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ABUNDANCE OF ANGUILLICOLA CRASSA IN DUTCH OUTDOOR WATERS AND THE REACTION OF ITS HOST *ANGUILLA ANGUILLA*

by

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Abundance of *Anguillicola crassa* in Dutch outdoor waters and the reaction of its host *Anguilla anguilla*.

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Abstract

The distribution and abundance of *Anguillicola crassa* in the swimbladder of the European eel (*Anguilla anguilla*) in Dutch outdoor waters is described. In 1987 it was observed that a high percentage of the eels in the most heavily infected waters showed an empty, thickened swimbladder, without (healthy) *Anguillicola*.. This swimbladder 'collapse' is thought to be a reaction to the infection by *Anguillicola*.

Resumé

Les données sur la distribution et des nombres de *Anguillicola crassa* dans la vessie natatoire des anguilles (*Anguilla anguilla*) dans les aux aux dehors en Pays Bas sont presenté. En 1987, dans les eaux les plus infecté, on a observé une grande partie des anguilles avec des vessies natatoires vides et inflées, sans *Anguillicola* vivantes. Cet enflure est consideré comme une defense contre *Anguillicola*.

Introduction

Anguillicola crassa is a well known parasite of the swimbladder of the Japanese eel (*Anguilla japonica*) (Egusa, 1979). In the Japanese eel, it is not very harmful; however, in European eel (*Anguilla anguilla*) in culture systems, it causes severe growth retardation and mortality (Egusa, 1979, Saroglia, 1985).Since its first occurrence, it has spread almost throughout whole (western) Europe.

This paper presents data on the outdoor occurrence of *Anguillicola crassa* in the Netherlands. It does not intend to be exhaustive, but merely represents a progress report.

Species identity

There has been some discussion on the exact identity of the *Anguillicola sp.* occurring in Europe (Charleroy et al., 1987). Careful examination of Dutch material has not shown any major differences with the description of *Anguillicola crassa* (van Banning et al., 1985). Therefore, until otherwise has been proven, it is taken to be *Anguillicola crassa* here.

Sampling procedures

During 1986 and 1987 many samples of eels from various locations in the Netherlands have been analysed for *Anguillicola*. A minimum of 50 eels was obtained, mostly from commercial fishermen, in a few cases by direct sampling using an electrified trawl. Total lengths of the eels varied between 25 and 40 cm. Swimbladders were examined by the naked eye, for live *Anguillicola*. Incidence rates are expressed as the fraction of eels having *Anguillicola* in their swimbladder; number of parasites are given as the count of *Anguillicola* per *infected* eel.

Distribution

Directly following the first description of *Anguillicola* from Dutch material (Saroglia, 1985), a broad survey in outdoor waters has been set up in 1986, covering as many waters as could be. The results of this survey are presented in figure 2. It turned out, that *Anguillicola* was distributed throughout the Netherlands, including many closed ponds and polders, with the exception of two small polders. These two negative spots should not be given too much weight, since one of them did show *Anguillicola* in autumn 1987. Samples from salt water did show *Anguillicola*, but always much less frequently than samples from nearby fresh water systems.

Swimbladder thickening and collapse

In the course of 1987, eels were observed having swimbladders with thickened walls, and (almost) no gas in it (figure 1). the size of the swimbladder was reduced. Inside this 'collapsed' swimbladder no *Anguillicola* were found, or seldom a few specimens in obviously bad condition. This phenomenon was recorded for the first time (spring 1987) in the lake with the highest infection by *Anguillicola* in 1986. Although no observations directly justified the assumption, this 'collapse' was thought to be a consequence of, or a reaction to the infection by *Anguillicola*, and the recording procedures in the surveys for *Anguillicola* extended to record this phenomenon. A similar observation was made on young elvers. This is described in more detail in van Banning and Haenen, 1988.

Although the term 'collapse' suggest a sudden break through of the swimbladder, expelling the contents into the body cavity, no such observations have actually been made. Observed were: healthy swimbladders with just a few parasites, swimbladders with many parasites in dark debris, ruptured swimbladders with parasites scattered through the body cavity (which could have been handling artefacts) and small, thickened swimbladders (almost) without gas. To indicate the thickened swimbladders without gas, the term 'collapsed swimbladder' will be used in quotes in the rest of this text.

Incidence and abundance through time

During 1987, the survey was reduced to three lakes (Lauwersmeer, IJsselmeer and Grevelingen, the latter being a sea water basin), increasing the sampling frequency to once per one or two months. Results are presented in table 1. From this table, it appears that infection by *Anguillicola* in 1986 in the Lauwersmeer was higher than in the IJsselmeer. During 1987, 'collapsed swimbladders' were first observed in the Lauwersmeer, and lateron on a low frequency in the IJsselmeer. This suggest, the infection in the Lauwersmeer could be in a more advanced state, probably having started earlier. Maybe, the infection of the IJsselmeer in may 1986 was in a very early phase, showing only 1.5 parasite per infected eel. In both lakes, infections stabilized around 10 *Anguillicola* per infected eel. In the Grevelingen (salt water) incidence rates never exceeded 5%.

Additionally, during 1987, the organization of professional fishermen in one province (Friesland, northern part of the Netherlands, near the Lauwersmeer) set up an inquire of its members, and reported the results to us. Each fishermen was expected to examine 50 eels per month for live *Anguillicola*. Results indicate that lakes near to the Lauwersmeer showed an early, and high incidence of *Anguillicola*, which was stabile or declined a little during 1987, while the lakes further down south or west showed a lower incidence, which rose quite fast. Unfortunately, the 'swimbladder collapse' was not recorded. During 1988 this fisherman-based-survey is extended to cover the whole country, and the recording procedure updated.

Length-weight relationship

In order to detect any influence of the parasite on the condition of its host, Fulton indices were calculated (W/L^3), and analysed by an ANOVA. Results are presented in table 2. It turns out that neither infection by live *Anguillicola*, nor a 'swimbladder collapse' had any significant effect on the Fulton index. Unfortunately, direct observations of growth rate (age readings and back calculations) are not yet available on a routine scale.

In an earlier report on *Anguillicola* in the Netherlands (Dekker, 1987a), it was reported that infection by *Anguillicola* was attended by increased weight. However, this was based on a direct cross-tabulation of Fulton indices by length and infection stage, without reference to season or area, thereby aliasing natural changes in Fulton indices with infection by *Anguillicola*. Thus, it should be stated here very clearly, that reexamination of the same material as was covered by Dekker, 1987a, by a more extensive analysis technique (as is used here), does not support the conclusion that infection by *Anguillicola* does affect the Fulton index of the host.

Infection of yellow vs. silver eel

Table 3 presents data on samples of yellow eel and silver eel, as far as they have been taken in one and the same water body on (almost) the same time. It should be noted that -because of its migratory behaviour- the origin of the silver eels is rather dubious. Only the samples taken in Loosdrecht are from this origin beyond any doubt.

The results of table 3 show that the incidence rates of *Anguillicola* in yellow and silver eel were nearly equal, except for the 1986 season in the IJsselmeer.

Miscellaneous additional observations

The effect of the introduction of *Anguillicola* into the Netherlands is difficult to assess, since the eel populations would have had their own variations and problems. During 1987 and 1988 fishermen and their organizations claim that all kind of misfortune is caused by *Anguillicola*. In this respect, high winter mortalities are mentioned, but no single case could be verified. High incidences of red disease have been verified in a few water bodies. Direct ruptures of the body wall by *Anguillicola* have been claimed, but again could not be verified. Sharp reductions in fishing yields do occur on the IJsselmeer, but reduced glasseel immigration (Dekker, 1986) and extremely severe overfishing (Dekker, 1987b) are the more conservative and more likely explanations

Discussion

From the observations during 1986 and 1987 in Dutch outdoor waters, the following tentative description of the development of infections of *Anguilla anguilla* by *Anguillicola* emerges:

After a first infection, only a low fraction of the population is infected, with only a small number of parasites per infected eel (IJsselmeer, may 1986; southern Frisian lakes). The number of parasites per infected eel gradually rises to around 10, while the incidence rate reaches nearly 100 % after at least one year (IJsselmeer 1986). In the next stage, the swimbladders become thickened and 'collapse', (Lauwersmeer, May 1987; IJsselmeer, August 1987) resulting in more and more infected eels without reproducing *Anguillicola*, and (as a consequence?) newly immigrating eels become less infected, resulting in increasing fractions of uninfected eels (Lauwersmeer, 1987). At this moment, it is difficult to foresee, whether *Anguillicola* will drop down to very low incidences in the coming years, or will stabilize at moderate levels or will reappear in some years in high frequencies, nor whether most eels will obtain 'collapsed swimbladders' either by gradual infections or by sudden outbreaks.

The effect of *Anguillicola* on the condition of *Anguilla anguilla* and *Anguilla japonica* in culture systems has been studied intensively. In *Anguilla anguilla* growth retardations, severe wounds, secondary infections and high mortality have been reported (Liewes and Schaminee-Main, 1987). In outdoor waters, the effect of *Anguillicola* is much more difficult to verify. Growth retardation (yield drops), severe wounds (ruptured body walls), secondary infections (red disease) and high winter mortalities have all been claimed, but (at least in the Netherlands) none of these claims have been based on quantitative measurements. The only objective measurement (Fulton indices) indicates not any effect at all, neither of the live parasite, nor of the 'collapsed swimbladder'. Thus, as long as the opposite has not been shown, one is forced to assume that *Anguillicola* does not affect the condition of *Anguilla anguilla* in outdoor waters to a measurable extend.

Finally, the loss of a functional swimbladder should be considered. One can hardly imagine, that a swimbladder filled with parasites and their debris still works adequately, but the inadequacy of the 'collapsed swimbladder' seems beyond any doubt. If this loss would affect the eel negatively in its continental phase, once again one would expect loss of weight, which was shown in the preceding sections not to occur. Thus, only loss of swimbladder functions to the silver eel stage in the oceanic phase seems plausible. Whatever the effect, one can hardly imagine assessing the impact on the population as a whole: speculations on reduced spawning stock biomass of a species whose reproduction has not been resolved (Tucker, 1959, Boëtius & Harding, 1985) is like handling black boxes in the dark.

Summarizing this discussion, it is tentatively stated that after its first introduction in an outdoor water, *Anguillicola* shows a rapid and severe outbreak, which then stabilizes, while it has no serious effect on the continental life stage of the eel, and a speculative and unprovable effect on the oceanic phases.

Literature

-Banning, P.v., Heermans, W., and Willigen, J.A.v., 1985, *Anguillicola crassa*, een nieuwe aalparasiet in Nederlandse wateren. Visserij 38(6-7):237-240.

-Banning, P.v., and Haenen, O.L.M., 1988(in press), Observations on the effect of the swimbladder nematode *Anguillicola crassus* in young eel *Anguilla anguilla*. PAMAQ-symposium, October 1988.

-Boëtius, J., and Harding, E.F., 1985, A re-examination of Johannes Schmidt's Atlantic eel investigations. Dana 4:129-162

-Charleroy, D. de, Thomas, K. and Belpaire, C., 1987, Problems concerning the species determination, biology, and diagnostical methods of *Anguillicola*, a swimbladder nematode in the European eel (*Anguilla anguilla L.*). EIFAC working party on eel, Bristol, April 1987. mimeo.

-Dekker, W., 1986, Regional variation in glasseel catches; an evaluation of multiple sampling sites. Vie et Milieu 36:251-254.

-Dekker, W., 1987a, Short note on the distribution and abundance of *Anguillicola crassa* in the Netherlands. EIFAC working party on eel, Bristol, April 1987. mimeo.

-Dekker, W., 1987b, Preliminary assessment of the IJsselmeer eel fishery based onlength frequency samples. ICES C.M. 1987/M:22.

-Egusa, S., 1979, Notes on the culture of the European eel (*Anguilla anguilla*) in Japanese eel farming ponds. In: Thurow, F., 1979, Eel research and management. Rap. Proc. Verb. Réun. Cons. Int. Exp. Mer 174:51-58.

-Liewes, E.W. and Schaminee-Main, S., 1987, Onderzoek naar de effecten van de parasiet *Anguillicola crassa* op de ontwikkeling van de paling (*Anguilla anguilla*) in een zoutwater palingmesterij. Intern Report Texvis BVC, Den Burg, Tessel, the Netherlands.

-Saroglia, M.G., Fantin, P., and Arlati, G., 1985, Eel production in Italy, problems and perspectives. EIFAC working party on eel, Perpignan, Sept. 1985. mimeo

-Tucker, D.W., 1959, A new solution to the Atlantic eel problem. Nature 183:495-501.

Table 1

Incidence and abundance of *Anguillicola* and incidence of 'collapsed swimbladders' in Lauwersmeer and IJsselmeer.

		IJsselmeer			Lauwersmeer		
year	month	incidence rate *Anguillicola*	'swimbladder collapse' rate	mean number *Anguillicola*	incidence rate *Anguillicola*	'swimbladder collapse' rate	mean number *Anguillicola*
1986	5	0.15	-	1.5			
1986	9	0.40	-	2.5	0.94	-	7.8
1986	11	0.88	-	7.8			
1987	4				0.29	-	9.9
1987	5	0.91	-	6.1	0.48	0.21	8.9
1987	6				0.37	0.15	10.7
1987	7	0.99	0.00	5.8	0.46	0.00‡	13.1
1987	8	0.94	0.04	9.5	0.34	0.34	8.0
1987	9				0.49	0.24	9.3
1987	10	0.91	0.07	11.1	0.58	0.30	9.7
1987	11				0.53	0.25	8.5
1987	12				0.35	0.38	10.6

‡ Due to holidays of the regular staff, probably an erroneous reading.

Table 2

ANOVA of Fulton index of European eel by (Taylor series of) length, month, area, year and infection by *Anguillicola* resp. 'collapsed swimbladders'. Factors were entered into the analysis in the order listed in the table. The factor 'swimbladder' contains both the effect of infections with *Anguillicola* and of a 'collapse' of the swimbladder (see text).

ANOVA of Fulton index				
source	SS	df	MS	F
length	0	1	0.0	0.0
$length^2$	11	1	11.0	3.2
$length^3$	12	1	12.0	3.5
subtotal	23	3	7.7	2.2
month	699	8	87.4	25.2 **
area	14	1	14.0	4.0 *
year	4	1	4.0	1.2
swimbladder	3	2	1.5	0.4
explained	743	15	49.5	14.3 **
unexplained	3975	1148	3.5	
total	4718	1163	4.1	

* $P < 0.05$ ** $P < 0.01$

Table 3

Comparison of the incidence rate of *Anguillicola* in yellow and silver eel.

date	area	yellow eel	silver eel
86/09/11	Lauwersmeer	0.94	
86/10/16	Lauwersmeer		0.88
87/11/05	Lauwersmeer	0.54	0.31
86/10/30	IJsselmeer		0.35
86/11/11	IJsselmeer	0.88	
87/10/07	IJsselmeer	0.91	
87/10/14	IJsselmeer		0.88
87/11/02	Loosdrecht	0.23	0.20

Figure 1

Drawing of a healthy swimbladder of *Anguilla anguilla*, a swimbladder with a severe infection of *Anguillicola*, and a so-called 'collapsed swimbladder'; see text

Figure 2

Distribution and incidence rate of *Anguillicola* in the Netherlands in 1986.