they were synonyms and at the most could be called variants of *T. spiralis*.

In later publications he highlighted that the

Trichinella larva is able to survive for a very long time in carrion. This was a neglected part of the epidemiology of trichinellosis and he therefore pointed out that an important stage in the dispersion of *Trichinella* is in fact a free-living one.

Professor Magnus Christiansen put a laboratory at Holger Madsen's disposal at Statens Veterinære Serumlaboratorium for the further investigation into coccidian oocysts from the Greenland hares. Among 4 species found, a new species, *Eimeria sculpta*, was described and the other 3 species were described as particularly large variants.

In his obituary for Magnus Christiansen, Holger Madsen writes in 1965 (translated), "In some of the publications mentioned it can already be seen how conditions regarding game becomes prevalent. This occupation with game was put into practice when Professor Christiansen - under the auspices of the Hunt Fund -started in 1935 to receive game regularly which was found ill or dead".

In 1936, Ragnar Spärck, a professor in zoology at the University of Copenhagen, had started the Investigations of Game Biology, beginning with research into feed and parasites in game. On his invitation, Holger Madsen joined the game research under the direction of Magnus Christiansen who provided him with a rich collection of ducks, mergansers, coots and gallinaceous game birds. Special emphasis was placed on the parasitic roundworms from the intestine of pheasant, partridge and black grouse. "During my investigations on the parasites of the Danish game birds a number of systematic and nomenclatorial problems turned up" (quote, 1950). Especially threadworms (*Capillaria* spp.) from the game birds underwent a thorough taxonomic treatment which was later revised further. In this revision three species of the peculiar "gapeworms" *Syngamus* spp. were combined in one single species *S. trachea.*
Together with the final more ecological treatment of the material the work culminated in the doctoral thesis in 1952.

In an amusing work on the digestion of rabbits Holger Madsen has been able to combine his interests, in ecological farming (rumination), in the use of the scientific method in the elucidation of Biblical themes, and in parasitology.
The mammal specialist F.W. Bræstrup had in the middle of the thirties drawn Holger Madsen's attention to an old description of rabbits having soft, excrement-like lumps in their stomachs in the morning. In the night, rabbits had been observed eating excrements directly from the anus, and this had raised the question if there was truth in the claim in the Bible about rabbits ruminating.

Through a simple test arrangement, where the rabbits were provided with collars, Holger Madsen was able to show that it was not an extra passage through the intestine, but a rhythm in the rabbits themselves which produced the particularly soft excrements. Where the special excrements came from was shown by the presence of the round worm *Passalurus ambiguus,* which normally lives in the caecum of the rabbit.

Rudolf Steiner's anthroposophy was an essential part of Holger Madsen's philosophy of life. He visited the International Centre for Anthroposophy in Dornach in Switzerland for the first time in 1946 in connection with a 3 months' study trip.
He became a member of a group which initiated the founding of Vidar School, the first Rudolf Steiner school in Denmark, in 1950.

In the Anthroposophic Society Holger Madsen was as radical in his views, as he was known to be in scientific circles.

Holger Madsen was pioneering as advocate for Rudolf Steiner's ideas of biological-dynamic farming, long before ecological farming was a generally known concept in Denmark. He called it "applied ecology", when realising that diseases cropped up where the ecological balance of nature had been disturbed. This interest was probably one of the reasons he became a scientific adviser to the publication of the book, "Silent Spring", which in Denmark gave the decisive push to the pollution debate.

The following quotes from Holger Madsen's publications on the subject parasite-host population dynamics, give an idea of his attitude: "People see the damage done, but overlook the fact that the violent population growth of the pests or of the parasites when all is said and done is a symptom of changes done to the biotopes." (1973, translated). "-virulence is a nice laboratory expression saying next to nothing" (1981). "The disease process is in the end something exceptional" (1975). "-the central point is the condition of the biotope" (1981). "One is tempted to ask: where do we find the highest degree of morbidity and mortality from infectious disease? In domestic animals and in man. Why? Because both of them are maltreated" (1981).

The ecological attitude was apparent already in 1938, in a book of illustrations of Danish birds which, as something quite new, were shown in their biotopes. The illustrator was Henning Anton, who was also interested in anthroposophy and became a close friend for the rest of his life.

In the following I have reconstructed the essence of Holger Madsen's mischievous philosophy which I have been particularly fond of: "The scientific method is based on faith. We watch the phenomena of nature and then believe that these always have and always will occur as observed. By this we can, by extrapolation, imagine incidences in the past and the future. Ergo: we observe that the living becomes dead but we have never observed that the dead becomes alive - so what was here first?"

From Derek Wakelin, now Professor at University of Nottingham comes the following commemorative words about Holger Madsen: "I am sure he has left behind a real contribution to our subject, and has influenced in several ways the approaches parasitologists make to understanding host-parasite relationships. We will not have scientists with such a breadth of knowledge and understanding in the future."

Acknowledgements: Grethe Drewsen has made a translation draft in English and Sylvia Holm has helped with the manuscript.

PUBLICATIONS

1931 Bemerkungen über einige entozoische und freilebende marine Infusorien der Gattungen Uronema, Cyclidium, Cristigera, Aspidisca und Entodiscus gen. nov. Zool Anz; 96: 99-112

1936 Investigations on the shore fauna of East Greenland with a survey of the shores of other arctic regions. Medd Grønland; 100: 1-79

1938 The Coccidia of the East Greenland Hares, with a revision of the Coccidia of Hares and Rabbits. Medd Grønland; 116: 1-38

1938 (Madsen H, Kampp AaH) Danske Fugle [Danish Birds]. E. Harcks forlag, København

1939 (Madsen H, Kampp AaH) Arbejdsopgaver. Tillæg til Holger Madsen og Aage H. Kampp Danske Fugle [Exercise book. Supplement to Danish Birds], E. Harcks forlag, København

1939 Does the rabbit chew the cud? Nature; 143: 981

1939 Om nogle nyere engelske undersøgelser over agerhøns [On some recent English investigations on partridges]. Naturens Verden; 20: 107-12

1939 Nogle ejendommelige forhold ved kaninernes fordøjelse [Some peculiar features concerning the digestion of rabbits]. Naturens Verden; 20: 214-20

1939 Cestoidea. - Zoology Faroes 1 (1) no X: 1-10

1939 *Protohydra leuckarti* Greef, neu für Dänemark. Vidensk Medd Dan Naturhist Foren; 103: 551-57

1940 A study of the littoral fauna of Northwest Greenland. Medd Grønland; 124: 1-24

1940 Mellemværten for planteædernes bændelorme fundet. En oversigt [The intermediate host of the tapeworms in herbivores has been found. A review]. Maanedsskr Dyrlæg; 52: 345-50

1941 The Occurrence of helminths and coccidia in partridges and pheasants in Denmark. J Parasitol; 27: 29-34

1941 Helminter og helmintiasis. En kort oversigt over kendt og ukendt [Helminths and helminthiasis. A short review of the known and the unknown]. Bibl. Læger; 5: 113-45

1941 (Hansen AC, Madsen H) Om forekomsten af trikiner hos sølvræve, minks og rotter. Nogle orienterende undersøgelser med negativt udfald [On the occurrence of trichinae in silver fox, minks and rats. Some introductory investigations with a negative result]. Maanedsskr Dyrlæg; 53: 136-38

1943 (Olsen HM, Madsen H) Investigations on pseudo-rumination in rabbits. Vidensk Medd Dan Naturhist Foren; 107: 37-58

1943 Trikinfund hos rotter i Danmark [Occurrence of Trichinae in rats in Denmark]. Maanedsskr Dyrlæg; 55: 61-66

1945 The species of Capillaria (Nematodes, Trichinelloidea) parasitic in the digestive tract of Danish gallinaceous and anatine game birds, with a revised list of species of Capillaria in birds. Dan Rev Game Biol; 1 (1): 1-112

1945 Biological observations upon *Enterobius vermicularis* (pinworm). Acta Pathol Microbiol Scand; 22: 392-97

1946 (Heinild S, Madsen H) Om allergien ved oxyuriasis [On allergy in oxyuriasis]. Ugeskr Læger; 108: 527-30

1948 (Christiansen M, Madsen H) *Eimeria bucephalae* n. sp. (Coccidia) pathogenic in Goldeneye (Bucephala clangula L.) in Denmark. Dan Rev Game Biol; 1 (2): 61-73

1949 A parasitic flea larva. Nature; 164: 187-88

1949 *Heterakis gallinarum* (Schrank, 1788) *Nec Heterakis gallinae* (Gmelin, 1790). J Parasitol; 35: 543

1950 Studies on Species of Heterakis (Nematodes) in Birds. Dan Rev Game Biol; 1 (3): 1-43

1950 On the Systematics of *Syngamus trachea* (Montagu, 1811) Chapin, 1925. J Helminthol; 24: 33-46

1950 Bændelorme [Tapeworms]. In: Bræstrup FW, Thorson G, Wesenberg-Lund E, eds. Vort Lands Dyreliv II. Gyldendal, Copenhagen: 443-67

1950 Rundorme [Nematodes]. Ibid: 450-60

1950 Kradsere [Acanthocephalae]. Ibid: 466-67

1951 Notes on the species of *Capillaria* Zeder, 1800 known from gallinaceous birds. J Parasitol; 37: 257-65

1952 A study on the Nematodes of Danish gallinaceous game-birds. Dan Rev Game Biol; 2: 1-126. (Doctoral Thesis)

1952 Über Parasitose jagdbarer Hühnervögel. Riistatiet. Julk. 8: 154-58

1958 (Whitlock JH, Madsen H) The inheritance of resistance to trichostrongylidosis in sheep. II. Observations on the genetic mechanism in trichostrongylidosis. Cornell Vet; 48: 134-45

1958 (Madsen H, Whitlock JH) The inheritance of resistance to trichostrongylidosis in sheep. III. Preliminary studies using a gastric pouch. Cornell Vet; 48: 145-64

1961 Om trikiner i Grønland [On trichinae in Greenland]. Tidsskr. Grønland; marts: 81-92

1961 The distribution of *Trichinella spiralis* in sledge dogs and wild mammals in Greenland, under a global aspect. Medd Grønland; 159: 1-124

1961 Nyt lys over trikinens økologi (epidemio logi) [New light on the ecology (epidemiology) of trichinae]. Nord Med; 65: 342-47

1962 On trichinae in wild-living carnivores. In: Kozar Z, ed. Trichinellosis. Proceedings of the 1st International Conference on Trichinellosis. Warsaw: Pol Sci Publ, 87-93

1962 On the interaction between *Heterakis gallinarum, Ascaridia galli,* "Blackhead" and the chicken. J Helminthol; 36: 107-42

1962 The so-called tissue phase in nematodes. J Helminthol; 36: 143-48

1963 Bemærkninger til litteraturlisten. Det tavse Forår [Comments to the list of references. The Silent Spring], Gyldendal, Copenhagen

1965 Magnus D. Christiansen 20. oktober 1882 - 21. juli 1965. Vidensk Medd Dan Naturhist Foren; 128: XXXIII-XXXVIII

1966 On the interaction between *Syngamus trachea* and other helminths. Proceedings I'st International Congress of Parasitology, Rome 1964; 1: 22

1966 On feather picking and cannibalism in pheasant and partridge chicks, particularly in relation to the amino acid arginine. Acta Vet Scand; 7: 272-87

1967 Om vekselvirkning mellem vaert og parasit [On the interaction between host and parasite]. Nordiskt symposium i parasitologi Åbo, Finland 1966. Finn Soc Sci Parasitol Inst Information; 7: 25-41

1968 En oversigt over hageormsproblemer [A review of hookworm problems]. II Nordiska symposiet i parasitologi Hillerød, Denmark 1967. Finn Soc Sci Parasitol Inst Information 1968; 9: 9-10

1969 Sexing day-old game pheasant chicks. Dan Rev Game Biol; 5: 3-8

1970 (Andreassen J, Madsen H) On *Diphyllo bothrium latum* in Denmark. Proceedings of the Scandinavian Society for Parasitology Stockholm, Sweden 1968 - Oslo, Norway 1969. Nytt Mag. Zool. 18: 99

1971 Ascaridiasis. Ugeskr Læg; 133: 1313-17

1973 Lidt om parasitologien og dens medicinske betydning. *Nogle økologiske betragtninger* [On parasitology and its medical importance. *Some reflections on ecology]*. Med Forum 26: 133-51

1974 The principles of the epidemiology of trichinelliasis, with a new view on the life cycle. In: Kim CW, ed. Trichinellosis. Proceedings of the Third International Conference on Trichinellosis. New York: Intext Educ Publ, 615-38

1975 On principles in the epidemiology of histomoniasis and histomonosis. Proceedings of the Second European Multicolloquy

of Parasitology Trogir, Yugoslavia: 59-64

1976 The life cycle of *Trichinella spiralis* (Owen, 1835) Railliet, 1896 (Syns.: *T. nativa* Britov et Boev, 1972, *T. nelsoni* Britov et Boev, 1972, *T. pseudospiralis* Garkavi, 1972), with remarks on epidemiology, and a new diagram. Acta Parasitol Pol; 24: 143-58

1976 Considerations on the epidemiology of histomoniasis and histomonosis. Proceedings of the Scandinavian Society for Parasitology Bergen, Norway 1976, Norw J Zool; 24: 460

1976 On the impact of epizootic diseases on wildlife population. Proceedings of the Scandinavian Society for Parasitology Bergen, Norway 1976, Norw J Zool; 24: 467-68

1979 On the life cycle of *Histomonas meleagridis* (Theobald Smith, 1895) E.E. Tyzzer, 1920. Proceedings of the IX Symposium of the Scandinavian Society for Parasitology Åbo, Finland 1979. Åbo Akademi Parasitol Inst Information; 15: 46-49

1979 The effect of infectious and parasitic diseases on the population dynamics of wildlife populations. Proceedings of the IX Symposium of the Scandinavian Society for Parasitology Åbo, Finland 1979. Åbo Akademi Parasitol Inst Information; 15: 50-53

1981 Parasites as Environmental Factors Controlling the Host Populations. In: Slusarski, ed. Review of Advances in Parasitology. Proc 4th Int Congr Parasitol 1978, Warsaw: Pol Sci Publ, 881-98

1981 The Apparently Exceptional *Trichinella spiralis* Situation in Denmark. In: Kim CW, Ruitenberg EJ, Teppema JS, eds. Trichinellosis. Proceedings of the Fifth International Conference on Trichinellosis. England: Reedbooks Ltd, 379-83

1984 (Engbæk K, Madsen H, Olesen Larsen S) A survey of helminths in stray cats from Copenhagen with ecological aspects. Z Parasitenkd; 70: 87-94

Bull Scand Soc Parasitol 1992; 2: 58-67

HELMINTH PARASITES OF AQUATIC ORGANISMS: TAXONOMIC PROBLEMS[1]

David I. Gibson
Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK

Abstract

Taxonomy is currently an unpopular discipline in developed countries. In addition to intractable difficulties in funding and employment opportunities, taxonomists are faced with numerous technical problems.

Despite recent technological advances, the majority of taxonomic work on helminth parasites is still carried out by specialists with a microscope using morphometric data, especially where a variety of material is dealt with. Although the new technology has enabled great advances, and promises more, it often creates as many problems as it solves in terms of the collection and treatment of material and the interpretation of data. Numerous examples of problems which have arisen when dealing with the taxonomy and systematics of helminth parasites of aquatic organisms are discussed. Amongst these are difficulties involving such aspects as terminology, nomenclature, zoogeography, intra-specific variation, fixation artifacts and experimental life-history studies as well as modern techniques, such as multivariate analysis, cladistics, enzyme electrophoresis and molecular biology.

Introduction

Taxonomy is seen as an unpopular discipline in the developed world. Intractable difficulties with regard to funding and employment opportunities mean that few students are being attracted into the field. Furthermore, the enormous size of some of the groups and the length of time it takes to acquire enough experience to work with these groups are also great deterrents. There are, therefore, few modern replacements for the great helminth systematists of the past. Moreover, there are many other reasons which make work in this discipline difficult: these include the facts that (i) the great compilatory volumes produced by Yamaguti and others are out of date and unlikely to be replaced, (ii) the literature which must be consulted often goes back 200 years and is in numerous different languages, (iii) published work is of variable quality, (vi) the species concepts advocated are impractical; (v) definitive answers to a problem are very

[1]Paper presented to the First Meeting on Parasitology in Aquatic Organisms at the 10th Congress of Latin-American Parasitologists, Montevideo, November, 1991.

often not possible, and (vi) the subject is difficult to teach because different groups are treated in different ways and with different techniques and terminology.

It is essential that bright young people are encouraged to enter the field and not be lured away by the greater attraction of molecular and other biochemical disciplines of parasitology. Unless this trend away from taxonomy in the developed countries is halted, we will have a situation where there will be few people capable of working with, or even identifying, a broad spectrum of material.

Parasites account for about half of the animal species, and it has been estimated that one million animals have been described and that the number yet to be described is between 3 and 30 million. In marine helminthology it appears that most species have still to be described. The 1,000 fish species in the region of Heron Island in Great Barrier Reef are, it is estimated (1), infested with 2,000 species of monogeneans, and the total number of fish parasites in the area is in the region of 20,000 species. Furthermore, 300 genera of nematodes and 400 genera of monogeneans have been erected in recent years (2,3). The proliferation of new taxa and the ever changing Linnaean classifications serve to make working in the taxonomic field very difficult.

Another general problem concerns resources. Classical taxonomy has in the past been a relatively cheap discipline: all a helminthologist required was a reasonable microscope. In recent years morphological studies have been improved by new technology. Scanning electron microscopy, image analysis systems, confocal laserscan microscopy and, to a lesser extent, differential interference contrast microscopy require expensive equipment and often expensive technical support.

There are many problems facing workers currently in the field, many with no clear answers. The following comments on some of these problems are illustrated mainly by examples from our studies at The Natural History Museum in London.

Traditional methods

Although resources in the developed countries are being directed into molecular biology and other modern taxonomic methods, it is important that morphology is not forgotten, since a morphological input is normally required in order to interpret or use these modern methods. It is important, therefore, that the traditional and modern approaches develop side by side. There is still much to be learned from morphological studies and especially from functional morphology in terms of phylogenetic relationships.

A major problem of systematics is the species concept. The biological species concept has in the past clearly been impractical in relation to hermaphroditic forms and even dioecious helminths. The advent of techniques, such as enzyme electrophoresis, has allowed access to genetic data which permit us to use this concept in certain situations. It

is a fact, nevertheless, that the only practical concept at the present time for any worker dealing with a quantity and a variety of material is that of the morphological species. So, unless there is significant genetic, biochemical or other biological evidence to the contrary, there must be a consistent morphological difference or combination of differences for the recognition of a species. There are of course dangers. It has been shown, for example, that in some trichostrongylid nematodes morphological changes can be induced by the immune reaction of the host (4), and in the Monogenea the anchor size of some *Gyrodactylus* species varies with temperature (5) Despite the pitfalls, however, morphology is currently the only practical answer for helminthologists dealing with a variety of material.

Decreasing resources, such as the loss of staff at museums which contain major archival collections, is also a problem in many of the countries which are no longer as rich as they used to be. The maintenance and availability of collections is vital to systematics. Type-collections are especially important, as the whole of nomenclature and, therefore, systematics is based upon type-material. Of course, the type-method is not infallible: if the type-material gets mixed in the museum collection, then problems can arise. A possible example of this is *Contracaecum spiculigerum*, a common parasite of cormorants, whose name was changed (6) to *C. rudolphii* because the concept of the species did not agree with the type-material. Disjunctive collecting is another problem which might confuse a taxonomist apparently dealing with allopatric forms. Zoogeographical data are often a better map of the distribution of helminthologists and their trips than that of the helminths themselves. Further problems may arise if experimental work is carried out using material from different regions. Because a taxon is adapted to its local conditions, it may not be able to acclimate to conditions in a new environment. For example, if material of the Holarctic freshwater fish digenean *Bunodera luciopercae* from Canada was transported to Northern Finland, where this species is also common, it would probably not be able to complete its life-history in the new environment because the temperature threshold essential for its development is never reached (7).

Zoogeography itself poses problems for taxonomists. For example, how long does it take allopatric populations of a particular species to speciate? The arctic-boreal hemiurid digenean *Brachyphallus crenatus* occurs in fishes in both the North Pacific and the North Atlantic (8). There has been no 'warm-water' link between these oceans since just after the last ice-age about 7,000 years ago. Is this long enough to permit speciation to occur?

Another worry for helminthologists is the existence and significance of host-induced polymorphism. One notable example concerns work at the Natural History Museum in London on the fellodistomid digeneans *Fellodistomum fellis* from the gall-bladder of the catfish *Anarhichas lupus* and *Steringotrema ovacutum* from the intestine of the long

rough dab *Hippoglossoides plattessoides.* These forms were considered generically distinct on morphological grounds (9), but experimental life-history studies (10) suggested that the same metacercaria from ophiuroids develops differently in the two fishes. If substantial host-induced polymorphism like this does occur and is a common phenomenon, then many current classifications and conceptions are questionable. In this case an isoenzyme study (11) proved conclusively that the two species were distinct and that confusing host-induced morphological variations did not occur.

Accurate data, and currently this usually means accurate morphological information, are essential whatever method of analysis is used. An indication of what can happen if errors occur in descriptions is exemplified by *Contracaecum*-like nematodes from fishes. The genus *Contracaecum* was erected (12) for species previously considered to be *Ascaris* which have opposed gut diverticula, i.e. with both an intestinal caecum and a ventricular appendix. There have been several attempts to split the genus, but the only universally accepted division of *Contracaecum* is that based upon the nature of the excretory system (13,14). Species from piscivorous homoiotherms with a glandular excretory system and an excretory pore at the ventral interlabium were retained in *Contracaecum*, and species from fishes with a filamentous excretory system and an excretory pore at the level of the nerve-ring were transferred to *Thynnascaris*. *Thynnascaris* was originally erected in error (15) as the ventricular appendix was not seen. An older available name *Hysterothylacium*, was also originally erected in error (16) because its intestinal caecum was not seen. The latest revision (17) has confirmed that *Hysterothylacium* should be considered a senior synonym of *Thynnascaris* and the relevant species transferred to this genus. The generic changes which have occurred in this genus have caused, and still do cause, considerable confusion, much of which might have been avoided if the original descriptions had been more accurate.

It is not always a matter of a lack of care that is to blame, since the state of the material and the nature of the fixation and preparatory techniques may be responsible. It is obvious that good information cannot be extracted from poorly fixed material, and it is essential, therefore, for good descriptive work that modern fixatives, such as Berland's fluid, or hot conventional fixatives are used upon live material. It is also important that internal details be elucidated from serial sections and not flattened material, as the latter causes distortion of both morphological and metrical data. Fixation and preparatory treatments can also cause changes in size and distortion. It has been demonstrated (18) that even nematodes can shrink in length up to 30% or expand by as much as 17%, depending upon their treatment.

The standards of descriptive work expected, or even possible in terms of the limitations of the equipment or techniques used, have changed considerably over the years. Many 19th Century descriptions are inadequate by modern standards and leave workers wonder-

ing which species the original author was dealing with. Since the oldest name for a taxon is valid by priority, it is important that the species the original author was dealing with is discovered by studying fresh material from the type-hosts.

The ascaridoid nematodes also serve to illustrate problems which can occur at higher taxonomic levels. Over the past 50 years there have been various classifications. Early work tended to use gut-structure as the main feature; but more recently the excretory system has been used (14,19) and generally accepted as the main diagnostic criterion. However, new revisions (20,21) of the group are re-opening the argument, as they place more reliance upon gut-structure and the position of oesophageal gland-cell nuclei or the morphology of the male tail. It must be said that ever changing hierarchies like this do cause considerable confusion, and, in instances where a whole range of classifications are in current usage, disorder abounds. For many purposes, such as for the arrangement of museum collections, stability is more important than accurate phylogenetic relationships.

New technology

In addition to the traditional approach to taxonomy, there are several recently developed methods, including numerical taxonomy, cladistics, enzyme electrophoresis and molecular biology. All of these are valuable techniques, but all present problems in terms of their interpretation and their marriage with the traditional approach.

Numerical taxonomy is a measure of the similarities between organisms which indicates relationships by simultaneous consideration of multiple characters: this has been little used by helminth taxonomists for producing classifications, but in the form of multivariate analysis it is becoming increasingly used to separate or consolidate species. The latter is especially useful in separating forms, such as diplostomid metacercariae (22), without obvious differentiating metrical or meristic data. While solving some problems, such analyses may create others. In cases where the differences between species are very small, between the sclerites of small monogeneans such as *Gyrodactylus* for example, this type of analysis shows that measurements made using the light microscope are not accurate enough (Des Clers and Shinn, pers. comm.). However, technology can overcome this: new developments at the Natural History Museum using sonication have permitted the removal of the sclerites so that they can be scanned by SEM and very accurately digitised by computer image analysis systems (Shinn, pers. comm.).

Cladistics is a measure of the difference between organisms which ranks organisms according to descent, emphasising the branching points. Taxa are arranged together according to the distribution of acquired characters. This is meant to give a more objective classification, but in fact there is a great deal of subjectivity early in the analysis. To be used correctly, this technique requires both the same degree of skill and

insight as the traditional approach, is just as time-consuming, does not permit inexperienced workers to classify their material, can only be used on small groups because of the limitations of present day computers, and, as yet, in helminth systematics has not produced classifications which are more acceptable than those of the classical approach. As with the latter approach the quality of the output is limited by the quality of the data and the ability of the taxonomist. One of the most familiar uses of cladistics is that concerning the classification of the Digenea (23,24), the results of which are extremely questionable (25). The resulting cladograms are heavily coloured by the inclusion of the Heronimidae as the sister group of the remainder of the Digenea, a position it almost certainly does not hold (25,26). Nevertheless, many of the processes involved in the cladistic technique are very sensible and have been used, perhaps unconsciously, by taxonomists for years. What is of great value is the rigour of its methodology. The technique should be treated as a valuable tool to be used in addition to, and not a replacement for, the traditional methods. The taxonomist can then use his subjective judgement on how much note to take of the results in the same way that he does with data from other sources. Nevertheless, the terminology and definitions of cladistics (27) continue to cause much confusion.

Two other modern approaches involve biochemical methods, namely enzyme electrophoresis and molecular biology. While these are valuable tools which can be used to solve a particular problem, they are as yet impractical for taxonomists working with a quantity and a variety of material in varying condition. They are especially valuable for linking different life-history stages of the same taxon. Enzyme electrophoresis is a powerful technique for distinguishing species and indicating relationships in terms of genetic distance, but it cannot be used with fixed material: specimens must be used fresh or stored at -70 ^{0}C. Molecular biology is a new technique by which species may be separated and relationships indicated using restriction fragment lengths and/or nucleotide sequence data. The former method has been used (28) for distinguishing anisakine nematode larvae, and sequencing has been used to indicate relationships between groups (29,30). Theoretically these techniques are very powerful because the genetic variation is being examined directly at the DNA level rather than trying to read the uncertainties of expression and phenotypic variation. Nevertheless, although the first results look promising, some of the preliminary phylogenetic results appear a little ambiguous in terms of accepted relationships (30). It is likely, as with any taxonomic technique, that there may well be problems not only with data analysis and interpretation (31) but also with variations in results from different parts of the genome. Nevertheless, these techniques will, no doubt, prove very useful, especially since the polymerase chain reaction (PCR) will permit the accumulation of large quantities of DNA from alcohol-fixed material, histological sections or perhaps even archival material. As yet, it is too early to assess their impact. At The Natural History Museum in London Drs Bray and Rollinson are looking

into the relationships and evolution of deep-sea and shallow-water digeneans by examining sequences of their ribosomal DNA.

A major problem of some modern techniques is that one cannot always rationalise the results which contradict those of other approaches. In practical terms how does one deal with species which can be determined genetically but not morphologically? The common cetacean stomach nematode *Anisakis simplex* has been split into two species based upon genetic evidence from enzyme electrophoresis (32), although no morphological evidence could be found to substantiate this action. Since few people have the facilities to use such techniques, or material in a condition which would make its routine use possible, there is currently no answer to this problem and in practice the genetic evidence tends to get ignored. A second example is provided by the cestodes. The Order Amphilinidea traditionally contains about nine species in six to eight genera. In a recent cladistic analysis (33) the number of valid genera was considered to be only three. However, there are two species of the genus Nesolecithus from fishes, one from West Africa and one from Brazil, which are morphologically very similar even though the two continents have been separated for more than 100 million years (34). In the cladistic analysis both species were transferred to the genus Schizochoerus, the type-species of which is morphologically quite distinct. Evidence from cladistics based on morphology, therefore, suggests a lumping of taxa. This contrasts markedly with the way a geneticist would look at the group. It has been speculated (35) that genetic evidence indicates that a genus can evolve over a period of between a minimum of three and a maximum of 30 million years. Palaeontological evidence also indicates that mammalian genera also survive on average for only seven million years. From the geneticist's point of view, therefore, although morphologically the two species of *Nesolecithus* are very similar, genetically they must, after 100 million years, be quite different. They would probably recommend splitting the genus. The experienced taxonomist must, therefore, make a practical compromise between these two approaches.

Final comments

One might rightly question how important is taxonomy in the modern world and whether it really matters if this unfashionable discipline declines still further. The answer is very clear: taxonomy is unique in that it is a link between all of the other disciplines of biology, many of which are now reduced to the cellular or molecular level. It is, therefore, a great unifying influence in a fragmenting science. It permits the presentation of important conceptual contributions which are not easily accessible to other disciplines and is thus an aid to the prediction of certain properties, such as the likely life-cycle of a parasite. Furthermore, and most important, all of the other disciplines are dependent upon taxonomy in terms of the identity of their material in order to give their results meaning (36).

References

1. Rohde K. Ecology of marine parasites. St. Lucia: University of Queensland Press, 1982

2. Spencer Jones M, Gibson DI. A list of old and recently erected nematode genus-group names not included in the 'CIH Keys' to nematode parasites of vertebrates and invertebrates. Systematic Parasitology 1987; 9: 125-36

3. Spencer Jones M, Gibson DI. A list of old and recently erected monogenean genus-group names not included in Yamaguti's *Systema helminthum*. Systematic Parasitology 1990; 16: 213-26

4. Lancaster MB, Hong C, Michel JF. Polymorphism in the Trichostrongylidae. In: Stone AR, Platt HM, Khalil LF. eds. Concepts in nematode systematics. London & New York: Academic Press: 1983: 293-302

5. Mo TA Variations of opisthaptoral hard parts of *Gyrodactylus salaris* Malmberg, 1957 (Monogenea: Gyrodactylidae) on parr of Atlantic salmon *Salmo salar* L. in laboratory experiments. Systematic Parasitology 1991; 19: 231-40

6. Hartwich G. Revision der Vogelparasitischen Nematoden Mitteleuropas. II. Die Gattung *Contracaecum* Railliet & Henry, 1912 (Ascaridoidea). Mitteilungen aus dem Zoologischen Museum in Berlin 1964; 40: 15-53

7. Rahkonen R, Valtonen ET, Gibson DI. Trematodes of northern Finland. II. The occurrence of *Bunodera luciopercae* (Müller, 1776) in three different water bodies in northern Finland. Bothnian Bay Reports 1984; 3: 55-66

8. Gibson DI, Bray RA. The Hemiuridae (Digenea) of fishes from the northeast Atlantic. Bulletin of the British Museum (Natural History), Zoology series, 1986; 51: 1-125

9. Bray RA, Gibson DI. The Fellodistomidae (Digenea) of fishes from the northeast Atlantic. Bulletin of the British Museum (Natural History), Zoology series 1980; 37: (4) 199-293

10. Køie M. On the morphology and life-history of *Steringotrema pagelli* (van Beneden, 1871) Odhner, 1911 and *Fellodistomum fellis* (Olsson, 1868) Nicoll, 1909) syn. *S. ovacutum* (Lebour, 1908) Yamaguti, 1953) (Trematoda: Fellodistomidae). Ophelia 1980; 19: 215-36

11. Bray RA, Rollinson D. Enzyme electrophoresis as an aid to distinguishing species of *Fellodistomum*, *Steringotrema* and *Steringophorus* (Digenea: Fellodistomidae). International Journal for Parasitology 1985; 15: 255-63

12. Railliet A, Henry A. Quelques nématodes parasites des reptiles. Bulletin de la Société de Pathologie Exotique 1912; 5: 251-59

13. Hartwich G. Zur Systematic der Nematoden-Superfamilie Ascaridoidea.Zoologische Jahrbücher. Abteilung für Systematik, Ökologie und Geographie der Tiere 1957; 85: 211-52

14. Hartwich G. Keys to genera of the Ascaridoidea. In: Anderson, R.C., Chabaud, A.G. & Willmott, S. eds. CIH keys to the nematode parasites of vertebrates. Farnham Royal: Commonwealth Agricultural Bureaux, 1984: No. 2

15. Dollfus R-Ph. *Thynnascaris legendrei,* n. gen., n. sp., de l'estomac du germon, *Germo alalonga* (Gmel.). Bulletin de la Société Zoologique de France 1933; 58: 7-13

16. Ward HB, Magath TB. Notes on some nematodes from freshwater fishes. Journal of Parasitology 1917; 3: 57-64

17. Deardorff TL, Overstreet RM. Review of *Hysterothylacium* and *Iheringascaris* (both previously = *Thynnascaris)* (Nematoda: Anisakidae) from the Northern Gulf of Mexico. Proceedings of the Biological Society of Washington 1981; 93: 1035-79

18. Fagerholm H-P, Lövedahl M. Induced morphometric variation in the preparation of nematode parasites for LM and SEM. Systematic Parasitology 1984; 6: 245-47

19. Gibson DI. The systematics of ascaridoid nematodes - a current assessment. In: Stone AR, Platt HM, Khalil LF. eds. Concepts in nematode systematics. London & New York: Academic Press, 1983: 321-38

20. Sprent JFA. Observations on the systematics of ascaridoid nematodes. In: Stone AR, Platt HM, Khalil LF, eds. Concepts in nematode systematics. Academic Press, London & New York, 1983: 303-19

21. Fagerholm HP. Systematic implications of male caudal morphology in ascaridoid nematode parasites. Systematic Parasitology 1991; 19: 215-28

22. Gibson DI, Oliver SE, Shaw KM. Can different species of *Diplostomum* metacercariae be distinguished by principal components analysis? Abstracts of the Spring Meeting of the British Society for Parasitology, Nottingham, 26-28 March, 1985, 63

23. Brooks DR, O'Grady RT, Glen. Phylogenetic analysis of the Digenea (Platyhelminthes: Cercomeria) with comments on their adaptive radiation. Canadian Journal of Zoology 1985; 63: 411-43

24. Brooks DR *et al.* Aspects of the phylogeny of the Trematoda (Platyhelminthes: Cercomeria). Canadian Journal of Zoology 1989; 67: 2609-24

25. Pearson JC. On the position of the digenean family Heronimidae: an enquiry into a cladistic classification of the Digenea. Systematic Parasitology 1992; 21: 81-166

26. Gibson DI. Questions in digenean systematics and evolution. Parasitology [Trends and Perspectives] 1987; 95: 429-60

27. Inglis WG. Characters: the central mystery of taxonomy and systematics. Biological Journal of the Linnean Society 1991; 44: 121-39

28. Sugane K, Qing L, Matsuura T. Restriction fragment length polymorphisms of anisakine larvae. Journal of Helminthology 1989; 63: 269-74

29. Qu LH *et al.* Phylogeny of helminths determined by rRNA sequence comparison. Molecular and Biochemical Parasitology 1986; 20: 93-99

30. Baverstock PL, Fielke R, Johnson AM, Bray RA, Beveridge I. Conflicting phylogenetic hypotheses for the parasitic platyhelminths tested by partial sequencing 18S ribosomal RNA. International Journal for Parasitology 1991; 21: 329-39

31. Nadler SA. Molecular approaches to studying helminth population genetics and phylogeny. International Journal for Parasitology 1990; 20: 11-29

32. Paggi L *et al.* Electrophoretic identification of larvae and adults of *Anisakis* (Ascaridida: Anisakidae). Journal of Helminthology, 1986; 60: 331-39

33. Bandoni SM, Brooks DR. Revision and phylogenetic analysis of the Amphilinidea Poche, 1922 (Platyhelminthes: Cercomeria: Cercomeromorphae). Canadian Journal of Zoology 1987; 65: 1110-28

34. Gibson DI, Bray RA, Powell CB. Aspects of the life-history and origins of *Nesolecithus africanus* (Cestoda: Amphilinidae). Journal of Natural History 1987; 21: 785-94

35. Thorpe JP. Enzyme variations, genetic distance and evolutionary divergence in relation to levels of taxonomic separation. In: Oxford, G.S. & Rollinson, D. eds. Protein polymorphism: adaptive and taxonomic significance. London & New York: Academic Press, 1983: 131-52

36. Mayr E. Principles of systematic zoology. Bombay-New Delhi: Tata McGraw-Hill Publishing Co., 1969

Bull Scand Soc Parasitol 1992; 2: 68-73

Mesocestoides canislagopodis (Rudolphi, 1810) (Krabbe, 1865) (Cestoda: Mesocestoididae) from arctic foxes, *Alopex lagopus* (L.), in Iceland redescribed.

B. Loos-Frank[1], K. Skírnisson[2] and M. Eydal[2].

[1] Abt. Parasitologie, Universität Hohenheim, FRG - 7000 Stuttgart 70, Germany
[2] Institute for Experimental Pathology, University of Iceland, Keldur, P.O. Box 8540, IS-128, Reykjavik, Iceland

Introduction

In 1865 Krabbe described various helminths from dogs and cats and from one arctic fox *(Alopex lagopus)* in Iceland (1). Among them he identified a cestode, after careful studies of the literature, as *Taenia Canis lagopodis* Rudolphi, 1810, not being aware that two years earlier Vaillant (2) had created a new genus, *Mesocestoides,* the characters of which seemed to be intermediate between *Taenia* and *Bothriocephalus* due to the position of genital organs, along the midline of the proglottis instead of being laterally, and the lack of rostellar hooks. A century later Baer (3) reexamined the material collected by Krabbe and in addition examined cestodes found in two arctic foxes which he identified as *Mesocestoides litteratus* (Batsch, 1786) syn. *Taenia Canis lagopodis* Rudolphi, 1810. This cestode, from Icelandic arctic foxes, has also been assigned to *M. lineatus* (Goeze, 1782) (4). In 1979 several *Mesocestoides* specimens from arctic foxes in Iceland were sent to the first author by Dr. Richter, but the worms were not in a state which allowed a detailed description. It could only be observed that the cirrus pouch was oval and contained a convoluted cirrus. In the last years the helminth fauna of arctic foxes in Iceland has been investigated by the co-authors. The complete results of the study are published in another paper (5). The results pertaining to *Mesocestoides* are given in the present paper.

Materials and methods

Intestines of 50 arctic foxes caught in 1986 and 1987 in the western and northern parts of Iceland were examined for parasites (5). The gastrointestinal tracts were removed during autopsy and kept frozen until examined for parasites. After thawing, the gut was cut open and washed in a stream of water and sieved through a mesh with an aperture of 100 µm. The contents of the small intestine and the caecum/colon were examined separately for parasites. *Mesocestoides* cestodes were stained with lactic acid carmine after a modified method by Rukhadze & Blajin (6). Whole mounts were prepared according to Loos-Frank (7).

Results

Mesocestoides canislagopodis was the most common helminth found in the arctic foxes in Iceland, with a prevalence of 72% (5). Worm burdens ranged from 1 to 6,000 with a mean intensity of 502. Nine foxes harboured more than 500 *M. canislagopodis,* six foxes (1 to 11 years old, x=4 years) carried more than 1,000 worms (Figure 1). 92% of foxes two years and older were infected but only 36% puppies and yearlings were infected with the parasite (Figure 2). Most of the worms were found in the small intestine but occasionally they were recovered from the colon.

Figure 1. Number of arctic foxes in each age group harbouring M. canislagopodis.

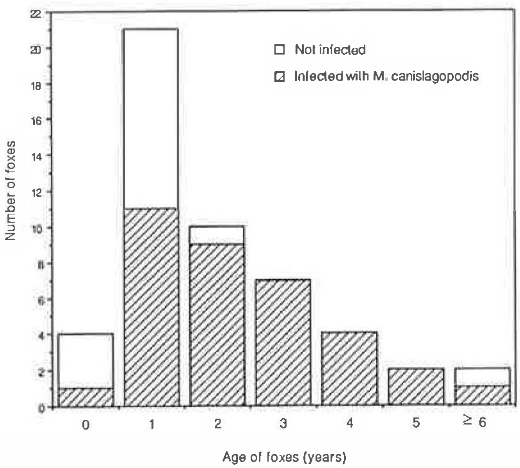
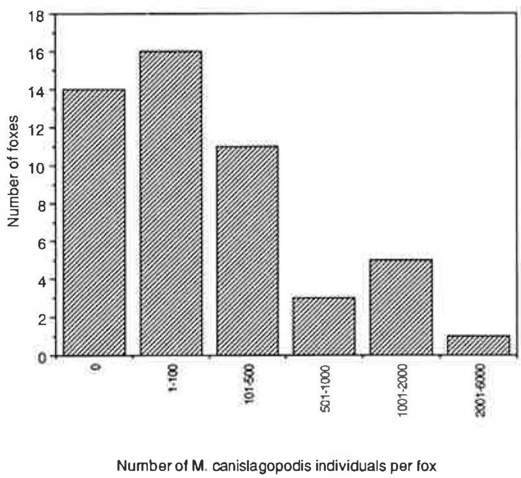


Figure 2. Number of M. canislagopodis individuals in the arctic foxes.



Description of the *M. canislagopodis* worms: The longest worm measured 500 mm, the smallest gravid worm was 30 mm long. Seen from the apex the scoleces show the genus--specific rectangular shape and the four suckers on each scolex have a typical longitudinal slit (Figure 3 A - E). In whole mounts of not well preserved worms the suckers are small round structures. Mature proglottids are square and measure up to 912 x 790 μm, gravid proglottids up to 2.26 x 1.18 mm. The number of testes ranges from 53 to 74 in each proglottis. They are unevenly distributed and are not confluent at the anterior and posterior margin (Fig. 3 F). The cirrus pouch is oval, but as it rarely lies horizontally it usually appears to be round. It is thin-walled. Its anterior half contains the ejaculatory duct with about 5 loops and the cirrus with about 4 loops. Before entering the genital atrium the cirrus widens and forms a cavity with a width of 43 x 30 μm

(Fig. 3 G). Fully developed parauterine organs measure 608 x 319 µm (Fig. 3 H).

Measurements of various organs are shown in Table 1.

Table 1. Measurements (in µm) of specimens of M. canislagopodis (Krabbe, 1865).

	no. of worms	no of measure-ments	minimum	maximum	average
Scolex diameter	7	7	448	714	549
Suckers length	5	20	150	233	188
Suckers width	5	20	179	269	214
Testes number	12	25	53	74	62
Testes length	8	25	46	67	57
Testes width	8	25	36	60	43
Ovary length	8	16	96	197	119
Ovary width	8	16	46	102	79
Vitellarium length	8	16	63	167	117
Vitellarium width	8	16	37	96	80
Cirrus pouch length	12	22	115	197	148
Cirrus pouch width	12	22	74	120	90
Oncospheres length	2	9	24	31	27
Oncospheres width	2	9	14	20	18

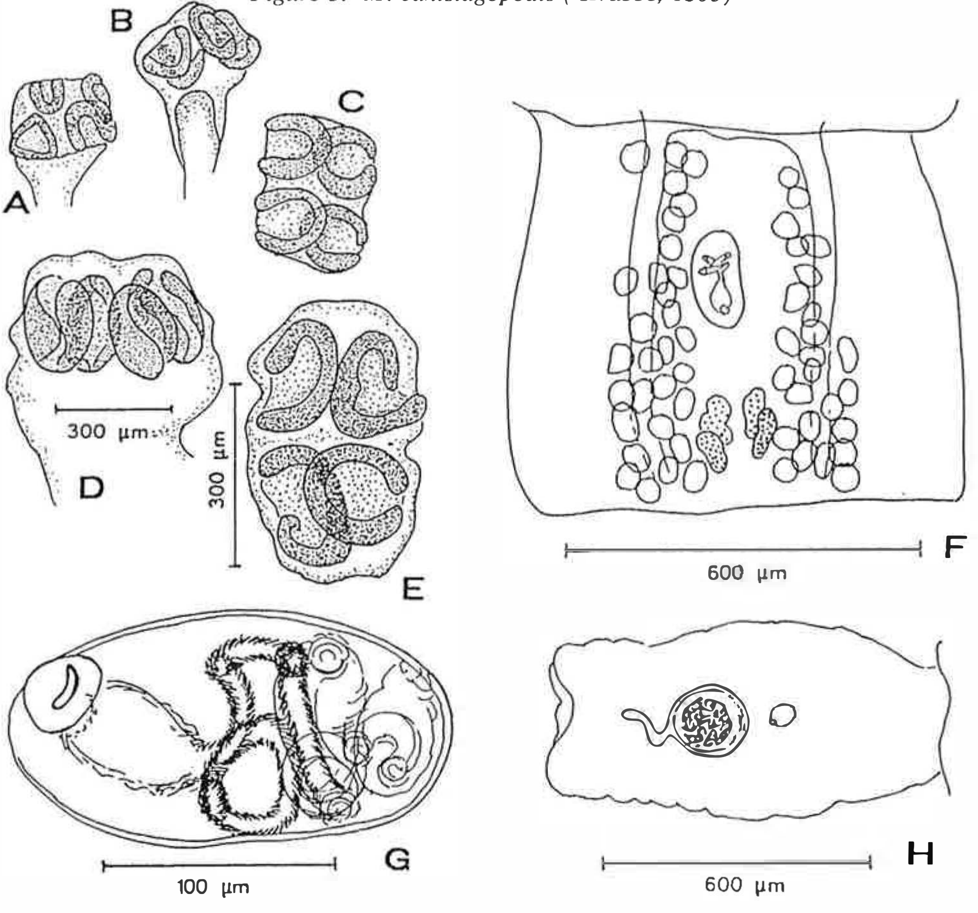
Discussion

Only with the investigations by Voge (8) and Certkova & Kosupko (9), it became apparent that the most important features which serve to distinguish species of the genus *Mesocestoides* are the shape of the cirrus and the cirrus pouch. Authors prior to this time usually did not pay attention to these morphological details. Consequently all over the world worms of the genus were allocated to *M. lineatus* (Goeze, 1782) or to *M. litteratus* (Batsch, 1786), the former being an insufficiently described species, the latter considered a nomen dubium by Loos-Frank (7). The description by Krabbe (1) is one of the rare exceptions. His *Taenia Canis lagopodis* can now be declared as valid species of the genus *Mesocestoides.*

The tapeworms from dogs described by Krabbe (1) attained the same maximum length as the ones found in arctic foxes in this study. Krabbe's statement that the worms have "rather circular" suckers can only be explained by the assumption that his specimens were not well preserved. In such specimens the suckers always look circular, while in properly preserved they have a shape which is typical for the genus (see description of worms and Fig. 3 A - E). Along the lateral parts of the mature proglottids Krabbe observed round, transparent bodies in three rows not showing a special arrangement. Correctly he identified them as testes. His description suggests that they were not confluent at the anterior and posterior margin of the proglottis and in this respect are identical

with the worms described above. In our material there are also roughly "three rows" of testes on each side, one row outside the longitudinal excretory vessels and approximately two rows inside. Krabbe did neither count the testes nor did he measure the cirrus pouch. But the other measurements given by him (scolex 600 µm, suckers 250µm, testes 500µm, eggs 30 x 25 µm) correspond surprisingly well to the respective sizes in worms of our material (Table 1). The most convincing similarity is the form of the cirrus which, according to Krabbe's description, "in an oblong, rather transparent apparatus" (apparently meaning the cirrus pouch) "forms irregular loops and ends or in a club - shaped part". The latter is exactly the widened portion of the cirrus seen in the present material.

Figure 3. M. canislagopodis (Krabbe, 1865)



A-E. Scoleces (A-C free-hand drawings of unmounted worms, D, E mounted worms, drawing apparatus, C, E scoleces seen from the apex).

F. Mature proglottis.

G. Cirrus pouch showing (left to right) genital opening, "cavity" of cirrus, cirrus and ejaculatory duct.

H. Gravid proglottis showing parauterine organ filled with eggs and cirrus pouch in front of it.

Krabbe (1) found the cestode in 1/5 of the dogs and in 1/3 of the cats he examined. The occurrence and prevalence of *Mesocestoides* in present day dogs and cats in Iceland has not been investigated.

The complete life cycle of cestodes belonging to the genus *Mesocestoides* is not known. The larval stage (tetrathyridium) which is infectious for the definitive host (carnivores) occurs in different forms and localizations in a wide range of vertebrates but is remains enigmatic how these animals obtain the larvae. Experiments suggesting the development of the early larval stage (cysticercoids) in oribatid mites (10) could never be repeated successfully. Even the existence of a first intermediate host is doubtful. Interpretation of the life history is often influenced by the knowledge of the asexually proliferating tetrathyridia of *M. vogae* Etges, 1991, (11) (hitherto assigned to *M. corti* Hoeppli, 1925). But most probably they represent an untypical strain of which naturally occurring adults are not known. In any case, the tetrathyridia of *M. leptothylacus* Loos-Frank, 1980, a common parasite of the red fox, do not multiply in the intermediate host (12), nor do the ones isolated from an *Anolis carolinensis* as reported by Etges (11).

In Iceland the tetrathyridia have not yet been found. It seems unlikely that they occur in wild birds, since the adult worms were not only found in foxes and cats, but also in dogs (1,) and these are usually not skilled enough to catch this sort of prey regularly. On the other hand, several authors have recorded tetrathyridia from chickens (13), which could easily be captured by dogs and cats. The rodent species in Iceland, the field mouse *(Apodemus sylvaticus)*, the house mouse *(Mus musculus)* and the common rat *(Rattus norvegicus)* might possibly serve as intermediate hosts. The black rat *(Rattus)* is found only occasionally. Foxes are known to feed on field mice in Iceland (14). Remains of field mice were seen in the stomach of several foxes we examined, which suggests they might serve as a source of infection if infected with the tetrathyridia. There are no other small mammalian species native of Iceland, except for the feral mink *(Mustela vison)*, introduced in this century.

The fact that the prevalence of *M. canislagopodis* in Iceland increased with increasing age of foxes is almost certainly due to the longevity of the worms. Once a fox becomes infected, the worms will stay alive more or less during the lifetime of its host.

References

1. Krabbe H. Helminthologiske undersøgelser i Danmark og på Island, med særligt hensyn til blæreormlidelserne på Island. Det kongelige danske videnskabernes selskabs skrifter (5), Naturvidenskabelig og mathematisk afdeling, 1865; 7

2. Valliant L. Sur deux helminthes cestoïde de la Genette. Inst, Paris, 1re Sect, Sc math, Phys Nat 1863; 31: 87-88

3. Baer JG. Cestoda. The zoology of Iceland. Copenhagen and Reykjavík: Ejnar Munksgaard, 1962; II, 12

4. Shults LM. *Mesocestoides kirby* and *M. lineatus:* Occurrence in Alaskan carnivores. Trans Amer Microsc Soc 1970; 89: 478-86

5. Skírnisson K, Eydal M, Gunnarsson E, Hersteinsson P. Parasites of the arctic fox *(Alopex lagopus)* in Iceland. Journal of Wildlife Diseases (Accepted for publication in 1992)

6. Rukhadze & Blajin. On a method for staining flukes and tapeworms segments as whole microscopical preparations. J Trop Med Hyg 1929; 23: 342-43

7. Loos-Frank B. *Mesocestoides leptothylacus* n. sp. und das nomenklatorische Problem in der Gattung *Mesocestoides* Vaillant, 1863 (Cestoda). Tropenmed Parasitologie 1980; 31: 2-14

8. Voge M. North American cestodes of the genus *Mesocestoides*. Univ Calif Publ Zool 1953; 59: 125-56

9. Čertkova AN & Kosupko GA. [Cestodes of the genus *Mesocestoides* - findings in domesticated and wild animals in the USSR, with principles of their systematics]. Trudy Vses Inst Gel'mint im K I Skrjabina, Moscow 1975; 22: 193-211

10. Soldatova AP. A contribution to the study of the development cycle in the cestode *Mesocestoides lineatus* (Goeze, 1782), parasite of carnivorous mammals. CR (Dokl) Acad Sci USSR 1944; 45: 310-12

11. Etges FJ. The proliferative tetrathyridium of *Mesocestoides vogae* sp. n. (Cestoda). Proc Helminthol Soc Wash. 1991; 58: 181-85

12. Loos-Frank B. The common vole, *Microtus arvalis* Pall. as intermediate host of *Mesocestoides* (Cestoda) in Germany. Z Parasitenk 1980; 63: 129-36

13. Macchioni G. Infestione del riccio (*Erinaceus europaeus* L., 1758) da larve di *Mesocestoides lineatus* (Goeze, 1782) (Raillet, 1893). Ann Fac Vet Pisa 1966 (Publ 1967); 19: 325-39

14. Hersteinsson P. The behavioral ecology of the arctic fox *(Alopex lagopus)* in Iceland. University of Oxford 1984, (Doctoral Thesis)

NEWS

Nordic training course in parasitic zoonoses II

The Danish Center for Parasitic Zoonoses in cooperation with the Scandinavian Society for Parasitology is planning a second Nordic training course in parasitic zoonoses is planned to be held in Copenhagen, May, 1993. The course will be a continuation of the one held in May this year, but with a special emphasis on epidemiology, transmission ecology and public health control. An application for financial support has recently been sent to NORFA - Nordisk Forskerutdanningsakademi (The Nordic Academy for Advanced Studies).

Scientific award

Peter Nansen, professor in Parasitology at the Royal Veterinary and Agricultural University, Denmark was recently awarded the Carlsberg Prize for Agricultural Sciences of 100.000 Dkr. The award, which covers all disciplines within agricultural sciences, was established in 1991, and given for the first time in 1992 to Peter Nansen.

Peter Nansen has distinguished himself as a researcher in veterinary parasitology with main interest in epidemiology, ecology and control of helminths in cattle and swine. He has been a leader of several joint Nordic research projects and was president of the Scandinavian Society for Parasitology 1985-89.

NEWS Baltic Section

A Baltic Society for Parasitology is being established

At a Baltic parasitology meeting held October 29-30, 1992, in Vilnius, Lithuania, it was decide to form a Baltic Society for Parasitology with participants from Estonia, Latvia and Lithuania. The society should encompass parasitologists with medical, veterinary or biology backgrounds.

Dr. V. Kontrimavichus, coordinator of the meeting in Vilnius, expressed a strong wish that the Baltic and the Scandinavian societies should have collaborative contacts, e.g in the form of joint meetings.

News from the secretary

The SSP-board and the Bulletin editor met in connection with the EMOP-conference in the Hague, on 7 September, to go through the treasurers report, the status of the Bulletin, and other society matter. Professor Odd Halvorsen was nominated as the SSP-candidate for the board in EFP, and was later elected as president at the EFP general assembly.

Next SSP-meeting, Oslo 30 September - 2 October.

An organizing committee has now been established, and the first announcement will be mailed to all members (see special information in this issue).

Erratum

Vol. 2 No. 1

page 7, the complete list of Honorary members should be:
Professor Orvar Nybelin, Gothenburg (1969), Professor Bertel von Bonsdorff, Helsingfors (1970), Professor Bo-Jungar Wikgren, Åbo (1976), Professor Elias Bengtsson, Stockholm (1983), and Professor Rolf Vik, Oslo (1985).

16th Scandinavian Symposium of Parasitology
NORWAY 30.9 - 2.10 1993

16th

SCANDINAVIAN

SYMPOSIUM

OF

PARASITOLOGY

VETTRE * OSLO * NORWAY

30 September-2 October 1993

Scandinavian Society for Parasitology

For more information and application form for the second, final announcement, see enclosed first announcement.

Welcome to Oslo

The Scandinavian Society for Parasitology is pleased to invite you to the SSP XVI, the 16th Scandinavian Symposium of Parasitology, which will take place at Vettre Hotel and Conference Centre, Asker, 30 September (afternoon)-2 October 1993. The conference centre is located 22 kilometers south-west of Oslo and 15 minutes away from the airport, in idyllic surroundings near the Oslo fjord.

Scientific programme

The symposium will accept contributions on all aspects of parasitology. The following themes have been chosen for plenary lectures:

* Consequences of the more open borders due to the EEA (the new agreement between the EEC and EFTA) from a parasitological point of view
* The origin of the eukaryotic cell by symbiosis
* Ribosomal RNA/gene technology as a diagnostic and taxonomic tool in microbiology
* Immunology of human parasitic diseases: experience gained from HIV/AIDS-patients
* Epidemiology and control of human helminthiasis

Symposium language

English.

Papers, posters and workshops

If you intend to present a paper or a poster at the symposium, please note that you must send an abstract to us **before 1 May 1993.** Suggested topics for workshops should be sent to us before **1 December 1992.**

Social events

A get-together party will be organized on Thursday evening, after the opening session, and a congress dinner is scheduled for Friday evening. A post-congress tour will be arranged in the Oslo area if there are enough participants.

Organizing secretariat

SSP XVI Secretariat
Ulf Gustavsen
Sognsveien 4
N-0451 OSLO, Norway
Phone: +47-2-56 76 50, Telefax: +47-2-69 04 50

Scientific secretariat

Norwegian College of Veterinary Medicine, Section of Parasitology
Professor *Oddvar Helle*
P.O. Box 8146 Dep., N-0033 OSLO, Norway
Phone: +47-2-96 49 64, Telefax: +47-2-56 57 04

Final announcement

A second, final announcement is scheduled to be distributed in January 1993. It will contain:

* Preliminary conference programme
* Information on registration fees
* Registration, accommodation, and abstract forms

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 have a maximum length of 2 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.*

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. 2 No. 2 **OCTOBER 1992**

CONTENTS

Holger Madsen 1909 - 1991.
O. Hindsbo *47*

Helminth parasites of aquatic organisms: taxonomic problems.
D.I. Gibson *58*

Mesocestoides canislagopodis (Rudolphi, 1810) (Krabbe, 1865) (Cestoda: Mesocestoididae) from arctic foxes, *Alopex lagopus* (L.) in Iceland redescribed.
B. Loos-Frank, K. Skírnisson and M. Eydal *68*

NEWS

Nordic training course in parasitic zoonoses II *74*

Scientific award *74*

Baltic section *74*

SOCIETY BUSINESS

News from the secretary *75*

16th Scandinavian Symposium for parasitology, Oslo 30 Sept-2 October 1993 . . . . . . *76*

Erratum *75*

Guidelines for contributors *78*