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THE STATUS OF THE ALIEN AMPHIPOD *GAMMARUS TIGRINUS* (SEXTON, 1939) IN FRIESLAND TWENTY FIVE YEARS AFTER ITS INTRODUCTION INTO THE NETHERLANDS

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ABSTRACT

A comparison is made between the abundance in 1985 and in previous surveys of the amphipod *Gammarus tigrinus* in the province of Friesland (in the north of the Netherlands). The decline noticed in the last survey is discussed.

INTRODUCTION

Gammarus tigrinus was first recorded in the Netherlands in 1960 (Nijssen & Stock, 1966) and subsequently spread into large areas of the country (Dennert et al, 1968; Gras, 1971; Lourens, 1972). During this spread it replaced either completely or to a large extent the indigenous gammarid fauna (Chambers, 1973). These successes were attributed to a combination of rapid growth rate, early onset of sexual maturity and high fecundity when compared to native gammarids (Chambers, 1977a).

The objective of this study was to assess the present status of *G. tigrinus* in Friesland by resampling localities studied in 1969 and 1970. The status was assessed both by surveying its distribution within Friesland and by estimating its densities within individual lakes.

METHODS

All samples were taken in mid-August 1985. The numbers of *G. tigrinus* in the littoral reed beds were estimated by enclosing 0.25 m^2 of the reed bed within an aluminium circular cylinder, cutting out the reeds to substrate level and stirring and sieving the enclosed water column until all fauna were removed. In the Tjeukemeer a transect of paired samples was taken from the same reed bed studied previously (Chambers, 1977a). In the other lakes one sample was taken from each lake from reed beds which appeared to provide a suitable habitat for *G. tigrinus* i.e. well aerated water without heavy accumulations of rotting detritus. Depths were recorded at all sam-

pling points and oxygen contents in the Tjeukemeer in addition.

RESULTS AND DISCUSSION

The sampling results from Tjeukemeer are in Table I and from the other Friesian lakes in Table II. No other amphipods were found during this survey.

In no localities was *G. tigrinus* abundant compared to 1969 and 1970 densities. In Tjeukemeer the maximum density recorded was 54/m^2, whilst overall the highest recorded was 76/m^2 from Grote Gaastmeer. In the same Tjeukemeer reed bed in mid-August 1970 a density of 14,776/m^2 was recorded (Chambers, 1977a). It thus appeared that the number of *G. tigrinus* had declined by more than 99% between 1970 and 1985. During the present study several other Tjeukemeer reed beds and shallow water habitats were sampled e.g. stony shores, but in all instances *G. tigrinus* was sparse or absent. The detailed situation recorded from the reed bed was therefore typical of the entire lake.

In the 1985 survey of the Friesian lakes *G. tigrinus* was also sparse or absent, as in Tjeukemeer. In the 1970 survey of these lakes (Chambers, 1973) densities were generally similar to those in Tjeukemeer except for Idzegaaster Poel in which *G. tigrinus* was then scarce and Schuttel Poel, from which it was apparently then, as now, absent. There is little doubt then that the decline has occurred throughout the whole of Friesland and is not confined to any particular locality.

The decline may have already happened by the early 1970's. Heermans (1978) noted that *G. tigrinus* in the IJsselmeer appeared less common from 1973-1976 than formerly, and was absent from some localities. He suggested the apparent decrease may have been due to increasing accumulations of organic matter causing oxygen depletion of the water. *G. tigrinus* prefers well aerated water and is absent from places with low oxygen levels. On the other hand Pinkster et al. (1980) attributed the decline to the severe winter of 1978-79. De Nie (in press) found low numbers of *G. tigrinus* in Tjeukemeer in 1979 and 1980 although his samples were taken at times of the year when populations would in any case be likely to be low. It does appear though that the Tjeukemeer decline had occurred by at least 1979. The lack of quantitative samples from 1971 to 1978 makes it difficult to say when the decline occurred.

Pinkster & Platvoet (1983) recorded that by 1981 *G. tigrinus* had reoccupied virtually every locality from which it was absent following the 1978-79 winter, and was again the dominant amphipod in Friesland. However their survey did not include quantitative estimates of abundance and it is not clear if numbers were low or high in 1981.

From the available data therefore it appears that *G. tigrinus* is now more or less widespread as ever, but that its numbers are severely depleted. Similarly it does not appear to have been replaced in abundance by any species, gammarid or other types. These findings seem to indicate that some major changes have occurred in the freshwater habitats of Friesland as the reproductive potential of *G. tigrinus* is so great that it could increase its numbers to their former high levels very quickly if environmental conditions so permitted. There are no detailed studies to show the total of changes that may have occurred, although De Haan & Moet (1984) documented the steadily increasing eutrophication of Tjeukemeer from 1968-1982. This resulted in increased levels of phosphate, nitrogen and chlorophyll-*a*. Presumably other factors such as organic matter production and oxygen regimes were also affected. But without detailed knowledge of all changes and without information as to how any observed changes may affect *G. tigrinus* it is impossible to say precisely why numbers are currently so low.

During the present study further differences in the Tjeukemeer system were also noted when compared to 1970. Firstly the beds of *Potamogeton* sp. were absent. According to De Nie (in press) these disappeared in the early 1970's. This may have been due to the increased eutrophication of the lake and its associated lessening of water clarity.

Finally the distribution and occurrence of *Asellus aquaticus* and *A. meridianus* had altered. In 1970 both species were virtually confined to the low oxy-

gen environments of the inner sections of sheltered reed beds (Chambers, 1977b). In 1985 both were abundant on wave-washed shores, a habitat occupied in 1970 by *G. tigrinus.* Similarly the ratio between the two species had altered. In mid-August 1970, *A. meridianus* was about twice as abundant as *A. aquaticus.* In 1985 the latter comprised 83% of the mixed populations. These data then support Redeke's (1948) contention that *A. aquaticus* will, in mixed populations, always outnumber *A. meridianus* and that the former may be replacing the latter as predicted by Moon (1968).

From the observations presented here it is clear that many changes have occurred in Tjeukemeer in the last 15 years. Further monitoring is required to see how the situation develops in the future.

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Table I. Densities of Gammarus tigrinus in the Tjeukemeer reed bed, 13th August 1985.

Sampling station and time	Depth (cm)	Temperature (°C)	Oxygen (mg/l)	Numbers of *G. tigrinus* (/m^2)
3.8 m from shore, *Phragmites-Typha* dense and co-dominant. Sandy substrate, much detritus. 09.30 h.	26	16.4	2.4 (surface) 1.2 (bottom)	0
12 m from shore, *Phragmites* dominant. Sandy substrate, less detritus. 11.00 h.	40	17.3	8.0 (surface and bottom)	54
16 m from shore, *Phragmites* dominant. Sandy substrate, little detritus. 12.15 h.	48	18.3	8.3 (surface and bottom)	42

Table II. Densities of *Gammarus tigrinus* in Friesian lakes on 15th August 1985 compared with densities in 1970

Lake	Numbers of *G. tigrinus* in 1985 (/m^2)	Numbers of *G. tigrinus* in 1970
Fluessen	20	Abundant
Grote Gastmeer	76	Abundant
Heegermeer	24	Common
Idzegaaster Poel	0	Scarce
Langweerder Wielen	0	Abundant
Oude Gaaster Brekken	44	Common
Schuttel Poel	0	Absent
Slotermeer	0	Abundant

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