

Population dynamics of *Melanoides tuberculata* (Müller) (Gastropoda: Prosobranchia: Thiaridae) near a cooling water discharge in the Twenthe Canal (The Netherlands)

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The occurrence of the (sub-)tropical freshwater snail *Melanoides tuberculata* (Müller) in a canal in the eastern part of The Netherlands was monitored during the period August 1992-September 1993. The species lives in a cooling water discharge plume which appears to be a good refugium for this thermophile organism. After winter, density had decreased considerably; however, the species did not become extinct. From shell length/frequency distributions, two to three cohorts could be distinguished, depending on the sampling period.

Key words: Gastropoda, Prosobranchia, Thiaridae, *Melanoides tuberculata*, distribution, alien species, population studies.

INTRODUCTION

The prosobranch snail *Melanoides tuberculata* (Müller, 1774) (fig. 1) is a common viviparous fresh- and brackish water species of tropical and subtropical origin. A description of the shell and the anatomy is given by Yousif (1975). It is a deposit-feeder (Dudgeon & Yipp, 1985), and is known to live in sediments with a grain size <125 µm (Dudgeon, 1982).

The species occurs from North Africa to southern China, in Southeast Asia, North Australia and western Polynesia (Berry & Kadri, 1974; Brandt, 1974). In tropical regions *M. tuberculata* is found in lentic and lotic habitats in which different species of thiarids may comprise a significant proportion of the benthic biomass (Dudgeon, 1983). In Europe, recently introduced populations are known from two locations in Spain (Gasull, 1974; Escobar et al., 1990). Records from The Netherlands are only known from hot-houses in Leiden and Utrecht. In both cases the animals were considered to be descendants of four specimens, accidentally imported in aquaria with tropical fish species in 1933 (Meeuse & Hubert, 1949). Nothing is known about the presence of a population of *M. tuberculata* outside the protected environment of hot-houses in The Netherlands. In this paper, the first observations of a population of *M. tuberculata* outside hot-houses are described. The species was found in a cooling water discharge plume in the Twenthe Canal in the vicinity of Hengelo (province of Overijssel). Specimens of *M. tuberculata* collected on August 26, 1992, were deposited in the Zoölogisch Museum, Amsterdam, The Netherlands.

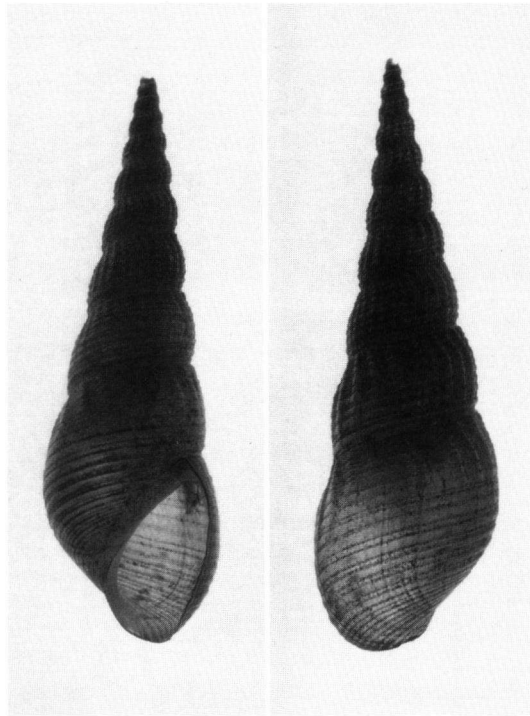


Fig. 1. Illustration of the shell of *M. tuberculata*. Shell length 28 mm.

METHODS

Bottom samples were taken with a Birge-Ekman grab (sampling surface 225 cm²), and immediately washed on a sieve with a mesh size of 0.5 mm. Then the residue on the sieve was collected and preserved either in ethanol 70% or frozen at -18°C. Shell length was measured to the nearest 1 mm. Embryos were measured to the nearest 0.1 mm with a stereo-microscope provided with an ocular micrometer. Particle size of bottom samples was analyzed by sieving dried samples. Probability paper was used to distinguish cohorts in the sampled population (Harding, 1949; Tanaka, 1962).

SAMPLING AREA

Samples were taken in a 1 km long section of the Twenthe canal, between the Boecklose bridge and the lock east of this bridge, in the vicinity of Hengelo (fig. 2). Sampling locations (fig. 2) were situated opposite one of the hotwater discharges of a chemical plant (AKZO Chemicals). The top layer of the canal bottom mainly consisted of fine and medium sand (table 1). Water quality data in this canal section are summarized in table 2 (unpublished data of the Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling RIZA).

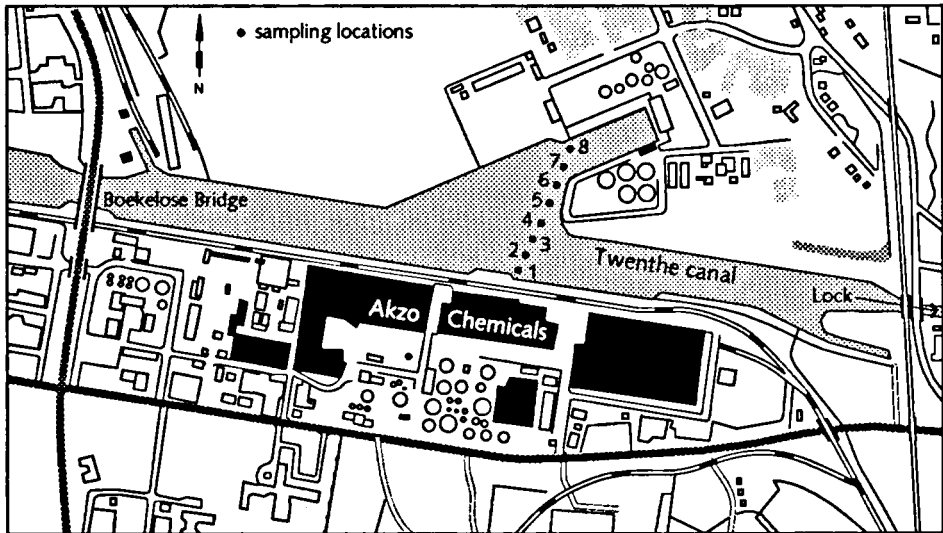


Fig. 2. Sampling locations in the Twenthe Canal.

RESULTS AND DISCUSSION

On August 26, 1992, the thiarid *Melanoides tuberculata* was found by chance opposite a cooling water discharge point of a chemical plant in the Twenthe Canal in the vicinity of Hengelo. In a bottom sample 526 live animals were found. The maximum shell length of the animals collected was 31 mm. The length is comparable with the maximum shell length of Malaysian and Hong Kong populations, being 34 and 31 mm respectively (Berry & Kadri, 1974; Dudgeon, 1986).

Resampling of the population took place on November 26, 1992, in a gradient from the cooling water discharge point (locations 1-8 in fig. 2). Outside the area influenced by the cooling water discharges of the chemical plant no specimens of *M. tuberculata* were observed in that month (unpublished data of Rijkswaterstaat, regionale directie Overijssel).

After the winter period, on March 10, 1993, and later, on September 3, 1993, the same locations were sampled again. On each location one bottom sample was taken on the successive sampling days. The results of the three samplings are summarized in table 3. Highest numbers of *M. tuberculata* were found along the canal bank opposite the discharge point on November 26, 1992, and September 3, 1993. On March 10, 1993, after the winter period, no live specimens of *M. tuberculata* were found in the bottom samples. Only empty shells were observed. In the area along the canal bank opposite the discharge point the highest number of empty shells was found on that sampling day as well. However, on September 3, 1993, live adult and juvenile specimens were found once more in relatively small amounts.

grain size (mm)	%	st. dev.
4 - 8	< 1.0	
2 - 4	< 1.0	
1 - 2	2.4	1.1
0.5 - 1	11.3	3.3
0.25 - 0.5	23.3	6.1
0.125 - 0.25	26.1	4.9
0.063 - 0.125	15.6	2.6
< 0.063	18.8	4.8

Table 1. Grain size of the top layer of the canal bottom. Percentage given are the average values of eight samples (from each location one).

Parameter	Value		Quantity	Frequency ¹
	max.	min.		
pH	7.3	9.2		m
Conductivity	58	41	mS/m	m
Ammonium	0.5	0.05	mg N/l	m
Nitrite	0.3	0.05	mg N/l	m
Nitrate	12.4	0.6	mg N/l	m
Phosphate	80	5	µg P/l	m
Sulphate	67	56	mg/l	m
Silicium	5.3	0.05	mg/l	m
Cadmium	<0.1	<0.1	µg/l	b
Chromium	1.0	0.3	µg/l	b
Copper	9	4	µg/l	b
Lead	<1	<1	µg/l	b
Mercury	0.05	<0.03	µg/l	b
Zinc	39	10	µg/l	b

¹ m = monthly; b = bimonthly.

Table 2. Water quality data of the Twenthe Canal section in the vicinity of Hengelo in 1992 (unpublished data of the Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling RIZA).

Location		Nov. 26, 1992		March 10, 1993		Sept. 3, 1993	
Number	Depth (m)	N	°C	N	°C	N	°C
1	1.5-2	100	27	0	28	0	29.5
2	4-5	14	21.5	0	23.5	0	26.5
3	4-5	154	21	0	23	0	26.5
4	1.5-2	1247	20.5	0	23	15	26.5
5	1.5-2	513	20	0	23	31	26
6	1.5-2	524	20	0	23.5	6	26
7	4-5	17	19.5	0	23	0	26
8	3-4	0	19.5	0	22.5	0	26
uninfluenced location			13		13		18

Table 3. Number of live specimens of *M. tuberculata* (N) per bottom sample (225 cm²) from the Twenthe Canal on three successive sampling dates, and the measured water temperature (for location number see fig. 1).

Regular disruption of the canal bottom by shipping is suspected to be the main factor causing the absence of animals in the deeper parts of the canal since water temperature was nearly the same on all locations, with the exception of location 1. On this location water temperature is not only much higher, but water quality is also strongly influenced by the cooling water. With the exception of location 1, water temperature in the gradient sampled varied only 1-2°C, and was about 7-10°C higher than in the uninfluenced water in the canal (table 3). No interruptions in the cooling water discharge of the chemical plant occurred between August 1992 and September 1993. Therefore, mortality of *M. tuberculata* during the winter of 1992/93 was not affected by this phenomenon.

The observation of specimens of *M. tuberculata* in September 1993 underlines the refugium function of cooling water discharge points for thermophile organisms.

At location 1 water quality is probably the main factor for the absence of *M. tuberculata*. Every eight hours, the water intake pumps are chlorinated for half an hour, leading to a calculated maximum chlorine concentration of 1.5-2.0 mg/l OCl⁻ at the outlet. At this concentration, effects on molluscs are to be expected. Jenner (1985) observed >90% mortality of juvenile zebra mussels (*Dreissena polymorpha* Pallas, 1771) after 11 and 26 days at water temperatures of 8-11°C and 13-18°C respectively, with continuous chlorination at a level of 0.4 mg/l OCl⁻. In situ measured oxygen concentration on the different sampling days and locations was never lower than 70% saturation.

From shell length/frequency distributions, two to three cohorts could be distinguished (table 4). Although juvenile specimens of *M. tuberculata* were observed in August and September (table 4), the main recruitment period of the Twenthe Canal population is probably autumn, since shell length of the first cohort in November 1992 was <6 mm. In that month 9% of the animals was <6 mm.

Relatively high standard deviations of average shell length of the cohorts distinguished can be explained by the long recruitment period of the juveniles. Dudgeon

Sampling date	Average shell length (mm)			n	range (mm)
	Cohort I	Cohort II	Cohort III		
26 Aug. 1992	11.8 (4.4)	23.8 (3.2)		526	3-31
26 Nov. 1992	<6	12.7 (2.7)	25.8 (2.6)	617	3-30
10 March 1993	only dead animals found				
03 Sept. 1993	9.0 (2.9)	>20		71	5-21

Table 4. Average shell length of *M. tuberculata* cohorts distinguished in the samples taken (between brackets s.d.; n is number of animals measured), and shell length range of the specimens measured.

(1989) observed a recruitment period of about 4-5 months (June-October) for a Hong Kong population, but in that region hatchlings occur in the population in the period May-January (Dugeon, 1986). In the literature (Berry & Kadri, 1974; Dudgeon, 1986) a shell length of 2.2-3.4 mm is given for the hatchlings. The smallest size of the juvenile animals observed in the Twenthe Canal was 3 mm (± 0.5 mm). However, maximum shell length observed of the embryos in the brood pouch was 4.1 mm. Embryos were found in animals with shell length of >17 mm.

From the observations in the Twenthe Canal it is impossible to calculate growth rate or to make any statements on the age of the largest specimens. Most of the animals in tropical or subtropical populations do not live longer than one year in their natural environment. The maximum life span amounted to 2-2.5 years for a Hong Kong population (Dudgeon, 1986) and >3.5 years for a Malaysian population (Berry & Kadri, 1974).

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SAMENVATTING

Het voorkomen van de (sub-)tropische zoetwaterslak *Melanoides tuberculata* (Müller) in het Twenthekanaal ter hoogte van Hengelo, is gevolgd in de periode augustus 1992-september 1993. De soort werd aangetroffen in een koelwaterpluim van een chemische fabriek. Vóór de winter van 1992-1993 werden op sommige bemonsteringslokaties relatief hoge dichtheden aangetroffen, in maart 1993 echter uitsluitend dode exemplaren of lege schelpen. Tijdens de laatste bemonstering, in september 1993, werden op een drietal lokaties opnieuw levende exemplaren aangetroffen, zij het in relatief lage aantallen. Dat wijst erop dat het koelwaterlozingspunt in de winterperiode als refugium fungeert voor de thermofiele *M. tuberculata*.