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Anguillicola-infestations in Germany and in German eel imports

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Summary

Anguillicola, a parasitic nematode in the swim-bladder of eels *(Anguilla anguilla)*, was introduced into European inland waters probably during the mid 1970's with imported live eels from the Far East and New Zealand. The parasite is spreading rapidly through live transport of eels and can now be found in central Europe ranging from Denmark to Italy and from the UK in western Europe to Poland in the east. Northern Baltic and east Mediterranean countries (except Egypt) as well as Ireland seem presently to be free of this parasite. Infestation rates vary by region and water type from 0 to over 90%. In the Federal Republik of Germany infestation rates of more than 50% are known from some rivers and lakes in the northern part of the country. Glass-eels seem to be uninfested because the parasite does not propagate in saline waters. Eels from fish farms are infested only when farms are stocked with brown eels obtained from the wild.

Zusammenfassung

Auftreten von Anguillicola in Deutschland und in deutschen Aalimporten

Anguillicola, ein parasitischer Nematode in der Schwimmblase des Aals *(Anguilla anguilla)*, wurde vermutlich Mitte der 70er Jahre in europäische Binnengewässer durch Lebendimporte von Aalen aus Fernost und Neuseeland eingeschleppt. Die starke Verbreitung der Parasiten ist auch auf die zahlreichen Lebendaaltransporte zurückzuführen. Der Parasit tritt mittlerweile in Mitteleuropa von Dänemark bis Italien und von England bis Polen auf. Die nordeuropäischen Staaten und die östlichen Mittelmeerstaaten (außer Ägypten) und Irland scheinen bislang parasitenfrei zu sein. Die Befallsrate variiert je nach Region und Gewässertyp von 0 bis 90%. In der Bundesrepublik Deutschland treten in einigen Flüssen und Seen Norddeutschlands Befallsraten von über 50% auf. Glasaale werden offensichtlich nicht befallen, da der Parasit nicht ins Meerwasser vordringt. Farmaale sind befallen, wenn parasitierte Gelbaale zur Mast gefangen werden.

Résumé

Infestation par Anguillicola en Allemagne et dans des importations allemandes d'anguilles

Anguillicola, un nématode parasite de la vessie natatoire d'anguilles *(Anguilla anguilla)* a été introduit dans les eaux intérieures européennes probablement vers le milieu des années 70 avec des anguilles vivantes importées d'Extrême-Orient et de Nouvelle-Zélande. La propagation extrême du parasite est entre autres due au transport d'anguilles vivantes. Le parasite est entre-temps présent en Europe centrale du Danemark à l'Italie et du Royaume-Uni à la Pologne. Les pays du nord de la Scandinavie et de la Méditerranée orientale (excepté l'Egypte) ainsi que l'Irlande semblent actuellement ne pas être touchés par ce parasite. Le taux d'infestation varie de 0 à 90% selon les régions et le type d'eau. En République fédérale allemande des taux de plus de 50% ont été constatés dans quelques rivières et lacs de l'Allemagne du nord. Les civelles ne semblent pas être infestées car le parasite ne pénètre pas dans l'eau de mer. Les anguilles de culture sont infestées lorsque des anguilles sauvages porteuses de parasites ont été utilisées pour l'élevage.

Introduction

The genus *Anguillicola* comprises 5 species *(A. crassa, A. globiceps, A. australiensis, A. novaezelandiae, A. papernai)*. These are exclusively parasites of the swim-bladder of eels. Two of these species are indigenous to the Far East *(A. crassa, A. globiceps)*, one originates

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from Australia (*A. australiensis*), one from New Zealand (*A. novaezelandiae*), and one from Africa (*A. papernai*). According to KØIE (1988a), *Anguillicola crassa* was inadequately described by KUWAHARA et al. (1974), leading to some confusion in species identification in several of the reported transfers. Recently, TARASCHEWSKI et al. (1987) have re-described this species; excellent micrographs depicting the various stages of development of this parasite have been presented by KØIE (1988b). As indicated by KØIE (1988a), the *Anguillicola* specimens from New Zealand were erroneously identified as *A. australiensis* by HINE (1978), while MORAVEC and TARASCHEWSKI (1988), have identified it as *A. novaezelandiae*.

Infestation rates (up to 40 %) of these parasites have been reported in Japanese eels from various regions (WANG and ZHAO 1980; EGUSA 1976). According to EGUSA (1976), the European eel, which is imported as glass-eel into Japanese eelfarms, is by far more susceptible to this parasite than the Japanese eel (infestation rate up to 100 %). Several copepod species act as intermediate hosts for this parasite (WANG and ZHAO 1980).

First reports on the introduction of this parasite into Europe date back to the early 1980s. The import of live eels some years before that date must have been the vehicle for the first, but unrecognized, introduction. During the years 1976 and 1977, New Zealand exported about 549 tonnes of live eels to Europe (HINE 1978). In 1980, the Federal Republic of Germany imported 35.2 tonnes of live eels from Taiwan and 15.9 tonnes from New Zealand, followed by 7.3 tonnes from New Zealand in 1981. Other European eel-trading countries, such as the Netherlands and Italy, have probably similarly contributd to the introduction of this parasite through live importation of eels; besides *A. crassa* and *A. novaezelandiae* a 3rd species, *A. australiensis*, may already be present in Europe. The spreading of this parasite and its impact on European eel populations is considered in this paper, presented at a meeting of the EIFAC (European Inland Fisheries Advisory Commission) Working Party on Eels, April 1987, in Bristol, England.

Infestation rates in samples of imported eels

During the past few months, an attempt has been made to acquire some preliminary information on the status of these parasites in the Federal Republic of Germany and other parts of Europe. Samples taken from eel shipments to the Federal Republic of Germany have been checked by using eel viscera kindly provided by two German processing companies (Table 1).

Total number of samples and sample size are by far too small to permit a quantitative statistical analysis. However, the results indicate that *Anguillicola* is now present from Italy to Denmark. The northern Baltic Sea area may (still) be free of the parasite, and the eastern Mediterranean countries seem not yet to be affected[1]. However, it may be only a matter of time until *Anguillicola* will be identified in these regions.

Infestation rates in eels from German waters

Infestation rates determined in samples from German waters are listed in Table 2. From these data it seems obvious that the parasite has spread rapidly among eel populations. It was not found in eel samples from the lower Elbe River in 1985. However, only one year after this first survey, the infestation rate in eels from the lower part of the river (downstream Hamburg) already varied between 6 % and 27 %. In the River Ems, the infestation rate of eels was 20 % in 1985, and rose quickly to 38 % in 1986. Sea water seems to act as a „barrier" for

[1] While this paper is in press the analysis of a recently received sample from Egypt showed an infestation rate of 4 % ($n = 50$; $\bar{x} = 1.0$).

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Table 1. **Rate of infection with Anguillicola spp. in eels imported into the Federal Republic of Germany (1986/1987) in relation to the origin of shipments.** N_1 = total sample size; N_2 = number of infested fish; $\bar{x}$ = average number of parasites per infested fish

Country of origin	Date month/year	N_1	N_2	% infested	$\bar{x}$
USA	XII/86	45	0	0	0
USA	XII/87	45	0	0	0
Canada	X – XI/87	105	0	0	0
Australia	X – XII/87	114	48	42	2.3
Turkey	I/87	184	0	0	0
Poland[1]	XI/86	41	0	0	0
Rep. Ireland	I/87	207	0	0	0
Netherlands	V/86	63	8	13	2.0
Netherlands	X – XI/86	120	22	18	10.0
Netherlands	X – XI/87	148	6	4	2.6
Denmark	X/86	334	4	1	8.8
Denmark	X – XI/87	150	4	3	1.3
Sweden, Farm	VIII/86	21	0	0	0
Denmark, Farm	XI/86	72	0	0	0
Italy, Farm	XI/86	37	19	51	3.3
Italy, Farm	IX/87	6	3	50	19.7

[1] One additional sample taken in 1988 was infested at a rate of 10 % ($\bar{x}$ = 5.0)

distribution of the parasite, largely restricting its propagation. Only 4 % of the eels caught by trawl fishery near the Island of Helgoland were infested with *Anguillicola*. It is known from tagging experiments that a large part of the coastal eel population enters freshwater in autumn for overwintering, and returns to the sea in spring (Aker and Koops 1969). The extremely high infestation rate of 97 % in the Havel River, which merges with the Elbe River in Berlin, is remarkable. The Havel River has been annually stocked over the years with young elvers caught in various North Sea river estuaries (possibly mixed with young eels of that size imported from The Netherlands).

Eels in the Trave River, a river flowing into the Baltic near Lübeck, are already highly affected by this parasite, as indicated in a recent study.

Table 2 lists a number of sample locations; three of them are lakes in Schleswig-Holstein. Eels in two of these lakes are almost free of the parasite, while in the third lake infection rate reaches about 90 %. The high infection rate in this lake is probably due to the practice of

Table 2. **Rates of infection with *Anguillicola* spp. in eels from different water bodies of the Federal Republic of Germany (1985 to 1987)**

Location	Date month/year	N1	N2	% infested	$\bar{x}$
North Sea, Helgoland	X/86	83	3	4	2.7
North Sea, Helgoland	XI/87	30	1	3	9.0
Lower River Elbe	V + VIII/85	77	0	0	0
Lower River Elbe	VII – IX/86	108	21	19	2.1
Oste (River to Elbe-estuary)	IX/86	50	9	18	1.3
Lower River Ems	IV/85	50	10	20	1.6
Lower River Ems	X/86	107	41	38	1.8
Havel (River to Elbe in Berlin)	X/86	58	56	97	9.2
Trave (River to Baltic Sea)	VI – VIII/87	43	26	60	7.2
Lake A, Schl.-Hlst.[1]	V/87	20	0	0	0
Lake B, Schl.-Hlst.	VI – VII/87	45	1	2	1.0
Lake C, Schl.-Hlst.	IX/87	73	64	88	11.3

[1] Schleswig-Holstein

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fishermen who regularly buy Italian farmed eels and store them live in the lake for extended periods of time until demand requires processing.

None of the samples analyzed in this study gave a significant correlation between fish size (length) and infestation rate. However, in several samples there was a trend in larger eels being more often infested. There can hardly be a chance for older eels to become infested more often because of age since the very small parasites found in these eels indicate a fairly recent infestation. The normal route of transmission of small parasites via copepod-zooplankton seems to be of no relevance because zooplankton is not a dominant food for large eels. Probably these large eels recently became infested by eating small fish that had been feeding extensively on infested copepods. This would also support the assumption that a higher infestation rate can be expected for lake eels.

A comparison of the average number of parasites per infested eel (Figure 1) and the infestation rate from samples taken in 1986 reveal an apparent positive correlation. No statistical difference within a sample was found for condition factor between individuals for infested and non-infested fish. The correlation between condition factor and number of parasites per fish was also not significant. Some infested eels, however, were slightly heavier than uninfested fish.

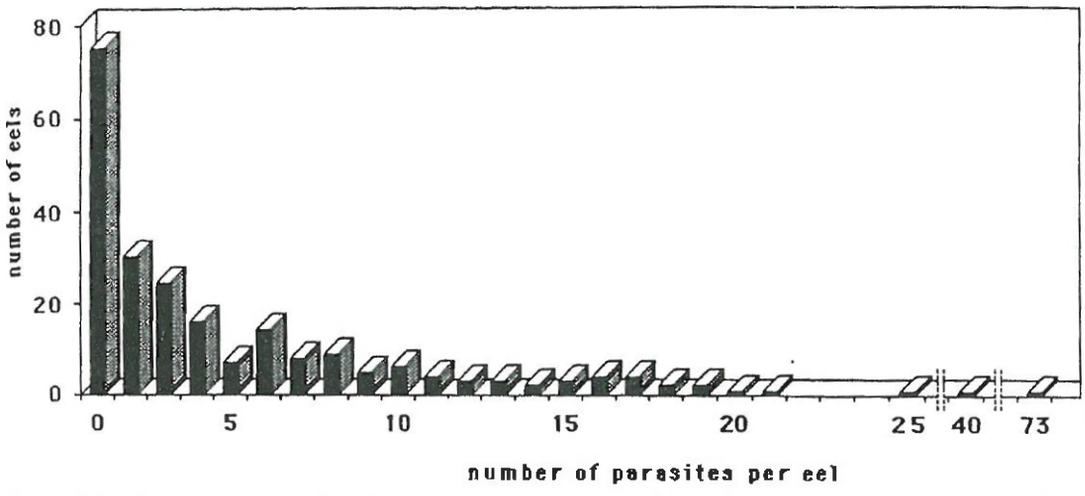

Fig. 1. Distribution of infestation intensity in eels (number of parasites per eel, pooled samples July 1987; n = 227)

Some of the import samples are farmed eels from Sweden and Denmark; these eels were not infested. Farmed eels from Italy showed an infestationrate of up to 51 %, while samples from a German eel farm near Emden were infested at a rate between 13 % and 44 %. The difference is that eel farming in Sweden and Denmark starts with glass eels. These glass eels are obviously free from the parasite. In Italy and in the Federal Republic of Germany some eel farms (at least those which were sampled so far) are stocked with on-growing eels from the wild. These fish already show a measurable infestation rate with *Anguillicola*.

Discussion

There is a consensus among scientists that *Anguillicola* spp. may severely affect growth and survival of eels in rivers and lakes, as stressed during the latest ICES Mini-Symposium on introduced species. According to Italian investigations, growth and feed conversion in farmed eels in negatively influenced by the parasite. The impact on the fisheries seems to be limited; however, some areas of Germany report that eels cannot be sold to restaurants and hotels live, but have to be slaughtered. It is also reported that the mortality of eels during storage and/or transport is higher in infested fish.

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Under normal environmental conditions and in relatively shallow inland waters, *Anguillicola* may not cause an immediate problem to eels; however, under situations of stress infested eels may react more sensitively. It is not clear what may happen to infested eels during their spawning migration at sea where eels have to travel long distances in open oceanic waters with a known day-night change of swimming depth (TESCH 1988).

In addition to the spread of this parasite through the stocking of eels in natural waters, trade of live farmed eels with Italy will contribute considerably to its further rapid range extension. Further records from other countries and areas are expected in the future, especially since the German Democratic Republic and Poland have already stocked their waters with young eels originating from areas where one expects to find infested fish. In 1988, one sample of eels imported to Germany from Poland was infested at a rate of 10%. There is a fair chance that Ireland can remain free for quite some time if the imports of live eels are kept under control or are strictly prohibited. *Anguillicola* has recently been recorded in two rivers in the United Kingdom (pers. Comm. D. FITCH, University of Exeter, 1988).

There was a slight but insignificant tendency that infested eels were slightly heavier than uninfected ones. This observation remains unexplained. However, a biological interpretation might be that eels with high condition factors fed on good and rich feeding grounds thereby more frequently encountering the chance of infestation while feeding on intermediate hosts. Another explanation might be that length increment rather than weight increment is negatively influenced by this parasite.

In summary, it can be stated that glass eels are obviously free from the parasite, but transport of young brown eels for stocking and the live transport of large eels for consumption are real vectors in continuing the spread of *Anguillicola*. The parasite has established itself in many European eel populations and will spread further. The impact on populations can at present not be evaluated, but it is recommended that efforts be made to prevent the spread of this parasite by prohibiting the stocking of infested fish into waters and areas known to be free of this parasite.

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